Volume 1

# BRUNNER & SUDDARTH'S Textbook of Medical-Surgical Nursing

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Janice L. Hinkle
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# BRUNNER & SUDDARTH'S Textbook of Medical-Surgical Nursing

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# PREFACE

The first edition of *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* was published in 1964 under the leadership of Lillian Sholtis Brunner and Doris Smith Suddarth. Lillian and Doris pioneered a medical-surgical nursing textbook that has become a classic. Medical-surgical nursing has come a long way since 1964 but continues to be strongly influenced by the expansion of science, medicine, surgery, and technology, as well as a myriad of social, cultural, economic, and environmental changes throughout the world. Nurses must be particularly skilled in critical thinking and clinical decision-making as well as in consulting and collaborating with other members of the multidisciplinary health care team.

Along with the challenges that today's nurses confront, there are many opportunities to provide skilled, compassionate nursing care in a variety of health care settings, for patients in the various stages of illness, and for patients across the age continuum. At the same time, there are significant opportunities for fostering health promotion activities for individuals and groups; this is an integral part of providing nursing care.

Continuing the tradition of Lillian's and Doris's first edition, this 12th edition of *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* is designed to assist nurses in preparing for their roles and responsibilities within the complex health care delivery system. A goal of the textbook is to provide balanced attention to the art and science of adult medical-surgical nursing. The textbook focuses on physiologic, pathophysiologic, and psychosocial concepts as they relate to nursing care, and emphasis is placed on integrating a variety of concepts from other disciplines such as nutrition, pharmacology, and gerontology. Content relative to health care needs of people with disabilities, nursing research findings, ethical considerations, and evidence-based practice has been expanded to provide opportunities for the nurse to refine clinical decision-making skills.

## Organization

*Brunner & Suddarth's Textbook of Medical-Surgical Nursing*, 12th edition, is organized into 16 units. Units 1 through 4 cover core concepts related to medical-surgical nursing practice. Units 5 through 16 discuss adult health conditions that are treated medically or surgically. Each unit covering adult health conditions is structured in the following way, to facilitate understanding:

- The first chapter in the unit covers assessment and includes a review of normal anatomy and physiology of the body system being discussed.
- The subsequent chapters in the unit cover management of specific disorders. Pathophysiology, clinical manifestations, assessment and diagnostic findings, medical management, and nursing management are presented. Special "Nursing Process" sections, provided for selected conditions, clarify and expand on the nurse's role in caring for patients with these conditions.

## Features

### Practice-Oriented Features

Nurses assume many different roles when caring for patients. Many of the features in this textbook have been developed to help nurses fulfill these varied roles.

**The Nurse as Practitioner**

One of the central roles of the nurse is to provide holistic care to patients and their families, both independently and through collaboration with other health care professionals. Many features in *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* are designed to assist students with clinical practice.

***Nursing Process sections.*** The nursing process is the basis for all nursing practice. Special sections throughout the text, organized according to the nursing process framework, clarify the nurse's responsibilities in caring for patients with selected disorders.

***Plans of Nursing Care.*** These plans, provided for selected disorders, illustrate how the nursing process is applied to meet the person's health care and nursing needs.

***Applying Concepts from NANDA, NIC, and NOC.*** Each unit begins with a case study and a chart presenting examples of NANDA, NIC, and NOC terminologies related to the case study. Concept maps, which provide a visual representation of the NANDA, NIC, and NOC chart for each case study, are found on the accompanying Web site thePoint to this book at thepoint.lww.com/Smeltzer12e. This feature introduces the student to the NIC and NOC language and classifications and brings them to life in graphic form.

***Assessment charts.*** These charts help to focus the student's attention on data that should be collected as part of the assessment step of the nursing process.

***Risk Factor charts.*** These charts draw the student's attention to factors that can impair health.

***Guidelines charts.*** These charts review key nursing interventions, and the rationales for those interventions, for specific patient care situations.

***Pharmacology charts and tables.*** Pharmacology charts and tables remind the student of important considerations relative to administering medications and monitoring drug therapy.

***Nursing Alerts.*** These special sections offer brief tips for clinical practice and red-flag warnings to help students avoid common mistakes.

***Critical Care.*** These special sections highlight nursing process considerations for the critically ill patient.

***Gerontologic Considerations.*** In the United States, older adults comprise the fastest-growing segment of the population. This icon is applied to headings, charts, and tables as appropriate to highlight information that pertains specifically to the care of the older adult patient.

***Genetics in Nursing Practice charts.*** These charts summarize and highlight the role that genetics play in many disorders.

***Physiology/Pathophysiology figures.*** These illustrations and algorithms help students to understand normal physiologic and pathophysiologic processes.

### The Nurse as Educator

Health education is a primary responsibility of the nursing profession. Nursing care is directed toward promoting, maintaining, and restoring health; preventing illness; and helping patients and families adapt to the residual effects of illness. Teaching, in the form of patient education and health promotion, is central to all of these nursing activities.

***Patient Education charts.*** These charts help the nurse to prepare the patient and family for procedures, assist them with understanding the patient's condition, and explain to them how to provide for self-care after discharge from the health care facility.

***Home Care checklists.*** These checklists review points that should be covered as part of patient education prior to discharge from the health care facility.

***Health Promotion charts.*** These charts review important points that the nurse should discuss with the patient to prevent common health problems from developing.

### The Nurse as Patient Advocate

Nurses advocate for patients by protecting their rights (including the right to health care) and assisting patients and their families to make informed decisions about health care.

***Ethics and Related Issues charts.*** These charts present a scenario, a description of potential ethical dilemmas that could arise as a result of the scenario, and a list of questions about the scenario to stimulate thought and discussion.

### The Nurse as Researcher

Nurses identify potential research problems and questions to increase nursing knowledge and improve patient care. Use and evaluation of research findings in nursing practice are essential to further the science of nursing.

***Nursing Research Profiles.*** These charts identify the implications and applications of nursing research findings for nursing practice.

EBP ***Evidence-Based Practice (EBP) questions.*** This icon appears next to critical thinking exercises that encourage the student to think about the evidence base for specific nursing interventions. A journals supplement offers students free online access to over 70 journal articles that relate to the evidence-based practice questions in the text.

### *Pedagogical Features*

***Learning Objectives.*** Each chapter begins with a list of learning objectives. These give the student an overview of the chapter and help to focus his or her reading.

***Glossaries.*** Glossaries provided at the beginning of each chapter let the student review vocabulary words before reading the chapter, and also serve as a useful reference tool while reading.

***Critical Thinking Exercises.*** These questions, which appear at the end of each chapter, foster critical thinking by challenging the student to apply textbook knowledge to clinical scenarios.

***References and Selected Readings.*** A list of current references cited is given at the end of each chapter.

***Resources.*** A resource list at the end of each chapter directs the reader to sources of additional information, Web sites, agencies, and patient education materials.

## A Comprehensive Package for Teaching and Learning

To further facilitate teaching and learning, a carefully designed ancillary package is available. In addition to the usual print resources, we are pleased to present multimedia tools that have been developed in conjunction with the text.

### *Resources for Students*

***Interactive DVD-ROM.*** Packaged with the textbook at no additional charge, this DVD helps students test their knowledge and enhance their understanding of medical-surgical nursing. This DVD includes:

- More than 700 study questions organized by unit
- 3,500 NCLEX-style cross-disciplinary questions
- Concepts in Action™ Animations
- Nursing in Action™ Videos
- Clinical Simulations
- Spanish-English Audioglossary
- Drug Monographs
- Other Learning Tools

***Study Guide to Accompany Smeltzer, Bare, Hinkle & Cheever: Brunner & Suddarth's Textbook of Medical-Surgical Nursing, 12th edition.*** Available at student bookstores or at www.LWW.com, this study guide presents a variety of exercises to reinforce the textbook content and enhance learning.

***Handbook to Accompany Smeltzer, Bare, Hinkle & Cheever: Brunner & Suddarth's Textbook of Medical-Surgical Nursing, 12th edition.*** Available at student bookstores or at www.LWW.com, this clinical reference presents need-to-know information on nearly 200 commonly encountered disorders in an easy-to-use alphabetized outline format.

### *Resources for Instructors*

***Instructor's Resource DVD-ROM.*** The instructor's resource DVD contains the following items:

- A thoroughly revised and augmented test generator, containing more than 2,000 NCLEX-style questions
- Sample syllabi for one-, two-, and three-semester courses
- Strategies for effective teaching
- PowerPoint™ lectures, guided lecture notes, and pre-lecture quizzes
- An image bank
- Discussion topics and assignments

### *Resources for Students and Instructors*

**ThePoint*** (thepoint.lww.com) Students and instructors can visit thePoint to access supplemental multimedia resources to enhance their learning.

It is with pleasure that we introduce these resources—the textbook and the ancillary package—to you. One of our primary goals in creating these resources has been to help nurses and nursing students provide quality care to patients and families across health care settings and in the home. We hope that we have succeeded in that goal, and we welcome feedback from our readers.

*thePoint is a trademark of Wolters Kluwer Health.

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unit 1

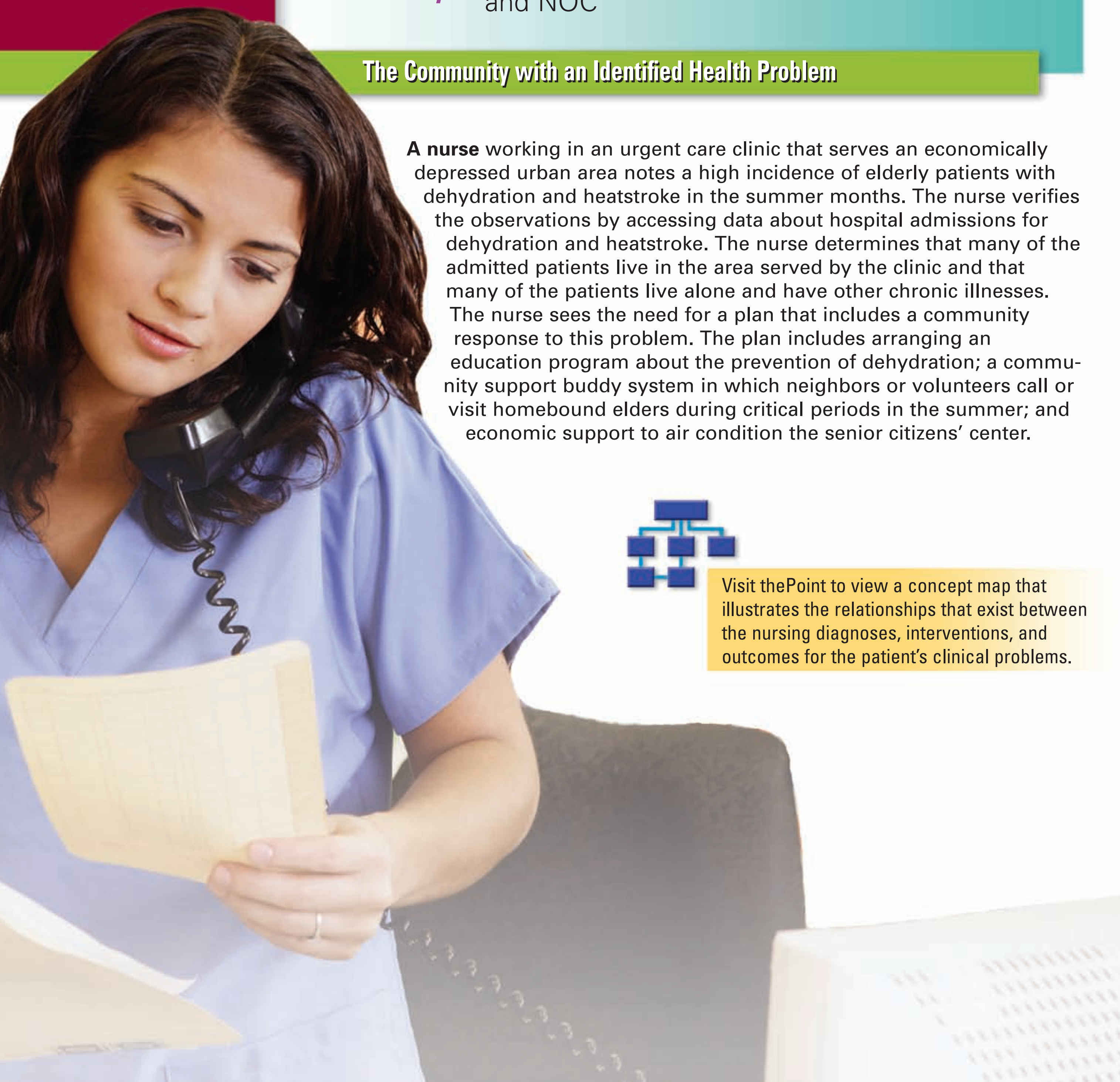
# Basic Concepts in Nursing

## Case Study • Applying Concepts from NANDA, NIC, and NOC

### The Community with an Identified Health Problem

**A nurse** working in an urgent care clinic that serves an economically depressed urban area notes a high incidence of elderly patients with dehydration and heatstroke in the summer months. The nurse verifies the observations by accessing data about hospital admissions for dehydration and heatstroke. The nurse determines that many of the admitted patients live in the area served by the clinic and that many of the patients live alone and have other chronic illnesses. The nurse sees the need for a plan that includes a community response to this problem. The plan includes arranging an education program about the prevention of dehydration; a community support buddy system in which neighbors or volunteers call or visit homebound elders during critical periods in the summer; and economic support to air condition the senior citizens' center.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.



# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **INEFFECTIVE COMMUNITY THERAPEUTIC REGIMEN MANAGEMENT—** Pattern of regulating and integrating into community processes programs for treatment of illness and the sequelae of illness that are unsatisfactory for meeting health-related goals | **COMMUNITY HEALTH DEVELOPMENT—**Assisting members of a community to identify a community's health concerns, mobilize resources, and implement solutions<br>**PROGRAM DEVELOPMENT—** Planning, implementing, and evaluating a coordinated set of activities designed to enhance wellness, or to prevent, reduce or eliminate one or more health problems for a group or community | **COMMUNITY COMPETENCE—** Capacity of a community to collectively problem solve to achieve community goals |
| **INEFFECTIVE COMMUNITY COPING—** Pattern of community activities (for adaptation and problem solving) that is unsatisfactory for meeting the demands or needs of the community | **SURVEILLANCE: COMMUNITY—** Purposeful and ongoing acquisition, interpretation, and synthesis of data for decision making in the community | **COMMUNITY HEALTH STATUS—**The general state of well-being of a community or population |
| **READINESS FOR ENHANCED COMMUNITY COPING—**Pattern of community activities for adaptation and problem solving that is satisfactory for meeting the demands or needs of the community but can be improved for management of current and future problems/stressors | **ENVIRONMENTAL RISK PROTECTION—**Preventing and detecting disease and injury in populations at risk from environmental hazards | |


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# Health Care Delivery and Nursing Practice

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Define health and wellness.
2. Describe factors causing significant changes in the health care delivery system and their impact on health care and the nursing profession.
3. Describe the practitioner, leadership, and research roles of nurses.
4. Describe nursing care delivery models.
5. Discuss expanded nursing roles.

## GLOSSARY

**Advanced Practice Nurse (APN):** a title which encompasses the nurse practitioners (NPs), clinical nurse specialists (CNSs), certified nurse midwives (CNMs) and certified registered nurse anesthetists (CRNAs).

**Collaborative practice model:** involves nurses, physicians, and ancillary health personnel functioning within a decentralized organizational structure and collaboratively making clinical decisions.

**Community-oriented nursing practice:** nursing intervention that promotes wellness, reduces the spread of illness, and improves the health status of groups of citizens or the community at large with emphasis on primary, secondary, and tertiary prevention.

**Continuous quality improvement (CQI):** the ongoing examination of processes used to provide care, with the aim of improving quality by assessing and improving those processes that might improve patient care outcomes and patient satisfaction.

**Health–illness continuum:** description of a person's health status as a range with anchors that include poor health or imminent death on one end of the continuum to high-level wellness on the other end.

Health care in the United States has undergone changes over the years as society has continued to change. Nursing, as a health care profession and a major component of the health care system, has been significantly affected by these changes. Nursing has played an important role in the health care system and will continue to do so.

# The Health Care Industry and the Nursing Profession

## Nursing Defined

Since the time of Florence Nightingale, who wrote in 1858 that the goal of nursing was "to put the patient in the best condition for nature to act upon him," nursing leaders have described nursing as both an art and a science. However, the definition of nursing has evolved over time. In its Social Policy Statement (2003), the American Nurses Association (ANA) defined nursing as the diagnosis and treatment of human responses to health and illness. The ANA identifies the following phenomena as the focus for nursing care and research:

- Self-care processes
- Physiologic and pathophysiologic processes such as rest, sleep, respiration, circulation, reproduction, activity, nutrition, elimination, skin, sexuality, and communication
- Comfort, pain, and discomfort
- Emotions related to health and illness
- Meanings ascribed to health and illnesses
- Decision making and ability to make choices
- Perceptual orientations such as self-image and control over one's body and environments
- Transitions across the lifespan, such as birth, growth, development, and death
- Affiliative relationships, including freedom from oppression and abuse
- Environmental systems

Nurses have a responsibility to carry out their role as described in the Social Policy Statement to comply with the nurse practice act of the state in which they practice, and to comply with the Code of Ethics for Nurses as spelled out by the ANA (2001) and the International Council of Nurses (ICN, 2006). To have a foundation for examining the delivery of nursing care, it is necessary to understand the needs of health care consumers and the health care delivery system, including the forces that affect nursing and health care delivery.

## The Patient/Client: Consumer of Nursing and Health Care

The central figure in health care services is, of course, the patient. The term *patient,* which is derived from a Latin verb meaning "to suffer," has traditionally been used to describe a person who is a recipient of care. The connotation commonly attached to the word is one of dependence. For this reason, many nurses prefer to use the term *client,* which is derived from a Latin verb meaning "to lean," connoting alliance and interdependence. The term *patient* is used throughout this book, with the understanding that either term is acceptable.

The patient who seeks care for a health problem or problems (increasing numbers of people have multiple health problems) is also an individual person, a member of a family, and a citizen of the community. Patients' needs vary depending on their problems, associated circumstances, and past experiences. Many patients, who as consumers of health care have become more knowledgeable about health care options, are assuming a collaborative approach with the nurse in the quest for optimal health (Hakesley-Brown & Malone, 2007). Among the nurse's important functions in health care delivery are identifying the patient's immediate needs and working in concert with the patient to address them.

### The Patient's Basic Needs

Certain needs are basic to all people. Some of these needs are more important than others. Once an essential need is met, people often experience a need on a higher level of priority. Addressing needs by priority reflects Maslow's hierarchy of needs (Fig. 1-1).

### Maslow's Hierarchy

Maslow ranked human needs as follows: physiologic needs; safety and security; sense of belonging and affection; esteem and self-respect; and self-actualization, which includes self-fulfillment, desire to know and understand, and aesthetic needs. Lower-level needs always remain, but a person's ability to pursue higher-level needs indicates movement toward psychological health and well-being. Such a hierarchy of needs is a useful framework that can be applied to the various nursing models for assessment of a patient's strengths, limitations, and need for nursing interventions.

## Health Care in Transition

Changes occurring in health care delivery and nursing are the result of societal, economic, technologic, scientific, and political forces that have evolved throughout the 20th and

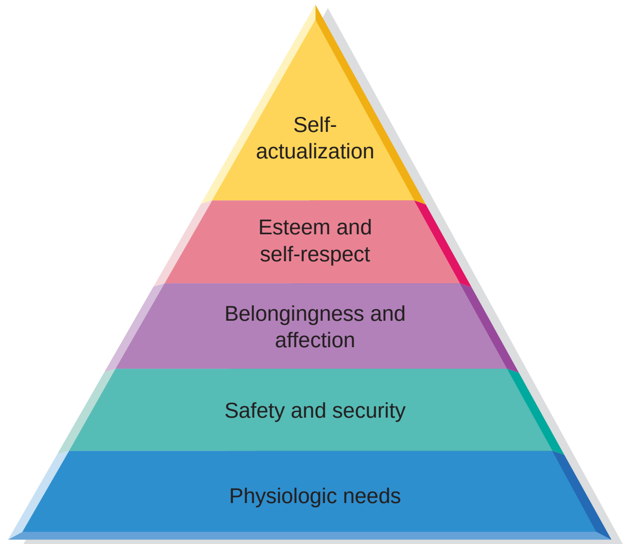



**Figure 1-1** This scheme of Maslow's hierarchy of human needs shows how a person moves from fulfillment of basic needs to higher levels of needs, with the ultimate goal being integrated human functioning and health.

21st centuries. Among the most significant changes are shifts in population demographics, particularly the increase in the aging population and the cultural diversity of the population; changing patterns of diseases; increased technology; increased consumer expectations; higher costs of health care and changes in health care financing; and other health care reform efforts. These changes have led to institutional restructuring, staff reduction and cross-training, increased outpatient care services, decreased lengths of hospital stay, and increased health care in community and home settings. Such changes have dramatically influenced where nurses practice. These changes have influenced society's view of health and illness and affected the focus of nursing and health care.

As the proportion of the population reaching age 65 years has increased, and with the shift from acute illnesses to chronic illnesses, the traditional disease management and care focus of the health care professions has expanded. There is increasing concern about emerging infectious diseases, trauma, obesity, and bioterrorism. Thus, health care must focus more on disease prevention, health promotion, and management of chronic conditions and disability than in previous times. This shift in focus coincides with a nationwide emphasis on cost control and resource management directed toward providing safe, cost-efficient and cost-effective health care services to the population as a whole.

## Health, Wellness, and Health Promotion

The health care system in the United States, which traditionally has been disease oriented, is placing increasing emphasis on health and its promotion. Similarly, a significant number of nurses in past decades focused on the care of patients with acute conditions, but now many are directing their efforts toward health promotion and illness prevention.

### Health

How health is perceived depends on how health is defined. The World Health Organization (WHO) defines *health* in the preamble to its constitution as a "state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity" (WHO, 2006 pg. 1). Although this definition of health does not allow for any variation in degrees of wellness or illness, the concept of a health–illness continuum allows for a greater range in describing a person's health status. By viewing health and illness on a continuum, it is possible to consider a person as being neither completely healthy nor completely ill. Instead, a person's state of health is ever-changing and has the potential to range from high-level wellness to extremely poor health and imminent death. Use of the health–illness continuum makes it possible to regard a person as simultaneously possessing degrees of both health and illness. On the **health–illness continuum**, even people with a chronic illness or disability may attain a high level of wellness if they are successful in meeting their health potential within the limits of their chronic illness or disability.

### Wellness

*Wellness* has been defined as being equivalent to health. Wellness involves being proactive and being involved in self-care activities aimed toward a state of physical, psychological, and spiritual well-being (Clark, Stuifbergen, Gottlieb, et al., 2006). Hood and Leddy (2007) consider that wellness has four components: (1) the capacity to perform to the best of one's ability, (2) the ability to adjust and adapt to varying situations, (3) a reported feeling of well-being, and (4) a feeling that "everything is together" and harmonious. With this in mind, it becomes evident that the goal of health care providers is to promote positive changes that are directed toward health and well-being. The sense of wellness has a subjective aspect that addresses the importance of recognizing and responding to patient individuality and diversity in health care and nursing.

### Health Promotion

Today, increasing emphasis is placed on health, health promotion, wellness, and self-care. Health is seen as resulting from a lifestyle oriented toward wellness. The result has been the evolution of a wide range of health promotion strategies, including multiphasic screening, genetic testing, lifetime health monitoring, environmental and mental health programs, risk reduction, and nutrition and health education. A growing interest in self-care skills is reflected by the large number of health-related publications, conferences, and workshops designed for the lay public.

People are increasingly knowledgeable about their health and take more interest in and responsibility for their health and well-being. Organized self-care education programs emphasize health promotion, disease prevention, management of illness, self-care, and judicious use of the professional health care system. In addition, numerous Web sites and chat groups promote sharing of experiences and information about self-care with others who have similar conditions, chronic diseases, or disabling conditions.

Special efforts are being made by health care professionals to reach and motivate members of various cultural and socioeconomic groups about lifestyle and health practices. Stress, unhealthy diet, lack of exercise, smoking, use of illicit drugs, high-risk behaviors (including risky sexual practices), and poor hygiene are all lifestyle behaviors known to affect health negatively. Health care professionals are concerned with encouraging behavior that promotes health. The goal is to motivate people to make improvements in the way they live, to modify risky behaviors, and to adopt healthy behaviors.

## Influences on Health Care Delivery

The health care delivery system is constantly adapting as the population shifts its health care needs and expectations change. The shifting demographics of the population, the increase in chronic illnesses and disability, the greater emphasis on health care costs, and technologic advances have resulted in changing emphases in health care delivery and in nursing.

## Population Demographics

Changes in the population in general are affecting the need for and the delivery of health care. The U.S. Bureau of the Census (2007) estimated that there were more than 303 million people in the country. Population growth is attributed in part to improved public health services and improved nutrition.

Not only is the population increasing, but also its composition is changing. The decline in birth rate and the increase in lifespan due to improved health care have resulted in fewer school-age children and more senior citizens, many of whom are women. Much of the population resides in highly congested urban areas, with a steady migration of members of ethnic minorities to the inner cities and a migration of members of the middle class to suburban areas. The number of homeless people, including entire families, has increased significantly. The population has become more culturally diverse as increasing numbers of people from different national backgrounds enter the country.

Because of population changes, the health care needs of people of specific ages, of women, and of diverse groups of people in specific geographic locations is altering the effectiveness of traditional means of providing health care. As a result, far-reaching changes in the overall health care delivery system are necessary.

### Aging Population

The elderly population in the United States has increased significantly and will continue to grow in future years. In 2003, the 35.9 million adults who were older than 65 years of age constituted 12.4% of the U.S. population (U.S. Bureau of the Census, 2004). By the year 2030, 20% of the U.S. population is expected to be older than 65 years of age. According to the U.S. Bureau of the Census (2000), the number of people 65 to 74 years of age was 8 times larger in 1999 than in 1900, and the number of people 75 to 84 years of age was 16 times larger. In addition, people 85 years of age and older constituted one of the fastest-growing segments of the population; the number was 34 times larger in 1999 than in 1900.

The health care needs of older adults are complex and demand significant investments, both professional and financial, by the health care industry. Many elderly people suffer from multiple chronic conditions that are exacerbated by acute episodes. In particular, elderly women, whose conditions are frequently underdiagnosed and undertreated, are of concern. There are approximately three women for every two men in the older population, and elderly women are expected to continue to outnumber elderly men.

### Cultural Diversity

An appreciation for the diverse characteristics and needs of people from varied ethnic and cultural backgrounds is important in health care and nursing. Some projections indicate that by 2030, racial and ethnic minority populations in the United States will triple. With increased immigration, both legal and illegal, this figure could approach 50% by the year 2030 (U.S. Bureaus of Census, 2004). As the cultural composition of the population changes, it is increasingly important to address cultural considerations in the delivery of health care. Patients from diverse sociocultural groups not only bring various health care beliefs, values, and practices to the health care setting, but also have a variety of risk factors for some disease conditions and unique reactions to treatment. These factors significantly affect a person's responses to health care problems or illnesses, to caregivers, and to the care itself. Unless these factors are assessed for, understood, and respected by health care providers, the care delivered may be ineffective, and health care outcomes may be negatively affected.

*Culture* is defined as learned patterns of behavior, beliefs, and values that are shared by a particular group of people. Included among the many characteristics that distinguish cultural groups are the manner of dress, language spoken, values, rules or norms of behavior, gender-specific practices, economics, politics, law and social control, artifacts, technology, dietary practices, and health beliefs and practices. Health promotion, illness prevention, causes of sickness, treatment, coping, caring, dying, and death are part of every culture. Every person has a unique belief and value system that has been shaped at least in part by his or her cultural environment. This belief and value system guides the person's thinking, decisions, and actions. It provides direction for interpreting and responding to illness and disability and to health care.

To promote an effective nurse–patient relationship and positive outcomes of care, nursing care must be culturally competent, appropriate, and sensitive to cultural differences. All attempts should be made to help patients retain their unique cultural characteristics. Providing special foods that have significance and arranging for religious observances may enable patients to maintain a feeling of wholeness at a time when they may feel isolated from family and community.

Knowing the cultural and social significance that particular situations have for each patient helps the nurse avoid imposing a personal value system when the patient has a different point of view. In most cases, cooperation with the plan of care occurs when communication among the nurse, the patient, and the patient's family is directed toward understanding the situation or the problem and respecting each other's goals.

## Changing Patterns of Disease

During the past 50 years, the health problems of the American people have changed significantly. Although many infectious diseases have been controlled or eradicated, others, such as tuberculosis, acquired immunodeficiency syndrome (AIDS), and sexually transmitted diseases/infections, are on the rise. An increasing number of infectious agents are becoming resistant to antibiotic therapy as a result of widespread and inappropriate use of antibiotics. Obesity has become a major health concern, and the multiple comorbidities that accompany it, such as hypertension, heart disease, diabetes, and cancer, add significantly to its associated mortality.

Conditions that were once easily treated have become more complex and life-threatening. The prevalence of chronic illnesses and disability is increasing because of the lengthening lifespan in the United States and the advances

in care and treatment options for conditions such as cancer, human immunodeficiency virus (HIV) infection, and cystic fibrosis. In addition, improvements in care for trauma and other serious acute health problems have meant that many people with these conditions live decades longer than in the past. People with chronic illness are the largest group of health care consumers in the United States. Because the majority of health problems seen today are chronic in nature, many people are learning to maximize their health within the constraints of chronic illness and disability.

As chronic conditions increase, health care broadens from a focus on cure and eradication of disease to include the prevention or rapid treatment of exacerbations of chronic conditions. Nursing, which has always encouraged patients to take control of their health and wellness, has a prominent role in the current focus on management of chronic illness and disability.

## Advances in Technology and Genetics

Advances in technology and genetics have occurred more rapidly during the past several decades compared with other time periods. Sophisticated techniques and devices have revolutionized surgery and diagnostic testing, making it possible to perform many procedures and tests on an outpatient basis. Increased knowledge and understanding of genetics have resulted in expanded screening, diagnostic testing, and treatments for a variety of conditions. The sophisticated communication systems that connect most parts of the world, with the capability of rapid storage, retrieval, and dissemination of information, have stimulated brisk change as well as swift obsolescence in health care delivery strategies. Advances in genetics and technology have also resulted in many ethical issues for the health care system, health care providers, patients, families, and society.

## Demand for Quality Health Care

Nurses in acute care settings must work with other health care team members to maintain quality care while facing pressures to discharge patients and decrease staffing costs. Nurses in hospitals now care for patients who are hospitalized for relatively few days. Nurses in the community care for patients who need high-technology acute care services as well as long-term care in the home. The importance of effective discharge planning and quality improvement cannot be overstated. Acute care nurses must also work with community-based nurses and others in community settings to ensure continuity of care.

The general public has become increasingly interested in and knowledgeable about health care and health promotion through television, newspapers, magazines, the Internet, and other communications media. Health care is a topic of political debate. The public has also become very health conscious and subscribes to the belief that health and quality health care constitute a basic right, rather than a privilege for a chosen few.

### Quality Improvement and Evidence-Based Practice

In the 1980s, hospitals and other health care agencies implemented ongoing quality assurance (QA) programs. These programs were required for reimbursement for services and for accreditation by the Joint Commission (previously known as the Joint Commission for Accreditation of Healthcare Organizations [JCAHO]). These QA programs sought to establish accountability to society on the part of the health professions for the quality, appropriateness, and cost of health services provided.

In the early 1990s, it was recognized that quality of care as defined by regulatory agencies is difficult to measure. QA criteria were identified as measures to ensure minimal expectations only; they did not provide mechanisms for identifying causes of problems or for determining systems or processes that needed improvement. **Continuous quality improvement (CQI)** was identified as a more effective mechanism for maintaining quality health care and its implementation was mandated in health care organizations in 1992. The Joint Commission specifies that patients have the right to health care (1) that is considerate and preserves dignity; (2) that respects cultural, psychosocial, and spiritual values; and (3) that is age specific (Joint Commission, 2007).

Unlike QA, which focuses on individual incidents or errors and minimal expectations, CQI focuses on the processes used to provide care, with the aim of improving quality by assessing and improving those processes that most affect patient care outcomes and patient satisfaction. CQI involves analyzing, understanding, and improving clinical, financial, and operational processes. Nurses directly involved in the delivery of care are engaged in analyzing data and refining the processes used in CQI. Their knowledge of the processes and conditions that affect patient care is critical in designing changes to improve the quality of the care provided.

Closely related to the implementation of CQI is the move to transform health care through evidence-based practice (EBP). The facilitation of EBP involves identifying and evaluating current literature and research, as well as incorporating the findings into patient care as a means of ensuring quality care (Bourgault, Ipe, Weaver, et al., 2007; Fineout-Overholt, Melnyk & Schultz, 2005). EBP includes the use of outcome assessment and standardized plans of care such as clinical guidelines, clinical pathways, and algorithms. Many of these measures are being implemented by nurses, particularly by nurse managers and **advanced practice nurses**, often in collaboration with other health care professionals.

### Clinical Pathways and Care Mapping

Many health care facilities and home health services use clinical pathways or care mapping to coordinate care for patients (Kinsman, James & Ham, 2004). Clinical pathways are tools for tracking a patient's progress toward achieving positive outcomes within specified time frames. Clinical pathways based on current literature and clinical expertise have been developed for patients with certain diagnosis-related groups (DRGs) (eg, heart failure, ischemic stroke, fractured hip), for high-risk patients (eg, those receiving chemotherapy), and for patients with certain common health problems (eg, diabetes, chronic pain). The pathways indicate key events, such as diagnostic tests, treatments, activities, medications, consultation, and education, that must occur within specified times for patients to achieve the desired and timely outcomes.

A case manager often facilitates and coordinates interventions to ensure that the patient progresses through the key events and achieves the desired outcomes. Nurses who provide direct care have an important role in the development and use of clinical pathways through their participation in researching the literature and then developing, piloting, implementing, and revising clinical pathways. In addition, nurses monitor outcome achievement and document and analyze variances. Examples of clinical pathways can be found in Appendix B.

Other EBP tools used for planning patient care are care mapping, multidisciplinary action plans (MAPs), clinical guidelines, and algorithms. These tools are used to move patients toward predetermined outcome markers. Algorithms are used more often in acute situations to determine a particular treatment based on patient information or response. Care maps, clinical guidelines, and MAPs (the most detailed of these tools) help facilitate coordination of care and education throughout hospitalization and after discharge.

Because care mapping and guidelines are used for conditions in which a patient's progress often defies prediction, specific time frames for achieving outcomes are excluded. A patient with a highly complex condition or multiple underlying illnesses may benefit more from care mapping or guidelines than from clinical pathways, because the use of outcome milestones (rather than specific time frames) is more realistic.

Through case management and the use of clinical pathways or care mapping, patients and the care they receive are continually assessed from preadmission to discharge—and in many cases after discharge to the home care and community settings. Continuity of care, effective utilization of services, and cost containment are the major benefits for society and for the health care system.

## Alternative Health Care Delivery Systems

The rising cost of health care over the past few decades has led to the use of managed health care and alternative health care delivery systems, including health maintenance organizations (HMOs) and preferred provider organizations (PPOs).

### *Managed Care*

The continued escalation of health care costs over the course of the past several decades has prompted business, labor, and government to assume greater control over the financing and delivery of health care. The common features that characterize managed care include prenegotiated payment rates, mandatory precertification, utilization review, limited choice of providers, and fixed-price reimbursement. The scope of managed care has expanded from inhospital services to HMOs or variations such as PPOs; ambulatory, long-term, and home care services; and related diagnostic and therapeutic services.

Managed care has contributed to a dramatic reduction in inpatient hospital days, continuing expansion of ambulatory care, fierce competition, and marketing strategies that appeal to consumers as well as to insurers and regulators. Hospitals are faced with declining revenues, a declining number of patients, more severely ill patients with shorter lengths of stay, and a need for cost-effective outpatient or ambulatory care services. As patients return to the community, they have more health care needs, many of which are complex. The demand for home care and community-based services is escalating. Despite their successes, managed care organizations are faced with the challenge of providing quality services under resource constraints. Case management is a strategy used by many organizations to meet this challenge.

### *Case Management*

Case management is a system of coordinating health care services to ensure cost-effectiveness, accountability, and quality care. The premise of case management is that the responsibility for meeting patient needs rests with one person or team whose goals are to provide the patient and family with access to required services, to ensure coordination of these services, and to evaluate how effectively these services are delivered.

Case management has gained such prominence because of decreased costs of care associated with decreased lengths of hospital stays coupled with rapid and frequent interunit transfers from specialty to standard care units. The case manager role focuses on managing the care of a caseload of patients and collaborating with nurses and other health care personnel who provide care. In some settings, particularly the community setting, the focus of the nurse case manager is on managing the treatment plan of the patient with complex conditions. The case manager follows the patient throughout hospitalization and at home after discharge in an effort to coordinate health care services that will avert or delay rehospitalization. The caseload is usually limited in scope to patients with similar diagnoses, needs, and therapies.

Case management was designed to plan and coordinate the inpatient and outpatient services needed by patients. The goals of case management are quality, appropriateness, and timeliness of services as well as cost reduction. Evidence-based pathways or similar plans are often used in case management of similar patient populations (Craig & Huber, 2007; Huber & Craig, 2007).

# *Roles of the Nurse*

As stated previously, nursing is the diagnosis and treatment of human responses to health and illness and therefore focuses on a broad array of phenomena. Professional nurses who work in institutional, community-oriented, or community-based settings have three major roles: the practitioner role, which includes providing care, teaching, and collaborating; the leadership role; and the research role. Although each role carries specific responsibilities, these roles are characteristic of all nursing positions, relate to one another, and are designed to meet the immediate and future needs of consumers who are the recipients of nursing care. Often, nurses act in a combination of roles to provide comprehensive patient care.

## Practitioner Role

The practitioner role involves those actions taken by nurses to meet the health care and nursing needs of individual patients, their families, and significant others. This role is a

dominant one for nurses in primary, secondary, and tertiary health care settings and in home care and community nursing. It is achieved through use of critical thinking, clinical judgment, and the nursing process, all of which are key tools for nursing practice. Nurses help patients meet their needs by using direct intervention, by teaching patients and family members to perform care, and by coordinating and collaborating with other disciplines to provide needed services.

### Leadership Role

The leadership role is often viewed as a role assumed by nurses who have titles that suggest leadership and who are the leaders of large groups of nurses or related health care professionals. However, because of the constant fluctuation of health care delivery demands and consumers, a broader definition of nursing leadership, one that identifies the leadership role as inherent within all nursing positions, is required. The leadership role involves those actions that nurses execute when they assume responsibility for the actions of others directed toward determining and achieving patient care goals. Many staff nurses now work in settings where they are held accountable for the nursing care delivered by unlicensed assistive personnel (UAPs) who work under their direct supervision.

Nursing leadership involves four components: decision making, relating, influencing, and facilitating. Each of these components promotes change and the ultimate outcome of goal achievement. Basic to the entire process is effective communication, which determines the success of the process and achievement of goals. The components of the leadership process are appropriate during all phases of the nursing process and in all settings. A new role, the clinical nurse leader (CNL) is a nurse generalist with a master's degree in nursing and a special background in clinical leadership to help patients navigate through complex health care systems (American Association of Colleges of Nursing [AACN], 2007).

### Research Role

The primary task of nursing research is to contribute to the scientific base of nursing practice. Studies are needed to determine the effectiveness of nursing interventions and nursing care. The science of nursing grows through research, leading to the generation of scientifically based rationale for nursing practice and patient care. This process is the basis of EBP, with a resultant increase in the quality of patient care.

The research role is considered to be a responsibility of *all* nurses in clinical practice. Nurses are constantly alert for nursing problems and important issues related to patient care that can serve as a basis for the identification of researchable questions. Nurses with a background in research methods can use their research knowledge and skills to initiate and implement timely, relevant studies.

Nurses directly involved in patient care are often in the best position to identify potential research problems and questions, and their clinical insights are invaluable. Nurses also have a responsibility to become actively involved in ongoing research studies. This may involve facilitating the data collection process, or it may include actual collection of data. Explaining the study to patients and their families and to other health care professionals is often of invaluable assistance to the researcher who is conducting the study.

Above all, nurses must use research findings in their nursing practice; the use, validation, replication, dissemination, and evaluation of research findings further the science of nursing. As stated previously, EBP requires the critique of the best evidence available in research-based studies and validating their saliency to nursing practice. Nurses must continually be aware of studies that are directly related to their own area of clinical practice and critically analyze those studies to determine the applicability of their implications for specific patient populations. Relevant conclusions and implications can be used to improve patient care.

## Models of Nursing Care Delivery

Several organizational methods or models that vary greatly from one facility to another and from one set of patient circumstances to another may be used to carry out nursing care. These methods and models have changed over the years and have included functional nursing, team nursing, primary nursing, and patient-focused or patient-centered care. The models most commonly utilized today include primary nursing, which is characterized by assigning one primary nurse to accept overall responsibility for a given patient's individualized nursing care, and patient-focused care, which is characterized by assigning a nurse to manage the care of a caseload of patients during a given shift, who may then delegate care activities to other nursing personnel, including UAPs.

## Community-Based Nursing and Community-Oriented/Public Health Nursing

Community health nursing, public health nursing, community-based nursing, and home health nursing may be discussed together. However, although aspects of patient care in each type do overlap, these terms are distinct from one another. The similar practice settings may blur these distinctions (Stanhope & Lancaster, 2008), and confusion exists regarding the differences. The central idea of **community-oriented nursing practice** is that nursing intervention can promote wellness, reduce the spread of illness, and improve the health status of groups of citizens or the community at large. Its emphasis is on primary, secondary, and tertiary prevention. Nurses in these settings have traditionally focused on health promotion, maternal and child health, and chronic care.

Community-based nursing occurs in a variety of settings within the community, including home settings, and is directed toward people and families (Stanhope & Lancaster, 2008). Most community-based and home health care is directed toward specific patient groups with identified needs, which usually relate to illness, injury, or disability, resulting most often from advanced age or chronic illness. However, nurses in the community are meeting the needs of groups of patients with a variety of problems and needs. Home health

care is a major aspect of community-based care discussed throughout this text. Community-based programs and agencies for specific populations (eg, the elderly, ventilator-dependent patients), as well as home health care agencies, hospices, independent professional nursing practices, and freestanding health care agencies, provide home health care services.

With shorter hospital stays and increased use of outpatient health care services, more nursing care is provided in the home and community setting. As a result, nurses have a choice of practicing in a variety of health care delivery settings. These settings include acute care medical centers, ambulatory care settings, clinics, urgent care centers, outpatient departments, neighborhood health centers, home health care agencies, independent or group nursing centers, and managed care agencies.

Community nursing centers are nurse managed and provide primary care services such as ambulatory and outpatient care, immunizations, health assessment and screening services, and patient and family education and counseling. These centers serve varied and often underserved populations that typically include a high proportion of patients who are rural, very young, very old, poor, or members of racial minorities.

Various agencies provide care in the home and community to meet the needs of patients who are discharged from acute care institutions to their homes and communities early in the recovery process and with complex needs. Many patients are elderly, and many have multiple medical and nursing diagnoses and multisystem health problems that require acute and intensive nursing care, including ventilatory support and intravenous (IV) or parenteral nutrition therapy.

As a result, there are many opportunities for employment for nurses in the community and home care settings. Home care nursing is a specialty area that requires advanced knowledge and skills in general nursing practice, with emphasis on community health and acute medical-surgical nursing. Also required are high-level assessment skills, critical thinking, and decision-making skills in a setting where other health care professionals are not available to validate observations, conclusions, and decisions.

Home care nurses often provide “high-tech, high-touch” services to patients with acute health care needs. In addition, they are responsible for patient and family teaching and for contacting community resources and coordinating the continuing care of patients. For these reasons, the scope of medical-surgical nursing encompasses not only the acute care setting within the hospital, but also the acute care setting as it expands into the community and the home. Throughout this textbook, the home health care needs of patients are addressed, with particular attention given to the teaching, self-care management, and health maintenance needs of patients and their families.

## Expanded Nursing Roles

Professional nursing is adapting to meet changing health needs and expectations. The role of the nurse has expanded to improve the distribution of health care services and to decrease the cost of health care. Nurses may receive advanced education in such specialties as family care, critical care, coronary care, respiratory care, oncologic care, maternal and child health care, neonatal intensive care, rehabilitation, trauma, rural health, and gerontologic nursing. In medical-surgical nursing, the most significant titles associated with an advanced specialized education include *nurse practitioner* (NP) and *clinical nurse specialist* (CNS), and the more recent title of *advanced practice nurse* (APN), which encompasses both NPs and CNSs. Certified nurse-midwives (CNMs) and certified registered nurse anesthetists (CRNAs) are also identified as APNs. Nurses who function in these roles provide direct care to patients through independent practice, practice within a health care agency, or collaboration with a physician. Specialization in nursing has evolved as a result of the recent explosion of technology and knowledge.

Most states require both NPs and CNSs to have graduate-level education. NPs are prepared as specialists (eg, family, acute care, pediatric, geriatric). They define their role in terms of direct provision of a broad range of health care services to patients and families. The focus is on providing direct health care to patients and collaborating with other health professionals. In most states, nurse practitioners have prescriptive authority and may receive direct Medicare reimbursement.

CNSs, on the other hand, are prepared as specialists who practice within a circumscribed area of care (eg, cardiovascular, oncology). They define their role as having five major components: clinical practice, education, management, consultation, and research. Studies have shown that CNSs often focus on their education and consultation roles, which involve education and counseling of patients and families, as well as education, counseling, and consultation with nursing staff. Some states have granted CNSs prescriptive authority if they have the required educational preparation. CNSs practice in a variety of settings, including the community and the home, although most practice in acute care settings. CNSs are ideal case managers because they have the educational background and the clinical expertise to organize and coordinate services and resources to meet the patient’s health care needs in a cost-effective and efficient manner. The expanding role of the nurse case manager has contributed to the designation of the APN case manager as an advanced practice role (Hamric, Spross & Hanson, 2005).

With advanced practice roles has come a continuing effort by professional nursing organizations to define more clearly the practice of nursing. States’ nurse practice acts give nurses the authority to perform functions that were previously restricted to the practice of medicine. These functions include diagnosis (nursing), treatment, performance of selected invasive procedures, and prescription of medications and treatments. The board of nursing in each state stipulates regulations regarding these functions, defines the education and experience required, and determines the clinical situations in which a nurse may perform these functions. Additionally, the introduction of the Doctor of Nursing Practice (DNP) as the terminal practice degree has generated considerable discussion

regarding the level of preparation needed for APNs (AACN, 2006).

Initial care, ambulatory health care, palliative care, and anticipatory guidance are all important in nursing practice. Advanced practice roles enable nurses to function interdependently with other health care professionals and to establish more collegial relationships with physicians. The role of advanced practice nurses is expected to continue to increase in terms of scope, responsibility, and recognition.

## Interdisciplinary Collaborative Practice

This chapter has explored the changing role of nursing. Many references have been made to the significance of nurses as members of the health care team. As the unique competencies of nurses become more clearly articulated, there is increasing evidence that nurses provide health care services distinct to the profession. However, nursing continues to recognize the importance of collaboration with other health care disciplines in meeting the needs of patients.

Some institutions use the **collaborative practice model** (Fig. 1-2). Nurses, physicians, and ancillary health personnel function within a decentralized organizational structure, collaboratively making clinical decisions. A joint practice committee, with representation from all care providers, may function at the unit level to monitor, support, and foster collaboration. Collaborative practice is further enhanced with integration of the health or medical record and with joint patient care record reviews. The collaborative model, or a variation of it, promotes shared participation, responsibility, and accountability in a health care environment that is striving to meet the complex health care needs of the public.

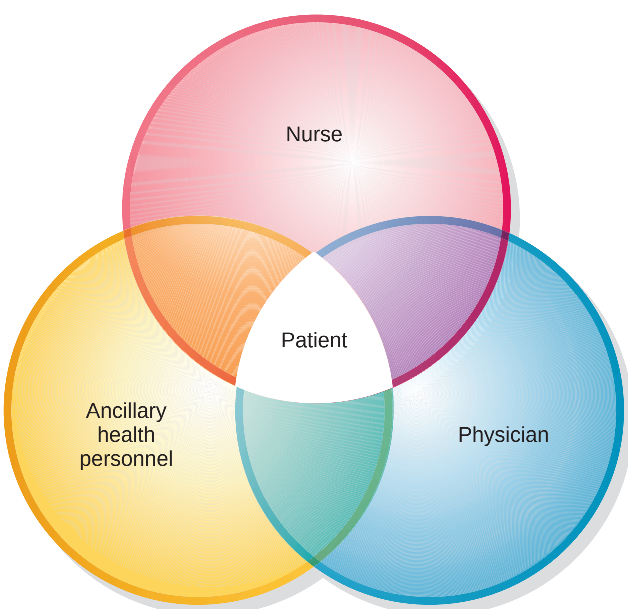



**Figure 1-2** Collaborative practice model.

## CRITICAL THINKING EXERCISES

**1** Your clinical assignment is in a long-term care facility. Identify a patient care issue (eg, nutritional status) that could be improved. Describe the mechanism that is available within a clinical facility to address such quality improvement issues.

**2** You are planning the discharge of an elderly patient who has several chronic medical conditions. A case manager has been assigned to this patient. How would you explain the role of the case manager to the patient and her husband?

EBP **3** You are assigned to care for a hospitalized patient who is obese, with a history of diabetes, and a new diagnosis of stable angina. There is a clinical nurse leader (CNL) assigned to provide consistent, quality care for this patient from hospital admission to discharge. Identify the evidence that supports the effectiveness of CNLs in supervising care of patients and promoting positive patient outcomes. What is the strength of the evidence? How might this specific patient's care be affected?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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# chapter 2

# Community-Based Nursing Practice

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Discuss the changes in the health care system that have increased the need for nurses to practice in community-based settings.
2. Compare the differences and similarities between community- and hospital-based nursing.
3. Describe the discharge planning process in relation to home care preparation.
4. Explain methods for identifying community resources and making referrals.
5. Discuss how to prepare for a home health care visit and how to conduct the visit.
6. Identify personal safety precautions a home care nurse should take when making home visits.
7. Describe the various types of nursing functions provided in ambulatory care facilities, in occupational health and school nursing programs, in community nurse–managed centers, in hospice care settings, and in facilities that provide services to the homeless.

## GLOSSARY

**community-based nursing:** nursing care of individuals and families that is designed to (1) promote and maintain health and (2) prevent disease. It is provided as patients transition through the health care system to health-related services outside of the hospital setting

**primary prevention:** health care delivery focused on health promotion and prevention of illness or disease

**secondary prevention:** health care delivery centered on health maintenance and aimed at early detection of disease, with prompt intervention to prevent or minimize loss of function and independence

**tertiary prevention:** health care delivery focused on minimizing deterioration associated with disease and improving quality of life through rehabilitation measures

As described in Chapter 1, the shift in health care delivery from inpatient to outpatient settings is a result of multiple factors, including new population trends. Changes in federal legislation, tighter insurance regulations, decreasing hospital revenues, and alternative health care delivery systems have also affected the ways in which health care is delivered. The growing number of older adults in the United States increases the demand for medical, nursing, and social services within the public health system. Hospitals and other health care providers are reimbursed at a fixed rate for patients who have the same diagnosis as defined by diagnosis-related groups (DRGs). Under this system, hospitals and other health care providers can reduce costs and earn income by carefully monitoring the types of services they provide and discharging patients as soon as possible. Consequently, patients are being discharged from acute care facilities to their homes or to residential or long-term care facilities in early stages of recovery.

As health care delivery shifts into the community, more nurses are working in a variety of community-based settings. These settings include public health departments, ambulatory health clinics, long-term care facilities, hospice settings, industrial settings (as occupational nurses), homeless shelters and clinics, nursing centers, home health agencies, urgent care centers, same-day surgical centers, short-stay facilities, and patients' homes. In these settings, nurses often deliver care without direct on-site supervision or support of other health care personnel. They must be self-directed, flexible, adaptable, and accepting of various lifestyles and living conditions. To function effectively, nurses in these settings must have expertise in independent decision making, critical thinking, assessment, health education, and competence in basic nursing care (Stanhope & Lancaster, 2008).

In addition, nurses in community settings must be culturally competent, as culture plays a role in the delivery of care. Culture can be structured within the context of care through the utilization of a theoretical framework involving cultural competence (Jirwe, Gerrish & Emami, 2006).

## Community-Based Care

**Community-based nursing** is a philosophy of care in which the care is provided as patients and their families move among various service providers outside of hospitals. This nursing practice focuses on promoting and maintaining the health of individuals and families, preventing and minimizing the progression of disease, and improving quality of life (Stanhope & Lancaster, 2008). Community health nurses provide direct care to patients and families and use political advocacy to secure resources for aggregate populations (eg, the aged population). Community health nurses have many roles, including epidemiologist, case manager for a group of patients, coordinator of services provided to a group of patients, occupational health nurse, school nurse (Fig. 2-1), visiting nurse, or parish nurse. (In parish nursing, the members of a religious community—the parish—are the recipients of care.) These roles have one element in common: a focus on community needs as well as on the needs of individual patients. Community-based care is generally focused on individuals or their families, although efforts may be undertaken to improve the health of the entire community.



**Figure 2-1** Community-based nursing takes many forms and focuses. Here the school nurse performs screening for scoliosis.

The primary concepts of community-based nursing care are self-care and preventive care within the context of culture and community. Two other important concepts are continuity of care and collaboration. Some community-based areas of nursing have become specialties in their own right, such as school health nursing and home health nursing.

Nurses in community-based practice provide preventive care at three levels—primary, secondary, and tertiary. **Primary prevention** focuses on health promotion and prevention of illness or disease, including interventions such as teaching about healthy lifestyles. **Secondary prevention** centers on health maintenance and is aimed at early detection and prompt intervention to prevent or minimize loss of function and independence, including interventions such as health screening and health risk appraisal. **Tertiary prevention** focuses on minimizing deterioration and improving quality of life, including rehabilitation to assist patients in achieving their maximum potential by working through their physical or psychological challenges. Home care nurses often focus on tertiary preventive nursing care, although primary and secondary prevention are also addressed.

## Home Health Care

Home care nursing is a unique component of community-based nursing. Home care visits are made by nurses who work for home care agencies, public health agencies, and visiting nurse associations; by nurses who are employed by hospitals; and by parish nurses or faith community nurses

who work with the members of faith-based communities to promote health. Such visits may also be part of the responsibilities of school nurses, clinic nurses, or occupational health nurses. Home health care agencies are continuing to employ more nurses. Because of the high acuity level of patients, nurses with acute care and critical care experience are in demand in this field.

The type of nursing services provided to patients in their homes varies from agency to agency. Nurses from home care or hospice agencies make home visits to provide skilled nursing care, follow-up care, and teaching to promote health and prevent complications. Hospice nursing has become a specialty area of nursing practice in which nurses provide palliative care in patients' homes and within hospice centers, thus promoting comfort, peace, and dignity to patients who are dying. Clinic nurses may conduct home visits as part of patient follow-up. Public health, parish, and school nurses may make visits to provide anticipatory guidance to high-risk families and follow-up care to patients with communicable diseases. Many home care patients are acutely ill, and many have chronic health problems or disabilities, requiring that nurses provide more education and monitoring to patients and families. Holistic care is provided in the home through the collaboration of an interdisciplinary team that includes professional nurses; home health aides; social workers; physical, speech, and occupational therapists; and physicians. An interdisciplinary approach is used to provide health and social services with oversight of the total health care plan by a case manager, clinical nurse specialist, or nurse practitioner. Interdisciplinary collaboration is required if a home health agency is to receive Medicare certification (Stanhope & Lancaster, 2008).

Home health care services are provided by official, publicly funded agencies; nonprofit agencies; private businesses; proprietary chains; and hospital-based agencies. Some agencies specialize in high-technology services. Most agencies are reimbursed from a variety of sources, including Medicare and Medicaid programs, private insurance, and direct patient payment. Many home health care expenditures are financed by Medicare, which allows nurses to manage and evaluate patient care for seriously ill patients who have complex, labile conditions and are at high risk for rehospitalization. Each funding source has its own requirements for services rendered, number of visits allowed, and amount of reimbursement the agency receives. The elderly are the most frequent users of home care services. To be eligible for service, the patient must be acutely ill, homebound, and in need of skilled nursing services.

Health care visits may be intermittent or periodic, and case management via telephone or via Internet may be used to promote communication with home care consumers. The nurse instructs the patient and family about skills and self-care strategies and about health maintenance and promotion activities (eg, nutritional counseling, exercise programs, stress management). Nursing care includes skilled assessment of the patient's physical, psychological, social, and environmental status (Fig. 2-2). Nursing interventions may include intravenous (IV) therapy and injections, parenteral nutrition, venipuncture, catheter insertion, pressure ulcer treatment, wound care, ostomy care, and patient and family teaching. Complex technical equipment, such as dialysis machines and ventilators, is often part of home health care (Stanhope & Lancaster, 2008). Nurses have a role in evaluating the safety and effectiveness of technology in the home setting. In addition, "tele-health" is an emerging trend in home health care; this facilitates exchange of information via telephone lines between patients and nurses regarding health information such as blood glucose readings, vital signs, and cardiac parameters (Stanhope & Lancaster, 2008). Use of a broad spectrum of computer and Internet resources, such as Web cams, also facilitates exchange of information.



**Figure 2-2** Assessment is an important part of any home health visit.

## Nursing in the Home Setting

The home care nurse is a guest in the patient's home and must have permission to visit and give care. The nurse has minimal control over the lifestyle, living situation, and health practices of the patients he or she visits. This lack of full decision-making authority can create a conflict for the nurse and lead to problems in the nurse–patient relationship. To work successfully with patients in any setting, the nurse must be nonjudgmental and convey respect for patients' beliefs, even if they differ sharply from the nurse's. This can be difficult when a patient's lifestyle involves activities that a nurse considers harmful or unacceptable, such as smoking, use of alcohol, drug abuse, or overeating.

The cleanliness of a patient's home may not meet the standards of a hospital. Although the nurse can provide teaching points about maintaining clean surroundings, the patient and family decide if they will implement the nurse's suggestions. The nurse must accept their decisions and deliver the care required regardless of the conditions of the setting.

The kind of equipment and the supplies or resources that usually are available in acute care settings are often unavailable in the patient's home. The nurse has to learn to improvise when providing care, such as when changing a dressing or catheterizing a patient in a regular bed that is

not adjustable and lacks a bedside table (Smith-Temple & Johnson, 2005).

Infection control is as important in the home as it is in the hospital, but it can be more challenging in the home and requires creative approaches. As in any situation, it is important to clean one's hands before and after giving direct patient care, even in a home that does not have running water. If aseptic technique is required, the nurse must have a plan for implementing this technique before going to the home. This applies to universal precautions, transmission-based precautions, and disposal of bodily secretions and excretions. If injections are given, the nurse must use a closed container to dispose of syringes. Injectable and other medications must be kept out of the reach of children during visits and must be stored in a safe place if they are to remain in the house.

Friends, neighbors, or family members may ask the nurse about the patient's condition. The patient has a right to confidentiality, and information should be shared only with the patient's permission. If the nurse carries a patient's medical record into a house, he or she must put it in a secure place to prevent it from being picked up by others or from being misplaced.

## Discharge Planning for Home Care

Discharge planning is an important part of making the transition from the acute to the home care setting, and it is mandated for Medicare reimbursement. Discharge planning begins with the patient's admission to the hospital and must consider the possible need for follow-up home care. Several different personnel (eg, social workers, home care nurses, and case managers) or agencies may be involved in the planning process.

The development of a comprehensive discharge plan requires collaboration with professionals at both the referring agency and the home care agency, as well as other community agencies that provide specific resources upon discharge. The process involves identifying the patient's needs and developing a thorough plan to meet them. It is essential to have open lines of communication with family members to ensure their understanding and cooperation.

## Community Resources and Referrals

As case managers, community-based nurses may make referrals to other team members, such as home health aides and social workers. These nurses work collaboratively with the health team and the referring agency or person. Continuous coordinated care among all health care providers involved in a patient's care is essential to avoid duplication of effort by the various personnel caring for the patient.

A community-based nurse must be knowledgeable about community resources available to patients as well as services provided by local agencies, eligibility requirements, and any possible charges for the services. Most communities have directories of health and social service agencies that the nurse can consult. These directories must be updated as resources change. If a community does not have a resource booklet, an agency may develop one for its staff. It should include the commonly used community resources that patients need, as well as the costs of the services and eligibility requirements. The telephone book and the Internet are often useful in helping patients identify the location and accessibility of grocery and drug stores, banks, health care facilities, ambulances, physicians, dentists, pharmacists, social service agencies, and senior citizens' programs. In addition, a patient's place of worship or parish may be an important resource for services.

The community-based nurse is responsible for informing the patient and family about the community resources available to meet their needs. During initial and subsequent home visits, the nurse helps the patient and family identify these community services and encourages them to contact the appropriate agencies. When appropriate, nurses may make the initial contact.

## Home Health Visits

### *Preparing for a Home Visit*

Most agencies have a policy manual that identifies the agency's philosophy and procedures and defines the services provided. Becoming familiar with these policies is essential before initiating a home visit. It is also important to know the agency's policies and the state law regarding what actions to take if the nurse finds a patient dead, suspects abuse, determines that a patient cannot safely remain at home, or observes a situation that possibly indicates malicious harm to the community at large.

Before making a home visit, the nurse should review the patient's referral form and other pertinent data concerning the patient. It may be necessary to contact the referring agency if the purpose for the referral is unclear or if important information is missing. The first step is to call the patient to obtain permission to visit, schedule a time for the visit, and verify the address. This initial phone conversation provides an opportunity to introduce oneself, identify the agency, and explain the reason for the visit. If the patient does not have a telephone, the nurse should see if the people who made the referral have a number where a phone message can be left for the patient. If an unannounced visit to a patient's home must be made, the nurse should ask permission to come in before entering the house. Explaining the purpose of the referral at the outset and setting up the times for future visits before leaving are also recommended.

Most agencies provide nurses with bags that contain standard supplies and equipment needed during home visits. It is important to keep the bag properly supplied and to bring any additional items that might be needed for the visit. Patients rarely have the medical supplies needed for treatment.

### *Conducting a Home Visit*

#### Personal Safety Precautions

Community nurses must pay particular attention to personal safety, because their practice settings are often in unknown environments. Based on the principle of due diligence, agencies must inform employees of at-risk working environments. Agencies have policies and procedures concerning the promotion of safety for clinical staff, and training is provided to facilitate personal safety. Environments must be proactively assessed for safety by the individual nurse and agency.

## Chart 2-1 • *Safety Precautions in Home Health Care*

- Learn or preprogram a cell phone with the telephone numbers of the agency and police and emergency services. Most agencies provide cell phones for their nurses so that the agency can contact the nurse, and so that the nurse can contact the agency in case of an emergency or unexpected situation.
- Carry agency identification and a charged cell phone to make telephone calls in case you become lost or have problems.
- Let the agency know your daily schedule and the telephone numbers of your patients so that you can be located if you do not return when expected.
- Know where the patient lives before leaving to make the visit and carry a map for quick referral.
- Keep your car in good working order and have sufficient gas in the tank.
- Park the car near the patient's home and lock the car during the visit.
- Do not drive an expensive car or wear expensive jewelry when making visits.
- Know the regular bus schedule and know the routes when using public transportation or walking to the patient's house.
- When making visits in high-crime areas, visit with another person rather than alone.
- Schedule visits only during daylight hours.
- Never walk into a patient's home uninvited.
- If you do not feel safe entering a patient's home, leave the area.
- Become familiar with the layout of the house, including exits from the house.
- If a patient or family member is intoxicated, hostile, or obnoxious, reschedule the visit and leave.
- If a family is having a serious argument or abusing the patient or anyone else in the household, reschedule the visit, contact your supervisor, and report the abuse to the appropriate authorities.

Whenever a nurse makes a home visit, the agency should know the nurse's schedule and the locations of the visits. The nurse should learn about the neighborhood and obtain directions to the destination. A plan of action should always be established in case of emergencies. If a dangerous situation is encountered during the visit, the nurse should return to the agency and contact his or her supervisor or law enforcement officials, or both. Suggested precautions to take when making a home visit are presented in Chart 2-1.

### Initial Home Visit

The first visit sets the tone for subsequent visits and is crucial in establishing the nurse–patient relationship. The situations encountered depend on numerous factors. Patients may be in pain and unable to care for themselves. Family members may be overwhelmed and doubt their ability to care for their loved ones. They may not understand why the patient was sent home from the hospital before being totally rehabilitated. They may not comprehend what home care is or why they cannot have 24-hour nursing services. It is critical that the nurse conveys an understanding of what patients and families are experiencing and how the illness is affecting their lives.

During the initial home visit, which usually lasts less than an hour, the individual patient is evaluated and a plan of care is established to be followed or modified on subsequent visits. The nurse informs the patient of the agency's practices, policies, and hours of operation. If the agency is to be reimbursed for the visit, the nurse asks for insurance information, such as a Medicare or Medicaid card.

The initial assessment includes evaluating the patient, the home environment, the patient's self-care abilities or the family's ability to provide care, and the patient's need for additional resources. Identification of possible hazards, such as cluttered walk areas, potential fire risks, air or water pollution, or inadequate sanitation facilities, is also part of the initial assessment.

Documentation considerations for home visits follow fairly specific regulations. The patient's needs and the nursing care provided must be documented to ensure that the agency qualifies for payment for the visit. Medicare, Medicaid, and third-party payers require documentation of the patient's homebound status and the need for skilled professional nursing care. The medical diagnosis and specific detailed information on the functional limitations of the patient are usually part of the documentation. The goals and the actions appropriate for attaining them must be identified. Expected outcomes of the nursing interventions must be stated in terms of patient behaviors and must be realistic and measurable. They must reflect the nursing diagnosis or the patient's problems and must specify those actions that address the patient's problems. Inadequate documentation may result in nonpayment for the visit and care services.

### Determining the Need for Future Visits

While conducting an assessment of a patient's situation, the home care nurse evaluates the need for future visits and the frequency with which those visits may need to be made. To make these judgments, the nurse should consider the questions listed in Chart 2-2. With each subsequent visit, these same factors are evaluated to determine the continuing health needs of the patient. As progress is made and the patient, with or without the help of significant others, becomes more capable of self-care and more independent, the need for home visits may decline.

### Ending the Visit

As the visit comes to a close, it is important to summarize the main points of the visit for the patient and family and to identify expectations for future visits or patient achievements. The following points should be considered at the end of each visit:

- What are the main points the patient or family should remember from the visit?
- What positive attributes have been noted about the patient and the family that will give them a sense of accomplishment?

**Chart 2-2 • *Assessing the Need for Home Visits***

**Current Health Status**

- How well is the patient progressing?
- How serious are the present signs and symptoms?
- Has the patient shown signs of progressing as expected, or does it seem that recovery will be delayed?

**Home Environment**

- Are worrisome safety factors apparent?
- Are family or friends available to provide care, or is the patient alone?

**Level of Self-Care Ability**

- Is the patient capable of self-care?
- What is the patient's level of independence?
- Is the patient ambulatory or bedridden?
- Does the patient have sufficient energy, or is he or she frail and easily fatigued?
- Does the patient need and use assistive devices?

**Level of Nursing Care Needed**

- What level of nursing care does the patient require?
- Does the care require basic skills or more complex interventions?

**Prognosis**

- What is the expectation for recovery in this particular instance?
- What are the chances that complications may develop if nursing care is not provided?

**Educational Needs**

- How well has the patient or family grasped the teaching points made?
- Is there a need for further follow-up and retraining?
- What level of proficiency does the patient or family show in carrying out the necessary care?

**Mental Status**

- How alert is the patient?
- Are there signs of confusion or thinking difficulties?
- Does the patient tend to be forgetful or have a limited attention span?

**Level of Adherence**

- Is the patient following the instructions provided?
- Does the patient seem capable of following the instructions?
- Are the family members helpful, or are they unwilling or unable to assist in caring for the patient as expected?

- What were the main points of the teaching plan or the treatments needed to ensure that the patient and family understand what they must do? A written set of instructions should be left with the patient or family, provided they can read and see (alternative formats include video or audio recordings). Printed material must be in the patient's primary language and in large print when indicated.
- Whom should the patient or family call if they need to contact someone immediately? Are current emergency telephone numbers readily available? Is telephone service available, or can an emergency cell phone service be provided?
- What signs of complications should be reported immediately?
- How frequently will visits be made? How long will they last (approximately)?
- What is the day and time of the next visit? Will a different nurse make the visit?

## *Other Community-Based Health Care Settings*

### Ambulatory Settings

Ambulatory health care is provided for patients in community- or hospital-based settings. The types of agencies that provide such care are medical clinics, ambulatory care units, urgent care centers, cardiac rehabilitation programs, mental health centers, student health centers, community outreach programs, and nursing centers. Some ambulatory centers provide care to a specific population, such as migrant workers or Native Americans. Neighborhood health centers provide services to patients who live in a geographically defined area. The centers may operate in freestanding buildings, storefronts, or mobile units. Agencies may provide ambulatory health care in addition to other services, such as an adult day care or health program. The kinds of services offered and the patients served depend on the agency's mission.

Nursing responsibilities in ambulatory health care settings include providing direct patient care, conducting patient intake screenings, treating patients with acute or chronic illnesses or emergency conditions, referring patients to other agencies for additional services, teaching patients self-care activities, and offering health education programs that promote health maintenance. A useful tool for community-based nurses might be the classification scheme developed by the Visiting Nurses Association of Omaha, which contains patient-focused problems in one of four domains: environmental, psychosocial, physiologic, and health-related behaviors (Barton, Clark & Baramee, 2004).

Nurses also work as clinic managers, direct the operation of clinics, and supervise other health team members. Nurse practitioners, educated in primary care, often practice in ambulatory care settings that focus on gerontology, pediatrics, family or adult health, or women's health. Constraints imposed by federal legislation and ambulatory payment classifications require efficient and effective management of patients in ambulatory settings. Nurses can play an important part in facilitating the function of ambulatory care facilities.

### Occupational Health Programs

Federal legislation, especially the Occupational Safety and Health Act (OSHA), has been enacted to ensure safe and healthy work conditions. A safe working environment results in decreased employee absenteeism, hospitalization, and disability, as well as reduced costs.

Occupational nurses may work in solo units in industrial settings, or they may serve as consultants on a limited or part-time basis. They may be members of an interdisciplinary team composed of a variety of personnel such as nurses,

physicians, exercise physiologists, health educators, counselors, nutritionists, safety engineers, and industrial hygienists. Occupational health nurses may:

- Provide direct care to employees who become ill or injured
- Conduct health education programs for company staff members
- Set up programs aimed at establishing specific health outcomes, such as healthy eating and regular exercise
- Monitor employees' hearing, vision, blood pressure, or blood glucose
- Track exposure to radiation, infectious diseases, and toxic substances, reporting results to government agencies as necessary

Occupational health nurses must be knowledgeable about federal regulations pertaining to occupational health and familiar with other pertinent legislation, such as the Americans With Disabilities Act.

## School Health Programs

School health programs provide services to students and may also serve the school's community. School-age children and adolescents with health problems are at major risk for underachieving or failing in school. The leading health problems of elementary school children are injuries, infections (including influenza and pneumonia), malnutrition, dental disease, and cancer. The leading problems of high school students are alcohol and drug abuse, injuries, homicide, pregnancy, eating disorders, sexually transmitted diseases/infections (STDs/STIs), sports injuries, dental disease, and mental and emotional problems. Contemporary school health issues that are being examined include school violence, which may affect students' and teachers' physical and emotional health, and the increasing numbers of overweight and obese children and adolescents.

Ideally, school health programs have an interdisciplinary health team consisting of physicians, nurses, dentists, social workers, counselors, school administrators, parents, and students. The school may serve as the site for a family health clinic that offers primary health and mental health services to children and adolescents as well as to all family members in the community. Advanced practice nurses perform physical examinations and diagnose and treat students and families for acute and chronic illnesses within the scope of their practice. These clinics are cost-effective and benefit students from low-income families who lack access to traditional health care or have no health insurance.

School nurses play a number of roles, including care provider, health educator, consultant, and counselor. They collaborate with students, parents, administrators, and other health and social service professionals regarding student health problems. School nurses perform health screenings, provide basic care for minor injuries and complaints, administer medications, monitor the immunization status of students and families, identify children with health problems, provide teaching related to health maintenance and safety, and monitor the weight of children in order to facilitate prevention and treatment of obesity. They need to be knowledgeable about state and local regulations affecting school-age children, such as ordinances for excluding students from school because of communicable diseases or parasites such as lice or scabies.

School nurses are also health education consultants for teachers. In addition to providing information on health practices, teaching health classes, and participating in the development of the health education curriculum, school nurses educate teachers and classes when a student has a special problem, a disability, or a disease such as hemophilia, asthma, or human immunodeficiency virus (HIV) infection.

## Community Nurse–Managed Centers

Community nurse–managed centers are a relatively new concept in community-based nursing, having appeared only in recent decades. Frequently sponsored by academic institutions, these centers typically are designed for the delivery of primary health care and typically serve people who are vulnerable, uninsured, and without access to health services. Community nurse–managed centers, which are usually run by advanced practice nurses, serve a large number of patients who are poor, members of minority groups, women, elderly, or homeless. The nurses provide health teaching, wellness and illness care, case management services, and psychosocial counseling (Pohl, Barkauskas, Benkert, et al., 2007). In some areas, various community partnership models facilitate care for the growing number of migrant workers.

## Care for the Homeless

Homelessness is a growing problem. The homeless population is heterogeneous and includes members of both dysfunctional and intact families, the unemployed, and those who cannot find affordable housing. In addition, increasing numbers of women with children (often victims of domestic abuse), elderly people, and veterans since the military action following the terrorist attacks of September 11, 2001, are homeless. Some people are temporarily homeless as a result of catastrophic natural disasters.

Homeless people are often underinsured or uninsured and have limited or no access to health care. Because of numerous barriers, they seek health care late in the course of a disease and deteriorate more quickly than patients who are not homeless. Many of their health problems are related in large part to their living situation. Street life exposes people to the extremes of hot and cold environments and it compounds their health risks. Homeless people have high rates of trauma, tuberculosis, upper respiratory tract infections, poor nutrition and anemia, lice, scabies, peripheral vascular disorders, STDs/STIs, dental problems, arthritis, hypothermia, skin disorders, and foot problems. Common chronic health problems also include diabetes, hypertension, heart disease, acquired immunodeficiency syndrome (AIDS), mental illness, and abuse of alcohol or other drugs (National Coalition for the Homeless, 2007a). These problems are made more difficult by living on the streets or discharge to a transitory, homeless situation in which follow-up care is unlikely. Shelters frequently are overcrowded and unventilated, promoting the spread of communicable diseases such as tuberculosis. Homeless people also tend to have a higher incidence of death prior to the age of 62 (National Coalition for the Homeless, 2006a, 2006b).

Community-based nurses who work with homeless people must be nonjudgmental, patient, and understanding. They must be skilled in dealing with people who have a wide variety of health problems and needs and must recognize that individualized treatment strategies are required in highly unpredictable environments. Nursing interventions are aimed at evaluating the health care needs of people who live in shelters and attempting to obtain health care services for all homeless people.

## CRITICAL THINKING EXERCISES

**1** You are a nurse employed at the health clinic of a community college. The dean asks you to organize a series of health fairs for the school year that focus on key problems of teenagers and young adults. How might you determine the key issues and trends that need to be addressed? Name the top five areas of concern that you will address.

EBP **2** A 27-year-old woman with newly diagnosed diabetes is being referred for home care after discharge from the hospital, and she needs glucose monitoring and teaching. She has several family members at home, but they all work. You are concerned about her ability to understand the basic information and applications for around-the-clock management. What resources could you use to assess her health literacy? How would you go about obtaining this information? What is the evidence base that supports conducting a literacy assessment to determine what is needed for appropriate home care follow-up in facilitating self-care measures in diabetes home care management? What is the strength of the evidence?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

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Centers for Disease Control and Prevention (CDC), www.cdc.gov
Centers for Medicare and Medicaid Services (CMS), www.cms.hhs.gov
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National Association for Home Care, www.nahc.org
National Association of School Nurses, Inc., Eastern Office, P.O. Box 1300, Scarborough, ME 04070-1300; 1-877-627-6476; www.nasn.org
National Guideline Clearing House (NGC), www.guideline.gov
National Institute for Literacy, www.nifl.gov
NurseLinx.com (MDLinx Inc.), 1025 Vermont Avenue, NW, Suite 810, Washington, DC 20005; 1-202-543-6544; www.nurselinx.com
Parish Nursing Health Information Resource, www.parishnursing.umaryland.edu
Urban Institute, www.urban.org



chapter 3

# Critical Thinking, Ethical Decision Making, and the Nursing Process

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Define the characteristics of critical thinking and critical thinkers.
2. Describe the critical thinking process.
3. Define ethics and nursing ethics.
4. Identify several ethical dilemmas common to the medical-surgical area of nursing practice.
5. Specify strategies that can be helpful to nurses in ethical decision making.
6. Describe the components of the nursing process.
7. Develop a plan of nursing care for a patient using strategies of critical thinking.

## GLOSSARY

**assessment:** the systematic collection of data to determine the patient's health status and any actual or potential health problems

**collaborative problems:** specific pathophysiologic manifestations that nurses monitor to detect onset or changes in status

**critical thinking:** a process of insightful thinking that utilizes multiple dimensions of one's cognition to develop conclusions, solutions, and alternatives that are appropriate for the given situation

**deontologic or formalist theory:** an ethical theory maintaining that ethical standards or principles exist independently of the ends or consequences

**ethics:** the formal, systematic study of moral beliefs

## GLOSSARY *(Continued)*

**evaluation:** determination of the patient's responses to the nursing interventions and the extent to which the outcomes have been achieved

**implementation:** actualization or carrying out of the plan of care through nursing interventions

**moral dilemma:** situation in which a clear conflict exists between two or more moral principles or competing moral claims

**moral distress:** conflict that arises within oneself when a person is aware of the correct course of action but institutional constraints stand in the way of pursuing the correct action

**moral problem:** competing moral claim or principle; one claim or principle is clearly dominant

**moral uncertainty:** conflict that arises within a person when he or she cannot accurately define what the moral situation is or what moral principles apply but has a strong feeling that something is not right

**morality:** the adherence to informal personal values

**nursing diagnoses:** actual or potential health problems that can be managed by independent nursing interventions

**nursing process:** a deliberate problem-solving approach for meeting people's health care and nursing needs; common components are assessment, diagnosis, planning, implementation, and evaluation

**planning:** development of goals and outcomes, as well as a plan of care designed to assist the patient in resolving the diagnosed problems and achieving the identified goals and desired outcomes

**teleologic theory or consequentialism:** the theoretical basis of ethics, which focuses on the ends or consequences of actions, such as utilitarianism

**utilitarianism:** a teleologic theory of ethics based on the concept of "the greatest good for the greatest number"

In today's health care arena, nurses face increasingly complex issues and situations resulting from advanced technology, greater acuity of patients in both hospital and community settings, an aging population, and complex disease processes, as well as ethical issues and cultural factors. The decision-making part of the problem-solving activities of nurses has become increasingly multifaceted and requires critical thinking.

## Critical Thinking

**Critical thinking** is a multidimensional skill, a cognitive or mental process or set of procedures. It involves reasoning and purposeful, systematic, reflective, rational, outcome-directed thinking based on a body of knowledge, as well as examination and analysis of all available information and ideas. Critical thinking leads to the formulation of conclusions and alternatives that are the most appropriate for the situation. Although many definitions of critical thinking have been offered in various disciplines, some consistent themes within those definitions are (1) a strong formal and informal foundation of knowledge; (2) willingness to pursue or ask questions; and (3) ability to develop solutions that are new, even those that do not fit the standard or current state of knowledge or attitudes. Willingness and openness to various viewpoints are inherent in critical thinking, and it is also important to reflect on the current situation (Banning, 2006). Critical thinking includes metacognition, the examination of one's own reasoning or thought processes, to help refine thinking skills. Independent judgments and decisions evolve from a sound knowledge base and the ability to synthesize information within the context in which it is presented. Nursing practice in today's society requires the use of high-level critical thinking skills. Critical thinking enhances clinical decision making, helping to identify patient needs and the best nursing actions that will assist patients in meeting those needs.

As previously stated, critical thinking is a conscious, outcome-oriented activity. It is not erratic but rather is systematic and organized. Critical thinkers are inquisitive truth seekers who are open to the alternative solutions that might surface. Alfaro-LeFevre (2008) identified critical thinkers as people who ideally are active thinkers, fair minded, open minded, persistent, empathic, independent in thought, good communicators, honest, organized and systematic, proactive, flexible, realistic, humble, cognizant of the rules of logic, curious and insightful, and creative and committed to excellence. The skills involved in critical thinking are developed over time through effort, practice, and experience.

### Rationality and Insight

Skills needed in critical thinking include interpretation, analysis, evaluation, inference, explanation, and self-regulation. Critical thinking requires background knowledge and knowledge of key concepts as well as logical thinking. Nurses use this disciplined process to validate the accuracy of data and the reliability of any assumptions they have made, and they then carefully evaluate the effectiveness of what they have identified as the necessary actions to take. Nurses also evaluate the reliability of sources, being mindful of and questioning inconsistencies. Nurses use interpretation to determine the significance of data that are gathered, analysis to identify patient problems suggested by the data, and inference to draw conclusions. Explanation is the justification of actions or interventions used to address patient problems and to help patients move toward desired outcomes. Evaluation is the process of determining whether outcomes have been or are being met. Self-regulation is the process of examining the care provided and adjusting the interventions as needed.

Critical thinking is also reflective, involving metacognition, active evaluation, and refinement of the thinking process. Nurses engaged in critical thinking consider the possibility of personal bias when interpreting data and determining appropriate actions. Critical thinkers must be insightful and have a sense of fairness and integrity, the courage to question personal ethics, and the perseverance to strive continuously to minimize the effects of egocentricity, ethnocentricity, and other biases on the decision-making process (Alfaro-LeFevre, 2008).

### Components of Critical Thinking

Certain cognitive or mental activities are key components of critical thinking. Critical thinkers:

- Ask questions to determine why certain developments have occurred and to see whether more information is needed to understand the situation accurately
- Gather as much relevant information as possible to consider as many factors as possible
- Validate the information presented to make sure that it is accurate (not just supposition or opinion), that it makes sense, and that it is based on fact and evidence
- Analyze the information to determine what it means and to see whether it forms clusters or patterns that point to certain conclusions
- Draw on past clinical experience and knowledge to explain what is happening and to anticipate what might happen next, acknowledging personal bias and cultural influences
- Maintain a flexible attitude that allows the facts to guide thinking and take into account all possibilities
- Consider available options and examine each in terms of its advantages and disadvantages
- Formulate decisions that reflect creativity and independent decision making

Critical thinking requires going beyond basic problem solving into a realm of inquisitive exploration, looking for all relevant factors that affect the issue, and being an "out-of-the-box" thinker. It includes questioning all findings until a comprehensive picture emerges that explains the phenomenon, possible solutions, and creative methods for proceeding (Wilkinson, 2007). Critical thinking in nursing practice results in a comprehensive plan of care with maximized potential for success.

### Critical Thinking in Nursing Practice

Critical thinking and decision making are thought to be associated with improved clinical expertise. Critical thinking is at the center of the process of clinical reasoning and clinical judgment (Jackson, 2006). Using critical thinking to

develop a plan of nursing care requires considering the human factors that might influence the plan. Nurses interact with patients, families, and other health care providers in the process of providing appropriate, individualized nursing care. The culture, attitude, and thought processes of nurses, patients, and others affect the critical thinking process from the data-gathering stage through the decision-making stage; therefore, aspects of the nurse–patient interaction must be considered (Wilkinson, 2007).

Nurses must use critical thinking skills in all practice settings—acute care, ambulatory care, extended care, and the home and community. Regardless of the setting, each patient situation is viewed as unique and dynamic. Key components of critical thinking behavior are withholding judgment and being open to options and explanations from one patient to another in similar circumstances (Jackson, 2006). The unique factors that patients and nurses bring to the health care situation are considered, studied, analyzed, and interpreted. Interpretation of the information then allows nurses to focus on those factors that are most relevant and most significant to the clinical situation. Decisions about what to do and how to do it are then developed into a plan of action.

In decision making related to the nursing process, nurses use intellectual skills in critical thinking. These skills include systematic and comprehensive assessment, recognition of assumptions and inconsistencies, verification of reliability and accuracy, identification of missing information, distinguishing relevant from irrelevant information, support of the evidence with facts and conclusions, priority setting with timely decision making, determination of patient-specific outcomes, and reassessment of responses and outcomes (Alfaro-LeFevre, 2008). For example, nurses use critical thinking and decision-making skills in providing genetics-related nursing care when they:

- Assess and analyze family history data for genetic risk factors
- Identify those individuals and families in need of referral for genetic testing or counseling
- Ensure the privacy and confidentiality of genetic information

To depict the process of "thinking like a nurse," Tanner (2006) developed a model known as the clinical judgment model. This model supports the idea that nurses engage in a complex process of clinical reasoning when caring for patients. Nurses draw on personal knowledge and experience from a variety of situations and consider the contextual background of the clinical culture. As nursing students develop their clinical reasoning skills and become professional nurses, their ability to reason clinically and to make sound clinical nursing judgments becomes more refined.

Because developing the skill of critical thinking takes time and practice, critical thinking exercises are offered at the end of each chapter as a means of honing the reader's ability to think critically. Some exercises include questions that stimulate the reader to seek information about evidence-based practice relative to the clinical situation described. Additional exercises may be found in the study guide that accompanies the text. The questions listed in Chart 3-1 can serve as a guide in working through the exercises. It is important to remember that each clinical situation is unique and calls for an individualized approach that fits its unique set of circumstances.

### Chart 3-1 • *The Inquiring Mind: Critical Thinking in Action*

Throughout the critical thinking process, a continuous flow of questions evolves in the thinker's mind. Although the questions will vary according to the particular clinical situation, certain general inquiries can serve as a basis for reaching conclusions and determining a course of action.

When faced with a patient situation, it is often helpful to seek answers to some or all of the following questions in an attempt to determine those actions that are most appropriate:

- What relevant assessment information do I need, and how do I interpret this information? What does this information tell me? What contextual factors must be considered when gathering this information?
- To what problems does this information point? Have I identified the most important ones? Does the information point to any other problems that I should consider?
- Have I gathered all the information I need (signs and symptoms, laboratory values, medication history, emotional factors, mental status)? Is anything missing?
- Is there anything that needs to be reported immediately? Do I need to seek additional assistance?
- Does this patient have any special risk factors? Which ones are most significant? What must I do to minimize these risks?
- What possible complications must I anticipate?
- What are the most important problems in this situation? Do the patient and the patient's family recognize the same problems?
- What are the desired outcomes for this patient? Which have the highest priority? Do the patient and I agree on these points?
- What is going to be my first action in this situation?
- How can I construct a plan of care to achieve the goals?
- Are there any age-related factors involved, and will they require some special approach? Will I need to make some change in the plan of care to take these factors into account?
- How do the family dynamics affect this situation, and will they have an effect on my actions or the plan of care?
- Are there cultural factors that I must address and consider?
- Am I dealing with an ethical issue here? If so, how am I going to resolve it?
- Has any nursing research been conducted on this subject? What are the nursing implications of this research for care of this patient?

## Ethical Nursing Care

In the complex modern world, we are surrounded by ethical issues in all facets of our lives. Consequently, there has been a heightened interest in the field of ethics in an attempt to gain a better understanding of how these issues influence us. Specifically, the focus on ethics in health care has intensified in response to controversial developments, including advances in technology and genetics, as well as diminished health care and financial resources.

Today, sophisticated technology can prolong life well beyond the time when death would have occurred in the past. Expensive experimental procedures, medications, equipment, and devices are available for attempting to preserve life, even when such attempts are likely to fail. The development of technologic support has influenced the quality and delivery of nursing care at all stages of life and also has contributed to an increase in average life expectancy. For example, the prenatal period has been influenced by genetic screening, in vitro fertilization, the harvesting and freezing of embryos, and prenatal surgery. Premature infants who once would have died early in life now may survive because of advances in technology. Children and adults who would have died of organ failure are living longer because of organ transplantation.

These advances in technology have been a mixed blessing. Questions have been raised about whether it is appropriate to use such technology, and if so, under what circumstances. Although many patients do achieve a better quality of life, others face extended suffering as a result of efforts to prolong life, usually at great expense. Ethical issues also surround those practices or policies that seem to allocate health care resources unjustly on the basis of age, race, gender, disability, or social mores.

The ethical dilemmas nurses may encounter in the medical-surgical nursing arena are numerous and diverse and occur in all settings. An awareness of underlying philosophical concepts helps nurses use reason to work through these dilemmas. Basic concepts related to moral philosophy, such as ethics and its terminology, theories, and approaches, are included in this chapter. Understanding the role of the professional nurse in ethical decision making helps nurses articulate their ethical positions and develop the skills needed to make ethical decisions.

### Ethics Versus Morality

The terms *ethics* and *morality* are used to describe beliefs about right and wrong and to suggest appropriate guidelines for action. In essence, **ethics** is the formal, systematic study of moral beliefs, whereas **morality** is the adherence to informal personal values. Because the distinction between *ethics* and *morality* is slight, the two terms are often used interchangeably.

### Ethics Theories

One classic theory in ethics is **teleologic theory or consequentialism,** which focuses on the ends or consequences of actions. The best-known form of this theory, **utilitarianism,** is based on the concept of "the greatest good for the greatest number." The choice of action is clear under this theory, because the action that maximizes good over bad is the correct one. The theory poses difficulty when one must judge intrinsic values and determine whose good is the greatest. In addition, it is important to ask whether good consequences can justify any amoral actions that might be used to achieve them.

Another theory in ethics is the **deontologic or formalist theory,** which argues that ethical standards or principles exist independently of the ends or consequences. In a given situation, one or more ethical principles may apply. Nurses have a duty to act based on the one relevant principle, or the most relevant of several ethical principles. Problems arise with this theory when personal and cultural biases influence the choice of the most primary ethical principle.

### Approaches to Ethics

Two approaches to ethics are meta-ethics and applied ethics. An example of meta-ethics (understanding the concepts and linguistic terminology used in ethics) in the health care environment is analysis of the concept of informed consent. Nurses are aware that patients must give consent before surgery, but sometimes a question arises as to whether a patient is truly informed. Delving more deeply into the concept of informed consent would be a meta-ethical inquiry.

An example of applied ethics is when a specific discipline identifies ethical problems within that discipline's practice. Various disciplines use the frameworks of general ethical theories and principles and apply them to specific problems within their domain. Common ethical principles that apply in nursing include autonomy, beneficence, confidentiality, double effect, fidelity, justice, nonmaleficence, paternalism, respect for people, sanctity of life, and veracity. Brief definitions of these important principles can be found in Chart 3-2.

Nursing ethics may be considered a form of applied ethics because it addresses moral situations that are specific to the nursing profession and patient care. Some ethical problems that affect nursing may also apply to the broader area of bioethics and health care ethics. Nursing has its own professional code of ethics.

### Moral Situations

Many situations exist in which ethical analysis is needed. Some are **moral dilemmas,** situations in which a clear conflict exists between two or more moral principles or competing moral claims, and nurses must choose the lesser of two evils. Other situations represent **moral problems,** in which there may be competing moral claims or principles, but one claim or principle is clearly dominant. Some situations result in **moral uncertainty,** when one cannot accurately define what the moral situation is or what moral principles apply but has a strong feeling that something is not right. Still other situations may result in **moral distress,** in which one is aware of the correct course of action but constraints stand in the way of pursuing the correct action.

For example, a patient tells a nurse that if he is dying he wants all possible measures taken to save his life. However, the surgeon and family have made the decision not to tell the patient that he is terminally ill and not to resuscitate him if he stops breathing. From an ethical

## Chart 3-2 • *Common Ethical Principles*

The following common ethical principles may be used to validate moral claims.

### Autonomy

This word is derived from the Greek words *autos* ("self") and *nomos* ("rule" or "law"), and therefore refers to self-rule. In contemporary discourse it has broad meanings, including individual rights, privacy, and choice. Autonomy entails the ability to make a choice free from external constraints.

### Beneficence

Beneficence is the duty to do good and the active promotion of benevolent acts (eg, goodness, kindness, charity). It may also include the injunction not to inflict harm (see nonmaleficence).

### Confidentiality

Confidentiality relates to the concept of privacy. Information obtained from an individual will not be disclosed to another unless it will benefit the person or there is a direct threat to the social good.

### Double Effect

This is a principle that may morally justify some actions that produce both good and evil effects.

All four of the following criteria must be fulfilled:

1. The action itself is good or morally neutral.
2. The agent sincerely intends the good and not the evil effect (the evil effect may be foreseen but is not intended).
3. The good effect is not achieved by means of the evil effect.
4. There is proportionate or favorable balance of good over evil.

### Fidelity

Fidelity is promise keeping; the duty to be faithful to one's commitments. It includes both explicit and implicit promises to another person.

### Justice

From a broad perspective, justice states that like cases should be treated alike. A more restricted version of justice is *distributive justice,* which refers to the distribution of social benefits and burdens based on various criteria that may include the following:

Equality
Individual need
Individual effort
Societal contribution
Individual merit
Legal entitlement

*Retributive justice* is concerned with the distribution of punishment.

### Nonmaleficence

This is the duty not to inflict harm as well as to prevent and remove harm. Nonmaleficence may be included within the principle of beneficence, in which case nonmaleficence would be more binding.

### Paternalism

Paternalism is the intentional limitation of another's autonomy, justified by an appeal to beneficence or the welfare or needs of another. Under this principle, the prevention of evil or harm takes precedence over any potential evil caused by interference with the individual's autonomy or liberty.

### Respect for Persons

*Respect for persons* is frequently used synonymously with *autonomy*. However, it goes beyond accepting the notion or attitude that people have autonomous choices, to treating others in such a way that enables them to make choices.

### Sanctity of Life

This is the perspective that life is the highest good. Therefore, all forms of life, including mere biologic existence, should take precedence over external criteria for judging quality of life.

### Veracity

Veracity is the obligation to tell the truth and not to lie or deceive others.

perspective, the patient should be told the truth about his diagnosis and should have the opportunity to make decisions about treatment. Ideally, this information should come from the physician, with the nurse present to assist the patient in understanding the terminology and to provide further support, if necessary. In this situation, a moral problem exists because of the competing moral claims of the family and physician, who wish to spare the patient distress, and the nurse, who wishes to be truthful with the patient. If the patient's competency were questionable, a moral dilemma would exist because no dominant principle would be evident. The nurse could experience moral distress if the hospital threatened disciplinary action or job termination because the information is disclosed to the patient without the agreement of the physician or the family, or both.

It is essential that nurses freely engage in dialogue concerning moral situations, even though such dialogue is difficult for everyone involved. Improved interdisciplinary communication is supported when all members of the health care team can voice their concerns and come to an understanding of the moral situation. The use of an ethics consultant or consultation team could be helpful to assist the health care team, patient, and family to identify the moral dilemma and possible approaches to the dilemma. Nurses should be familiar with agency policy supporting patient self-determination and resolution of ethical issues.

## Types of Ethical Problems in Nursing

As a profession, nursing is accountable to society. This accountability is spelled out in the American Hospital

Association's Patient Care Partnership, which reflects social beliefs about health and health care. In addition to accepting this document as one measure of accountability, nursing has further defined its standards of accountability through a formal code of ethics that explicitly states the profession's values and goals. The code (Chart 3-3), established by the American Nurses Association (ANA), consists of ethical standards, each with its own interpretive statements (ANA, 2001). The interpretive statements provide guidance to address and resolve ethical dilemmas by incorporating universal moral principles. The code is an ideal framework for nurses to use in ethical decision making.

Ethical issues have always affected the role of professional nurses. The accepted definition of professional nursing supports the advocacy role for nurses. The ANA, in *Nursing's Social Policy Statement* (2003, p. 6), defines nursing as "the protection, promotion, and optimization of health and abilities, prevention of illness and injury, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, communities, and populations." This definition supports the claim that nurses must be actively involved in the decision-making process regarding ethical concerns surrounding health care and human responses. Efforts to enact this standard may cause conflict in health care settings in which the traditional roles of nurses are delineated within a bureaucratic structure. However, if nurses learn to present ethical conflicts within a logical, systematic framework, struggles over jurisdictional boundaries may decrease. Health care settings in which nurses are valued members of the team promote interdisciplinary communication and may enhance patient care. To practice effectively in these settings, nurses must be aware of ethical issues and assist patients in voicing their moral concerns.

Nursing theories that incorporate the biopsychosocial–spiritual dimensions emphasize a holistic viewpoint, with humanism or caring at the core. As the nursing profession strives to delineate its own theory of ethics, caring is often cited as the moral foundation. For nurses to embrace this professional ethos, they must be aware not only of major ethical dilemmas, but also of those daily interactions with health care consumers that frequently give rise to less easily identifiable ethical challenges. Although technologic advances and diminished resources have been instrumental in raising numerous ethical questions and controversies, including life-and-death issues, nurses should not ignore the many routine situations that involve ethical considerations. Some of the most common issues faced by nurses today include confidentiality, use of restraints, trust, refusing care, and end-of-life concerns.

### Confidentiality

All nurses should be aware of the confidential nature of information obtained in daily practice. If information is not pertinent, they should question whether it is prudent to document it in a patient's record. In the practice setting, discussion of patients with other members of the health care team is often necessary. However, these discussions should occur in a private area where it is unlikely that the conversation will be overheard. Nurses should also be aware that the use of family members as interpreters for patients who are not fluent in the English language or who are deaf violates patients' rights of confidentiality. Translation services should be provided for non–English-speaking patients and interpreters should be provided for those who use sign language.

Another threat to confidentiality is the widespread use of computer-based technologies and people's easy access to them. The growing demand for tele-health innovations and the increasing use of this new method can result in unchecked access to health information. In addition, personal

**Chart 3-3 • *American Nurses Association Code of Ethics for Nurses***

1. The nurse, in all professional relationships, practices with compassion and respect for the inherent dignity, worth, and uniqueness of every individual, unrestricted by considerations of social or economic status, personal attributes, or the nature of health problems.
2. The nurse's primary commitment is to the patient, whether an individual, family, group, or community.
3. The nurse promotes, advocates for, and strives to protect the health, safety, and rights of the patient.
4. The nurse is responsible and accountable for individual nursing practice and determines the appropriate delegation of tasks consistent with the nurse's obligation to provide optimum patient care.
5. The nurse owes the same duties to self as to others, including the responsibility to preserve integrity and safety, to maintain competence, and to continue personal and professional growth.
6. The nurse participates in establishing, maintaining, and improving health care environments and conditions of employment conducive to the provision of quality health care and consistent with the values of the profession through individual and collective action.
7. The nurse participates in the advancement of the profession through contributions to practice, education, administration, and knowledge development.
8. The nurse collaborates with other health professionals and the public in promoting community, national, and international efforts to meet health needs.
9. The profession of nursing, as represented by associations and their members, is responsible for articulating nursing values, for maintaining the integrity of the profession and its practice, and for shaping social policy.

and health information is often made available to numerous individuals and corporate stakeholders, which may increase the potential for misuse of health care information. Because of these possibilities of maleficence (see Chart 3-2), sensitivity to the principle of confidentiality is essential. Federal legislation has been developed to protect the right of confidentiality. According to the Health Insurance Portability and Accountability Act (HIPAA) (U.S. Department of Health and Human Services [USDHHS], 2003), efforts must be made to protect each patient's private information, whether it is transmitted by verbal, written, or electronic means of communication. Communication should be confined to the appropriate settings and with appropriate individuals, and occur for the appropriate purposes of facilitating patient care. Violations of protection of any patient's privacy could result in criminal or civil litigation (USDHHS, 2007).

### Restraints

The use of restraints (including physical and pharmacologic measures) is another issue with ethical overtones because of the perception of imprisonment when restraints are used. It is important to weigh carefully the risks of limiting a person's autonomy and increasing the risk of injury by using restraints against the risks of not using restraints; they have been documented as resulting in physical harm and death. Before restraints are used, other strategies, such as asking family members to sit with the patient or utilizing a specially trained sitter, should be tried. The Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations [JCAHO]) and the Centers for Medicare and Medicaid Services (CMS) have designated standards for use of restraints; these standards are available on the Web site listed at the end of this chapter.

### Trust Issues

Telling the truth (veracity) is one of the basic principles of our culture. Three ethical dilemmas in clinical practice that can directly conflict with this principle are the use of placebos (nonactive substances used for treatment), not revealing a diagnosis to a patient, and revealing a diagnosis to people other than the patient with the diagnosis. All involve the issue of trust, which is an essential element in the nurse–patient relationship.

Placebos may be used in experimental research, in which a patient is involved in the decision-making process and is aware that placebos are being used in the treatment regimen. However, the use of a placebo as a substitute for an active drug to show that a patient does not have actual symptoms of a disease is deceptive, and this practice may severely undermine the nurse–patient relationship.

Informing a patient of his or her diagnosis when the family and physician have chosen to withhold information is a common ethical situation in nursing practice. The nursing staff may often use evasive comments with the patient as a means of maintaining professional relationships with other health practitioners. This area is indeed complex, because it challenges a nurse's integrity. Strategies nurses could consider include the following:

- Not lying to the patient
- Providing all information related to nursing procedures and diagnoses
- Communicating the patient's requests for information to the family and physician. The family is often unaware of the patient's repeated questions to the nurse. With a better understanding of the situation, the family members may change their perspective

Although providing the information may be the morally appropriate behavior, the manner in which the patient is told is important. Nurses must be compassionate and caring while informing patients; disclosure of information merely for the sake of patient autonomy does not convey respect for others.

Disclosing the patient's diagnosis to others without the patient's consent is a HIPAA violation and, therefore, is not only unethical, but also illegal.

### Refusing to Provide Care

Any nurse who feels compelled to refuse to provide care for a particular type of patient faces an ethical dilemma. The reasons given for refusal range from a conflict of personal values to fear of personal injury. Feelings related to care of people of different cultures also surface as changes emerge in the cultural makeup of the U.S. population. For example, a highly publicized case in 2007 involved a Latina patient who died after she hemorrhaged in the emergency department of an urban California hospital (MSNBC News, June 13, 2007). The ethical dilemmas surrounding this case relative to lack of care of the patient put many health care personnel, including nurses, under close scrutiny. The ethical obligation to care for all patients is clearly identified in the first statement of the *Code of Ethics for Nurses* (ANA, 2001). To avoid facing ethical dilemmas, nurses can follow certain strategies. For example, when applying for a job, a nurse should ask questions regarding the patient population. If a nurse is uncomfortable with a particular situation, then not accepting the position would be an option. Denial of care, or providing substandard nursing care to some members of society, is not acceptable nursing practice.

### End-of-Life Issues

Dilemmas that center on death and dying are prevalent in medical-surgical nursing practice and frequently initiate discussion. With the availability of increasingly sophisticated and advanced technology, it may be difficult to accept that nothing more can be done to prolong life or that technology may prolong life but at the expense of the patient's comfort and quality of life. Nurses are being faced with increasingly controversial dilemmas concerning patients' desires to avoid prolongation of life. Many people who are terminally ill seek legal options for a peaceful and dignified death.

End-of-life issues shift the focus from curative care to palliative and end-of-life care. Focusing on the caring as well as the curing role may help nurses deal with these difficult moral situations. Needs of patients and families require holistic and interdisciplinary approaches. End-of-life issues that often involve ethical dilemmas include pain control, "do not resuscitate" orders, life support measures, and administration of food and fluids. These are discussed in detail in Chapter 17.

## Preventive Ethics

When a nurse is faced with two conflicting alternatives, it is his or her moral decision to choose the lesser of the

two evils. Various preventive strategies are available to help nurses anticipate or avoid certain kinds of ethical dilemmas.

Frequently, dilemmas occur when health care practitioners are unsure of the patient's wishes because the patient is unconscious or too cognitively impaired to communicate directly. The Patient Self-Determination Act, enacted in December 1991, encourages people to prepare advance directives in which they indicate their wishes concerning the degree of supportive care they wish if they become incapacitated. This legislation requires that patients be informed about advance directives by the staff of the health care facility.

In 2005, the highly publicized case of Terri Schiavo focused national attention on the importance of advance directives. Schiavo was a young woman who suffered severe brain damage in 1990 after her heart stopped because of a chemical imbalance that was believed to have been caused by an eating disorder. Court-appointed physicians ruled she was in a persistent vegetative state with no chance of recovery. She left no living will or advance directive. Her husband requested that her feeding tube be removed to allow her to die, but her parents opposed this for 7 years. They involved the courts, Congress, and the president. After the courts ruled that her feeding tube could be removed, Terri Schiavo died in 2005. This case represents an area in which nurses can play a significant role in patient education about the significance of advance directives.

#### Advance Directives

Advance directives are legal documents that specify a person's wishes before hospitalization and provide valuable information that may assist health care providers in decision making. A living will is one type of advance directive. In most situations, living wills are limited to situations in which the patient's medical condition is deemed terminal. Because it is difficult to define "terminal" accurately, living wills are not always honored. Another potential drawback is that living wills are frequently written while people are in good health. It is not unusual for people to change their minds as an illness progresses; therefore, patients retain the option to nullify these documents.

Durable power of attorney for health care, in which one person identifies another person to make health care decisions on his or her behalf, is another type of advance directive. Patients may have clarified their wishes concerning a variety of medical situations. The power of attorney for health care is a less restrictive type of advance directive. Laws concerning advance directives vary among state jurisdictions. However, even in states where these documents are not legally binding, they provide helpful information to determine the patient's prior expressed wishes in situations in which this information can no longer be obtained. (See Chapter 17 for further discussion of end-of-life care.)

#### Ethics Committees

Institutional ethics committees exist in many hospitals to assist clinicians with ethical dilemmas. The purpose of these multidisciplinary committees varies among institutions. In some hospitals, the committees exist solely for the purpose of developing policies, whereas in others, they may have a strong educational or consultation focus. These committees usually are composed of people with some advanced training in ethics and are important resources for the health care team, patient, and family. Nurses with a particular interest or expertise in the area of ethics can serve as members of these committees, which are valuable resources for staff nurses.

The heightened interest in ethical decision making has resulted in many continuing education programs, ranging from small seminars or workshops to full-semester courses offered by local colleges or professional organizations. In addition, nursing and medical journals contain articles on ethical issues, and numerous textbooks on clinical ethics or nursing ethics are available. The resources listed at the end of this chapter are valuable because they discuss ethical theory and dilemmas of practice in greater depth.

### Ethical Decision Making

As noted in the preceding discussions, ethical dilemmas are common and diverse in nursing practice. Situations vary, and experience indicates that there are no clear solutions to these dilemmas. However, the fundamental philosophical principles are the same, and the process of moral reflection helps nurses justify their actions. The approach to ethical decision making can follow the steps of the nursing process. Chart 3-4 outlines the steps of an ethical analysis.

## The Nursing Process

### Definition

The **nursing process** is a deliberate problem-solving approach for meeting people's health care and nursing needs. Although the steps of the nursing process have been stated in various ways by different writers, the common components cited are assessment, diagnosis, planning, implementation, and evaluation. ANA's *Standards of Clinical Nursing Practice* (2004) includes an additional component entitled outcome identification and establishes the sequence of steps in the following order: **assessment,** diagnosis, outcome identification, **planning, implementation,** and **evaluation.** For the purposes of this text, the nursing process is based on the traditional five steps and delineates two components in the diagnosis step: **nursing diagnoses** and **collaborative problems.** After the diagnoses or problems have been determined, the desired outcomes are often evident. The traditional steps are defined as follows:

1. *Assessment:* The systematic collection of data to determine the patient's health status and any actual or potential health problems. (Analysis of data is included as part of the assessment. Analysis may also be identified as a separate step of the nursing process.)
2. *Diagnosis:* Identification of the following two types of patient problems:
   - *Nursing diagnoses:* Actual or potential health problems that can be managed by independent nursing interventions
   - *Collaborative problems:* "Certain physiologic complications that nurses monitor to detect onset or

## Chart 3-4 • *Steps of an Ethical Analysis*

The following are guidelines to assist nurses in ethical decision making. These guidelines reflect an active process in decision making, similar to the nursing process detailed in this chapter.

**Assessment**

1. Assess the ethical/moral situations of the problem. This step entails recognition of the ethical, legal, and professional dimensions involved.
   a. Does the situation entail substantive moral problems (conflicts among ethical principles or professional obligations)?
   b. Are there procedural conflicts? (For example, who should make the decisions? Any conflicts among the patient, health care providers, family and guardians?)
   c. Identify the significant people involved and those affected by the decision.

**Planning**

2. Collect information.
   a. Include the following information: the medical facts, treatment options, nursing diagnoses, legal data, and the values, beliefs, and religious components.
   b. Make a distinction between the factual information and the values/beliefs.
   c. Validate the patient's capacity, or lack of capacity, to make decisions.
   d. Identify any other relevant information that should be elicited.
   e. Identify the ethical/moral issues and the competing claims.

**Implementation**

3. List the alternatives. Compare alternatives with applicable ethical principles and professional code of ethics. Choose either of the frameworks below, or other frameworks, and compare outcomes.
   a. *Utilitarian approach:* Predict the consequences of the alternatives; assign a positive or negative value to each consequence; choose the consequence that predicts the highest positive value or "the greatest good for the greatest number."
   b. *Deontologic approach:* Identify the relevant moral principles; compare alternatives with moral principles; appeal to the "higher-level" moral principle if there is a conflict.

**Evaluation**

4. Decide and evaluate the decision.
   a. What is the best or morally correct action?
   b. Give the ethical reasons for your decision.
   c. What are the ethical reasons against your decision?
   d. How do you respond to the reasons against your decision?

changes in status. Nurses manage collaborative problems using physician-prescribed and nurse-prescribed interventions to minimize the complications of the events" (Carpenito-Moyet, 2008 pg. 19).

3. *Planning:* Development of goals and outcomes, as well as a plan of care designed to assist the patient in resolving the diagnosed problems and achieving the identified goals and desired outcomes
4. *Implementation:* Actualization of the plan of care through nursing interventions
5. *Evaluation:* Determination of the patient's responses to the nursing interventions and the extent to which the outcomes have been achieved

Dividing the nursing process into distinct steps serves to emphasize the essential nursing actions that must be taken to address the patient's nursing diagnoses and manage any collaborative problems or complications. However, dividing the process into separate steps is artificial: The process functions as an integrated whole, with the steps being interrelated, interdependent, and recurrent (Fig. 3-1). Chart 3-5 presents an overview of the nursing activities involved in applying the nursing process.

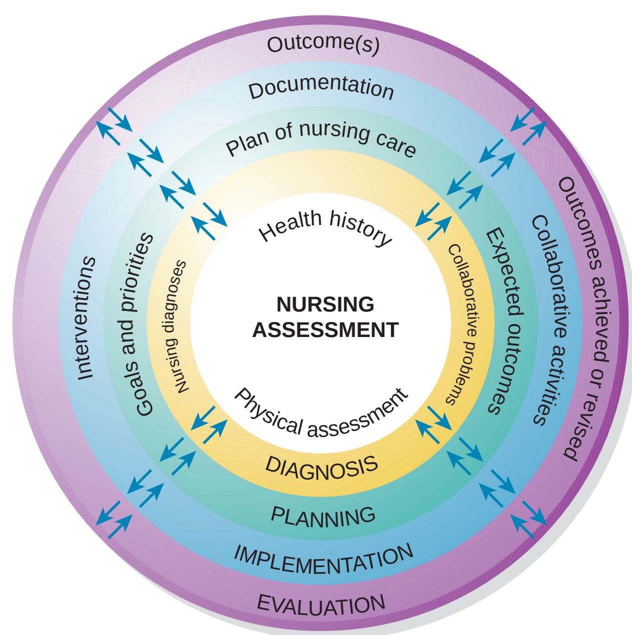



**Figure 3-1** The nursing process is depicted schematically in this circle. Starting from the innermost circle, nursing assessment, the process moves outward through the formulation of nursing diagnoses and collaborative problems; planning, with setting of goals and priorities in the nursing plan of care; implementation and documentation; and, finally, the ongoing process of evaluation and outcomes.

## Using the Nursing Process

### *Assessment*

Assessment data are gathered through the health history and the physical assessment. In addition, ongoing monitoring is crucial to remain aware of changing patient needs and the effectiveness of nursing care.

## Chart 3-5 • *Steps of the Nursing Process*

### Assessment

1. Conduct the health history.
2. Perform the physical assessment.
3. Interview the patient's family or significant others.
4. Study the health record.
5. Organize, analyze, synthesize, and summarize the collected data.

### Diagnosis

**Nursing Diagnosis**

1. Identify the patient's nursing problems.
2. Identify the defining characteristics of the nursing problems.
3. Identify the etiology of the nursing problems.
4. State nursing diagnoses concisely and precisely.

**Collaborative Problems**

1. Identify potential problems or complications that require collaborative interventions.
2. Identify health team members with whom collaboration is essential.

### Planning

1. Assign priority to the nursing diagnoses.
2. Specify the goals.
   a. Develop immediate, intermediate, and long-term goals.
   b. State the goals in realistic and measurable terms.
3. Identify nursing interventions appropriate for goal attainment.
4. Establish expected outcomes.
   a. Make sure that the outcomes are realistic and measurable.
   b. Identify critical times for the attainment of outcomes.
5. Develop the written plan of nursing care.
   a. Include nursing diagnoses, goals, nursing interventions, expected outcomes, and critical times.
   b. Write all entries precisely, concisely, and systematically.
   c. Keep the plan current and flexible to meet the patient's changing problems and needs.
6. Involve the patient, family or significant others, nursing team members, and other health team members in all aspects of planning.

### Implementation

1. Put the plan of nursing care into action.
2. Coordinate the activities of the patient, family or significant others, nursing team members, and other health team members.
3. Record the patient's responses to the nursing actions.

### Evaluation

1. Collect data.
2. Compare the patient's actual outcomes with the expected outcomes. Determine the extent to which the expected outcomes were achieved.
3. Include the patient, family or significant others, nursing team members, and other health care team members in the evaluation.
4. Identify alterations that need to be made in the nursing diagnoses, collaborative problems, goals, nursing interventions, and expected outcomes.
5. Continue all steps of the nursing process: assessment, diagnosis, planning, implementation, and evaluation.

### Health History

The health history is conducted to determine a person's state of wellness or illness and is best accomplished as part of a planned interview. The interview is a personal dialogue between a patient and a nurse that is conducted to obtain information. The nurse's approach to the patient largely determines the amount and quality of the information that is received. To achieve a relationship of mutual trust and respect, the nurse must have the ability to communicate a sincere interest in the patient. Examples of effective therapeutic communication techniques that can be used to achieve this goal are found in Table 3-1.

The use of a health history guide may help in obtaining pertinent information and in directing the course of the interview. A variety of health history formats designed to guide the interview are available, but they must be adapted to the responses, problems, and needs of the person. See Chapter 5 for further information about the health history.

### Physical Assessment

A physical assessment may be carried out before, during, or after the health history, depending on a patient's physical and emotional status and the immediate priorities of the situation. The purpose of the physical assessment is to identify those aspects of a patient's physical, psychological, and emotional state that indicate a need for nursing care. It requires the use of sight, hearing, touch, and smell, as well as appropriate interview skills and techniques. Physical examination techniques as well as techniques and strategies for assessing behaviors and role changes are presented in Chapters 5 and 7 and in each unit of this book.

### Other Components of the Assessment

Additional relevant information should be obtained from the patient's family or significant others, from other members of the health team, and from the patient's health record or chart. Depending on the patient's immediate needs, this information may have been completed before the health history and the physical assessment were obtained. Whatever the sequence of events, it is important to use all available sources of pertinent data to complete the nursing assessment.

### Recording the Data

After the health history and physical assessment are completed, the information obtained is recorded in the patient's permanent record. This record provides a means of

**Table 3-1 THERAPEUTIC COMMUNICATION TECHNIQUES**

| Technique | Definition | Therapeutic Value |
|---|---|---|
| Listening | Active process of receiving information and examining one's reactions to the messages received | Nonverbally communicates nurse's interest in patient |
| Silence | Periods of no verbal communication among participants for therapeutic reasons | Gives patient time to think and gain insights, slows the pace of the interaction, and encourages the patient to initiate conversation, while conveying the nurse's support, understanding, and acceptance |
| Restating | Repeating to the patient what the nurse believes is the main thought or idea expressed | Demonstrates that the nurse is listening and validates, reinforces, or calls attention to something important that has been said |
| Reflection | Directing back to the patient his or her feelings, ideas, questions, or content | Validates the nurse's understanding of what the patient is saying and signifies empathy, interest, and respect for the patient |
| Clarification | Asking the patient to explain what he or she means or attempting to verbalize vague ideas or unclear thoughts of the patient to enhance the nurse's understanding | Helps to clarify the patient's feelings, ideas, and perceptions and to provide an explicit correlation between them and the patient's actions |
| Focusing | Questions or statements to help the patient develop or expand an idea | Allows the patient to discuss central issues and keeps communication goal-directed |
| Broad openings | Encouraging the patient to select topics for discussion | Indicates acceptance by the nurse and the value of the patient's initiative |
| Humor | Discharge of energy through the comic enjoyment of the imperfect | Promotes insight by bringing repressed material to consciousness, resolving paradoxes, tempering aggression, and revealing new options; a socially acceptable form of sublimation |
| Informing | Providing information | Helpful in health teaching or patient education about relevant aspects of patient's well-being and self-care |
| Sharing perceptions | Asking the patient to verify the nurse's understanding of what the patient is thinking or feeling | Conveys the nurse's understanding to the patient and has the potential to clarify confusing communication |
| Theme identification | Underlying issues or problems experienced by the patient that emerge repeatedly during the course of the nurse-patient relationship | Allows the nurse to best promote the patient's exploration and understanding of important problems |
| Suggesting | Presentation of alternative ideas for the patient's consideration relative to problem solving | Increases the patient's perceived options or choices |

Adapted from Stuart, G. W. & Laraia, M. T. (2005). *Principles and practice of psychiatric nursing* (8th ed.). St Louis: CV Mosby.

communication among members of the health care team and facilitates coordinated planning and continuity of care. The record fulfills other functions as well:

- It serves as the legal and business record for a health care agency and for the professional staff members who are responsible for the patient's care. A variety of systems are used for documenting patient care, and each health care agency selects the system that best meets its needs.
- It serves as a basis for evaluating the quality and appropriateness of care and for reviewing the effective use of patient care services.
- It provides data that are useful in research, education, and short- and long-range planning.

### *Diagnosis*

The assessment component of the nursing process serves as the basis for identifying nursing diagnoses and collaborative problems. Soon after the completion of the health history and the physical assessment, nurses organize, analyze, synthesize, and summarize the data collected and determine the patient's need for nursing care.

#### Nursing Diagnosis

Nursing diagnoses, the first taxonomy created in nursing, have fostered autonomy and accountability in nursing and have helped delineate the scope of practice. Many state nurse practice acts include nursing diagnosis as a nursing function, and nursing diagnosis is included in the ANA's *Standards of Clinical Nursing Practice* (ANA, 2004) and the standards of nursing specialty organizations.

North American Nursing Diagnosis Association (NANDA) International is the official organization responsible for developing the taxonomy of nursing diagnoses and formulating nursing diagnoses acceptable for study. Approved nursing diagnoses are compiled and categorized by NANDA International in a taxonomy that is updated to maintain currency. The diagnostic labels identified by NANDA International (2008) have been generally accepted, but ongoing validation, refinement, and expansion based on clinical use and research are encouraged. They are not yet complete or mutually exclusive, and more research is needed to determine their validity and clinical applicability.

### Choosing a Nursing Diagnosis

When choosing the nursing diagnoses for a particular patient, nurses must first identify the commonalities among the assessment data collected. These common features lead to the categorization of related data that reveal the existence of a problem and the need for nursing intervention. The identified problems are then defined as specific nursing diagnoses. Nursing diagnoses represent actual or potential health problems that can be managed by independent nursing actions.

It is important to remember that nursing diagnoses are not medical diagnoses; they are not medical treatments prescribed by the physician, and they are not diagnostic studies. Rather, they are succinct statements in terms of specific patient problems that guide nurses in the development of the nursing plan of care.

To give additional meaning to the nursing diagnosis, the characteristics and the etiology of the problem are identified and included as part of the diagnosis. For example, the nursing diagnoses and their defining characteristics and etiology for a patient who has anemia may include the following:

- Activity intolerance related to weakness and fatigue
- Ineffective tissue perfusion related to inadequate blood volume
- Imbalanced nutrition: Less than body requirements related to fatigue and inadequate intake of essential nutrients

### Collaborative Problems

In addition to nursing diagnoses and their related nursing interventions, nursing practice involves certain situations and interventions that do not fall within the definition of nursing diagnoses. These activities pertain to potential problems or complications that are medical in origin and require collaborative interventions with the physician and other members of the health care team. The term *collaborative problem* is used to identify these situations.

Collaborative problems are certain physiologic complications that nurses monitor to detect changes in status or onset of complications. Nurses manage collaborative problems using physician-prescribed and nurse-prescribed interventions to minimize complications (Carpenito-Moyet, 2008). When treating collaborative problems, a primary nursing focus is monitoring patients for the onset of complications or changes in the status of existing complications. The complications are usually related to the disease process, treatments, medications, or diagnostic studies. The nurse recommends nursing interventions that are appropriate for managing the complications and implements the treatments prescribed by the physician. The algorithm in Figure 3-2 depicts the differences between nursing diagnoses and collaborative problems. After the nursing diagnoses and collaborative problems have been identified, they are recorded on the plan of nursing care.

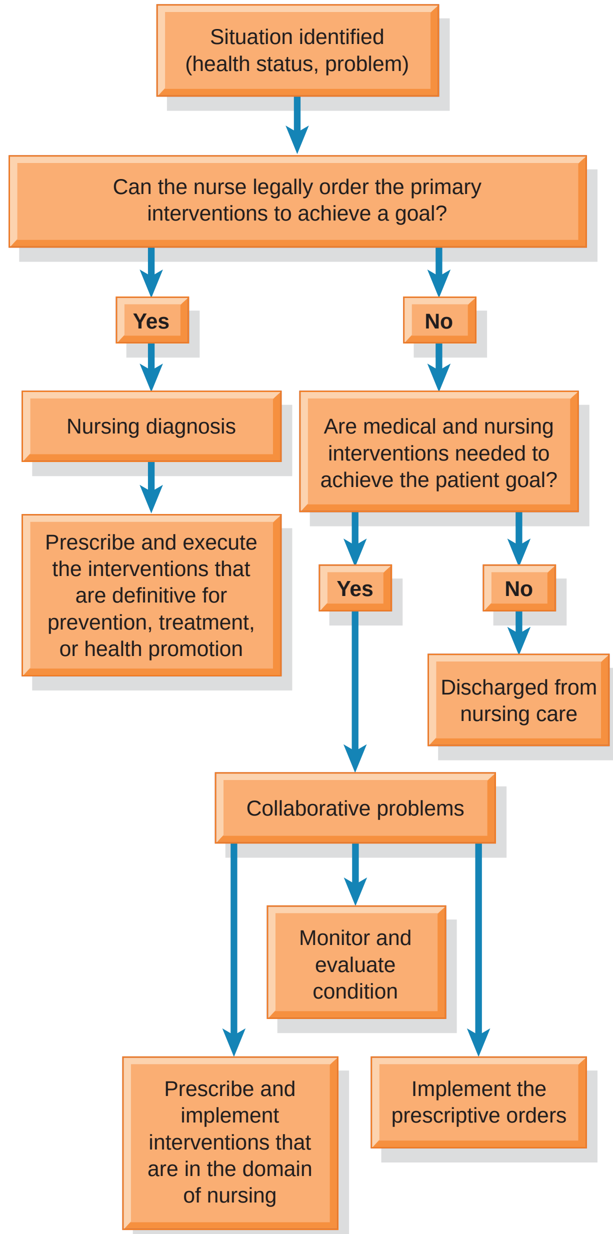



**Figure 3-2** Differentiating nursing diagnoses and collaborative problems. Redrawn from Carpenito-Moyet, L. J. (2008). *Nursing diagnosis: Application to clinical practice* (12th ed., p. 28). Philadelphia: Lippincott Williams & Wilkins.

### *Planning*

Once the nursing diagnoses have been identified, the planning component of the nursing process begins. This phase involves the following steps:

1. Assigning priorities to the nursing diagnoses and collaborative problems
2. Specifying expected outcomes
3. Specifying the immediate, intermediate, and long-term goals of nursing action
4. Identifying specific nursing interventions appropriate for attaining the outcomes
5. Identifying interdependent interventions
6. Documenting the nursing diagnoses, collaborative problems, expected outcomes, nursing goals, and nursing interventions on the plan of nursing care
7. Communicating to appropriate personnel any assessment data that point to health care needs that can

best be met by other members of the health care team

### Setting Priorities

Assigning priorities to the nursing diagnoses and collaborative problems is a joint effort by the nurse and the patient or family members. Any disagreement about priorities is resolved in a way that is mutually acceptable. Consideration must be given to the urgency of the problems, with the most critical problems receiving the highest priority. The Maslow hierarchy of needs provides one framework for prioritizing problems, with importance being given first to physical needs; once those basic needs are met, higher-level needs can be addressed. See Chapter 1 for a further discussion of the Maslow hierarchy.

### Establishing Expected Outcomes

Expected outcomes of the nursing interventions are expressed in terms of the patient's behaviors and the time period in which the outcomes are to be achieved, as well as any special circumstances related to achieving the outcome (Smith-Temple & Johnson, 2005). These outcomes must be realistic and measurable. Resources for identifying appropriate expected outcomes include the Nursing-Sensitive Outcomes Classification (NOC) (Chart 3-6) and standard outcome criteria established by health care agencies for people with specific health problems. These outcomes can be associated with nursing diagnoses and interventions and can be used when appropriate. However, the NOC may need to be adapted to establish realistic criteria for the specific patient involved.

## Chart 3-6 • *Nursing-Sensitive Outcomes Classification (NOC)*

The NOC is a classification of patient outcomes sensitive to nursing interventions. Each outcome is a neutral statement about a variable patient condition, behavior, or perception, coupled with a rating scale. The outcome statement and scale can be used to identify baseline functioning, expected outcomes, and actual outcomes for individual patients. The following table is an example of a nursing-sensitive outcome.

**Respiratory Status: Gas Exchange (0402)**

***Domain—Physiologic Health (II)***
***Class—Cardiopulmonary (E)***
***Scale(s)—Severe deviation from normal range to No deviation from normal range (b) and Severe to None (n)***
***Definition:*** Alveolar exchange of carbon dioxide and oxygen to maintain arterial blood gas concentrations.

***Outcome Target Rating Maintain at ____ Increase to ___***

| **Respiratory Status: Gas Exchange Overall Rating** | | **Severe Deviation from Normal Range 1** | **Substantial Deviation from Normal Range 2** | **Moderate Deviation from Normal Range 3** | **Mild Deviation from Normal Range 4** | **No Deviation from Normal Range 5** | |
|---|---|---|---|---|---|---|---|
| Indicators | | | | | | | |
| 040208 | Partial pressure of oxygen in arterial blood ($PaO_2$) | 1 | 2 | 3 | 4 | 5 | NA |
| 040209 | Partial pressure of carbon dioxide in arterial blood ($PaCO_2$) | 1 | 2 | 3 | 4 | 5 | NA |
| 040210 | Arterial pH | 1 | 2 | 3 | 4 | 5 | NA |
| 040211 | Oxygen saturation | 1 | 2 | 3 | 4 | 5 | NA |
| 040212 | End-tidal carbon dioxide | 1 | 2 | 3 | 4 | 5 | NA |
| 040213 | Chest x-ray findings | 1 | 2 | 3 | 4 | 5 | NA |
| 040214 | Ventilation–perfusion balance | 1 | 2 | 3 | 4 | 5 | NA |
| | | **Severe** | **Substantial** | **Moderate** | **Mild** | **None** | |
| 040203 | Dyspnea at rest | 1 | 2 | 3 | 4 | 5 | NA |
| 040204 | Dyspnea with mild exertion | 1 | 2 | 3 | 4 | 5 | NA |
| 040205 | Restlessness | 1 | 2 | 3 | 4 | 5 | NA |
| 040206 | Cyanosis | 1 | 2 | 3 | 4 | 5 | NA |
| 040207 | Somnolence | 1 | 2 | 3 | 4 | 5 | NA |
| 040216 | Impaired cognition | 1 | 2 | 3 | 4 | 5 | NA |

With permission from Moorhead, S., Johnson, M., Maas, M. L., et al. (Eds.). (2008). *Nursing outcomes classification (NOC)* (4th ed.). St. Louis: Mosby–Elsevier.

The expected outcomes that define the desired behavior of the patient are used to measure the progress made toward resolving the problem. The expected outcomes also serve as the basis for evaluating the effectiveness of the nursing interventions and for deciding whether additional nursing care is needed or whether the plan of care needs to be revised.

#### Establishing Goals

After the priorities of the nursing diagnoses and expected outcomes have been established, goals (immediate, intermediate, and long-term) and the nursing actions appropriate for attaining the goals are identified. The patient and family are included in establishing goals for the nursing actions. Immediate goals are those that can be attained within a short period. Intermediate and long-term goals require a longer time to be achieved and usually involve preventing complications and other health problems and promoting self-care and rehabilitation. For example, goals for a patient with a nursing diagnosis of impaired physical mobility related to pain and edema following total knee replacement may be stated as follows:

- Immediate goal: Stands at bedside for 5 minutes 6 to 12 hours after surgery
- Intermediate goal: Ambulates with walker or crutches in hospital and home
- Long-term goal: Ambulates independently 1 to 2 miles each day

#### Determining Nursing Actions

In planning appropriate nursing actions to achieve the desired goals and outcomes, the nurse, with input from the patient and significant others, identifies individualized interventions based on the patient's circumstances and preferences that address each outcome. Interventions should identify the activities needed and who will implement them. Determination of interdisciplinary activities is made in collaboration with other health care providers as needed.

The nurse identifies and plans patient teaching and demonstration as needed to assist the patient in learning certain self-care activities. Planned interventions should be ethical and appropriate to the patient's culture, age, and gender. Standardized interventions, such as those found on institutional care plans or in the Nursing Interventions Classification (NIC) (Bulechek, Butcher & Dochterman, 2008) can be used. Chart 3-7 describes the NIC system and provides an example of an NIC system intervention. It is important to individualize prewritten interventions to promote optimal effectiveness for each patient. Actions of nurses should be based on established standards.

### Implementation

The implementation phase of the nursing process involves carrying out the proposed plan of nursing care. The nurse assumes responsibility for the implementation and coordinates the activities of all those involved in implementation, including the patient and family, other members of the nursing team, and other members of the health care team, so that the schedule of activities facilitates the patient's recovery. The plan of nursing care serves as the basis for implementation, as described below:

- The immediate, intermediate, and long-term goals are used as a focus for the implementation of the designated nursing interventions.

### Chart 3-7 • *Nursing Interventions Classification (NIC)*

The NIC is a standardized classification of nursing treatments (interventions) that includes independent and collaborative interventions. Intervention labels are terms such as hemorrhage control, medication administration, or pain management. Listed under each intervention are multiple discrete nursing actions that together constitute a comprehensive approach to the treatment of a particular condition. Not all actions are applicable to every patient; nursing judgment will determine which actions to implement. The following is an example of a nursing intervention:

#### Ventilation Assistance

**Definition**

Promotion of an optimal spontaneous breathing pattern that maximizes oxygen and carbon dioxide exchange in the lungs

**Activities**

Maintain a patent airway.
Position to alleviate dyspnea.
Position to facilitate ventilation–perfusion matching ("good lung down"), as appropriate.
Assist with frequent position changes, as appropriate.
Position to minimize respiratory efforts (eg, elevate the head of the bed and provide overbed table for patient to lean on).
Monitor the effects of position change on oxygenation (eg, arterial blood gases, $SaO_2$, $S\bar{v}O_2$).
Encourage slow deep breathing, turning, and coughing.
Assist with incentive spirometer, as appropriate.
Auscultate breath sounds, noting areas of decreased or absent ventilation and presence of adventitious sounds.
Monitor for respiratory muscle fatigue.
Initiate and maintain supplemental oxygen, as prescribed.
Administer appropriate pain medication to prevent hypoventilation.
Ambulate three to four times per day, as appropriate.
Monitor respiratory and oxygenation status.
Administer medications (eg, bronchodilators and inhalers) that promote airway patency and gas exchange.
Teach pursed lips breathing techniques, as appropriate.
Teach breathing techniques, as appropriate.
Initiate a program of respiratory muscle strength and/or endurance training, as appropriate.
Initiate resuscitation efforts, as appropriate.

Used with permission from Bulechek, G. M., Butcher, H. K. & Dochterman, J. M. (Eds.). (2008). *Nursing interventions classification (NIC)* (5th ed.). St. Louis: Mosby-Elsevier.

- While implementing nursing care, the nurse continually assesses the patient and his or her response to the nursing care.
- Revisions are made in the plan of care as the patient's condition, problems, and responses change and when reordering of priorities is required.

Implementation includes direct or indirect execution of the planned interventions. It is focused on resolving the patient's nursing diagnoses and collaborative problems and achieving expected outcomes, thus meeting the patient's health needs. Examples of nursing interventions are assisting with hygiene care; promoting physical and psychological comfort; supporting respiratory and elimination functions; facilitating the ingestion of food, fluids, and nutrients; managing the patient's immediate surroundings; providing health teaching; promoting a therapeutic relationship; and carrying out a variety of therapeutic nursing activities. Judgment, critical thinking, and good decision-making skills are essential in the selection of appropriate evidence-based and ethical nursing interventions. All nursing interventions are patient-focused and outcome-directed and are implemented with compassion, confidence, and a willingness to accept and understand the patient's responses.

Although many nursing actions are independent, others are interdependent, such as carrying out prescribed treatments, administering medications and therapies, and collaborating with other health care team members to accomplish specific expected outcomes and to monitor and manage potential complications. Such interdependent functioning is just that—interdependent. Requests or orders from other health care team members should not be followed blindly but should be assessed critically and questioned when necessary. The implementation phase of the nursing process ends when the nursing interventions have been completed.

### Evaluation

Evaluation, the final step of the nursing process, allows the nurse to determine the patient's response to the nursing interventions and the extent to which the objectives have been achieved. The plan of nursing care is the basis for evaluation. The nursing diagnoses, collaborative problems, priorities, nursing interventions, and expected outcomes provide the specific guidelines that dictate the focus of the evaluation. Through evaluation, the nurse can answer the following questions:

- Were the nursing diagnoses and collaborative problems accurate?
- Did the patient achieve the expected outcomes within the critical time periods?
- Have the patient's nursing diagnoses been resolved?
- Have the collaborative problems been resolved?
- Do priorities need to be reordered?
- Have the patient's nursing needs been met?
- Should the nursing interventions be continued, revised, or discontinued?
- Have new problems evolved for which nursing interventions have not been planned or implemented?
- What factors influenced the achievement or lack of achievement of the objectives?
- Should changes be made in the expected outcomes and outcome criteria?

Objective data that provide answers to these questions are collected from all available sources (eg, patients, families, significant others, health care team members). These data are included in patients' records and must be substantiated by direct patient observation before the outcomes are documented.

### Documentation of Outcomes and Revision of Plan

Outcomes are documented concisely and objectively. Documentation should relate outcomes to the nursing diagnoses and collaborative problems, describe the patient's responses to the interventions, indicate whether the outcomes were met, and include any additional pertinent data. An example of an individualized plan of nursing care is given in Chart 3-8.

The plan of care is subject to change as a patient's needs change, as the priorities of needs shift, as needs are resolved, and as additional information about a patient's state of health is collected. As the nursing interventions are implemented, the patient's responses are evaluated and documented, and the plan of care is revised accordingly. A well-developed, continuously updated plan of care is the greatest assurance that the patient's nursing diagnoses and collaborative problems are addressed and his or her basic needs are met.

### Framework for a Common Nursing Language: Combining NANDA, NIC, and NOC

Various frameworks or taxonomies can be used for determining nursing diagnoses (eg, NANDA), establishing outcomes (eg, NOC), and designing interventions (eg, NIC). Ultimately, a framework that uses a language common to all aspects of nursing, regardless of the classification system, is desirable. Although still controversial and in its infancy, significant efforts have been made toward accomplishing this goal of unifying the language of nursing. In 2001, a taxonomy of nursing practice was developed for the harmonization of NANDA, NIC, and NOC. This three-part combination links nursing diagnoses, accompanying interventions, and outcomes, organizing them in the same way. Such organization of concepts in a common language may facilitate the process of critical thinking, because interventions and outcomes are more accurately matched with appropriately developed nursing diagnoses (Johnson, Bulechek, Butcher, et al., 2006). The final taxonomic scheme identifies four clinical domains (functional, physiologic, psychosocial, and environmental), which contain numerous classes of diagnoses, outcomes, and interventions. Chart 3-9 presents the taxonomy of nursing practice.

CHART 3-8

## PLAN OF NURSING CARE
### *Example of an Individualized Plan of Nursing Care*

Mrs. T.C., a 52-year-old elementary school teacher, was admitted to the nursing unit from the emergency department. She had had a gnawing pain on her right side radiating to her back for 3 days. She now describes her pain as "excruciating after eating or drinking." In the past 48 hours she has been vomiting about 2 to 3 hours after she eats. She has not had anything to eat or drink for the past 12 hours.

Mrs. T.C. stated that she had not been successful in adhering to the weight reduction diet that had been prescribed by her physician and that she had rapidly lost, then regained, weight several times in the past year and a half. She stated, "My life is just too busy—I work late hours planning lessons and have to buy my meals out a lot." She indicated that in addition to her work, she and her husband share the responsibility for raising their three young children.

Admission physical examination revealed BP 132/84, P 104, R 22, T 100.1°F, height 5′7″, weight 205 lbs, skin warm, no jaundice. She stated that her urine has been "a strange gold color" and her stools were "grayish." She was admitted with the diagnosis of acute cholecystitis. The physician's orders on admission included: monitor vital signs every 4 hours; IV of $D_5$ Ringer's lactate 125 mL per hour; 1500-calorie, low-fat liquid diet and progress to low-fat soft diet if no pain in 16 hours; morphine sulfate 2 mg IV every 2 hours as needed; notify physician for sudden increase in frequency or intensity of pain; promethazine 12.5 mg IV every 4 hours as needed for nausea or vomiting.

#### Nursing Diagnoses

- Acute pain related to distended cystic duct and inflamed or infected gallbladder
- Risk for deficient fluid volume related to vomiting and decreased intake
- Ineffective coping related to role and responsibilities at work and home
- Imbalanced nutrition: More than body requirements, related to knowledge deficit about sedentary lifestyle, poor food choices and eating pattern

#### Collaborative Problems

- Risk for cystic duct necrosis or perforation
- Obesity

#### Goals

**Immediate:**

- Relief of pain
- Prevent fluid volume deficit and electrolyte imbalance
- Promote rest
- Early detection of any complications

**Intermediate:**

- Initiation of lifestyle alterations to decrease stress and facilitate rest

**Long-term:**

- Alteration of lifestyle to reduce emotional and environmental stressors
- Compliance with dietary regimen
- Weight reduction

| Nursing Interventions | Expected Outcomes | Outcomes |
|---|---|---|
| 1. Monitor BP, pulse, temperature, and respirations every 4 hours. | 1. Vital signs within normal limits | 1. BP range 110/62–128/78 with pain relief measures; temperature 98°–98.8°F; pulse range 74–88; respirations 18–22 |
| 2. Monitor pain status with accompanying abdominal assessment every 2 hours, or more frequently, as needed.<br>a. Assess pain characteristics every 2 hours or as needed.<br>b. Assess abdomen every 2 hours or with pain assessment.<br>c. Use nonpharmacologic measures (pillows, repositioning, etc.) as desired and tolerated by patient for pain relief.<br>d. Administer analgesic at regular intervals as needed, and assess response. | 2. Experiences pain relief; abdominal assessment within normal limits | 2. Verbalized decrease in pain from severe (8) to low (2) intensity within 10 minutes after morphine administered; no pain radiation to back<br>Abdomen soft and nontender |

*Continued on following page*

CHART 3-8 PLAN OF NURSING CARE

**Example of an Individualized Plan of Nursing Care (Continued)**

| Nursing Interventions | Expected Outcomes | Outcomes |
|---|---|---|
| 3. Monitor and support fluid and electrolyte status:<br>a. Monitor weight.<br>b. I&O<br>c. Monitor skin turgor and temperature.<br>d. Monitor serum electrolytes.<br>e. Monitor color and consistency of urine and stool output.<br>f. Encourage low-fat liquid intake if pain-free.<br>g. Administer promethazine as prescribed to control or relieve vomiting. | 3. Fluid balance maintained; electrolytes within normal limits | 3. Weight 205 on admission and 199 after 2-day period<br>Urinary output adequate in relation to oral and IV intake<br>Skin warm and supple, good recoil<br>Electrolytes in normal range<br>Urine dark amber in color, no sediment; stools soft, formed, light brown<br>No vomiting reported |
| 4. Promote atmosphere conducive to physical and mental rest:<br>a. Encourage alternation of rest and activity.<br>b. Encourage limitation of visitors and interactions that are stress producing. | 4. Alternates periods of rest and activity<br>Limits visitors to family in the evenings<br>Avoids stress-producing interactions | 4. Rested in bed 2 hours in morning and 2 hours in afternoon; disconnected phone during rest periods.<br>8 hours uninterrupted sleep at night; husband and children visit 2 hours in evening; patient calm and relaxed after visits<br>Accurately described relationship between stress, sedentary lifestyle, and obesity |
| 5. Assist patient to alter lifestyle to decrease stress:<br>a. Discuss relationship between emotional stress and physiologic function.<br>b. Encourage patient to identify stress-producing stimuli.<br>c. Encourage patient to identify adjustments necessary to reduce stress relative to the home and work setting. | 5. Describes stress, sedentary lifestyle, and obesity as precursors to alteration in physiologic functioning<br>Identifies lifestyle factors that produce stress | 5. Identified the following stressors:<br>Demands of job<br>Excessive involvement in children's school and recreational activities |
| 6. Encourage patient to identify sedentary lifestyle, obesity, and repetitive weight loss and gain as physiologic and emotional stressors; request consultation with dietitian and reinforce instructions given. | 6. Identifies lifestyle adjustments necessary to reduce stress<br>Discusses lifestyle adjustments with family | 6. Identified need to stop taking work home with her<br>Consulted with husband and children; will alternate with husband in attending children's activities; all family members supportive |
| 7. Teach importance of maintaining low-fat liquid diet and progression toward long-term low-fat diet. Teach food and menu choices low in fat. | 7. Identifies harmful effects of obesity and high-fat foods<br>Makes plans for losing weight<br>Makes plans for preplanned meals<br>Identifies foods/menu choices low in fat | 7. Accurately described effects of obesity and intake of high-fat foods on overall physical health and well-being<br>Plans to attend Weight Watchers; has had success with this program in the past<br>Identified that preparing low-fat lunches at home the night before work is a good preplanning option |

**Chart 3-9 • *Hierarchy of Taxonomy in Nursing Practice: A Unified Structure of Nursing Language***

I. The **functional domain** is defined as the diagnoses, outcomes, and interventions that promote basic needs and includes the following eight classes:
   - **Activity/exercise:** physical activity, including energy conservation and expenditure
   - **Comfort:** a sense of emotional, physical, and spiritual well-being and relative freedom from distress
   - **Growth and development:** physical, emotional, and social growth and developmental milestones
   - **Nutrition:** processes related to taking in, assimilating, and using nutrients
   - **Self-care:** ability to accomplish basic and instrumental activities of daily living
   - **Sexuality:** maintenance or modification of sexual identity and patterns
   - **Sleep/rest:** the quantity and quality of sleep, rest, and relaxation patterns
   - **Values/beliefs:** ideas, goals, perceptions, and spiritual and other beliefs that influence choices or decisions

II. **The physiologic domain** is defined as the diagnoses, outcomes, and interventions to promote optimal biophysical health and includes the following 10 classes:
   - **Cardiac function:** cardiac mechanisms used to maintain tissue perfusion
   - **Elimination:** processes related to secretion and excretion of body wastes
   - **Fluid and electrolyte:** regulation of fluid/electrolytes and acid-base balance
   - **Neurocognition:** mechanisms related to the nervous system and neurocognitive functioning, including memory, thinking, and judgment
   - **Pharmacologic function:** effects (therapeutic or adverse) of medications or drugs and other pharmacologically active products
   - **Physical regulation:** body temperature, endocrine, and immune system responses to regulate cellular processes.
   - **Reproduction:** processes related to human procreation and birth
   - **Respiratory function:** ventilation adequate to maintain arterial blood gases within normal limits
   - **Sensation/perception:** intake and interpretation of information through the senses, including seeing, hearing, touching, tasting, and smelling
   - **Tissue integrity:** skin and mucous membrane protection to support secretion, excretion, and healing

III. The **psychosocial domain** is defined as the diagnoses, outcomes, and interventions to promote optimal mental and emotional health and social functioning and includes the following seven classes:
   - **Behavior:** actions that promote, maintain, or restore health
   - **Communication:** receiving, interpreting, and expressing spoken, written, and nonverbal messages
   - **Coping:** adjusting or adapting to stressful events
   - **Emotional:** a mental state of feeling that may influence perception of the world
   - **Knowledge:** understanding and skill in applying information to promote, maintain, and restore health
   - **Roles/relationships:** maintenance and/or modification of expected social behaviors and emotional connectedness with others
   - **Self-perception:** awareness of one's body and personal identity

IV. The **environmental domain** is defined as the diagnoses, outcomes, and interventions that promote and protect the environmental health and safety of individuals, systems, and communities and includes the following three classes:
   - **Health care system:** social, political, and economic structures and processes for delivery of health care services
   - **Populations:** aggregates of individuals or communities having characteristics in common
   - **Risk management:** avoidance or control of identifiable health threats

From: NANDA International. (2008). *Nursing diagnoses: Definitions & classification 2009–2011*. Indianapolis: Wiley-Blackwell.

## CRITICAL THINKING EXERCISES

**1** A 50-year-old, morbidly obese man is admitted to your unit with a severe asthma attack. He is complaining of extreme shortness of breath and chest pain. What are the priorities for data collection for this patient's current condition? How would these priorities change if the client is in no acute distress and not having chest pain?

**2** You are at the bedside of a 93-year-old patient who has no advance directives. The patient has been comatose for 3 days and the physician has not prescribed any feedings. When you ask the physician about an enteral nutritional supplement (tube feeding), he responds, "No, I don't think so." What actions should be taken in this situation? What ethical and legal dilemmas exist? What other health professionals could be helpful in resolving any issues?

EBP **3** You are caring for a patient with another nursing student, and the student shares that he administered a wrong medication to the patient but is afraid to share this with the faculty and nurses. The patient was given an antihypertensive agent that was not due for another 12 hours. The patient appears to be "OK" at this time, and it is 2 hours after the medication was given. What actions should be taken? Should this information be communicated to your faculty supervisor? What is the care priority for the patient? What evidence supports or does not support disclosure of medication administration errors to patients? What steps would you take and in what order?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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### Resources

American Nurses Association, Center for Ethics and Human Rights, www.nursingworld.org/ethics

Centers for Medicare & Medicaid Services (CMS), www.cms.hhs.gov

The Hastings Center, www.thehastingscenter.org

The Joint Commission, www.jointcommission.org

NANDA International, www.nanda.org

National Center for Ethics in Health Care, www.ethics.va.gov/ETHICS/pubs/index.asp



chapter 4

# Health Education and Health Promotion

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the purposes and significance of health education.
2. Describe the concept of adherence to a therapeutic regimen.
3. Identify variables that affect learning readiness and adult learning abilities.
4. Describe the relationship of the teaching–learning process to the nursing process.
5. Develop a teaching plan for a patient.
6. Identify modifications indicated when teaching patients with disabilities.
7. Define the concepts of health, wellness, and health promotion.
8. Discuss major health promotion theories.
9. Describe the components of health promotion: self-responsibility, nutritional awareness, stress reduction and management, and physical fitness.
10. Specify the variables that affect health promotion activities for adolescents, young and middle-aged adults, and elderly adults.
11. Describe the role of the nurse in health promotion.

## GLOSSARY

**adherence:** the process of faithfully following guidelines or directions

**community:** an interacting population of individuals living together within a larger society

**feedback:** the return of information about the results of input given to a person or a system

**health education:** a variety of learning experiences designed to promote behaviors that facilitate health

**health promotion:** the art and science of assisting people to change their lifestyle toward a higher state of wellness

**learning:** the act of gaining knowledge and skill

**learning readiness:** the optimum time for learning to occur; usually corresponds to the learner's perceived need and desire to obtain specific knowledge

**nutrition:** the science that deals with food and nourishment in humans

**physical fitness:** the condition of being physically healthy as a result of proper exercise and nutrition

**reinforcement:** the process of strengthening a given response or behavior to increase the likelihood that the behavior will continue

**self-responsibility:** personal accountability for one's actions or behavior

**stress management:** behaviors and techniques used to strengthen a person's resources against stress

**teaching:** the imparting of knowledge

**therapeutic regimen:** a routine that promotes health and healing

**wellness:** a condition of good physical and emotional health sustained by a healthy lifestyle

Effective **health education** lays a solid foundation for individual and **community** wellness. Teaching is an integral tool that all nurses use to assist patients and families in developing effective health behaviors and altering lifestyle patterns that predispose people to health risks. Health education is an influential factor directly related to positive patient care outcomes.

## Health Education Today

Today's health care environment mandates the use of an organized approach to health education so that patients can meet their specific health care needs. Significant factors for nurses to consider when planning patient education include the availability of health care outside the hospital setting, the use of diverse health care providers to accomplish care management goals, and the increased use of complementary and alternative strategies rather than traditional approaches to care. Careful consideration of these factors can provide patients with the comprehensive information that is essential for making informed decisions about health care. Demands from consumers for comprehensive information about their health issues throughout the life cycle accentuate the need for holistic health education to occur in every patient–nurse encounter.

Teaching, as a function of nursing, is included in all state nurse practice acts and in the *Standards of Clinical Nursing Practice* of the American Nurses Association (ANA, 2004). Health education is an independent function of nursing practice and is a primary nursing responsibility. All nursing care is directed toward promoting, maintaining, and restoring health; preventing illness; and helping people adapt to the residual effects of illness. Many of these nursing activities are accomplished through health education or patient teaching. Nurses who serve as teachers are challenged to focus on the educational needs of communities and to provide specific patient and family education. Health education is important to nursing care because it affects the abilities of people and families to perform important self-care activities.

Every contact an individual nurse has with a health care consumer, whether or not that person is ill or has a disability, should be considered an opportunity for health teaching. Although people have a right to decide whether or not to learn, nurses have the responsibility to present information that motivates people to recognize the need to learn. Therefore, nurses must use opportunities in all health care settings to promote **wellness.** Educational environments may include homes, hospitals, community health centers, schools, places of business, service agencies, shelters, and consumer action or support groups.

### Purpose of Health Education

This emphasis on health education stems in part from the public's right to comprehensive health care, which includes up-to-date health information. It also reflects the emergence of an informed public that is asking more significant questions about health and health care. Because of the importance American society places on health and the responsibility each person has to maintain and promote his or her own health, members of the health care team, specifically nurses, are obligated to make health education available. Without adequate knowledge and training in self-care skills, consumers cannot make informed decisions about their health.

People with chronic illnesses and disabilities are among those most in need of health education. As the lifespan of the population increases, the number of people with such illnesses also increases. People with chronic illness need health care information to participate actively in and assume responsibility for self-care. Health education can help those with chronic illness adapt to their illness, prevent complications, carry out prescribed therapy, and solve problems when confronted with new situations. It can also help prevent crisis situations and reduce the potential for rehospitalization resulting from inadequate information about self-care. The goal of health education is to teach people to live life to its healthiest—that is, to strive toward achieving their maximum health potential.

In addition to the public's right to and desire for health education, patient education is also a strategy for promoting self-care at home and in the community, reducing health care costs by preventing illness, effectively managing necessary therapies, avoiding expensive medical interventions, decreasing hospital lengths of stay, and facilitating earlier discharge. For health care agencies, offering community wellness programs is a public relations tool for increasing patient satisfaction and for developing a positive image of the institution. Patient education is also a cost-avoidance strategy in that positive staff–patient relationships may avert malpractice suits.

### Adherence to the Therapeutic Regimen

One of the goals of patient education is to encourage people to adhere to their **therapeutic regimen. Adherence** to treatment usually requires that a person make one or more lifestyle changes to carry out specific activities that promote and maintain health. Common examples of behaviors facilitating health include taking prescribed medications, maintaining a healthy diet, increasing daily activities and exercise, self-monitoring for signs and symptoms of illness, practicing specific hygiene measures, seeking recommended health evaluations and screening, and performing other therapeutic and preventive measures.

Many people do not adhere to their prescribed regimens; rates of adherence are generally low, especially when the regimens are complex or of long duration (eg, therapy for tuberculosis, multiple sclerosis, and human immunodeficiency virus [HIV] infection and hemodialysis). Nonadherence to prescribed therapy has been the subject of many studies (Belguzar, Kayser & Selim, 2007; Gelmanova, Keshavjee, Golubchikova, et al., 2007; Vik, Hogan, Patten, et al., 2006). For the most part, findings have been inconclusive, and no one predominant causative factor has been identified. Instead, a wide range of variables appears to influence the degree of adherence, including the following:

- Demographic variables, such as age, gender, race, socioeconomic status, and level of education
- Illness variables, such as the severity of the illness and the relief of symptoms afforded by the therapy

- Therapeutic regimen variables, such as the complexity of the regimen and uncomfortable side effects
- Psychosocial variables, such as intelligence, motivation, availability of significant and supportive people (especially family members), attitudes toward health professionals, acceptance or denial of illness, substance abuse, and religious or cultural beliefs
- Financial variables, especially the direct and indirect costs associated with a prescribed regimen

Nurses' success with health education is determined by ongoing assessment of the variables that affect patients' ability to adopt specific behaviors, to obtain resources, and to maintain a healthy social environment (Edelman & Mandle, 2006). Teaching programs are more likely to succeed if the variables affecting patient adherence are identified and considered in the teaching plan.

The problem of nonadherence to therapeutic regimens is a substantial one that must be addressed before patients can achieve their maximum health potential. Surprisingly, patients' need for knowledge has not been found to be a sufficient stimulus for acquiring knowledge and thereby enabling complete adherence to a health regimen. Teaching directed toward stimulating patient motivation results in varying degrees of adherence. The variables of choice, establishment of mutual goals, and quality of the patient–provider relationship directly influence the behavioral changes that can result from patient education. These factors are directly linked to motivation for learning.

Using a learning contract or agreement can also be a motivator for learning. Such a contract is based on assessment of patient needs; health care data; and specific, measurable goals (Redman, 2007). A well-designed learning contract is realistic and positive; it includes measurable goals, with a specific time frame and reward system for goal achievement. The learning contract is recorded in writing and contains methods for ongoing evaluation.

The value of the contract lies in its clarity, its specific description of what is to be accomplished, and its usefulness for evaluating behavioral change. In a typical learning contract, a series of goals is established, beginning with small, easily attainable objectives and progressing to more advanced goals. Frequent, positive **reinforcement** is provided as the person moves from one goal to the next. For example, incremental goals such as weight loss of 1 to 2 pounds per week are more appropriate in a weight reduction program than a general goal such as a 30-pound weight loss.

### Gerontologic Considerations

Nonadherence to therapeutic regimens is a significant problem for elderly people, leading to increased morbidity, mortality, and cost of treatment (U.S. Public Health Service, 2005). Many admissions to nursing homes and hospitals are associated with nonadherence.

Elderly people frequently have one or more chronic illnesses that are managed with numerous medications and complicated by periodic acute episodes. Elderly people may also have other problems that affect adherence to therapeutic regimens, such as increased sensitivity to medications and their side effects, difficulty in adjusting to change and stress, financial constraints, forgetfulness, inadequate support systems, lifetime habits of self-treatment with over-the-counter medications, visual and hearing impairments, and mobility limitations. To promote adherence among the elderly, all variables that may affect health behavior should be assessed (Fig. 4-1). Nurses must also consider that cognitive impairment may be manifested by the elderly person's inability to draw inferences, apply information, or understand the major teaching points (Ebersole & Touhy, 2006). The person's strengths and limitations must be assessed to encourage use of existing strengths to compensate for limitations. Above all, health care professionals must work together to provide continuous, coordinated care; otherwise, the efforts of one health care professional may be negated by those of another.



**Figure 4-1** Taking time to teach patients about their medication and treatment program promotes interest and cooperation. Older adults who are actively involved in learning about their medication and treatment program and the expected effects may be more likely to adhere to the therapeutic regimen.

## The Nature of Teaching and Learning

**Learning** can be defined as acquiring knowledge, attitudes, or skills. **Teaching** is defined as helping another person learn. These definitions indicate that the teaching–learning process is an active one, requiring the involvement of both teacher and learner in the effort to reach the desired outcome, a change in behavior. The teacher does not simply give knowledge to the learner but instead serves as a facilitator of learning.

In general, there is no definitive theory about how learning occurs and how it is affected by teaching. However, learning can be affected by factors such as readiness to learn, the learning environment, and the teaching techniques used (Bastable, 2008; London, 2007).

### Learning Readiness

One of the most significant factors influencing learning is a person's **learning readiness.** For adults, readiness is based on culture, personal values, physical and emotional status, and past experiences in learning. The "teachable moment" occurs when the content and skills being taught are congruent with the task to be accomplished (Redman, 2007).

## CHART 4-1 NURSING RESEARCH PROFILE
### *Health and Health Promotion Behaviors Among Amish Families*

Armer, J. M. & Radina, M. E. (2006). Definition of health and health promotion behaviors among midwestern Old Order Amish families. *Journal of Multicultural Nursing and Health, 12*(3), 44–53.

**Purpose**

The purpose of this study was to explore health promotion practices and well-being among three generations of Old Order Amish people. The study specifically investigated the responses of the participants to measures of health perceptions, health practices, affective experiences, perceived control, locus of control, health-promoting lifestyle, perceived social support of family and friends, self-rated health, and morale.

**Design**

The study used a mixed method design, with the collection of both quantitative and qualitative data. Researchers interviewed 78 participants who also completed the research tools. The instruments used included the Wallston and Wallston's 18-item Multidimensional Health Locus of Control Scale, Pender's 48-item Health-Promoting Lifestyle Profile, and Procidano and Heller's 20-item Perceived Social Support–Family and Friends Scale.

**Findings**

The qualitative findings of this study revealed six themes about the Old Order Amish definition of health: the importance of being healthy, the ability to work hard, a sense of freedom to enjoy life, family responsibility, and physical and spiritual well-being. On the Multidimensional Health Locus of Control Scale, the mean responses were the same across the generations. On the Health-Promoting Lifestyle Profile, the nutrition subscale ranked the highest and the exercise scale ranked the lowest. On the Perceived Social Support–Family and Friends Scale, all three generations scored higher on the family subscale than on the friend subscale. Extended family members provide assistance and support to each of the three generations as needed.

**Nursing Implications**

Nurses need to consider unique perspectives, needs, and choices of the Old Order Amish. By developing an understanding of this culture and a definition of what constitutes health, the nurse is in a better position to provide culturally sensitive care. The importance of the family and the community in making health care decisions must be recognized. Family involvement in individual health decisions is essential if a person is to obtain the care required. Health promotion programs in Amish communities should be developed only after establishing strong and sensitive communication with the elders and family leaders. It is essential for the nurse to recognize that health promotion and health maintenance activities among culturally diverse rural populations often differ from those of urban and suburban middle-class populations.

Culture encompasses values, ideals, and behaviors, and the traditions within each culture provide the framework for solving the issues and concerns of daily living. Because people with different cultural backgrounds have different values and lifestyles, choices about health care vary. Culture is a major variable influencing readiness to learn because it affects how people learn and what information can be learned. Sometimes people do not accept health teaching because it conflicts with culturally mediated values. Before beginning health teaching, nurses must conduct an individual cultural assessment instead of relying only on generalized assumptions about a particular culture. A patient's social and cultural patterns must be appropriately incorporated into the teaching–learning interaction. Chapter 8 (Chart 8-3) describes cultural assessment components to consider when formulating a teaching plan. Chart 4-1 summarizes a research study exploring health promotion practices among Old Order Amish families.

A person's values include beliefs about behaviors that are desirable and undesirable. The nurse must know what value the patient places on health and health care. In clinical situations, patients express their values through their actions and the level of knowledge pursued (Andrews & Boyle, 2007). When the nurse is unaware of the patient's cultural values, misunderstanding, lack of cooperation, and negative health outcomes may occur (Leininger & McFarland, 2006). A person's values and behaviors can be either an asset or a deterrent to readiness to learn. Therefore, patients are unlikely to accept health education unless their values and beliefs about health and illness are respected (Giger & Davidhizar, 2008).

Physical readiness is of vital importance, because until the person is physically capable of learning, attempts at teaching and learning may be both futile and frustrating. For example, a person in acute pain is unable to focus attention away from the pain long enough to concentrate on learning. Likewise, a person who is short of breath concentrates on breathing rather than on learning.

Emotional readiness also affects the motivation to learn. A person who has not accepted an existing illness or the threat of illness is not motivated to learn. A person who does not accept a therapeutic regimen, or who views it as conflicting with his or her present lifestyle, may consciously avoid learning about it. Until the person recognizes the need to learn and demonstrates an ability to learn, teaching efforts may be thwarted. However, it is not always wise to wait for the person to become emotionally ready to learn, because that time may never come unless the nurse makes an effort to stimulate the person's motivation.

Illness and the threat of illness are usually accompanied by anxiety and stress. Nurses who recognize such reactions can use simple explanations and instructions to alleviate these anxieties and provide further motivation to learn. Because learning involves behavior change, it often produces mild anxiety, which can be a useful motivating factor.

Emotional readiness can be promoted by creating a warm, accepting, positive atmosphere and by establishing realistic learning goals. When learners achieve success and a feeling of accomplishment, they are often motivated to participate in additional learning opportunities.

**Feedback** about progress also motivates learning. Such feedback should be presented in the form of positive reinforcement when the learner is successful, and in the form of constructive suggestions for improvement when the learner is unsuccessful.

Experiential readiness refers to past experiences that influence a person's ability to learn. Previous educational experiences and life experiences in general are significant determinants of a person's approach to learning. People with little or no formal education may not be able to understand the instructional materials presented. People who have had difficulty learning in the past may be hesitant to try again. Many behaviors required for reaching maximum health potential require knowledge, physical skills, and positive attitudes. In their absence, learning may be very difficult and very slow. For example, a person who does not understand the basics of normal nutrition may not be able to understand the restrictions of a specific diet. A person who does not view the desired learning as personally meaningful may reject teaching efforts. A person who is not future-oriented may be unable to appreciate many aspects of preventive health teaching. Experiential readiness is closely related to emotional readiness, because motivation tends to be stimulated by an appreciation for the need to learn and by those learning tasks that are familiar, interesting, and meaningful.

## The Learning Environment

Although learning can take place without teachers, most people who are attempting to learn new or altered health behaviors benefit from contact with a nurse. The interpersonal interaction between the person and the nurse who is attempting to meet the person's learning needs may be formal or informal, depending on the method and techniques of teaching.

Learning may be optimized by minimizing factors that interfere with the learning process. For example, the room temperature, lighting, noise levels, and other environmental conditions should be appropriate to the learning situation. In addition, the time selected for teaching should be suited to the needs of the individual person. Scheduling a teaching session at a time of day when a patient is fatigued, uncomfortable, or anxious about a pending diagnostic or therapeutic procedure, or when visitors are present, is not conducive to learning. However, if the family is to participate in providing care, the sessions should be scheduled when family members are present so that they can learn any necessary skills or techniques.

## Teaching Techniques

Teaching techniques and methods enhance learning if they are appropriate to the patient's needs. Numerous techniques are available, including lectures, group teaching, and demonstrations, all of which can be enhanced with specially prepared teaching materials. The lecture or explanation method of teaching is commonly used but should be accompanied by discussion. Discussion is important because it affords learners opportunities to express their feelings and concerns, to ask questions, and to receive clarification.

Group teaching is appropriate for some people because it allows them not only to receive needed information, but also to feel secure as members of a group. People with similar problems or learning needs have the opportunity to identify with each other and gain moral support and encouragement. However, not everyone relates or learns well in groups or benefits from such experiences. Also, if group teaching is used, assessment and follow-up are imperative to ensure that each person has gained sufficient knowledge and skills.

Demonstration and practice are essential ingredients of a teaching program, especially when teaching skills. It is best to demonstrate the skill and then give the learner ample opportunity for practice. When special equipment is involved, such as syringes, colostomy bags, dialysis equipment, dressings, or suction apparatus, it is important to teach with the same equipment that will be used in the home setting. Learning to perform a skill with one kind of equipment and then having to change to a different kind may lead to confusion, frustration, and mistakes.

Teaching aids used to enhance learning include books, pamphlets, pictures, films, slides, audio tapes, models, programmed instruction, other visual aids (eg. charts), and computer-assisted learning modules. These are made available as needed for home, clinic, or hospital use, and they allow review and reinforcement of content and enhanced visual and auditory learning. Such teaching aids are invaluable when used appropriately and can save a significant amount of personnel time and related cost. However, all such aids should be reviewed before use to ensure that they meet the person's learning needs and are free of advertisements that may confuse the patient. Human interaction and discussion cannot be replaced by teaching technologies but may be enhanced by them.

Reinforcement and follow-up are important because learning takes time. Allowing ample time to learn and reinforcing what is learned are important teaching strategies; a single teaching session is rarely adequate. Follow-up sessions are imperative to promote the learner's confidence in his or her abilities and to plan for additional teaching sessions. For hospitalized patients who may not be able to transfer what they have learned in the hospital to the home setting, follow-up after discharge is essential to ensure that they have realized the full benefits of a teaching program.

## Teaching Special Populations

### People With Disabilities

When providing health information to people with disabilities, the individual needs of each person must be assessed and incorporated into the teaching plan. Teaching techniques and the imparting of information may need to be altered. The nurse must be aware of the health promotion needs when teaching specific groups of people with physical disabilities; emotional, psychiatric, or mental health disabilities; hearing, visual, or sensory impairments; learning disabilities; and developmental disabilities. It may be necessary to institute new or modified approaches to teach these people with disabilities about their health. Table 4-1 outlines some of the teaching strategies to use when teaching people with disabilities.

### Elderly

Nurses caring for elderly people must be aware of how the normal changes that occur with aging may affect learning abilities and how they can help elderly people age well.

**Table 4-1 TEACHING PEOPLE WITH DISABILITIES**

| Type of Disability | Teaching Strategy |
|---|---|
| **Physical, Emotional, or Cognitive Disability** | Adapt information to accommodate the person's cognitive, perceptual, and behavioral disabilities.<br>Give clear written and oral information.<br>Highlight significant information for easy reference.<br>Avoid medical terminology or "jargon." |
| **Hearing Impairment** | Use slow, directed, deliberate speech.<br>Use sign language or interpreter services if appropriate.<br>Position yourself so that the person can see your mouth if speech reading.<br>Use telecommunication devices (TTY or TDD) for the person with hearing impairment.<br>Use written materials and visual aids, such as models and diagrams.<br>Use captioned videos, films, and computer-generated materials.<br>Teach on the side of the "good ear" if unilateral deafness is present. |
| **Visual Impairment** | Use optical devices such as a magnifying lens.<br>Use proper lighting and proper contrast of colors on materials and equipment.<br>Use large-print materials.<br>Use Braille materials if appropriate.<br>Convert information to auditory and tactile formats.<br>Obtain audiotapes and talking books.<br>Explain noises associated with procedures, equipment, and treatments.<br>Arrange materials in clockwise pattern. |
| **Learning Disabilities** | |
| Input disability | If visual perceptual disorder:<br>• Explain information verbally, repeat, and reinforce frequently.<br>• Use audiotapes.<br>• Encourage learner to verbalize information received.<br>If auditory perceptual disorder:<br>• Speak slowly with as few words as possible, repeat, and reinforce frequently.<br>• Use direct eye contact to focus person on task.<br>• Use demonstration and return demonstration such as modeling, role playing, and hands-on experiences.<br>• Use visual tools, written materials, and computers. |
| Output disability | Use all senses as appropriate.<br>Use written, audiotape, and computer information.<br>Review information and give time verbally, repeto interact and ask questions.<br>Use hand gestures and motions. |
| Developmental disability | Base information and teaching on developmental stage, not chronologic age.<br>Use nonverbal cues, gestures, signing, and symbols as needed.<br>Use simple explanations and concraete examples with repetition.<br>Encourage active participation.<br>Demonstrate information and have the person perform return demonstrations. |

Above all, it is important to recognize that just because a person is elderly does not mean that he or she cannot learn. Older adults *can* learn and remember if information is paced appropriately, relevant, and followed by the appropriate feedback strategies that apply to all learners (Miller, 2009). Because changes associated with aging vary significantly among elderly people, the nurse should conduct a thorough assessment of each person's level of physiologic and psychological functioning before beginning teaching. More information on the physiologic effects of aging can be found in Chapter 12.

Changes in cognition with age may include slowed mental functioning; decreased short-term memory, abstract thinking, and concentration; and slowed reaction time. These changes are often accentuated by the health problems that cause the elderly person to seek health care in the first place. Effective teaching strategies include slow-paced presentation of small amounts of material at a time; frequent repetition of information; and the use of reinforcement techniques, such as audiovisual and written materials and repeated practice sessions. Distracting stimuli should be minimized as much as possible in the teaching environment.

Sensory changes associated with aging also affect teaching and learning. Teaching strategies to accommodate decreased visual acuity include large-print and easy-to-read materials printed on nonglare paper. Because color discrimination is often impaired, the use of color-coded or highlighted materials may not be effective. To maximize hearing, teachers must speak distinctly with a normal or lowered pitch, facing the person so that speech reading can occur as needed. Visual cues often help reinforce verbal teaching.

Family members should be involved in teaching sessions when possible and appropriate. They provide another source for reinforcement of material and can help the elderly person recall instructions later. Family members can also provide valuable assessment information about the person's living situation and related learning needs.

The chance of success is maximized when nurses, families, and other health care professionals work collaboratively to facilitate the elderly person's learning. Successful learning should result in improved self-care management

skills, enhanced self-esteem, confidence, and a willingness to learn in the future.

## The Nursing Process in Patient Teaching

The steps of the nursing process are used when constructing a teaching plan to meet people's teaching and learning needs (Chart 4-2).

### Assessment

Assessment in the teaching–learning process is directed toward the systematic collection of data about the person and family's learning needs and readiness to learn. All internal and external variables that affect the patient's readiness to learn are identified. A learning assessment guide may be used for this purpose. Some of the available guides are directed toward the collection of general health information (eg, smoking cessation), whereas others are specific to medication regimens or disease processes (eg, stroke risk assessments). Such guides facilitate assessment but must be adapted to the responses, problems, and needs of each person. The nurse organizes, analyzes, synthesizes, and summarizes the assessment data collected and determines the patient's need for teaching.

### Nursing Diagnosis

The process of formulating nursing diagnoses makes educational goals and evaluations of progress more specific and meaningful. Teaching is an integral intervention implied by all nursing diagnoses, and for some diagnoses, education is the primary intervention. Examples of nursing diagnoses that help in planning for educational needs are ineffective therapeutic regimen management, impaired or ineffective home maintenance, health-seeking behaviors (specify), and decisional conflict (specify). The diagnosis "deficient knowledge" should be used cautiously, because knowledge deficit is not a human response but a factor relating to or causing the diagnosis. For example, "ineffective therapeutic

**Chart 4-2 • *A Guide to Patient Education***

**Assessment**

1. Assess the person's readiness for health education.
   a. What are the person's health beliefs and behaviors?
   b. What physical and psychosocial adaptations does the person need to make?
   c. Is the learner ready to learn?
   d. Is the person able to learn these behaviors?
   e. What additional information about the person is needed?
   f. Are there any variables (eg, hearing or visual impairment, cognitive issues, literacy issues) that will affect the choice of teaching strategy or approach?
   g. What are the person's expectations?
   h. What does the person want to learn?
2. Organize, analyze, synthesize, and summarize the collected data.

**Nursing Diagnosis**

1. Formulate the nursing diagnoses that relate to the person's learning needs.
2. Identify the learning needs, their characteristics, and their etiology.
3. State nursing diagnoses concisely and precisely.

**Planning and Goals**

1. Assign priority to the nursing diagnoses that relate to the individual's learning needs.
2. Specify the immediate, intermediate, and long-term learning goals established by teacher and learner together.
3. Identify teaching strategies appropriate for goal attainment.
4. Establish expected outcomes.
5. Develop the written teaching plan.
   a. Include diagnoses, goals, teaching strategies, and expected outcomes.
   b. Put the information to be taught in logical sequence.
   c. Write down the key points.
   d. Select appropriate teaching aids.
   e. Keep the plan current and flexible to meet the person's changing learning needs.
6. Involve the learner, family or significant others, nursing team members, and other health care team members in all aspects of planning.

**Implementation**

1. Put the teaching plan into action.
2. Use language the person can understand.
3. Use appropriate teaching aids and provide Internet resources if appropriate.
4. Use the same equipment that the person will use after discharge.
5. Encourage the person to participate actively in learning.
6. Record the learner's responses to the teaching actions.
7. Provide feedback.

**Evaluation**

1. Collect objective data.
   a. Observe the person.
   b. Ask questions to determine whether the person understands.
   c. Use rating scales, checklists, anecdotal notes, and written tests when appropriate.
2. Compare the person's behavioral responses with the expected outcomes. Determine the extent to which the goals were achieved.
3. Include the person, family or significant others, nursing team members, and other health care team members in the evaluation.
4. Identify alterations that need to be made in the teaching plan.
5. Make referrals to appropriate sources or agencies for reinforcement of learning after discharge.
6. Continue all steps of the teaching process: assessment, diagnosis, planning, implementation, and evaluation.

regimen management related to a lack of information about wound care" is a more appropriate nursing diagnosis than "deficient knowledge" (Carpenito-Moyet, 2008; NANDA International, 2007). A nursing diagnosis that relates specifically to a patient's and family's learning needs serves as a guide in the development of the teaching plan.

## Planning

Once the nursing diagnoses have been identified, the planning component of the teaching–learning process is established in accordance with the steps of the nursing process:

1. Assigning priorities to the diagnoses
2. Specifying the immediate, intermediate, and long-term goals of learning
3. Identifying specific teaching strategies appropriate for attaining goals
4. Specifying the expected outcomes
5. Documenting the diagnoses, goals, teaching strategies, and expected outcomes of the teaching plan

The assignment of priorities to the diagnoses should be a collaborative effort by the nurse and the patient or family members. Consideration must be given to the urgency of the patient's learning needs; the most critical needs should receive the highest priority.

After the diagnostic priorities have been mutually established, it is important to identify the immediate and long-term goals and the teaching strategies appropriate for attaining the goals. Teaching is most effective when the objectives of both the patient and nurse are in agreement (Bastable, 2006). Learning begins with the establishment of goals that are appropriate to the situation and realistic in terms of the patient's ability and desire to achieve them. Involving the patient and family in establishing goals and in planning teaching strategies promotes their cooperation in the implementation of the teaching plan.

Outcomes of teaching strategies can be stated in terms of expected behaviors of patients, families, or both. Outcomes should be realistic and measurable, and the critical time periods for attaining them should also be identified. The desired outcomes and the critical time periods serve as a basis for evaluating the effectiveness of the teaching strategies.

During the planning phase, the nurse must consider the sequence in which the subject matter is presented. Critical information (eg, survival skills for a patient with diabetes) and material that the person or family identifies to be of particular importance must receive high priority. An outline is often helpful for arranging the subject matter and for ensuring that all necessary information is included. In addition, appropriate teaching aids to be used in implementing teaching strategies are prepared or selected at this time.

The entire planning phase concludes with the formulation of the teaching plan. This teaching plan communicates the following information to all members of the nursing team:

- The nursing diagnoses that specifically relate to the patient's learning needs and the priorities of these diagnoses
- The goals of the teaching strategies
- The teaching strategies that are appropriate for goal attainment
- The expected outcomes, which identify the desired behavioral responses of the learner
- The critical time period within which each outcome is expected to be met
- The patient's behavioral responses (which are documented on the teaching plan)

The same rules that apply to writing and revising the plan of nursing care apply to the teaching plan.

## Implementation

In the implementation phase of the teaching–learning process, the patient, the family, and other members of the nursing and health care team carry out the activities outlined in the teaching plan. The nurse coordinates these activities.

Flexibility during the implementation phase of the teaching–learning process and ongoing assessment of patient responses to the teaching strategies support modification of the teaching plan as necessary. Creativity in promoting and sustaining the patient's motivation to learn is essential. New learning needs that may arise after discharge from the hospital or after home care visits have ended should also be taken into account.

The implementation phase ends when the teaching strategies have been completed and when the patient's responses to the actions have been recorded. This serves as the basis for evaluating how well the defined goals and expected outcomes have been achieved.

## Evaluation

Evaluation of the teaching–learning process determines how effectively the patient has responded to teaching and to what extent the goals have been achieved. An evaluation must be made to determine what was effective and what needs to be changed or reinforced. It cannot be assumed that patients have learned just because teaching has occurred; learning does not automatically follow teaching. An important part of the evaluation phase addresses the question, "What can be done to improve teaching and enhance learning?" Answers to this question direct the changes to be made in the teaching plan.

A variety of measurement techniques can be used to identify changes in patient behavior as evidence that learning has taken place. These techniques include directly observing the behavior; using rating scales, checklists, or anecdotal notes to document the behavior; and indirectly measuring results using oral questioning and written tests. All direct measurements should be supplemented with indirect measurements whenever possible. Using more than one measuring technique enhances the reliability of the resulting data and decreases the potential for error from a measurement strategy.

In many situations, measurement of actual behavior is the most accurate and appropriate evaluation technique. Nurses often perform comparative analyses using patient admission data as the baseline: Selected data points observed when nursing care is given and self-care is initiated are compared with the patient's baseline data. In other cases, indirect measurement may be used. Some examples of indirect measurement are patient satisfaction surveys, attitude surveys, and instruments that evaluate specific health status variables.

Measurement is only the beginning of evaluation, which must be followed by data interpretation and value judgments about learning and teaching. These aspects of

evaluation should be conducted periodically throughout the teaching–learning program, at its conclusion, and at varying periods after the teaching has ended.

Evaluation of learning after teaching that occurs in any setting (eg, clinics, offices, nursing centers, hospitals) is essential, because the analysis of teaching outcomes must extend into aftercare. With shortened hospital lengths of stay and with short-stay and same-day surgical procedures, follow-up evaluation is especially important. Coordination of efforts and sharing of information between hospital-based and community-based nursing personnel facilitate postdischarge teaching and home care evaluation.

Evaluation is not the final step in the teaching–learning process but is the beginning of a new patient assessment. The information gathered during evaluation should be used to redirect teaching actions, with the goal of improving the patient's responses and outcomes.

## Health Promotion

Health teaching and **health promotion** are linked by a common goal—to encourage people to achieve as high a level of wellness as possible so that they can live maximally healthy lives and avoid preventable illnesses. The call for health promotion has become a cornerstone in health policy because of the need to control costs and reduce unnecessary sickness and death.

Health goals for the nation were established in the publication *Healthy People 2000*. The priorities from this initiative were identified as health promotion, health protection, and the use of preventive services. *Healthy People 2010* defines the current national health promotion and disease prevention initiative for the nation. The two essential goals from this report are (1) to increase the quality and years of healthy life for people and (2) to eliminate health disparities among various segments of the population (U.S. Public Health Service, 2005) (Chart 4-3).

### Definition

Health promotion may be defined as those activities that assist people in developing resources that maintain or enhance well-being and improve their quality of life. These activities involve people's efforts to remain healthy in the absence of symptoms and do not require the assistance of a health care team member.

The purpose of health promotion is to focus on the person's potential for wellness and to encourage appropriate alterations in personal habits, lifestyle, and environment in ways that reduce risks and enhance health and well-being. Health promotion is an active process; that is, it is not something that can be prescribed or dictated. It is up to each person to decide whether to make changes to promote a higher level of wellness. Only the individual can make these choices.

**Chart 4-3 • *Leading Health Indicators to be Used to Measure the Health of the Nation***

1. Physical activity
2. Overweight and obesity
3. Tobacco use
4. Substance abuse
5. Responsible sexual behavior
6. Mental health
7. Injury and violence
8. Environmental quality
9. Immunization
10. Access to health care

From U.S. Department of Health & Human Services. (2005). *Healthy people 2010.* Available at: www.healthypeople.gov/LHI/1hiwhat.htm

### Health and Wellness

The concept of health promotion has evolved because of a changing definition of health and an awareness that wellness exists at many levels of functioning. Health is viewed as a dynamic, ever-changing condition that enables people to function at an optimal potential at any given time. The ideal health status is one in which people are successful in achieving their full potential, regardless of any limitations they might have.

Wellness, a reflection of health, involves a conscious and deliberate attempt to maximize one's health. Wellness does not just happen; it requires planning and conscious commitment and is the result of adopting lifestyle behaviors for the purpose of attaining one's highest potential for well-being. Wellness is not the same for every person. The person with a chronic illness or disability may still be able to achieve a desirable level of wellness. The key to wellness is to function at the highest potential within the limitations over which there is no control, such as a lifelong disability or genetic disorders (Chart 4-4).

A significant amount of research has shown that people, by virtue of what they do or fail to do, influence their own health. Today, many of the major causes of illness are chronic diseases that have been closely related to lifestyle behaviors (eg, type 2 diabetes mellitus, heart disease, lung and colon cancer, chronic obstructive pulmonary diseases, hypertension, cirrhosis, traumatic injury, and HIV infection). To a large extent, a person's health status may be reflective of his or her lifestyle.

### Health Promotion Models

Several health promotion models identify health-protecting behaviors and seek to explain what makes people engage in preventive behaviors. A health-protecting behavior is defined as any behavior performed by people, regardless of their actual or perceived health condition, for the purpose of promoting or maintaining their health, whether or not the behavior produces the desired outcome (Keleher, MacDougall & Murphy, 2007). One model, the Health Belief Model, was designed to foster understanding of why some healthy people choose actions to prevent illness while others do not. Another model, the resource model of preventive health behavior, addresses the ways in which people use resources to promote health (Keleher, et al., 2007). Nurse educators can use this model to assess how demographic variables, health behaviors, and social and health resources influence health promotion.

The Canadian health promotion initiative, Achieving Health for All, builds on the work of Lalonde (1977), in

CHART 4-4

GENETICS IN NURSING PRACTICE

## *Genetics Aspects of Health Education and Promotion*

Nurses in all settings should be prepared to incorporate genetics into health education and promotion by:

- Inquiring about patients' and families' desired health outcomes with regard to genetics-related conditions or risk factors
- Referring patients for genetics services when indicated
- Identifying barriers to accessing genetics-related health services
- Offering appropriate genetics information and resources

which four determinants of health—human biology, environment, lifestyle, and the health care delivery system—were identified. Determinants of health were defined as factors and conditions that have an influence on the health of individuals and communities. Since the 1970s, a total of 12 health determinants have been identified, and this number will continue to increase as population health research progresses. Determinants of health provide a framework for assessing and evaluating the population's health.

The Health Belief Model developed by Becker and colleagues (1974) is based on the premise that four variables influence the selection and use of health promotion behaviors. Demographic and disease factors, the first variable, include patient characteristics such as age, gender, education, employment, severity of illness or disability, and length of illness. Barriers, the second variable, are defined as factors leading to unavailability or difficulty in gaining access to a specific health promotion alternative. Resources, the third variable, encompass such factors as financial and social support. Perceptual factors, the fourth variable, consist of how the person views his or her health status, self-efficacy, and the perceived demands of the illness. Becker and colleagues demonstrated that these four variables have a positive correlation with a person's quality of life.

The health promotion model described by Pender, Murdaugh and Parsons (2006) is based on social learning theory and emphasizes the importance of motivational factors in acquiring and sustaining health promotion behaviors. This model explores how cognitive-perceptual factors affect the person's view of the importance of health. It also examines perceived control of health, self-efficacy, health status, and the benefits and barriers to health-promoting behaviors.

The Transtheoretical Model of Change, also known as the stages of change model, is a framework that focuses on the motivation of a person to make decisions that promote healthy behavior change (Miller, 2009; DiClemente, 2007). Table 4-2 shows the six stages of the model. Research indicates that people seeking assistance from professionals or self-help groups progress through these stages of change (Kim, 2007).

Any of the models can serve as an organizing framework for clinical work and research that support the enhancement of health. Research and other literature that support health promotion concepts and frameworks increase the nurse's understanding of the health promotion behaviors of families and communities (Betz, 2007; Chen, Shiao & Gau, 2007; Rowley, Dixon & Palk, 2007; Seals, 2007).

## Components of Health Promotion

There are several components of health promotion as an active process: self-responsibility, nutritional awareness, stress reduction and management, and physical fitness.

### *Self-Responsibility*

Taking responsibility for oneself is the key to successful health promotion. The concept of **self-responsibility** is based on the understanding that the individual controls his or her life. Each person alone must make the choices that determine how healthy his or her lifestyle is. As more people recognize that lifestyle and behavior significantly affect health, they may assume responsibility for avoiding high-risk behaviors such as smoking, alcohol and drug abuse, overeating, driving while intoxicated, risky sexual practices, and other unhealthy habits. They may also assume responsibility for adopting routines that have been found to have a positive influence on health, such as engaging in regular exercise, wearing seat belts, and eating a healthy diet.

A variety of techniques have been used to encourage people to accept responsibility for their health, ranging from extensive educational programs to reward systems. No one technique has been found to be superior to any other. Instead, self-responsibility for health promotion is individualized and depends on a person's desires and inner motivations. Health promotion programs are important tools for encouraging people to assume responsibility for their health and to develop behaviors that improve health.

### *Nutritional Awareness*

**Nutrition,** as a component of health promotion, has become the focus of considerable attention and publicity with the growing epidemic of obesity in the United States. A vast array of books and magazine articles address the topics of special diets; natural foods; and the hazards associated with certain substances, such as sugar, salt, cholesterol,

**Table 4-2 STAGES IN THE TRANSTHEORETICAL MODEL OF CHANGE**

| Stage | Description |
|---|---|
| 1. Precontemplative | The person is not thinking about making a change. |
| 2. Contemplative | The person is only thinking about change in the near future. |
| 3. Decision making | The person constructs a plan to change behavior. |
| 4. Action | The person takes steps to operationalize the plan of action. |
| 5. Maintenance | The person works to prevent relapse and to sustain the gains made from the actions taken. |
| 6. Termination | The person has the ability to resist relapse back to unhealthy behavior(s). |

Adapted from DiClemente, C. (2007). The transtheoretical model of intentional behavior change. *Drugs & Alcohol Today*, *7*(1), 29–33; and Miller, C. A. (2009). *Nursing wellness in older adults* (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

trans fats, carbohydrates, artificial colors, and food additives. It has been suggested that good nutrition is the single most significant factor in determining health status, longevity, and weight control.

Nutritional awareness involves an understanding of the importance of a healthy diet that supplies all of the essential nutrients. Understanding the relationship between diet and disease is an important facet of a person's self-care. Some clinicians believe that a healthy diet is one that substitutes "natural" foods for processed and refined ones and reduces the intake of sugar, salt, fat, cholesterol, caffeine, alcohol, food additives, and preservatives.

Chapter 5 contains further information about the assessment of a person's nutritional status. It describes the physical signs indicating nutritional status, assessment of food intake (food record, 24-hour recall), the dietary guidelines presented in the MyPyramid plan, and calculation of ideal body weight.

#### Stress Reduction and Management

**Stress management** and stress reduction are important aspects of health promotion. Studies have shown the negative effects of stress on health and a cause-and-effect relationship between stress and infectious diseases, traumatic injuries (eg, motor vehicle crashes), and some chronic illnesses. Stress has become inevitable in contemporary societies in which demands for productivity have become excessive. More and more emphasis is placed on encouraging people to manage stress appropriately and to reduce the pressures that are counterproductive. Techniques such as relaxation training, exercise, and modification of stressful situations are often included in health promotion programs dealing with stress. Further information on stress management, including health risk appraisal and stress reduction methods such as biofeedback and the relaxation response, can be found in Chapter 6.

#### Physical Fitness

**Physical fitness** is another important component of health promotion. Clinicians and researchers (Perry, Rosenfeld, Bennett, et al., 2007; Chao, Lian, Yu, et al., 2007) who have examined the relationship between health and physical fitness have found that a regular exercise program can promote health in the following ways:

- Improve the function of the circulatory system and the lungs
- Decrease cholesterol and low-density lipoprotein levels
- Decrease body weight by increasing calorie expenditure
- Delay degenerative changes such as osteoporosis
- Improve flexibility and overall muscle strength and endurance

An appropriate exercise program can have a positive effect on a person's performance capacity, appearance, and level of stress and fatigue, as well as his or her general state of physical, mental, and emotional health. An exercise program should be designed specifically for a given person, with consideration given to age, physical condition, and any known cardiovascular or other risk factors. Exercise can be harmful if it is not started gradually and increased slowly in accordance with a person's response.

## Health Promotion Throughout the Lifespan

Health promotion is a concept and a process that extends throughout the lifespan. The health of a child can be affected either positively or negatively by the health practices of the mother during the prenatal period. Therefore, health promotion starts before birth and extends through childhood, adolescence, adulthood, and old age.

Health promotion includes health screening. The American Academy of Family Physicians has developed recommendations for periodic health examinations that identify the age groups for which specific screening interventions are appropriate. Table 4-3 presents general population guidelines. Specific population standards and guidelines have also been recommended, including adult immunization recommendations (Centers for Disease Control and Prevention [CDC], 2007).

### Adolescents

Health screening has traditionally been an important aspect of adolescent health care. The goal has been to detect health problems at an early age so that they can be treated at this time. Today, health promotion goes beyond the mere screening for disabilities and includes extensive efforts to promote positive health practices at an early age. Because health habits and practices are formed early in life, adolescents should be encouraged to develop positive health attitudes. For this reason, more and more programs are being offered to adolescents to help them develop good health habits. Although the negative results of practices such as smoking, risky sexual activities, alcohol and drug abuse, and poor nutrition are explained in these educational programs, emphasis is also placed on values training, self-esteem, and healthy lifestyle practices. The projects are designed to appeal to a particular age group, with emphasis on learning experiences that are fun, interesting, and relevant.

### Young and Middle-Aged Adults

Young and middle-aged adults represent an age group that not only expresses an interest in health and health promotion, but also responds enthusiastically to suggestions that show how lifestyle practices can improve health. Adults are frequently motivated to change their lifestyles in ways that are believed to enhance their health and wellness. Many adults who wish to improve their health turn to health promotion programs to help them make the desired changes in their lifestyles. Many have responded to programs that focus on topics such as general wellness, smoking cessation, exercise, physical conditioning, weight control, conflict resolution, and stress management. Because of the nationwide emphasis on health during the reproductive years, young adults actively seek programs that address prenatal health, parenting, family planning, and women's health issues.

Programs that provide health screening, such as those that screen for cancer, high cholesterol, hypertension, diabetes, abdominal aneurysm, and visual and hearing impairments, are quite popular with young and middle-aged adults. Programs that involve health promotion for people with specific chronic illnesses such as cancer, diabetes, heart

**Table 4-3 ROUTINE HEALTH PROMOTION SCREENING FOR ADULTS**

| Type of Screening | Suggested Time Frame |
|---|---|
| Routine health examination | Yearly |
| Blood chemistry profile | Baseline at age 20, then as mutually determined by patient and clinician |
| Complete blood count | Baseline at age 20, then as mutually determined by patient and clinician |
| Lipid profile | Baseline at age 20, then as mutually determined by patient and clinician |
| Hemoccult screening | Yearly after age 50 |
| Electrocardiogram | Baseline at age 40, then as mutually determined by patient and clinician |
| Blood pressure | Yearly, then as mutually determined by patient and clinician |
| Tuberculosis skin test | Every 2 years or as mutually determined by patient and clinician |
| Chest x-ray film | For positive PPD results |
| Breast self-examination | Monthly |
| Mammogram | Yearly for women over 40, or earlier or more often if indicated |
| Clinical breast examination | Yearly |
| Gynecologic examination | Yearly |
| Pap test | Yearly |
| Bone density screening | Based on identification of primary and secondary risk factors (prior to onset of menopause, if indicated) |
| Nutritional screening | As mutually determined by patient and clinician |
| Digital rectal examination | Yearly |
| Colonoscopy | Every 3–5 years after age 50 or as mutually determined by patient and clinician |
| Prostate examination | Yearly |
| Prostate-specific antigen | Every 1–2 years after age 50 |
| Testicular examination | Monthly |
| Skin examination | Yearly or as mutually determined by patient and clinician |
| Vision screening | Every 2–3 years |
| Glaucoma | Baseline at age 40, then every 2–3 years until age 70, then yearly |
| Dental screening | Every 6 months |
| Hearing screening | As needed |
| Health risk appraisal | As needed |
| **Adult Immunizations** | |
| Hepatitis B (if not received as a child) | Series of three doses (now, 1 month later, then 5 months after the second date) |
| Influenza vaccine | Yearly |

*Note:* Any of these screenings may be performed more frequently if deemed necessary by the patient or recommended by the health care provider.

disease, and pulmonary disease are also popular. Chronic disease and disability do not preclude health and wellness; rather, positive health attitudes and practices can promote optimal health for people who must live with the limitations imposed by their chronic illnesses and disabilities.

Health promotion programs can be offered almost anywhere in the community. Common sites include local clinics, schools, colleges, recreation centers, churches, and even private homes. Health fairs are frequently held in civic centers and shopping malls. The outreach idea for health promotion programs has served to meet the needs of many adults who otherwise would not avail themselves of opportunities to strive toward a healthier lifestyle.

The workplace has become a center for health promotion activity for several reasons. Employers have become increasingly concerned about the rising costs of health care insurance to treat illnesses related to lifestyle behaviors, and they are also concerned about increased absenteeism and lost productivity. Some employers use health promotion specialists to develop and implement these programs, and others purchase packaged programs that have already been developed by health care agencies or private health promotion corporations.

Programs offered at the workplace usually include employee health screening and counseling, physical fitness, nutritional awareness, work safety, and stress management and stress reduction. In addition, efforts are made to promote a safe and healthy work environment. Many large businesses provide exercise facilities for their employees and offer their health promotion programs to retirees.

## Gerontologic Considerations

Health promotion is as important for the elderly as it is for others. Although 80% of people older than 65 years have one or more chronic illnesses and many are limited in their activity, the elderly as a group experience significant gains from health promotion. The elderly are very health-conscious, and most view their health positively and are willing to adopt practices that will improve their health and well-being (Ebersole & Hess, 2005). Although their chronic illnesses and disabilities cannot be eliminated, these adults can benefit from activities that help them maintain independence and achieve an optimal level of health.

Various health promotion programs have been developed to meet the needs of older Americans. Both public and private organizations continue to be responsive to health promotion, and more programs that serve the elderly are emerging. Many of these programs are offered by health care agencies, churches, community centers, senior citizen residences, and a variety of other organizations. The activities directed toward health promotion for the elderly are the same as those for other age groups: physical fitness and exercise, nutrition, safety, and stress management (Fig. 4-2).



**Figure 4–2** Health promotion for the elderly includes physical fitness. Here, a nurse teaches simple exercises at a senior center.

## Nursing Implications

By virtue of their expertise in health and health care and their long-established credibility with consumers, nurses play a vital role in health promotion. In many instances, they have initiated health promotion and health screening programs or have participated with other health care personnel in developing and providing wellness services in a variety of settings.

As health care professionals, nurses have a responsibility to promote activities that foster well-being, self-actualization, and personal fulfillment. Every interaction with consumers of health care must be viewed as an opportunity to promote positive health attitudes and behaviors.

## CRITICAL THINKING EXERCISES

EBP **1** A female college student with a 2-year history of irritable bowel syndrome makes an appointment to speak with the nurse practitioner at the college health center to discuss her increased use of antidiarrheal medication. The student states, "I've been very busy with my studies and several activities this semester, and I haven't been eating right." What health promotion components guide the nurse in assessing the student's situation? What is the evidence base for offering information and health programs to help this young adult make appropriate health decisions and establish positive health behaviors? Identify the criteria used to evaluate the strength of the evidence for this practice.

**2** After falling from a piece of machinery at a construction site, a 40-year-old man is recuperating at home after being in the hospital. A home health nurse visits three times a week to perform abdominal wound care. During a visit, the man complains that he misses his daily exercise routine and asks when he will be able to resume exercising. Determine the factors that influence his ability to engage in exercise. What factors support the overall relationship between fitness and health? Develop a plan to assist the man to maintain muscle tone and promote well-being.

EBP **3** A 74-year-old woman is volunteering at a local health fair being held at her granddaughter's high school. When the nurse coordinator asks the woman if she would like to participate in the screening events and other informational activities, she replies, "No, thank you. I'm too old to think about health promotion. I just need to take care of the health problems that I already have." What evidence supports the importance of health promotion strategies for the older adult? What information should you include in a discussion with this woman about promoting health in the elderly? What type of information, available at various booths at the health fair, would be appropriate for this woman to obtain?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing reseach.*
***Double asterisk indicates classic reference.*

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## RESOURCES

Centers for Disease Control and Prevention, www.cdc.gov

Health Education Resourced Exchange, Washington State Department of Health, http://fortress.wa.gov/doh/here

Health Promotion for Women With Disabilities, Villanova University College of Nursing, www.nurseweb.villanova.edu/WomenWithDisabilities/welcome.htm

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), http://chppm-www.apgea.army.mil/

U.S. Department of Health and Human Services, National Institutes of Health, www.nih.gov/icd/

U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, www.odphp.osophs.dhhs.gov

World Health Organization, www.who.int/hpr/




# Adult Health and Nutritional Assessment

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify ethical considerations necessary for protecting a person's rights related to data collected in the health history and physical assessment.
2. Describe the components of the health history.
3. Apply culturally sensitive interviewing skills and techniques to conduct a successful health history, physical examination, and nutritional assessment.
4. Identify genetic aspects nurses should incorporate into the health history and physical assessment.
5. Identify modifications needed to obtain a health history and conduct a physical assessment for a person with a disability.
6. Describe the techniques of inspection, palpation, percussion, and auscultation to perform a basic physical assessment.
7. Discuss the techniques of measurement of body mass index, biochemical assessment, clinical examination, and assessment of food intake to assess a person's nutritional status.
8. Describe factors that may contribute to altered nutritional status in high-risk groups such as adolescents and the elderly.
9. Conduct a health history and physical and nutritional assessment of a person at home.

## GLOSSARY

**auscultation:** listening to sounds produced within different body structures created by the movement of air or fluid

**body mass index (BMI):** a calculation done to estimate the amount of body fat of a person

**health history:** a series of questions that provides an overview of the patient's current health status

**inspection:** visual assessment of different aspects of the patient

**palpation:** examination of different organs of the body using the sense of touch

**percussion:** the use of sound to examine different organs of the body

The ability to assess patients is a skill integral to nursing, regardless of the practice setting. In all settings in which nurses interact with patients and provide care, eliciting a complete health history and using appropriate assessment skills are critical to identifying physical and psychological problems and concerns experienced by the patient. As the first step in the nursing process, patient assessment is necessary to obtain data that enable the nurse to make an accurate nursing diagnosis, identify and implement appropriate interventions, and assess their effectiveness. This chapter covers the complete health history and basic assessment techniques. Because a patient's nutritional status is an important factor in overall health and well-being, a section on nutritional assessment is also addressed.



**Figure 5-1** A comfortable, relaxed atmosphere and an attentive interviewer are essential for a successful clinical interview.

## Considerations for Conducting a Health History and Physical Assessment

### The Role of the Nurse

All members of the health care team use their unique skills and knowledge to contribute to the resolution of patient problems by first obtaining some level of history and assessment (Weber & Kelley, 2007). Because the focus of each member of the health care team is unique, a variety of health history and physical examination formats have been developed. Regardless of the format, the information obtained by the nurse complements the data obtained by other members of the health care team and focuses on nursing's unique concerns for the patient. In health assessment, the nurse obtains the patient's health history and performs a physical assessment, which can be carried out in a variety of settings, including the acute care setting, clinic or outpatient office, school, long-term care facility, or home. Nurses use a growing list of nursing diagnoses to identify and categorize patient problems that nurses have the knowledge, skills, and responsibility to treat independently (NANDA International, 2007).

### Communicating Effectively

People who seek health care for a specific problem are often anxious. Their anxiety may be increased by fear about potential diagnoses, possible disruption of lifestyle, and other concerns. With this in mind, the nurse attempts to establish rapport, put the patient at ease, encourage honest communication, make eye contact, and listen carefully to the patient's responses to questions about health issues (Fig. 5-1).

When obtaining a health history or performing a physical examination, the nurse must be aware of his or her own nonverbal communication, as well as that of the patient. The nurse should take into consideration the patient's educational and cultural background as well as language proficiency. Questions and instructions to the patient are phrased in a way that is easily understandable. Technical terms and medical jargon are avoided. In addition, the nurse must take into consideration the patient's disabilities or impairments (hearing, vision, cognitive, and physical limitations). At the end of the assessment, the nurse may summarize and clarify the information obtained and ask the patient if he or she has any questions; this gives the nurse the opportunity to correct misinformation and add facts that may have been omitted.

### Ethical Use of History or Physical Examination Data

Whenever information is elicited from a person through a health history or physical examination, the person has the right to know why the information is sought and how it will be used. For this reason, it is important to explain what the history and physical examination are, how the information will be obtained, and how it will be used (Bickley, 2007; Weber & Kelley, 2007). It is also important that the person be aware that the decision to participate is voluntary. A private setting for the history interview and physical examination promotes trust and encourages open, honest communication. After the history and examination are completed, the nurse selectively records the data pertinent to the patient's health status. This written record of the patient's history and physical examination findings is then maintained in a secure place and made available only to those health professionals directly involved in the care of the patient. This protects confidentiality and promotes professional conduct.

### Increasing Use of Technology

The use of technology to augment the information-gathering process has become an increasingly important aspect of obtaining a health history and physical examination. Computerization of medical records is becoming more common in private health care providers' offices as well as in medical centers as the Institute of Medicine has called for the implementation of the computerized patient health record (Simpson, 2007). Electronic health records are thought to improve the quality of care, reduce medical errors, and help reduce health care costs; therefore, their implementation is moving forward on a global scale (Arnold, Wagner, Hyatt, et al., 2007). Assessments such as the nutrition assessment (Vereecken, Covents, Matthys, et al., 2005) and screening for intimate partner violence (MacMillan, Wathen, Jamieson, et al., 2006) can be completed on a computer. Nurses must be sensitive to the needs of older adults and

others who may not be comfortable with computer technology. Nurses may need to allow extra time and provide detailed instructions or assistance.

## Health History

The **health history** is a series of questions used to provide an overview of the current health status of the patient. When obtaining the health history, attention is focused on the impact of psychosocial, ethnic, and cultural background on a person's health, illness, and health promotion behaviors. The interpersonal and physical environments, as well as the person's lifestyle and activities of daily living, are explored in depth. Many nurses are responsible for obtaining a detailed history of the person's current health problems, past medical history, and family history and a review of the person's functional status. This results in a total health profile that focuses on health as well as illness.

The format of the health history traditionally combines the medical history and the nursing assessment, although formats based on nursing frameworks, such as functional health patterns, have also become standard. Both the review of systems and the patient profile are expanded to include individual and family relationships, lifestyle patterns, health practices, and coping strategies. These components of the health history are the basis of nursing assessment and can be easily adapted to address the needs of any patient population in any setting, institution, or agency (Bickley, 2007; Weber & Kelley, 2007). Combining the information obtained by the physician and the nurse into one health history prevents duplication of information and minimizes efforts on the part of the patient to provide this information repeatedly. This also encourages collaboration among members of the health care team who share in the collection and interpretation of the data.

### The Informant

The informant, or the person providing the health history, may not always be the patient, as in the case of a developmentally delayed, mentally impaired, disoriented, confused, unconscious, or comatose patient. The interviewer assesses the reliability of the informant and the usefulness of the information provided. For example, a disoriented patient is often unable to provide reliable information; people who use alcohol and illicit drugs often deny using these substances. The interviewer must make a clinical judgment about the reliability of the information (based on the context of the entire interview) and include this assessment in the record. Chart 5-1 provides special considerations for obtaining a health history from an older adult.

### Components of the Health History

When a patient is seen for the first time by a member of the health care team, the first requirement is that baseline information be obtained (except in emergency situations). The sequence and format of obtaining data about a patient may vary, but the content, regardless of format, usually addresses the same general topics. A traditional approach includes the following: biographical data, chief complaint, present health concern (or present illness), past history, family history, review of systems, and patient profile.

**CHART 5-1** ***Health Assessment in the Older Adult***

A health history should be obtained from elderly patients in a calm, unrushed manner. Because of the increased incidence of impaired vision and hearing in the elderly, lighting should be adequate but not glaring, and distracting noises should be kept to a minimum. The interviewer should assume a position that enables the person to read lips and facial expressions. People who normally use a hearing aid are asked to use it during the interview. The interviewer should also recognize that there is wide diversity among the elderly and that differences exist in health practices, gender, income, and functional status (Mai & Eng, 2007).

Elderly people often assume that new physical problems are a result of age rather than a treatable illness. In addition, the signs and symptoms of illness in the elderly are often more subtle than those in younger people and may go unreported. Therefore, a question such as, "What interferes most in your daily activities?" may be useful in focusing the clinical evaluation (Soriano, Fernandes, Cassel, et al., 2007). Special care is taken in obtaining a complete history of medications used, because many elderly people take many different kinds of prescription and over-the-counter (OTC) medications. Although elderly people may experience a decline in mental function, it should not be assumed that they are unable to provide an adequate history (Soriano, et al., 2007). Nevertheless, including a member of the family in the interview process (eg, spouse, adult child, sibling, caretaker) may validate information and provide missing details. However, this should be done after obtaining the patient's permission. Further details about assessment of the older adult are provided in Chapter 12.

#### Biographical Data

Biographical information puts the patient's health history into context. This information includes the person's name, address, age, gender, marital status, occupation, and ethnic origins. Some interviewers prefer to ask more personal questions at this part of the interview, whereas others wait until more trust and confidence have been established or until a patient's immediate or urgent needs are first addressed. A patient who is in severe pain or has another urgent problem is unlikely to have a great deal of patience for an interviewer who is more concerned about marital or occupational status than with quickly addressing the problem at hand.

#### Chief Complaint

The chief complaint is the issue that brings a person to the attention of the health care provider. Questions such as, "Why have you come to the health center today?" or "Why were you admitted to the hospital?" usually elicit the chief complaint. In the home setting, the initial question might be, "What is bothering you most today?" When a problem is identified, the person's exact words are usually recorded in quotation marks. However, a statement such as, "My doctor sent me," should be followed up with a question that identifies the probable reason why the person is seeking health care; this reason is then identified as the chief complaint (Bickley, 2007; Weber & Kelley, 2007).

### Present Health Concern or Illness

The history of the present health concern or illness is the single most important factor in helping the health care team arrive at a diagnosis or determine the patient's needs. The physical examination is helpful but often only validates the information obtained from the history. A careful history assists in correct selection of appropriate diagnostic tests. Although diagnostic test results can be helpful, they often support rather than establish the diagnosis.

If the present illness is only one episode in a series of episodes, the entire sequence of events is recorded. For example, a history from a patient whose chief complaint is an episode of insulin shock describes the entire course of the diabetes to put the current episode in context. The details of the health concern or present illness are described from onset until the time of contact with the health care team. These facts are recorded in chronologic order, beginning with, for example, "The patient was in good health until . . ." or "The patient first experienced abdominal pain 2 months prior to seeking help."

The history of the present illness or problem includes such information as the date and manner (sudden or gradual) in which the problem occurred, the setting in which the problem occurred (at home, at work, after an argument, after exercise), manifestations of the problem, and the course of the illness or problem. This includes self-treatment (including complementary and alternative therapies), medical interventions, progress and effects of treatment, and the patient's perceptions of the cause or meaning of the problem.

Specific symptoms (pain, headache, fever, change in bowel habits) are described in detail, along with the location and radiation (if pain), quality, severity, and duration. The interviewer also asks whether the problem is persistent or intermittent, what factors aggravate or alleviate it, and whether any associated manifestations exist.

Associated manifestations are symptoms that occur simultaneously with the chief complaint. The presence or absence of such symptoms may shed light on the origin or extent of the problem, as well as on the diagnosis. These symptoms are referred to as significant positive or negative findings and are obtained from a review of systems directly related to the chief complaint. For example, if a patient reports a vague symptom such as fatigue or weight loss, all body systems are reviewed and included in this section of the history. If, on the other hand, a patient's chief complaint is chest pain, only the cardiopulmonary and gastrointestinal systems may be included in the history of the present illness. In either situation, both positive and negative findings are recorded to define the problem further.

### Past Health History

A detailed summary of a person's past health is an important part of the health history. After determining the general health status, the interviewer should inquire about immunization status according to the recommendations of the adult immunization schedule and record the dates of immunization (if known). The Advisory Committee on Immunization Practices (ACIP) updates the schedule each year (Centers for Disease Control and Prevention [CDC], 2007). The interviewer should also inquire about any known allergies to medications or other substances, along with the type of allergy and adverse reactions. Other relevant material includes information, if known, about the patient's last physical examination, chest x-ray, electrocardiogram, eye examination, hearing test, dental checkup (Chart 5-2), Papanicolaou

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**CHART 5-2** NURSING RESEARCH PROFILE
## *Oral Health Assessment*

Chen, C. C.-H., Chyun, D. A., Li, C., et al. (2007). A single-item approach to screening elders for oral health assessment. *Nursing Research, 56*(5), 332–338.

#### Purpose

When performing health assessments for elderly patients, nurses are aware that oral health is an important indicator of overall health. The main purpose of this study was to evaluate the usefulness of asking the question, "Do you have regular dental checkups?" as a means of determining whether an oral health assessment or further referral is indicated for elders.

#### Design

The study was a secondary analysis using a nutritional survey of 240 elderly participants who were living in the community. A gerontologic nurse practitioner was trained to rate each participant on three oral indices: the Kayer-Jones Brief Oral Health Status Examination, the self-reported General Oral Health Assessment Index, and the number of remaining teeth. During an assessment in their home, the participants were also asked about their pattern of dental checkups (regular versus irregular).

#### Findings

Approximately half (55%) of participants reported a dental visit within the past year for any reason, but only 81 (33.8%) reported having regular dental checkups. For participants with teeth ($n$ = 147), an irregular dental checkup was associated with lower educational level, Protestant faith, and black race. Participants with a pattern of irregular dental checkups scored lower on all three oral indices. The question, "Do you have regular dental checkups?" was found to be valid for identifying those with teeth and good oral health; it was less effective for those participants without teeth.

#### Nursing Implications

During the general health assessment for the elderly, the nurse should be aware that a single question, "Do you have regular dental checkups?" can be used effectively to identify those with teeth and good oral health and not in need of further oral health assessment or referral. This one question was less effective in identifying those in need of further oral health assessment or referral.

(Pap) smear and mammogram (if female), digital rectal examination of the prostate gland (if male), bone density testing, colon cancer screening, and any other pertinent tests. The interviewer then discusses previous illnesses and records negative as well as positive responses to a list of specific diseases. Dates of illness, or the age of the patient at the time, as well as the names of the primary health care provider and hospital, the diagnosis, and the treatment are noted. The interviewer elicits a history of the following areas:

- Childhood illnesses—rubeola, rubella, polio, whooping cough, mumps, measles, chickenpox, scarlet fever, rheumatic fever, strep throat
- Adult illnesses
- Psychiatric illnesses
- Injuries—burns, fractures, head injuries
- Hospitalizations
- Surgical and diagnostic procedures
- Current medications—prescription, over-the-counter (OTC), home remedies, complementary and alternative therapies
- Use of alcohol and other drugs

If a particular hospitalization or major medical intervention is related to the present illness, the account of it is not repeated; rather, the report refers to the appropriate part of the record, such as "See history of present illness" on the data sheet.

### Family History

To identify diseases that may be genetic, communicable, or possibly environmental in origin, the interviewer asks about the age and health status, or the age and cause of death, of first-order relatives (parents, siblings, spouse, children) and second-order relatives (grandparents, cousins). In general, the following conditions are included: cancer, hypertension, heart disease, diabetes, epilepsy, mental illness, tuberculosis, kidney disease, arthritis, allergies, asthma, alcoholism, and obesity. One of the easiest methods of recording such data is by using the family tree, genogram, or pedigree (Fig. 5-2). The results of genetic testing or screening, if known, are recorded. Chart 5-3 provides genetic considerations related to health assessment; see also Chapter 9 for a detailed discussion of genetics.

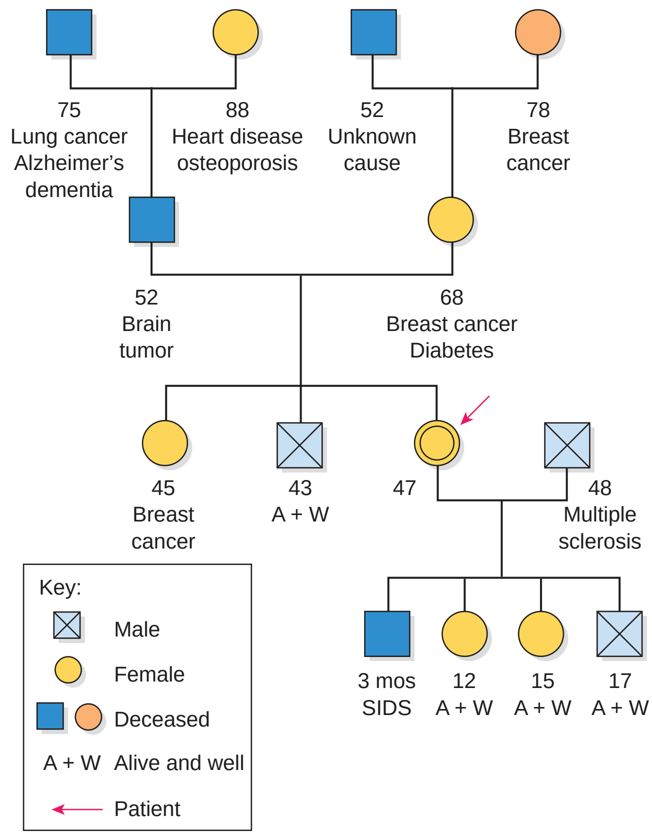



**Figure 5-2** Diagram (called a genogram) used to record history of family members, including their age and cause of death or, if living, their current health status.

### Review of Systems

The review of systems includes an overview of general health as well as symptoms related to each body system. Questions are asked about each of the major body systems for information about past and present symptoms. Reviewing each body system helps reveal relevant data. Negative as well as positive answers are recorded. If a patient responds positively to questions about a particular system, the information is analyzed carefully. If any illnesses were previously mentioned or recorded, it is not necessary to repeat them in this part of the history. Instead, reference is made to the appropriate place in the health history where the information can be found.

A review of systems can be organized in a formal checklist, which becomes a part of the health history. One advantage of a checklist is that it can be easily audited and is less subject to error than a system that relies heavily on the interviewer's memory.

**CHART 5-3** GENETICS IN NURSING PRACTICE

***Genetics Aspects of Health Assessment***

Nurses incorporate a genetics focus into the following health assessments:

- Family history—assess for genetics-related risk factors.
- Cultural, social, and spiritual assessment—assess for individual and family perceptions and beliefs around genetics topics.
- Physical assessment—assess for clinical features that may suggest a genetic condition is present (eg, unusually tall stature—Marfan syndrome).
- Ethnic background—since many conditions are more common in specific ethnic populations, the nurse gathers information about ethnic background (eg, Tay-Sachs disease in Ashkenazi Jewish populations or thalassemia in Southeast Asian populations).

## Chart 5-4 • *Patient Profile*

**Past Events Related to Health**

Place of birth
Places lived
Significant childhood/adolescent experiences

**Education and Occupation**

Jobs held in past
Current position/job
Length of time at position
Educational preparation
Work satisfaction and career goals

**Financial Resources**

Income
Insurance coverage

**Environment**

Physical—living arrangements (type of housing, neighborhood, presence of hazards)
Spiritual—extent to which religion is a part of individual's life; religious beliefs related to perception of health and illness; religious practices
Interpersonal—ethnic background (language spoken, customs and values held, folk practices used to maintain health or to cure illness); family relationships (family structure, roles, communication patterns, support system); friendships (quality of relationship)

**Lifestyle Patterns**

Sleep (time person retires, hours per night, comfort measures, awakens rested)
Exercise (type, frequency, time spent)
Nutrition (24-hour diet recall, idiosyncrasies, restrictions)
Recreation (type of activity, time spent)
Caffeine (coffee, tea, cola, chocolate–kind), amount
Smoking (cigarette, pipe, cigar, marijuana–kind), amount per day, number of years, desire to quit
Alcohol–kind, amount, pattern over past year
Drugs–kind, amount, route of administration

**Physical or Mental Disability**

Presence of a disability (physical or mental)
Effect of disability on function and health access
Accommodations needed to support functioning

**Self-Concept**

View of self in present
View of self in future
Body image (level of satisfaction, concerns)

**Sexuality**

Perception of self as a man or woman
Quality of sexual relationships
Concerns related to sexuality or sexual functioning

**Risk for Abuse**

Physical injury in past
Afraid of partner, caregiver, or family member
Refusal of caregiver to provide necessary equipment or assistance

**Stress and Coping Response**

Major concerns or problems at present
Daily "hassles"
Past experiences with similar problems
Past coping patterns and outcomes
Present coping strategies and anticipated outcomes
Individual's expectations of family/friends and health care team in problem resolution

### *Patient Profile*

In the patient profile, more biographical information is gathered. A complete composite, or profile, of the patient is critical to analysis of the chief complaint and of the person's ability to deal with the problem. A complete patient profile is summarized in Chart 5-4.

At this point in the interview, the information elicited is highly personal and subjective. People are encouraged to express feelings honestly and to discuss personal experiences. It is best to begin with general, open-ended questions and to move to direct questioning when specific facts are needed. Interviews that progress from information that is less personal (birthplace, occupation, education) to information that is more personal (sexuality, body image, coping abilities) often reduce anxiety.

A general patient profile consists of the following content areas: past life events related to health, education and occupation, environment (physical, spiritual, cultural), lifestyle (patterns and habits), presence of a physical or mental disability, self-concept, sexuality, risk for abuse, and stress and coping response.

#### Past Life Events Related to Health

The patient profile begins with a brief life history. Questions about place of birth and past places of residence help focus attention on the earlier years of life. Personal experiences during childhood or adolescence that have special significance may be elicited by asking a question such as, "Was there anything that you experienced as a child or adolescent that would be helpful for me to know about?" The interviewer's intent is to encourage the patient to make a quick review of his or her earlier life, highlighting information of particular significance. Although many patients may not recall anything significant, others may share information such as a personal achievement, a failure, a developmental crisis, or an instance of physical, emotional, or sexual abuse. The life history should include a brief medication history as appropriate for the patient.

#### Education and Occupation

Inquiring about current occupation can reveal much about a person's economic status and educational preparation. A statement such as, "Tell me about your job," often elicits information about role, job tasks, and satisfaction with the

position. Direct questions about past employment and career goals may be asked if the person does not provide this information.

It is important to learn about a person's educational background. Asking a person what kind of educational requirements were necessary to attain his or her present job is a more sensitive approach than asking whether he or she graduated from high school. Information about the patient's general financial status may be obtained by questions such as, "Do you have any financial concerns at this time?" or "Sometimes there just doesn't seem to be enough money to make ends meet. Are you finding this true?" Inquiries about the person's insurance coverage and plans for health care payment are also appropriate.

### Environment

The concept of environment includes a person's physical environment and its potential hazards, spiritual awareness, cultural background, interpersonal relationships, and support system.

***Physical Environment.*** Information is elicited about the type of housing (apartment, duplex, single-family) in which the person lives, its location, the level of safety and comfort within the home and neighborhood, and the presence of environmental hazards (eg, isolation, potential fire risks, inadequate sanitation). If the patient is homeless or living in a homeless shelter or has a disability, the patient's environment assumes special importance (Mai & Eng, 2007).

***Spiritual Environment.*** The term *spiritual environment* refers to the degree to which a person thinks about or contemplates his or her existence, accepts challenges in life, and seeks and finds answers to personal questions. Spirituality may be expressed through identification with a particular religion. Spiritual values and beliefs often direct a person's behavior and approach to health problems and can influence responses to sickness. Illness may create a spiritual crisis and can place considerable stress on a person's internal resources and beliefs. Inquiring about spirituality can identify possible support systems as well as beliefs and customs that need to be considered in planning care. Information is gathered about the extent to which religion is a part of the person's life as well as religious beliefs and practices related to health and illness.

A spiritual assessment may involve asking the following questions:

- Is religion or God important to you?
- If yes, in what way?
- If no, what is the most important thing in your life?
- Are there any religious practices that are important to you?
- Do you have any spiritual concerns because of your present health problem?

***Cultural Environment.*** When obtaining the health history, the person's cultural and religious backgrounds are taken into account. Cultural attitudes and beliefs about health, illness, health care, hospitalization, the use of medications, and use of complementary and alternative therapies, which are derived from personal experiences, vary according to ethnic, cultural, and religious background. A person from another culture may have different views of personal health practices from those of the health care practitioner (Bickley, 2007; Weber & Kelley, 2007). See Chapter 8 for more cultural considerations.

The beliefs and practices that have been shared from generation to generation are known as cultural or ethnic patterns. They are expressed through language, dress, dietary choices, and role behaviors; in perceptions of health and illness; and in health-related behaviors. The influence of these beliefs and customs on how a person reacts to health problems and interacts with health care providers cannot be underestimated. The following questions may assist in obtaining relevant information:

- Where did your parents or ancestors come from? When?
- What language do you speak at home?
- Are there certain customs or values that are important to you?
- Is there anything special you do to keep in good health?
- Do you have any specific practices for treating illness?

***Family Relationships and Support System.*** An assessment of family structure (members, ages, and roles), patterns of communication, and the presence or absence of a support system is an integral part of the patient profile. Although the traditional family is recognized as a mother, a father, and children, many different types of living arrangements exist within our society. "Family" may mean two or more people bound by emotional ties or commitments. Live-in companions, roommates, and close friends can all play a significant role in a person's support system.

### Lifestyle

The lifestyle section of the patient profile provides information about health-related behaviors. These behaviors include patterns of sleep, exercise, nutrition, and recreation, as well as personal habits such as smoking and the use of illicit drugs, alcohol, and caffeine. Although most people readily describe their exercise patterns or recreational activities, many are unwilling to report their smoking, alcohol use, and illicit drug use, and many deny or understate the degree to which they use such substances. Questions such as, "What kind of alcohol do you enjoy drinking at a party?" may elicit more accurate information than, "Do you drink?" The specific type of alcohol (eg, wine, liquor, beer) and the amount ingested per day or per week (eg, 1 pint of whiskey daily for 2 years) should be described (Lussier-Cushing, Repper-DeLisi, Mitchell, et al., 2007).

If alcohol abuse is suspected, additional information may be obtained by using common alcohol screening questionnaires such as the CAGE (*C*utting down, *A*nnoyance by criticism, *G*uilty feelings, and *E*ye-openers) (Ewing, 1984), AUDIT (*A*lcohol *U*se *D*isorders *I*dentification *T*est), TWEAK (*T*olerance, *W*orry, *E*ye-opener, *A*mnesia, *K*ut down) (Chan, Pristach, Welte, et al. 1993), or SMAST (*S*hort *M*ichigan *A*lcohol *S*creening *T*est). Chart 5-5 shows the CAGE Questions Adapted to Include Drugs (CAGEAID). The MAST (Michigan Alcohol Screening Test) has been updated to include drug use and has a geriatric version (The New York State Office of Alcoholism and Substance Abuse Services [OASAS], 2007).

CHART 5-5 **Assessing for Alcohol or Drug Use**

**CAGE Questions Adapted to Include Drugs (CAGEAID)***

**Have you felt you ought to cut down on your drinking *(or drug use)*?**
_____Yes _____No

**Have people annoyed you by criticizing your drinking *(or drug use)*?**
_____Yes _____No

**Have you felt bad or guilty about your drinking *(or drug use)*?**
_____Yes _____No

**Have you ever had a drink *(or used drugs)* first thing in the morning to steady your nerves or get rid of a hangover *(or to get the day started)*?**
_____Yes _____No

*Boldface text shows the original CAGE questions; boldface italic text shows modifications of the CAGE questions used to screen for drug disorders. In a general population, two or more positive answers indicate a need for more in-depth assessment.

From Fleming, M. F. & Barry, K. L. (1992). *Addictive disorders.* St. Louis: Mosby; and Ewing, J. A. (1984). Detecting alcoholism: The CAGE questionnaire. *Journal of the American Medical Association*, 252(14), 1905–1907.

Similar questions can be used to elicit information about smoking and caffeine consumption. Questions about illicit drug use follow naturally after questions about smoking, caffeine consumption, and alcohol use. A nonjudgmental approach makes it easier for a person to respond truthfully and factually. If street names or unfamiliar terms are used to describe drugs, the person is asked to define the terms used.

Investigation of lifestyle should also include questions about complementary and alternative therapies. It is estimated that as many as 40% of Americans use some type of complementary or alternative therapies, including special diets, prayer, visualization or guided imagery, massage, meditation, herbal products, and many others. Marijuana is used for management of symptoms, especially pain, in a number of chronic conditions.

### Disability

The general patient profile needs to contain questions about any hearing, vision, or other type of physical disability. Mental, sensory, or cognitive disabilities need to be inquired about as well. The presence of an obvious physical limitation (eg, using crutches to walk or using a wheelchair to get around) necessitates further investigation. The etiology of the disability should be elicited, and the length of time the patient has had the disability, the impact on function, and health access are important to assess (Smeltzer, Sharts-Hopko, Ott, et al., 2007). Chart 5-6 presents specific issues that the nurse should consider when obtaining health histories and conducting physical assessments of patients with disabilities.

### Self-Concept

Self-concept refers to a person's view of himself or herself, an image that has developed over many years. To assess self-concept, the interviewer might ask how a person views life, using a question such as, "How do you feel about your life in general?" A person's self-concept can be threatened very easily by changes in physical function or appearance or other threats to health. The impact of certain medical conditions or surgical interventions, such as a colostomy or a mastectomy, can threaten body image. The question, "Do you have any particular concerns about your body?" may elicit useful information about self-image.

### Sexuality

No area of assessment is more personal than the sexual history. Interviewers are frequently uncomfortable with such questions and ignore this area of the patient profile or conduct a very cursory interview about this subject. Lack of knowledge about sexuality, preconceived notions (eg, assuming all people are heterosexual), and anxiety about one's own sexuality may hamper the interviewer's effectiveness in dealing with this subject (Neville & Henrickson, 2006).

Sexual assessment can be approached at the end of the interview, at the time interpersonal or lifestyle factors are assessed, or it may be easier to discuss sexuality as a part of the genitourinary history within the review of systems. In female patients, a discussion of sexuality would follow questions about menstruation. In male patients, a similar discussion would follow questions about the urinary system.

Obtaining the sexual history provides an opportunity to discuss sexual matters openly and gives the person permission to express sexual concerns to an informed professional. The interviewer must be nonjudgmental and must use language appropriate to the patient's age and background (Neville & Henrickson, 2006). The assessment begins with an orienting sentence such as, "Next, I would like to ask about your sexual health and practices." Such an opening may lead to a discussion of concerns related to sexual expression or the quality of a relationship, or to questions about contraception, risky sexual behaviors, and safer sex practices. Examples of other questions are, "Do you have one or more sexual partners?" and "Are you satisfied with your sexual relationships?"

Determining whether a person is sexually active should precede any attempts to explore issues related to sexuality and sexual function. Care should be taken to initiate conversations about sexuality with elderly patients and patients with disabilities and not to treat them as asexual people. Questions are worded in such a way that the person feels free to discuss his or her sexuality regardless of marital status or sexual preference. Direct questions are usually less threatening when prefaced with such statements as, "Most people feel that . . ." or "Many people worry about . . . ." This suggests the normalcy of such feelings or behavior and encourages the person to share information that might otherwise be omitted because of fear of seeming "different."

If a person answers abruptly or does not wish to carry the discussion any further, then the interviewer should move to the next topic. However, introducing the subject of sexuality indicates to the person that a discussion of sexual

## Chart 5-6 • *Health Assessment of People With Disabilities*

### Overview

People with disabilities are entitled to the same level of health assessment and physical examination as people without disabilities. The nurse needs to be aware of the patient's disabilities or impairments (hearing, vision, cognitive, and physical limitations) and take these into consideration when obtaining a health history and conducting a physical assessment. It is appropriate to ask the patient what assistance he or she needs rather than assuming that help is needed for all activities or that, if assistance is needed, the patient will ask for it.

### Health History

Communication between the nurse and the patient is essential. To ensure that the patient is able to respond to assessment questions and provide needed information, interpreters, assistive listening devices, or other alternative formats (eg, Braille, large-print forms) may be required.

When interpreters are needed, interpretation services should be arranged. Health care facilities have a responsibility to provide these services without charge to the patient. Family members (especially children) should *not* be used as interpreters, because doing so violates the patient's right to privacy and confidentiality.

The nurse should speak directly to the patient and not to family members or others who have accompanied the patient. If the patient has vision or hearing loss, normal tone and volume of the voice should be used when conducting the assessment. The patient should be able to see the nurse's face clearly during the health history, so that speech reading and nonverbal clues can be used to aid communication.

The health history should address general health issues that are important to all patients, including sexual history and risk for abuse. It should also address the impact of the patient's disability on health issues and access to care and the effect of the patient's current health problem on his or her disability.

The nurse should verify what the patient has said; if the patient has difficulty communicating verbally, the nurse should ask for clarification rather than assume that it is too difficult for the patient to do so. Most people would rather be asked to explain again than run the risk of being misunderstood (Smeltzer, et al., 2007).

### Physical Examination

Inaccessible facilities remain a major barrier to health care for people with disabilities. Barriers include lack of ramps and grab bars, inaccessible restrooms, small examination rooms, and examination tables that cannot be lowered to allow the patient to move himself or herself onto, or be transferred easily and safely to, the examination table. The patient may need help getting undressed for the physical examination (and dressed again), moving on and off the examination table, and maintaining positions usually required during physical examination maneuvers. It is important to ask the patient what assistance is needed.

If the patient has impaired sensory function (eg, lack of sensation, hearing or vision loss), it is important to inform the patient that you will be touching him or her. Furthermore, it is important to explain all procedures and maneuvers.

Gynecologic examinations should *not* be deferred because a patient has a disability or is assumed to be sexually inactive. Explanations of the examination are important for all women, and even more so for women with disabilities, because they may have had previous negative experiences. Slow, gentle moving and positioning of the patient for the gynecologic examination and warming the speculum before attempting insertion often minimize spasticity in women with neurologically related disabilities.

### Health Screening and Testing

Many people with disabilities report that they have not been weighed for years or even decades because they are unable to stand for this measurement. Alternative methods (eg, use of wheelchair scales) are needed to monitor weight and body mass index. This is particularly important because of the increased incidence of obesity and its effects on health status and transfer of persons with disabilities.

Patients with disabilities may require special assistance if urine specimens are to be obtained as part of the visit. They are often able to suggest strategies to obtain urine specimens based on previous experience.

If it is necessary for the nurse to wear a mask during a procedure or if the patient is unable to see the face of the nurse during a procedure, it is important to explain the procedure and the expected role of the patient ahead of time. If the patient is unable to hear or is unable to communicate with the nurse or other health care provider verbally during an examination or diagnostic test, a method of communication (eg, signaling the patient by tapping his or her arm, signaling the nurse by using a bell) should be established beforehand.

Inaccessible facilities have resulted in decreased participation of people with disabilities in recommended preventive screening, including gynecologic examinations, mammograms, and bone density testing (Smeltzer, Zimmerman & Capriotti, 2005). Therefore, it is important to ask about health screening and recommendations for screening. In addition, people with disabilities should be asked about their participation in health promotion activities, because inaccessible environments may limit their participation in exercise, health programs, and other health promotion efforts.

concerns is acceptable and can be approached again in the future if so desired. Further discussion of the sexual history is presented in Chapters 46 and 49.

**Risk for Abuse**

Physical, sexual, and psychological abuse is a topic of growing importance in today's society. Such abuse occurs to people of both genders, of all ages, and from all socioeconomic, ethnic, and cultural groups. Patients rarely discuss this topic unless specifically asked about it. In fact, research shows that the majority of women currently in an abusive relationship have never told a health care provider. Therefore, it is important to ask direct questions, such as:

- Is anyone physically hurting you or forcing you to have sexual activities?
- Has anyone ever hurt you physically or threatened to do so?
- Are you ever afraid of anyone close to you (your partner, caregiver, or other family members)?

Patients who are elderly or have disabilities are at increased risk for abuse and should be asked about it as a routine part of assessment. However, when elderly patients are questioned directly, they rarely admit to abuse. Health care professionals should assess for risk factors, such as high levels of stress or alcoholism in caregivers, evidence of violence, and emotional outbursts, as well as financial, emotional, or physical dependency.

Two additional questions have been found to be effective in uncovering specific types of abuse that may occur only in people with disabilities:

- Does anyone prevent you from using a wheelchair, cane, respirator, or other assistive device?
- Does anyone you depend on refuse to help you with an important personal need, such as taking your medicine, getting to the bathroom, getting in or out of bed, bathing, dressing, or getting food or drink?

If a person's response indicates that abuse is a risk, further assessment is warranted, and efforts are made to ensure the patient's safety and provide access to appropriate community and professional resources and support systems. Further discussion of domestic violence and abuse is presented in Chapter 46.

**Stress and Coping Responses**

Each person handles stress differently. How well people adapt depends on their ability to cope. During a health history, past coping patterns and perceptions of current stresses and anticipated outcomes are explored to identify the person's overall ability to handle stress. It is especially important to identify expectations that a person may have of family, friends, and caregivers in providing financial, emotional, or physical support. Further discussion of stress and coping is presented in Chapter 6.

### Other Health History Formats

The health history format discussed in this chapter is only one possible approach that is useful in obtaining and organizing information about a person's health status. Some experts consider this traditional format to be inappropriate for nurses, because it does not focus exclusively on the assessment of human responses to actual or potential health problems. Several attempts have been made to develop an assessment format and database with this focus in mind. One example is a nursing database based on the North American Nursing Diagnosis Association and its 13 domains: health promotion, nutrition, elimination/exchange, activity/rest, perception/cognition, self-perception, role relationship, sexuality, coping/stress tolerance, life principles, safety/protection, comfort, and growth/development (NANDA International, 2007). Although there is support in nursing for using this approach, no consensus for its use has been reached. Other examples include electronic systems specific to home care and perioperative nursing (Simpson, 2007).

The National Center for Health Services Research of the U.S. Department of Health and Human Services (USDHHS) and other groups from the public and private sectors have focused on assessing not only biologic health, but also other dimensions of health. These dimensions include physical, functional, emotional, mental, and social health. Efforts to assess health status have focused on the manner in which disease or disability affects a patient's functional status—that is, the ability of the person to function normally and perform his or her usual physical, mental, and social activities. An emphasis on functional assessment is viewed as more holistic than the traditional health or medical history. Instruments to assess health status in these ways may be used by nurses along with their own clinical assessment skills to determine the impact of illness, disease, disability, and health problems on functional status.

Health concerns that are not complex (eg, earache, sinusitis) and can be resolved in a short period usually do not require the depth or detail that is necessary when a person is experiencing a major illness or health problem. Additional assessments that go beyond the general patient profile may be used if the patient's health problems are acute and complex or if the illness is chronic (Bickley, 2007; Weber & Kelley, 2007).

The person should be asked about continuing health promotion and screening practices. If the person has not been involved in these practices in the past, he or she should be educated about their importance and referred to appropriate health care providers. Research has shown that health promotion is beneficial even for frail older home care clients. One study found that proactively providing older people with health promotion compared to providing standard nursing home care services resulted in better mental health functioning, decreased depression, and enhanced perceptions of social support with no increase in costs (Markle-Reid, Weir, Browne, et al., 2006).

Regardless of the assessment format used, the focus of nurses during data collection is different from that of physicians and other health team members. However, the nursing focus complements these other approaches and encourages collaboration among the health care providers, with each member bringing his or her own expertise and focus to the situation.

## Physical Assessment

Physical assessment, or the physical examination, is an integral part of nursing assessment. The basic techniques and tools used in performing a physical examination are

described in general in this chapter. The examinations of specific systems, including special maneuvers, are described in the appropriate chapters throughout the book.

## Examination Considerations

The physical examination is usually performed after the health history is obtained. It is carried out in a well-lighted, warm area. The patient is asked to (or helped to) undress and is draped appropriately so that only the area to be examined is exposed. The person's physical and psychological comfort are considered at all times. It is necessary to describe procedures to the patient and explain what sensations to expect before each part of the examination. The examiner's hands are washed before and immediately after the examination. Fingernails are kept short to avoid injuring the patient. If there is a possibility of coming into contact with blood or other body secretions during the physical examination, gloves should be worn.

An organized and systematic examination is the key to obtaining appropriate data in the shortest time. Such an approach encourages cooperation and trust on the part of the patient. The person's health history provides the examiner with a health profile that guides all aspects of the physical examination.

A "complete" physical examination is not routine. Many of the body systems are selectively assessed on the basis of the presenting problem. For example, if a healthy 20-year-old college student requires an examination to study abroad and reports no history of neurologic abnormality, the neurologic assessment is brief. Conversely, a history of transient numbness and diplopia (double vision) usually necessitates a complete neurologic investigation. Similarly, a patient with chest pain receives a much more intensive examination of the chest and heart than one with an earache. In general, the health history guides the examiner in obtaining additional data for a complete picture of the patient's health.

The process of learning to perform a physical examination requires repetition and reinforcement in a clinical setting. Only after basic physical assessment techniques are mastered can the examiner tailor the routine screening examination to include thorough assessments of particular systems, including special maneuvers (Bickley, 2007; Weber & Kelley, 2007).

## Components of the Physical Examination

The components of a physical examination include general observations and then a more focused assessment of the pertinent body systems. The tools of the physical examination are the human senses of vision, hearing, touch, and smell. These may be augmented by special tools (eg, stethoscope, ophthalmoscope, reflex hammer) that are extensions of the human senses; they are simple tools that anyone can learn to use well. Expertise comes with practice, and sophistication comes with the interpretation of what is seen and heard.

### *Initial Observations*

General inspection begins with the first contact with the patient. Introducing oneself and shaking hands provide opportunities for making initial observations: Is the person old or young? How old? How young? Does the person appear to be his or her stated age? Is the person thin or obese? Does the person appear anxious or depressed? Is the person's body structure normal or abnormal? In what way, and how different from normal? It is essential to pay attention to the details in observation. Vague, general statements are not a substitute for specific descriptions based on careful observation. Consider the following examples:

- "The person appears sick." In what way does he or she appear sick? Is the skin clammy, pale, jaundiced, or cyanotic? Is the person grimacing in pain or having difficulty breathing? Does he or she have edema? What specific physical features or behavioral manifestations indicate that the person is "sick"?
- "The person appears chronically ill." In what way does he or she appear chronically ill? Does the person appear to have lost weight? People who lose weight secondary to muscle-wasting diseases (eg, acquired immunodeficiency syndrome [AIDS], malignancy) have a different appearance than those who are merely thin, and weight loss may be accompanied by loss of muscle mass or atrophy. Does the skin have the appearance of chronic illness (ie, is it pale, or does it give the appearance of dehydration or loss of subcutaneous tissue)?

These important specific observations are documented in the patient's chart or health record. Among general observations that should be noted in the initial examination of the patient are posture and stature, body movements, nutritional status, speech pattern, and vital signs.

#### Posture

The posture that a person assumes often provides valuable information. Patients who have breathing difficulties (dyspnea) secondary to cardiac disease prefer to sit and may report feeling short of breath when lying flat for even a brief time. Patients with abdominal pain due to peritonitis prefer to lie perfectly still; even slight jarring of the bed causes agonizing pain. In contrast, patients with abdominal pain due to renal or biliary colic are often restless and may pace the room.

#### Body Movements

Abnormalities of body movement are of two kinds: generalized disruption of voluntary or involuntary movement and asymmetry of movement. The first category includes tremors of a wide variety; some tremors may occur at rest (Parkinson's disease), whereas others occur only on voluntary movement (cerebellar ataxia). Other tremors may exist during both rest and activity (alcohol withdrawal syndrome, thyrotoxicosis). Some voluntary or involuntary movements are fine, and others are quite coarse. At the extreme are the convulsive movements of epilepsy or tetanus and the choreiform (involuntary and irregular) movements of patients with rheumatic fever or Huntington disease.

Asymmetry of movement, in which only one side of the body is affected, may occur with disorders of the central nervous system (CNS), primarily in those patients who have had a cerebrovascular accident (stroke). Patients may have drooping of one side of the face, weakness or paralysis of the extremities on one side of the body, and a

foot-dragging gait. Spasticity (increased muscle tone) may also be present, particularly in patients with multiple sclerosis.

### Nutritional Status

Nutritional status is important to note. Obesity may be generalized as a result of excessive intake of calories, or it may be specifically localized to the trunk in patients who have an endocrine disorder (Cushing's disease) or who have been taking corticosteroids for long periods. Loss of weight may be generalized as a result of inadequate caloric intake, or it may be seen in loss of muscle mass with disorders that affect protein synthesis. Nutritional assessment is discussed in more detail later in this chapter.

### Speech Pattern

Speech may be slurred because of CNS disease or because of damage to cranial nerves. Recurrent damage to the laryngeal nerve results in hoarseness, as do disorders that produce edema or swelling of the vocal cords. Speech may be halting, slurred, or interrupted in flow in patients with some CNS disorders (eg, multiple sclerosis, stroke).

### Vital Signs

The recording of vital signs is a part of every physical examination (Bickley, 2007). Blood pressure, pulse rate, respiratory rate, and body temperature measurements are obtained and recorded. Acute changes and trends over time are documented, and unexpected changes and values that deviate significantly from a patient's normal values are brought to the attention of the patient's primary health care provider. The "fifth vital sign," pain, is also assessed and documented, if indicated.

A normal oral temperature for most people is 37.0°C (98.6°F); however, some variation is normal. Some people's temperatures are quite normal at 36.6°C (98°F) or 37.3°C (99°F). There is a normal diurnal variation of a degree or two in body temperature throughout the day; temperature is usually lowest in the morning and increases during the day to between 37.3° and 37.5°C (99° to 99.5°F), and it then decreases during the night (Bickley, 2007; Weber & Kelley, 2007).

## *Focused Assessment*

Following the general inspection, a more focused assessment is conducted. Although the sequence of physical examination depends on the circumstances and on the patient's reason for seeking health care, the complete examination usually proceeds as follows:

- Skin
- Head and neck
- Thorax and lungs
- Breasts
- Cardiovascular system
- Abdomen
- Rectum
- Genitalia
- Neurologic system
- Musculoskeletal system

In clinical practice, all relevant body systems are tested throughout the physical examination, not necessarily in the sequence described (Weber & Kelley, 2007). For example, when the face is examined, it is appropriate to check for facial asymmetry and, thus, for the integrity of the fifth and seventh cranial nerves; the examiner does not need to repeat this as part of a neurologic examination. When systems are combined in this manner, the patient does not need to change positions repeatedly, which can be exhausting and time-consuming.

The traditional sequence in the focused portion of the examination is inspection, palpation, percussion, and then auscultation, except in the case of an abdominal examination.

### Inspection

The first fundamental technique is **inspection** or observation of each relevant body system in more detail as indicated from the health history or the general inspection. Characteristics such as skin color, presence and size of lesions, edema, erythema, symmetry, and pulsations are noted. Specific body movements that are noted on inspection include spasticity, muscle spasms, and an abnormal gait (Porth & Matfin, 2009).

### Palpation

**Palpation** is a vital part of the physical examination. Many structures of the body, although not visible, may be assessed through the techniques of light and deep palpation (Fig. 5-3).




**Figure 5-3** **A,** Light palpation. **B,** Deep palpation.

Examples include the superficial blood vessels, lymph nodes, thyroid gland, organs of the abdomen and pelvis, and rectum. When the abdomen is examined, auscultation is performed before palpation and percussion to avoid altering bowel sounds (Bickley, 2007; Weber & Kelley, 2010).

Sounds generated within the body, if within specified frequency ranges, also may be detected through touch. For example, certain murmurs generated in the heart or within blood vessels (thrills) may be detected. Thrills cause a sensation to the hand much like the purring of a cat. Voice sounds are transmitted along the bronchi to the periphery of the lung. These may be perceived by touch and may be altered by disorders affecting the lungs. The phenomenon is called *tactile fremitus* and is useful in assessing diseases of the chest. The significance of these findings is discussed in Chapters 21 and 26.

### Percussion

The technique of **percussion** translates the application of physical force into sound (Fig. 5-4). It is a skill requiring practice that yields much information about disease processes in the chest and abdomen (Bickley, 2007; Weber & Kelley, 2007). The principle is to set the chest wall or abdominal wall into vibration by striking it with a firm object. The sound produced reflects the density of the underlying structure. Certain densities produce sounds as percussion notes. These sounds, listed in a sequence that proceeds from the least to the most dense, are tympany, hyperresonance, resonance, dullness, and flatness. Tympany is the drumlike sound produced by percussing the air-filled stomach. Hyperresonance is audible when one percusses over inflated lung tissue in a person with emphysema. Resonance is the sound elicited over air-filled lungs. Percussion of the liver produces a dull sound, whereas percussion of the thigh produces a flat sound.

Percussion allows the examiner to assess such normal anatomic details as the borders of the heart and the movement of the diaphragm during inspiration. It is also possible to determine the level of a pleural effusion (fluid in the pleural cavity) and the location of a consolidated area caused by pneumonia or atelectasis (collapse of alveoli). The use of percussion is described further with disorders of the thorax and abdomen (see Chapters 21 and 34).



**Figure 5-4** Percussion technique. The middle finger of one hand strikes the terminal phalanx of the middle finger of the other hand, which is placed firmly against the body. If the action is performed sharply, a brief, resonant tone will be produced. The clarity of the tone depends on the brevity of the action. The intensity of the tone varies with the force used.

### Auscultation

**Auscultation** is the skill of listening to sounds produced within the body created by the movement of air or fluid. Examples include breath sounds, the spoken voice, bowel sounds, heart sounds, and cardiac murmurs. Physiologic sounds may be normal (eg, first and second heart sounds) or pathologic (eg, heart murmurs in diastole, crackles in the lung). Some normal sounds may be distorted by abnormalities of structures through which the sound must travel (eg, changes in the character of breath sounds as they travel through the consolidated lung of a patient with lobar pneumonia).

Sound produced within the body, if of sufficient amplitude, may be detected with the stethoscope, which functions as an extension of the human ear and channels sound. The nurse must avoid touching the tubing or rubbing other surfaces (hair, clothing) during auscultation to minimize extraneous noises.

Sound produced by the body, like any other sound, is characterized by intensity, frequency, and quality. The *intensity*, or loudness, associated with physiologic sound is low; therefore, the use of the stethoscope is needed. The *frequency*, or pitch, of physiologic sound is in reality "noise," in that most sounds consist of a frequency spectrum, as opposed to the single-frequency sounds that we associate with music or a tuning fork. The frequency spectrum may be quite low, yielding a rumbling noise, or comparatively high, producing a harsh or blowing sound. *Quality* of sound relates to overtones that allow one to distinguish among various sounds. Sound quality enables the examiner to distinguish between the musical quality of high-pitched wheezing and the low-pitched rumbling of a diastolic murmur (Bickley, 2007; Weber & Kelley, 2007).

## Nutritional Assessment

Nutrition is important to maintain health and to prevent disease and death. When illness or injury occurs, optimal nutrition is essential for healing and resisting infection and other complications. An in-depth nutritional assessment is often integrated into the health history and physical examination. Assessment of nutritional status provides information about obesity, weight loss, undernutrition, malnutrition, deficiencies in specific nutrients, metabolic abnormalities, the effects of medications on nutrition, and special problems affecting patients both in hospitals and in the home and other community settings (Chen, 2005).

Disorders caused by nutritional deficiency, overeating, or eating unhealthy meals are among the leading causes of illness and death in the United States today. The three leading causes of death—heart disease, cancer, and stroke—are related, in part, to consequences of unhealthy nutrition (Lear, Humphries, Kohl, et al., 2007). Other examples of health problems associated with poor nutrition include obesity, osteoporosis, cirrhosis, diverticulitis, and eating disorders.

Certain signs and symptoms that suggest possible nutritional deficiency, such as muscle wasting, poor skin integrity, loss of subcutaneous tissue, and obesity, are easy to note because they are specific; these should be pursued further. Other physical signs may be subtle and must be carefully assessed. For example, certain signs that appear to indicate nutritional deficiency may actually reflect other systemic conditions (eg, endocrine disorders, infectious disease). Others may result from impaired digestion, absorption, excretion, or storage of nutrients in the body (Porth & Matfin, 2009; Weber & Kelley, 2007).

## Lifespan Considerations

Adolescence is a time of critical growth and acquisition of lifelong eating habits, and therefore nutritional assessment, analysis, and intervention are critical (Vereecken et al., 2005). In the past two decades rates of obesity in adolescents have increased at an alarming rate.

Adolescent girls are at particular nutritional risk, because iron, folate, and calcium intakes are below recommended levels and they are a less physically active group compared to adolescent males. Adolescents with other nutritional disorders, such as anorexia and bulimia, have a better chance of recovery if these disorders are identified and treated in the adolescent years rather than in adulthood.

The elderly are also at risk for altered nutrition. Special considerations for nutritional assessment in the older adult are presented in Chart 5-7.

## Components of Nutritional Assessment

The sequence of assessment of parameters may vary, but evaluation of nutritional status includes one or more of the following methods: measurement of body mass index and waist circumference, biochemical measurements, clinical examination findings, and dietary data.

### Body Mass Index

**Body mass index (BMI)** is a ratio based on body weight and height. The obtained value is compared to the established standards; however, trends or changes in values over time are considered more useful than isolated or one-time measurements. BMI (Fig. 5-5) is highly correlated with body fat, but increased lean body mass or a large body frame can also increase the BMI. People who have a BMI lower than 24 (or who are 80% or less of their desirable body weight for height) are at increased risk for problems associated with poor nutritional status. In addition, a low BMI is associated with a higher mortality rate among hospitalized patients and community-dwelling elderly. Those who have a BMI of 25 to 29 are considered overweight; those with a BMI of 30 to 39, obese; and those with a BMI greater than 40, extremely obese (Dudek, 2006). In analyzing BMI, the nurse must be aware that cutoff scores for normal, overweight, and obese may differ for different ethnic groups.

It is important to assess for usual body weight and height and to compare these values with ideal weight (Chart 5-8). Current weight does not provide information about recent changes in weight; therefore, patients are asked about their usual body weight. Loss of height may be due to osteoporosis, an important problem related to nutrition, especially in postmenopausal women. A loss of 2 or 3 inches of height may indicate osteoporosis (Bickley, 2007; Weber & Kelley, 2007).

In addition to the calculation of BMI, waist circumference measurement is particularly useful for adult patients who are categorized as being of normal weight or over-

CHART 5-7

### *Nutritional Assessment in the Older Adult*

Nutritional screening in the elderly is a first step in maintaining adequate nutrition and replacing nutrient losses to maintain the individual's health and well-being. Aging is associated with increases in the incidence of weight loss, being underweight, and having protein-energy malnutrition (Soriano, et al., 2007). Elderly people who are malnourished tend to have longer and more expensive hospital stays than those who are adequately nourished; the risk of costly complications is also increased in malnourished patients (Dudek, 2006).

Inadequate dietary intake in the elderly may result from physiologic changes in the gastrointestinal tract, social and economic factors, drug interactions, disease, excessive use of alcohol, and poor dentition or missing teeth. Malnutrition is a common consequence of these factors and in turn leads to illness and frailty of the elderly. Important aspects of care of the elderly in the hospital, home, outpatient setting, or extended care facility include recognizing risk factors and identifying those who are at risk for inadequate nutrition (Soriano, et al., 2007).

Many elderly people take excessive and inappropriate medications; this is referred to as polypharmacy. The number of adverse reactions increases proportionately with the number of prescribed and over-the-counter medications taken. Age-related physiologic and pathophysiologic changes may alter the metabolism and elimination of many medications. Medications can influence food intake by producing side effects such as nausea, vomiting, decreased appetite, and changes in sensorium. They may also interfere with the distribution, utilization, and storage of nutrients. Disorders affecting any part of the gastrointestinal tract can alter nutritional requirements and health status in people of any age; however, they are likely to occur more quickly and more frequently in the elderly.

Nutritional problems in the elderly often occur or are precipitated by such illnesses as pneumonia and urinary tract infections. Acute and chronic diseases may affect the metabolism and utilization of nutrients, which already are altered by the aging process. Up-to-date immunizations, prompt treatment of bacterial infections, and social programs such as Meals on Wheels may reduce the risk of illness-associated malnutrition. Alcohol and substance abuse are potential factors in the elderly population that should not be overlooked (OASAS, 2007). Even the well elderly may be nutritionally at risk because of decreased odor perception, poor dental health, limited ability to shop and cook, financial hardship, and the fact that they often eat alone. Also, reduction in exercise with age without concomitant changes in carbohydrate intake places the elderly at risk for obesity.

**Body Mass Index**

The body mass index (BMI) is used to determine who is overweight.

$$\textbf{BMI} = \frac{703 \times \text{weight in pounds}}{(\text{height in inches})^2} \quad \text{OR} \quad \frac{\text{weight in kilograms}}{(\text{height in meters})^2}$$

BMI score is at the intersection of height and weight. A body mass index score of 25 or more is considered overweight and 30 or more is considered obese.

25 Overweight Limit    Overweight

| Weight / Height | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 | 205 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5′0″** | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| **5′1″** | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| **5′2″** | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 37 |
| **5′3″** | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 36 |
| **5′4″** | 17 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 33 | 34 | 35 |
| **5′5″** | 17 | 17 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 32 | 33 | 34 |
| **5′6″** | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 31 | 32 | 33 |
| **5′7″** | 16 | 16 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 31 | 32 |
| **5′8″** | 15 | 16 | 17 | 17 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 30 | 31 |
| **5′9″** | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 30 |
| **5′10″** | 14 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 29 |
| **5′11″** | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 28 | 29 |
| **6′0″** | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 28 |
| **6′1″** | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 26 | 27 |
| **6′2″** | 13 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 26 |
| **6′3″** | 12 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 |
| **6′4″** | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 24 | 25 |

Source: Shape Up America. National Institutes of Health

**Figure 5-5** Body mass index.

weight (Dudek, 2006). To measure waist circumference, a tape measure is placed in a horizontal plane around the abdomen at the level of the iliac crest. A waist circumference greater than 40 inches for men or 35 inches for women indicates excess abdominal fat. Those with a high waist circumference are at increased risk for diabetes, dyslipidemias, hypertension, cardiovascular disease, and atrial fibrillation (Bickley, 2007; Weber & Kelley, 2009).

### Chart 5-8 • *Calculating Ideal Body Weight*

**Women**

- Allow 100 lb for 5 feet of height.
- Add 5 lb for each additional inch over 5 feet.
- Subtract 10% for small frame; add 10% for large frame.

**Men**

- Allow 106 lb for 5 feet of height.
- Add 6 lb for each additional inch over 5 feet.
- Subtract 10% for small frame, add 10% for large frame.

**Example:** Ideal body weight for a 5′6″ adult is

| | Female | Male |
|---|---|---|
| 5′ of height | 100 lb | 106 lb |
| Per additional inch | 6″ × 5 lb/inch = 30 lb | 6″ × 6 lb/inch = 36 lb |
| Ideal body weight | 130 lb ± 13 lb depending on frame size | 142 lb ± 14 lb depending on frame size |

## *Biochemical Assessment*

Biochemical assessment reflects both the tissue level of a given nutrient and any abnormality of metabolism in the utilization of nutrients. These determinations are made from studies of serum (albumin, transferrin, retinol-binding protein, electrolytes, hemoglobin, vitamin A, carotene, vitamin C, and total lymphocyte count) and studies of urine (creatinine, thiamine, riboflavin, niacin, and iodine). See Appendix A for normal serum and urine biochemical values. Some of these tests, while reflecting recent intake of the elements detected, can also identify below-normal levels when there are no clinical symptoms of deficiency.

Low serum albumin and prealbumin levels are most often used as measures of protein deficit in adults. Albumin synthesis depends on normal liver function and an adequate supply of amino acids. Because the body stores a large amount of albumin, the serum albumin level may not decrease until malnutrition is severe; therefore, its usefulness in detecting recent protein depletion is limited. Decreased albumin levels may be caused by overhydration, liver or renal disease, or excessive protein loss due to burns, major surgery, infection, or cancer. Serial measurements of prealbumin

levels are also used to assess the results of nutritional therapy. Prealbumin, also called thyroxin-binding protein, is a more sensitive indicator of protein status than albumin, but the test is more expensive and therefore less frequently ordered (Dudek, 2006; Kuszajewski & Clontz, 2005).

Additional laboratory data, such as levels of transferrin and retinol-binding protein, anergy panels, and lymphocyte and electrolyte counts, are used in many institutions. Transferrin is a protein that binds and carries iron from the intestine through the serum. Because of its short half-life, transferrin levels decrease more quickly than albumin levels in response to protein depletion. Although measurement of retinol-binding protein is not available from many laboratories, it may be a useful means of monitoring acute, short-term changes in protein status. The total lymphocyte count may be reduced in people who are acutely malnourished as a result of stress and low-calorie feeding and in those with impaired cellular immunity. Anergy, the absence of an immune response to injection of small concentrations of recall antigen under the skin, may also indicate malnutrition because of delayed antibody synthesis and response. Serum electrolyte levels provide information about fluid and electrolyte balance and kidney function. The creatinine/height index calculated over a 24-hour period assesses the metabolically active tissue and indicates the degree of protein depletion, comparing expected body mass for height with actual body cell mass. A 24-hour urine sample is obtained, and the amount of creatinine is measured and compared to normal ranges based on the patient's height and gender. Values lower than normal may indicate loss of lean body mass and protein malnutrition.

### Clinical Examination

The state of nutrition is often reflected in a person's appearance. Although the most obvious physical sign of good nutrition is a normal body weight with respect to height, body frame, and age, other tissues can serve as indicators of general nutritional status and adequate intake of specific nutrients; these include the hair, skin, teeth, gums, mucous membranes, mouth and tongue, skeletal muscles, abdomen, lower extremities, and thyroid gland (Table 5-1). Specific aspects of clinical examination that are useful in identifying nutritional deficits include an examination (Chen, Chyun, Li, et al., 2007) and assessment of skin for turgor, edema, elasticity, dryness, subcutaneous tone, poorly healing wounds and ulcers, purpura, and bruises (Porth & Matfin, 2009). The musculoskeletal examination also provides information about muscle wasting and weakness.

### Dietary Data

Commonly used methods of determining individual eating patterns include the food record, the 24-hour food recall, and a dietary interview. Each of these methods helps estimate whether food intake is adequate and appropriate. If these methods are used to obtain the dietary history, instructions must be given to the patient about measuring and recording food intake.

#### Methods of Collecting Data

***Food Record.*** The food record is used most often in nutritional status studies. A person is instructed to keep a record of food actually consumed over a period of time, varying from 3 to 7 days, and to accurately estimate and describe the specific foods consumed. Food records are fairly accurate if the person is willing to provide factual information and is able to estimate food quantities.

***24-Hour Recall.*** As the name implies, the 24-hour recall method is a recall of food intake over a 24-hour period. A person is asked to recall all foods eaten during the previous day and to estimate the quantities of each food consumed.

**Table 5-1 PHYSICAL INDICATORS OF NUTRITIONAL STATUS**

| Indicator | Signs of Good Nutrition | Signs of Poor Nutrition |
|---|---|---|
| General appearance | Alert, responsive | Listless, appears acutely or chronically ill |
| Hair | Shiny, lustrous; firm, healthy scalp | Dull and dry, brittle, depigmented, easily plucked; thin and sparse |
| Face | Skin color uniform; healthy appearance | Skin dark over cheeks and under eyes, skin flaky, face swollen or hollow/sunken cheeks |
| Eyes | Bright, clear, moist | Eye membranes pale, dry (xerophthalmia); increased vascularity, cornea soft (keratomalacia) |
| Lips | Good color (pink), smooth | Swollen and puffy; angular lesion at corners of mouth (cheilosis) |
| Tongue | Deep red in appearance; surface papillae present | Smooth appearance, swollen, beefy-red, sores, atrophic papillae |
| Teeth | Straight, no crowding, no dental caries, bright | Dental caries, mottled appearance (fluorosis), malpositioned |
| Gums | Firm, good color (pink) | Spongy, bleed easily, marginal redness, recession |
| Thyroid | No enlargement of the thyroid | Thyroid enlargement (simple goiter) |
| Skin | Smooth, good color, moist | Rough, dry, flaky, swollen, pale, pigmented; lack of fat under skin |
| Nails | Firm, pink | Spoon-shaped, ridged, brittle |
| Skeleton | Good posture, no malformation | Poor posture, beading of ribs, bowed legs or knock knees |
| Muscles | Well developed, firm | Flaccid, poor tone, wasted, underdeveloped |
| Extremities | No tenderness | Weak and tender; edematous |
| Abdomen | Flat | Swollen |
| Nervous system | Normal reflexes | Decreased or absent ankle and knee reflexes |
| Weight | Normal for height, age, and body build | Overweight or underweight |

Because information does not always represent usual intake, at the end of the interview the patient is asked whether the previous day's food intake was typical. To obtain supplementary information about the typical diet, it is also necessary to ask how frequently the person eats foods from the major food groups.

***Dietary Interview.*** The success of the interviewer in obtaining information for dietary assessment depends on effective communication, which requires that good rapport be established to promote respect and trust. The interviewer explains the purpose of the interview. The interview is conducted in a nondirective and exploratory way, allowing the respondent to express feelings and thoughts while encouraging him or her to answer specific questions. The manner in which questions are asked influences the respondent's cooperation. The interviewer must be nonjudgmental and avoid expressing disapproval, either by verbal comments or by facial expression.

*Character of General Intake* Several questions may be necessary to elicit the information needed. When attempting to elicit information about the type and quantity of food eaten at a particular time, leading questions such as, "Do you use sugar or cream in your coffee?" should be avoided. In addition, assumptions are not made about the size of servings; instead, questions are phrased so that quantities are more clearly determined. For example, to help determine the size of one hamburger, the patient may be asked, "How many servings were prepared with the pound of meat you bought?" Another approach to determining quantities is to use food models of known sizes in estimating portions of meat, cake, or pie, or to record quantities in common measurements, such as cups or spoonfuls (or the size of containers, when discussing intake of bottled beverages).

In recording a particular combination dish, such as a casserole, it is useful to ask about the ingredients, recording the largest quantities first. When recording quantities of ingredients, the interviewer notes whether the food item was raw or cooked and the number of servings provided by the recipe. When a patient lists the foods for the recall questionnaire, it may help to read back the list of foods and ask whether anything was forgotten, such as fruit, cake, candy, between-meal snacks, or alcoholic beverages.

Additional information obtained during the interview should include methods of preparing food, sources available for food (including donated foods and food stamps), food-buying practices, use of vitamin and mineral supplements, and income range (Chen, 2005; Gilliam, 2006).

*Cultural and Religious Considerations* An individual's culture determines to a large extent which foods are eaten and how they are prepared and served. Culture and religious practices together often determine whether certain foods are prohibited and whether certain foods and spices are eaten on certain holidays or at specific family gatherings. Because of the importance of culture and religious beliefs to many individuals, it is important to be sensitive to these factors when obtaining a dietary history. It is, however, equally important not to stereotype individuals and assume that because they are from a certain culture or religious group, they adhere to specific dietary customs. One particular area of consideration is the presence of fish and shellfish in the diet, where they come from (farmed versus wild), and the method of preparation. These methods may put certain populations at risk for toxicity due to contaminants. Culturally sensitive materials, such as the food pagoda and the Mediterranean Pyramid, are available for making appropriate dietary recommendations (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2005).

### Evaluating Dietary Information

After obtaining basic dietary information, the nurse evaluates the patient's dietary intake and communicates the information to the dietitian and the rest of the health care team for more detailed assessment and for clinical nutrition intervention. If the goal is to determine whether the patient generally eats a healthful diet, his or her food intake may be compared with the dietary guidelines outlined in the U.S. Department of Agriculture's Food Guide Pyramid (Fig. 5-6). The pyramid divides foods into five major groups (grains, vegetables, fruits, milk products, and meat and beans), plus fats and oils. Recommendations are provided for variety in the diet, proportion of food from each food group, and moderation in eating fats, oils, and sweets. A person's food intake is compared with recommendations based on various food groups for different age groups and activity levels (Weber & Kelley, 2007).

If nurses or dietitians are interested in knowing about the intake of specific nutrients, such as vitamin A, iron, or calcium, the patient's food intake is analyzed by consulting a list of foods and their composition and nutrient content. The diet is analyzed in terms of grams and milligrams of specific nutrients. The total nutritive value is then compared with the recommended dietary allowances specific for the patient's age category, gender, and special circumstances such as pregnancy or lactation.

Fat intake and cholesterol levels are additional aspects of the nutritional assessment. Trans fats are produced when hydrogen atoms are added to monounsaturated or polyunsaturated fats to produce a semisolid product, such as margarine. Trans fats, which are contained in many baked goods and restaurant foods, are a concern, because increased amounts of trans fats have been associated with increased risk for heart disease and stroke. Since 2006, the U.S. Food and Drug Administration has required the inclusion of trans fats information on food labels.

## Factors Influencing Nutritional Status in Various Situations

One sensitive indicator of the body's gain or loss of protein is its nitrogen balance. An adult is said to be in nitrogen equilibrium when the nitrogen intake (from food) equals the nitrogen output (in urine, feces, and perspiration); it is a sign of health. A positive nitrogen balance exists when nitrogen intake exceeds nitrogen output and indicates tissue growth, such as occurs during pregnancy, childhood, recovery from surgery, and rebuilding of wasted tissue. A negative nitrogen balance indicates that tissue is breaking down faster than it is being replaced. In the absence of an adequate intake of protein, the body converts protein to glucose for energy. This can occur with fever, starvation, surgery, burns, and debilitating diseases. Each gram of nitrogen

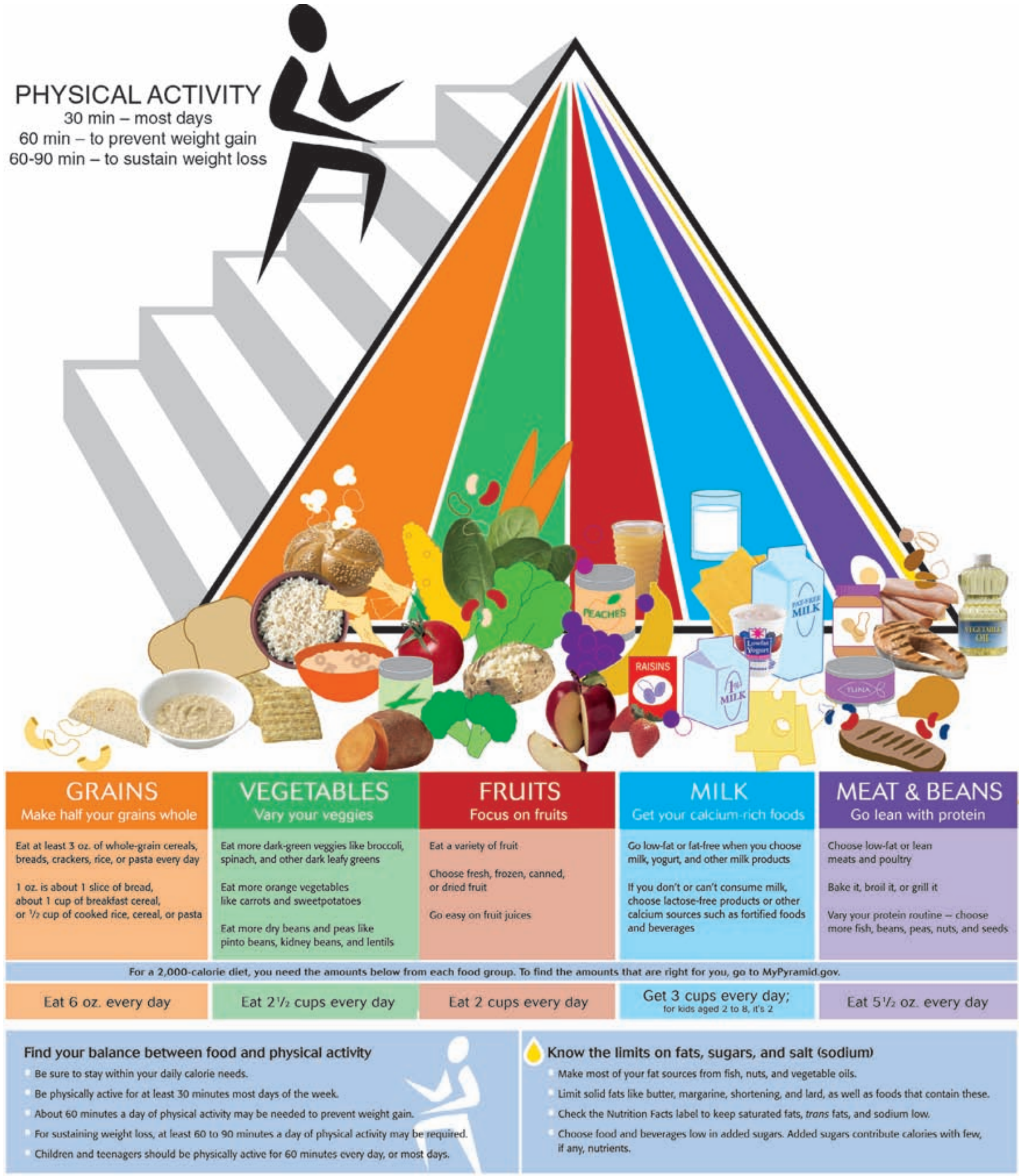



**Figure 5-6** MyPyramid emphasizes foods from the five major food groups. Each of these food groups provides some, but not all, of the nutrients an adult needs. Foods in one group cannot replace those in another. No one of these major food groups is more important than another. From U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. (2005). *MyPyramid: Steps to a healthier you* (5th ed.). Available at: www.MyPyramid.gov.

loss in excess of intake represents the depletion of 6.25 g of protein or 25 g of muscle tissue. Therefore, a negative nitrogen balance of 10 g/day for 10 days could mean the wasting of 2.5 kg (5.5 pounds) of muscle tissue as it is converted to glucose for energy.

When conditions that result in negative nitrogen balance are combined with anorexia (loss of appetite), they can lead to malnutrition. Malnutrition interferes with wound healing, increases susceptibility to infection, and contributes to an increased incidence of complications, longer hospital stays, and prolonged confinement of patients to bed (Morton, Fontaine, Hudak, et al., 2005).

Patients who are hospitalized may have an inadequate dietary intake because of the illness or disorder that necessitated the hospital stay or because the hospital's food is unfamiliar or unappealing. Patients who are cared for at home may feel too sick or fatigued to shop and prepare food, or they may be unable to eat because of other physical problems or limitations. Limited or fixed incomes or the high costs of medications may result in insufficient money to

**Table 5-2 FACTORS ASSOCIATED WITH POTENTIAL NUTRITIONAL DEFICITS**

| Factor | Possible Consequences |
|---|---|
| Dental and oral problems (missing teeth, ill-fitting dentures, impaired swallowing or chewing) | Inadequate intake of high-fiber foods |
| NPO for diagnostic testing | Inadequate caloric and protein intake; dehydration |
| Prolonged use of glucose and saline IV fluids | Inadequate caloric and protein intake |
| Nausea and vomiting | Inadequate caloric and protein intake; loss of fluid, electrolytes, and minerals |
| Stress of illness, surgery, and/or hospitalization | Increased protein and caloric requirement; increased catabolism |
| Wound drainage | Loss of protein, fluid, electrolytes, and minerals |
| Pain | Loss of appetite; inability to shop, cook, eat |
| Fever | Increased caloric and fluid requirement; increased catabolism |
| Gastrointestinal intubation | Loss of protein, fluid, and minerals |
| Tube feedings | Inadequate amounts; various nutrients in each formula |
| Gastrointestinal disease | Inadequate intake and malabsorption of nutrients |
| Alcoholism | Inadequate intake of nutrients; increased consumption of calories without other nutrients; vitamin deficiencies |
| Depression | Loss of appetite; inability to shop, cook, eat |
| Eating disorders (anorexia, bulimia) | Inadequate caloric and protein intake; loss of fluid, electrolytes, and minerals |
| Medications | Inadequate intake due to medication side effects, such as dry mouth, loss of appetite, decreased taste perception, difficulty swallowing, nausea and vomiting, physical problems that limit shopping, cooking, eating; malabsorption of nutrients |
| Restricted ambulation or disability | Inability to help self to food, liquids, other nutrients |

buy nutritious foods. Patients with inadequate housing or inadequate cooking facilities are unlikely to have an adequate nutritional intake (Mai & Eng, 2007). Because complex treatments (eg, mechanical ventilation, intravenous infusions, chemotherapy), once used only in the hospital setting, are now being provided in the home and outpatient settings, nutritional assessment of patients in these settings is an important aspect of home and community-based care.

Many medications influence nutritional status by suppressing the appetite, irritating the oral or gastric mucosa, or causing nausea and vomiting. Others may influence bacterial flora in the intestine or directly affect nutrient absorption so that secondary malnutrition results. People who must take many medications in a single day often report feeling too full to eat. A patient's use of prescription and OTC medications and their effects on appetite and dietary intake are assessed. Many of the factors that contribute to poor nutritional status are identified in Table 5-2.

## Analysis of Nutritional Status

Physical measurements (BMI, waist circumference) and biochemical, clinical, and dietary data are used in combination to determine a patient's nutritional status. Often, these data provide more information about the patient's nutritional status than the clinical examination, which may not detect subclinical deficiencies unless they become so advanced that overt signs develop. A low intake of nutrients over a long period may lead to low biochemical levels and, without nutritional intervention, may result in characteristic and observable signs and symptoms (see Table 5-2). A plan of action for nutritional intervention is based on the results of the dietary assessment and the patient's clinical profile. To be effective, the plan must meet the patient's need for a healthy diet, maintain (or control) weight, and compensate for increased nutritional needs.

# Assessment in the Home and Community

Assessment of people in community settings, including the home, consists of collecting information specific to existing health problems, including data on the patient's physiologic and emotional status, the community and home environment, the adequacy of support systems or care given by family and other care providers, and the availability of needed resources. In addition, it is important to evaluate the ability of the individual and family to cope with and address their respective needs. The physical assessment in the community and home consists of the same techniques used in the hospital, outpatient clinic, or office setting. Privacy is provided, and the person is made as comfortable as possible.

Before the first home visit, the nurse usually calls the patient's home to let the patient know when to expect the home care nurse; this also gives the patient's primary caregiver the opportunity to be available. During the home visit, assessment is not limited to physical assessment of the patient. Other aspects of assessment are related to the home environment and support systems (Chart 5-9). The patient may not have family members available to assist him or her and may live alone in substandard housing or in a shelter for the homeless (Mai & Eng, 2007). Therefore, the nurse must be aware of resources available in the community and methods of obtaining those resources for the patient.

CHART 5–9

## Assessing the Home Environment

**Physical Facilities** (check all that apply)

**Exterior**

- ☐ steps
- ☐ unsafe steps
- ☐ porch
- ☐ litter
- ☐ noise
- ☐ inadequate lighting
- ☐ other________________________________________

**Interior**

- ☐ accessible bathroom
- ☐ level, safe floor surface
- ☐ number of rooms
- ☐ privacy
- ☐ sleeping arrangements
- ☐ refrigeration
- ☐ trash management
- ☐ animals
- ☐ adequate lighting
- ☐ steps/stairs
- ☐ other________________________________________

**Safety Hazards** found in the patient's current residence (check all that apply)

- ☐ none
- ☐ inadequate floor, roof, or windows
- ☐ inadequate lighting
- ☐ unsafe gas/electric appliances
- ☐ inadequate heating
- ☐ inadequate cooling
- ☐ lack of fire safety devices
- ☐ unsafe floor coverings
- ☐ inadequate stair rails
- ☐ lead-based paint
- ☐ improperly stored hazardous material
- ☐ improper wiring/electrical cords
- ☐ other________________________________________

**Safety factors** (check all that apply)

- ☐ fire/smoke detectors
- ☐ telephone
- ☐ placement of electrical cords
- ☐ emergency plan
- ☐ emergency phone numbers displayed
- ☐ safe portable heaters
- ☐ obstacle-free paths
- ☐ other________________________________________

## CRITICAL THINKING EXERCISES

EBP **1** Your health history and physical examination of a young adult male patient alerts you to the possibility of substance abuse. Explain how you would pursue this. What is the evidence base for available assessments to assist in a more comprehensive evaluation? Identify the criteria used to evaluate the strength of the evidence for this practice.

EBP **2** Your health assessment of a female college freshman reveals that she has a high fat intake, has a minimal calcium intake, and gets little exercise. What recommendations would you make for this patient? If the patient is a vegetarian, what dietary instructions would you develop for her? What is the evidence base for the type of instructional method to use with a college student? Identify the criteria used to evaluate the strength of the evidence for this practice.

**3** How would you modify your health history and physical assessment technique if your patient has the following disabilities: (1) impaired communication due to aphasia secondary to stroke, (2) impaired mobility due to spinal cord injury, or (3) cognitive impairment?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

### REFERENCES AND SELECTED READINGS

**Asterisk indicates nursing reseach.*
***Double asterisk indicates classic reference.*


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## RESOURCES

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Alliance of Cannabis Therapeutics, http://marijuana-as-medicine.org/alliance.htm

American Dietetic Association, www.eatright.org/cps/rde/xchg/ada/hs.xsl/index.html

American Heart Association, www.americanheart.org

Healthcare Information and Management Systems Society (HIMSS), www.himss.org/ASP/index.asp

Medical Records Institute, www.medrecinst.com

National Cancer Institute, Cancer Information Service, www.nci.nih.gov or www.cancer.gov

### Genetics Resources for Nurses and Patients on the Web

Gene Clinics, www.geneclinics.org

Genetic Alliance, www.geneticalliance.org

National Organization of Rare Disorders, www.rarediseases.org/

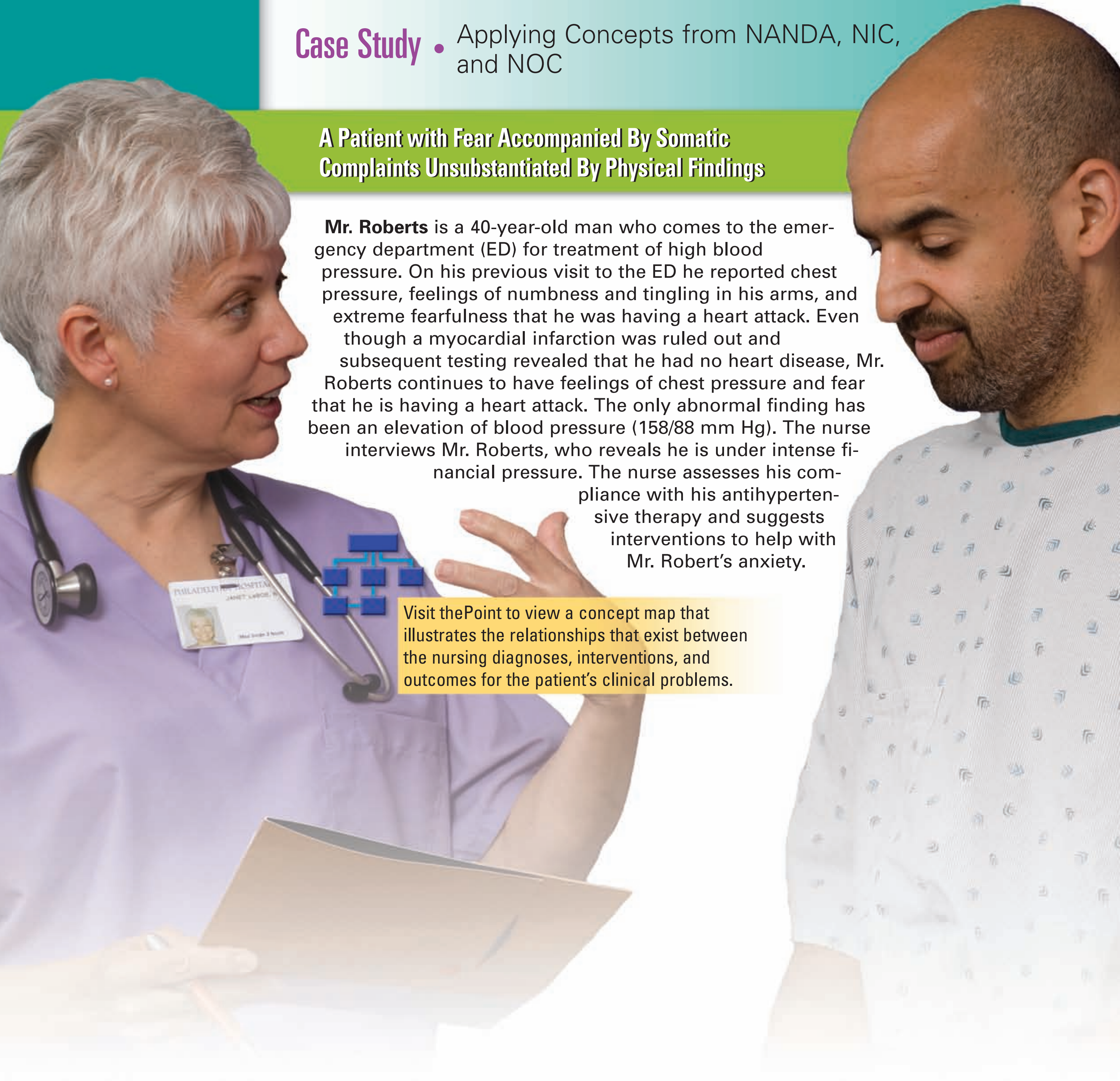
OMIM: Online Mendelian Inheritance in Man, www.ncbi.nlm.nih.gov/Omim/mimstats.html

unit 2

# Biophysical and Psychosocial Concepts in Nursing Practice

## Case Study • Applying Concepts from NANDA, NIC, and NOC

### A Patient with Fear Accompanied By Somatic Complaints Unsubstantiated By Physical Findings



**Mr. Roberts** is a 40-year-old man who comes to the emergency department (ED) for treatment of high blood pressure. On his previous visit to the ED he reported chest pressure, feelings of numbness and tingling in his arms, and extreme fearfulness that he was having a heart attack. Even though a myocardial infarction was ruled out and subsequent testing revealed that he had no heart disease, Mr. Roberts continues to have feelings of chest pressure and fear that he is having a heart attack. The only abnormal finding has been an elevation of blood pressure (158/88 mm Hg). The nurse interviews Mr. Roberts, who reveals he is under intense financial pressure. The nurse assesses his compliance with his antihypertensive therapy and suggests interventions to help with Mr. Robert's anxiety.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **ANXIETY**—Vague uneasy feeling of discomfort or dread accompanied by an autonomic response (the source often nonspecific or unknown to the individual); a feeling of apprehension caused by anticipation of danger. It is an alerting signal that warns of impending danger and enables the individual to take measures to deal with threat. | **ANXIETY REDUCTION**—Minimizing apprehension, dread, foreboding, or uneasiness related to unidentified source of anticipated danger | **ANXIETY SELF-CONTROL**—Personal actions to eliminate or reduce feelings of apprehension, tension, or uneasiness from an unidentifiable source |
| **INEFFECTIVE COPING**—Inability to form a valid appraisal of the stressors, inadequate choices of practiced responses, and/or inability to use available resources | **COPING ENHANCEMENT**—Assisting a patient to adapt to perceived stressors, changes, or threats that interfere with meeting life demands and roles<br>**COUNSELING**—Use of an interactive helping process focusing on the needs, problems, or feelings of the patient and significant others to enhance or support coping, problem-solving, and interpersonal relationships<br>**SUPPORT SYSTEM ENHANCEMENT**—Facilitation of support to patient by family, friends, and community | **COPING**—Personal actions to manage stressors that tax an individual's resources |


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# Homeostasis, Stress, and Adaptation

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Relate the principles of internal constancy, homeostasis, stress, and adaptation to the concept of steady state.
2. Identify the significance of the body's compensatory mechanisms in promoting adaptation and maintaining the steady state.
3. Identify physiologic and psychosocial stressors.
4. Compare the sympathetic-adrenal-medullary and hypothalamic-pituitary responses to stress.
5. Describe the general adaptation syndrome as a theory of adaptation to biologic stress.
6. Describe the relationship of the process of negative feedback to the maintenance of the steady state.
7. Compare the adaptive processes of hypertrophy, atrophy, hyperplasia, dysplasia, and metaplasia.
8. Describe the inflammatory and reparative processes.
9. Assess the health patterns of a person and determine their effects on maintenance of the steady state.
10. Identify ways in which maladaptive responses to stress can increase the risk of illness and cause disease.
11. Identify individual and group measures that are useful in reducing stress.

## GLOSSARY

**adaptation:** a change or alteration designed to assist in adapting to a new situation or environment

**adrenocorticotropic hormone (ACTH):** a hormone produced by the anterior lobe of the pituitary gland that stimulates the secretion of cortisol and other hormones by the adrenal cortex

**antidiuretic hormone (ADH):** a hormone secreted by the posterior lobe of the pituitary gland that constricts blood vessels, elevates blood pressure, and reduces the excretion of urine

**catecholamines:** any of the group of amines (such as epinephrine, norepinephrine, or dopamine) that serve as neurotransmitters

**coping:** the cognitive and behavioral strategies used to manage the stressors that tax a person's resources

**dysplasia:** bizarre cell growth resulting in cells that differ in size, shape, or arrangement from other cells of the same tissue type

**glucocorticoids:** the group of steroid hormones, such as cortisol, that are produced by the adrenal cortex; they are involved in carbohydrate, protein, and fat metabolism and have anti-inflammatory properties

**gluconeogenesis:** the formation of glucose by the liver from noncarbohydrate sources, such as amino acids and the glycerol portion of fats

**guided imagery:** the mindful use of a word, phrase, or visual image to achieve relaxation or direct attention away from uncomfortable sensations or situations

**homeostasis:** a steady state within the body; the stability of the internal environment

**hyperplasia:** an increase in the number of new cells of a tissue

**hypoxia:** inadequate supply of oxygen to the cell

**inflammation:** a localized, protective reaction of tissue to injury, irritation, or infection, manifested by pain, redness, heat, swelling, and sometimes loss of function

**metaplasia:** a cell transformation in which there is conversion of one type of mature cell into another type of cell

**negative feedback:** feedback that decreases the output of a system

**positive feedback:** feedback that increases the output of a system

**steady state:** a stable condition that does not change over time, or when change in one direction is balanced by change in an opposite direction

**stress:** a disruptive condition that occurs in response to adverse influences from the internal or external environments

When the body is threatened or suffers an injury, its response may involve functional and structural changes; these changes may be adaptive (having a positive effect) or maladaptive (having a negative effect). The defense mechanisms that the body uses determine the difference between adaptation and maladaptation—health and disease. This chapter discusses homeostasis, stress, adaptation, health problems associated with maladaptation, and ways nurses can intervene to reduce stress and its health-related effects.

## Fundamental Concepts

Each body system performs specific functions to sustain optimal life for an organism. Mechanisms for adjusting internal conditions promote the normal steady state of the organism and its survival. These mechanisms are compensatory in nature and work to restore balance in the body. An example of this restorative effort is the development of rapid breathing (hyperpnea) after intense exercise in an attempt to compensate for an oxygen deficit and excess lactic acid accumulated in the muscle tissue.

Pathophysiologic processes result when cellular injury occurs at such a rapid rate that the body's compensatory mechanisms can no longer make the adaptive changes necessary to remain healthy. An example of a pathophysiologic change is the development of heart failure; the body reacts by retaining sodium and water and increasing venous pressure, which worsens the condition. These pathophysiologic responses give rise to symptoms that are reported by patients or signs that are observed by patients, nurses, or other health care providers. These observations, plus a sound knowledge of physiologic and pathophysiologic processes, can assist in determining the existence of a problem and can guide nurses in planning the appropriate course of action.

### Steady State

Physiologic mechanisms must be understood in the context of the body as a whole. Each person, as a living system, has both an internal and an external environment, between which information and matter are continuously exchanged. Within the internal environment, each organ, tissue, and cell is also a system or subsystem of the whole, each with its own internal and external environment, each exchanging information and matter (Fig. 6-1). The goal of the interaction of the body's subsystems is to produce a dynamic balance or **steady state** (even in the presence of change), so that all subsystems are in harmony with each other. Four concepts—constancy, homeostasis, stress, and adaptation—are key to the understanding of steady state.

Claude Bernard, a 19th-century French physiologist, developed the biologic principle that for life there must be a constancy or "fixity of the internal milieu" despite changes in the external environment. The internal milieu was the fluid that bathed the cells, and the constancy was the balanced internal state maintained by physiologic and biochemical processes. His principle implied a static process.

**Homeostasis** refers to a steady state within the body. When a change or stress occurs that causes a body function to deviate from its stable range, processes are initiated to restore and maintain dynamic balance. When these adjustment processes or compensatory mechanisms are not adequate, steady state is threatened, function becomes disordered, and dysfunctional responses occur. This can lead to disease, which is a threat to steady state. Disease is an abnormal variation in the structure or function of any part of the body. It disrupts function and therefore can limit freedom of action.

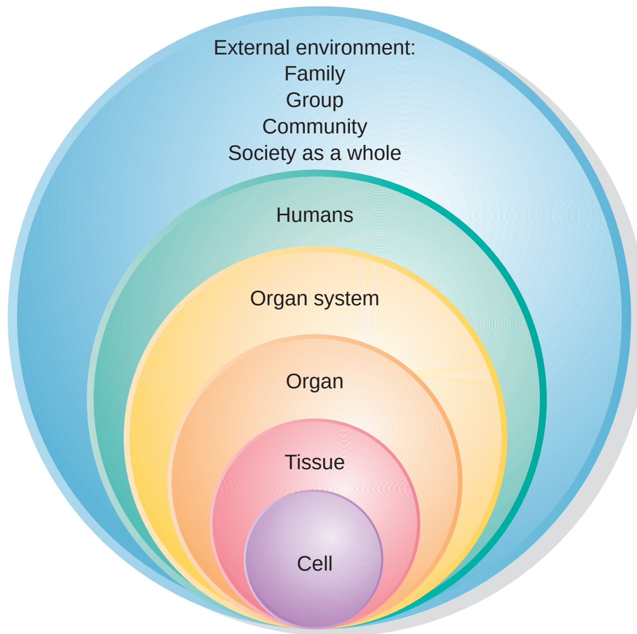



**Figure 6-1** Constellation of systems. Each system is a subsystem of the larger system (suprasystem) of which it is a part. In this figure the cells represent the smallest system and are a subsystem of all other systems.

### Stress and Adaptation

**Stress** is a state produced by a change in the environment that is perceived as challenging, threatening, or damaging to a person's dynamic balance or equilibrium. The person may feel unable to meet the demands of the new situation. The change or stimulus that evokes this state is the stressor. The nature of the stressor is variable; an event or change that is stressful for one person may not be stressful for another, and an event that produces stress at one time and place may not do so at another time and place. A person appraises and copes with changing situations. The desired goal is **adaptation** or adjustment to the change so that the person is again in equilibrium and has the energy and ability to meet new demands. This is the process of **coping** with the stress, a compensatory process that has physiologic and psychological components.

Adaptation is a constant, ongoing process that requires a change in structure, function, or behavior so that a person is better suited to the environment; it involves an interaction between the person and the environment. The outcome depends on the degree of "fit" between the skills and capacities of the person, the type of social support available, and the various challenges or stressors encountered. As such, adaptation is an individual process: Each person has varying abilities to cope or respond. As new challenges are

met, this ability to cope and adapt can change, thereby providing the person with a wide range of adaptive ability. Adaptation occurs throughout the lifespan as the person encounters many developmental and situational challenges, especially related to health and illness. The goal of adaptation is optimal wellness.

Because both stress and adaptation may exist at different levels of a system, it is possible to study these reactions at the cellular, tissue, and organ levels. Biologists are concerned mainly with subcellular components or with subsystems of the total body. Behavioral scientists, including many nurse researchers, study stress and adaptation in individuals, families, groups, and societies; they focus on how a group's organizational features are modified to meet the requirements of the social and physical environment in which the group exists. In any system, the desired goals of adaptation are survival, growth, and reproduction.

## Overview of Stress

### Types of Stressors

Each person operates at a certain level of adaptation and regularly encounters a certain amount of change. Such change is expected; it contributes to growth and enhances life. A stressor can upset this equilibrium. A stressor may be defined as an internal or external event or situation that creates the potential for physiologic, emotional, cognitive, or behavioral changes in an individual.

Stressors exist in many forms and categories. They may be described as physical, physiologic, or psychosocial. Physical stressors include cold, heat, and chemical agents; physiologic stressors include pain and fatigue. An example of a psychosocial stressor is fear (eg, fear of failing an examination, losing a job, and waiting for a diagnostic test result). Stressors can also occur as normal life transitions that require some adjustment, such as going from childhood into puberty, getting married, or giving birth.

Stressors have also been classified as (1) day-to-day frustrations or hassles, (2) major complex occurrences involving large groups, and (3) stressors that occur less frequently and involve fewer people. The first group, the day-to-day stressors, includes such common occurrences as getting caught in a traffic jam, experiencing computer downtime, and having an argument with a spouse or roommate. These experiences vary in effect. For example, encountering a rainstorm while you are vacationing at the beach will most likely evoke a more negative response than it might at another time. These daily hassles have been shown to have a greater health impact than major life events because of the cumulative effect they have over time. They can lead to high blood pressure, palpitations, or other physiologic problems (Rice, 2005).

The second group of stressors influences larger groups of people, sometimes even entire nations. These include events of history, such as terrorism and war, experienced either directly in the war zone or indirectly through live news coverage. The demographic, economic, and technologic changes occurring in society also serve as stressors. The tension produced by any stressor is sometimes a result not only of the change itself, but also of the speed with which the change occurs.

The third group of stressors has been studied most extensively and concerns relatively infrequent situations that directly affect people. This category includes the influence of life events such as death, birth, marriage, divorce, and retirement. It also includes the psychosocial crises that occur in the life cycle stages of the human experience. More enduring chronic stressors may include having a permanent disability or coping with the need to provide long-term care to a frail elderly parent.

Duration may also be used to categorize stressors, as in the following:

- An acute, time-limited stressor, such as studying for final examinations
- A stressor sequence—a series of stressful events that result from an initial event such as job loss or divorce
- A chronic intermittent stressor, such as daily hassles
- A chronic enduring stressor that persists over time, such as chronic illness, a disability, or poverty

### Stress as a Stimulus for Disease

Relating life events to illness (the theoretical approach that defines stress as a stimulus) has been a major focus of psychosocial studies. Research has revealed that people under constant stress have a high incidence of psychosomatic disease.

Holmes and Rahe (1967) developed life events scales that assign numerical values, called life-change units, to typical life events. Because the items in the scales reflect events that require a change in a person's life pattern, and stress is defined as an accumulation of changes in one's life that require psychological adaptation, one can theoretically predict the likelihood of illness by checking off the number of recent events and deriving a total score. The Recent Life Changes Questionnaire (Tausig, 1982) contains 118 items such as death, birth, marriage, divorce, promotions, serious arguments, and vacations. The items include both desirable and undesirable events.

Sources of stress for people have been well researched (Barnard, Street & Love, 2006; Lunney, 2006; Tak, 2006). People typically experience distress related to alterations in their physical and emotional health status, changes in their level of daily functioning, and decreased social support or the loss of significant others. Fears of immobilization, isolation, loneliness, sensory changes, financial problems, and death or disability increase a person's anxiety level. Loss of one's role or perceived purpose in life can cause intense discomfort. Any of these identified variables, plus myriad other conditions or overwhelming demands, are likely to cause ineffective coping, and a lack of necessary coping skills is often a source of additional distress for the person. When a person endures prolonged or unrelenting suffering, the outcome is frequently the development of a stress-related illness. Nurses have the skills to assist people to alter their distressing circumstances and manage their responses to stress.

### Psychological Responses to Stress

After recognizing a stressor, a person consciously or unconsciously reacts to manage the situation. This is termed the mediating process. A theory developed by Lazarus (1991a)

emphasizes cognitive appraisal and coping as important mediators of stress. Appraisal and coping are influenced by antecedent variables, including the internal and external resources of the individual person.

### *Appraisal of the Stressful Event*

Cognitive appraisal (Lazarus, 1991a; Lazarus & Folkman, 1984) is a process by which an event is evaluated with respect to what is at stake (primary appraisal) and what might and can be done (secondary appraisal). What a person sees as being at stake is influenced by his or her personal goals, commitments, or motivations. Important factors include how important or relevant the event is to the person, whether the event conflicts with what the person wants or desires, and whether the situation threatens the person's own sense of strength and ego identity.

Primary appraisal results in the situation being identified as either nonstressful or stressful. Secondary appraisal is an evaluation of what might and can be done about the situation. Reappraisal, a change of opinion based on new information, may occur. The appraisal process is not necessarily sequential; primary and secondary appraisal and reappraisal may occur simultaneously.

The appraisal process contributes to the development of an emotion. Negative emotions such as fear and anger accompany harm/loss appraisals, and positive emotions accompany challenge. In addition to the subjective component or feeling that accompanies a particular emotion, each emotion also includes a tendency to act in a certain way. For example, unprepared students may view an unexpected quiz as threatening. They might feel fear, anger, and resentment and might express these emotions through hostile behavior or comments.

Lazarus (1991a) expanded his initial ideas about stress, appraisal, and coping into a more complex model relating emotion to adaptation. He called this model a "cognitive-motivational-relational theory," with the term *relational* "standing for a focus on negotiation with a physical and social world" (p. 13). A theory of emotion was proposed as the bridge to connect psychology, physiology, and sociology: "More than any other arena of psychological thought, emotion is an integrative, organismic concept that subsumes psychological stress and coping within itself and unites motivation, cognition, and adaptation in a complex configuration" (p. 40).

### *Coping With the Stressful Event*

Coping consists of the cognitive and behavioral efforts made to manage the specific external or internal demands that tax a person's resources and may be emotion-focused or problem-focused. Coping that is emotion-focused seeks to make the person feel better by lessening the emotional distress. Problem-focused coping aims to make direct changes in the environment so that the situation can be managed more effectively. Both types of coping usually occur in a stressful situation. Even if the situation is viewed as challenging or beneficial, coping efforts may be required to develop and sustain the challenge—that is, to maintain the positive benefits of the challenge and to ward off any threats. In harmful or threatening situations, successful coping reduces or eliminates the source of stress and relieves the emotion generated.

Appraisal and coping are affected by internal characteristics such as health, energy, personal belief systems, commitments or life goals, self-esteem, control, mastery, knowledge, problem-solving skills, and social skills. The characteristics that have been studied most often in nursing research are health-promoting lifestyles and hardiness. A health-promoting lifestyle buffers the effect of stressors. From a nursing practice standpoint, this outcome—buffering the effect of stressors—supports nursing's goal of promoting health. In many circumstances, promoting a healthy lifestyle is more achievable than altering the stressors.

Hardiness is a general quality that comes from having rich, varied, and rewarding experiences. Hardy people perceive stressors as something they can change and therefore control. To them, potentially stressful situations are interesting and meaningful; change and new situations are viewed as challenging opportunities for growth. Researchers have found positive support for hardiness as a significant variable that positively influences rehabilitation and overall improvement after an onset of an illness (Ayalon & Covinsky, 2007; Baumgartner, 2007; Greeff & Holtzkamp, 2007; Travis, 2007).

## Physiologic Response to Stress

The physiologic response to a stressor, whether it is physical or psychological, is a protective and adaptive mechanism to maintain the homeostatic balance of the body. When a stress response occurs, it activates a series of neurologic and hormonal processes within the brain and body systems. The duration and intensity of the stress can cause both short-term and long-term effects. A stressor can disrupt homeostasis to the point where adaptation to the stressor fails, and a disease process results.

### *Selye's Theory of Adaptation*

Hans Selye developed a theory of adaptation that profoundly influenced the scientific study of stress (1976). Selye first described a syndrome consisting of enlargement of the adrenal cortex; shrinkage of the thymus, spleen, lymph nodes, and other lymphatic structures; and the appearance of deep, bleeding ulcers in the stomach and duodenum. He identified this as a nonspecific response to diverse, noxious stimuli.

#### General Adaptation Syndrome

Selye then developed a theory of adaptation to biologic stress that he named the general adaptation syndrome (GAS), which has three phases: alarm, resistance, and exhaustion. During the alarm phase, the sympathetic "fight-or-flight" response is activated with release of **catecholamines** and the onset of the **adrenocorticotropic hormone** (ACTH)–adrenal cortical response. The alarm reaction is defensive and anti-inflammatory but self-limited. Because living in a continuous state of alarm would result in death, people move into the second stage, resistance. During the resistance stage, adaptation to the noxious stressor occurs, and cortisol activity is still increased. If exposure to the stressor is prolonged, the third stage, exhaustion, occurs. During the exhaustion stage, endocrine activity increases, and this has negative effects on the body systems (especially the circulatory, digestive, and immune systems) that can

lead to death. Stages one and two of this syndrome are repeated, in different degrees, throughout life as the person encounters stressors.

Selye compared the GAS with the life process. During childhood, too few encounters with stress occur to promote the development of adaptive functioning, and children are vulnerable. During adulthood, a number of stressful events occur, and people develop resistance or adaptation. During the later years, the accumulation of life's stressors and wear and tear on the organism again decrease people's ability to adapt, resistance falls, and eventually death occurs.

### Local Adaptation Syndrome

According to Selye, a local adaptation syndrome also occurs. This syndrome includes the inflammatory response and repair processes that occur at the local site of tissue injury. The local adaptation syndrome occurs in small, topical injuries, such as contact dermatitis. If the local injury is severe enough, the general adaptation syndrome is activated as well.

Selye emphasized that stress is the nonspecific response common to all stressors, regardless of whether they are physiologic, psychological, or social. The many conditioning factors in each person's environment account for why different demands are experienced by different people as stressors. Conditioning factors also account for differences in the tolerance of different people for stress: Some people may develop diseases of adaptation, such as hypertension and migraine headaches, whereas others are unaffected.

## *Interpretation of Stressful Stimuli by the Brain*

Physiologic responses to stress are mediated by the brain through a complex network of chemical and electrical messages. The neural and hormonal actions that maintain homeostatic balance are integrated by the hypothalamus, which is located in the center of the brain, surrounded by the limbic system and the cerebral hemispheres. The hypothalamus is made up of a number of nuclei and integrates autonomic nervous system mechanisms that maintain the chemical constancy of the internal environment of the body. Together with the limbic system, which contains the amygdala, hippocampus, and septal nuclei, along with other structures, the hypothalamus regulates emotions and many visceral behaviors necessary for survival (eg, eating, drinking, temperature control, reproduction, defense, aggression).

Each of the brain structures responds differently to stimuli. The cerebral hemispheres are concerned with cognitive functions: thought processes, learning, and memory. The limbic system has connections with both the cerebral hemispheres and the brain stem. In addition, the reticular activating system (RAS), a network of cells that forms a two-way communication system, extends from the brain stem into the midbrain and limbic system. This network controls the alert or waking state of the body.

In the stress response, afferent impulses are carried from sensory organs (eye, ear, nose, skin) and internal sensors (baroreceptors, chemoreceptors) to nerve centers in the brain. The response to the perception of stress is integrated in the hypothalamus, which coordinates the adjustments necessary to return to homeostatic balance. The degree and duration of the response vary; major stress evokes both sympathetic and pituitary adrenal responses.

**Physiology ■■■ Pathophysiology**

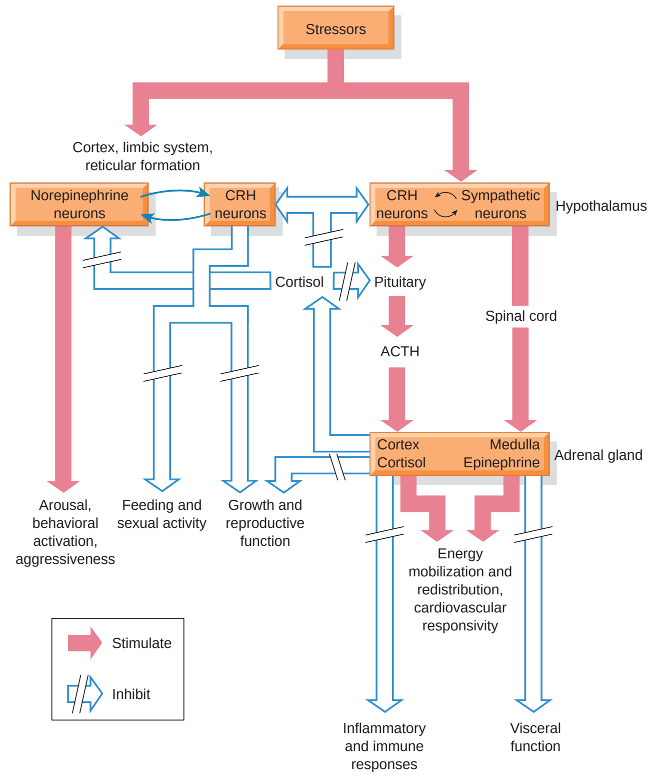



**Figure 6-2** Integrated responses to stress mediated by the sympathetic nervous system and the hypothalamic-pituitary-adrenocortical axis. The responses are mutually reinforcing at both the central and peripheral levels. Negative feedback by cortisol also can limit an overresponse that might be harmful to the individual. Colored arrows represent stimulation, open arrows, inhibition. CRH, corticotropin-releasing hormone; ACTH, adrenocorticotropic hormone. Reproduced with permission from Berne, R. M. & Levy, M. N. (2003). *Physiology*. St. Louis: C. V. Mosby.

Neural and neuroendocrine pathways under the control of the hypothalamus are also activated in the stress response. Initially, there is a sympathetic nervous system discharge, followed by a sympathetic-adrenal-medullary discharge. If the stress persists, the hypothalamic-pituitary system is activated (Fig. 6-2).

### Sympathetic Nervous System Response

The sympathetic nervous system response is rapid and short-lived. Norepinephrine is released at nerve endings that are in direct contact with their respective end organs to cause an increase in function of the vital organs and a state of general body arousal. The heart rate is increased and peripheral vasoconstriction occurs, raising the blood pressure. Blood is also shunted away from abdominal organs. The purpose of these responses is to provide better perfusion of vital organs (brain, heart, skeletal muscles). Blood glucose is increased, supplying more readily available energy. The pupils are dilated, and mental activity is increased; a greater sense of awareness exists. Constriction of the blood vessels of the skin limits bleeding in the event of trauma. The person is likely to experience cold feet, clammy skin

and hands, chills, palpitations, and "knots" in the stomach. Typically, the person appears tense, with the muscles of the neck, upper back, and shoulders tightened; respirations may be rapid and shallow, with the diaphragm tense.

#### Sympathetic-Adrenal-Medullary Response

In addition to its direct effect on major end organs, the sympathetic nervous system stimulates the medulla of the adrenal gland to release the hormones epinephrine and norepinephrine into the bloodstream. The action of these hormones is similar to that of the sympathetic nervous system and has the effect of sustaining and prolonging its actions. Epinephrine and norepinephrine are catecholamines that stimulate the nervous system and produce metabolic effects that increase the blood glucose level and increase the metabolic rate. The effect of the sympathetic-adrenal-medullary responses is summarized in Table 6-1. This effect is called the "fight-or-flight" reaction.

#### Hypothalamic-Pituitary Response

The longest-acting phase of the physiologic response, which is more likely to occur in persistent stress, involves the hypothalamic-pituitary pathway. The hypothalamus secretes corticotropin-releasing factor, which stimulates the anterior pituitary to produce ACTH, which in turn stimulates the adrenal cortex to produce **glucocorticoids,** primarily cortisol. Cortisol stimulates protein catabolism, releasing amino acids; stimulates liver uptake of amino acids and their conversion to glucose (**gluconeogenesis**); and inhibits glucose uptake (anti-insulin action) by many body cells but not those of the brain and heart. These cortisol-induced metabolic effects provide the body with a ready source of energy during a stressful situation. This effect has some important implications. For example, a person with diabetes who is under stress, such as that caused by an infection, needs more insulin than usual. Any patient who is under stress (eg, illness, surgery, trauma, or prolonged psychological stress) catabolizes body protein and needs supplements.

The actions of the catecholamines (epinephrine and norepinephrine) and cortisol are the most important in the general response to stress. Other hormones that play a role are **antidiuretic hormone** (ADH) released from the posterior pituitary and aldosterone released from the adrenal cortex. ADH and aldosterone promote sodium and water retention, which is an adaptive mechanism in the event of hemorrhage or loss of fluids through excessive perspiration. ADH has also been shown to influence learning and may thus facilitate coping in new and threatening situations. Secretion of growth hormone and glucagon stimulates the uptake of amino acids by cells, helping to mobilize energy resources. Endorphins, which are endogenous opioids, increase during stress and enhance the threshold for tolerance of painful stimuli. They may also affect mood and have been implicated in the so-called high that long-distance runners experience. The secretion of other hormones is also affected, but their adaptive function is less clear.

#### Immunologic Response

Research findings show that the immune system is connected to the neuroendocrine and autonomic systems. Lymphoid tissue is richly supplied by autonomic nerves capable of releasing a number of different neuropeptides that can have a direct effect on leukocyte regulation and the inflammatory response. Neuroendocrine hormones released by the central nervous system and endocrine tissues can inhibit or stimulate leukocyte function. The wide variety of stressors a person experiences may result in different alterations in autonomic activity and subtle variations in neurohormone

**Table 6-1 SYMPATHETIC–ADRENAL–MEDULLARY RESPONSE TO STRESS**

| Effect | Purpose | Mechanism |
|---|---|---|
| Increased heart rate and blood pressure | Better perfusion of vital organs | Increased cardiac output due to increased myocardial contractility and heart rate; increased venous return (peripheral vasoconstriction) |
| Increased blood glucose level | Increased available energy | Increased liver and muscle glycogen breakdown; increased breakdown of adipose tissue triglycerides |
| Mental acuity | Alert state | Increase in amount of blood shunted to the brain from the abdominal viscera and skin |
| Dilated pupils | Increased awareness | Contraction of radial muscle of iris |
| Increased tension of skeletal muscles | Preparedness for activity, decreased fatigue | Excitation of muscles; increase in amount of blood shunted to the muscles from the abdominal viscera and skin |
| Increased ventilation (may be rapid and shallow) | Provision of oxygen for energy | Stimulation of respiratory centre in medulla; bronchodilation |
| Increased coagulability of blood | Prevention of hemorrhage in event of trauma | Vasoconstriction of surface vessels |

and neuropeptide synthesis. All of these possible autonomic and neuroendocrine responses can interact to initiate, weaken, enhance, or terminate an immune response.

The study of the relationships among the neuroendocrine system, the central and autonomic nervous systems, and the immune system and the effects of these relationships on overall health outcomes is called *psychoneuroimmunology*. Because one's perception of events and one's coping styles determine whether, and to what extent, an event activates the stress response system, and because the stress response affects immune activity, one's perceptions, ideas, and thoughts can have profound neurochemical and immunologic consequences. Studies have demonstrated alteration of immune function in people who are under stress (Kendall-Tackett, 2007; Leserman & Drossman, 2007; Mertin, Sawatzky, Diehl-Jones, et al., 2007). Other studies have identified certain personality traits, such as optimism and active coping, as having positive effects on health (Dilworth-Anderson, Boswell & Cohen, 2007; Krucoff, 2007; Verhaeghe, van Zuuren, DeFloor, et al., 2007). As research continues, this field of study will likely uncover to what extent and by what mechanisms people can consciously influence their immunity.

## Maladaptive Responses to Stress

The stress response, as indicated earlier, facilitates adaptation to threatening situations, and is retained from humans' evolutionary past. The "fight-or-flight" response, for example, is an anticipatory response that mobilized the bodily resources of our ancestors to deal with predators and other harsh factors in their environment. This same mobilization comes into play in response to emotional stimuli unrelated to danger. For example, a person may get an "adrenaline rush" when competing over a decisive point in a ball game, or when excited about attending a party.

When responses to stress are ineffective, they are referred to as *maladaptive*. Maladaptive responses are chronic, recurrent responses or patterns of response that do not promote the goals of adaptation. The goals of adaptation are somatic or physical health (optimal wellness); psychological health or having a sense of well-being (happiness, satisfaction with life, morale); and enhanced social functioning, which includes work, social life, and family (positive relationships). Maladaptive responses that threaten these goals include faulty appraisals and inappropriate coping (Lazarus, 1991a).

The frequency, intensity, and duration of stressful situations contribute to the development of emotions and subsequent patterns of neurochemical discharge. By appraising situations adequately and coping appropriately, it is possible to anticipate and defuse some of these situations. For example, frequent stressful encounters (eg, marital discord) might be avoided with better communication and problem solving, or a pattern of procrastination (eg, delaying work on tasks) could be corrected to reduce stress when deadlines approach.

Coping processes that include the use of alcohol or drugs to reduce stress increase the risk of illness. Other inappropriate coping patterns may increase the risk of illness less directly. For example, people who demonstrate "type A" behaviors, including impatience, competitiveness, and achievement orientation, have an underlying aggressive approach to life and are more prone than others to develop stress-related illnesses. Type A behaviors increase the output of catecholamines, the adrenal-medullary hormones, with their attendant effects on the body.

Other forms of inappropriate coping include denial, avoidance, and distancing. Denial may be illustrated by the woman who feels a lump in her breast but downplays its seriousness and delays seeking medical attention. The intent of denial is to control the threat, but it may also endanger life.

Models of illness frequently include stress and maladaptation as precursors to disease. A general model of illness, based on Selye's theory, suggests that any stressor elicits a state of disturbed physiologic equilibrium. If this state is prolonged or the response is excessive, it increases the susceptibility of the person to illness. This susceptibility, coupled with a predisposition in the person (from genetic traits, health, or age), leads to illness. If the sympathetic adrenal-medullary response is prolonged or excessive, a state of chronic arousal develops that may lead to high blood pressure, arteriosclerotic changes, and cardiovascular disease. If the production of ACTH is prolonged or excessive, behavior patterns of withdrawal and depression are seen. In addition, the immune response is decreased, and infections and tumors may develop.

Selye (1976) proposed a list of disorders known as diseases of maladaptation: high blood pressure (including hypertension of pregnancy), diseases of the heart and blood vessels, diseases of the kidney, rheumatic and rheumatoid arthritis, inflammatory diseases of the skin and eyes, infections, allergic and hypersensitivity diseases, nervous and mental diseases, sexual dysfunction, digestive diseases, metabolic diseases, and cancer.

## Indicators of Stress

Indicators of stress and the stress response include both subjective and objective measures. Chart 6-1 lists signs and symptoms that may be observed directly or reported by a person. They are psychological, physiologic, or behavioral and reflect social behaviors and thought processes. Some of these reactions may be coping behaviors. Over time, each person tends to develop a characteristic pattern of behavior during stress to warn that the system is out of balance.

Laboratory measurements of indicators of stress have helped in understanding this complex process. Blood and urine analyses can be used to demonstrate changes in hormonal levels and hormonal breakdown products. Blood levels of catecholamines, glucocorticoids, ACTH, and eosinophils are reliable measures of stress. Serum cholesterol and free fatty acid levels can be used to measure stress. When the body experiences distress, there are changes in adrenal hormones such as cortisol and aldosterone. As the levels of these chemicals increase, there is a simultaneous release of additional cholesterol into the general circulation. Both physical and psychological distress can trigger an elevated cholesterol level. In addition, the results of immunoglobulin assays are increased when a person is exposed to a variety of stressors, especially infections and immunodeficiency conditions. With greater attention to the field of neuroimmunology, improved laboratory measures are likely to follow.

**CHART 6-1** *Assessing for Stress*

Be alert for the following signs and symptoms:

- Restlessness
- Depression
- Dry mouth
- Overpowering urge to act out
- Fatigue
- Loss of interest in life activities
- Intense periods of anxiety
- Strong startle response
- Hyperactivity
- Gastrointestinal distress
- Diarrhea
- Nausea or vomiting
- Changes in menstrual cycle
- Change in appetite
- Injury-prone
- Palpitations
- Impulsive behaviors
- Emotional lability
- Concentration difficulties
- Feeling weak or dizzy
- Increased body tension
- Tremors
- Nervous habits
- Nervous laughter
- Bruxism (grinding of teeth)
- Difficulty sleeping
- Excessive perspiration
- Urinary frequency
- Headaches
- Pain in back, neck, or other parts of the body
- Increased use of tobacco
- Substance use or abuse
- Unintentional weight loss or gain

In addition to using laboratory tests, researchers have developed questionnaires to identify and assess stressors, stress, and coping strategies. The work of Rice (2005), a compilation of information gained from research on stress, coping, and health, includes some of these questionnaires. Research reports also contain examples of instruments that nurses use to measure levels of patient distress and patient functioning (Caetano, Ramisetty-Miller, Caetano-Vaeth, et al., 2007; Weisel, Most & Michael, 2007). Miller and Smith (1993) provided a stress audit and a stress profile measurement tool that is available in the popular lay literature.

## Nursing Implications

It is important for nurses to realize that the optimal point of intervention to promote health is during the stage when a person's own compensatory processes are still functioning effectively. A major role of nurses is the early identification of both physiologic and psychological stressors. Nurses should be able to relate the presenting signs and symptoms of distress to the physiology they represent and identify a person's position on the continuum of function, from health and compensation to pathophysiology and disease.

For example, if an anxious, middle-aged woman presented for a checkup and was found to be overweight with a blood pressure of 150/85 mm Hg, the nurse would counsel her with respect to diet, stress management, and activity. The nurse would also encourage weight loss and discuss the woman's intake of salt (which affects fluid balance) and caffeine (which provides a stimulant effect). The patient and the nurse would identify both individual and environmental stressors and discuss strategies to decrease her lifestyle stress, with the ultimate goal being to create a healthy lifestyle and prevent hypertension and its sequelae.

## Stress at the Cellular Level

Pathologic processes may occur at all levels of the biologic organism. If the cell is considered the smallest unit or subsystem (tissues being aggregates of cells, organs aggregates of tissues, and so on), the processes of health and disease or adaptation and maladaptation can all occur at the cellular level. Indeed, pathologic processes are often described by scientists at the subcellular or molecular level.

The cell exists on a continuum of function and structure, ranging from the normal cell, to the adapted cell, to the injured or diseased cell, to the dead cell (Fig. 6-3). Changes from one state to another may occur rapidly and may not be readily detectable, because each state does not have discrete boundaries, and disease represents disruption of normal processes. The earliest changes occur at the molecular or subcellular level and are not perceptible until steady-state functions or structures are altered. With cell injury, some changes may be reversible; in other instances, the injuries are lethal. For example, tanning of the skin is an adaptive, morphologic response to exposure to the rays of the sun. However, if the exposure is continued, sunburn and injury occur, and some cells may die, as evidenced by desquamation ("peeling").

Different cells and tissues respond to stimuli with different patterns and rates of response, and some cells are more vulnerable to one type of stimulus or stressor than others. The cell involved, its ability to adapt, and its physiologic state are determinants of the response. For example, cardiac muscle cells respond to **hypoxia** (inadequate oxygenation) more quickly than do smooth muscle cells.

Other determinants of cellular response are the type or nature of the stimulus, its duration, and its severity. For

**Physiology ■■■ Pathophysiology**

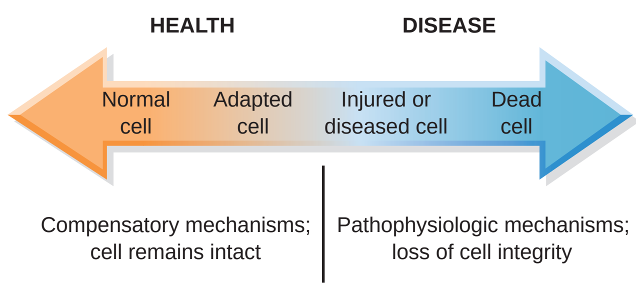



**Figure 6-3** The cell on a continuum of function and structure. Changes in the cell are not as easily discerned as the diagram depicts, and the point at which compensation subsides and pathophysiology begins is not clearly defined.

example, neurons that control respiration can develop a tolerance to regular, small amounts of a barbiturate, but one large dose may result in respiratory depression and death.

## Control of the Steady State

The concept of the cell as existing on a continuum of function and structure includes the relationship of the cell to compensatory mechanisms, which occur continuously in the body to maintain the steady state. Compensatory processes are regulated primarily by the autonomic nervous system and the endocrine system, with control achieved through negative feedback.

### Negative Feedback

**Negative feedback** mechanisms throughout the body monitor the internal environment and restore homeostasis when conditions shift out of the normal range. These mechanisms work by sensing deviations from a predetermined set point or range of adaptability and triggering a response aimed at offsetting the deviation. Blood pressure, acid–base balance, blood glucose level, body temperature, and fluid and electrolyte balance are examples of functions regulated through such compensatory mechanisms.

Most of the human body's control systems are integrated by the brain with feedback from the nervous and endocrine systems. Control activities involve detecting deviations from the predetermined reference point and stimulating compensatory responses in the muscles and glands of the body. The major organs affected are the heart, lungs, kidneys, liver, gastrointestinal tract, and skin. When stimulated, these organs alter their rate of activity or the amount of secretions they produce. Because of this, they have been called the "organs of homeostasis or adjustment."

In addition to the responses influenced by the nervous and endocrine systems, local responses consisting of small feedback loops in a group of cells or tissues are possible. The cells detect a change in their immediate environment and initiate an action to counteract its effect. For example, the accumulation of lactic acid in an exercised muscle stimulates dilation of blood vessels in the area to increase blood flow and improve the delivery of oxygen and removal of waste products.

The net result of the activities of feedback loops is homeostasis. A steady state is achieved by the continuous, variable action of the organs involved in making the adjustments and by the continuous exchange of chemical substances among cells, interstitial fluid, and blood. For example, an increase in the $CO_2$ concentration of the extracellular fluid leads to increased pulmonary ventilation, which decreases the $CO_2$ level. On a cellular level, increased $CO_2$ raises the hydrogen ion concentration of the blood. This is detected by chemosensitive receptors in the respiratory control center of the medulla of the brain. The chemoreceptors stimulate an increase in the rate of discharge of the neurons that innervate the diaphragm and intercostal muscles, which increases the rate of respiration. Excess $CO_2$ is exhaled, the hydrogen ion concentration returns to normal, and the chemically sensitive neurons are no longer stimulated (Porth & Matfin, 2009).

### Positive Feedback

Another type of feedback, **positive feedback,** perpetuates the chain of events set in motion by the original disturbance instead of compensating for it. As the system becomes more unbalanced, disorder and disintegration occur. There are some exceptions to this; blood clotting in humans, for example, is an important positive feedback mechanism.

## Cellular Adaptation

Cells are complex units that dynamically respond to the changing demands and stresses of daily life. They possess a maintenance function and a specialized function. The maintenance function refers to the activities that the cell must perform with respect to itself; specialized functions are those that the cell performs in relation to the tissues and organs of which it is a part. Individual cells may cease to function without posing a threat to the organism. However, as the number of dead cells increases, the specialized functions of the tissues are altered, and health is threatened.

Cells can adapt to environmental stress through structural and functional changes. Some of these adaptations include cellular hypertrophy, atrophy, hyperplasia, dysplasia, and metaplasia (Table 6-2). These adaptations reflect changes in the normal cell in response to stress. If the stress is unrelenting, cellular injury and death may occur.

Hypertrophy and atrophy lead to changes in the size of cells and hence the size of the organs they form. Compensatory hypertrophy is the result of an enlarged muscle mass and commonly occurs in skeletal and cardiac muscle that experiences a prolonged, increased workload. One example is the bulging muscles of the athlete who engages in body building.

Atrophy can be the consequence of disease, decreased use, decreased blood supply, loss of nerve supply, or inadequate nutrition. Disuse of a body part is often associated with the aging process and immobilization. Cell size and organ size decrease, and the structures principally affected are the skeletal muscles, the secondary sex organs, the heart, and the brain.

**Hyperplasia** is an increase in the number of new cells in an organ or tissue. As cells multiply and are subjected to increased stimulation, the tissue mass enlarges. This mitotic response (a change occurring with mitosis) is reversible when the stimulus is removed. This distinguishes hyperplasia from neoplasia or malignant growth, which continues after the stimulus is removed. Hyperplasia may be hormonally induced. An example is the increased size of the thyroid gland caused by thyroid-stimulating hormone (secreted from the pituitary gland) when a deficit in thyroid hormone occurs.

**Dysplasia** is bizarre cell growth resulting in cells that differ in size, shape, or arrangement from other cells of the same tissue type. Dysplastic cells have a tendency to become malignant; dysplasia is seen commonly in epithelial cells in the bronchi of people who smoke.

**Metaplasia** is a cell transformation in which there is a conversion of one type of mature cell into another type of cell. This serves a protective function, because less transformed cells are more resistant to the stress that stimulated

**Table 6-2 CELLULAR ADAPTATION TO STRESSORS**

| Adaptation | Stimulus | Example |
|---|---|---|
| Hypertrophy—increase in cell size leading to increase in organ size | Increased workload | Leg muscles of runner<br>Arm muscles in tennis player<br>Cardiac muscle in person with hypertension |
| Atrophy—shrinkage in size of cell, leading to decrease in organ size | Decrease in:<br>Use<br>Blood supply<br>Nutrition<br>Hormonal stimulation<br>Innervation | Secondary sex organs in aging person<br>Extremity immobilized in cast |
| Hyperplasia—increase in number of new cells (increase in mitosis) | Hormonal influence | Breast changes of girl in puberty or of pregnant woman<br>Regeneration of liver cells<br>New red blood cells in blood loss |
| Dysplasia—bizarre changes in the appearance of cells | Reproduction of cells with resulting alteration of their size and shape | Alterations in epithelial cells of the skin or the cervix, producing irregular tissue changes that could be the precursors of a malignancy |
| Metaplasia—transformation of one adult cell type to another (reversible) | Stress applied to highly specialized cell | Changes in epithelial cells lining bronchi in response to smoke irritation (cells become less specialized) |

the change. For example, the ciliated columnar epithelium lining the bronchi of people who smoke is replaced by squamous epithelium. The squamous cells can survive; loss of the cilia and protective mucus, however, can have damaging consequences.

## Cellular Injury

Injury is defined as a disorder in steady-state regulation. Any stressor that alters the ability of the cell or system to maintain optimal balance of its adjustment processes leads to injury. Structural and functional damage then occurs, which may be reversible (permitting recovery) or irreversible (leading to disability or death). Homeostatic adjustments are concerned with the small changes within the body's systems. With adaptive changes, compensation occurs and a new steady state may be achieved. With injury, steady-state regulation is lost, and changes in functioning ensue.

Causes of disorder and injury in the system (cell, tissue, organ, body) may arise from the external or internal environment (Fig. 6-4) and include hypoxia, nutritional imbalance, physical agents, chemical agents, infectious agents, immune mechanisms, genetic defects, and psychogenic factors. The most common causes are hypoxia (oxygen deficiency), chemical injury, and infectious agents. In addition, the presence of one injury makes the system more susceptible to another injury. For example, inadequate oxygenation and nutritional deficiencies make the system vulnerable to infection. These agents act at the cellular level by damaging or destroying:

- The integrity of the cell membrane, necessary for ionic balance
- The ability of the cell to transform energy (aerobic respiration, production of adenosine triphosphate)
- The ability of the cell to synthesize enzymes and other necessary proteins
- The ability of the cell to grow and reproduce (genetic integrity)

### *Hypoxia*

Inadequate cellular oxygenation (hypoxia) interferes with the cell's ability to transform energy. Hypoxia may be caused by a decrease in blood supply to an area, a decrease in the oxygen-carrying capacity of the blood (decreased hemoglobin), a ventilation/perfusion or respiratory problem that reduces the

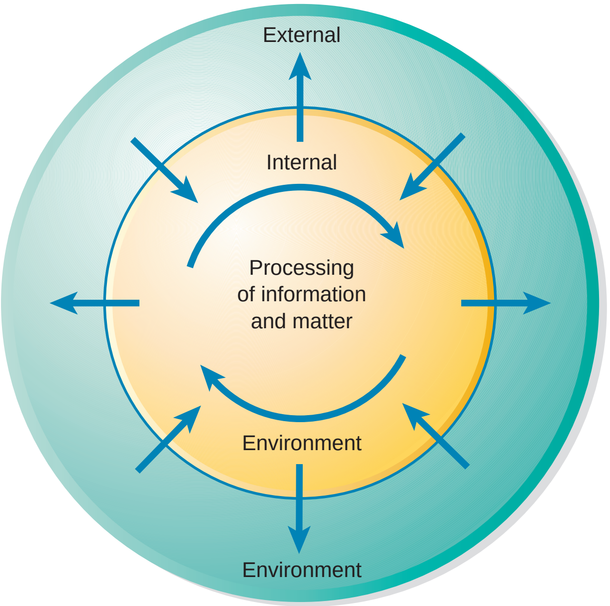



**Figure 6-4** Influences leading to disorder may arise from the internal environment and the external environment of the system. Excesses or deficits of information and matter may occur, or there may be faulty regulation of processing.

amount of arterial oxygen available, or a problem in the cell's enzyme system that makes it unable to use oxygen.

The usual cause of hypoxia is ischemia, or deficient blood supply. Ischemia is commonly seen in myocardial cell injury in which arterial blood flow is decreased because of atherosclerotic narrowing of blood vessels. Ischemia also results from intravascular clots (thrombi or emboli) that may form and interfere with blood supply. Thrombi and emboli are common causes of cerebrovascular accidents (strokes, brain attacks). The length of time different tissues can survive without oxygen varies. For example, brain cells most often succumb in 3 to 6 minutes. If the condition leading to hypoxia is slow and progressive, collateral circulation may develop, whereby blood is supplied by other blood vessels in the area. However, this mechanism is not highly reliable.

### Nutritional Imbalance

Nutritional imbalance refers to a relative or absolute deficiency or excess of one or more essential nutrients. This may be manifested as undernutrition (inadequate consumption of food or calories) or overnutrition (caloric excess). Caloric excess to the point of obesity overloads cells in the body with lipids. By requiring more energy to maintain the extra tissue, obesity places a strain on the body and has been associated with the development of disease, especially pulmonary and cardiovascular disease.

Specific deficiencies arise when an essential nutrient is deficient or when there is an imbalance of nutrients. Protein deficiencies and avitaminosis (deficiency of vitamins) are typical examples. An energy deficit leading to cell injury can occur if there is insufficient glucose, or insufficient oxygen to transform the glucose into energy. A lack of insulin, or the inability to use insulin, may also prevent glucose from entering the cell from the blood. This occurs in diabetes mellitus, a metabolic disorder that can lead to nutritional deficiency, as well as a host of short-term and long-term life-threatening complications.

### Physical Agents

Physical agents, including temperature extremes, radiation, electrical shock, and mechanical trauma, can cause injury to the cells or to the entire body. The duration of exposure and the intensity of the stressor determine the severity of damage.

#### Temperature

When a person's temperature is elevated, hypermetabolism occurs and the respiratory rate, heart rate, and basal metabolic rate all increase. With fever induced by infections, the hypothalamic thermostat may be reset at a higher temperature and then return to normal when the fever abates. The increase in body temperature is achieved through physiologic mechanisms. Body temperatures greater than 41°C (106°F) indicate hyperthermia, because the physiologic function of the thermoregulatory center breaks down and the temperature soars. This physiologic condition occurs in people who have heat stroke. Eventually, the high temperature causes coagulation of cell proteins, and cells die. The body must be cooled rapidly to prevent brain damage.

The local response to burn injury is similar. There is an increase in metabolic activity, and, as heat increases, proteins coagulate and enzyme systems are destroyed. In extreme situations, charring or carbonization occurs. For more information about burn injuries, see Chapter 57.

Extremes of low temperature, or cold, cause vasoconstriction. Blood flow becomes sluggish and clots form, leading to ischemic damage in the involved tissues. With still lower temperatures, ice crystals may form, and cells may burst.

#### Radiation and Electrical Shock

Radiation is used for diagnosis and treatment of diseases. Ionizing forms of radiation may cause injury by their destructive action. Radiation decreases the protective inflammatory response of the cell, creating a favorable environment for opportunistic infections. Electrical shock produces burns as a result of the heat generated when electrical current travels through the body. It may also abnormally stimulate nerves, leading, for example, to fibrillation of the heart.

#### Mechanical Trauma

Mechanical trauma can result in wounds that disrupt the cells and tissues of the body. The severity of the wound, the amount of blood loss, and the extent of nerve damage are significant factors in the outcome.

### Chemical Agents

Chemical injuries are caused by poisons, such as lye, which have a corrosive action on epithelial tissue, or by heavy metals, such as mercury, arsenic, and lead, each of which has its own specific destructive action. Many other chemicals are toxic in certain amounts, in certain people, and in specific tissues. For example, excessive secretion of hydrochloric acid can damage the stomach lining; large amounts of glucose can cause osmotic shifts, affecting the fluid and electrolyte balance; and too much insulin can cause subnormal levels of glucose in the blood (hypoglycemia) and can lead to coma.

Drugs, including prescribed medications, can also cause chemical poisoning. Some people are less tolerant of medications than others and manifest toxic reactions at the usual or customary dosages. Aging tends to decrease tolerance to medications. Polypharmacy (taking many medications at one time) also occurs frequently in the aging population and is a problem because of the unpredictable effects of the resulting medication interactions.

Alcohol (ethanol) is also a chemical irritant. In the body, alcohol is broken down into acetaldehyde, which has a direct toxic effect on liver cells that leads to a variety of liver abnormalities, including cirrhosis in susceptible people. Disordered liver cell function leads to complications in other organs of the body.

### Infectious Agents

Biologic agents known to cause disease in humans are viruses, bacteria, rickettsiae, mycoplasmas, fungi, protozoa, and nematodes. The severity of the infectious disease depends on the number of microorganisms entering the body, their virulence, and the host's defenses (eg, health, age, immune responses).

Some bacteria, such as those that cause tetanus and diphtheria, produce exotoxins that circulate and create cell damage. Others, such as gram-negative bacteria, produce endotoxins when they die. Tubercle bacilli induce an immune reaction.

Viruses, the smallest living organisms known, survive as parasites of the living cells they invade. Viruses infect specific cells. Through a complex mechanism, viruses replicate within cells and then invade other cells, where they continue to replicate. An immune response is mounted by the body to eliminate the viruses, and the cells harboring the viruses can be injured in the process. Typically, an inflammatory response and immune reaction are the physiologic responses of the body to viral infection.

### *Disordered Immune Responses*

The immune system is an exceedingly complex system, the purpose of which is to defend the body from invasion by any foreign object or foreign cell type, such as cancerous cells. This is a steady-state mechanism, but like other adjustment processes it can become disordered, and cellular injury results. The immune response detects foreign bodies by distinguishing non-self substances from self substances and destroying the non-self entities. The entrance of an antigen (foreign substance) into the body evokes the production of antibodies that attack and destroy the antigen (antigen–antibody reaction).

The immune system may function normally or it may be hypoactive or hyperactive. When it is hypoactive, immunodeficiency diseases occur; when it is hyperactive, hypersensitivity disorders occur. A disorder of the immune system itself can result in damage to the body's own tissues. Such disorders are labeled autoimmune diseases (see Unit 11).

### *Genetic Disorders*

There is intense research interest in genetic defects as causes of disease and modifiers of genetic structure. Many of these defects produce mutations that have no recognizable effect, such as lack of a single enzyme; others contribute to more obvious congenital abnormalities, such as Down syndrome. People can be assessed for many genetic conditions (or the risk for such conditions) such as sickle cell disease, cystic fibrosis, hemophilia A and B, breast cancer, obesity, cardiovascular disease, phenylketonuria, and Alzheimer's disease. The availability of genetic information and technology enables health care providers to perform screening, testing, and counseling for people with genetics concerns. Knowledge obtained from the Human Genome Project has also created opportunities for assessing a person's genetic profile and preventing or treating diseases. Diagnostic genetics and gene therapy have the potential to identify and modify genes before they begin to express traits that would lead to disease or disability. (For further information, see Chapter 9.)

## Cellular Response to Injury: Inflammation

Cells or tissues of the body may be injured or killed by any of the agents (physical, chemical, infectious) described earlier. When this happens, an inflammatory response (or inflammation) naturally occurs in the healthy tissues adjacent to the site of injury. **Inflammation** is a defensive reaction intended to neutralize, control, or eliminate the offending agent and to prepare the site for repair. It is a nonspecific response (not dependent on a particular cause) that is meant to serve a protective function. For example, inflammation may be observed at the site of a bee sting, in a sore throat, in a surgical incision, and at the site of a burn. Inflammation also occurs in cell injury events, such as strokes and myocardial infarctions.

Inflammation is not the same as infection. An infectious agent is only one of several agents that may trigger an inflammatory response. An infection exists when the infectious agent is living, growing, and multiplying in the tissues and is able to overcome the body's normal defenses.

Regardless of the cause, a general sequence of events occurs in the local inflammatory response. This sequence involves changes in the microcirculation, including vasodilation, increased vascular permeability, and leukocytic cellular infiltration (Fig. 6-5). As these changes take place, five cardinal signs of inflammation are produced: redness, heat, swelling, pain, and loss of function.

The transient vasoconstriction that occurs immediately after injury is followed by vasodilation and an increased rate of blood flow through the microcirculation to the area of

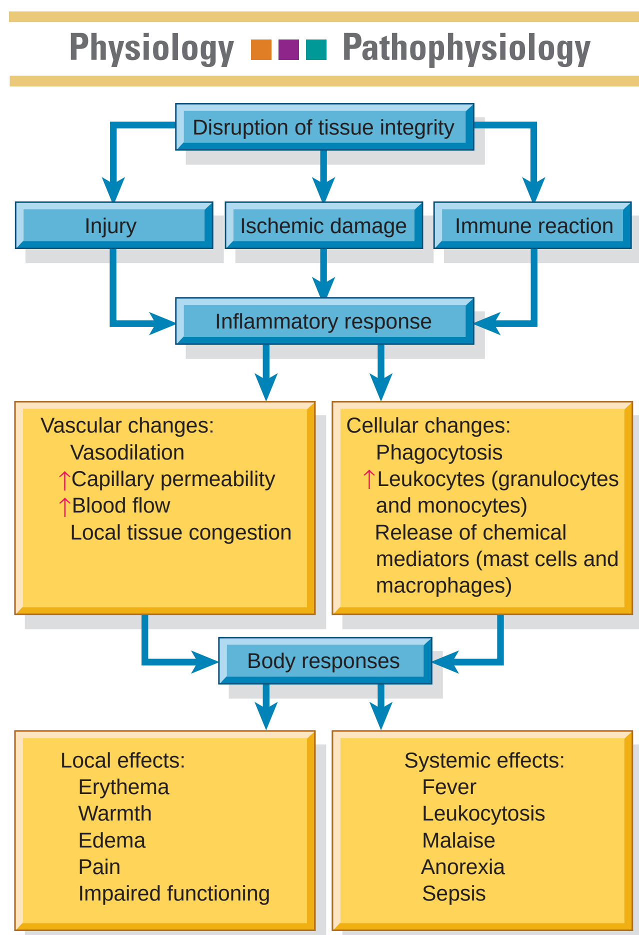



**Figure 6-5** Inflammatory response.

tissue damage. Local heat and redness result. Next, the structure of the microvascular system changes to accommodate the movement of plasma protein from the blood into the tissues. Following this increase in vascular permeability, plasma fluids (including proteins and solutes) leak into the inflamed tissues, producing swelling. Leukocytes migrate through the endothelium and accumulate in the tissue at the site of the injury. The pain that occurs is attributed to the pressure of fluids or swelling on nerve endings and to the irritation of nerve endings by chemical mediators released at the site. Bradykinin is one of the chemical mediators suspected of causing pain. Loss of function is most likely related to the pain and swelling, but the exact mechanism is not completely known.

As blood flow increases and fluid leaks into the surrounding tissues, the formed elements (red blood cells, white blood cells, and platelets) remain in the blood, causing it to become more viscous. Leukocytes (white blood cells) collect in the vessels, exit, and migrate to the site of injury to engulf offending organisms and to remove cellular debris in a process called phagocytosis. Fibrinogen in the leaked plasma fluid coagulates, forming fibrin for clot formation, which serves to wall off the injured area and prevent the spread of infection.

### Chemical Mediators of Inflammation

Injury initiates the inflammatory response, but chemical substances released at the site induce vascular changes. Foremost among these chemicals are histamine and kinins. Histamine is present in many tissues of the body but is concentrated in the mast cells. It is released when injury occurs and is responsible for the early changes in vasodilation and vascular permeability. Kinins increase vascular dilations and permeability and attract neutrophils to the area. Prostaglandins, another group of chemical substances, are also suspected of causing increased vascular permeability (Porth & Matfin, 2009).

### Systemic Response to Inflammation

The inflammatory response is often confined to the site, causing only local signs and symptoms. However, systemic responses can also occur. Fever is the most common sign of a systemic response to injury, and it is most likely caused by endogenous pyrogens (internal substances that cause fever) released from neutrophils and macrophages (specialized forms of leukocytes). These substances reset the hypothalamic thermostat, which controls body temperature, and produce fever. Leukocytosis, an increase in the synthesis and release of neutrophils from bone marrow, may occur to provide the body with greater ability to fight infection. During this process, general, nonspecific symptoms develop, including malaise, loss of appetite, aching, and weakness.

### Types of Inflammation

Inflammation is categorized primarily by its duration and the type of exudate produced. It may be acute, subacute, or chronic. Acute inflammation is characterized by the local vascular and exudative changes described previously and usually lasts less than 2 weeks. An acute inflammatory response is immediate and serves a protective function. After the causative agent is removed, the inflammation subsides and healing takes place with the return of normal or near-normal structure and function.

Chronic inflammation develops if the injurious agent persists and the acute response is perpetuated. Symptoms are present for many months or years. Chronic inflammation may also begin insidiously and never have an acute phase. The chronic response does not serve a beneficial and protective function; on the contrary, it is debilitating and can produce long-lasting effects. As the inflammation becomes chronic, changes occur at the site of injury and the nature of the exudate becomes proliferative. A cycle of cellular infiltration, necrosis, and fibrosis begins, with repair and breakdown occurring simultaneously. Considerable scarring may occur, resulting in permanent tissue damage.

Subacute inflammation falls between acute and chronic inflammation. It includes elements of the active exudative phase of the acute response as well as elements of repair, as in the chronic phase. The term *subacute inflammation* is not widely used.

## Cellular Healing

The reparative process begins at approximately the same time as the injury. Healing proceeds after the inflammatory debris has been removed. Healing may occur by regeneration, in which gradual repair of the defect occurs by proliferation of cells of the same type as those destroyed, or by replacement, in which cells of another type, usually connective tissue, fill in the tissue defect and result in scar formation.

### Regeneration

The ability of cells to regenerate depends on whether they are labile, permanent, or stable. Labile cells multiply constantly to replace cells worn out by normal physiologic processes; these include epithelial cells of the skin and those lining the gastrointestinal tract. Permanent cells include neurons—the nerve cell bodies, not their axons. Destruction of neurons is permanent, but axons may regenerate. If normal activity is to return, tissue regeneration must occur in a functional pattern, especially in the growth of several axons. Stable cells in some organ systems have a latent ability to regenerate. Under normal physiologic processes, they are not shed and do not need replacement, but if they are damaged or destroyed, they are able to regenerate. Examples include functional cells of the kidney, liver, and pancreas. Cells in other organs, such as the brain, for example, do not regenerate.

### Replacement

The condition of the host, the environment, and the nature and severity of the injury affect the processes of inflammation, repair, and replacement. Depending on the extent of damage, repair and replacement may occur by first-, second-, or third-intention healing. In first-intention healing, the wound edges are approximated, as in a surgical wound. Little scar formation occurs, and the wound healing occurs without granulation. In second-intention healing, the edges are not approximated and the wound fills with granulation tissue. The process of repair takes longer and may results in scar formation, with loss of specialized function. For example, people who have recovered from myocardial infarction have abnormal electrocardiographic tracings because the

electrical signal cannot be conducted through the connective tissue that has replaced the infarcted area. In third-intention healing, the wound edges are not approximated and healing is delayed. For more information about wound healing see Chapter 20.

## Nursing Implications

In the assessment of people who seek health care, both objective signs and subjective symptoms are the primary indicators of existing physiologic processes. The following questions are addressed:

- Are the heart rate, respiratory rate, and temperature normal?
- What emotional distress may be contributing to the patient's health problems?
- Are there other indicators of steady-state deviation?
- What are the patient's blood pressure, height, and weight?
- Are there any problems in movement or sensation?
- Are there any problems with affect, behavior, speech, cognitive ability, orientation, or memory?
- Are there obvious impairments, lesions, or deformities?

Objective evidence can be obtained from laboratory data, such as electrolytes, blood urea nitrogen, blood glucose, and urinalysis results. Further signs of change are seen in diagnostic studies such as computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). Further information on diagnostic studies can be found in assessment chapters of each unit of the book.

In making a nursing diagnosis, the nurse must relate the symptoms or problems reported by the patient to the existing physical signs. Management of specific biologic disorders is discussed in subsequent chapters; however, nurses can assist any patient to respond to stress-inducing biologic or psychological disorders with stress management interventions.

# Stress Management: Nursing Interventions

Stress or the potential for stress is ubiquitous; that is, it is both everywhere and anywhere. Anxiety, frustration, anger, and feelings of inadequacy, helplessness, or powerlessness are emotions often associated with stress. In the presence of these emotions, the customary activities of daily living may be disrupted; for example, a sleep disturbance may occur, eating and activity patterns may be altered, and family processes or role performance may be disrupted.

Many nursing diagnoses are possible for patients suffering from stress. One nursing diagnosis related to stress is Anxiety, which is defined as a vague, uneasy feeling, the source of which may be nonspecific or not known to the person. Stress may also be manifested as ineffective coping patterns, impaired thought processes, or disrupted relationships. These human responses are reflected in the nursing diagnoses of Risk-prone health behavior, Ineffective coping, Defensive coping, and Ineffective denial, all of which indicate poor adaptive responses (NANDA International, 2007). Other possible nursing diagnoses include Social isolation, Risk for impaired parenting, Risk for spiritual distress, Readiness for enhanced family coping, Decisional conflict, Situational low self-esteem, and Risk for powerlessness, among others. Because human responses to stress are varied, as are the sources of stress, arriving at an accurate diagnosis allows interventions and goals to be more specific and leads to improved outcomes.

Stress management is directed toward reducing and controlling stress and improving coping. The need to prevent illness, improve the quality of life, and decrease the cost of health care makes efforts to promote health essential, and stress control is a significant health promotion goal. Stress reduction methods and coping enhancements can derive from either internal or external sources. For example, healthy eating habits and relaxation techniques are internal resources that help reduce stress, and a broad social network is an external resource that helps reduce stress. Goods and services that can be purchased are also external resources for stress management. It may be easier for people with adequate financial resources to cope with constraints in the environment, because their sense of vulnerability to threat is decreased compared to those without adequate financial resources.

## Promoting a Healthy Lifestyle

A health-promoting lifestyle provides internal resources that aid in coping, and it buffers or cushions the impact of stressors. Lifestyles or habits that contribute to the risk of illness can be identified through a health risk appraisal, an assessment method designed to promote health by examining a person's habits and recommending changes when a health risk is identified.

Health risk appraisals involve the use of health risk questionnaires to estimate the likelihood that people with a given set of characteristics will become ill. It is hoped that if people are provided with this information, they will adopt healthy behaviors (eg, stop smoking, have periodic screening examinations) to improve their health. Questionnaires typically address the information presented in Chart 6-2.

The personal information is compared with average population risk data, and the risk factors are identified and weighted. From this analysis, a person's risks and major

**Chart 6-2 • *Information Addressed in Health Risk Questionnaires***

Demographic data: age, gender, race, ethnic background
Personal and family history of diseases and health problems
Lifestyle choices
- Eating, sleeping, exercise, smoking, drinking, sexual activity, and driving habits
- Stressors at home and on the job
- Role relationships and associated stressors

Physical measurements
- Blood pressure
- Height, weight, body mass index (BMI)
- Laboratory analyses of blood and urine

Participation in high-risk behaviors

## Chart 6-3 • *Coping Enhancement: Nursing Interventions*

**Definition**

Assisting a patient to adapt to perceived stressors, changes, or threats that interfere with meeting life demands and roles.

**Selected Activities**

Use a calm, reassuring approach and provide an atmosphere of acceptance for patients and families.

Assist the patient and family in developing an objective appraisal of the event.

Provide factual information concerning diagnosis, treatment, and prognosis as needed.

Encourage an attitude of realistic hope as a way of dealing with feelings of helplessness.

Acknowledge the patient's spiritual/cultural background and encourage the use of spiritual resources if desired.

Foster constructive methods of dealing with life problems for patients and families.

Assist the patient and family to identify appropriate short- and long-term goals.

Appraise the needs and desires for social support and assist the patient and family to identify available support systems.

Assist the patient to identify positive strategies to deal with limitations, manage needed lifestyle or role changes, and work through the losses of chronic illness and/or disability if appropriate.

Adapted from Bulechek, G. M., Butcher, H. K. & Dochterman, J. C. (Eds.). (2008). *Nursing interventions classification (NIC)* (5th ed.). St. Louis: Mosby.

health hazards are identified. Further comparisons with population data can estimate how many years will be added to a person's lifespan if the suggested changes are made. However, research has not yet demonstrated that providing people with such information ensures that they will change their behaviors. The single most important factor for determining health status is social class, and within a social class the research suggests that the major factor influencing health is level of education (Bastable, 2008).

## Enhancing Coping Strategies

Bulechek, Butcher, and Dochterman (2008, p. 228) identified "coping enhancement" as a nursing intervention and defined it as "assisting a patient to adapt to perceived stressors, changes, or threats that interfere with meeting life demands and roles" (Chart 6-3). The nurse can build on the patient's existing coping strategies, as identified in the health appraisal, or teach new strategies for coping if necessary.

The five predominant ways of coping with illness identified in a review of 57 nursing research studies were as follows (Jalowiec, 1993):

- Trying to be optimistic about the outcome
- Using social support
- Using spiritual resources
- Trying to maintain control either over the situation or over feelings
- Trying to accept the situation

Other ways of coping included seeking information, reprioritizing needs and roles, lowering expectations, making compromises, comparing oneself to others, planning activities to conserve energy, taking things one step at a time, listening to one's body, and using self-talk for encouragement.

## Teaching Relaxation Techniques

Relaxation techniques are a major method used to relieve stress. Commonly used techniques include progressive muscle relaxation, the Benson Relaxation Response, and relaxation with guided imagery. The goal of relaxation training is to produce a response that counters the stress response. When this goal is achieved, the action of the hypothalamus adjusts and decreases the activity of the sympathetic and parasympathetic nervous systems. The sequence of physiologic effects and their signs and symptoms are interrupted, and psychological stress is reduced. This is a learned response and requires practice to achieve.

The different relaxation techniques share four similar elements: (1) a quiet environment, (2) a comfortable position, (3) a passive attitude, and (4) a mental device (something on which to focus one's attention, such as a word, phrase, or sound).

### *Progressive Muscle Relaxation*

Progressive muscle relaxation involves tensing and releasing the muscles of the body in sequence and sensing the difference in feeling. It is best if the person lies on a soft cushion, in a quiet room, breathing easily. Someone usually reads the instructions in a low tone in a slow and relaxed manner, or a recording of the instructions may be played. The person tenses the muscles in the entire body (one muscle group at a time), holds, senses the tension, and then relaxes. As each muscle group is tensed, the person keeps the rest of the body relaxed. Each time the focus is on feeling the tension and relaxation. When the exercise is completed, the entire body should be relaxed (Benson, 1993; Benson & Stark, 1996).

### *Benson's Relaxation Response*

Benson (1993) described the following steps of the Benson Relaxation Response:

1. Pick a brief phrase or word that reflects your basic belief system.
2. Choose a comfortable position.
3. Close your eyes.
4. Relax your muscles.
5. Become aware of your breathing, and start using your selected focus word.
6. Maintain a passive demeanor.
7. Continue for a set period of time.
8. Practice the technique twice daily.

This response combines meditation with relaxation. Along with the repeated word or phrase, a passive demeanor is essential. If other thoughts or distractions (noises,

pain) occur, Benson recommends not fighting the distraction but simply continuing to repeat the focus phrase. Time of day is not important, but the exercise works best on an empty stomach.

#### *Relaxation With Guided Imagery*

Simple **guided imagery** is the mindful use of a word, phrase, or visual image for the purpose of distracting oneself from distressing situations or consciously taking time to relax or reenergize. A nurse can help a person select a pleasant scene or experience, such as watching the ocean or dabbling the feet in a cool stream. This image serves as the mental device in this technique. As the person sits comfortably and quietly, the nurse guides the person to review the scene, trying to feel and relive the imagery with all of the senses. A recording may be made of the description of the image, or commercial recordings for guided imagery and relaxation can be used. Other relaxation techniques include meditation, breathing techniques, massage, Reiki, music therapy, biofeedback, and the use of humor.

### Educating About Stress Management

Two commonly prescribed nursing educational interventions—providing sensory information and providing procedural information (eg, preoperative teaching)—have the goal of reducing stress and improving the patient's coping ability. This preparatory education includes giving structured content, such as a lesson in childbirth preparation to expectant parents, a review of cardiovascular anatomy to a cardiac patient, or a description of sensations a patient will experience during cardiac catheterization. These techniques may alter the person–environment relationship such that something that might have been viewed as harmful or a threat will now be perceived more positively. Giving patients information also reduces the emotional response so that they can concentrate and solve problems more effectively (Eggenberger & Nelms, 2007; Kasper, Köpke, Mühlhauser, et al., 2006).

### Enhancing Social Support

The nature of social support and its influence on coping have been studied extensively. Social support has been demonstrated to be an effective moderator of life stress. Social support has been found to provide people with several different types of emotional information (Glass, Perrin, Campbell, et al., 2007; Wilsey & Shear, 2007). The first type of information leads people to believe that they are cared for and loved. This emotional support appears most often in a relationship between two people in which mutual trust and attachment are expressed by helping one another meet their emotional needs. The second type of information leads people to believe that they are esteemed and valued. This is most effective when there is recognition demonstrating a person's favorable position in the group. Known as esteem support, this elevates the person's sense of self-worth. The third type of information leads people to feel that they belong to a network of communication and mutual obligation. Members of this network share information and make goods and services available to the members as needed.

Social support also facilitates a person's coping behaviors; however, this depends on the nature of the social support. People can have extensive relationships and interact frequently, but the necessary support comes only when there is a deep level of involvement and concern, not when people merely touch the surface of each other's lives. The critical qualities within a social network are the exchange of intimate communications and the presence of solidarity and trust.

Emotional support from family and significant others provides love and a sense of sharing the burden. The emotions that accompany stress are unpleasant and often increase in a spiraling fashion if relief is not provided. Being able to talk with someone and express feelings openly may help a person gain mastery of the situation. Nurses can provide this support; however, it is important to identify the person's social support system and encourage its use. People who are "loners," who are isolated, or who withdraw in times of stress have a high risk of coping failure.

Because anxiety can also distort a person's ability to process information, it helps to seek information and advice from others who can assist with analyzing the threat and developing a strategy to manage it. Again, this use of others helps people maintain mastery of a situation and self-esteem.

Thus, social networks assist with management of stress by providing people with:

- A positive social identity
- Emotional support
- Material aid and tangible services
- Access to information
- Access to new social contacts and new social roles

### Recommending Support and Therapy Groups

Support groups exist especially for people in similar stressful situations. Groups have been formed by parents of children with leukemia; people with ostomies; women who have had mastectomies; and people with other kinds of cancer or other serious diseases, chronic illnesses, and disabilities. There are groups for single parents, substance abusers and their family members, and victims of child abuse. Professional, civic, and religious support groups are active in many communities. There are also encounter groups, assertiveness training programs, and consciousness-raising groups to help people modify their usual behaviors in their transactions with their environment. Being a member of a group with similar problems or goals has a releasing effect on a person that promotes freedom of expression and exchange of ideas.

As previously noted, a person's psychological and biologic health, internal and external sources of stress management, and relationships with the environment are predictors of health outcomes. These factors are directly related to the person's health patterns. The nurse has a significant role and responsibility in identifying the health patterns of the patient receiving care. If those patterns are not achieving physiologic, psychological, and social balance, the nurse is obligated, with the assistance and agreement of the patient, to seek ways to promote balance.

Although this chapter has presented some physiologic mechanisms and perspectives on health and disease, the way that one copes with stress, the way one relates to others, and the values and goals held are also interwoven into those physiologic patterns. To evaluate a patient's health patterns and to intervene if a disorder exists requires a total assessment of the person. Specific disorders and their nursing management are addressed in greater depth in other chapters.

## CRITICAL THINKING EXERCISES

**1** A woman was carjacked, raped, and left on the shoulder of the road, where she was hit by a car. She is hospitalized with injuries related to her sexual assault and the hit-and-run vehicle crash. Describe the physiologic and psychological trauma she has experienced. Discuss the parameters that should be assessed. Identify appropriate nursing interventions used to alleviate the patient's physiologic and emotional stressors. Address the need for emotional support from both the nursing staff and the family.

**2** A 50-year-old woman had a successful kidney transplant 18 months ago. She developed an intimate relationship with a man in her neighborhood. Several months later she was diagnosed with genital herpes. The woman verbalized to the nurse that this new illness only added to her health problems as well as to her financial, personal, and relational stressors. Discuss the methods the nurse would use to help this patient effectively cope with the multitude of stressors that she is experiencing. Address health care referrals to support groups or social networks that are appropriate for this patient.

EBP **3** A patient experiences burns to the upper extremities after being involved in a kitchen fire. Describe the manner in which homeostasis has been disrupted and the compensatory mechanisms that are evident. How does the patient's medical treatment support the body's compensatory mechanisms? Determine the evidence-based nursing interventions that are appropriate for promoting the healing process.

EBP **4** A 70-year-old woman recently moved to a retirement community where she lives independently. A nurse practitioner assesses this patient's health promotion needs. The family's health history reveals that her mother had type 2 diabetes and thyroid disease, and that her father had hypertension and coronary artery disease. This patient has limited resources and support networks for making necessary lifestyle changes. What evidence exists to support the nurse practitioner's initiating strategies to promote a healthy lifestyle? What is the evidence that supports intervention to limit or prevent maladaptive responses from occurring with this woman? Describe the strength of the evidence regarding the effectiveness of lifestyle changes in promoting health in older adults.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing reseach.*
***Double asterisk indicates classic reference.*

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## RESOURCES

A.D.A.M. Inc.: Stress, http://adam.about.com/reports/Stress.htm
Centre for Stress Management, www.managingstress.com/articles/definition.htm
Inflammation—The Key to Chronic Disease, www.womentowomen.com/inflammation/default.aspx
Institute of HeartMath: Empowering Heart-Based Living, www.heartmath.org/
Learnthat: How to Cope with Stress—Stress Management Tutorial and Exercises, www.learnthat.com/courses/lifestyle/stress/index.shtml
Physiological Stress Response: Its effects on the body, www.stressfocus.com/stress_focus_article/physiological-stress-effects.htm
The Psychology of Stress, www.guidetopsychology.com/stress.htm
Stress: The Silent Killer, http://holisticonline.com/stress/stress_GAS.htm



chapter 7

# Individual and Family Considerations Related to Illness

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the holistic approach to maintaining health and well-being.
2. Discuss the concepts of emotional well-being and emotional distress.
3. Identify variables that influence the ability to cope with stress and that are antecedents to emotional disorders.
4. Explain the concepts of anxiety, posttraumatic stress disorder, depression, loss, and grief.
5. Determine the role of the nurse in identifying substance abuse problems and in helping families to cope.
6. Assess the impact of illness on the patient's family and on family functioning.
7. Explore the concept of spirituality and address the spiritual needs of patients.
8. Identify nursing actions that promote effective coping for both patients and families.

## GLOSSARY

**anxiety:** an emotional state characterized by feelings of apprehension, discomfort, restlessness, or worry

**bereavement:** feelings, thoughts, and responses that occur after a loss

**depression:** state in which a person feels sad, distressed, and hopeless, with little to no energy for normal activities

**faith:** belief and trust in God or a higher power

**family:** a group whose members are related by reciprocal caring, mutual responsibilities, and loyalties

**grief:** a universal response to any loss

**holistic health:** promotion of the total health of mind, body, and spirit

**mental disorder:** a state in which a person has deficits in functioning, has a distorted sense of self or the world, is unable to sustain relationships, or cannot handle stress or conflict effectively

**mental health:** a state in which a person can meet basic needs, assume responsibilities, sustain relationships, resolve conflicts, and grow throughout life

**posttraumatic stress disorder (PTSD):** the development of severe anxiety-type symptoms after the experience of a traumatic life event

**spirituality:** connectedness with self, others, a life force, or God that allows people to find meaning in life

**substance abuse:** a maladaptive pattern of drug use that causes physical and emotional harm with the potential for disruption of daily life

When people experience threats to their health, they seek out various care providers for the purpose of maintaining or restoring health. In recent years, both patients and families have become increasingly involved in health care and health promotion activities. This chapter discusses the holistic approach to health and wellness, how a person's emotional state contributes to health and illness, and how nurses can help individuals and families prevent the recurrence or exacerbation of health problems and develop strategies to improve their future health status.

## Holistic Approach to Health and Health Care

Since the 1980s, holistic therapies often accompany traditional health care. It is estimated that approximately 35% to 45% of consumers in the United States follow **holistic health** practices. More than 50% of people supplement traditional health care treatments with complementary and alternative therapies. In ambulatory care settings, more consumers request these therapies, and increasing numbers of clinicians integrate them into their clinical practice (Hardy-Pickering, Adams, Sim, et al., 2007; Sood, 2007; van Tulder, 2007). In all settings, it is imperative that during clinical assessments the use of complementary and alternative therapies be assessed. Complementary and alternative therapies are discussed in Chapter 8.

For some people, the holistic approach is viewed as a way to capitalize on personal strengths and recultivate the values and beliefs about health that were common before the age of technologic innovations and the sophistication of biomedical science. A lack of focus on individuals, families, and their environments by some health care providers has created feelings of disillusionment and depersonalization.

Active participation by individuals and families in health promotion supports the self-care model historically embraced by the nursing profession. This model is congruent with the philosophy that seeks to balance and integrate the use of traditional medicine and advanced technology with the influence of the mind and spirit on healing. A holistic approach to health reconnects the traditionally separate approaches to mind and body. Factors such as the physical environment, economic conditions, sociocultural issues, emotional state, interpersonal relationships, and support systems can influence health. The connections among physical health, emotional health, and spiritual well-being must be understood and considered when providing health care. It is the nurse's conceptual integration of the physiologic health condition within the emotional and social context, along with the patient's developmental life stage, that allows for the development of a holistic plan of nursing care.

## The Brain and Physical and Emotional Health

Research findings suggest fundamental relationships between the brain's environment and mood, behavior, and resistance to disease. One focus of brain research has been the biologic basis of mental disturbances and the relationship between mental disorders and changes in the brain. The field of psychoneuroimmunology examines connections between the emotions and the central nervous, neuroendocrine, and immune systems and has established compelling evidence that psychosocial variables can affect the functioning of the immune system.

As neuroscientific research continues, data about neurotransmitters and brain functioning contribute to increased understanding of emotions, intelligence, memory, and many aspects of physical functioning. Increased knowledge about the brain and nervous system has led to breakthroughs in the treatment of both symptoms and illnesses.

These findings suggest the need for health care providers to recognize how biologic, emotional, and societal problems combine to affect individuals, families, and communities. Some problems that nurses and other health care providers must address include substance abuse, homelessness, family violence, eating disorders, trauma, and chronic **mental health** conditions such as anxiety and depression. To focus attention on these and other mental health problems, the U.S. Department of Health and Human Services initiated a mental health agenda for the nation in *Healthy People 2010* (U.S. Public Health Service, 2005). The objectives identified are summarized in Chart 7-1.

## Mental Health and Emotional Distress

Emotional health involves the ability to function as comfortably and productively as possible. Typically, people who are mentally healthy are satisfied with themselves and their life situations. In the usual course of living, emotionally healthy people focus on activities geared to meet their needs and attempt to accomplish personal goals while managing everyday challenges and problems. Often, people must work hard to balance their feelings, thoughts, and behaviors to alleviate emotional distress, and much energy is used to change, adapt, or manage the obstacles inherent in daily living. A mentally healthy person accepts reality and has a positive sense of self. Emotional health is also manifested by having moral and humanistic values and beliefs, having satisfying interpersonal relationships, doing productive work, and maintaining a realistic sense of hope.

When people have unmet emotional needs or distress, they experience an overall feeling of unhappiness. As tension escalates, security and survival are threatened. How different people respond to these troublesome situations reflects their level of coping and maturity. Emotionally healthy people endeavor to meet the demands of distressing situations while still coping with the typical issues that emerge in their lives. The ways in which people respond to uncomfortable stimuli reflect their exposure to various biologic, emotional, and sociocultural experiences.

When stress interferes with a person's ability to function comfortably and inhibits the effective management of personal needs, that person is at risk for emotional problems. The use of ineffective and unhealthy methods of coping is manifested by dysfunctional behaviors, thoughts, and feelings. These behaviors are aimed at relieving the overwhelming stress, even though they may cause further problems.

### Chart 7-1 • *Major Mental Health Objectives for Healthy People in the Year 2010*

- Reduce the proportion of children and adolescents with disabilities who are reported to be sad, unhappy, or depressed.
- Reduce the proportion of adults with disabilities who report feelings such as sadness, unhappiness, or depression that prevent them from being active.
- Increase the proportion of adults with disabilities reporting sufficient emotional support.
- Increase the proportion of adults with disabilities reporting satisfaction with life.
- Reduce the suicide rate.
- Reduce the rate of suicide attempts by adolescents.
- Reduce the proportion of homeless adults who have serious mental illness.
- Increase the proportion of persons with serious mental illness who are employed.
- Reduce the relapse rates for persons with eating disorders including anorexia nervosa and bulimia nervosa.
- Increase the number of persons in primary care who receive mental health screening and assessment.
- Increase the proportion of children with mental health problems who receive treatment.
- Increase the proportion of juvenile justice facilities that screen admissions for mental health problems.
- Increase the proportion of adults with mental disorders who receive treatment.
- Increase the proportion of persons with co-occurring substance abuse and mental disorders who receive treatment for both disorders.
- Increase the number of states and the District of Columbia that track consumer satisfaction with the mental health services they receive.
- Increase the number of states, territories, and the District of Columbia with an operational mental health plan that addresses cultural competence.

U.S. Public Health Service. (2005). *Healthy people 2010: Understanding and improving health.* Washington, DC: U.S. Government Printing Office. Available at: http://healthypeople.gov

Coping ability is strongly influenced by biologic or genetic factors, physical and emotional growth and development, family and childhood experiences, and learning. Typically, people revert to the strategies observed early in life that were modeled by family members, caregivers, and others to resolve conflicts. If these strategies were not adaptive, the person exhibits a range of unproductive behaviors. Dysfunctional behavior in one person not only seriously affects that person's emotional health but can also put others at risk for injury or death. As these destructive behaviors are repeated, a cyclic pattern becomes evident: impaired thinking, negative feelings, and more dysfunctional actions that prevent the person from meeting the demands of daily living.

No universally accepted definition of what constitutes an emotional disorder exists, but many views and theories share the idea that a number of variables can interfere with emotional growth and development and impede successful adaptation to the environment. Most clinicians have adopted the statement from the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR), which defines the term **mental disorder** as a group of behavioral or psychological symptoms or a pattern that manifests itself in significant distress, impaired functioning, or accentuated risk of enduring severe suffering or possible death (American Psychiatric Association, 2000). Risk factors for mental health problems are listed in Chart 7-2.

Patients seen in medical-surgical settings often struggle with psychosocial issues of anxiety, depression, loss, and grief. Abuse, addiction, chemical dependency, body image disturbances, and eating disorders are a few examples of issues that require extensive physical and emotional care to restore optimal functioning. The dual challenge for the health care team is to understand how the patient's emotions influence physical conditions and to identify the best care for the patient experiencing underlying emotional and spiritual distress.

## Anxiety

All people experience some degree of **anxiety** (a tense emotional state) as they face new, challenging, or threatening life situations. In clinical settings, fear of the unknown, unexpected news about one's health, and impairment of bodily functions engenders anxiety. Although a mild level of anxiety can mobilize a person to take a position, act on the task that needs to be done, or learn to alter lifestyle habits, more severe anxiety can be paralyzing. Anxiety that escalates to a near panic state can be incapacitating. When patients receive unwelcome news about results of diagnostic studies, they are certain to experience anxiety. Different patients manifest physiologic, emotional, and behavioral signs and symptoms of anxiety in different ways.

### CHART 7-2 *Risk Factors for Mental Health Problems*

**Nonmodifiable Risk Factors**

- Age
- Gender
- Genetic background
- Family history

**Modifiable Risk Factors**

- Marital status
- Family environment
- Housing problems
- Poverty or economic difficulties
- Physical health
- Nutritional status
- Stress level
- Social environment and activities
- Exposure to trauma
- Alcohol and drug misuse
- Environmental toxins or other pollutants
- Availability, accessibility, and cost of health services

## CHART 7-3 Assessing for Anxiety

Be on the alert for the following assessment findings:

**Physiologic Indicators**

- Appetite change
- Headaches
- Muscle tension
- Fatigue or lethargy
- Weight change
- Cold and flu symptoms
- Digestive upsets
- Grinding teeth
- Palpitations
- Hypertension
- Restlessness
- Difficulty sleeping
- Skin irritations
- Injury prone
- Increased use of any alcohol or drugs

**Emotional Indicators**

- Forgetfulness
- Low productivity
- Feeling dull
- Poor concentration
- Negative attitude
- Confusion
- Whirling mind
- No new ideas
- Boredom
- Negative self-talk
- Anxiety
- Frustration
- Depression
- Crying periods
- Irritability
- Worrying
- Feeling discouraged
- Nervous laughter

**Relational Indicators**

- Isolation
- Intolerance
- Resentment
- Loneliness
- Lashing out
- "Clamming up"
- Nagging
- Distrust
- Few friends
- No intimacy
- Using people

**Spiritual Indicators**

- Emptiness
- Loss of meaning
- Doubt
- Unforgiving attitude
- Martyrdom
- Loss of direction
- Cynicism
- Apathy

### Nursing Implications

Early clinical observations of anxiety are essential components of nursing care (Chart 7-3). A high level of anxiety in a patient probably exacerbates physiologic distress. For example, a postoperative patient who is in pain may discover that anxiety intensifies the sensation of pain. A patient newly diagnosed with type 1 diabetes mellitus may be worried and fearful and therefore unable to focus on or complete essential self-care activities. Many medical conditions (eg, a breast lump or heart condition) cause anxiety. Many assessment findings alert the nurse to patients with moderate to severe anxiety.

All nurses must be vigilant about patients who worry excessively and deteriorate in emotional, social, or occupational functioning. If participation in the therapeutic regimen (eg, administration of insulin) becomes a problem because of extreme anxiety, nursing interventions must be immediately initiated. Caring strategies emphasize ways for the patient to verbalize feelings and fears and to identify sources of anxiety. The need to teach and promote effective coping abilities and the use of relaxation techniques are the priorities of care. In some cases, antianxiety medication may be prescribed. Chart 7-4 provides a list of basic nursing principles that are useful to assist patients in managing severe anxiety. Chapter 6 presents additional information about stress and the relaxation response.

## Chart 7-4 • Managing Anxiety

- Listen actively and focus on having the patient discuss personal feelings.
- Use positive remarks and focus on the positive aspects of life in the "here and now."
- Use appropriate touch (with patient permission) to demonstrate support.
- Discuss the importance of safety and the patient's overall sense of well-being.
- Explain all procedures, policies, diagnostic studies, medications, treatments, or protocols for care.
- Explore coping strategies and work with the patient to practice and use them effectively (eg, breathing, progressive relaxation, visualization, imagery).
- Use distraction as indicated to relax and prevent self from being overwhelmed.

## Posttraumatic Stress Disorder

In medical-surgical settings, especially in emergency departments, burn units, and rehabilitation centers, nurses care for extremely anxious patients who have experienced overwhelming events that may be outside the range of normal human experience. Patients can suffer from **posttraumatic stress disorder** (PTSD), a condition that generates waves of anxiety, anger, aggression, depression, and suspicion; threatens a person's sense of self; and interferes with daily functioning. Specific examples of events that place people at risk for PTSD are rape, family violence, torture, terrorist attacks, fire, earthquake, and military combat. Patients who have experienced a traumatic event are often frequent users of the health care system, seeking treatment for the overall emotional and physical trauma that they experienced.

The physiologic responses of people who have been severely traumatized include increased activity of the sympathetic nervous system, increased plasma catecholamine levels, and increased urinary epinephrine and norepinephrine levels. People with PTSD may lose the ability to control their response to stimuli (Loseke, Gelles & Cavanaugh, 2005). The resulting excessive arousal can increase overall body metabolism and trigger emotional reactivity. In this situation, patients have difficulty sleeping, have an exaggerated startle response, and are excessively vigilant.

Symptoms of PTSD can occur hours to years after the trauma is experienced. Acute PTSD is defined as the experience of symptoms for less than a 3-month period. Chronic PTSD is defined as the experience of symptoms lasting longer than 3 months. In the case of delayed PTSD, up to 6 months may elapse between the trauma and the manifestation of symptoms (American Psychiatric Association, 2000). For more information, see Chart 7-5.

### Nursing Implications

It is often thought that the incidence of PTSD is very low in the overall population. However, when high-risk groups are studied, the results indicate that more than 50% of study participants have PTSD (McKenny & Price, 2005). Therefore, it is important that nurses consider which of their

### CHART 7-5 Assessing for Posttraumatic Stress Disorder (PTSD)

Be on the alert for the following assessment findings:

**Physiologic Indicators**

- Dilated pupils
- Headaches
- Sleep pattern disturbances
- Tremors
- Elevated blood pressure
- Tachycardia or palpitations
- Diaphoresis with cold, clammy skin
- Hyperventilation
- Dyspnea
- Smothering or choking sensation
- Nausea, vomiting, or diarrhea
- Stomach ulcers
- Dry mouth
- Abdominal pain
- Muscle tension or soreness
- Exhaustion

**Psychological Indicators**

- Anxiety
- Anger
- Depression
- Fears or phobias
- Survivor guilt
- Hypervigilance
- Nightmares or flashbacks
- Intrusive thoughts about the trauma
- Impaired memory
- Dissociative states
- Restlessness or irritability
- Strong startle response
- Substance abuse
- Self-hatred
- Feelings of estrangement
- Feelings of helplessness, hopelessness, or powerlessness
- Lack of interest in life
- Inability to concentrate
- Difficulty communicating, caring, and expressing love
- Problems with relationships
- Sexual problems ranging from acting out to impotence
- Difficulty with intimacy
- Inability to trust
- Lack of impulse control
- Aggressive, abusive, or violent behavior, including suicide
- Thrill-seeking behaviors

Copel, L. C. (2000). *Nurse's clinical guide: Psychiatric and mental health care* (2nd ed.). Springhouse, PA: Springhouse.

patients are at risk for PTSD and be knowledgeable about the common symptoms associated with it. Older people are more susceptible to the physical effects of trauma and the effects of PTSD because of the neural inactivation associated with aging. One study reported that people with strong support networks were less likely to experience PTSD after a natural disaster than people without a strong support system (Acierno, Ruggiero, Kilpatrick, et al., 2006).

The sensitivity and caring of the nurse creates the interpersonal relationship necessary to work with patients who have PTSD. These patients are physically compromised and are struggling emotionally with situations that are not considered part of normal human experience, situations that violate the commonly held perceptions of human social justice. Treatment of patients with PTSD includes several essential components: establishing a trusting relationship, addressing and working through the trauma experience, and teaching the coping skills needed for recovery and self-care. The patient's progress can be influenced by the ability to cope with the various aspects of both the physical and the emotional distress.

## Depression

**Depression** is a common response to health problems and is an underdiagnosed problem, particularly in hospitalized patients. People may become depressed as a result of injury or illness; may be suffering from an earlier loss that is compounded by a new health problem; or may seek health care for somatic manifestations of depression.

Clinical depression is distinguished from everyday feelings of sadness by its duration and severity. Most people occasionally feel down or depressed, but these feelings are short-lived and do not result in impaired functioning. Clinically depressed people usually have had signs of a depressed mood or a decreased interest in pleasurable activities for at least a 2-week period. An obvious impairment in social, occupational, and overall daily functioning occurs in some people. Others function appropriately in their interactions with the outside world by exerting great effort and forcing themselves to mask their distress. Sometimes they are successful at hiding their depression for months or years and astonish family members and others when they finally admit that they are seriously depressed.

Many people experience depression but seek treatment for somatic complaints. The leading somatic complaints of patients struggling with depression are headache, backache, abdominal pain, fatigue, malaise, anxiety, and decreased desire or problems with sexual functioning (Varcarolis, Carson & Shoemaker, 2006). It is estimated that depression is undiagnosed about half of the time and masquerades as physical health problems (Townsend, 2005). People with depression also exhibit poor functioning with frequent absences from work and school.

Specific symptoms of clinical depression include feelings of sadness, worthlessness, fatigue, guilt, and difficulty concentrating or making decisions. Changes in appetite, weight gain or loss, sleep disturbances, and psychomotor retardation or agitation are also common. Often, patients have recurrent thoughts about death or suicide or have made suicide attempts. A diagnosis of clinical depression is made when a person presents with at least five of nine diagnostic criteria for depression (Chart 7-6). Unfortunately, only one of three depressed people is properly diagnosed and appropriately treated (American Psychiatric Association, 2000).

### Nursing Implications

Because any loss in function, change in role, or alteration in body image is a possible antecedent to depression, nurses in all settings encounter patients who are depressed or who have thought about suicide. Depression is suspected if changes in the patient's thoughts or feelings and a loss of

**Chart 7-6 • *Diagnostic Criteria for Depression Based on the DSM-IV-TR***

A person experiences at least five out of nine characteristics, with one of the first two symptoms present most of the time:
1. Depressed mood
2. Loss of pleasure or interest
3. Weight gain or loss
4. Sleeping difficulties
5. Psychomotor agitation or retardation
6. Fatigue
7. Feeling worthless
8. Inability to concentrate
9. Thoughts of suicide or death

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (DSM-IV-TR)* (4th ed.). Washington, DC: Author.

self-esteem are noted. Chart 7-7 lists risk factors for depression. Depression can occur at any age, and it is diagnosed more frequently in women than in men. In elderly patients, nurses should be aware that decreased mental alertness or withdrawal-type responses may be indicative of depression. Consultation with an advanced practice psychiatric mental health nurse to assess and differentiate between dementia-like symptoms and depression is often helpful.

Talking with the patient about his or her fears, frustration, anger, and despair can help alleviate a sense of helplessness and lead to necessary treatment. Helping the patient learn to cope effectively with conflict, interpersonal problems, and grief and encouraging the patient to discuss actual and potential losses may hasten his or her recovery from depression. It may also be possible to help the patient identify and decrease negative self-talk and unrealistic expectations and show how these contribute to depression. The nurse should monitor the patient for the onset of new problems because depression adversely affects physical health and self-care activities (Chart 7-8). All patients with depression should be evaluated to determine if they would benefit from antidepressant therapy.

In addition to the measures previously listed, psychoeducational programs, establishment of support systems, and counseling can reduce anxiety- and depression-related distress (McKenny & Price, 2005). Psychoeducational programs can help patients and their families understand depression, treatment options, and coping strategies. (In crisis situations, it is imperative that patients be referred to psychiatrists, psychiatric nurse specialists, advanced practice psychiatric mental health nurses, or crisis centers.) Explaining to patients that depression is a medical illness and not a sign of personal weakness, and that effective treatment will allow them to feel better and stay emotionally healthy, is an important aspect of care (Varcarolis, et al., 2006).

In the United States, 1% of deaths are due to suicide, and screening in primary care settings helps reduce mortality (Bickley, 2007). When patients make statements that are self-deprecating, express feelings of failure, or are convinced that things are hopeless and will not improve, they may be at risk for suicide. Risk factors for suicide are listed in Chart 7-9.

**CHART 7-7 *Risk Factors for Depression***

- Family history
- Stressful situations
- Female gender
- Prior episodes of depression
- Onset before age 40 years
- Medical comorbidity
- Past suicide attempts
- Lack of support systems
- History of physical or sexual abuse
- Current substance abuse

## Substance Abuse

Some people use mood-altering substances as a coping mechanism. People who engage in **substance abuse** use illegally obtained drugs, prescribed or over-the-counter medications, and alcohol alone or in combination with other drugs in ineffective attempts to cope with the pressures, strains, and burdens of life. They are unable to make healthy decisions and to solve problems effectively. Typically, they are also unable to identify and implement adaptive behaviors. Some people may respond to personal illness or the illness of a loved one by using those substances to decrease emotional pain. Over time, physiologic, emotional, cognitive, and behavioral problems develop as a result of continuous substance abuse. These problems cause distress for people, their families, and their communities.

### *Nursing Implications*

Substance abuse is encountered in all clinical settings. Intoxication and withdrawal are two common substance abuse problems. Nurses may treat patients who have experienced trauma as a result of intoxication. Other patients who are active substance abusers enter the primary care setting with a diagnosis other than that of substance abuse. Many do not disclose the extent of their substance use. The nurse who performs a substance use assessment can detect the patient's use of denial or lack of knowledge about the harmful effects of psychoactive substances.

A number of tools are available to nurses to assess drug and alcohol abuse. Examples of such instruments are the CAGE Questionnaire (Ewing, 1984), the Michigan Alcohol Screening Test (MAST) (Selzer, 1971), the Addiction Severity Index (McLellan, Kushner, Metzger, et al., 1992), the Drug Abuse Screening Test for Adolescents (Martino, Grilo & Fehon, 2000), and the TWEAK alcohol screening test (Chan, Pristach, Welte, et al., 1993). The MAST has been updated to include drug use and has a geriatric version (The New York State Office of Alcoholism and Substance Abuse Services [OASAS], 2007). The CAGE Questions Adapted to Include Drugs (CAGEAID) instrument is presented in Chapter 5, Chart 5-5. Information that is commonly addressed in substance abuse questionnaires is summarized in Chart 7-10.

Health care professionals are in a pivotal position to identify substance abuse problems, institute treatment

CHART 7-8 NURSING RESEARCH PROFILE

### Lonliness and Social Support in MS

Beal, C. C. & Stuifbergen, A. (2007). Loneliness in women with multiple sclerosis. *Rehabilitation Nursing, 32*(4), 165–171.

**Purpose**

Women diagnosed with multiple sclerosis (MS) are at risk for loneliness due to the changes that frequently occur in their social activities and networks. This study was designed to (1) examine the relationship between loneliness, social support, functional limitations, self-rated health status, social responses to illness, and marital status, as well as to (2) determine the extent that the previously mentioned variables could predict loneliness.

**Design**

A secondary analysis examined data collected from 659 women in 1996. Participants, from the southwest region of the United States, were members of the National Multiple Sclerosis Society. The women provided information on age, gender, ethnicity, education, employment, marital status, and type of MS. The participants completed a longitudinal survey concerning health promotion behaviors and quality of life for people with MS. The researchers used descriptive statistics to describe the subjects. Pearson correlations and regression analysis were used to identify the variables that explained the variance for loneliness.

**Findings**

The subjects reported few problems with activities of daily living. Ninety-eight of the women (approximately 15%) revealed that they experienced fatigue, with 48% indicating that the fatigue was frequent or disabling. The majority of the participants reported that they were less social as a result of the MS because it was difficult to plan social activities. These women believed that other people did not understand what they were going through, and they felt obligated to help others learn about and understand their illness. Approximately 67% of the participants stated that other people treated them differently because of their chronic illness. Fifty percent of the women reported feeling lonely at some time in the past week. Loneliness was positively correlated with all the study variables, although the correlations with functional limitation, self-rated health status, and marital status were weak. Researchers noted that there was a negative relationship between loneliness and social support. They found a positive correlation between loneliness and social responses to illness.

**Nursing Implications**

Loneliness occurs in women with MS who have low levels of social support, low self-rated health status, and increased social demands of illness. In this study, loneliness was a frequent experience in women with MS and was also more common in those who were unmarried.

Health care providers must be aware that women with MS need to be assessed for loneliness, because loneliness is a precursor to depression. Loneliness may not be easily recognized. Astute nurses are able to determine if social isolation exists; this situation is essential to determine if women are at risk for loneliness. Nurses also need to recognize that social support must be assessed and social networks encouraged. For women with MS, another significant nursing intervention is the strengthening of interpersonal resources. It is necessary to develop programs that increase social interaction. These women need opportunities to participate in activities that allow them to form new friendships. Nurses can assist in promoting the overall emotional health of women with MS.

protocols, and make referrals. Because substance abuse severely affects families, nurses can help family members confront the situation, decrease enabling behaviors, and motivate the person with the substance abuse problem to obtain treatment.

CHART 7-9

### Risk Factors for Suicide

- Age younger than 20 or older than 45 years, especially older than 65 years
- Gender—women make more attempts, men are more successful
- Dysfunctional family—members have experienced cumulative multiple losses and possess limited coping skills
- Family history of suicide
- Severe depression
- Severe, intractable pain
- Chronic, debilitating medical problems
- Substance abuse
- Severe anxiety
- Overwhelming problems
- Severe alteration in self-esteem or body image
- Lethal suicide plan

Caring for codependent family members is another nursing priority. Codependent people tend to manifest unhealthy patterns in relationships with others. Codependents struggle with a need to be needed, an urge to control others, and a willingness to remain involved and suffer with a person who has a drug problem.

Families may approach the health care team to help set limits on the dysfunctional behavior of people who abuse substances. At these times, a therapeutic intervention is organized for the purpose of confronting the patient about

CHART 7-10

### Assessing for Substance Abuse

- Past and recurrent use of the substance
- Patient's view of substance use as a problem
- Age when substance was first used and last used
- Length and duration of use of substance
- Preferred method of use of substance
- Amount of substance used
- How substance is procured
- Effect of or reaction to substance
- Previous attempts to cease or decrease substance use

substance use and the need to obtain drug or alcohol treatment. Nurses or other skilled addiction counselors help families present the addicted person with a realistic perspective about the problem, their concerns about and caring for the person, and a specific plan for treatment. This therapeutic intervention works on the premise that honest and caring confrontation can break through a person's denial of the addiction. If a person refuses to participate in the designed plan, the family members define the consequences and state their commitment to follow through with them. This intervention is empowering to the family and usually provides the structure needed to secure treatment.

However, even with treatment, the patient may experience relapse. The nurse works with the patient and family to prevent relapse and to be prepared if relapse occurs. Relapse is considered a part of the illness process and therefore must be viewed and addressed in the same way that chronic illness is treated.

Nurses who work with patients and families struggling with addiction must dispel the myth that addiction is a defect in character or a moral fault. Views on substance abuse vary within society. A person's background may help determine whether he or she uses drugs, what drugs are used, and when they are used. The combination of factors, such as values and beliefs, family and personal norms, spiritual convictions, and conditions of the current social environment, predisposes a person to the possibility of drug use, motivation for treatment, and continual recovery. It has also been said that a person's attitude, especially toward alcohol, reflects the overall beliefs and attitudes of that person's culture (Giger & Davidhizar, 2008).

## Family Health and Distress

The **family** (a group related by reciprocal caring, mutual responsibilities, and loyalties) plays a central role in the life of the patient and is a major part of the context of the patient's life. It is within families that people grow, are nurtured, acquire a sense of self, develop beliefs and values about life, and progress through life's developmental stages (Fig. 7-1). Families are also the first source for socialization and teaching about health and illness. Families prepare their own members with strategies for balancing closeness with separateness and togetherness with individuality. A major role of families is to provide physical and emotional resources to maintain health and a system of support in times of crises, such as in illness and disability.



**Figure 7-1** There are many types of families.

Health problems often affect the family's ability to function. Five family functions are viewed as essential to the growth of individuals and families. The first function, *management*, involves the use of power, decision making about resources, establishment of rules, provision of finances, and future planning—responsibilities assumed by the adults of the family. The second function, *boundary setting*, makes clear distinctions between the generations and the roles of adults and children within the family structure. The third function, *communication*, is important to individual and family growth; healthy families have a full range of clear, direct, and meaningful communication among their members. The fourth function is *education and support*. Education involves modeling skills for living a physically, emotionally, and socially healthy life. Support is manifested by actions that tell family members they are cared about and loved; it promotes health and is seen as a critical factor in coping with crises and illness situations. The fifth function, *socialization*, involves families' transmission of culture and the acceptable behaviors needed to perform adequately in the home and in the world (Wright & Leahey, 2005).

### Nursing Implications

When a family member becomes ill, injured, or disabled, all members of the family are affected. Depending on the nature of the health problem, family members may need to modify their existing lifestyles or even restructure their lives.

There are many degrees of family functioning. Nurses assess family functioning to determine how a particular family copes with the impact of the health condition. If the family is chaotic or disorganized, promoting coping skills becomes a priority in the plan of care. The family with preexisting problems may require additional assistance before participating fully in the current health situation. In performing a family assessment, the nurse must evaluate the present family structure and function. Areas of appraisal include demographic data, developmental information (keeping in mind that different family members can be in different developmental stages simultaneously), family structure, family functioning, and coping abilities. The role the environment plays in family health is also assessed.

Interventions with family members are based on strengthening coping skills through direct care, fostering communication skills, and providing education. Healthy family communication has a strong influence on the quality of family life and can help the family make appropriate choices, consider alternative strategies, or persevere through complex circumstances. Within a family system, for example, a particular patient may be undergoing extensive surgery for cancer while the partner has cardiac disease, an adolescent has type 1 diabetes mellitus, and a child has a fractured arm. In this situation, there are multiple health concerns along with competing developmental tasks and needs. Despite the obvious concerns of the family members, both individually and collectively, a crisis may or may not be present. The family may be coping effectively, or it may

be in crisis or unable to handle the situation. Ideally, the health care team conducts a careful and comprehensive family assessment, develops interventions tailored to handle the stressors, implements the specified treatment protocols, and facilitates the construction of social support systems.

The use of existing family strengths, resources, and education is augmented by therapeutic family interventions. The primary goals of the nurse are to maintain and improve the patient's present level of health and to prevent physical and emotional deterioration. Next, the nurse intervenes in the cycle that the illness creates: patient illness, stress for other family members, new illness in other family members, and additional patient stress.

Helping the family members handle the myriad stressors that bombard them daily involves working with family members to develop coping skills. Seven traits that enhance coping of family members under stress have been identified (Burr, Klein, Burr, et al., 1994). Communication skills and spirituality were the most useful traits. Cognitive abilities, emotional strengths, relationship capabilities, willingness to use community resources, and individual strengths and talents were also associated with effective coping. As nurses work with families, they must not underestimate the impact their therapeutic interactions, educational information, positive role modeling, provision of direct care, and teaching have on promoting health.

Without the active support of the family members by the health care team, the potential for maladaptive coping increases. Often, denial and blaming of others occur. Sometimes, physiologic illness, emotional withdrawal, and physical distancing are the results of severe family conflict, violent behavior, or addiction to drugs and alcohol. Substance abuse may develop in family members who feel unable to cope or solve problems. Frequently, people engage in these dysfunctional behaviors when faced with difficult or problematic situations.

## Loss and Grief

Loss is a part of the life cycle. All people experience loss in the form of change, growth, and transition. The experience of loss and **grief** is painful, frightening, and lonely, and it triggers an array of emotional responses (Chart 7-11). People may vacillate between denial, shock, disbelief, anger, inertia, intense yearning, loneliness, sadness, loss of control, depression, and spiritual despair (Kubler-Ross & Kessler, 2005).

In addition to normal losses associated with life cycle stages, there are the potential losses of health, a body part, self-image, self-esteem, and even one's life. When loss is not acknowledged or there are multiple losses, anxiety, depression, and health problems may occur. People with physical health problems, such as diabetes mellitus, human immunodeficiency virus (HIV) infection/acquired immunodeficiency syndrome (AIDS), cardiac disorders, gastrointestinal disorders, disabilities, and neurologic impairments, tend to respond to these conditions with feelings of loss and grief.

People grieve in different ways, and there is no timeline for completing the **bereavement** process. The time of grieving often depends on the significance of the loss, the anticipation of or preparation for the loss, the person's emotional stability and maturity, and the person's coping ability.

Regardless of the duration of the grieving process, there are two basic goals: (1) healing the self and (2) recovering from the loss. Other factors that influence grieving are the type of loss, life experiences with various changes and transitions, religious beliefs, cultural background, and personality type. Some patients may resort to abuse of prescription medications, illegal drugs, or alcohol if they find it difficult to cope with the loss; the grief process is then complicated by the use of addictive substances.

### Nursing Implications

Nurses identify patients and family members who are grieving and work with them to accomplish the four major tasks of the grief process: (1) acceptance of the loss, (2) acknowledgment of the intensity of the pain of the loss, (3) adaptation to life after the loss, and (4) cultivation of new relationships and activities. Nurses also assess and differentiate between grief and depression by knowing the common thoughts, feelings, physical or bodily reactions, and behaviors associated with grief compared with depression.

The physical response to grief includes the sensation of somatic distress, a tightness in the throat followed by a choking sensation or shortness of breath, the need to sigh,

CHART 7-11 *Assessing for Grieving*

Be on the alert for the following assessment findings:

**Physiologic Indicators**

- Heart rate changes
- Blood pressure alterations
- Gastrointestinal disturbances
- Chest discomfort
- Shortness of breath
- Weakness
- Appetite changes
- Sleep problems
- Vague, but distressing, physical symptoms

**Emotional Indicators**

- Sadness
- Depression
- Anger
- Social withdrawal
- Loneliness
- Apathy
- Longing for who or what was lost
- Blaming of self or others
- Questioning of beliefs

**Behavioral Indicators**

- Slow movements
- Forgetfulness
- Purposeless activity
- Crying
- Sighing
- Lack of interest
- Easily distracted from tasks

an empty feeling inside the abdomen, a lack of muscle power, and intense disabling distress. Grief can further debilitate already compromised patients and can have a strong impact on family functioning.

## Death and Dying

Coping with the death of a loved one or with anticipation of one's own death is considered the ultimate challenge. The idea of death is threatening and anxiety provoking to many people. Kubler-Ross (1975, p. 1) stated: "The key to the question of death unlocks the door of life. . . . For those who seek to understand it, death is a highly creative force." Common fears of those who are dying are fear of the unknown, pain, suffering, loneliness, loss of the body, and loss of personal control.

In recent years, the experience of dying has changed as advances have been made in the care of chronically and terminally ill patients. Technologic innovations and modern therapeutic treatments have prolonged the lifespan, and many deaths are now the result of chronic illnesses that result in progressive physiologic deterioration and subsequent multisystem failure. For more information on end-of-life care and death and dying, see Chapter 17.

## Spirituality and Spiritual Distress

**Spirituality** is defined as connectedness with self, others, a life force, or God that allows people to experience self-transcendence and find meaning in life. Spirituality helps people discover a purpose in life, understand the ever-changing qualities of life, and develop their relationship with God or a higher power. Within the framework of spirituality, people may discover truths about the self, about the world, and about concepts such as love, compassion, wisdom, honesty, commitment, imagination, reverence, and morality. Sacred texts for the major religious traditions offer guidelines for personal conduct and social and spiritual behavior. It is important that the spiritual beliefs of people and families be acknowledged, valued, and respected for the comfort and guidance they provide.

Spiritual behavior can be expressed through sacrifice, self-discipline, and spending time in activities that focus on the inner self or the soul. Although religion and nature are two vehicles that people use to connect themselves with God or a higher power, bonds to religious institutions, beliefs, or dogma are not required to experience the spiritual sense of self. **Faith,** considered the foundation of spirituality, is a belief in something that a person cannot see. The spiritual part of a person views life as a mystery that unfolds over one's lifetime, encompassing questions about meaning, hope, relatedness to God, acceptance or forgiveness, and transcendence.

A strong sense of spirituality or religious faith can have a positive impact on health (Hovey & Seligman, 2007; McManus, 2007). Spirituality is also a component of hope, and, especially during chronic, serious, or terminal illness, patients and their families often find comfort and emotional strength in their religious traditions or spiritual beliefs. At other times, illness and loss can cause a loss of faith or meaning in life and a spiritual crisis. The nursing diagnosis of spiritual distress is applicable to those who have a disturbance in the belief or value system that provides strength, hope, and meaning in life.

### Nursing Implications

Spiritually distressed patients (or family members) may show despair, discouragement, ambivalence, detachment, anger, resentment, or fear. They may question the meaning of suffering, life, and death and express a sense of emptiness. The nurse assesses spiritual strength by inquiring about the patient's sense of spiritual well-being, hope, and peacefulness and assesses whether spiritual beliefs and values have changed in response to illness or loss. In addition, the nurse assesses current and past participation in religious or spiritual practices and notes the patient's responses to questions about spiritual needs—grief, anger, guilt, depression, doubt, anxiety, or calmness—to help determine the patient's need for spiritual care. Another simple assessment technique is to inquire about the patient's and family's desire for spiritual support.

For nurses to provide spiritual care, they must be open to being present and supportive when patients experience doubt, fearfulness, suffering, despair, or other difficult psychological states of being. Interventions that foster spiritual growth or reconciliation include being fully present; listening actively; conveying a sense of caring, respect, and acceptance; using therapeutic communication techniques to encourage expression; suggesting the use of prayer, meditation, or imagery; and facilitating contact with spiritual leaders or performance of spiritual rituals.

Patients with serious, chronic, or terminal illnesses face physical and emotional losses that threaten their spiritual integrity. During acute and chronic illness, rehabilitation, or the dying process, spiritual support can stimulate patients to regain or strengthen their connections with their inner selves, their loved ones, and God or a higher power to transcend suffering and find meaning. Nurses can alleviate distress and suffering and enhance wellness by meeting their patients' spiritual needs.

## CRITICAL THINKING EXERCISES

EBP **1** A 60-year-old woman who survived an earthquake is in a hospital emergency department for treatment of severe lacerations. She tells the nurse she is fearful that her spouse, who was already admitted to the hospital with a fractured hip, is alone and suffering. She states, "I am nervous about his condition and that he will go to surgery before I see him. I know that he will be better if he knows that I am all right, too. Please, let me see him!" What assessment data should be collected to determine measures that will most likely allay this patient's anxiety? What evidenced-based nursing interventions are appropriate for assisting the woman through the trauma that she experienced? What complementary or alternative interventions might be helpful to this woman? Discuss the strength of the evidence. Identify the criteria used to evaluate the strength of the evidence for the strategies.

**2** The night before a patient's major cardiac surgery, the nurse learns her patient has lost both his wife and his adult son in the past 6 months. What physiologic, emotional, and behavioral indicators should the nurse be alert for in assessing grieving? Generate a list of possible nursing diagnoses for this patient. Identify the nursing interventions that would be most appropriate for each of the possible nursing diagnoses and evaluation criteria for these interventions.



The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing reseach.*
***Double asterisk indicates classic reference.*

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## RESOURCES

### General

American Holistic Nurses Association (AHNA), 323 N. San Francisco Street, Ste 201 Flagstaff, AZ 86001; 1-800-278-AHNA; www.ahna.org

Grief Recovery Institute Education Foundation, Inc. (GRIEF), P.O. Box 6061-382, Sherman Oaks, CA 91413; 1-818-907-9600; 1-800-445-4808 (hotline); www.grief.net

National Hospice and Palliative Care Organization (NHPCO), 1700 Diagonal Road, Suite 625, Arlington, VA 22314; 1-703-837-1500; www.nhpco.org

### Aging

American Association of Retired Persons (AARP), www.aarp.org

Children of Aging Parents, www.caps4caregivers.org

National Council on Headquarters, www.ncoa.org

National Family Caregiver Support Program, www.aoa.gov/prof/aoaprog/caregiver/overview/overview

National Office of the Gray Panthers, http://graypanthers.e-actionmax.com/contact.asp

### Anxiety

Anxiety Disorders Association of America, www.adaa.org

### Bereavement

The Compassionate Friends Inc., www.compassionatefriends.org

Widowed Persons Service, 601 "E" Street NW, Washington, DC 20049-0001; 1-202-434-2260

### Depression

Mental Health America, www.nmha.org

National Alliance on Mental Illness, www.nami.org

### Posttraumatic Stress Disorder

National Center for PTSD, www.ncptsd.org

### Substance Abuse

Adult Children of Alcoholics World Service Organization, Inc., www.adultchildren.org

Al-Anon and Alateen Family Group Headquarters Inc., www.al-anon.alateen.org

Alcoholics Anonymous, www.alcoholics-anonymous.org

Center for Substance Abuse Prevention Drug-Free Workplace, www.drugfreeworkplace.gov

Center for Substance Abuse Treatment, http://csat.samhsa.gov/faqs.aspx

Children of Alcoholics Foundation, www.coaf.org

Co-Anon Family Groups, www.co-anon.org

Cocaine Anonymous, www.ca.org

Dual Recovery Anonymous World Services Central Office, www.draonline.org

Narcotics Anonymous World Services Inc., www.na.org

National Alcohol Hotline, Helpline: 1-800-NCA-CALL (1-800-622-2255)

National Cocaine Hotline, 1-800-COCAINE (1-800-262-2463)

Rational Recovery Systems, www.rational.org



chapter 8

# Perspectives in Transcultural Nursing

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Identify key components of cultural assessment.

**2** Apply transcultural nursing principles, concepts, and theories when providing nursing care to individuals, families, groups, and communities.

**3** Develop strategies for planning, providing, and evaluating culturally competent nursing care for patients from diverse backgrounds.

**4** Critically analyze the influence of culture on nursing care decisions and actions for patients.

**5** Discuss the impact of diversity and health care disparities on health care delivery.

## GLOSSARY

**culture:** the knowledge, belief, art, morals, laws, customs, and any other capabilities and habits acquired by humans as members of society

**culturally competent nursing care:** effective, individualized care that demonstrates respect for the dignity, personal rights, preferences, beliefs, and practices of the person receiving care, while acknowledging the biases of the caregiver and preventing these biases from interfering with the care provided

**cultural nursing assessment:** a systematic appraisal or examination of individuals, families, groups, and communities in terms of their cultural beliefs, values, and practices

**minority:** group of people whose physical or cultural characteristics differ from the majority of people in a society

**subculture:** relatively large groups of people who share characteristics that identify them as a distinct entity

**transcultural nursing:** nursing care to clients and families across cultural variations

In the health care delivery system, as in society, nurses interact with people of similar as well as diverse cultural backgrounds. People may have different frames of reference and varied preferences regarding their health and health care needs. Nurses must often practice **transcultural nursing,** providing care to clients and families across cultural variations. Acknowledging, respecting, and adapting to the cultural needs of patients and significant others are important components of nursing care. In addition, facilitating access to culturally appropriate health care is critical to ensure holistic nursing care. To plan and deliver culturally appropriate and competent care, nurses must understand the language of culture, culturally appropriate care, and cultural competence and the various aspects of culture that should be explored for each patient.

## Cultural Concepts

The concept of culture and its relationship to the health care beliefs and practices of the patient and his or her family or significant others provide the foundation for transcultural nursing. This awareness of culture in the delivery of nursing care has been described in different terms and phrases, including respect for cultural diversity; culturally sensitive or comprehensive care; and culturally competent, appropriate (Giger, Davidhizar, Purnell, et al., 2007b), or culturally congruent nursing care (Leininger, 2002). Two important concepts are cultural diversity and culturally competent care.

**Culture** is commonly defined as the knowledge, belief, art, morals, laws, customs, and any other capabilities and habits acquired by humans as members of society. During the past century, and especially during recent decades, hundreds of definitions of culture have been offered that integrate these themes and the themes of ethnic variations of a population based on race, nationality, religion, language, physical characteristics, and geography (Underwood, 2006). To fully appreciate the broad impact of culture, factors such as disabilities, gender, social class, physical appearance (eg, weight, height), ideologies (political views), or sexual orientation must be integrated into the definition of culture as well (Underwood, 2006).

Madeleine Leininger (2002), founder of the specialty called transcultural nursing, writes that culture involves learned and transmitted knowledge about values, beliefs, rules of behavior, and lifestyle practices that guide designated groups in their thinking and actions in patterned ways. Giger and Davidhizar (2008) define transcultural nursing as a research-focused, client-based practice field of culturally competent nursing. Transcultural nursing addresses the differences and similarities among cultures in relation to health, health care, and illness, with consideration of patient values, beliefs, and practices. Culture develops over time as a result of exposure to social and religious structures and intellectual and artistic manifestations, and each individual person, including each nurse, is culturally unique (Giger & Davidhizar, 2008).

Ethnic culture has four basic characteristics:

- It is learned from birth through language and socialization.
- It is shared by members of the same cultural group, and it includes an internal sense and external perception of distinctiveness.
- It is influenced by specific conditions related to environmental and technical factors and to the availability of resources.
- It is dynamic and everchanging.

With the exception of the first characteristic, cultures related to aging, physical appearance, lifestyle, and other less frequently acknowledged aspects also share the above characteristics.

Cultural diversity has also been defined in a number of ways. Often, differences in skin color, religion, and geographic area are the only elements used to identify diversity, with ethnic minorities being considered the primary sources of cultural diversity. However, there are many other possible sources of cultural diversity. To truly acknowledge the cultural differences that may influence health care delivery, the nurse must confront bias and recognize the influence of his or her own culture and cultural heritage (Evans, 2007).

**Culturally competent nursing care** is defined as effective, individualized care that demonstrates respect for the dignity, personal rights, preferences, beliefs, and practices of the person receiving care, while acknowledging the biases of the caregiver and preventing these biases from interfering with the care provided. Culturally competent nursing care is a dynamic process that requires comprehensive knowledge of culture-specific information and an awareness of, and sensitivity to, the effect that culture has on the care situation. It requires that the nurse integrate cultural knowledge, awareness of his or her own cultural perspective, and the patient's cultural perspectives when preparing and implementing a plan of care (Giger & Davidhizar, 2008). Exploring one's own cultural beliefs and how they might conflict with the beliefs of the patients being cared for is a first step toward becoming culturally competent. Understanding the diversity within cultures, such as subcultures, is also important. In addition, culturally competent care involves facilitating patient access to culturally appropriate resources (Cutilli, 2006).

### Subcultures

Although culture is a universal phenomenon, it takes on specific and distinctive features for a particular group because it encompasses all of the knowledge, beliefs, customs, and skills acquired by the members of that group. When such groups function within a larger cultural group, they are referred to as subcultures.

The term **subculture** is used for relatively large groups of people who share characteristics that identify them as a distinct entity. Examples of American subcultures based on ethnicity (ie, subcultures with common traits such as physical characteristics, language, or ancestry) include African Americans, Hispanic/Latino Americans, Asian/Pacific Islanders, and Native Americans. Each of these subcultures may be further divided; for example, Native Americans consist of American Indians and Alaska Natives, who represent more than 500 federally and state-recognized tribes in addition to an unknown number of tribes that are not officially recognized.

Subcultures may also be based on religion (more than 1200 religions exist in the United States), occupation (eg, nurses, physicians, other members of the health care team), disability (eg, the deaf community), or illness. In addition, subcultures may be based on age (eg, infants, children, adolescents, adults, older adults), gender (eg, male, female), sexual orientation (eg, homosexual, bisexual, heterosexual), or geographic location (eg, Texan, Southern, Appalachian).

Nurses should also be sensitive to the interracial applications of cultural competence. Differences between individuals in subcultures in a designated group add to the challenge to plan and provide culturally competent care. Focusing on cultural "norms" while ignoring individual uniqueness could offend or anger patients and result in stereotyped care that is not truly culturally appropriate for that patient (Gray & Thomas, 2006). Nurses must refrain from culturally stereotyping patients. Instead, nurses should consult patients or significant others regarding personal values, beliefs, preferences, and cultural identification. This strategy is also applicable for members of nonethnic subcultures.

### Minorities

The term **minority** refers to a group of people whose physical or cultural characteristics differ from the majority of people in a society. At times, minorities may be singled out or isolated from others in society or treated in different or unequal ways. Although there are four generally identified minority groups—blacks/African Americans, Hispanics, Asian/Pacific Islanders, and Native Americans (Baldwin, 2004; Sullivan Commission, 2004)—the concept of "minority" varies widely and must be understood in a cultural context. For example, men may be considered a minority in the nursing profession, but they constitute a majority in the field of medicine. In addition, Caucasians may be in the minority in some communities in the United States, but they are currently the majority group in the country (although it has been projected that by the middle to late 21st century, Caucasians will no longer be in the majority in the United States). Because the term minority often connotes inferiority, members of many racial and ethnic groups object to being identified as minorities.

## *Transcultural Nursing*

Transcultural nursing, a term sometimes used interchangeably with cross-cultural, intercultural, or multicultural nursing, refers to research-focused practice that focuses on patient-centered, culturally competent nursing. Transcultural nursing incorporates the care (caring) values, beliefs, and practices of people and groups from a particular culture without imposing the nurse's cultural perspective on the patient. The underlying focus of transcultural nursing is to provide culture-specific and culture-universal care that promotes the well-being or health of individuals, families, groups, communities, and institutions (Giger & Davidhizar, 2008; Leininger, 2002). All people as well as the community or institution at large benefit when culturally competent care is provided. When the care is delivered beyond a nurse's national boundaries, the term *international* or *transnational nursing* is often used.

Although many nurses, anthropologists, and others have written about the cultural aspects of nursing and health care, Leininger (2002) developed a comprehensive research-based theory called Culture Care Diversity and Universality to promote culturally congruent nursing for people of different or similar cultures. This means promoting recovery from illness, preventing conditions that would limit the patient's health or well-being, or facilitating a peaceful death in ways that are culturally meaningful and appropriate. Nursing care needs to be tailored to fit the patient's cultural values, beliefs, and lifestyles.

Leininger's theory stresses the importance of providing culturally congruent nursing care (meaningful and beneficial health care tailored to fit the patient's cultural values) through culture care accommodation and culture care restructuring. *Culture care accommodation* refers to professional actions and decisions that nurses make on behalf of those in their care to help people of a designated culture achieve a beneficial or satisfying health outcome. *Culture care restructuring* or repatterning refers to professional actions and decisions that help patients reorder, change, or modify their lifestyles toward new, different, or more beneficial health care patterns (Fig. 8-1). At the same time, the patient's cultural values and beliefs are respected, and a better or healthier lifestyle results. Other terms and definitions that provide further insight into culture and health care include the following:

- *Acculturation:* the process by which members of a cultural group adapt to or take on the behaviors of another group
- *Cultural blindness:* the inability of people to recognize their own values, beliefs, and practices and those of others because of strong ethnocentric tendencies (the tendency to view one's own culture as superior to others)
- *Cultural imposition:* the tendency to impose one's cultural beliefs, values, and patterns of behavior on a person or people from a different culture
- *Cultural taboos:* activities or behaviors that are avoided, forbidden, or prohibited by a particular cultural group

### Culturally Competent Nursing Care

Culturally competent nursing care is the delivery of interventions that are congruent with a given culture. It involves a complex integration of attitudes, knowledge, and skills (including assessment, decision making, judgments, critical thinking, and evaluation) that enables nurses to provide culturally sensitive and appropriate care. Agency policies are important to achieve culturally competent care. Policies that promote culturally competent care establish flexible regulations pertaining to visitors (number, frequency, and length of visits), provide translation services for non–English-speaking patients, and train staff to provide care for patients with different cultural values (Purnell & Paulanka, 2005). Culturally competent policies are developed to promote an environment in which the traditional healing, spiritual, and religious practices of patients are respected and encouraged and to recognize the special dietary practices of patients from selected cultural groups.

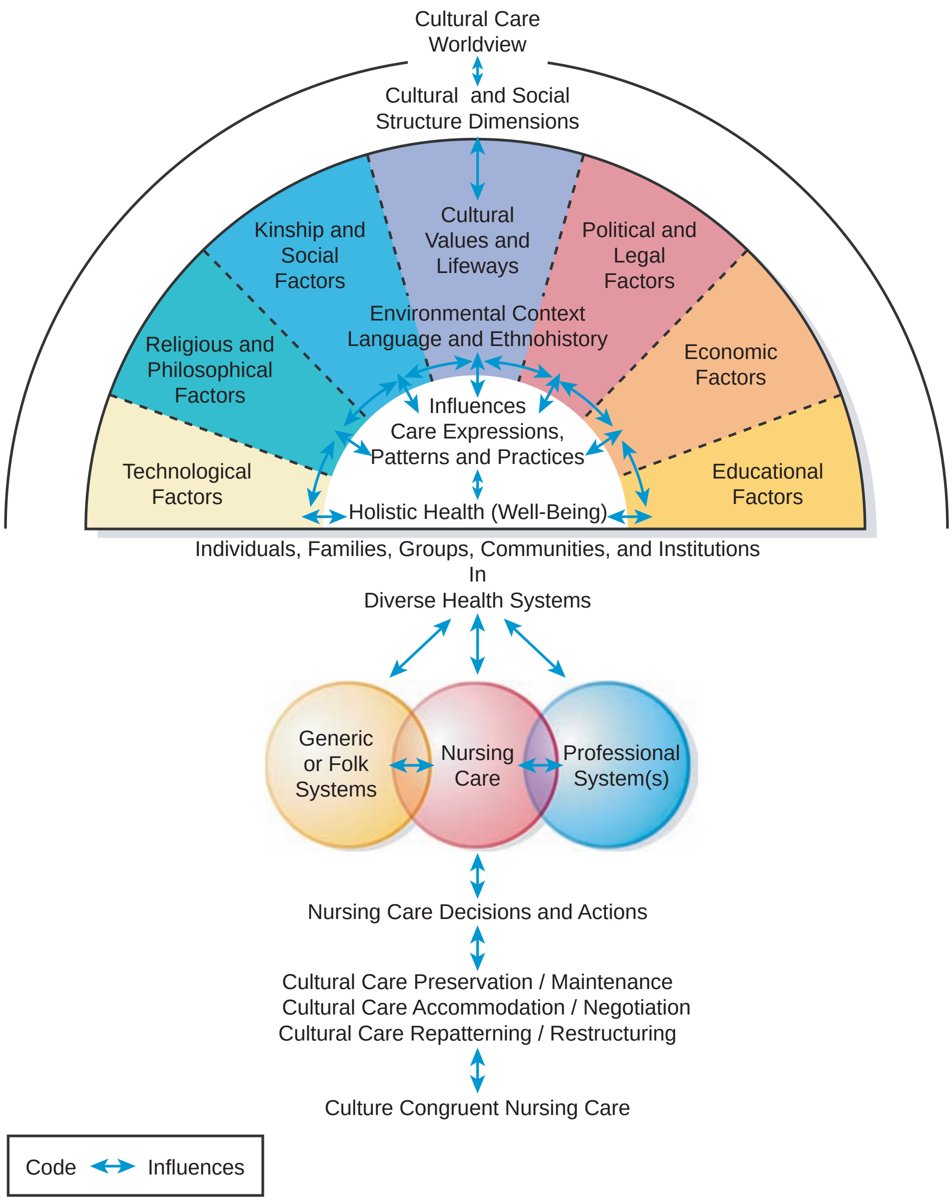



**Figure 8-1** Leininger's Sunrise Model depicts her theory of cultural care diversity and universality. From Leininger, M. M. (Ed.). (2001). *Culture care diversity and university: A theory of nursing.* New York: National League for Nursing Press.

Giger and Davidhizar (2008) created an assessment model to guide nurses in exploring cultural phenomena that might affect nursing care. They identified communication, space, time orientation, social organization, environmental control, and biologic variations as relevant phenomena. This model has been used in various patient care settings to provide data essential to the provision of culturally competent care.

## Cross-Cultural Communication

Establishment of an environment of culturally congruent care and respect begins with effective communication, which occurs not only through words, but also through body language and other cues, such as voice, tone, and loudness. Nurse–patient interactions, as well as communication among members of a multicultural health care team, are dependent on the ability to understand and be understood.

Approximately 150 different languages are spoken in the United States, with Spanish accounting for the largest percentage after English. Obviously, nurses cannot become fluent in all languages, but certain strategies for fostering effective cross-cultural communication are necessary when providing care for patients who are not fluent in English. Cultural needs should be considered when choosing an interpreter; for instance, fluency in varied dialects is beneficial (Cutilli, 2006). The interpreter's voice quality, pronunciation, use of silence, use of touch, and use of nonverbal communication should also be considered (Giger & Davidhizar, 2008). The interpreter should not be a member of the patient's family because that could violate the patient's right to privacy.

## Chart 8-1 • *Overcoming Language Barriers*

- Greet the patient using the last or complete name. Avoid being too casual or familiar. Point to yourself and say your name. Smile.
- Proceed in an unhurried manner. Pay attention to any effort by the patient or family to communicate.
- Speak in a low, moderate voice. Avoid talking loudly. Remember that there is a tendency to raise the volume and pitch of your voice when the listener appears not to understand. The listener may perceive that you are shouting or angry.
- Organize your thoughts. Repeat and summarize frequently. Use audiovisual aids when feasible.
- Use short, simple sentence structure and speak in the active voice.
- Use simple words, such as "pain" rather than "discomfort." Avoid medical jargon, idioms, and slang. Avoid using contractions, such as don't, can't, won't.
- Use nouns repeatedly instead of pronouns. *Example*: Do not say: "He has been taking his medicine, hasn't he?" Do say: "Does Juan take his medicine?"
- Pantomime words (use gestures) and simple actions while verbalizing them.
- Give instructions in the proper sequence. *Example*: Do not say: "Before you rinse the bottle, sterilize it." Do say: "First, wash the bottle. Second, rinse the bottle."
- Discuss one topic at a time, and avoid giving too much information in a single conversation. Avoid using conjunctions. *Example*: Do not say: "Are you cold and in pain?" Do say (while pantomiming/gesturing): "Are you cold?" "Are you in pain?"
- Talk directly to the patient rather than to the person who accompanied him or her.
- Validate whether the person understands by having him or her repeat instructions, demonstrate the procedure, or act out the meaning.
- Use any words you know in the person's language. This indicates that you are aware of and respect the patient's primary means of communicating.
- Try a third language. Many Indo-Chinese speak French. Europeans often know three or four languages. Try Latin words or phrases, if you are familiar with the language.
- Be aware of culturally based gender and age differences and diverse socioeconomic, educational, and tribal or regional differences when choosing an interpreter.
- Obtain phrase books from a library or bookstore, make or purchase flash cards, contact hospitals for a list of interpreters, and use both formal and informal networking to locate a suitable interpreter. Although they are costly, some telecommunication companies provide translation services.

During illness, patients of all ages tend to regress, and the regression often involves language skills. Chart 8-1 summarizes suggested strategies for overcoming language barriers. Nurses should also assess how well patients and families have understood what has been said. The following cues may signify a lack of effective communication:

- Efforts to change the subject: This could indicate that the listener does not understand what was said and is attempting to talk about something more familiar.
- Absence of questions: Paradoxically, this often means that the listener is not grasping the message and therefore has difficulty formulating questions to ask.
- Inappropriate laughter: A self-conscious giggle may signal poor comprehension and may be an attempt to disguise embarrassment.
- Nonverbal cues: A blank expression may signal poor understanding. However, among some Asian Americans, it may reflect a desire to avoid overt expression of emotion. Avoidance of eye contact may be a cultural expression of respect for the speaker in some Native Americans and Asian Americans.

## Culturally Mediated Characteristics

Nurses should be aware that patients act and behave in a variety of ways, in part because of the influence of culture on behaviors and attitudes. However, although certain attributes and attitudes are frequently associated with particular cultural groups, as described in the rest of this chapter, it is important to remember that not all people from the same cultural background share the same behaviors and views. Although nurses who fail to consider patients' cultural preferences and beliefs are considered insensitive and possibly indifferent, nurses who assume that all members of any one culture act and behave in the same way run the risk of stereotyping people. As previously stated, the best way to avoid stereotyping is to view each patient as an individual and to assess the patient's cultural preferences. A thorough culture assessment using a culture assessment tool or questionnaire (see later discussion) is very beneficial.

Many aspects of care may be influenced by the diverse cultural perspectives held by health care providers, patients, families, or significant others. One example is the issue of informed consent and full disclosure. In general, nurses may argue that patients have the right to full disclosure concerning their disease and prognosis and may believe that advocacy means working to provide that disclosure. However, family members in some cultural backgrounds may believe it is their responsibility to protect and spare the patient (their loved one) knowledge about a terminal illness. Similarly, patients may in fact not want to know about their condition and may expect their family members to "take the burden" of that knowledge and related decision making. Nurses should not decide that a family or patient is simply wrong or that a patient must know all of the details of his or her illness regardless of the patient's preference. Similar concerns may be noted when patients refuse pain medication or treatment because of cultural beliefs regarding pain or beliefs in divine intervention or faith healing.

Determining the most appropriate and ethical approach to patient care requires an exploration of the cultural aspects of these situations. Self-examination and recognition of one's own cultural bias and worldview, as discussed earlier, play a major part in helping the nurse resolve cultural and ethical conflicts. Nurses must promote open dialogue

and work with patients, families, physicians, and other health care providers to reach the culturally appropriate solution for the individual patient.

## Space and Distance

People tend to regard the space in their immediate vicinity as an extension of themselves. The amount of space they need between themselves and others to feel comfortable is a culturally determined phenomenon.

Because nurses and patients usually are not consciously aware of their personal space requirements, they frequently have difficulty understanding different behaviors in this regard. For example, one patient may perceive the nurse sitting close to him or her as an expression of warmth and care; another patient may perceive the nurse's act as a threatening invasion of personal space. Research reveals that people from the United States, Canada, and Great Britain require the most personal space between themselves and others, whereas those from Latin America, Japan, and the Middle East need the least amount of space and feel comfortable standing close to others (Giger & Davidhizar, 2008).

If the patient appears to position himself or herself too close or too far away, the nurse should consider cultural preferences for space and distance. Ideally, the patient should be permitted to assume a position that is comfortable to him or her in terms of personal space and distance. The nurse should be aware that the wheelchair of a person with a disability is considered an extension of the person; therefore, the nurse should ask the person's permission before moving or touching the wheelchair. Because a significant amount of communication during nursing care requires close physical contact, the nurse should be aware of these important cultural differences and consider them when providing care (Smith-Temple & Johnson, 2006).

## Eye Contact

Eye contact is also a culturally determined behavior. Although most nurses have been taught to maintain eye contact when speaking with patients, some people from certain cultural backgrounds may interpret this behavior differently. For example, some Asians, Native Americans, Indo-Chinese, Arabs, and Appalachians may consider direct eye contact impolite or aggressive, and they may avert their own eyes when talking with nurses and others whom they perceive to be in positions of authority. Some Native Americans stare at the floor during conversations, a cultural behavior conveying respect and indicating that the listener is paying close attention to the speaker. Some Hispanic patients maintain downcast eyes as a sign of culturally appropriate deferential behavior toward others on the basis of age, gender, social position, economic status, and position of authority (Giger & Davidhizar, 2008). The nurse who is aware that eye contact may be culturally determined can better understand the patient's behavior and provide an atmosphere in which the patient can feel comfortable.

## Time

Attitudes about time vary widely among cultures and can be a barrier to effective communication between nurses and patients. Views about punctuality and the use of time are culturally determined, as is the concept of waiting. Symbols of time, such as watches, sunrises, and sunsets, represent methods for measuring the duration and passage of time (Giger & Davidhizar, 2008).

For most health care providers, time and promptness are extremely important. For example, nurses frequently expect patients to arrive at an exact time for an appointment, although patients are often kept waiting by health care providers who are running late. Health care providers are likely to function according to an appointment system in which there are short intervals of perhaps only a few minutes. However, for patients from some cultures, time is a relative phenomenon, with little attention paid to the exact hour or minute. For example, some Hispanic people consider time in a wider frame of reference and make the primary distinction between day and night. Time may also be determined according to traditional times for meals, sleep, and other activities or events. For people from some cultures, the present is of the greatest importance, and time is viewed in broad ranges rather than in terms of a fixed hour. Being flexible in regard to schedules is the best way to accommodate these differences.

Value differences also may influence a person's sense of priority when it comes to time. For example, responding to a family matter may be more important to a patient than meeting a scheduled health care appointment. Allowing for these different views is essential in maintaining an effective nurse–patient relationship. Scolding or acting annoyed at patients for being late undermines their confidence and may result in further missed appointments or indifference to health care suggestions.

## Touch

The meaning people associate with touching is culturally determined to a great degree. In some cultures (eg, Hispanic, Arab), male health care providers may be prohibited from touching or examining certain parts of the female body. Similarly, it may be inappropriate for females to care for males. Among many Asian Americans, it is impolite to touch a person's head because the spirit is believed to reside there. Therefore, assessment of the head or evaluation of a head injury requires permission of the patient or a family member, if the patient is not able to give permission.

The patient's culturally defined sense of modesty must also be considered when providing nursing care. For example, some Jewish and Muslim women believe that modesty requires covering their head, arms, and legs with clothing.

## Observance of Holidays

People from all cultures observe certain civil and religious holidays. Nurses should familiarize themselves with major observances for members of the cultural groups they serve. Information about these observances is available from various sources, including religious organizations, hospital chaplains, and patients themselves. Routine health appointments, diagnostic tests, surgery, and other major procedures should be scheduled to avoid observances patients identify as significant. If not contraindicated, efforts should also be made to accommodate patients and families or significant others who wish to perform cultural and religious rituals in the health care setting.

## Diet

The cultural meanings associated with food vary widely but usually include one or more of the following: relief of hunger; promotion of health and healing; prevention of disease or illness; expression of caring for another; promotion of interpersonal closeness among individual people, families, groups, communities, or nations; and promotion of kinship and family alliances. Food may also be associated with strengthening of social ties; celebration of life events (eg, birthdays, marriages, funerals); expression of gratitude or appreciation; recognition of achievement or accomplishment; validation of social, cultural, or religious ceremonial functions; facilitation of business negotiations; and expression of affluence, wealth, or social status.

Culture determines which foods are served and when they are served, the number and frequency of meals, who eats with whom, and who receives the choicest portions. Culture also determines how foods are prepared and served, how they are eaten (with chopsticks, hands, or fork, knife, and spoon), and where people shop (eg, ethnic grocery stores, specialty food markets). Culture also determines the impact of excess weight and obesity on self-esteem and social standing. In some cultures, physical bulk is viewed as a sign of affluence and health (eg, a healthy baby is a chubby baby).

Religious practices may include fasting (eg, Mormons, Catholics, Buddhists, Jews, Muslims) and abstaining from selected foods at particular times (eg, Catholics abstain from meat on Ash Wednesday and on Fridays during Lent). Practices may also include the ritualistic use of food and beverages (eg, Passover dinner, consumption of bread and wine during religious ceremonies). Chart 8-2 summarizes some dietary practices of selected religious groups.

Many groups tend to feast, often in the company of family and friends, on selected holidays. For example, many Christians eat large dinners on Christmas and Easter and consume other traditional high-calorie, high-fat foods, such as seasonal cookies, pastries, and candies. These culturally based dietary practices are especially significant in the care of patients with diabetes, hypertension, gastrointestinal disorders, obesity, and other conditions in which diet plays a key role in the treatment and health maintenance regimen.

## Biologic Variations

Along with psychosocial adaptations, nurses must also consider the physiologic impact of culture on patients' response to treatment, particularly medications. Data have been collected for many years regarding differences in the effect some medications have on people of diverse ethnic or cultural origins. Genetic predispositions to different rates of metabolism cause some patients to be prone to adverse reactions to the standard dose of a medication, whereas other patients are likely to experience a greatly reduced benefit from the standard dose of the medication. For example, an antihypertensive agent may work well for a Caucasian man within a 4-week time span but may take much longer to work or not work at all for an African American man with hypertension. General polymorphism—biologic variation in response to medications resulting from patient age, gender, size, and body composition—has long been acknowledged by the health care community. Nurses must be aware that ethnicity and related factors such as values and beliefs regarding the use of herbal supplements, dietary intake, and genetic factors can affect the effectiveness of treatment and compliance with the treatment regimen (Giger & Davidhizar, 2008).

## Complementary and Alternative Therapies

Interventions for alterations in health and wellness vary among cultures. Interventions most commonly used in the United States have been labeled as *conventional medicine* by

### Chart 8-2 • *Prohibited Foods and Beverages of Selected Religious Groups*

**Hinduism**

All meats
Animal shortenings

**Islam**

Pork
Alcoholic products and beverages (including extracts, such as vanilla and lemon)
Animal shortenings
Gelatin made with pork, marshmallow, and other confections made with gelatin
*Note*: *Halal* food is lawful food that may be consumed according to tenets of the Koran whereas *Haram* is food that is unlawful to consume

**Judaism**

Pork
Predatory fowl
Shellfish and scavenger fish (eg, shrimp, crab, lobster, escargot, catfish). Fish with fins and scales are permissible.
Mixing milk and meat dishes at same meal
Blood by ingestion (eg, blood sausage, raw meat).
*Note*: Packaged foods will contain labels identifying kosher ("properly preserved" or "fitting") and pareve (made without meat or milk) items.

**Mormonism (Church of Jesus Christ of Latter-Day Saints)**

Alcohol
Beverages containing caffeine stimulants (coffee, tea, colas, and selected carbonated soft drinks)

**Seventh-Day Adventism**

Alcohol
Beverages containing caffeine stimulants (coffee, tea, colas, and selected carbonated soft drinks)
Pork
Certain seafood, including shellfish
Fermented beverages
*Note*: Optional vegetarianism is encouraged.

the National Institutes of Health (National Center for Complementary and Alternative Medicine [NCCAM], 2007). Other names for conventional medicine are allopathy, Western medicine, regular medicine, mainstream medicine, and biomedicine. Alternative therapy used to supplement conventional medicine may be referred to as *complementary therapy*. Interest in interventions that are not an integral part of conventional medicine prompted the National Institutes of Health to create the Office of Alternative Medicine and then to establish NCCAM.

According to a nationwide survey, 36% of adults in the United States use some form of complementary and alternative medicine. This percentage increases to 75% when prayer specifically for health reasons is included in the definition. Complementary and alternative interventions are classified into five main categories: alternative medical systems, mind–body interventions, biologically based therapies, manipulative and body-based methods, and energy therapies (NCCAM, 2007):

- *Alternative medical systems* are defined as complete systems of theory and practice that are different from conventional medicine. Some examples are traditional Eastern medicine (including acupuncture, herbal medicine, Oriental massage, and Qi gong); India's traditional medicine, Ayurveda (including diet, exercise, meditation, herbal medicine, massage, exposure to sunlight, and controlled breathing to restore harmony of a person's body, mind, and spirit); homeopathic medicine (including use of herbal medicine and minerals); and naturopathic medicine (including diet, acupuncture, herbal medicine, hydrotherapy, spinal and soft-tissue manipulation, electrical currents, ultrasound and light therapy, therapeutic counseling, and pharmacology).
- *Mind–body interventions* are defined as techniques to facilitate the mind's ability to affect symptoms and bodily functions. Some examples are meditation, dance, music, art therapy, prayer, and mental healing.
- *Biologically based therapies* are defined as natural and biologically based practices, interventions, and products. Some examples are herbal therapies (a plant or plant part that produces and contains chemical substances that act on the body), special diet therapies (such as those of Drs. Atkins, Ornish, and Pritikin), orthomolecular therapies (magnesium, melatonin, megadoses of vitamins), and biologic therapies (shark cartilage, bee pollen).
- *Manipulative and body-based methods* are defined as interventions based on body movement. Some examples are chiropractic (primarily manipulation of the spine), osteopathic manipulation, massage therapy (soft-tissue manipulation), and reflexology.
- *Energy therapies* are defined as interventions that focus on energy fields within the body (biofields) or externally (electromagnetic fields). Some examples are Qi gong, Reiki, therapeutic touch, pulsed electromagnetic fields, magnetic fields, alternating electrical current, and direct electrical current.

Patients may choose to seek an alternative to conventional medical or surgical therapies. Many of these alternative therapies are becoming widely accepted as feasible treatment options. Therapies such as acupuncture and herbal treatments may be recommended by physicians to address aspects of a condition that are unresponsive to conventional medical treatment or to minimize the side effects associated with conventional medical therapy. Physicians and advanced practice nurses may work in collaboration with herbalists or with spiritualists or shamans to provide a comprehensive treatment plan. Out of respect for the way of life and beliefs of patients from different cultures, it is often necessary that healers and health care providers respect the strengths of each approach (NCCAM, 2007).

Complementary therapy is becoming more common as health care consumers learn what information is available in printed media and on the Internet. As patients become more informed, they are more likely to participate in a variety of therapies in conjunction with their conventional medical treatments (Hart, 2007). Nurses must assess all patients for use of complementary therapies, be alert to the danger of herb–drug interactions or conflicting treatments, and be prepared to provide information to patients about treatments that may be harmful. However, nurses must be accepting of patients' beliefs and right to control their own care. As patient advocates, nurses facilitate the integration of conventional medical, complementary, and alternative therapies.

## Causes of Illness

People may view illness differently. Three major views, or paradigms, attempt to explain the causes of disease and illness: the biomedical or scientific view, the naturalistic or holistic perspective, and the magico-religious view.

### Biomedical or Scientific

The biomedical or scientific worldview prevails in most health care settings and is embraced by most nurses and other health care providers. The basic assumptions underlying the biomedical perspective are that all events in life have a cause and effect, that the human body functions much like a machine, and that all of reality can be observed and measured (eg, blood pressures, partial pressure of arterial oxygen [$PaO_2$] levels, intelligence tests). One example of the biomedical or scientific view is the bacterial or viral explanation of communicable diseases.

### Naturalistic or Holistic

The naturalistic or holistic perspective is another viewpoint that explains the cause of illness and is commonly embraced by many Native Americans, Asians, and others. According to this view, the forces of nature must be kept in natural balance or harmony.

One example of a naturalistic belief, held by many Asian groups, is the yin/yang theory, in which health is believed to exist when all aspects of a person are in perfect balance or harmony. Rooted in the ancient Chinese philosophy of Taoism (which translates as "The Way"), the yin/yang theory proposes that all organisms and objects in the universe consist of yin and yang energy. The seat of the energy forces is within the autonomic nervous system, where balance between the opposing forces is maintained during health. Yin

energy represents the female and negative forces, such as emptiness, darkness, and cold, whereas the yang forces are male and positive, emitting warmth and fullness. Foods are classified as cold (yin) or hot (yang) in this theory and are transformed into yin and yang energy when metabolized by the body. Cold foods are eaten when a person has a hot illness (eg, fever, rash, sore throat, ulcer, infection), and hot foods are eaten when a person has a cold illness (eg, cancer, headache, stomach cramps, "cold"). The yin/yang theory is the basis for Eastern or Chinese medicine and is embraced by some Asian Americans.

Many Hispanic, African American, and Arab groups also embrace the hot/cold theory of health and illness. The four humors of the body—blood, phlegm, black bile, and yellow bile—regulate basic bodily functions and are described in terms of temperature and moisture. The treatment of disease consists of adding or subtracting cold, heat, dryness, or wetness to restore the balance of these humors. Beverages, foods, herbs, medicines, and diseases are classified as hot or cold according to their perceived effects on the body, not their physical characteristics. According to the hot/cold theory, the person as a whole, not just a particular ailment, is significant. People who embrace the hot/cold theory maintain that health consists of a positive state of total well-being, including physical, psychological, spiritual, and social aspects of the person.

According to the naturalistic worldview, breaking the laws of nature creates imbalances, chaos, and disease. People who embrace the naturalistic paradigm use metaphors such as "the healing power of nature." For example, from the perspective of many Chinese people, illness is viewed not as an intruding agent but as a part of life's rhythmic course and an outward sign of disharmony within.

### Magico-Religious

The third major way in which people view the world and explain the causes of illness is the magico-religious worldview. This view's basic premise is that the world is an arena in which supernatural forces dominate, and that the fate of the world and those in it depends on the action of supernatural forces for good or evil. Examples of magical causes of illness include belief in voodoo or witchcraft among some African Americans and people from Caribbean countries. Faith healing is based on religious beliefs and is most prevalent among selected Christian religions, including Christian Science, whereas various healing rituals may be found in many other religions, such as Roman Catholicism and Mormonism (Church of Jesus Christ of Latter-Day Saints).

Of course, it is possible to hold a combination of worldviews, and many patients offer more than one explanation for the cause of their illness. As a profession, nursing largely embraces the scientific or biomedical worldview, but some aspects of holism have begun to gain popularity, including a wide variety of techniques for managing chronic pain, such as hypnosis, therapeutic touch, and biofeedback. Belief in spiritual power is also held by many nurses who credit supernatural forces with various unexplained phenomena related to patients' health and illness states. Regardless of the view held and whether the nurse agrees with the patient's beliefs in this regard, it is important to be aware of how the person views illness and health and to work within this framework to promote patient care and well-being.

## Folk Healers

People of some cultures believe in folk or indigenous healers. For example, nurses may find that some Hispanic patients may seek help from a *curandero* or *curandera, espiritualista* (spiritualist), *yerbo* (herbalist), or *sabador* (healer who manipulates bones and muscles). Some African American patients may seek assistance from a *hougan* (voodoo priest or priestess), spiritualist, root doctor (usually a woman who uses magic rituals to treat diseases), or "old lady" (an older woman who has successfully raised a family and who specializes in child care and folk remedies). Native American patients may seek assistance from a shaman or medicine man or woman. Asian patients may mention that they have visited herbalists, acupuncturists, or bone setters. Several cultures have their own healers, most of whom speak the native tongue of that culture, make house calls, and charge significantly less than healers practicing in the conventional medical health care system.

People seeking complementary and alternative therapies have expanded the practices of folk healers beyond their traditional populations, so the nurse should ask the patient about use of folk healers regardless of the patient's cultural background. It is best not to disregard the patient's belief in folk healers or try to undermine trust in the healers. To do so may alienate the patient and drive him or her away from receiving the prescribed care. Nurses should make an effort to accommodate the patient's beliefs while also advocating the treatment proposed by health science.

## Cultural Assessment

**Cultural nursing assessment** refers to a systematic appraisal or examination of individuals, families, groups, and communities in terms of their cultural beliefs, values, and practices. The purpose of such an assessment is to provide culturally competent care (Giger & Davidhizar, 2008). In an effort to establish a database for determining a patient's cultural background, nurses have developed cultural assessment tools or modified existing assessment tools (Leininger, 2002) to ensure that transcultural considerations are included in the plan of care. Giger and Davidhizar's model has been used to design nursing care from health promotion to nursing skills activities (Giger & Davidhizar, 2008; Smith-Temple & Johnson, 2006). The information presented in this chapter and the general guidelines presented in Chart 8-3 can be used to direct nursing assessment of culture and its influence on a patient's health beliefs and practices.

## Additional Cultural Considerations: Know Thyself

Because the nurse–patient interaction is the focal point of nursing, nurses should consider their own cultural orientation when conducting assessments of patients and their

**Chart 8-3 • *Assessing for Patients' Cultural Beliefs***

- What is the patient's country of origin? How long has the patient lived in this country? What is the patient's primary language and literacy level?
- What is the patient's ethnic background? Does he or she identify strongly with others from the same cultural background?
- What is the patient's religion, and how important is it to his or her daily life?
- Does the patient participate in cultural activities such as dressing in traditional clothing and observing traditional holidays and festivals?
- Are there any food preferences or restrictions?
- What are the patient's communication styles? Is eye contact avoided? How much physical distance is maintained? Is the patient open and verbal about symptoms?
- Who is the head of the family, and is he or she involved in decision making about the patient?
- What does the patient do to maintain his or her health?
- What does the patient think caused the current problem?
- Has the advice of traditional healers been sought?
- Have complementary and alternative therapies been used?
- What kind of treatment does the patient think will help? What are the most important results he or she hopes to get from this treatment?
- Are there cultural or religious rituals related to health, sickness, or death that the patient observes?

families and friends. The following guidelines may prove useful to nurses who want to provide culturally appropriate care:

- Know your own cultural attitudes, values, beliefs, and practices.
- Regardless of "good intentions," recognize that everyone has cultural "baggage" that ultimately results in ethnocentrism.
- In general, it is easier to understand those whose cultural heritage is similar to your own, while viewing those who are unlike you as strange and different.
- Maintain a broad, open attitude. Expect the unexpected. Enjoy surprises.
- Avoid seeing all people as alike; that is, avoid cultural stereotypes, such as "all Chinese like rice" or "all Italians eat spaghetti."
- Try to understand the reasons for any behavior by discussing commonalities and differences with representative of ethnic groups different from your own.
- If a patient has said or done something that you do not understand, ask for clarification. Be a good listener. Most patients will respond positively to questions that arise from a genuine concern for and interest in them.
- If at all possible, speak the patient's language (even simple greetings and social courtesies are appreciated). Avoid feigning an accent or using words that are ordinarily not part of your vocabulary.
- Be yourself. There are no right or wrong ways to learn about cultural diversity.

## Health Disparities

Health disparities—higher rates of morbidity, mortality, and burden of disease in a population or community than found in the overall population—are significant in ethnic and racial minorities. Key health indicators in the United States reveal a significant gap in health status between the overall American population and people of specific ethnic backgrounds (Sullivan Commission, 2004). Ethnic and racial minorities are disproportionately burdened with cancer, heart disease, diabetes, human immunodeficiency virus (HIV) infection/acquired immunodeficiency syndrome (AIDS), and other conditions. They receive a lower quality of health care than nonminorities and are at a greater risk for declining health. Health disparities also occur with women, gays and lesbians, and people with disabilities. Many reasons are cited for these disparities, including low socioeconomic status; health behaviors; limited access to health care because of poverty or disability; environmental factors; and direct and indirect manifestations of discrimination. Other causes include lack of health insurance; overdependence on publicly funded facilities; and barriers to health care such as insufficient transportation, geographic location (not enough providers in an area), cost of services, and the low numbers of minority health care providers (Baldwin, 2004; Cutilli, 2006; Institute of Medicine, 2003; Sullivan Commission, 2004).

## The Future of Transcultural Nursing Care

By the middle of the 21st century, half of all Americans will trace their ancestry to Africa, Asia, the Pacific Islands, or the Hispanic or Arab worlds, rather than to Europe (Cutilli, 2006). As indicated previously, the concept of culturally competent care applies to health care institutions, which must develop culturally sensitive policies and provide a climate that fosters the provision of culturally competent care by nurses. Nurses must learn to acknowledge and adapt to diversity among their colleagues in the workplace (Evans, 2007).

As the population becomes more culturally diverse, efforts to increase the number of ethnic minority nurses must continue and accelerate (Sullivan Commission, 2004). Today more than 87% of all nurses are Caucasian. Progress toward increasing the percentage of culturally diverse nurses has been significantly slower than the increasing percentage of ethnic minorities in the United States. Greater efforts must be made to facilitate the recruitment and program completion of nursing students who are members of ethnic minorities. In addition, educational institutions must prepare nurses to deliver culturally competent care and must work to increase the number of ethnic minority providers in the nursing workforce. Nursing programs are exploring creative ways to promote cultural competence and humanistic care in nursing students, including offering multicultural health studies in their curricula (Kleiman, 2007; Underwood, 2006).

Cultural diversity remains one of the foremost issues in health care today. Nurses are expected to provide culturally competent care for patients. Nurses must work effectively with the increasing number of patients, other nurses, and

other health care team members whose ancestry reflects the multicultural complexion of contemporary society.

## CRITICAL THINKING EXERCISES

EBP **1** You are assigned to care for a hospitalized patient whose cultural background is Hispanic. You know little about this culture. What is the evidence base for use of a cultural assessment tool to ensure that cultural considerations are included in the nursing plan of care? What is the strength of that evidence? What resources are available to you to promote culturally competent care? Explain why it is important to examine your own feelings about each patient's cultural beliefs and practices.

**2** An 84-year-old man who is originally from Vietnam is hospitalized in the neurosurgical intensive care unit with a cerebrovascular accident (CVA, stroke). His immediate family members insist on staying with him around the clock, and many extended family members visit each day, staying late into the night. His prognosis is poor, and when his attending physician discusses discontinuing his life support therapy with his family members who are his legal next of kin, they acquiesce but request that all family members be allowed to remain present to witness his death. Policies in the intensive care unit do not permit more than three family members to be with a patient at any given time. The staff members complain that they have difficulty completing their tasks with other critically ill patients because of the distractions they face from the multiple family members visiting this man. How can you help the nursing staff explore the meaning of the family's behavior and understand their own negative feelings about this behavior? Devise a strategy that will help resolve this situation.

**3** As a diabetes educator, you are consulted about providing initial teaching services for a young Arab woman who is admitted to the hospital with a new diagnosis of diabetes. Her husband insists that he must be present for any teaching you perform. During your initial meeting with the patient and her husband, you note that the patient does not make eye contact and defers all questions you pose to her husband. You wish to initiate her diabetes teaching and begin a teaching plan for her. What aspects of the patient's and family's background would you want to further assess to determine the need for continuing assessment and care? Identify culturally sensitive methods you might use to ensure that the patient receives the diabetes teaching she requires. What resources might you use to assist you in providing the teaching?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing

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## RESOURCES

### *Organizations*

Asian & Pacific Islander Nurses Association, www.aapina.org/

Council on Nursing and Anthropology, www.conaa.net/eng/index.html

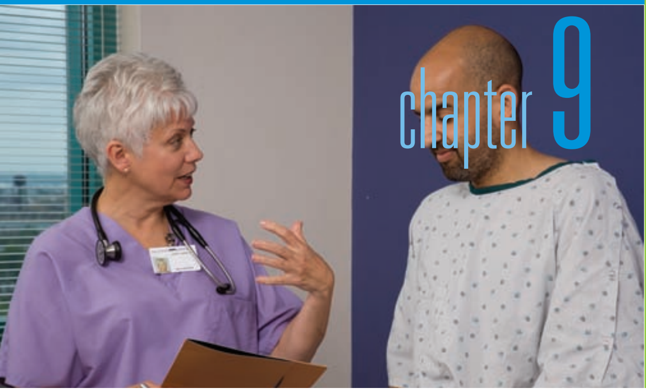
Language Line Services, www.languageline.com/ (Provides written and oral translation in 140 languages.)

National Black Nurses Association, www.nbna.org

National Institutes of Health, National Center for Complementary and Alternative Medicine, nccam.nih.gov

Office of Minority Health, www.omhrc.gov

Transcultural Nursing Society, www.tcns.org




# Genetics and Genomics Perspectives in Nursing

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the role of the nurse in integrating genetics and genomics in nursing care.
2. Conduct a genetics- and genomics-based assessment.
3. Identify the common patterns of inheritance of genetic disorders.
4. Identify ethical issues in nursing related to genetics and genomics.

## GLOSSARY

**carrier:** person who is heterozygous; possessing two different alleles of a gene pair

**chromosome:** microscopic structures in the cell nucleus that contain genetic information and are constant in number in a species (eg, humans have 46 chromosomes)

**deoxyribonucleic acid (DNA):** the primary genetic material in humans consisting of nitrogenous bases, a sugar group, and phosphate combined into a double helix

**dominant:** a genetic trait that is normally expressed when a person has a gene mutation on one of a pair of chromosomes and the "normal" form of the gene is on the other chromosome

**genetics:** the scientific study of heredity; how specific traits or predispositions are transmitted from parents to offspring

**genome:** the total genetic complement of an individual genotype

**genomics:** the study of the human genome, including gene sequencing, mapping, and function

**genotype:** the genes and the variations therein that a person inherits from his or her parents

**Human Genome Project:** an international research effort aimed at identifying and characterizing the order of every base in the human genome

**mutation:** a heritable alteration in the genetic material

**nondisjunction:** the failure of a chromosome pair to separate appropriately during meiosis, resulting in abnormal chromosome numbers in reproductive cells (gametes)

**pedigree:** a diagrammatic representation of a family history

**phenotype:** a person's entire physical, biochemical, and physiologic makeup, as determined by the person's genotype and environmental factors

**predisposition testing:** testing that is used to determine the likelihood that a healthy person with or without a family history of a condition will develop a disorder

**prenatal screening:** testing that is used to identify whether a fetus is at risk for a birth defect such as Down syndrome or spina bifida (eg, multiple marker maternal serum screening in pregnancy)

**presymptomatic testing:** genetic testing that is used to determine whether persons with a family history of a disorder, but no current symptoms, have the gene mutation (eg, testing for Huntington disease)

**recessive:** a genetic trait that is expressed only when a person has two copies of a mutant autosomal gene or a single copy of a mutant X-linked gene in the absence of another X chromosome

**variable expression:** variation in the degree to which a trait is manifested; clinical severity

**X-linked:** located on the X chromosome

The **Human Genome Project** has ushered in a new type of medicine, personalized medicine that includes the influence of both genetic and genomic factors in disease causation, response to treatment, and health outcomes (Feetham, Thomson & Hinshaw, 2005). The term **genetics** applies to single genes and their impact on relatively rare single gene disorders (American Nurses Association [ANA], 2006). The term **genomics** involves "all of the genes in the human genome together, including their interactions with each other, the environment, and the influence of other psychosocial and cultural factors" (ANA, 2006, p. 9). Personalized medicine aims to tailor health care at the individual level by using a patient's genomic information, often called genetic makeup or genomic profile. Identification of the genetic and genomic factors associated with disease, including gene–gene function and gene–environment interactions, contributes to the development of more effective therapies customized to that particular patient's genetic makeup and the genomic profile of his or her disease. Genetic and genomic profiles allow health care providers to prescribe more specific and effective treatment for each patient; to identify and follow individuals at high risk for disease; and to avoid adverse drug reactions (National Human Genome Research Institute, 2007a). New genomic-based strategies for disease detection, management, and treatment are being utilized, making personalized medicine a reality (Table 9-1).

To meet the challenges of personalized medicine, nurses must understand the new technologies and treatments of genetic-based and genomic-based health care. Nurses also must recognize that they are a vital link between the patient and health care services; patients often turn to nurses first with questions about a family history of risk factors, genetics information, and genetic tests and interpretations. The incorporation of genetics and genomics into nursing means including genetics and genomics in health assessments, planning, and interventions that support identification of and response to the changing genetics-related health needs of people (ANA, 2006). This chapter offers a foundation for the clinical application of genetic and genomic principles in medical and surgical nursing, outlines the nurse's role in genetic counseling and evaluation, addresses important ethical issues, and provides related information for nurses and patients. The foundation for this information is based on the ANA document, *Essential Nursing Competencies and Curricula Guidelines for Genetics and Genomics* (ANA, 2006).

## Genomic Framework for Nursing Practice

The unique contribution of nursing to genomic medicine is its holistic perspective that takes into account each person's intellectual, physical, spiritual, social, cultural, biopsychologic, ethical, and aesthetic experiences. Because genomics addresses all of the genes of a given individual's human **genome** working together as a whole, genomics expands nursing's holistic view. Genetics and genomics are the basis of normal and pathophysiologic development, human health and disease, and health outcomes. Knowledge and interpretation of genetic and genomic information, gene-based testing, diagnosis, and treatment broaden the holistic view of nursing. Such expertise in genetics and genomics is basic to nursing practice and its holistic approach to patient care (ANA, 2006).

The *Essential Nursing Competencies and Curricula Guidelines for Genetics and Genomics* provides a framework for integrating genetics and genomics into nursing practice (Chart 9-1). This document includes a philosophy of care that recognizes when genetic and genomic factors play a role or could play a role in a person's health. This means assessing predictive genetic and genomic factors using family history and the results of genetic tests effectively, informing patients about genetics and genomic concepts, understanding the personal and societal impact of genetics and genomic information, and valuing the privacy and confidentiality of genetics and genomic information (ANA, 2006).

A person's response to genetics and genomics information, genetic testing, or genetics-related conditions may be either empowering or disabling. Genetic and genomic information may stigmatize people if it affects how they view themselves or how others view them. Nurses help individuals and families learn how genetic traits and conditions are passed on within families as well as how genetic and environmental factors influence health and disease (ANA, 2006). Nurses facilitate communication among family members, the health care system, and community resources, and they offer valuable support to patients and families. All nurses should be able to recognize when a patient is asking a question related to genetic or genomic information and should know how to obtain genetics information by gathering family and health histories and conducting physical and developmental assessments. This allows nurses to provide

**Table 9-1 TRANSITION FROM THE MEDICAL ERA TO THE GENOMIC ERA OF PERSONALIZED MEDICINE**

| | Medical Era | Genomic Era of Personalized Medicine |
|---|---|---|
| Defining characteristics | • Consider single genes<br>• Wait for disease symptoms to appear<br>• Treat symptoms of presenting disease<br>• Use trial-and-error approach to treatment | • Consider interaction of genes with one another and the environment<br>• Identify genetic predisposition and optimize risk reduction to prevent disease<br>• Treat underlying genetic cause of disease<br>• Use personalized approach tailored to the genetic/genomic profile of the individual and the disease |

**Chart 9-1 • *Essential Nursing Competencies for Genetics and Genomics***

**Professional Responsibilities**

1. Recognition of attitudes and beliefs related to genetic and genomic science
2. Advocacy for genetic and genomic services
3. Incorporation of genetic and genomic technologies and information into practice
4. Demonstration of personalizing genetic and genomic information and services
5. Provide autonomous, informed genetic-related and genomic-related decision making

**Professional Practice**

1. Integrate and apply genetic and genomic knowledge to nursing assessment
2. Identify clients who may benefit from specific genetic and genomic resources, services, or technologies
3. Facilitate referrals for genetic and genomic services
4. Provide education, care, and support related to the interpretation of genetic or genomic tests, services, interventions, or treatments

American Nurses Association. (2006). *Essential nursing competencies and curricula guidelines for genetics and genomics.* Washington, DC: Author.

appropriate genetics resources and support to patients and families (ANA, 2006; Jenkins & Lea, 2005).

For example, when nurses assess patients' cardiovascular risk, they can expand their assessment to include information about family history of hypertension, hypercholesterolemia, and clotting disorders. Knowledge that genes are involved in the control of lipid metabolism, insulin resistance, blood pressure regulation, clotting factors, and vascular lining function helps individualize care based on the patient's genetic and genomic risk profile (Moss, Ryan, Oakes, et al., 2005).

Essential to a genetic and genomic framework in nursing is the awareness of one's attitudes, experience, and assumptions about genetics and genomics concepts and how these are manifested in one's own practice (ANA, 2006). To develop awareness of these attitudes, experiences, and assumptions, the nurse must examine his or her own:

- Beliefs or values about health as well as family, religious, or cultural beliefs about the cause of illness; and how one's values or biases affect understanding of genetic conditions
- Philosophical, theologic, cultural, and ethical perspectives related to health and how these perspectives influence one's use of genetics information or services
- Level of expertise about genetics and genomics
- Experiences with birth defects, chronic illnesses, and genetic conditions along with one's view of such conditions as disabling or empowering
- Attitudes about the right to access and other rights of individuals with genetic disorders
- View and assumptions about DNA and beliefs about the value of information about one's risk for genetic disorders
- Beliefs about reproductive options
- View of genetic testing and engineering
- Approach to patients with disabilities

## Integrating Genetic and Genomic Knowledge

Scientific developments and advances in technology have increased the understanding of genetics, resulting in better understanding of relatively rare diseases such as phenylketonuria (PKU) or hemophilia that are related to mutations of a single gene inherited in families. Scientists are able to characterize inherited metabolic variations that interact over time and lead to common diseases such as cancer, heart disease, and dementia. The transition from genetics to genomics has increased understanding of how multiple genes act and control biologic processes. Most health conditions are now believed to be the result of a combination of genetic and environmental influences (Guttmacher & Collins, 2004).

### Genes and Their Role in Human Variation

Genes are central components of human health and disease. The Human Genome Project has shown how basic human genetics is to human development, health, and disease. Knowledge that specific genes are associated with specific genetic conditions makes diagnosis possible, even in the unborn. Many common conditions have genetic causes and many more associations between genetics, health, and disease are likely to be identified. Genomics is the study of the interaction of genes with other genes and environmental factors.

#### *Genes and Chromosomes*

A person's unique genetic constitution, called a **genotype,** is made up of some 30,000 to 40,000 genes (Guttmacher & Collins, 2004). A person's **phenotype,** the observable characteristics of his or her genotype, includes physical appearance and other biologic, physiologic, and molecular traits. Environmental influences modify every person's phenotype, even phenotypes with a major genetic component. This concept of genotype and phenotype applies to a person's total genome and the respective traits of his or her genetic makeup.

The concept of genotype and phenotype also applies to specific diseases. For example, in hypercholesterolemia, the genotype refers to the genes that control lipid metabolism, and the phenotype may be manifested in various corresponding ways. The genotype involves mutations in low-density lipoprotein (LDL) receptors and in one of the apolipoprotein genes (Dedoussis, 2007). The phenotype is characterized by early onset of cardiovascular disease, high levels of LDL, skin xanthomas, and a family history of heart disease. An individual's genotype, consisting of normal functioning genes as well as some mutations, is characterized by physical and biologic traits that may predispose to disease.

Human growth, development, and disease occur as a result of both genetic and environmental influences and interactions. The contribution of genetic factors may be large or small. For example, in a person with cystic fibrosis or PKU, the genetic contribution is significant. In contrast,

the genetic contribution underlying a person's response to infection may be less applicable.

A single gene is conceptualized as a unit of heredity. A gene is composed of a segment of **deoxyribonucleic acid (DNA)** that contains a specific set of instructions for making the protein or proteins needed by body cells for proper functioning. Genes regulate both the types of proteins made and the rate at which proteins are produced. The structure of the DNA molecule is referred to as a double helix. The essential components of the DNA molecule are sugar–phosphate molecules and pairs of nitrogenous bases. Each nucleotide contains a sugar (deoxyribose), a phosphate group, and one of four nitrogenous bases: adenine (A), cytosine (C), guanine (G), and thymine (T). DNA is composed of two paired strands, each made up of a number of nucleotides. The strands are held together by hydrogen bonds between pairs of bases (Fig. 9-1).

Genes are arranged in a linear order within **chromosomes,** which are located in the cell nucleus. In humans, 46 chromosomes occur in pairs in all body cells except oocytes (eggs) and sperm, which each contain only 23 chromosomes. Twenty-two pairs of chromosomes, called autosomes, are the same in females and males. The 23rd pair is referred to as the gender chromosome. A female has two X chromosomes, whereas a male has one X and one Y chromosome. At conception, each parent normally gives one chromosome of each pair to his or her child. As a result, children receive half of their chromosomes from their fathers and half from their mothers (Fig. 9-2).

Careful examination of DNA sequences from many people shows that these sequences have multiple versions in a population. The different versions of these sequences are called alleles. Sequences found in many forms are said to be polymorphic, meaning that there are at least two common forms of a particular gene.

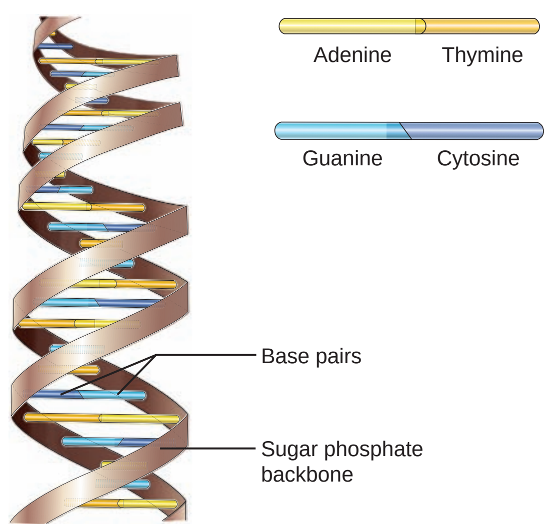



**Figure 9-1** DNA is a double helix formed by base pairs attached to a sugar-phosphate backbone. DNA carries the instructions that allow cells to make proteins. DNA is made up of four chemical bases. Redrawn from Genetic Home Reference http://ghr.nlm.nih.gov/handbook/illustrations/dnastructure

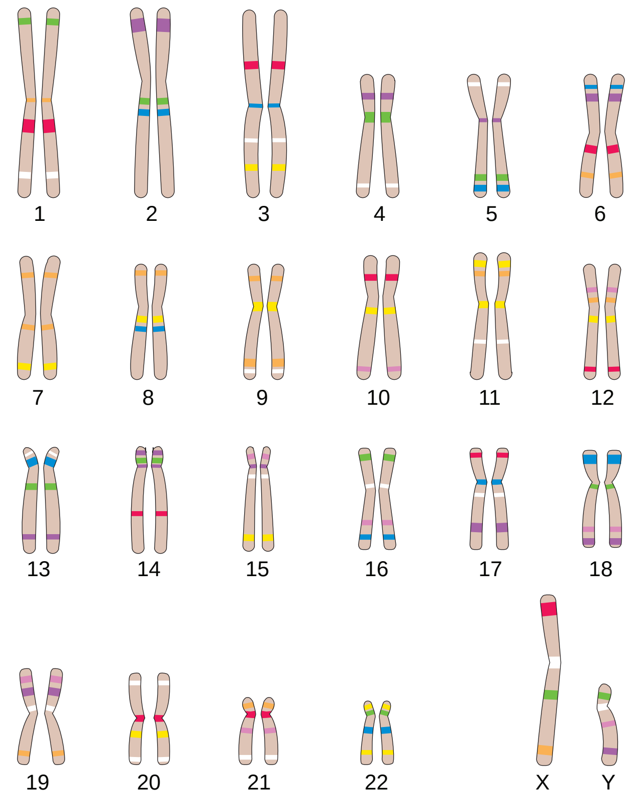



**Figure 9-2** Each human cell contains 23 pairs of chromosomes, which can be distinguished by their size and unique banding patterns. This set is from a male, because it contains a Y chromosome. Females have two X chromosomes. Redrawn from Genetics Home Reference, http://ghr.nlm.nih.gov/handbook/basics/howmanychromosomes

### *Cell Division*

The human body grows and develops as a result of the process of cell division. Mitosis and meiosis are two distinctly different types of cell division.

*Mitosis* is involved in cell growth, differentiation, and repair. During mitosis, the chromosomes of each cell duplicate. The result is two cells, called daughter cells, each of which contains the same number of chromosomes as the parent cell. The daughter cells are said to be diploid because they contain 46 chromosomes in 23 pairs. Mitosis occurs in all cells of the body except oocytes and sperm.

*Meiosis*, in contrast, occurs only in reproductive cells and is the process by which oocytes and sperm are formed. During meiosis, a reduction in the number of chromosomes takes place, resulting in oocytes or sperm that contain half the usual number, or 23 chromosomes. Oocytes and sperm are referred to as haploid because they contain a single copy of each chromosome, compared to the usual two copies in all other body cells. During meiosis, as the paired chromosomes come together in preparation for cell division, portions cross over, and an exchange of genetic material occurs before the chromosomes separate. This event, called recombination, creates greater diversity in the makeup of oocytes and sperm.

During the process of meiosis, a pair of chromosomes may fail to separate completely, creating a sperm or oocyte

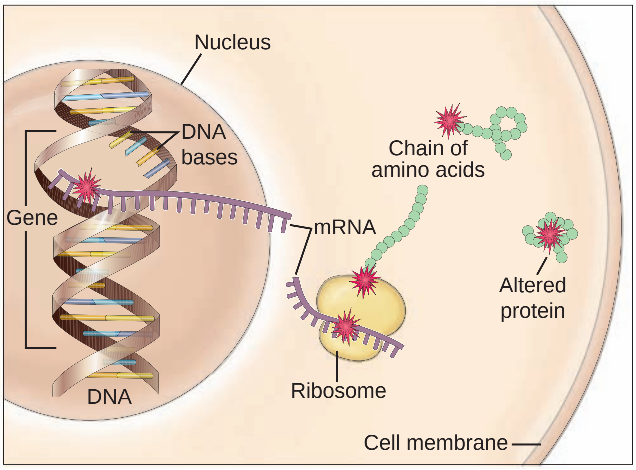



**Figure 9-3** When a gene contains a mutation, the protein encoded by that gene is likely to be abnormal. Sometimes the protein is able to function, although it does so imperfectly. In other cases, it is totally disabled. The outcome depends not only on how the mutation alters the protein's function but also on how vital that particular protein is to survival.

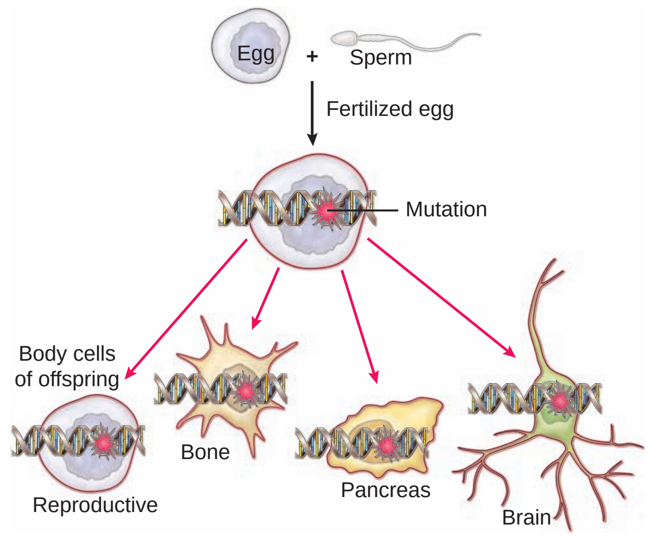



**Figure 9-4** Hereditary mutations are carried in the DNA of the reproductive cells. When reproductive cells containing mutations combine to produce offspring, the mutation is present in all of the offspring's body cells. Redrawn from National Cancer Institute, www.cancer.gov/cancertopics/understandingcancer/genetesting/Slide11

that contains either two copies or no copy of a particular chromosome. This sporadic event, called **nondisjunction,** can lead to either a trisomy or a monosomy. Down syndrome is an example of trisomy, in which people have three copies of chromosome number 21. Turner's syndrome is an example of monosomy, in which girls have a single X chromosome, causing them to have short stature and infertility (National Human Genome Research Institute, 2007b).

### *Gene Mutations*

Within each cell, many intricate and complex interactions regulate and express human genes. Gene structure and function, transcription and translation, and protein synthesis are all involved. Alterations in gene structure and function and the process of protein synthesis may influence a person's health. Changes in gene structure, called **mutations,** permanently change the sequence of DNA, which in turn can alter the nature and type of proteins made (Fig. 9-3).

Some gene mutations have no significant effect on the protein product, whereas others cause partial or complete changes. How a protein is altered and its importance to body functioning determine the impact of the mutation. Gene mutations may occur in hormones, enzymes, or other important protein products, with significant implications for health and disease. Sickle cell anemia is a genetic condition caused by a small gene mutation that affects protein structure, producing hemoglobin S. A person who inherits two copies of the hemoglobin S gene mutation has sickle cell anemia and experiences the symptoms of severe anemia and thrombotic organ damage resulting from hypoxia (National Human Genome Research Institute, 2007c).

Other gene mutations include deletion (loss), insertion (addition), duplication (multiplication), or rearrangement (translocation) of a longer DNA segment. Duchenne muscular dystrophy, myotonic dystrophy, Huntington disease, and fragile X syndrome are examples of conditions caused by gene mutations.

Gene mutations may be inherited or acquired. Inherited or germline gene mutations are present in the DNA of all body cells and are passed on in reproductive cells from parent to child. Germline or hereditary mutations are passed on to all daughter cells when body cells replicate (Fig. 9-4). The gene that causes Huntington disease is one example of a germline mutation.

Spontaneous mutations take place in individual oocytes or sperm at the time of conception. A person who carries the new "spontaneous" mutation may pass on the mutation to his or her children. Achondroplasia, Marfan syndrome, and neurofibromatosis type 1 are examples of genetic conditions that may occur in a single family member as a result of spontaneous mutation.

Acquired mutations take place in somatic cells and involve changes in DNA that occur after conception, during a person's lifetime. Acquired mutations develop as a result of cumulative changes in body cells other than reproductive cells (Fig. 9-5). Somatic gene mutations are passed on to the daughter cells derived from that particular cell line.

Gene mutations occur in the human body all the time. Cells have built-in mechanisms by which they can recognize mutations in DNA, and in most situations, they correct the changes before they are passed on by cell division. However, over time, body cells may lose their ability to repair damage from gene mutations, causing an accumulation of genetic changes that may ultimately result in diseases such as cancer and possibly other conditions of aging, such as Alzheimer's disease (Jenkins & Lea, 2005).

### *Genetic Variation*

Research is ongoing to sort out the genetic components of complex conditions (eg, heart disease, diabetes, common

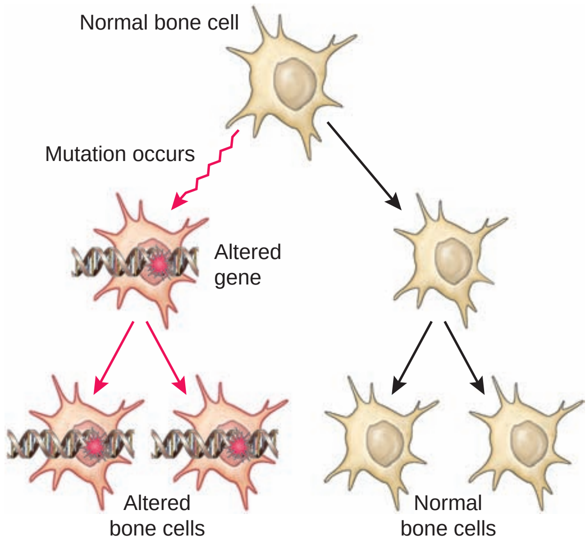



**Figure 9-5** Acquired mutations develop in DNA during a person's lifetime. If the mutation arises in a body cell, copies of the mutation will exist only in the descendants of that particular cell. Redrawn from the National Cancer Institute, www.cancer.gov/cancertopics/understandingcancer/genetesting/Slide12

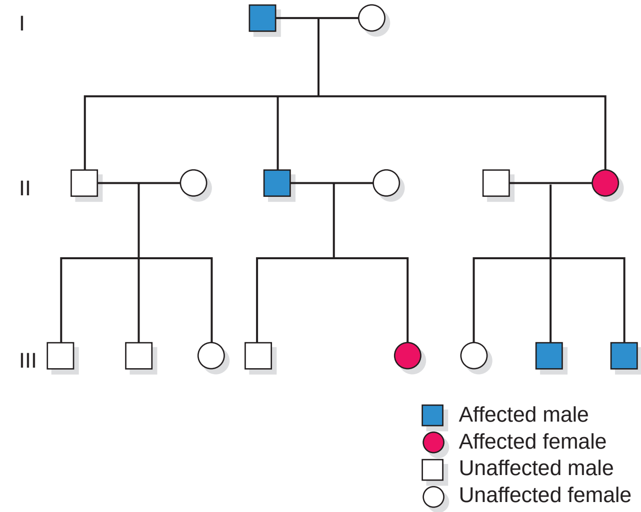



**Figure 9-6** Three-generation pedigree illustrating autosomal dominant inheritance.

cancers, psychiatric disorders) that result from the interaction of environment, lifestyle, and genetic effects and to develop a map of common DNA variants. Genetic variations occur among people of all populations. Polymorphisms and single nucleotide polymorphisms (SNPs, or "snips") are the terms used for common genetic variations that occur most frequently throughout the human genome. Some SNPs may contribute directly to a trait or disease expression by altering function. SNPs are becoming increasingly important for the discovery of DNA sequence variations that affect biologic function. Such knowledge allows clinicians to subclassify diseases and adapt therapies to individual patients (Guttmacher & Collins, 2004). For example, a polymorphism or SNP can alter protein or enzyme activity, and thereby affect drug efficacy and safety, if it occurs in proteins that are targets of medication regimens or that are involved in drug transport or drug metabolism.

## Inheritance Patterns

Nursing assessment of the patient's health includes obtaining and recording family history information in the form of a **pedigree**. This is a first step in establishing the pattern of inheritance. Nurses must be familiar with mendelian patterns of inheritance and pedigree construction and analysis to help identify patients and families who may benefit from further genetic counseling, testing, and treatment (ANA, 2006; Jenkins & Lea, 2005).

Mendelian conditions are genetic conditions that are inherited in fixed proportions among generations. They result from gene mutations that are present on one or both chromosomes of a pair. A single gene inherited from one or both parents can cause a mendelian condition. Mendelian conditions are classified according to their pattern of inheritance: autosomal dominant, autosomal recessive, and **X-linked**. The terms **dominant** and **recessive** refer to the trait, genetic condition, or phenotype but not to the genes or alleles that cause the observable characteristics (Nussbaum, McInnes & Willard, 2004).

### Autosomal Dominant Inheritance

Autosomal dominant inherited conditions affect female and male family members equally and follow a vertical pattern of inheritance in families (Fig. 9-6). A person who has an autosomal dominant inherited condition carries a gene mutation for that condition on one chromosome of a pair. Each of that person's offspring has a 50% chance of inheriting the gene mutation for the condition and a 50% chance of inheriting the normal version of the gene (Fig. 9-7). Offspring who do not inherit the gene mutation do not develop the condition and do not have an increased chance for having children with the same condition. Table 9-2 presents characteristics and examples of different patterns of inherited conditions.

Autosomal dominant conditions often manifest with varying degrees of severity. Some affected people may have significant symptoms, whereas others may have only mild ones. This characteristic is referred to as **variable expression;** it results from the influences of genetic and environmental factors on clinical presentation.

Another phenomenon observed in autosomal dominant inheritance is penetrance, or the percentage of persons known to have a particular gene mutation who actually show the trait. Almost complete penetrance is observed in conditions such as achondroplasia, in which nearly 100% of people with the gene mutation typically display traits of the disease. However, in some conditions, the presence of a gene mutation does not invariably mean that a person has or will develop an autosomal inherited condition. For example, a woman who has the *BRCA1* hereditary breast cancer gene mutation has a lifetime risk of breast cancer that can be as high as 80%, not 100%. This quality, known as incomplete penetrance, indicates the probability that a given gene will produce disease. In other words, a person may inherit the

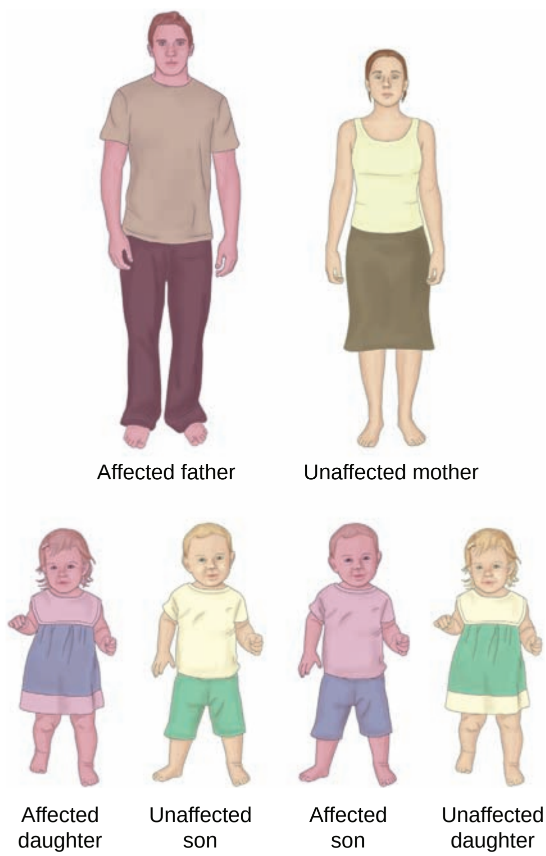



**Figure 9-7** In dominant genetic disorders, if one affected parent has a disease-causing allele that dominates its normal counterpart, each child in the family has a 50% chance of inheriting the disease allele and the disorder. Redrawn from Genetics Home Reference, http://ghr.nlm.nih.gov/handbook/illustrations/autodominant

gene mutation that causes an autosomal dominant condition but may not have any of the observable physical or developmental features of that condition. However, this person carries the gene mutation and still has a 50% chance of passing the gene for the condition to each of his or her children.

One of the effects of incomplete penetrance is that the gene appears to "skip" a generation, thus leading to errors in interpreting family history and in genetic counseling. Examples of other genetic conditions with incomplete penetrance include otosclerosis (40%) and retinoblastoma (80%) (Nussbaum, et al., 2004).

### Autosomal Recessive Inheritance

In contrast to autosomal dominant conditions, autosomal recessive conditions have a pattern that is more horizontal than vertical; relatives of a single generation tend to have the condition (Fig. 9-8). Autosomal recessive conditions are frequently seen among particular ethnic groups and usually occur more often in children of parents who are related by blood, such as first cousins (see Table 9-2).

In autosomal recessive inheritance, each parent carries a gene mutation on one chromosome of the pair and a normal gene on the other chromosome. The parents are said to be **carriers** of the gene mutation. Unlike people with an autosomal dominant condition, carriers of a gene mutation for a recessive condition do not have symptoms of the genetic condition. When carriers have children together, there is a 25% chance that each child may inherit the gene mutation from both parents and have the condition (Fig. 9-9). Gaucher's disease, cystic fibrosis, sickle cell anemia, and PKU are examples of autosomal recessive conditions (National Human Genome Research Institute, 2007d).

### X-Linked Inheritance

X-linked conditions may be inherited in recessive or dominant patterns (see Table 9-2). In both, the gene mutation is located on the X chromosome. All males inherit an X chromosome from their mothers and a Y chromosome from their fathers for a normal sex constitution of 46,XY. Because males have only one X chromosome, they do not have a counterpart for its genes, as do females. This means that a gene mutation on the X chromosome of a male is expressed even though it is present in only one copy. Females, on the other hand, inherit one X chromosome from each parent for a normal sex constitution of 46,XX. A female may be an unaffected carrier of a gene mutation, or she may be affected if the condition results from a gene mutation causing an X-linked dominant condition. Either the X chromosome that she received from her mother or the X chromosome she received from her father may be passed on to each of her offspring, and this is a random occurrence.

The most common pattern of X-linked inheritance is that in which a female is a carrier for a gene mutation on one of her X chromosomes. This is referred to as X-linked recessive inheritance in which a female carrier has a 50% chance of passing on the gene mutation to a son, who would be affected, or to a daughter, who would be a carrier like her mother (Fig. 9-10). Examples of X-linked recessive conditions include factor VIII and factor IX hemophilia, severe combined immunodeficiency, and Duchenne muscular dystrophy.

### Nontraditional Inheritance

Although mendelian conditions manifest with a specific pattern of inheritance in some families, many diseases and traits do not follow these simple patterns. A variety of factors influence how a gene performs and is expressed. Different mutations in the same gene can produce variable symptoms in different people, as in cystic fibrosis. Different mutations in several genes can lead to identical outcomes, as in Alzheimer's disease. Some traits involve simultaneous mutation in two or more genes. A recently observed phenomenon, imprinting, can determine which of a pair of genes (the mother's or the father's) is silenced or activated. This form of inheritance has been observed in Angelman syndrome, a severe form of mental retardation and ataxia (Nussbaum, et al., 2004).

### Multifactorial Inheritance and Complex Genetic Conditions

Many birth defects and common health conditions such as heart disease, high blood pressure, cancer, osteoarthritis, and diabetes occur as a result of interactions of multiple gene mutations and environmental influences. Thus, they

**Table 9-2 PATTERNS OF MENDELIAN INHERITANCE**

| Characteristics | Examples |
|---|---|
| **Autosomal Dominant Inherited Conditions** | |
| Vertical transmission in families<br>Males and females equally affected<br>Variable expression among family members and others with condition<br>Reduced penetrance (in some conditions)<br>Advanced paternal age associated with sporadic cases | Hereditary breast/ovarian cancer syndrome<br>Familial hypercholesterolemia<br>Hereditary non-polyposis colorectal cancer<br>Huntington disease<br>Marfan syndrome<br>Neurofibromatosis |
| **Autosomal Recessive Inherited Conditions** | |
| Horizontal pattern of transmission seen in families<br>Males and females equally affected<br>Associated with consanguinity (genetic relatedness)<br>Associated with particular ethnic groups | Cystic fibrosis<br>Galactosemia<br>Phenylketonuria<br>Sickle cell anemia<br>Tay-Sachs disease<br>Canavan disease |
| **X-Linked Recessive Inherited Conditions** | |
| Vertical transmission in families<br>Males predominantly affected | Duchenne muscular dystrophy<br>Hemophilia A and B<br>Wiscott-Aldrich syndrome<br>Protan and Deutran forms of color blindness |
| **Multifactorial Inherited Conditions** | |
| Occur as a result of combination of genetic and environmental factors<br>May recur in families<br>Inheritance pattern does not demonstrate characteristic pattern of inheritance seen with other mendelian conditions | Congenital heart defects<br>Cleft lip and/or palate<br>Neural tube defects (anencephaly and spina bifida)<br>Diabetes mellitus<br>Osteoarthritis<br>High blood pressure |

Adapted from Jenkins, J. & Lea, D. H. (2005). *Nursing care in the genomic era: A case-based approach*. Sudbury, MA: Jones & Bartlett Publishers. Skirton, H, Patch, C. & Williams, J. (2005). *Applied genetics in healthcare: A handbook for specialists*. New York: Taylor and Francis Group.

are called multifactorial or complex conditions (see Table 9-2). Other examples of multifactorial genetic conditions include neural tube defects such as spina bifida and anencephaly. Multifactorial conditions may cluster in families, but they do not always result in the characteristic pattern of inheritance seen in families who have mendelian inherited conditions (Fig. 9-11).

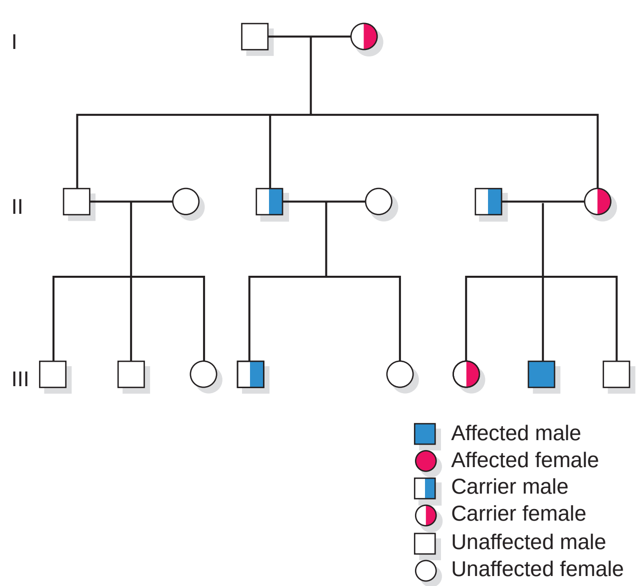



**Figure 9-8** Three-generation pedigree illustrating autosomal recessive inheritance.

## Chromosomal Differences and Genetic Conditions

Differences in the number or structure of chromosomes are a major cause of birth defects, mental retardation, and malignancies. Chromosomal differences are present in approximately 1 of every 160 liveborn infants and are the cause of greater than 50% of all spontaneous first-trimester pregnancy losses (Nussbaum, et al., 2004). Chromosomal differences most commonly involve an extra or missing chromosome; this is called aneuploidy. Whenever there is an extra or missing chromosome, there is always associated mental or physical disability to some degree.

Down syndrome, or trisomy 21, is a common chromosomal condition that occurs with greater frequency in pregnancies of women who are 35 years of age or older. A person with trisomy 21 has a complete extra chromosome 21, which causes a particular facial appearance and increased risk of congenital heart defects, thyroid and vision problems, and mental retardation. Other examples of chromosomal differences include trisomy 13 and trisomy 18, both more severe than Down syndrome, and conditions involving extra or missing sex chromosomes, such as Turner's syndrome (Nussbaum, et al., 2004).

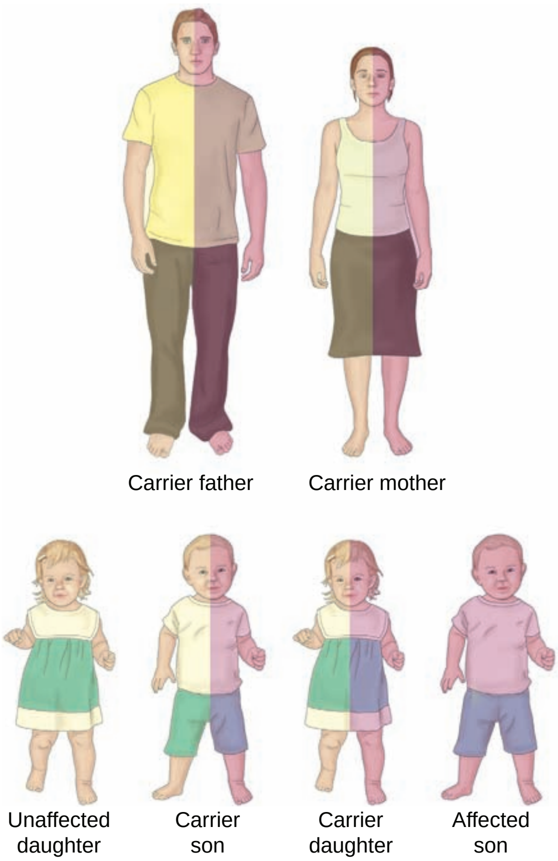



**Figure 9-9** In diseases associated with altered recessive genes, both parents—although disease-free themselves—carry one normal allele and one altered allele. Each child has one chance in four of inheriting two abnormal alleles and developing the disorder; one chance in four of inheriting two normal alleles; and two chances in four of inheriting one normal and one altered allele, and therefore being a carrier like both parents. Redrawn from Genetics Home Reference, http://ghr.nlm.nih.gov/handbook/illustrations/autorecessive

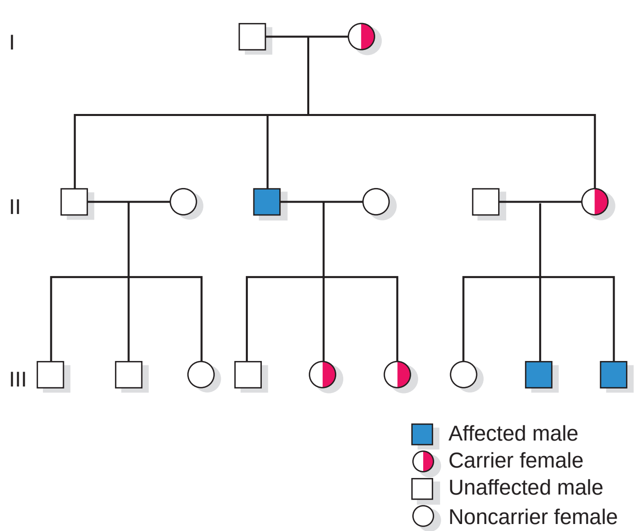



**Figure 9-10** Three-generation pedigree illustrating X-linked recessive inheritance.

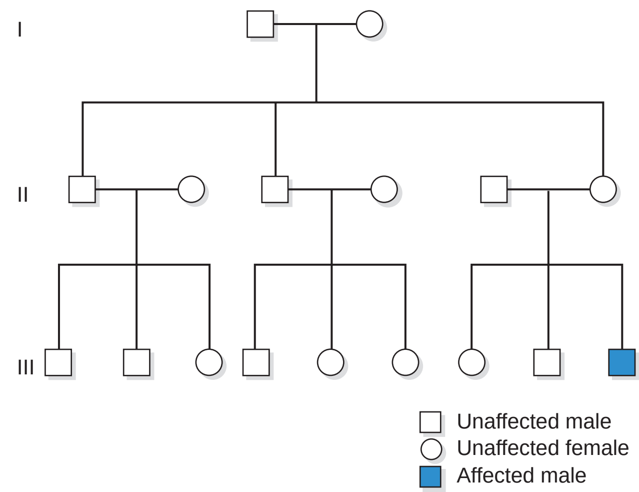



**Figure 9-11** Three-generation pedigree illustrating multifactorial conditions.

Chromosomal differences may also involve a structural rearrangement within or between chromosomes. These are less common than chromosomal conditions in which there is an extra or missing chromosome, but they still occur in 1 of every 500 newborns (Nussbaum, et al., 2004). People who carry "balanced" chromosome rearrangements have all of their chromosomal material, but it is rearranged. Women with a "balanced" chromosomal rearrangement have an increased risk of spontaneous pregnancy loss and of having children with an unbalanced chromosomal arrangement that may result in physical or mental disabilities. Known carriers of these chromosomal differences are offered prenatal counseling and testing.

Chromosome studies may be needed at any age, depending on the indication. Two common indications are a suspected diagnosis such as Down syndrome and a history of two or more unexplained pregnancy losses. Chromosome studies are accomplished by obtaining a tissue sample (eg, blood, skin, amniotic fluid), preparing and staining the chromosomes, and analyzing them under a microscope. The microscopic study of chromosomes, called cytogenetics, is used with new molecular techniques such as fluorescent in situ hybridization (FISH), which permits more detailed examination of chromosomes. FISH is useful to detect small abnormalities and to characterize chromosomal rearrangements (Skirton, Patch & Williams, 2005).

## Genetic and Genomic Technologies in Practice

One of the most immediate applications of new genetic and genomic discoveries is the development of genetic tests that can be used to detect a trait, diagnose a genetic condition, and identify people who have a genetic predisposition to a disease such as cancer or heart disease. Another emerging application is pharmacogenetics, which

involves the use of genetic testing to identify genetic variations that relate to the safety and efficacy of medications and gene-based treatments, so that individualized treatment can be developed. Future applications may include the use of gene chips to map a person's individual genome for genetic variations that may lead to disease. Some nurses are involved in caring for patients who are undergoing genetic testing and gene-based treatments. Knowledge of the clinical applications of modern genetic and genomic technologies enables nurses to inform and support patients and to provide high-quality genetics-related health care (ANA, 2006).

## Genetic Testing

Genetic testing is the primary tool used to identify individuals predisposed to specific genetic diseases. Genetic tests provide information that can lead to the diagnosis of inherited conditions or other conditions with a known genetic contribution.

In genetic testing, approaches may be genotypic or phenotypic. Genotypic methods involve analysis of the chromosomes and genes directly, using specific laboratory techniques to learn whether a genetic alteration related to a specific disease or condition is present. This testing may be DNA based, chromosomal, or biochemical. Phenotypic methods examine the familial or biologic presentation of disease and include assessment of the patient's personal or family history and medical factors influencing his or her disease as well as testing for gene products such as protein markers in body fluids or diseased tissues. The family history, which is considered the first genetic test, is discussed later in this chapter (see Family History Assessment). It is expected that all nurses will know how to use this genetic tool.

Another phenotypic approach involves searching for gene products, such as proteins and enzymes that can clinically indicate a genetic abnormality. For example, germline mutations in the repair genes *MLH1, MSH2, MSH6,* and *PMS2* are responsible for hereditary early-onset colorectal cancer. Colorectal tumors are now tested to measure the presence or absence of these proteins using immunohistochemistry, a routine type of pathology test. Tumors that stain negative for one of those proteins signify malfunction of the gene whose protein is missing. Patients with absent or negative protein expression in their tumors (eg, MLH1 protein–negative) can proceed with genetic testing for a germline *MLH1* mutation (Southey, Jenkins, Mead, et al., 2005).

Genetic testing can be used for a variety of purposes in prenatal, pediatric, and adult populations (Skirton, et al., 2005). Prenatal testing is widely used for **prenatal screening** and diagnosis of such conditions as Down syndrome. Carrier testing is used to determine if a person carries a recessive allele for an inherited condition (eg, cystic fibrosis, sickle cell anemia, Tay-Sachs disease) and therefore risks passing it on to his or her children. Genetic testing is also used widely in newborn screening. In the United States, it is available for an increasing number of genetic conditions (eg, PKU, galactosemia) (Therrell & Adams, 2007).

Diagnostic testing is used to detect the presence or absence of a particular genetic alteration or allele to identify or confirm a diagnosis of a disease or condition (eg, myotonic dystrophy, fragile X syndrome). Increasingly, genetic tests are being used to predict drug response and to design specific and individualized treatment plans, or personalized medicine. For example, genetic testing is used to identify specific gene variants that can predict the effectiveness of treatments for human immunodeficiency virus (HIV) infection and the use of tacrine for Alzheimer's disease (Weinshilboum & Wang, 2006). Examples of current uses of genetic tests are shown in Table 9-3.

Nurses are increasingly participating in patient's genetic testing, especially in the area of taking family histories and patient education. They contribute by ensuring informed health choices and consent, advocating for privacy and confidentiality with regard to genetic test results, and helping patients understand the complex issues involved (ANA, 2006; Skirton, et al., 2005).

## Genetic Screening

Genetic screening, in contrast to genetic testing, applies to testing of populations or groups independent of a positive family history or symptom manifestation. Genetic screening, as defined in 1975 by the Committee for the Study of Inborn Errors of Metabolism of the National Academy of Sciences (Secretary's Advisory Committee on Genetic Testing, 2000), has several major aims. The first aim is to improve management; that is, to identify people with treatable genetic conditions that could prove dangerous to their health if left untreated. For example, newborns are screened for an increasing number of conditions, including PKU, congenital hypothyroidism, and galactosemia. The second aim is to provide reproductive options to people with a high probability of having children with severe, untreatable diseases and for whom genetic counseling, prenatal diagnosis, and other reproductive options could be helpful and of interest. For example, people of Ashkenazi Jewish descent (Jews of Eastern European origin) are screened for conditions such as Tay-Sachs disease and Canavan disease. The third aim is to screen pregnant women to detect birth defects such as neural tube defects and Down syndrome. Genetic screening may also be used for public health purposes to determine the incidence and prevalence of a birth defect or to investigate the feasibility and value of new genetic testing methods. Most commonly, genetic screening occurs in prenatal and newborn programs. Table 9-4 gives examples of types of genetic screening.

## Testing and Screening for Adult-Onset Conditions

Adult-onset conditions with a genetic or genomic basis are manifested in later life. Often clinical signs or symptoms occur only in late adolescence or adulthood, and disease is clearly observed to run in families. Some of these conditions are attributed to specific genetic mutations and follow either an autosomal dominant or an autosomal recessive inheritance pattern. However, the majority of adult-onset conditions are considered to be genomic or multifactorial. Examples of multifactorial conditions include heart disease, diabetes, and arthritis. Genomic or multifactorial influences

**Table 9-3 GENETIC TESTS: EXAMPLES OF CURRENT USES**

| Purpose of Genetic Test | Type of Genetic Test |
|---|---|
| **Carrier Testing** | |
| Cystic fibrosis | DNA analysis |
| Tay-Sachs disease | Hexosaminidase A activity testing and DNA analysis |
| Canavan disease | DNA analysis |
| Sickle cell anemia | Hemoglobin electrophoresis |
| Thalassemia | Complete blood count and hemoglobin electrophoresis |
| **Prenatal Diagnosis**—amniocentesis is often performed when there is a risk for a chromosomal or genetic disorder: | |
| Risk of Down syndrome | Chromosomal analysis |
| Risk of cystic fibrosis | DNA analysis |
| Risk of Tay-Sachs disease | Hexosaminidase A activity testing and/or DNA analysis |
| Risk of open neural tube defect | Protein analysis |
| **Diagnosis** | |
| Down syndrome | Chromosomal analysis |
| Fragile X syndrome | DNA analysis |
| Myotonic dystrophy | DNA analysis |
| **Presymptomatic Testing** | |
| Huntington disease | DNA analysis |
| Myotonic dystrophy | DNA analysis |
| **Susceptibility Testing** | |
| Hereditary breast/ovarian cancer | DNA analysis |
| Hereditary non-polyposis colorectal cancer | DNA analysis |

involve interactions among several genes (gene–gene interactions) and between genes and the environment (gene–environment interactions), as well as the individual's lifestyle (Guttmacher & Collins, 2004).

Nursing assessment for adult-onset conditions is based on family history, personal and medical risk factors, and identification of associated diseases or clinical manifestations (the phenotype). Knowledge of adult-onset conditions and their genetic bases (ie, mendelian versus multifactorial conditions) influences the nursing considerations for genetic testing and health promotion. Table 9-5 describes selected adult-onset conditions, their age of onset, pattern of inheritance, and risk factors, both genetic and environmental.

If a single gene accounts for an adult-onset condition in a symptomatic person, diagnostic testing is used to confirm a diagnosis to assist in the plan of care and management. Diagnostic testing for adult-onset conditions is most frequently used with autosomal dominant conditions, such as Huntington disease or factor V Leiden thrombophilia, and with autosomal recessive conditions such as hemochromatosis. In families with known adult-onset conditions or

**Table 9-4 APPLICATIONS FOR GENETIC SCREENING**

| Timing of Screening | Purpose | Examples |
|---|---|---|
| Preconception screening | For autosomal recessive inherited genetic conditions that occur with greater frequency among individuals of certain ethnic groups | Cystic fibrosis—all couples, but especially Northern European Caucasian, and Ashkenazi Jewish<br>Tay-Sachs disease—Ashkenazi Jewish<br>Sickle cell anemia—African American, Puerto Rican, Mediterranean, Middle Eastern<br>Alpha-thalassemia—Southeast Asian, African American |
| Prenatal screening | For genetic conditions that are common and for which prenatal diagnosis is available when a pregnancy is identified at increased risk | Neural tube defects—spina bifida, anencephaly<br>Down syndrome<br>Other chromosomal abnormalities—trisomy 18 |
| Newborn screening | For genetic conditions for which there is specific treatment | Phenylketonuria (PKU)<br>Galactosemia<br>Homocystinuria<br>Biotinidase deficiency |

**Table 9-5 ADULT-ONSET DISORDERS**

| Clinical Description | Age of Onset (y) | Inheritance | Risk Factors |
|---|---|---|---|
| **Neurologic Conditions** | | | |
| **Early-Onset Familial Alzheimer's Disease** | | | |
| Progressive dementia, memory failure, personality disturbance, loss of intellectual functioning associated with cerebral cortical atrophy, beta-amyloid plaque formation, intra-neuronal neurofibrillary tangles | <60–65 and often before 55 | A.D. <2% | Mutations on preslin 1 (PSEN1), preslin 2 (PSEN2), and/or beta-amyloid precursor protein (APP) |
| **Late-Onset Familial Alzheimer's Disease** | | | |
| Progressive dementia, cognitive decline | >60–65 | A.D. ~25%<br>M.F. ~75% | Gene-gene interactions<br>Carriers of apolipoprotein E4<br>Down syndrome |
| **Huntington Disease** | | | |
| Widespread degenerative brain change with progressive motor loss, both voluntary and involuntary disability, cognitive decline, chorea (involuntary movements) at later stage, psychiatric disturbances | 35–44 (mean) | A.D. 100% | *HD* gene |
| **Hematologic Conditions** | | | |
| **Hereditary Hemochromatosis (HHC)** | | | |
| High absorption of iron by gastro-intestinal mucosa, resulting in excessive iron storage in liver, skin, pancreas, heart, joints, and testes<br>Early symptoms of abdominal pain, weakness, lethargy, weight loss<br>Possible pigmentation, diabetes mellitus, hepatic fibrosis or cirrhosis, heart failure, and dysrhythmias or arthritis in untreated people | 40–60 in males; after menopause in females | A.R. ~60–90%<br>M.F. ~10–30% | Carrier or sibling of carrier of *HFE* gene mutations<br>Liver disease such as alcoholic liver disease, acute viral hepatitis, or chronic hepatitis C<br>Iron overload resulting from ingested iron in foods, cookware, and medicines, as well as parenteral iron from iron injections or transfusions for a chronic anemia such as beta-thalassemia or sickle cell disease |
| **Factor V Leiden Thrombophilia** | | | |
| Poor anticoagulant response to activated protein C with increased risk for venous thrombosis and risk for increased fetal loss during pregnancy | 30s; during pregnancy in females | A.D. | Carriers or relatives of individuals known to have factor V Leiden mutations<br>Family or personal history of high rates of venous thromboembolism, deep venous thrombosis, or pulmonary embolism, especially if age <50 y<br>Women with recurrent pregnancy loss or venous thromboembolism during pregnancy or who use oral contraceptives |
| **Diabetes Mellitus Type 2** | | | |
| Insulin resistance, impaired glucose tolerance | Variable onset; most often 40–60 | M.F. | Gene-gene interactions<br>TCF7L2 variant<br>Obesity<br>Hypertension<br>Hyperlipidemia<br>High intake of refined carbohydrates |
| **Cardiovascular Disease** | | | |
| Familial hypercholesterolemia<br>Elevated LDL levels leading to coronary artery disease, xanthomas, and corneal arcus<br>Atherosclerotic plaque | 35–50 | A.D. | Family or personal history of coronary heart disease at <45 y in women or <40 y in men<br>Elevated LDL |
| **Oncology Conditions** | | | |
| **Multiple Endocrine Neoplasia** | | | |
| Familial medullary thyroid cancer, pheochromocytoma, and parathyroid abnormalities | Early adulthood | A.D. | Carrier or relative of carrier of a *RET* mutation<br>Family history of medullary thyroid cancer, pheochromocytoma, and parathyroid abnormalities |

**Table 9-5 ADULT-ONSET DISORDERS (Continued)**

| Clinical Description | Age of Onset (y) | Inheritance | Risk Factors |
|---|---|---|---|
| **Breast Cancer** | | | |
| *BRCA1* and *BRCA2* hereditary breast/ovarian cancer<br>Breast, ovarian, and prostate (*BRCA1*)<br>Breast, ovarian, and other cancer (*BRCA2*) | 30–70; often <50 | A.D. ~5–10% of breast and ovarian cancers | Carrier of *BRCA1*, *BRCA2* mutations |
| | | M.F. >75% | Older age<br>Early menses (<11 y)<br>Nulliparity<br>Family history of breast, ovarian, or prostate cancer<br>Breast biopsies |
| **Hereditary Non-Polyposis Colorectal Cancer (HNPCC)** | | | |
| Colorectal, ovarian, endometrial, gastric, small intestines, hepato-biliary, and renal cell cancers | <50 | A.D. ~1–3% of colorectal colon cancer; ~1% of endometrial cancers | Mutations in family of repair genes |
| | | M.F. >75% | Older age<br>Personal or family history of colon cancer or adenomas<br>High-fat, low-fiber diet<br>Inflammatory bowel disease |

From Bird, 2007; Kohlmann & Gruber, 2006; Kowdley, Tait, Bennett, et al., 2006; Kujovich, 2007; Online Mendelian Inheritance in Man, 2007; Petrucelli, Daly, Bars Culver, et al., 2007; Warby, Graham, & Hayden, 2007; Wiesner & Snow-Bailey, 2005.
A.D. = autosomal dominant, A.R. = autosomal recessive, M.F. = multifactorial

with a confirmed genetic mutation in an affected family member, **presymptomatic testing** provides asymptomatic people with information about the presence of a genetic mutation and about the likelihood of developing the disease. Presymptomatic testing is considered for people in families with a known adult-onset condition in which either a positive or a negative test result indicates an increased or reduced risk of developing the disease, affects medical management, or allows earlier treatment of a condition.

Huntington disease has served as the model for presymptomatic testing because the presence of the genetic mutation predicts disease onset and progression. Although preventive measures are not yet available for Huntington disease, the genetics information enables health care providers to develop a clinical, supportive, and psychological plan of care.

The foremost factor that may influence the development and severity of disease is a person's genomic makeup. In the absence of a single disease-causing gene, it is thought that multiple genes and other environmental factors are related to the onset of most adult diseases. For some diseases, the interactions among several genes and other environmental or metabolic events affect disease onset and progression. Specific gene–gene interactions or SNPs can confer susceptibility to disease. Most susceptibility testing is conducted in the research setting to identify candidate genes for diseases such as Alzheimer's disease, psychiatric conditions, heart disease, hypertension, and hypercholesterolemia. Susceptibility testing helps distinguish variations within the same disease or response to treatment. For example, no single gene is associated with osteoporosis. Several polymorphisms on candidate genes related to the vitamin D receptor, estrogen and androgen receptors, and regulation of bone mineral density (BMD) have been shown to contribute to osteoporosis and fracture risk. Moreover, diet and exercise have a strong interaction with the polymorphisms regulating BMD (Ralston, 2007).

Some susceptibility genes may predict treatment response. For example, people may present with similar clinical signs and symptoms of asthma but have different responses to glucocorticoid (GC) treatment. Mutations in genes that regulate GC receptors are helpful to classify people with asthma as sensitive or resistant to treatment with corticosteroids (Pujols, Mullol & Picado, 2007).

Population screening, the use of genetic testing for large groups or entire populations, to identify late-onset conditions is under development. For a test to be considered for population screening, there must be (1) sufficient information about gene distribution within populations, (2) accurate prediction about the development and progression of disease, and (3) appropriate medical management for asymptomatic people with a mutation. Currently, population screening is offered in some ethnic groups to identify cancer-predisposing genes. For example, the Ashkenazi Jewish have a greater chance of having a specific genetic mutation in the *BRCA1* or *BRCA2* gene. People with one of these *BRCA* mutations have approximately an 80% risk of breast cancer, a 40% to 65% risk of ovarian cancer (*BRCA1* carriers), a 20% risk of ovarian cancer (*BRCA2* carriers), and a 16% risk of prostate cancer (Chen, Iversen, Friebel, et al., 2006). The identification of one of these mutations gives patients options for cancer screening as well as chemoprevention or prophylactic mastectomy or oophorectomy. Population screening is also being explored for other adult-onset conditions such as type 2 diabetes, heart disease, and hereditary hemochromatosis (iron overload disorder).

Nurses will be expected to participate in explaining risk and genetic predisposition, supporting informed health

decisions and opportunities for prevention and early intervention, and protecting patients' privacy (Skirton, et al., 2005). Nurses must be alert for family histories that indicate multiple generations (autosomal dominant inheritance) or multiple siblings (autosomal recessive inheritance) are affected with the same condition or that onset of disease is earlier than expected (eg, multiple generations with early-onset hyperlipidemia). Possible adult-onset conditions are discussed with other members of the health care team for appropriate resources and referral. When a family history of disease is identified, a patient is made aware that this is a risk factor for disease; resources and referral are then provided. It is the patient's decision whether or not to pursue a genetic testing workup. For example, if a 45-year-old woman presents for her annual gynecology visit and reports a family history of colon cancer in multiple paternal relatives, including her father, the nurse should discuss the family history with the gynecologist. In addition, the woman should be alerted to the risk of colon cancer based on the family history and given information about possible genetic testing and referral for a colonoscopy.

If the existence of a mutation for an adult-onset condition in a family is identified, at-risk family members can be referred for **predisposition testing**. If the patient is found to carry the mutation, the nurse provides him or her with information and referral for risk-reduction measures and information about the risk to other family members. In that discussion, the nurse assures the patient that the test results are private and confidential and will not be shared with others, including family members, without the patient's permission. If the patient is an unaffected family member, the nurse discusses inheritance and the risk of developing the disease, provides support for the decision-making process, and offers referral for genetics services.

## Personalized Genomic Treatments

Information about genes and their variations is helping researchers identify genetic differences that predispose certain people to more aggressive diseases and affect their responses to treatment. Genetics and genomics have revolutionized the field of oncology because genetic mutations are the basis for the development and progression of all cancers. Until recently, individuals with cancer faced treatment based on the stage of the cancer, lymph node involvement, and spread to distant organs. Treatments for a particular type of cancer, stage for stage, were similar. However, studies have shown that individuals with the same type and stage of cancer who received the same treatment did not always have the same response or survival rate. The differences in a given cancer are due to genetic differences in that cancer (Calzone, Lea & Masny, 2006). For example, women with early-stage breast cancer (ie, tumor diameter less than 2 cm, estrogen receptor–positive tumors, no lymph node involvement) have often received chemotherapy. In the past, deciding which of these women would benefit the most from chemotherapy was unclear. Currently, a gene tumor profile of these women's tumors can be used to predict which women are more likely to have an aggressive cancer. This genetic test allows clinicians to recognize which early breast cancers pose a higher risk for recurrence and respond to chemotherapy (Paik, 2007). Other patients who need treatment are receiving personalized cancer treatment based on the genetic signature of the tumor. This treatment, called targeted therapy, tries to match the treatment to the specific malfunctioning genes expressed in the tumor or to selectively inhibit genetic factors that promote cancer growth (Kalyn, 2007).

The use of individualized genetic and genomic data is rapidly resulting in personalized treatment for some common diseases. It has long been known that patients differ in their response to medications. The genetic and genomic variations in drug metabolism account largely for the differences in drug response and drug-related toxicities. Drug metabolism involves genetically controlled protein/enzyme activity for absorption, distribution, drug–cell interaction, inactivation, and excretion, metabolic processes that are known as pharmacokinetics. The cytochrome P450 (CYP) family genes play a key role in the pharmacokinetic process of drug metabolism. Once a drug reaches its target cell, other genes such as those regulating cell receptors and cell signaling control the drug's effect, known as pharmacodynamics. Single genes may affect drug response. More commonly, drug response involves the interaction of multiple genes, the host, and the effects of other drugs. Figure 9-12 is a schematic display of the genetic and genomic influences on drug metabolism and treatment effect.

The difference between genetics and genomics, described earlier in this chapter, aptly corresponds to the terms pharmacogenetics and pharmacogenomics, which combine pharmacology and genetics/genomics. Pharmacogenetics refers to the study of the effect of variations in a single gene on drug response and toxicity. The field of pharmacogenetics has evolved so that it has become a broader genomic-based approach that recognizes the interaction of multiple genes and the environment on drug response. Pharmacogenomics refers to the study of the combined effect of variations in many genes on drug response and toxicity and involves methods that rapidly identify which genetic variations influence a drug's effect. Pharmacogenomics involves the search for genetic variations associated with medication metabolism and efficacy, with the goal of tailoring treatment to each individual's genomic makeup (National Human Genome Research Institute, 2007e).

SNPs, described earlier, are common genetic variations that occur most frequently throughout the human genome and often contribute to variations in enzymatic activity that affect drug metabolism. The CYPs, a family of enzymes, play a key role in the pharmacokinetic process of drug metabolism. More than 200 variations (SNPs) of genes that control CYP activation and deactivation have been identified. Researchers have created a catalog of CYP variations because of their role in drug metabolism (Sim & Ingelman-Sundberg, 2006).

Four classes of CYP metabolic activity levels have been identified based on a person's CYP genotype and the corresponding drug response: (1) poor metabolizers, (2) intermediate

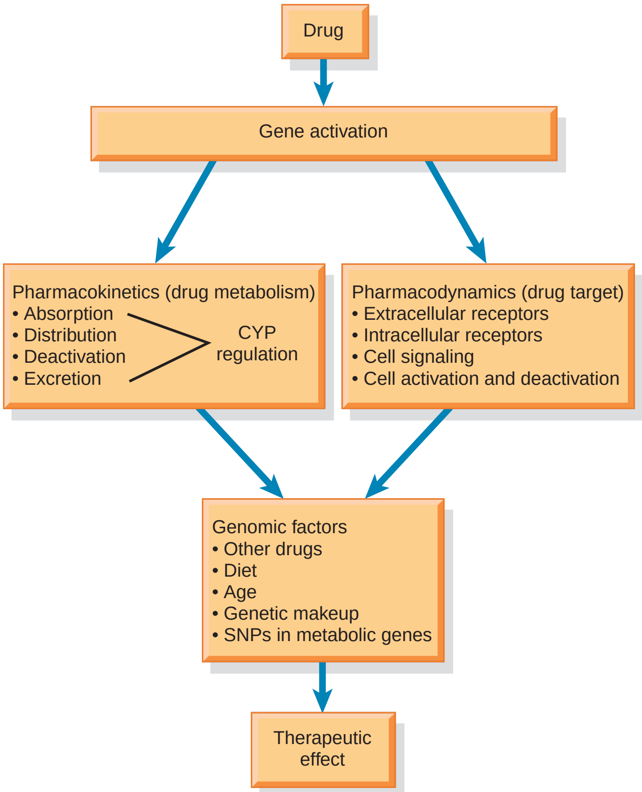



**Figure 9-12** Simplified schematic representation of the multiple, complex, genetic-regulated mechanisms involved in pharmacokinetics (cytochrome [CYP]–dependent) and pharmacodynamics, along with other genomic and environmental factors affecting drug metabolism and treatment effect. SNP, single nucleotide polymorphism.

metabolizers, (3) extensive metabolizers, and (4) ultrarapid metabolizers (Ingelman-Sundberg, 2004). Poor metabolizers have a specific SNP variation in a CYP gene that causes little or no enzyme function, resulting in very little or no drug metabolism and higher blood levels of active drug because the drug cannot be absorbed or excreted. Conversely, ultrarapid metabolizers have SNP variations that cause increased enzyme activity, resulting in rapid absorption, distribution, and excretion of a drug. Ultrarapid metabolizers have lower drug blood levels, usually with inadequate therapeutic response or longer treatment time to achieve therapeutic results. Both poor metabolizers and ultrarapid metabolizers are predisposed to adverse drug reactions. Poor metabolizers may have adverse effects or toxicities from high blood levels of drugs and need a lower dose, whereas ultrarapid metabolizers have inadequate treatment response because of lower drug blood levels and may need a higher dose or more frequent dosing. Table 9-6 shows examples of differences in drug response in poor versus ultrarapid metabolizers. Intermediate metabolizers have reduced enzyme activity levels and metabolize drugs at a slower than normal rate. Because intermediate metabolizers have some enzyme activity, they may have differences in treatment response. Extensive metabolizers have normal enzyme activity levels and normal drug metabolism. Differences in metabolism of other medications occur with other genetic variations.

Nurses have traditionally monitored and reported drug response and drug adverse effects. In the future, pharmacogenetic testing for such genetic variations will give patients more information about drug dosage, time to achieve response, and risk of adverse effects. Nurses will be expected to provide education about a particular patient's profile for drug metabolism and explain the rationale for the recommended dosage and likelihood of adverse effects. Nurses will continue to incorporate information about gender differences, food interactions, and drug compliance into patient education (Prows & Prows, 2004).

Clinical guidelines for pharmacogenomic testing for several drugs are being tested and will soon be part of clinical practice. Examples include warfarin (Coumadin) (Millican, Lenzini, Milligan, et al., 2007; Sconce, Kahn, Wynne, et al., 2005), tricyclic antidepressants (deLeon, Armstrong, Cozza, 2006), and vitamin K (Pestka, Hale, Johnson, et al., 2007). Once pharmacogenomic guidelines for drug dosing are established, it is expected that nurses will advocate for testing and educate patients about the rationale for pharmacogenetic testing prior to treatment with these medications.

**Table 9-6 CLINICAL EFFECTS OF CYTOCHROME P450 ENZYME VARIATIONS**

| | | Effects | |
|---|---|---|---|
| **Enzyme** | **Drug** | **Poor Metabolizer** | **Ultrarapid Metabolizer** |
| CYP2C9 | Warfarin | Bleeding | Longer treatment time to achieve stable dosing |
| | Phenytoin | Ataxia | Not established |
| CYP2C19 | Diazepam | Sedation | Poor response |
| CYP2D6 | Tricyclic antidepressants | Cardiotoxicity | No response to recommended dose; need 10-fold increase in dose |
| | Selective serotonin reuptake inhibitors | Nausea | Not established |
| | Antipsychotics | Parkinson-like effects | Longer treatment time and higher drug costs |

## Applications of Genetics and Genomics in Nursing Practice

Nurses who provide genetics-related and genomics-related health care blend the principles of human genetics with nursing care in collaboration with other professionals, including genetics specialists, to foster improvement, maintenance, and restoration of patients' health. In all nursing practice settings, nurses have five main tasks (ANA, 2006): (1) help collect and interpret relevant family and medical histories, (2) identify patients and families who need further genetics evaluation and counseling and refer them to appropriate genetics services, (3) offer genetics information and resources to patients and families, (4) collaborate with genetics specialists, and (5) participate in the management and coordination of care of patients with genetic conditions. Genetics-related nursing practice involves the care of people who have genetic conditions, those who may be predisposed to develop or pass on genetic conditions, and those who are seeking genetics information and referral for additional genetics services (Jenkins & Lea, 2005; Skirton, et al., 2005).

Nurses support patients and families with genetics-related and genomics-related health concerns by ensuring that their health choices are informed ones and by advocating for the privacy and confidentiality of genetic and genomic information and for equal access to genetic testing and treatments (ANA, 2006).

## Genetics and Genomics in Health Assessment

Assessment of a person's genetic and genomic health status is an ongoing process. Nurses collect information that can help identify individuals and families who have actual or potential genetics-related or genomics-related health concerns or who may benefit from further genetics information, counseling, testing, and treatment. This process can begin before conception and continue throughout the lifespan. Nurses evaluate family and past medical histories, including prenatal history, childhood illnesses, developmental history, adult-onset conditions (in adults), past surgeries, treatments, and medications; this information may relate to the genetic or genomic condition at hand or to a condition being considered. (See Chapter 5 for more information on assessing past medical history.) Nurses also identify the patient's ethnic background and conduct a physical assessment to gather pertinent genetics information. The assessment also includes information about culture, spiritual beliefs, and ancestry. Health assessment includes determining a patient's or family's understanding of actual or potential genetics-related or genomics-related health concerns and awareness of how these issues are communicated within a family (ANA, 2006; Jenkins & Lea, 2005).

### Family History Assessment

Nurses in any practice setting can assess families' genetics histories to identify the presence of a genetic trait, inherited condition, or predisposition. Targeted questions are used to identify genetic and genomic conditions for which further information, education, testing, or treatment can be offered (Chart 9-2). After consultation and collaboration with other health care providers and specialists, further genetic testing and evaluation is offered for the trait or condition in question. The genetics family history is used to make a diagnosis, identify testing strategies, and establish a pattern of inheritance. It includes at least three generations, as well as information about the current and past health status of all family members, including the age at onset of any illnesses, cause of death, and age at death. Nurses also can inquire about medical conditions that are known to have a heritable component and for which genetic testing may be

**Chart 9-2 • *Genetics Family History: An Essential Tool for All Nurses***

A well-documented family history can be used to:
- Assess risk of certain diseases
- Decide on testing strategies, such as what genetic and other diagnostic tests to order
- Establish a pattern of inheritance
- Identify other family members who are at increased risk
- Identify shared environmental risk factors
- Calculate risks
- Assess risk of passing on conditions to children
- Determine and recommend treatments that modify disease risk
- Making decisions about management or surveillance
- Develop patient rapport
- Educate patients

Key questions to ask about each family member include:
- What is the current age or what was the age at death?
- What is the ethnic background (some genetic conditions are more common in certain ethnic groups)?
- Is there a history of:
  - Multiple pregnancy losses/stillbirths?
  - Unexplained infertility?
  - Birth defects?
  - Mental retardation or developmental delay?
  - Learning disabilities?
  - Medical problems in children whose parents are closely related (second cousins or closer)?
  - Congenital or juvenile blindness, cataracts, hearing loss, or deafness?
  - Very short or very tall stature?
  - Several close relatives with the same or related conditions (eg, breast or colon cancer, diabetes, heart disease, asthma, stroke, high blood pressure, kidney disease)?
  - Occurrence of a common condition with earlier age of onset than is usual (eg, breast or colon cancer, hearing loss, dementia, heart disease)?

Adapted from Centers for Disease Control and Prevention, Frequently asked questions about family history, www.hhs.gov/familyhistory/docs/FAQs.pdf and Mayo Clinic, Medical history: How to compile your medical family tree, www.mayoclinic.com/health/medical-history/HQ01707

available. Nurses obtain information about the presence of birth defects, mental retardation, familial traits, or similarly affected family members (Jenkins & Lea, 2005; Skirton, et al., 2005).

Nurses also consider the closeness of the relationship (genetic relatedness or consanguinity) among family members when assessing the risk of genetic conditions in couples or families. For example, when obtaining a preconception or prenatal family history, it is important for the nurse to ask if the prospective parents have common ancestors (ie, are they first cousins?). This is important because people who are related have more genes in common than those who are unrelated, thus increasing their chance of having children with an autosomal recessive inherited condition such as cystic fibrosis. Ascertaining genetic relatedness provides direction for genetic counseling and evaluation. It may also serve as an explanation for parents who have a child with a rare autosomal recessive inherited condition or for a person who is similarly affected.

When the assessment of family history reveals that a patient has been adopted, genetics-based and genomics-based health assessment becomes more challenging. Every effort is made to help the patient obtain as much information as possible about his or her biologic parents, including their ethnic backgrounds.

Questions about previous miscarriage or stillbirth are included in genetics health assessments to identify possible chromosomal conditions. Nurses can also inquire about any history of family members with inherited conditions or birth defects; maternal health conditions such as type 1 diabetes, seizure disorders, or PKU, which may increase the risk for birth defects in children; and about exposure to alcohol or other drugs during pregnancy. Maternal age is also noted; women who are 35 years of age or older who are considering pregnancy and childbearing or who are already pregnant should be offered prenatal diagnosis (eg, testing through amniocentesis) because of the association between advanced maternal age and chromosomal abnormalities such as Down syndrome (Skirton, et al., 2005).

### Physical Assessment

Physical assessment may provide clues that a particular genetic or genomic condition is present in a person and family. Family history assessment may serve as a guide to focus the physical assessment. For example, a history of familial hypercholesterolemia would alert the nurse to assess for symptoms of hyperlipidemias (xanthomas, corneal arcus, abdominal pain of unexplained origin). As another example, a family history of neurofibromatosis type 1, an inherited condition involving tumors of the central nervous system, would prompt the nurse to carry out a detailed assessment of closely related family members. Skin findings such as *café-au-lait* spots, axillary freckling, or tumors of the skin (neurofibromas) would warrant referral for further evaluation, including genetic evaluation and counseling (Skirton, et al., 2005).

If a genetic or genomic condition is suspected as a result of a family history or physical assessment, the nurse, as a part of his or her role, and in collaboration with the health care team, may initiate further discussion of genetics and genomic information, offering and discussing genetic tests and suggesting a referral for further genetic evaluation. (Chart 9-3).

## Chart 9-3 • *Indications for Making a Genetics Referral*

**Prepregnancy and Prenatal**

- Maternal age of 35 years or greater at expected time of delivery
- Previous child with a chromosome problem
- Positive alpha-fetoprotein profile screening test
- Previous child with a birth defect or family history of birth defects
- Pregnancy history of two or more unexplained miscarriages
- Maternal conditions such as diabetes, epilepsy, or alcoholism
- Exposures to certain medications or drugs during pregnancy
- Family history of mental retardation
- Either member of the couple has a birth defect such as cleft lip or palate, spina bifida, or congenital heart defect
- Either member of the couple has a chromosome abnormality

**Pediatric**

- Positive newborn screening test
- One or more major birth defects
- Unusual (dysmorphic) facial features
- Developmental delay/mental retardation
- Suspicion of a metabolic disorder
- Unusually tall or short stature, or growth delays
- Known chromosomal abnormality

**Adult**

- Mental retardation without a known cause
- Unexplained infertility or multiple pregnancy losses
- A personal or family history of thrombotic events
- Adult-onset conditions such as hemochromatosis, hearing loss, visual impairment
- Family history of an adult-onset neurodegenerative disorder (eg, Huntington disease)
- Features of a genetic condition such as neurofibromatosis (*café-au-lait* spots, neurofibromas on the skin), Marfan syndrome (unusually tall stature, dilation of the aortic root), others
- Personal or family history of cardiovascular disorders known to be associated with genetic factors such as cardiomyopathy or long QT syndrome
- Family history of cancers known to be associated with specific genes such as hereditary breast/ovarian cancer or hereditary nonpolyposis colorectal cancer (HNPCC)
- Family history of early onset cancers and familial clustering of related tumors

Adapted from Pletcher, B. A., Toriello, H. V., Noblin, S. J., et al. (2007). Indications for genetic referral: A guide for healthcare providers. *Genetics in Medicine, 9*(6), 385–389.

### Ancestry, Cultural, Social, and Spiritual Assessment

Genetics assessment addresses the ancestry of patients and families, as well as their ethnicity. This information helps identify individual patients and groups who could benefit

from genetic testing for carrier identification, prenatal diagnosis, and susceptibility testing. For example, carrier testing for sickle cell anemia is routinely offered to people of African American descent, and carrier testing for Tay-Sachs disease and Canavan disease is offered to people of Ashkenazi Jewish descent. The American College of Obstetrics and Gynecology (ACOG) recommends that members of at-risk racial and ethnic populations be offered carrier testing (ACOG Committee on Genetics, 2004). ACOG and the American College of Medical Genetics (ACMG) recommend that all couples, particularly those of Northern European and Ashkenazi Jewish ancestry, be offered carrier screening for cystic fibrosis (ACOG, 2004; Watson, et al., 2004). Ideally, carrier testing is offered before conception to allow people who are carriers to make decisions about reproduction. Prenatal diagnosis is offered and discussed when both partners of a couple are found to be carriers.

It is also important to inquire about the patient's ethnic backgrounds when assessing for susceptibilities to adult-onset conditions such as hereditary breast or ovarian cancer. For example, a *BRCA1* cancer-predisposing gene mutation seems to occur more frequently in women of Ashkenazi Jewish descent. Therefore, asking about ethnicity can help identify people with an increased risk of cancer gene mutations (American Medical Association, 2006).

Nurses also should consider their patients' views about the significance of a genetic condition and its effect on self-concept, as well as patients' perception of the role of genetics in health and illness, reproduction, and disability. Patients' social and cultural backgrounds determine their interpretations and values about information obtained from genetic testing and evaluation and thus influence their perceptions of health, illness, and risk (Chart 9-4). Family structure, decision making, and educational background contribute in the same way (Jenkins & Lea, 2005; Skirton, et al., 2005).

Assessment of the patients' beliefs, values, and expectations regarding genetic testing and genetic and genomic information helps nurses provide appropriate information about the specific genetics or genomics topic. For example, in some cultures, people believe that health means the absence of symptoms and that the cause of illness is supernatural. Patients with these beliefs may initially reject suggestions for presymptomatic or carrier testing. However, by including resources such as family, cultural, and religious community leaders when providing genetics-related or genomics-related health care, nurses can help ensure that patients receive information in a way that transcends social, cultural, and economic barriers (Tranin, Masny & Jenkins, 2003).

### *Psychosocial Assessment*

Psychosocial assessment is an essential nursing component of the genetics health assessment to understand the potential impact of new genetic and genomic information on the patient and family and how they may cope with this information (Chart 9-5).

## CHART 9-4 NURSING RESEARCH PROFILE
## *Knowledge of Hereditary Prostate Cancer among High-Risk African American Men*

Weinrich, S., Svinivasan, V., Powell, I. J., et al. (2007). Knowledge of hereditary prostate cancer among high-risk African American men. *Oncology Nursing Forum, 35*(4), 854–860.

**Purpose**

Hereditary prostate cancer accounts for 5% to 10% of all reported cases of prostate cancer. African American men develop prostate cancer 50% to 60% more often than Caucasian men and die from it at twice the rate of any other ethnic group. The purpose of this study was to assess knowledge about hereditary prostate cancer in a group of African American men at high risk for prostate cancer because of family history.

**Design**

This pilot study used a cross-sectional, correlational design. O'Connor's Decision Support Framework served as the basis for the study. This framework addresses three steps in decision making: assessing determinants (a person's perceptions, resources, and individual characteristics), support, and decision making. A total of 79 men were recruited from four U.S. sites that were part of the African American Hereditary Prostate Cancer Study. Of these, 38 men had been diagnosed with prostate cancer. Telephone interviews were conducted using the nine true-false questions that make up the Knowledge of Hereditary Prostate Cancer Scale. Each participant's answers were scored as correct or incorrect based on the known correct answer for each item and then totaled to provide a score. The possible range of scores was 0 to 9.

**Findings**

The mean score was 6.34, with an average of 67% of answers correct; this was interpreted by the authors as a low level of overall knowledge about hereditary prostate cancer. The authors reported a high percentage of incorrect answers on questions related to genetic testing, prevention of prostate cancer, and risk based on a positive family history of prostate cancer. Older men had more knowledge than younger men, and responses did not differ by educational level.

**Nursing Implications**

The finding of a low level of knowledge of hereditary prostate cancer emphasizes the need for nurses to address the knowledge of hereditary prostate cancer among African American men, particularly those at high risk because of a family history of the disease. Nurses can use the Knowledge of Hereditary Prostate Cancer Scale to assist in assessing patients' baseline knowledge level and to guide teaching about risk of prostate cancer. Nurses need to be aware that genetic disorders, such as hereditary prostate cancer, affect families as well as individual patients and also be aware of the ethical implications of genetic testing for both individual patients and their families when such testing is available.

CHART 9-5 **Assessing Psychosocial Genetic Health**

The assessment of a client's psychosocial genetic health is based on the nurse's professional responsibility to "demonstrate in practice the importance of tailoring genetic and genomic information and services to clients based on their culture, religion, knowledge level, literacy and preferred language."

The nurse assesses:

- Educational level and understanding of the genetic condition or concern in the family
- Desired goals and health outcomes in relation to the genetic condition or concern
- Family rules regarding disclosure of medical information (eg, some families may not reveal a history of a disease such as cancer or mental illness during the family history assessment)
- Family rules, boundaries, and cultural practices as well as personal preference about knowing genetic information
- Past coping mechanisms and social support
- Ability to make an informed decision (eg, is the patient under stress from family situations, acute or chronic illness, or medications that may impair the patient's ability to make an informed decision?)

Adapted from American Nurses Association. (2006). *Essential nursing competencies and curricula guidelines for genetics and genomics.* Silver Spring, MD: Author, p. 11. Skirton, H., Patch, C. & Williams, J. (2005). *Applied genetics in healthcare: A handbook for specialist practitioners.*New York: Taylor and Francis Group.

## Genetic Counseling and Evaluation Services

People seek genetic counseling for a variety of reasons and at different stages of life. Some are seeking preconception or prenatal information, others are referred after the birth of a child who has a birth defect or suspected genetic condition, and still others are seeking information for themselves or their families because of the presence of, or a family history of, a genetic condition. Regardless of the timing or setting, genetic counseling is offered to all people who have questions about genetics or genomics and their health. In collaboration with the health care team, nurses consider referral for genetic counseling for any patient who belongs to a family with a hereditary condition and who asks questions such as, "What are my chances for having this condition? Is there a genetic test that will tell me? Is there a gene-based treatment or cure? What are my options?" (Skirton, et al., 2005).

As the contribution of genetics and genomics to the health–illness continuum is recognized, genetic counseling will become a responsibility of all health care professionals in clinical practice. Nurses are in an ideal position to assess the patient's health and genetics family history and to make referrals for specialized diagnosis and treatment. They offer anticipatory guidance by explaining the purpose and goals of a referral. They collaborate with other health care providers in giving supportive and follow-up counseling and coordinating follow-up and case management.

### Genetics Services

Genetics services provide genetics information, education, and support to patients and families. Medical geneticists, genetics counselors, and advanced practice nurses in genetics provide specific genetics services to patients and families who are referred by their primary or specialty health care providers. A team approach is often used to obtain and interpret complex family history information, evaluate and diagnose genetic conditions, interpret and discuss complicated genetic test results, support patients throughout the evaluation process, and offer professional and family support. Patients participate as team members and decision makers throughout the process. Genetics services enable patients and their families to learn and understand relevant aspects of genetics and genomics, to make informed health decisions, and to receive support as they integrate personal and family genetic and genomic information into daily living (Jenkins & Lea, 2005).

Genetic counseling may take place over an extended period and may entail more than one counseling session, which may include other family members. The components of genetic counseling are outlined in Chart 9-6. Although genetic counseling may be offered at any point during a patient's lifespan, counseling issues are often relevant to the life stage in which counseling is sought (Jenkins & Lea, 2005). Some examples are presented in Chart 9-7.

### Nursing Care and Interventions in Genetic Counseling

The process of genetic counseling and evaluation often involves additional genetic testing and procedures as well as decisions by patients and families about reproduction, fertility, testing of children, and management options such as prophylactic surgery. In each of these areas, nurses provide psychosocial interventions and information as family members consider their genetic testing and treatment options. Nurses consider individual patients in the context of the family.

When a patient undergoes presymptomatic genetic testing for hereditary breast and ovarian cancer and tests positive for a cancer-causing mutation, the nurse provides information and support as the patient makes decisions about treatment and interventions.

Decision-making support is an important nursing intervention in many genetic counseling situations. Examples include consideration of pregnancy termination, presymptomatic testing for conditions such as Huntington disease, or predisposition testing for a hereditary cancer. Nurses help patients and families obtain information about options, identify the pros and cons of each option, and explore their values and beliefs. In addition, nurses respect each person's right to receive or not to receive information and help them explain their decision to other family members (Bulechek, Butcher & Dochterman, 2008).

Another essential component of nursing care and genetic counseling is coping enhancement. Coping enhancement involves helping people adapt to stressors or changes that interfere with daily living and functioning (Bulechek, et al., 2008). Coping enhancement is essential throughout the entire genetic counseling, evaluation, and testing process. Nurses can use indicators of patient

## Chart 9-6 • *Components of Genetic Counseling*

**Information and Assessment Sources**

- Reason for referral
- Family history
- Medical history/records
- Relevant test results and other medical evaluations
- Social and emotional concerns
- Relevant cultural, educational, and financial factors

**Analysis of Data**

- Family history
- Physical examination as needed
- Additional laboratory testing and procedures (eg, echocardiogram, ophthalmology or neurologic examination)

**Communication of Genetic Finding**

- Natural history of disorder
- Pattern of inheritance
- Reproductive and family health issues and options
- Testing options
- Management and treatment issues

**Counseling and Support**

- Identify individual and family questions and concerns
- Identify existing support systems
- Provide emotional and social support
- Refer for additional support and counseling as indicated

**Follow-Up**

- Written summary to referring primary care providers and family
- Coordination of care with primary care providers and specialists
- Additional discussions of test results or diagnosis

Adapted from Gene Clinics. What is a Genetics Consultation? www.geneclinics.org/servlet/

## Chart 9-7 • *Genetic Counseling Across the Lifespan*

**Prenatal Issues**

- Understanding prenatal screening and diagnosis testing
- Implications of reproductive choices
- Potential for anxiety and emotional distress
- Effects on partnership, family, and parental-fetal bonding

**Newborn Issues**

- Understanding newborn screening results
- Potential for disrupted parent-newborn relationship on diagnosis of a genetic condition
- Parental guilt
- Implications for siblings and other family members
- Coordination and continuity of care

**Pediatric Issues**

- Caring for children with complex medical needs
- Coordination of care
- Potential for impaired parent-child relationship
- Potential for social stigmatization

**Adolescent Issues**

- Potential for impaired self-image and decreased self-esteem
- Potential for altered perception of family
- Implications for lifestyle and family planning

**Adult Issues**

- Potential for ambiguous test results
- Identification of a genetic susceptibility or diagnosis without an existing cure
- Effect on marriage, reproduction, parenting, and lifestyle
- Potential impact on insurability and employability

Adapted from Jenkins, J.F. & Lea, D.H. (2005). *Nursing care in the genomic era: A case-based approach*. Boston: Jones & Bartlett Publishers.

knowledge, decision making, and coping outcomes to document nursing care provided to families and its effectiveness. These activities are carried out in collaboration with patients and families and help ensure that they receive the most benefit from genetic counseling (ANA, 2006).

### *Advocacy in Genetic and Genomic Decisions*

Respecting the patient's right to self-determination—that is, supporting decisions that reflect the patient's personal beliefs, values, and interests—is a central principle in directing how nurses provide genetic and genomic information and counseling. Nurses and others participating in genetic counseling make every attempt to respect the patient's ability to make autonomous decisions. A first step in providing such nondirective counseling is recognizing one's own values (see Chart 9-1) and how communication of genetic and genomic information may be influenced by those values.

Confidentiality of genetic and genomic information and respect for privacy are other essential principles underlying genetic counseling. Patients have the right to have testing without having the results divulged to anyone, including insurers, physicians, employers, or family members. Some patients pay for testing themselves so that insurers will not learn of the test, and others use a different name for testing to protect their privacy.

A nurse may want to disclose genetics information to family members who could experience significant harm if they do not know such information. However, the patient may have other views and may wish to keep this information from the family, resulting in an ethical dilemma for both patient and nurse (Chart 9-8). The nurse must honor the patient's wishes, while explaining to the patient the potential benefit this information may have for other family members (International Society of Nurses in Genetics, 2005).

CHART 9-8

## Ethics and Related Issues: Sharing of Genetic Information

**Are Individuals Who Are Identified to Have a Disease-Causing Gene Mutation Obligated to Share This Information With Other At-Risk Family Members?**

**Situation**

Genetic technologies are creating new sources of medical information for individuals, families, and communities that raise important ethical, legal, and social issues. Genetic information is defined as heritable, biological information (National Human Genome Research Institute, 2007a), and it can be identified at any point throughout a person's lifespan from preconception until after death. In addition to heritable, biological information, the family history, genetic test results, and medical records are also sources of genetic information.

Privacy involves the right of the individual to control his or her own body, actions, and personal information. Confidentiality refers to the nurse's obligation to protect, and not to disclose, personal information provided in confidence to another. However, genetic information obtained from family history and genetic testing may reveal information not only about the health risks to the individual patient, but also of other family members who may not be aware of the health concern.

**Dilemma**

An ethical dilemma arises for nurses and other health care providers when a patient chooses not to share genetic information with other family members when it may be important to their health. This creates a dilemma for the nurse, who on the one hand must respect the patient's confidentiality, while on the other hand has the duty to warn other family members of the potential health risks. For example, a woman who tests positive for *BRCA1* informs the nurse that she does not wish to share this information with her sisters and her mother because she does not get along with them and has not spoken to them in more than 5 years. The nurse is aware that mutations in *BRCA1* or *BRCA2* predispose those who carry one of these gene mutations to breast cancer, ovarian cancer, prostate cancer (*BRCA1*), and other cancers (*BRCA2*). When a family member such as a sibling or parent is found to have a mutation in one of these genes, other family members have an increased risk of also having that same gene mutation. The ethical concern in this example is for the patient's sisters and mother. Each of them now has a 1 in 2 chance of having the same breast/ovarian cancer gene mutation that confers a significantly increased risk of developing breast/ovarian and other cancers.

**Discussion**

1. What arguments would you offer for informing the patient's family members about their risk of having a hereditary breast/ovarian cancer gene mutation?
2. What arguments would you offer against informing the patient's family members about their risk of having a hereditary breast/ovarian cancer gene mutation?
3. Are there any professional guidelines that you can turn to for help in resolving this ethical dilemma? If so, what are they, and how can they help?
4. What would you do if the patient with the *BRCA1* gene mutation ultimately refuses to share the information with family members based on her beliefs about confidentiality of genetic information?
5. How would your respond if the patient with the *BRCA1* mutation says that she is afraid to let her family know because she feels guilty about bringing them bad news?

Schneider, K. A., Chittenden, A. B., Branda, K. J., et al. (2006). Ethical issues in cancer genetics: I 1) Whose information is it? *Journal of Genetic Counseling, 15*(6), 491–503.

The Health Insurance Portability and Accountability Act (HIPAA) of 1996 prohibits the use of genetics information to establish insurance eligibility. However, HIPAA does not prohibit group plans from increasing premiums, excluding coverage for a specific condition, or imposing a lifetime cap on benefits. The National Human Genome Research Institute, Policy and Public Affairs and Legislative Activities Branch (2009a), has a summary of each state's legislation on employment and insurance discrimination. (See also the Resources list at the end of this chapter.)

Most lawmakers, scientists, and health advocacy groups strongly believe that there is a need for federal legislation to prevent genetic discrimination. Nurses need to become familiar with the Genetic Information Nondiscrimination Act (GINA), which was signed into law in 2008. Its purpose is to protect Americans against improper use of genetic and genomic information in insurance and employment decisions. The act prohibits health insurers from denying coverage to a healthy person or charging higher insurance rates based on a person's genetic predisposition to a disease. The act also prevents employers from using a person's genetic and genomic information to make decisions about hiring, job placement, promotion, or firing. As a result, most Americans are free to use genetics and genomics information in health care without the fear of misuse (National Human Genome Research Institute, 2009b). However, GINA does not cover life, disability, or long-term care insurance. Furthermore, GINA and other state and federal protections do not extend to genetic testing of active duty military personnel or genetic information obtained from active military personnel (Baruch & Hudson, 2008).

All genetics specialists, including nurses who participate in the genetic counseling process and those with access to a person's genetics information, must honor a patient's desire for confidentiality. Genetics information should not be revealed to family members, insurance companies, employers, and schools if the patient so desires, even if keeping the information confidential is difficult.

### Providing Precounseling Information

Preparing the patient and family, promoting informed decision making, and obtaining informed consent are essential in genetic counseling. Nurses assess the patient's capacity

and ability to give voluntary consent. This includes assessment of factors that may interfere with informed consent, such as hearing loss, language differences, cognitive impairment, and the effects of medication. Nurses make sure that a person's decision to undergo testing is not affected by coercion, persuasion, or manipulation. Because information may need to be repeated over time, nurses offer follow-up discussion as needed (Tranin, et al., 2003).

The genetics service to which a patient or family is referred for genetic counseling will ask the nurse for background information for evaluation. Genetics specialists need to know the reason for referral, the patient's or family's reason for seeking genetic counseling, and potential genetics-related health concerns. For example, a nurse may refer a family with a new diagnosis of hereditary breast or ovarian cancer for counseling or to discuss the likelihood of developing the disease and the implications for other family members. The family may have concerns about confidentiality and privacy. The nurse and the genetics specialist tailor the genetic counseling to respond to these concerns.

With the patient's permission, genetics specialists will request the relevant test results and medical evaluations. Nurses obtain permission from the patient and, if applicable, from other family members to provide medical records that document the genetic condition of concern. In some situations, evaluation of more than one family member may be necessary to establish a diagnosis of a genetic disorder. Nurses explain that the medical information is needed to ensure that appropriate information and counseling (including risk interpretation) are provided.

The genetics service asks nurses about the emotional and social status of the patient and family. Genetics specialists want to know the coping skills of patients and families who have recently learned of the diagnosis of a genetic disorder as well as what type of genetics information is being sought. Nurses help identify cultural and other issues that may influence how information is provided and by whom. For example, for patients with hearing loss, a sign interpreter's services may have to be arranged. For those with vision loss, alternative forms of communication may be necessary. Genetics professionals prepare for the genetic counseling and evaluation with these relevant issues in mind (Jenkins & Lea, 2005).

#### Preparing Patients for Genetics Evaluation

Before a genetic counseling appointment, the nurse discusses with the patient and family the type of family history information that will be collected during the consultation. Family history collection and analysis are comprehensive and focus on information that may be relevant to the genetics-related or genomics-related concern in question. The genetic analysis always includes assessment for any other potentially inherited conditions for which testing, prevention, and treatment may be possible.

A physical examination may be performed by the medical geneticist to identify specific clinical features that are diagnostic of a genetic condition. The examination also helps determine if further testing is needed to diagnose a genetic disorder. This examination generally involves assessment of all body systems, with a focus on specific physical characteristics considered for diagnosis. Nurses describe the diagnostic evaluations that are part of a genetics consultation and explains their purposes (Skirton, et al., 2005).

#### Communicating Genetic and Genomic Information to Patients

After the family history and physical examination are completed, the genetics team reviews the information gathered before beginning genetic counseling with the patient and family. The genetics specialists meet with the patient and family to discuss their findings. If the information gathered confirms the presence of a genetic condition in a family, genetics specialists discuss with the patient the natural history of the condition, the pattern of inheritance, and the implications of the condition for reproductive and general health. When appropriate, specialists also discuss relevant testing and management options.

#### Providing Support

The genetics team provides support throughout the counseling session and identifies personal and family concerns. Genetics specialists use active listening to interpret patient concerns and emotions, seek and provide feedback, and demonstrate understanding of those concerns. Genetics specialists suggest referral for additional social and emotional support. Genetics specialists discuss pertinent patient and family concerns and needs with nurses and primary health care teams so that they can provide additional support and guidance (Jenkins & Lea, 2005; Skirton, et al., 2005). Nurses assess the patient's understanding of the information given during the counseling session, clarify information, answer questions, assess patient reactions, and identify support systems.

### *Follow-Up After Genetic Evaluation*

As follow-up to genetic evaluation and counseling, genetics specialists prepare a written summary of the evaluation and counseling session for the patient and, with the patient's consent, send this summary to the primary health care provider as well as other providers identified by the patient as participants in care. The consultation summary outlines the results of the family history and physical and laboratory assessments, provides a discussion of the specific diagnosis (if made), reviews the inheritance and associated risk of recurrence for the patient and his or her family, presents reproductive and general health options, and makes recommendations for further testing and management. The nurse reviews the summary with the patient and identifies information, education, and counseling for which follow-up genetic counseling may be useful (Skirton, et al., 2005).

Follow-up genetic counseling is always offered because some patients and families need more time to understand and discuss the specifics of a genetic test or diagnosis, or they may wish to review reproductive options again later, when pregnancy is being considered. Follow-up counseling is also offered to patients when further evaluation and counseling of extended family members is recommended (Skirton, et al., 2005).

As part of follow-up, nurses can educate patients about sources of information about genetic and genomic

issues. Some resources that provide the most up-to-date and reliable genetic and genomic information are available on the Internet (see Resources at the end of this chapter).

## Ethical Issues

Nurses must consider their responsibilities in handling genetic and genomic information and potential ethical issues such as informed decision making, privacy and confidentiality of such information, and access to and justice in health care. The ethical principles of autonomy, fidelity, and veracity are also important (ANA, 2008).

Ethical questions relating to genetics and genomics occur in all settings and at all levels of nursing practice. At the level of direct patient care, nurses participate in providing genetics information, testing, and gene-based therapeutics. They offer patient care based on the values of self-determination and personal autonomy. To be as fully informed as possible, patients need appropriate, accurate, and complete information given at such a level and in such a form that they and their families can make well-informed personal, medical, and reproductive health decisions. Nurses can help patients clarify values and goals, assess understanding of information, protect patients' rights, and support their decisions. Nurses can advocate for patient autonomy in health decisions. Several resources and position statements have been developed to guide nursing practice (ANA, 2006). These position statements are listed at the end of this chapter.

Many people are increasingly concerned about threats to their personal privacy and the confidentiality of genetic and genomic information. An ethical foundation provides nurses with a holistic framework for handling ethical issues with integrity and a basis for communicating genetic and genomic information to a patient, a family, other care providers, community agencies and organizations, and society. Ethical principles of beneficence (to do good) and nonmaleficence (to do no harm), as well as autonomy, justice, fidelity, and veracity, are used to resolve ethical dilemmas that may arise in clinical care. Respect for people is the ethical principle underlying all nursing care. Using these principles and the values of caring, nurses can promote thoughtful discussions that are useful when patients and families are facing genetic-related and genomic-related health and reproductive decisions and consequences (ISONG, 2000; Tranin, et al., 2003). Further information about ethics is included in Chapter 3.

## CRITICAL THINKING EXERCISES

EBP **1** A 42-year-old man has biopsy-proven, right-sided colon cancer. The pathology report shows a 3-cm poorly differentiated tumor that is negative for *MLH1* by immunohistochemistry. His father had colon cancer at age 48 and his sister had uterine cancer at age 52. Clinicians present the patient with options for genetic testing and surgical consideration of a colon resection. He reports that he does not understand why he should have genetic testing. What evidence about the patient's phenotype (ie, age and tumor characteristics) is the basis for the recommendation for genetic testing and what is the strength of that evidence? What information about his family history supports having genetic testing? What genetic resources or referrals would you suggest for this patient? What professional guidelines support your recommendation for genetic testing?

EBP **2** A 32-year-old woman has been admitted to your nursing unit after having orthopedic surgery—open reduction with internal fixation—to stabilize a right ankle fracture. Your nursing intervention includes a pain assessment. The patient is already asking questions about when her parenteral opioids will be changed to oral ones. She reports having had poor pain control with oral opioids after a prior fracture; she describes having to ask more frequently for pain medication than was recommended. During that recovery period, she felt very discouraged because she was accused of "drug-seeking behavior." What pharmacogenomic evidence-based information would you give this patient about her past experience with pain medications? What evidence related to pain medications supports your discussion? How would you determine the strength of that evidence? What pharmacologic measures would you discuss with the surgical team to plan for effective pain control?

**3** A 50-year-old woman is seen in the clinic for concerns about recent episodes of forgetfulness. She has a strong family history of early-onset Alzheimer's disease (AD). Her father recently died at the age of 68 after having AD for 10 years. Her physician wants her to see a genetic counselor to discuss the pros and cons of being tested to see if she carries one of the genes for AD. She sees you for patient education and asks how she would cope with knowing that AD may be in her future. In addition, she has concerns about the privacy of genetic information and what that would mean in terms of her health insurance. What further nursing assessment would you pursue regarding this patient's psychosocial, coping, and support mechanisms? What information could you provide about preparation for genetic counseling, autonomous decision making, and genetic privacy? What resources and referrals would you make available?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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*Asterisk insticates nursing research.
**Double asterisk indicates classic reference.

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## RESOURCES

Association of Women's Health, Obstetric and Neonatal Nurses, www.awhonn.org/awhonn/

Gene Tests, www.genetests.org/

Genetic Alliance, Inc., www.geneticalliance.org

Genetic Home Reference, Your guide to understanding genetic conditions, http://ghr.nlm.nih.gov/

Genetic and Rare Diseases Information Center, www.genome.gov/Health/GARD/

Genetics Nursing Credentialing Commission, www.geneticnurse.org/

International Society of Nurses in Genetics, Inc. (ISONG). www.isong.org

MedlinePlus Health Topics, www.nlm.nih.gov/medlineplus/healthtopics.html

National Cancer Institute (NCI), www.nci.nih.gov

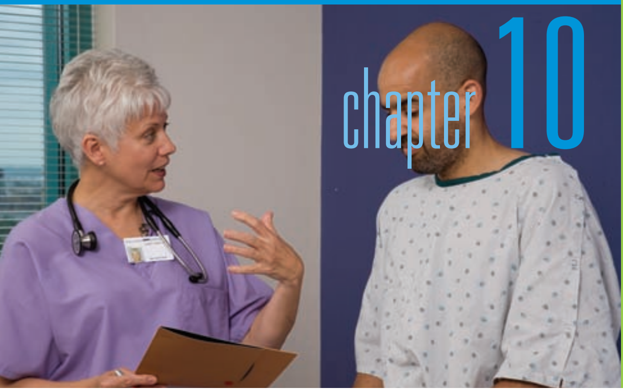
National Coalition for Health Professional Education in Genetics (NCHPEG), www.nchpeg.org

National Human Genome Research Institute, Policy and Public Affairs and Legislative Activities Branch [summary of each state's legislation on employment and insurance discrimination], www.genome.gov/PolicyEthics/LegDatabase/pubsearch.cfm

National Organization for Rare Disorders, Inc. (NORD), www.rarediseases.org

Oncology Nursing Society (ONS), www.ons.org

Online Mendelian Inheritance in Man (OMIM), National Center for Biotechnology Information, www.ncbi.nlm.nih.gov



chapter 10

# Chronic Illness and Disability

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Define "chronic conditions."
2. Identify factors related to the increasing incidence of chronic conditions.
3. Describe characteristics of chronic conditions and implications for people with chronic conditions and for their families.
4. Describe advantages and disadvantages of various models of disability.
5. Describe implications of disability for nursing practice.

## GLOSSARY

**chronic conditions:** medical or health problems with associated symptoms or disabilities that require long-term management (3 months or longer)

**disability:** restriction or lack of ability to perform an activity in a normal manner; the consequences of impairment in terms of an individual's functional performance and activity. Disabilities represent disturbances at the level of the person (eg, bathing, dressing, communication, walking, grooming)

**impairment:** loss or abnormality of psychological, physiologic, or anatomic structure or function at the organ level (eg, dysphagia, hemiparesis); an abnormality of body structure, appearance, and organ or system function resulting from any cause

**secondary conditions or disorders:** any physical, mental, or social disorders resulting directly or indirectly from an initial disabling condition; a condition to which a person with a disability is more susceptible because of having a primary disabling condition

Chronic illness and disability affect people of all ages—the very young, the middle aged, and the very old. Chronic illnesses and disability are found in all ethnic, cultural, and racial groups, although some disorders occur more frequently in some groups than in others (Centers for Disease Control and Prevention [CDC], 2006). Chronic diseases account for 7 of the 10 leading causes of death in the United States, including the three most frequently occurring diseases that result from preventable causes (tobacco use, improper diet and physical inactivity, and alcohol use). Chronic diseases accounted for about 88% of deaths in the United States in 2002 (World Health Organization [WHO], 2005). Chronic disease occurs in all socioeconomic groups, but people who have low incomes and disadvantaged backgrounds are more likely to report poor health. Factors such as poverty and inadequate health insurance decrease the likelihood that people with chronic illness or disability receive health care and health screening measures such as mammography, cholesterol testing, and routine checkups (U.S. Department of Health and Human Services [USDHHS], 2005a). In addition, chronic disease can lead to poverty at the level of the patient and family, a society, or country as a whole because deaths due to chronic illness occur most often during a person's most productive years (WHO, 2006).

Many people with chronic health conditions and disability function independently with only minor inconvenience to their everyday lives; others require frequent and close monitoring or placement in long-term care facilities. Certain conditions require advanced technology for survival, as in the late stages of amyotrophic lateral sclerosis or end-stage renal disease, or intensive care or mechanical ventilation for periods of weeks or months. People with disorders such as these have been described as chronically critically ill (Lipson, Kelley, Higgins, et al., 2006). Some chronic conditions have little effect on quality of life, but others have a considerable effect because they result in disability. However, not all disabilities are a result of chronic illness, and not all chronic illnesses cause disability. In this chapter, chronic illness is discussed, followed by a discussion of disability and the implications for nursing practice.

# Overview of Chronicity

Although each chronic condition has its own specific physiologic characteristics, chronic conditions do share common features. Many chronic conditions, for example, have pain and fatigue as associated symptoms. Some degree of disability is usually present in severe or advanced chronic illness, limiting the patient's participation in many activities. Many chronic conditions require therapeutic regimens to keep them under control. Unlike the term *acute,* which implies a curable and relatively short disease course, the term *chronic* describes a long disease course and conditions that may be incurable. This often makes managing chronic conditions difficult for those who must live with them.

Psychological and emotional reactions of patients to acute and chronic conditions and changes in their health status are described in detail in Chapter 7. People who develop chronic conditions or disabilities may react with shock, disbelief, depression, anger, resentment, or a number of other emotions. How people react to and cope with chronic illness is usually similar to how they react to other events in their lives, depending, in part, on their understanding of the condition and their perceptions of its potential impact on their own and their families' lives. Adjustment to chronic illness (and disability) is affected by various factors:

- Suddenness, extent, and duration of lifestyle changes necessitated by the illness
- Family and individual resources for dealing with stress
- Stages of individual/family life cycle
- Previous experience with illness and crises
- Underlying personality characteristics
- Unresolved anger or grief from the past

Psychological, emotional, and cognitive reactions to chronic conditions are likely to occur at their onset and recur if symptoms worsen or after a period of remission. Symptoms associated with chronic health conditions are often unpredictable and may be perceived as crisis events by patients and their families who must contend with both the uncertainty of chronic illness and the changes it brings to their lives. These possible effects of chronic conditions can guide nursing assessment and interventions for the patient who has a chronic illness.

## Definition of Chronic Conditions

**Chronic conditions** are often defined as medical conditions or health problems with associated symptoms or disabilities that require long-term management (3 months or longer). Chronic conditions can also be defined as illnesses or diseases that have a prolonged course, that do not resolve spontaneously, and for which complete cures are unlikely or rare. The specific condition may be a result of illness, genetic factors, or injury; or it could be a consequence of conditions or unhealthy behaviors that began during childhood or young adulthood. Management of chronic conditions includes learning to live with symptoms or disabilities and coming to terms with identity changes resulting from having a chronic condition. It also consists of carrying out the lifestyle changes and regimens designed to control symptoms and prevent complications. Although some people assume what might be called a "sick role" identity, most people with chronic conditions do not consider themselves to be sick or ill and try to live as normal a life as possible. Only when complications develop or symptoms interfere with activities of daily living (ADLs) do most people with chronic health conditions think of themselves as being sick or disabled.

## Prevalence and Causes of Chronic Conditions

Chronic conditions occur in people of every age group, socioeconomic level, race, and culture. In 2000, an estimated 125 million people in the United States had one or more chronic conditions, and 61 million people (21% of the population) had multiple chronic conditions. It is predicted that by the year 2050, about 167 million people (about 50% of the population) will have a chronic illness, with 81 million (24%) having two or more chronic health conditions (Anderson & Horvath, 2004). As the incidence of chronic

**Table 10-1 MYTHS AND TRUTHS ABOUT CHRONIC DISEASE**

| Common Misconceptions About Chronic Disease | The Reality About Chronic Disease |
|---|---|
| 1. Everyone has to die of something. | Chronic illnesses typically do not result in sudden death but often result in progressive illness and disability. People with chronic disease often die slowly, painfully, and prematurely. |
| 2. People can live to old age even if they lead unhealthy lives (smoke, are obese). | Although there are exceptions (some people who live unhealthy lives live to old age and some people who live healthy lives develop chronic illnesses), the majority of chronic illnesses can be traced to common risk factors and can be prevented by eliminating these risks. |
| 3. Solutions for chronic disease prevention and control are too expensive to be feasible for low-income and middle-income countries. | A full range of chronic disease interventions are very cost-effective for all regions of the world, including the poorest. Many of these interventions are inexpensive to implement. |
| 4. There is nothing that can be done anyway; chronic diseases cannot be prevented. | The major causes of chronic diseases are known, and if these risk factors were eliminated, over 80% of heart disease, stroke, and type 2 diabetes would be prevented; and over 40% of cancer would be prevented. |
| 5. If individuals develop chronic disease as a result of unhealthy "lifestyles," they have no one to blame but themselves. | Individual responsibility can have its full effect only if individuals have equal access to a healthy life and are supported to make healthy choices. Poor people often have limited choices about the food they eat, their living conditions, and access to education and health care. |
| 6. Certain chronic diseases, especially heart disease, primarily affect men. | Chronic diseases, including heart disease, affect women and men almost equally. Almost half of all deaths due to chronic illness occur in women. |
| 7. Chronic diseases primarily affect the elderly. | Almost half of chronic disease deaths occur prematurely, in people under 70 years of age. |
| 8. Chronic diseases mainly affect people who are rich (affluent). | People who are poor are much more likely than the wealthy to develop chronic diseases and are more likely to die as a result. Chronic diseases cause substantial financial burden and can push people and families into poverty. |
| 9. The priority of low-income and middle-income countries should be on control of infectious diseases. | Although infectious diseases are an issue, low-income and middle-income countries are experiencing a rapid increase in chronic disease risk factors and deaths, especially in urban settings. |
| 10. Chronic diseases affect mostly high-income countries. | Eighty percent of deaths due to chronic disease are in low-income and middle-income countries. |

Based on World Health Organization (2005). Widespread misunderstandings about chronic disease—and the reality. Facing the facts #2. Available at: www.who.int/entity/chp/chronic_disease_report/media/Factsheet2.pdf

illnesses increases, the costs associated with these illnesses (ie, hospital costs, equipment, medications, supportive services) also increase. Expenditures for health care for people with chronic conditions exceed billions of dollars every year; these costs represent four of every five health care dollars expended. Chronic disease is associated with 78% of health care costs in the United States. It accounts for 96% of home health care, 88% of prescriptions, 72% of physician visits, and 76% of hospital stays. Most of these health care costs are associated with having two or more chronic conditions (Anderson & Horvath, 2004).

Although some chronic health conditions cause little or no inconvenience, others are severe enough to cause major activity limitations. When people with activity limitations are unable to meet their needs for health care and personal services, they may be unable to carry out their therapeutic regimens or have their prescriptions filled on time, may miss appointments and office visits with their health care providers, and may be unable to carry out ADLs.

Chronic disease is a global issue that affects both rich and poor nations. Chronic conditions have become the major cause of health-related problems in developed countries as well as in developing countries, which are also trying to cope with new and emerging infectious diseases. In almost all countries, chronic diseases are currently the major cause of death among adults. More than 35 million people died of chronic diseases worldwide in 2005. Four of every five deaths occurred in countries characterized as low or middle income, where people tend to develop chronic diseases at younger ages, suffer longer, and die sooner than people in high-income countries. In contrast to common belief, the total number of people dying from chronic disease is twice that of patients dying from infectious (including human immunodeficiency virus [HIV] infection), maternal and perinatal conditions, and nutritional deficiencies combined (WHO, 2005). The majority of these chronic diseases and complications of chronic illness are preventable. Although chronic diseases or illnesses are common, people have many myths or misunderstandings about them (Table 10-1).

Causes of the increasing number of people with chronic conditions include the following:

- A decrease in mortality from infectious diseases (eg, smallpox, diphtheria, acquired immunodeficiency syndrome [AIDS]–related infections) and from acute conditions because of prompt and aggressive management of acute conditions (eg, myocardial infarction, trauma).
- Lifestyle factors, such as smoking, chronic stress, and sedentary lifestyle, which increase the risk of chronic health problems such as respiratory disease, hypertension, cardiovascular disease, and obesity. Although signs and symptoms of chronic illness often first appear during older age, risks may begin earlier, even during fetal development.
- Longer lifespans because of advances in technology and pharmacology, improved nutrition, safer working conditions, and greater access (for some people) to health care.
- Improved screening and diagnostic procedures, enabling early detection and treatment of diseases, re-

sulting in improved outcomes of management of cancer and other disorders (Oeffinger, Mertens, Sklar, et al., 2006).

Consequences of unhealthy lifestyles include an alarming increase in the incidence of diabetes, hypertension, obesity, and cardiac and chronic respiratory disorders (WHO, 2005). Physiologic changes in the body often occur before the appearance of symptoms of chronic disease. Therefore, the goal of emphasizing healthy lifestyles early in life is to improve overall health status and slow the development of such disorders. Major risk factors for chronic disease, which represent a growing challenge to public health, include unhealthy eating habits, decreased energy expenditure associated with a sedentary lifestyle, increasing age, and tobacco use and alcohol consumption (WHO, 2005). In addition, serious psychiatric or mental illness puts people at greater risk for chronic illness than the general population and leads to higher morbidity and mortality rates of chronic diseases (Robson & Gray, 2007).

## Characteristics of Chronic Conditions

Sometimes it is difficult for people who are disease free to understand the profound effect that chronic illness often has on the lives of patients and their families. It is easy for health professionals to focus on the illness or disability itself while overlooking the person who has the disorder. In all illnesses, but even more so with chronic conditions, the illness cannot be separated from the person. People with chronic illness must contend with it daily. To relate to what people must cope with or to plan effective interventions, nurses must understand what it means to have a chronic illness. Characteristics of chronic illness include the following:

- Managing chronic illness involves more than treating medical problems. Associated psychological and social problems must also be addressed, because living for long periods with illness symptoms and disability can threaten identity, bring about role changes, alter body image, and disrupt lifestyles. These changes require continuous adaptation and accommodation, depending on age and situation in life. Each decline in functional ability requires physical, emotional, and social adaptation for patients and their families (Corbin, 2003).
- Chronic conditions usually involve many different phases over the course of a person's lifetime. There can be acute periods, stable and unstable periods, flare-ups, and remissions. Each phase brings its own set of physical, psychological, and social problems, and each requires its own regimens and types of management.
- Keeping chronic conditions under control requires persistent adherence to therapeutic regimens. Failure to adhere to a treatment plan or to do so consistently increases the risk of developing complications and accelerating the disease process. However, the realities of daily life, including the impact of culture, values, and socioeconomic factors, affect the degree to which people adhere to a treatment regimen. Managing a chronic illness takes time, requires knowledge and planning, and can be uncomfortable and inconvenient. It is not unusual for patients to stop taking medications or alter dosages because of side effects that are more disturbing or disruptive than symptoms of the illness, or to cut back on regimens they consider overly time consuming, fatiguing, or costly (Corbin, 2003).
- One chronic disease can lead to the development of other chronic conditions. Diabetes, for example, can eventually lead to neurologic and vascular changes that may result in visual, cardiac, and kidney diseases and erectile dysfunction. The presence of a chronic illness also contributes to a higher risk of morbidity and mortality in patients admitted to the intensive care unit with acute health conditions as well as greater utilization of clinical services during hospitalization (Dartmouth Atlas of Health Care Working Group, 2006).
- Chronic illness affects the entire family. Family life can be dramatically altered as a result of role reversals, unfilled roles, loss of income, time required to manage the illness, decreases in family socialization activities, and the costs of treatment. Stress and caretaker fatigue are common with severe chronic conditions, and the entire family rather than just the patient may need care (Ray & Street, 2007). However, some families are able to master the treatment regimen and changes that accompany chronic illness as well as make the treatment regimen a routine part of life. Furthermore, they are able to keep the chronic illness from becoming the focal point of family life.
- The day-to-day management of illness is largely the responsibility of people with chronic disorders and their families. As a result, the home, rather than the hospital, is the center of care in chronic conditions. Hospitals, clinics, physicians' offices, nursing homes, nursing centers, and community agencies (home care services, social services, and disease-specific associations and societies) are considered adjuncts or backup services to daily home management.
- The management of chronic conditions is a process of discovery. People can be taught how to manage their conditions. However, each person must discover how his or her own body reacts under varying circumstances—for example, what it is like to be hypoglycemic, what activities are likely to bring on angina, and how these or other conditions can best be prevented and managed.
- Managing chronic conditions must be a collaborative process that involves many different health care professionals working together with patients and their families to provide the full range of services that are often needed for management at home. The medical, social, and psychological aspects of chronic health problems are often complex, especially in severe conditions.
- The management of chronic conditions is expensive. Many of the expenses incurred by an individual patient (eg, costs for hospital stays, diagnostic tests, equipment, medications, supportive services) may be covered by health insurance and by federal and state agencies. However, the cost increases affect society as

a whole as insurance premiums increase to cover these costs. Cost increases at the government level decrease resources that might benefit society. In addition, many out-of-pocket expenses are not reimbursed. Many people with chronic disorders, including the elderly and people who are working, are uninsured or underinsured and may be unable to afford the high costs of care often associated with chronic illnesses (CDC, 2006). Absence from work because of chronic disorders may jeopardize job security and income.

- Chronic conditions raise difficult ethical issues for patients, families, health care professionals, and society. Problematic questions include how to establish cost controls, how to allocate scarce resources (eg, organs for transplantation), and what constitutes quality of life and when life support should be withdrawn.
- Living with chronic illness means living with uncertainty. Although health care providers may be aware of the usual progression of a chronic disease such as Parkinson's disease or multiple sclerosis, no one can predict with certainty a person's illness course because of individual variation. Even when a patient is in remission or symptom free, he or she often fears that the illness will reappear.

## Implications of Managing Chronic Conditions

Chronic conditions have implications for everyday living and management for those affected and their families as well as for society at large. Most importantly, individual efforts should be directed at preventing chronic conditions, since many chronic illnesses or disorders are linked to unhealthy lifestyles or behaviors such as smoking and overeating. Therefore, changes in lifestyle can prevent some chronic disorders, or at least delay onset until a later age. Because most people resist change, bringing about alterations in people's lifestyles is a major challenge for nurses today.

Once a chronic condition has occurred, the focus shifts to managing symptoms, avoiding complications (eg, eye complications in a person with diabetes), and avoiding the development of other acute illnesses (eg, pneumonia in a person with chronic obstructive lung disease). Quality of life, often overlooked by health professionals in their approach to people with chronic conditions, is also important. Health-promoting behaviors, such as exercise, are essential to quality of life even in people who have chronic illnesses and disabilities, because they help to maintain functional status (USDHHS, 2005a; Stuifbergen, Seraphine, Harrison, et al., 2005).

Although coworkers, extended family, and health care professionals are affected by chronic illnesses, the problems of living with chronic conditions are most acutely experienced by patients and their immediate families. They experience the greatest impact, with lifestyle changes that directly affect quality of life. Nurses provide direct care, especially during acute episodes, but they also provide the teaching and secure the resources and other supports that enable people to integrate their illnesses into their lives and to have an acceptable quality of life despite the illness. To understand what nursing care is needed, it is important to recognize and appreciate the issues that people with chronic illness and their families contend with and manage, often on a daily basis. The challenges of living with chronic conditions include the need to accomplish the following:

- Alleviate and manage symptoms
- Psychologically adjust to and physically accommodate disabilities
- Prevent and manage crises and complications
- Carry out regimens as prescribed
- Validate individual self-worth and family functioning
- Manage threats to identity
- Normalize personal and family life as much as possible
- Live with altered time, social isolation, and loneliness
- Establish the networks of support and resources that can enhance quality of life
- Return to a satisfactory way of life after an acute debilitating episode (eg, another myocardial infarction or stroke) or reactivation of a chronic condition
- Die with dignity and comfort

Many people with chronic illness must face an additional challenge: the need to deal with more than one chronic illness at a time. The symptoms or treatment of a second chronic condition may aggravate the first chronic condition. Patients need to be able to deal with their various chronic conditions separately as well as in combination. Some Medicare beneficiaries have five or more chronic conditions, see an average of 13 physicians per year, and fill an average of 50 prescriptions per year (Anderson, 2005). Furthermore, the effects of increasing longevity among Americans are likely to increase health care costs in the future.

Even more challenging for many people with chronic illness is the need to hire and oversee caregivers who come into their homes to assist with ADLs and instrumental activities of daily living (IADLs). It is difficult for many people to be in a position of hiring, supervising, and sometimes firing people who may provide them with intimate physical care. The need to balance the role of recipient of care and oversight of the person providing care may lead to blurring of role boundaries.

The challenges of living with and managing a chronic illness are well known, and people with chronic illnesses often report receiving inadequate care, information, services, and counseling (Chart 10-1). This provides an opportunity for nurses to assume a more active role in addressing many of the issues experienced, coordinating care, and serving as an advocate for patients who need additional assistance to manage their illnesses while maintaining a quality of life that is acceptable to them.

## Phases of Chronic Conditions

Chronic conditions can pass through different phases, as described in Table 10-2. However, this course may be too uncertain to predict with any degree of accuracy. The course of an illness can be thought of as a trajectory that can be managed or shaped over time, to some extent, through proper illness management strategies (Corbin, 1998). It is important to keep in mind that not all phases occur in all patients; some phases do not occur at all, and some phases may recur. Each phase is characterized by different medical and psychosocial issues. For example, the needs of a patient with a stroke who is a good candidate for rehabilitation are

**Chart 10-1 • *Characteristics of Patients With Chronic Illness in America***

A representative sample of 24,053 people with one of six chronic health conditions (arthritis, asthma, hypertension, cardiovascular disease, depression, type 2 diabetes) or family caregivers of people with chronic illness were invited to participate in an online survey.

A total of 6447 people (4013 patients and 2434 family caregivers) completed the online survey. The findings reveal that people with chronic illnesses

- Experience greater gaps in economic and cultural access to the health care system than those without chronic illness
- Report having increasing difficulty affording health care
- Have high rates of unmet needs for support services, including home care and transportation, rehabilitation services, referral, and counseling
- Lack financial access to health care and to insurance coverage and affordability, as well as physical access
- Report poorer quality of life, fewer visits to health care providers, less knowledge about how to manage their illness, poorer relationships with their physicians, and less complete benefit from modern standards of care if they are uninsured or underinsured when compared with those who have adequate insurance
- Do not receive the information and services needed to manage their illness successfully
- Are infrequently advised by their physicians to make healthy behavior choices
- Do not receive recommended condition-specific tests and treatments about one half of the time
- Are at high risk for having unmet health-related needs
- Are less likely to receive appropriate levels of care, information, and attention from their physicians if they are members of minority groups, especially Hispanics, are poor, or are younger than 25 years of age
- Report that they do not receive adequate information and counseling about self-care from their physician, including information about medication therapy needed to avoid complications
- Report being confused about self-care activities even if they receive counseling about self-care from their physicians
- Report that treatment options and their pros and cons are not discussed with them by their physicians
- Report that their preferences regarding treatment are not taken into account and they do not feel that their physicians collaborate with them about management of their illness
- Do not feel fully involved in decisions about their own care and do not feel a sense of confidence about managing their illness
- Report that they were never advised or are confused about how to manage their illness
- Report having little sense of control over their lives and their illness
- Report infrequently receiving information or recommendations from their physicians about healthy behaviors (eg, exercise, weight control, smoking avoidance, misuse of alcohol, healthy eating)

Adapted from Robert Wood Johnson Foundation (2001). *A portrait of the chronically ill in America, 2001.* Report from the Robert Wood Johnson Foundation National Strategic Indicator Survey. Princeton, NJ: Robert Wood Johnson Foundation.

very different from those of a patient with terminal cancer. By thinking in terms of phases and individual patients within a phase, nurses can target their care more specifically to each person. Not every chronic condition is necessarily life-threatening, and not every patient passes through each possible phase of a chronic condition in the same order.

Using the trajectory model enables the nurse to put the present situation into the context of what might have happened to the patient in the past—that is, the life factors and understandings that might have contributed to the present state of the illness. In this way, the nurse can more readily address the underlying issues and problems.

## Nursing Care of Patients With Chronic Conditions

Nursing care of patients with chronic conditions is varied and occurs in a variety of settings. Care may be direct or supportive. Direct care may be provided in the clinic or physician's office, a nurse-managed center or clinic, the hospital, or the patient's home, depending on the status of the illness. Examples of direct care include assessing the patient's physical status, providing wound care, managing and overseeing medication regimens, and performing other technical tasks. The availability of this type of nursing care may allow the patient to remain at home and return to a more normal life after an acute episode of illness. Nurses have also used "telehealth" care (use of the telephone in health care) to monitor patients with chronic illnesses, deliver selected nursing interventions (eg, counseling), and provide ongoing education and support (Coyle, Duffy & Martin, 2007).

Because much of the day-to-day responsibility for managing chronic conditions rests with the patient and family, nurses often provide supportive care at home. Supportive care may include ongoing monitoring, teaching, counseling, serving as an advocate for the patient, making referrals, and managing the case. Giving supportive care is just as important as giving technical care. For example, through ongoing monitoring either in the home or in a clinic, a nurse might detect early signs of impending complications and make a referral (ie, contact the physician or consult the medical protocol in a clinic) for medical evaluation, thereby preventing a lengthy and costly hospitalization.

Working with people with chronic illness or disability requires not just dealing with the medical aspects of their disorder, but also working with the whole person—physically, emotionally, and socially. This holistic approach to care requires nurses to draw on their knowledge and skills, including knowledge from the social sciences and psychology in particular. People often respond to illness, health teaching, and regimens in ways that differ from the expectations of health care providers. Although quality of life is usually affected by chronic illness, especially if the illness is severe, patients' perceptions of what constitutes quality of life often drive their management behaviors or affect how they view

**Table 10-2 PHASES IN THE TRAJECTORY MODEL OF CHRONIC ILLNESS**

| Phase | Description | Focus of Nursing Care |
|---|---|---|
| Pretrajectory | Genetic factors or lifestyle behaviors that place a person or community at risk for a chronic condition | Refer for genetic testing and counseling if indicated; provide education about prevention of modifiable risk factors and behaviors |
| Trajectory onset | Appearance or onset of noticeable symptoms associated with a chronic disorder; includes period of diagnostic workup and announcement of diagnosis; may be accompanied by uncertainty as patient awaits a diagnosis and begins to discover and cope with implications of diagnosis | Provide explanations of diagnostic tests and procedures and reinforce information and explanations given by primary health care provider; provide emotional support to patient and family |
| Stable | Illness course and symptoms are under control as symptoms, resulting disability and everyday life activities are being managed within limitations of illness; illness management centered in the home | Reinforce positive behaviors and offer ongoing monitoring; provide education about health promotion and encourage participation in health promoting activities and health screening |
| Unstable | Characterized by an exacerbation of illness symptoms, development of complications, or reactivation of an illness in remission<br>Period of inability to keep symptoms under control or reactivation of illness; difficulty in carrying out everyday life activities<br>May require more diagnostic testing and trial of new treatment regimens or adjustment of current regimen, with care usually taking place at home | Provide guidance and support; reinforce previous teaching |
| Acute | Severe and unrelieved symptoms or the development of illness complications necessitating hospitalization, bed rest, or interruption of the person's usual activities to bring illness course under control | Provide direct care and emotional support to the patient and family members |
| Crisis | Critical or life-threatening situation requiring emergency treatment or care and suspension of everyday life activities until the crisis has passed | Provide direct care, collaborate with other health care team members to stabilize patient's condition |
| Comeback | Gradual recovery after an acute period and learning to live with or to overcome disabilities and return to an acceptable way of life within the limitations imposed by the chronic condition or disability; involves physical healing, limitations stretching through rehabilitative procedures, psychosocial coming-to-terms, and biographical reengagement with adjustments in everyday life activities | Assist in coordination of care; rehabilitative focus may require care from other health care providers; provide positive reinforcement for goals identified and accomplished |
| Downward | Illness course characterized by rapid or gradual worsening of a condition; physical decline accompanied by increasing disability or difficulty in controlling symptoms; requires biographical adjustment and alterations in everyday life activities with each major downward step | Provide home care and other community-based care to help patient and family adjust to changes and come to terms with these changes; assist patient and family to integrate new treatment and management strategies; encourage identification of end-of-life preferences and planning |
| Dying | Final days or weeks before death; characterized by gradual or rapid shutting down of body processes, biographical disengagement and closure, and relinquishment of everyday life interests and activities | Provide direct and supportive care to patients and their families through hospice programs |

Adapted from Corbin, J. M. (1998). The Corbin and Strauss Chronic Illness Trajectory Model: An update. *Scholarly Inquiry for Nursing Practice, 12*(1), 33–41.

advice about health care. Nurses and other health care professionals need to recognize this, even though it may be difficult to see patients make unwise choices and decisions about lifestyles and disease management. People have the right to receive care without fearing ridicule or refusal of treatment, even if their behaviors (eg, smoking, substance abuse, overeating, failure to follow health care providers' recommendations) may have contributed to their chronic disorders.

## Applying the Nursing Process Using the Phases of the Chronic Illness System

The focus of care for patients with chronic conditions is determined largely by the phase of the illness and is directed by the nursing process, which includes assessment, diagnosis, planning, implementation, and evaluation.

### *Step 1: Identifying Specific Problems and the Trajectory Phase*

The first step is assessment of the patient to determine the specific problems identified by the patient, family, nurse, and other health care providers. Assessment enables the nurse to identify the specific medical, social, and psychological problems likely to be encountered in a phase. For instance, the problems of a patient with an acute myocardial infarction are very different from those likely to occur with the same patient, 10 years later, dying at home of heart failure. The types of direct care, referrals, teaching, and emotional support needed in each situation are different as well. Because complementary and alternative therapies are often used by people with chronic illness, it is important to determine whether a patient with a chronic illness is using these regimens.

### Step 2: Establishing and Prioritizing Goals

Once the phase of illness has been identified for a specific patient, along with the specific medical problems and related social and psychological problems, the nurse helps prioritize problems and establish the goals of care. Identification of goals must be a collaborative effort, with the patient, family, and nurse working together, and the goals must be consistent with the abilities, desires, motivations, and resources of those involved.

### Step 3: Defining the Plan of Action to Achieve Desired Outcomes

Once goals have been established, it is necessary to identify a realistic and mutually agreed-on plan for achieving them, including specific criteria that will be used to assess the patient's progress. The identification of the person responsible for each task in the action plan is also essential.

In addition, identification of the environmental, social, and psychological factors that might interfere with or facilitate achieving the desired outcome is an important part of planning.

### Step 4: Implementing the Plan and Interventions

This step addresses implementation of the plan. Possible nursing interventions include providing direct care, serving as an advocate for the patient, teaching, counseling, making referrals, and managing the case (eg, arranging for resources). Nurses can help patients implement the actions that allow patients to live with the symptoms and therapies associated with chronic conditions, thus helping them to gain independence. The nurse works with each patient and family to identify the best ways to integrate treatment regimens into their ADLs to accomplish two tasks: (1) adhering to regimens to control symptoms and keep the illness stable, and (2) dealing with the psychosocial issues that can hinder illness management and affect quality of life. Helping patients and their families to understand and implement regimens and to carry out ADLs within the limits of the chronic illness or disability is an important aspect of nursing care for patients with chronic disorders and disabilities and their families.

### Step 5: Following Up and Evaluating Outcomes

The final step involves following up to determine if the problem is resolving or being managed and if the patient and family are adhering to the plan. This follow-up may uncover the existence of new problems resulting from the intervention, problems that interfere with the ability of the patient and family to carry out the plan, or previously unexpected problems. Maintaining the stability of the chronic condition while preserving the patient's control over his or her life and the patient's sense of identity and accomplishment is a primary goal. Based on the follow-up and evaluation, consideration of alternative strategies or revision of the initial plan may be warranted.

Helping the patient and family to integrate changes into their lifestyle is an important part of the process. Change takes time, patience, and creativity and often requires encouragement from the nurse. Validation by the nurse for each small increment toward goal accomplishment is important for enhancing self-esteem and reinforcing behaviors. Success may be defined as making some progress toward a goal when a patient is unable to implement rapid and dramatic changes in his or her life. If no progress is made, or if progress toward goals seems too slow, it may be necessary to redefine the goals, the intervention, or the time frame. The nurse must realize and accept that some people will not change. Patients share responsibility for management of their conditions, and outcomes are as much related to their ability to accommodate the illness and carry out regimens as they are to nursing intervention.

## Home and Community-Based Care

### Teaching Patients Self-Care

Because chronic conditions are so costly to people, families, and society, one of the major goals of nursing today should be the prevention of chronic conditions and the care of people with them. This requires promoting healthy lifestyles and encouraging the use of safety and disease-prevention measures, such as wearing seat belts and obtaining immunizations. Prevention should also begin early in life and continue throughout life. Self-care teaching may need to address interactions among the patient's chronic conditions as well as skills necessary to care for the individual diseases and their interactive effects.

Patient and family teaching is an important nursing role that may make the difference in the ability of the patient and family to adapt to chronic conditions. Well-informed, educated patients are more likely than uninformed patients to be concerned about their health and to do what is necessary to maintain it. They are also more likely to manage symptoms, recognize the onset of complications, and seek health care early. Knowledge is the key to making informed choices and decisions during all phases of the chronic illness trajectory.

Despite the importance of teaching the patient and family, the nurse must recognize that patients recently diagnosed with serious chronic conditions and their families may need time to understand the significance of their condition and its effect on their lives. Teaching must be planned carefully so that it is not overwhelming. Furthermore, it is important to assess the impact of a new diagnosis of chronic illness on a patient's life and the meaning of self-management to the patient (Kocaman, Kutlu, Özkan, et al., 2007).

The nurse who cares for patients with chronic conditions in the hospital, clinic, or home should assess each patient's knowledge about his or her illness and its management; the nurse cannot assume that a patient with a long-standing chronic condition has the knowledge necessary to manage the condition. Learning needs change as the trajectory phase and the patient's personal situation change. The nurse must also recognize that patients may know how their body responds under certain conditions and how best to manage their symptoms. Contact with patients in the hospital, clinic, nursing center, home, or long-term care facility offers nurses the ideal opportunity to reassess patients' learning needs and to provide additional teaching about an illness and its management.

Teaching strategies and teaching materials should be adapted to the individual patient, so that the patient and

family can understand and follow recommendations from health care providers. For instance, teaching materials should be tailored for people with low literacy levels and available in several languages and in various alternative formats (eg, Braille, large print, audiotapes). It may be necessary to provide sign interpreters.

### *Continuing Care*

Chronic illness management is a collaborative process between the patient, family, nurse, and other health care providers. Collaboration extends to all settings and throughout the illness trajectory. Keeping an illness stable over time requires careful monitoring of symptoms and attention to management regimens. Detecting problems early and helping patients develop appropriate management strategies can make a significant difference in outcomes.

Most chronic conditions are managed in the home. Therefore, care and teaching during hospitalization should focus on essential information about the condition so that management can continue once the patient is discharged home. Nurses in all settings should be aware of the resources and services available in a community and should make the arrangements (before hospital discharge, if the patient is hospitalized) that are necessary to secure those resources and services. When appropriate, home care services are contacted directly. The home care nurse reassesses how the patient and family are adapting to the chronic condition and its treatment and continues or revises the plan of care accordingly.

Because chronic conditions occur worldwide and the world is increasingly interconnected, nurses should think beyond the personal level to the community and global levels. In terms of illness prevention and health promotion, this entails wide-ranging efforts to assess people for risks of chronic illness (eg, blood pressure and diabetes screening, stroke risk assessments) and group teaching related to illness prevention and management.

In addition, nurses should also remind patients with chronic illnesses or disabilities and their families about the need for ongoing health promotion and screening recommended for all people, because chronic illness and disability are often considered the main concern while other health-related issues are ignored.

## Nursing Care for Special Populations With Chronic Illness

When providing care and teaching, the nurse must consider a variety of factors (eg, age, gender, culture and ethnicity, cognitive status, the presence of physical and sensory limitations) that influence susceptibility to chronic illness and the ways patients respond to chronic disorders. Certain populations, for example, tend to be more susceptible to certain chronic conditions. Populations at high risk for specific conditions can be targeted for special teaching and monitoring programs; this includes those at risk because of their genetic profile (see Chapter 9 for further discussion of genetics). People of different cultures and genders may respond to illness differently, and being aware of these differences is essential. For cultures in which patients rely heavily on the support of their families, the families must be involved and made part of the nursing plan of care. As the United States becomes more multicultural and ethnically diverse, and as the general population ages, nurses need to be aware of how a person's culture and age affect chronic illness management and be prepared to adapt their care accordingly.

It is also important to consider the effect of a preexisting disability, or a disability associated with recurrence of a chronic condition, on the patient's ability to manage ADLs, self-care, and the therapeutic regimen. These issues are discussed in the following section.

# *Overview of Disability*

## Definitions of Disability

A person is considered to have a disability such as a limitation in performance or function in everyday activities if he or she has difficulty talking, hearing, seeing, walking, climbing stairs, lifting or carrying objects, performing ADLs, doing school work, or working at a job. A severe disability is present if a person is unable to perform one or more activities, uses an assistive device for mobility, or needs help from another person to accomplish basic activities. People are also considered severely disabled if they receive federal benefits because of an inability to work.

The World Health Organization (WHO) once defined a disability as a limitation in a person's abilities (eg, mobility, personal care, communication, behavior), an **impairment** as a body system or function affected (eg, neurologic, respiratory, urologic), and a handicap as a disadvantage experienced by a person in his or her environment (eg, workplace, economic sufficiency, independence) (WHO, 1980). In an effort to change the focus from a classification based on *disease* to one based on *health,* these definitions were revised in 2001. According to the WHO, *disability* is an umbrella term for impairments, activity limitations, participation restrictions, and environmental factors, and *impairment* is a loss or abnormality in body structure or physiologic function, including mental function. A person's functioning or disability is viewed as a dynamic interaction between health conditions (ie, diseases, disorders, injuries, trauma) and contextual factors (ie, personal and environmental factors) (WHO, 2001).

The term *handicap* is no longer included in the revised WHO classification system: *International Classification of Functioning, Disability and Health—ICF* (WHO, 2001). The term was used previously to identify those circumstances in which the environment played a role in limiting the participation of people with disabilities in activities. The term *societal participation* is used in the revised WHO classification system in place of handicap to acknowledge the fact that the environment is always interacting with people to either assist or hinder participation in life activities. The revision of the classification system acknowledges that the environment may have a greater impact on the ability of an individual to participate in life activities than does the physical, mental, or emotional condition.

Federal legislation uses more than 50 definitions of disability, which illustrates how difficult it is to define the term. The Americans With Disabilities Act of 1990 (ADA; discussed later) defines a person with a **disability** as one who

(1) has a physical or mental impairment that substantially limits one or more major life activities, (2) has a record of such an impairment, or (3) is regarded as having such an impairment. Other terms used to describe people with disabilities that are not universally accepted or understood are "people who are physically challenged," and "people with special needs."

Another approach to disability is described by Lutz and Bowers (2005), who stated that none of the existing definitions adequately addresses disability in everyday life. They defined disability as a multifaceted, complex experience that is integrated into the lives of people with disabilities. The degree of the integration is influenced by three disability-related factors: (1) the effects of the disabling condition, (2) others' perceptions of disability, and (3) the need for and use of resources by the person with a disability.

## Prevalence of Disability

An estimated 54 to 60 million people in the United States have disabilities (U.S. Census Bureau, 2005); they compose the nation's third largest minority. The number of people with disabilities is expected to increase over time as people with early-onset disabilities, chronic disorders, and severe trauma survive and have normal or near-normal lifespans (Cristian, 2005). In addition, changes in the demographic profile are resulting in an increased number of older people with chronic illnesses and disabilities. As the population ages, the prevalence of disability is expected to increase. Although disability is often perceived as being associated only with old age, national data demonstrate that disability occurs across the lifespan; however, its incidence increases with age (U.S. Census Bureau, 2005; USDHHS, 2005a).

The U.S. Census, last conducted in 2000, indicates that 20% of people have a disability and 10% have a severe disability. More than 32 million Americans, or 1 in every 10 Americans, have a severe disability. A total of 72.3 million families have at least one family member with a disability. More than 46% of people with one disability have other disabilities. More than 50% of people with a disability are women. Although the prevalence of disability is higher in males than in females for people younger than 65 years of age, the prevalence is higher in women than in men for people older than 65 years of age. Among people 65 years of age and older, almost 60% of those with disabilities are women (U.S. Census Bureau, 2005).

Currently, more than 10 million people need personal assistance with one or more ADLs, which include bathing, dressing, feeding, and toileting, or IADLs, which include grocery shopping, meal preparation, housekeeping, transportation, and managing finances. In addition, more than 9.3 million people have sensory disabilities that affect hearing or vision. About 5 million people use a cane, more than 2 million use a wheelchair, and at least 1 million use crutches or a walker.

Among all people 21 to 64 years of age (the prime employable years), approximately 33% of people with a severe disability and 77% of those with a nonsevere disability are employed, compared with 82% of people without a disability. However, employed people with a disability earn less money than people without disabilities (U.S. Census Bureau, 2005). Furthermore, 17.5% of people with disabilities live in poverty. Many people with disabilities who are unemployed want to work; however, they are often unable to do so because of the limited access to work settings, lack of accommodations in the workplace, reluctance of employers to hire them, and financial risk if their income exceeds eligibility limits to qualify for disability benefits.

## Characteristics of Disability

### Categories and Types of Disability

Disabilities can be categorized as developmental disabilities, acquired disabilities, and age-associated disabilities. Developmental disabilities are those that occur any time from birth to 22 years of age and result in impairment of physical or mental health, cognition, speech, language, or self-care. Examples of developmental disabilities are spina bifida, cerebral palsy, Down syndrome, and muscular dystrophy (Chart 10-2). Some developmental disabilities occur as a result of birth trauma or severe illness or injury at a very young age, whereas many developmental disabilities are genetic in origin (see Chapter 9). Acquired disabilities may occur as a result of an acute and sudden injury (eg, traumatic brain injury, spinal cord injury, traumatic amputation), acute nontraumatic disorders (eg, stroke, myocardial infarction), or progression of a chronic disorder (eg, arthritis, multiple sclerosis, chronic obstructive pulmonary disease, blindness due to diabetic retinopathy). Age-related disabilities are those that occur in the elderly population and are thought to be due to the aging process. Examples of age-related disabilities include osteoarthritis, osteoporosis, and hearing loss. Because people with disabilities, including those with severe developmental disabilities, are surviving longer than ever before, there is a growing number of young, middle-age, and elderly adults with disabilities, including developmental disabilities.

Types of disability include sensory disabilities that affect hearing or vision; learning disabilities that affect the ability to learn, remember, or concentrate; disabilities that affect the ability to speak or communicate; and disabilities that affect the ability to work, shop, care for oneself, or obtain health care (U.S. Census Bureau, 2005). Many disabilities are visible, but invisible disabilities are often as disabling as those that can be seen. Some disabilities affect only IADLs, whereas others affect ADLs. People can be temporarily disabled because of an injury or acute exacerbation of a chronic disorder but later return to full functioning; this definition of disability may not apply for legal purposes.

Although different impairments may result from different types of disabilities, there are some similarities across disabilities. People with disabilities are often considered by society to be dependent and in need of care from others; however, many people with disabilities are highly functioning, independent, productive people who are capable of caring for themselves and others, having children and raising families, holding a full-time job, and making significant and major contributions to society (Fig. 10-1). Like other people, those with disabilities often prefer to live in their own homes with family members. Most people with disabilities are able to live at home independently. Some patients live alone in their own homes and use home care services. However, alternative living arrangements may be necessary; these include assisted living facilities, long-term care facilities, and group homes.

CHART 10-2 NURSING RESEARCH PROFILE

### Health Experiences of Adults With Neural Tube Defects

Nehring, W. M. & Faux, S. A. (2006). Transitional and health issues of adults with neural tube defects. *Journal of Nursing Scholarship, 38*(1), 63–70.

**Purpose**

Increasing numbers of people with neural tube defects (NTDs; eg, spina bifida) are living well into adulthood because of better health care and medical management. However, although survival rates of people born with NTDs have increased, the experiences of people with NTDs are largely unexplored. Furthermore, the experiences of adults with NTDs from minority populations are unknown. The purpose of this study was to explore the health-related and life experiences of Caucasian, African American, and Mexican American adults with NTDs.

**Design**

A descriptive, qualitative research design was used in which individual interviews were conducted with 16 Caucasian, 11 African American, and 15 Mexican American adults with NTDs at the thoracic, sacral, or lumbar areas of the spine. Most interviews were conducted in person; three were conducted by telephone. A semistructured interview guide was used to obtain data about each study participant, including information about health status and secondary conditions, health care management, current physical functioning, sexuality, independence, self-care, mobility, social activities and relationships, and cultural and religious influences. Qualitative data analysis methods were used to analyze the interview transcripts.

**Findings**

Three themes identified across all three groups were uncertainty about the future, access to health care and information, and advocacy. Concerns regarding uncertainty about the future related to health, mortality and lifespan, sexuality, marriage and family, mobility, and self-care. Participants in all groups identified sexuality and pregnancy as important issues. Issues of mobility and deterioration of health status with aging were major concerns. Concerns about access to health care and information related in part to barriers to care as well as to the need for health care providers who were knowledgeable about their conditions and about their complex medical histories. Concerns about the ability to advocate for themselves for information, independence, and acceptance by others, including family members, were also issues.

**Nursing Implications**

Nurses in contact with adults with developmental disabilities need to assess these people's concerns and assist them in identifying and accessing appropriate health care and services. Although adults with developmental disabilities have usually received information about management of conditions associated with their disability as children, the transitions that occur throughout life mandate that current learning needs be assessed and addressed. Learning needs include self-advocacy skills.

### Models of Disability

Several models of disability have been used to address or explain the issues encountered by people with disabilities (Smeltzer, 2007a). These include the medical and rehabilitation models, the social model, the biopsychosocial model, and the interface model. Chart 10-3 briefly describes these models of disability. Of these, the interface model (Goodall, 1995) may be the most appropriate for use by nurses to provide care that is empowering rather than care that promotes dependency. The interface model does not ignore the disabling condition or its disabling effects; instead, it promotes the view that people with disabilities are capable, responsible people who are able to function effectively despite having a disability. The interface model can serve as a basis for the role of nurses as advocates for removal of barriers to health care and for examination of how society and health care professionals contribute to discrimination by viewing disability as an abnormal state.

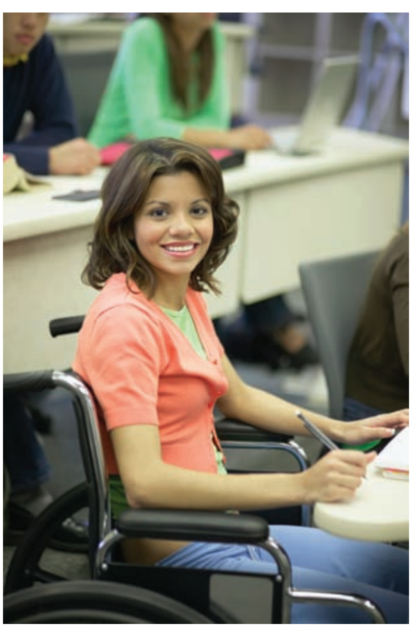


**Figure 10-1** Many people with disabilities lead full, productive lives. A woman attends college classes.

### Disability Versus Disabling Disorders

Regardless of which definition or model of disability is adopted, it is important to realize that it is possible to understand the pathophysiology of a disabling condition or injury or be very knowledgeable about the physical changes resulting from a disorder without understanding the concept of disability. The nurse who cares for patients with preexisting disabilities or new disabilities must recognize the impact of a disability on current and future health and well-being, the ability to participate in self-care or self-management, and the ability to obtain required health care and health screening. Nursing management, from assessment through evaluation of the effectiveness of nursing interventions, must be examined to determine whether appropriate modifications have been made to ensure that those with

## Chart 10-3 • *Models of Disability*

**Medical Model**

This model equates people who are disabled with their disabilities and views disability as a problem of the person, directly caused by disease, trauma, or other health condition, which requires medical care provided in the form of individual treatment by professionals. Health care providers, rather than people with disabilities, are viewed as the experts or authorities. Management of the disability is aimed at cure or the person's adjustment and behavior change. The model is viewed as promoting passivity and dependency. People with disabilities are viewed as tragic (Goodall, 1995; Scullion, 1999, 2000; World Health Organization, 2001; Lollar & Crews, 2003).

**Rehabilitation Model**

The rehabilitation model emerged from the medical model. It regards disability as a deficiency that requires a rehabilitation specialist or other helping professional to fix the problem. People with disabilities are often perceived as having failed if they do not overcome the disability (Lollar & Crews, 2003).

**Social Model**

The social model, which is also referred to as the barriers or disability model, views disability as socially constructed and as a political issue that is a result of social and physical barriers in the environment. Its perspective is that disability can be overcome by removal of these barriers (French, 1992; Richardson, 1997; Shakespeare & Watson, 1997; World Health Organization, 2001).

**Biopsychosocial Model**

The biopsychosocial model integrates the medical and social models to address perspectives of health from a biologic, individual, and social perspective (World Health Organization, 2001; USDHHS, 2005a). Critiques of this model have suggested that the disabling condition, rather than the person and the experience of the person with a disability, remains the defining construct of the biopsychosocial model (Lutz & Bowers, 2005).

**Interface Model**

The interface model is based on the life experience of the person with a disability and views disability at the intersection (ie, interface) of the medical diagnosis of a disability and environmental barriers. It considers rather than ignores the diagnosis. The person with a disability, rather than others, defines the problems and seeks or directs solutions (Goodall, 1995).

disabilities receive health care equal to that of people without disabilities. Furthermore, nurses as well as other health care providers need to examine their facilities and procedures to ensure that the needs of people with a variety of disabilities can be adequately addressed. Although the health care needs of people with disabilities generally do not differ from those of the general population, some disabilities create special needs and necessitate the use of special accommodations. Chart 10-4 reviews specific areas of assessment when caring for people with disabilities.

## Federal Legislation

Because of widespread discrimination against people with disabilities, the U.S. Congress has enacted legislation to address health care disparities in this population. This legislation includes the Rehabilitation Act of 1973 and the ADA. Health care in people with disabilities has received further national attention through the first-time inclusion of specific national objectives that address health care for people with disabilities in *Healthy People 2010* (USDHHS, 2005b). In 2005, the U.S. surgeon general called for action to improve the health and wellness of people with disabilities (Smeltzer, 2007a; USDHHS, 2005a).

The Rehabilitation Act of 1973 is a law that protects people from discrimination based on their disabilities. The act applies to employers and organizations that receive financial assistance from any federal department or agency; this includes many hospitals, long-term care facilities, mental health centers, and human service programs. It forbids organizations from excluding or denying people with disabilities equal access to program benefits and services. It also prohibits discrimination related to availability, accessibility, and delivery of services, including health care services.

The ADA of 1990 mandates that people with disabilities have access to job opportunities and to the community. It requires that employers evaluate an applicant's ability to perform the job and not discriminate on the basis of a disability. According to the ADA, communities must provide public transportation that is accessible to people with disabilities. The ADA also requires that "reasonable accommodations" be provided to facilitate employment of a person with a disability. Facilities used by the public must be accessible and accommodate those with disabilities. Examples of reasonable accommodations in health care settings include accessible facilities and equipment (eg, accessible restrooms, adjustable examination tables, access ramps, grab bars, elevated toilet seats) and alternative communication methods (eg, telecommunication devices and sign interpreters for use by people who are deaf).

Although the ADA took effect in 1992, compliance has been slow, and some facilities continue to be inaccessible. However, all new construction and modifications of public facilities must address access for people with disabilities. Examples of modifications that are needed to provide equal access to health care to people with disabilities are identified in Chart 10-4.

# *Right of Access to Health Care*

People with disabilities have the right of access to health care that is equal in quality to that of other people. For years, people with disabilities have been discriminated against in employment, public accommodations, and public and private services, including health care. The needs of the people with disabilities in health care settings present

## Chart 10-4 • *Strategies to Ensure Quality Health Care for People With Disabilities*

### Communication Strategies

- Does the patient with a disability require or prefer accommodations (eg, a sign interpreter) to ensure full participation in conversations about his or her own health care?
- Are appropriate accommodations made to communicate with the patient?
- Are efforts made to direct all conversations to the patient rather than to others who have accompanied the patient to the health care facility?

### Accessibility of the Health Care Facility

- Are clinics, hospital rooms, offices, restrooms, laboratories, and imaging facilities accessible to people with disabilities, as legally required by the Americans With Disabilities Act and Rehabilitation Act?
- Has accessibility been verified by a person with a disability?
- Is a sign interpreter other than family member available to assist in obtaining a patient's health history and in conducting a physical assessment?
- Does the facility include appropriate equipment to permit people with disabilities to obtain health care (including mammography, gynecologic examination and care, dental care) in a dignified and safe manner?

### Assessment

#### Usual Health Considerations

- Does the health history address the same issues that would be included when obtaining a history from a person without disabilities, including sexuality, sexual function, and reproductive health issues?

#### Disability-Related Considerations

- Does the health history address the patient's specific disability and the effect of disability on the patient's ability to obtain health care, manage self-care activities, and obtain preventive health screening and follow-up care?
- What physical modifications and positioning are needed to ensure a thorough physical examination, including pelvic or testicular and rectal examination?

#### Abuse

- Is the increased risk for abuse (physical, emotional, financial, and sexual) by a variety of people (family, paid care providers, strangers) addressed in the assessment?
- If abuse is detected, are men and women with disabilities who are survivors of abuse directed to appropriate resources, including accessible shelters and hotlines?

#### Depression

- Is the patient experiencing depression? If so, is treatment offered just as it would be to a patient without a disability, without assuming that depression is normal and a result of having a disability?

#### Aging

- What concerns does the patient have about aging with a preexisting disability?
- What effect has aging had on the patient's disability and what effect has the disability had on the patient's aging?

#### Secondary Conditions

- Does the patient have secondary conditions related to his or her disability or its treatment?
- Is the patient at risk for secondary conditions because of environmental barriers or lack of access to health care or health promotion activities?
- Are strategies in place to reduce the risk for secondary conditions or to treat existing secondary conditions?

#### Accommodations in the Home

- What accommodations does the patient have at home to encourage or permit self-care?
- What additional accommodations does the patient need at home to encourage or permit self-care?

### Cognitive Status

- Is it assumed that the patient is able to participate in discussion and conversation rather than assuming that he or she is unable to do so because of a disability?
- Are appropriate modifications made in written and verbal communication strategies?

### Modifications in Nursing Care

- Are modifications made during hospital stays, acute illness or injury, and other health care encounters to enable a patient with disability to be as independent as he or she prefers?
- Is "person-first language" used in referring to a patient with disability, and do nurses and other staff talk directly to the patient rather than to those who accompanied the patient?
- Are all staff informed about the activities of daily living (ADLs) for which the patient will require assistance?
- Are accommodations made to enable the patient to use his or her assistive devices (hearing/visual aids, prostheses, limb support devices, ventilators, service animals)?
- If a patient with disability is immobilized because of surgery, illness, injury, or treatments, are risks of immobility addressed and strategies implemented to minimize those risks?
- Is the patient with a disability assessed for other illnesses and health issues (eg, other acute or chronic illness, depression, psychiatric/mental health and cognitive disorders) not related to his or her primary disability?

### Patient Teaching

- Are accommodations and alternative formats of teaching materials (large print, Braille, visual materials, audiotapes) provided for patients with disabilities?
- Does patient teaching address the modifications (eg, use of assistive devices) needed by patients with disabilities to enable them to adhere to recommendations?
- Are modifications made in teaching strategies to address learning needs, cognitive changes, and communication impairment?

### Health Promotion and Disease Prevention

- Are health promotion strategies discussed with people with disabilities along with their potential benefits: improving quality of life and preventing secondary conditions (health problems that result because of preexisting disability)?
- Are patients aware of accessible community-based facilities (eg, health care facilities, imaging centers, public

*Continued*

**Chart 10-4 • *Strategies to Ensure Quality Health Care for People With Disabilities* (Continued)**

exercise settings, transportation) to enable them to participate in health promotion?

**Independence Versus Dependence**

- Is independence, rather than dependence, of the person with a disability the focus of nursing care and interaction?
- Are care and interaction with the patient focused on empowerment rather than promoting dependence of the patient?

**Insurance Coverage**

- Does the patient have access to the health insurance coverage and other services for which he or she qualifies?
- Is the patient aware of various insurance and other available programs?
- Would the patient benefit from talking to a social worker about eligibility for Medicaid, Medicare, Disability Insurance, and other services?

many challenges to health care providers: how to communicate effectively if there are communication deficits, the additional physical requirements for mobility, and time required to provide assistance with self-care routines during hospitalization. Health care providers, including nurses, may not be aware of the specific needs of people with disabilities and may fail to provide appropriate care and services for them. However, it is essential that health care providers, including nurses, realize that people with disabilities have a legally mandated right to accessible health care facilities for all medical care and screening procedures. Furthermore, people with disabilities have the right to health care provided by professionals who are knowledgeable about and sensitive to the effects of disability on access to health care, including care that addresses their reproductive issues and sexuality. Reasonable accommodations are mandated by law and are the financial responsibility of the health care provider or facility. People with disabilities should not be expected to provide their own accommodations (eg, sign interpreters, assistants). Family members should not be expected to serve as interpreters because of concern for the patient's privacy and confidentiality and the risk of errors in interpreting information by either the patient or the health care provider. Chart 10-5 identifies strategies to communicate effectively with people with disabilities.

In response to continued accessibility issues, the U.S. surgeon general issued a *Call to Action to Improve the Health and Wellness of Persons with Disabilities* (USDHHS, 2005a). This report recognized that all persons with disabilities need to have access to comprehensive health care so that they are able to have full, engaged, and productive lives in their own communities. Among strategies to accomplish this, the document stipulated that health care professionals need to become knowledgeable about disability. It further recommended that schools training people for the health professions teach about disability and address the need for increased availability of methods to screen, diagnose, and treat the whole person with a disability with dignity.

In an effort to improve the health care of people with disabilities, Senator Thomas Harkin proposed bill S. 1050, "Promoting Wellness for Individuals with Disabilities Act of 2007" in the U.S. Senate in 2007. This bill would amend the Rehabilitation Act of 1973 to require that standards be set for medical diagnostic equipment to ensure that such equipment is accessible to and usable by individuals with disabilities. The amended act would apply to examination tables and chairs, weight scales, mammography equipment, and other equipment commonly used for diagnostic purposes by health professionals (Congressional Record, 2007). The bill would also increase training programs to improve competency and clinical skills of health care professionals who provide health care and communicate with patients with disabilities by integrating the topic of disability into curricula.

## Barriers to Health Care

Many people with disabilities encounter barriers to full participation in life, including health care, health screening, and health promotion (Nehring & Faux, 2006; Smeltzer, Sharts-Hopko, Ott, et al., 2007). Some of these barriers are structural and make certain facilities inaccessible. Examples of structural barriers include stairs, lack of ramps, narrow doorways that do not permit entry of a wheelchair, and restroom facilities that cannot be used by people with disabilities (eg, restrooms that lack grab bars and those that lack larger restroom stalls designed for people using wheelchairs) (Kirschner, Breslin & Iezzoni, 2007).

Structural barriers to accessibility are most easily identified and eliminated. Other, less visible barriers include negative and stereotypic attitudes (eg, believing that all people with disabilities have a poor quality of life and are dependent and nonproductive) on the part of the public. Health care providers with similar negative attitudes make it difficult for people with disabilities to obtain health care equal in quality to that of people without disabilities. The Rehabilitation Act and the ADA were enacted more than 30 and 15 years ago, respectively, to ensure equal access to people with disabilities, but people with disabilities continue to encounter and report multiple barriers to health care facilities and providers (Smeltzer, et al., 2007). This legislation and the U.S. surgeon general's call to improve the health and wellness of people with disabilities (USDHHS, 2005a) are examples of efforts to eliminate barriers encountered by people with disabilities.

People with disabilities have reported that they often encounter barriers that prevent them from obtaining recommended health care screening and care. They have also reported lack of access to information, transportation difficulties, inability to pay because of limited income, difficulty finding a health care provider knowledgeable about their particular disability, previous negative health care encounters, reliance on caregivers, and the demands

## Chart 10-5 • *Interacting and Communicating With People With Disabilities*

Patients will feel most comfortable receiving health care if you consider the following suggestions.

### General Considerations

- Do not be afraid to make a mistake when interacting and communicating with someone with a disability or chronic medical condition. Keep in mind that a person with a disability is a person first, and is entitled to the dignity, consideration, respect, and rights you expect for yourself.
- Treat adults as adults. Address people with disabilities by their first names only if extending the same familiarity to all others present. Never patronize people by patting them on the head or shoulder.
- Relax. If you do not know what to do, allow the person who has a disability to identify how you may be of assistance and to put you at ease.
- If you offer assistance and the person declines, do not insist. If your offer is accepted, ask how you can best help, and follow directions. Do not take over.
- If someone with a disability is accompanied by another individual, address the person with a disability directly rather than speaking through the accompanying companion.
- Be considerate of the extra time it might take for a person with a disability to get things done or said. Let the person set the pace.
- Do not be embarrassed to use common expressions such as, "See you later," or "Got to be running," that seem to relate to the person's disability.
- Use person-first language: refer to "a person with a disability" rather than "a disabled person," and avoid referring to people by the disability or disorder they have (eg, "the diabetic").

### Mobility Limitations

- Do not make assumptions about what a person can and cannot do.
- Do not push a person's wheelchair or grab the arm of someone walking with difficulty without first asking if you can be of assistance and how you can assist. Personal space includes a person's wheelchair, scooter, crutches, walker, cane, or other mobility aid.
- Never move someone's wheelchair, scooter, crutches, walker, cane, or other mobility aid without permission.
- When speaking for more than a few minutes to a person who is seated in a wheelchair, try to find a seat for yourself, so that the two of you are at eye level.
- When giving directions to people with mobility limitations, consider distance, weather conditions, and physical obstacles such as stairs, curbs, and steep hills.
- It is appropriate to shake hands when introduced to a person with a disability. People who have limited hand use or who wear an artificial limb do shake hands.

### Vision Loss (Low Vision and Blindness)

- Identify yourself when you approach a person who has low vision or blindness. If a new person approaches, introduce him or her.
- It is appropriate to touch the person's arm lightly when you speak so that he or she knows to whom you are speaking before you begin.
- Face the person and speak directly to him or her. Use a normal tone of voice.
- Do not leave without saying you are leaving.
- If you are offering directions, be as specific as possible, and point out obstacles in the path of travel. Use specifics such as, "Left about twenty feet," or "Right two yards." Use clock cues, such as, "The door is at 10 o'clock."
- When you offer to assist someone with vision loss, allow the person to take your arm. This will help you to guide rather than propel or lead the person. When offering seating, place the person's hand on the back or arm of the seat.
- Alert people with low vision or blindness to posted information.
- Never pet or otherwise distract a canine companion or service animal unless the owner has given you permission.

### Hearing Loss (Hard of Hearing, Deaf, Deaf-Blind)

- Ask the person how he or she prefers to communicate.
- If you are speaking through a sign language interpreter, remember that the interpreter may lag a few words behind—especially if there are names or technical terms to be fingerspelled—so pause occasionally to allow the interpreter time to translate completely and accurately.
- Talk directly to the person who has hearing loss, not to the interpreter. However, although it may seem awkward to you, the person who has hearing loss will look at the interpreter and may not make eye contact with you during the conversation.
- Before you start to speak, make sure you have the attention of the person you are addressing. A wave, a light touch on the arm or shoulder, or other visual or tactile signals are appropriate ways of getting the person's attention.
- Speak in a clear, expressive manner. Do not overenunciate or exaggerate words. Unless you are specifically requested to do so, do not raise your voice. Speak in a normal tone; do not shout.
- To facilitate lip reading, face the person and keep your hands and other objects away from your mouth. Maintain eye contact. Do not turn your back or walk around while talking. If you look away, the person might assume the conversation is over.
- Avoid talking while you are writing a message for someone with hearing loss, because the person cannot read your note and your lips at the same time.
- Try to eliminate background noise.
- Encourage feedback to assess clear understanding.
- If you do not understand something that is said, ask the person to repeat it or to write it down. The goal is communication; do not pretend to understand if you do not.
- If you know any sign language, try using it. It may help you communicate, and it will at least demonstrate your interest in communicating and your willingness to try.

### Speech Disabilities or Speech Difficulties

- Talk to people with speech disabilities as you would talk to anyone else.
- Be friendly; start up a conversation.
- Be patient; it may take the person a while to answer. Allow extra time for communication. Do not speak for the person.
- Give the person your undivided attention.
- Ask the person for help in communicating with him or her. If the person uses a communication device such as a manual or electronic communication board, ask the person how best to use it.
- Speak in your regular tone of voice.

*Continued*

## Chart 10-5 • *Interacting and Communicating With People With Disabilities* (Continued)

- Tell the person if you do not understand what he or she is trying to say. Ask the person to repeat the message, spell it, tell you in a different way, or write it down. Use hand gestures and notes.
- Repeat what you understand. The person's reactions will clue you in and guide you to understanding.
- To obtain information quickly, ask short questions that require brief answers or a head nod. However, try not to insult the person's intelligence with oversimplification.
- Keep your manner encouraging rather than correcting.

### Intellectual/Cognitive Disabilities

- Treat adults with intellectual/cognitive disabilities as adults.
- Try to be alert to the individual's responses so that you can adjust your method of communication as necessary. For example, some people may benefit from simple, direct sentences or from supplementary visual forms of communication, such as gestures, diagrams, or demonstrations.
- Use concrete rather than abstract language. Be specific, without being too simplistic. When possible, use words that relate to things you both can see. Avoid using directional terms such as right, left, east, or west.
- Be prepared to give the person the same information more than once in different ways.
- When asking questions, phrase them to elicit accurate information. People with intellectual/cognitive disabilities may be eager to please and may tell you what they think you want to hear. Verify responses by repeating the question in a different way.
- Give exact instructions. For example, "Be back for lab work at 4:30," not "Be back in 15 minutes."
- Too many directions at one time may be confusing.
- The person may prefer information provided in written or verbal form. Ask the person how you can best relay the information.
- Using humor is fine, but do not interpret a lack of response as rudeness. Some people may not grasp the meaning of sarcasm or other subtleties of language.
- People with brain injuries may have short-term memory deficits and may repeat themselves or require information to be repeated.
- People with auditory perceptual problems may need to have directions repeated and may take notes to help them remember directions or the sequence of tasks. They may benefit from watching a task demonstrated.
- People with perceptual or "sensory overload" problems may become disoriented or confused if there is too much to absorb at once. Provide information gradually and clearly. Reduce background noise if possible.
- Repeat information using different wording or a different communication approach if necessary. Allow time for the information to be fully understood.
- Do not pretend to understand if you do not. Ask the person to repeat what was said. Be patient, flexible, and supportive.
- Some people who have an intellectual disability are easily distracted. Try not to interpret distraction as rudeness.
- Do not expect all people to be able to read well. Some people may not read at all.

### Psychiatric/Mental Health Disabilities

- Speak directly to the person. Use clear, simple communication.
- Offer to shake hands when introduced. Use the same good manners in interacting with a person who has a psychiatric/mental health disability that you would with anyone else.
- Make eye contact and be aware of your own body language. Like others, people with psychiatric/mental health disabilities will sense your discomfort.
- Listen attentively and wait for the person to finish speaking. If needed, clarify what the person has said. Never pretend to understand.
- Treat adults as adults. Do not patronize, condescend, or threaten. Do not make decisions for the person or assume that you know the person's preferences.
- Do not give unsolicited advice or assistance. Do not panic or summon an ambulance or the police if a person appears to be experiencing a mental health crisis. Calmly ask the person how you can help.
- Do not blame the person. A person with a psychiatric disability has a complex, biomedical condition that is sometimes difficult to control. They cannot just "shape up." It is rude, insensitive, and ineffective to tell or expect a person to do so.
- Question the accuracy of media stereotypes of psychiatric/mental health disabilities: movies and media often sensationalize psychiatric/mental health disabilities. Most people never experience symptoms that include violent behavior.
- Relax. Be yourself. Do not be embarrassed if you happen to use common expressions that seem to relate to a psychiatric/mental health disability.
- Recognize that beneath the symptoms and behaviors of psychiatric disabilities is a person who has many of the same wants, needs, dreams, and desires as anyone else. If you are afraid, learn more about psychiatric/mental health disabilities.

This material is adapted and based in part on *Achieving Physical and Communication Accessibility*, a publication of the National Center for Access Unlimited; *Community Access Facts,* an Adaptive Environments Center publication; and *The Ten Commandments of Interacting with People with Mental Health Disabilities,* a publication of The Ability Center of Greater Toledo.

of coping with the disability itself (Institute of Medicine [IOM], 2007; Smeltzer, et al., 2007; USDHHS, 2005a). These issues affect both men and women who have severe disabilities; however, women appear to be at higher risk for receiving a lower level of health care than men. Women with disabilities are significantly less likely to receive pelvic examinations than women without disabilities; the more severe the disability, the less frequent the examination. In particular, minority women and older women with disabilities are less likely to have regular pelvic examinations and Papanicolaou (Pap) tests. Reasons given by women for not having regular pelvic examinations are difficulty transferring onto the examination table, belief that they do not need pelvic examinations because of their disability, difficulty in accessing the office or clinic, and difficulty finding transportation

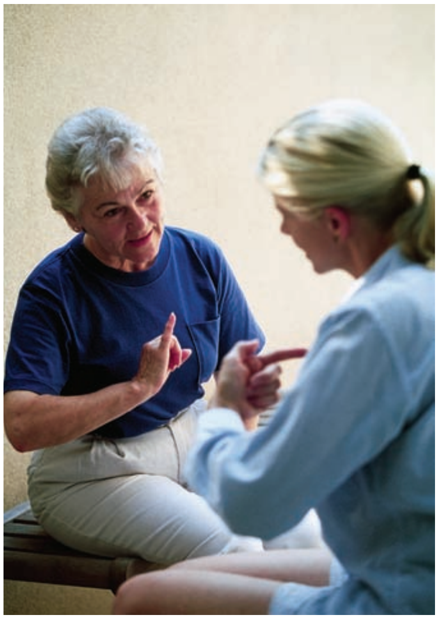


**Figure 10-2** Alternative communication methods and types of patient education are essential to provision of appropriate health-related information to people with disabilities. © Will & Deni McIntyre/Photo Researchers, Inc.

(Smeltzer, et al., 2007; USDHHS, 2005a). Health care providers may underestimate the effect of disabilities on women's ability to access health care, including health screening and health promotion, and they may focus on women's disabilities while ignoring women's general health issues and concerns. Furthermore, women with disabilities have also reported a lack of knowledge about disability and insensitivity on the part of health care providers (Smeltzer, et al., 2007).

Because of the persistence of these barriers, it is essential that nurses and other health care providers take steps to ensure that clinics, offices, hospitals, and other health care facilities are accessible to people with disabilities. This includes removal of structural barriers by adding ramps, designating accessible parking spaces, and modifying restrooms to make them usable by people with disabilities. Alternative communication methods (eg, sign interpreters, teletypewriter [TTY] devices, assistive listening devices) and types of patient education (eg, audiotapes, large print, Braille) are essential to provision of appropriate health-related information to people with disabilities (Fig. 10-2). These reasonable accommodations are mandated by the ADA, which requires their provision without cost to the patient.

### Federal Assistance Programs

Lack of financial resources, including health insurance, is an important barrier to health care for people with chronic illness and disabilities. However, several federal assistance programs provide financial assistance for health-related expenses for people with some chronic illnesses, acquired disabling acute and chronic diseases, and childhood disabilities.

Medicare is a federal health insurance program that is available to most people 65 years of age and older, people with permanent renal failure, and qualified people with disabilities. Title II of the Social Security Disability Insurance program pays benefits to those people who meet medical criteria for disability, who have worked long enough (40 quarters of covered employment) to qualify, and who have paid Social Security taxes. Title II also provides benefits to people disabled since childhood (younger than 22 years of age) who are dependants of a deceased insured parent or a parent entitled to disability or retirement benefits, and disabled widows or widowers, 50 to 60 years of age, if their deceased spouse was insured under Social Security. Title XVI of the Social Security Disability Insurance program provides supplemental security income (SSI) payments to people who are disabled and have limited income and resources.

Medicaid provides home and community-based services to people with disabilities and long-term illnesses to enable them to lead meaningful lives with their families and in their communities (USDHHS, 2005a). (See Resources at the end of the chapter for more information about these benefits.)

Despite the availability of these federal programs, people with disabilities often have health-related costs and other expenses related to their disabilities that result in low income status. Furthermore, people must undergo a disability determination process to establish eligibility for benefits, and the process can be prolonged and cumbersome for those who may need assistance in establishing their eligibility.

## Nursing Care of Patients With Disabilities

As active members of society, people with disabilities are no longer an invisible minority. An increased awareness of the needs of people with disabilities will bring about changes to improve their access and accommodate their needs. Modification of the physical environment permits access to public and private facilities and services, including health care, and nurses can serve as advocates for people with disabilities to eliminate discriminatory practices.

### Nursing Considerations During Hospitalization

During hospitalization, as well as during periods of acute illness or injury or while recovering from surgery, patients with preexisting disabilities may require assistance with carrying out ADLs that they could otherwise manage at home independently and easily. Patients should be asked preferences about approaches to carrying out their ADLs, and assistive devices they require should be readily available. Careful planning with patients to ensure that the hospital room is arranged with their input enables them to manage as independently as possible. For example, patients who have paraplegia may be able to transfer independently from bed to wheelchair; however, if the bed is left in an elevated position, they may be unable to do so. If patients usually use

service animals to assist them with ADLs, it is necessary to make arrangements for the accommodation of these animals. If patients with hearing loss or communication impairments are hospitalized, it is essential to establish effective communication strategies (Lieu, Sadler, Fullerton, et al., 2007; Wallhagen, Pettengill & Whiteside, 2006). Alternative methods for these patients to communicate with the health care team must be put in place and used, and all staff members must be aware that some patients are not able to respond to the intercom or telephone. If patients have vision impairment, it is necessary to orient them to the environment and to make an effort to talk to them in a normal tone of voice (Rushing, 2007).

## Health Promotion and Prevention

Health care providers often neglect health promotion concerns of people with disabilities, who may be unaware of these concerns. For example, people who have had hearing loss since childhood may lack exposure to information about AIDS through radio and television. People with lifelong disabilities may not have received information about general health issues as children, and people with new-onset as well as lifelong disabilities may not receive encouragement to participate in health promotion activities. Therefore, nurses should take every opportunity to emphasize the importance of participation, both in health promotion activities (eg, healthy diet, exercise, social interactions) and in preventive health screening.

The management of some disabilities increases the risk of illness, and in some people, health screening (eg, bone density testing, gynecologic examinations, mammography) may be required earlier in life or more frequently (Smeltzer, 2006; Smeltzer & Sharts-Hopko, 2005). Referrals by nurses to accessible sites for screening may be needed, because many imaging centers are inaccessible. In addition, nursing consultation with physical therapists may be needed to identify creative ways of enabling people with disabilities to exercise safely, because exercise facilities are also often inaccessible for people with disabilities.

General health promotion strategies and health screening recommendations for all men and women also apply to those with disabilities. Although physical limitations, cognitive impairments, and structural and attitudinal barriers that exist in clinical facilities may make it difficult for some men and women to obtain health care and preventive health screening, the presence of a disability should not be used as a reason or excuse to defer recommended screening. Rather, the presence of a disability may increase the risk of **secondary conditions** that require screening and follow-up. Just as people without disabilities should have regular screening tests, such as mammography or testicular and prostate examinations, so should people with disabilities (USDHHS, 2005a, 2005b). Nurses are often in a position to influence decisions about how equipment and procedures can be adapted to meet the special needs of their patients, whether these needs are cognitive, motor, or communicative.

The effect of the disabling condition on health risks should be considered. For example, the risk of osteoporosis may be increased in women and men whose disabilities limit their ability to participate in weight-bearing exercise or who use medications that contribute to bone loss (Smeltzer, Zimmerman & Capriotti, 2005). Although people with disabilities have an increased risk of osteoporosis at a younger age than people without disabilities, little attention is given to prevention, detection, and treatment of osteoporosis, despite the increased risk for falls associated with many disabling disorders (Smeltzer, 2006).

Nurses can provide expert health promotion education classes that are targeted to people with disabilities and refer them to accessible online resources. Classes on nutrition and weight management are extremely important to people who are wheelchair users and need assistance with transfers. Safer sex classes are needed by adolescents and young adults who have spinal cord injury, traumatic brain injury, or developmental disabilities, because the threats of sexually transmitted infections (STIs) and unplanned pregnancy exist for these populations just as they do for the population in general. Other healthy behaviors about which people with neurologic disabilities need education include avoiding alcohol and nonprescription medications while taking antispasmodic and antiseizure medications.

## Significance of "People-First" Language

It is important to all people, both those with and those without disabilities, that they not be equated with their illness or physical condition. Therefore, it is important to refer to all people using "people-first" language. Using "people-first" language means referring to the person first: "the patient with diabetes" rather than "the diabetic" or "the diabetic patient"; "the person with a disability" rather than the "disabled person"; "women with disabilities" rather than "disabled women"; and "people who are wheelchair users" rather than "the wheelchair-bound." This simple use of language conveys the message that the person, rather than the illness or disability, is of greater importance to the nurse.

## Gerontologic Considerations

Stereotypical thinking often leads to the conclusion that disability is associated only with being elderly. However, aging is an important issue that affects people with preexisting disabilities. In addition, the process of aging has been described as accelerated in people with disabilities because they often develop changes associated with aging at a younger age than do those without disabilities (IOM, 2007). Therefore, it is important that the nurse consider the effects of aging on a preexisting disability and in turn the effects of disability on aging. The following examples may be useful.

- People who use crutches for ambulation because of polio often experience muscle problems as they age because of long-time overuse of the upper extremities; symptoms may not occur for many years but may cause discomfort and interfere with the person's ability to perform ADLs.
- People who experienced respiratory compromise with the onset of polio decades earlier may experience increasing respiratory symptoms with aging (Bartels & Omura, 2005).
- Women with long-standing mobility limitations and lack of weight-bearing exercise may experience bone loss and osteoporosis prior to menopause (Smeltzer, et al., 2005). Therefore, people with a preexisting

disability should be evaluated for early onset of changes related to aging.

Concern about what the future holds is common in people aging with preexisting disabilities who may have questions about what physical, financial, and emotional supports they will have as they age (Nosek, 2000). If their disability becomes more severe in the future, they may be concerned about placement in an assisted living facility or a long-term care facility. The nurse should recognize the concerns of people with disabilities about their future and encourage them to make suitable plans, which may relieve some of their fears and concerns about what will happen to them as they age.

Parents of adult children with developmental disabilities often fear what will happen when they are no longer available and able to care for their children. Limited long-term care resources, increased life expectancy for people with developmental disabilities, changing family patterns, and competition with the elderly population for similar resources increase the fears of these parents (Parish & Lutwick, 2005). Thus, there is a need for the nurse to identify needed community resources and services. Identifying these issues and concerns and assessing arrangements made by aging parents of adult children with disabilities can help reduce some of their fears about their children's futures.

## Disability in Medical-Surgical Nursing Practice

Disability is often considered an issue that is specific or confined to rehabilitation nursing or to gerontologic nursing. However, as noted previously, disability can occur across the lifespan, and it is encountered in all settings. Patients with preexisting disabilities due to conditions that have been present from birth or due to illnesses or injuries experienced as an adolescent or young adult often require health care and nursing care in medical-surgical settings. Although in the past many people with lifelong disabilities or adult onset of severe disabilities may have had shortened lifespans, today most can expect to have a normal or near-normal lifespan and to live a productive and meaningful life (Cristian, 2005). They are also at risk for the same acute and chronic illnesses that can affect all people.

Because of unfavorable interactions with health care providers, including negative attitudes, insensitivity, and lack of knowledge, people with disabilities may avoid seeking medical intervention or health care services. For this reason, and because the number of people with disabilities is increasing, nurses must acquire knowledge and skills and be accessible to assist them in maintaining a high level of wellness. Nurses are in key positions to influence the architectural design of health care settings and the selection of equipment that promotes ease of access and health. Padded examination tables that can be raised or lowered make transfers easier for people with disabilities. Birthing chairs benefit women with disability during yearly pelvic examinations and Pap smears and during urologic evaluations. Ramps, grab bars, and raised and padded toilet seats benefit many people who have neurologic or musculoskeletal disabilities and need routine physical examination and monitoring (eg, bone density measurements). When a patient with a disability is admitted to the hospital for any reason, the patient's needs for these modifications should be assessed and addressed (Smeltzer, 2007b).

Men and women with disabilities may be encountered in hospitals, clinics, offices, and nursing centers when they seek health care to address a problem related to their disabilities. However, they may also be encountered in these settings when they seek care for a health problem that is not related in any way to their disabilities. For example, a woman with spina bifida or polio might seek health care related to a gynecologic issue, such as vaginal bleeding. Although her disability should be considered in the course of assessment and delivery of health and nursing care, it should not become the overriding focus or exclusive focus of the assessment or the care that she receives. Furthermore, neither a severe physical disability that affects a woman's ability to transfer to an examination table for a gynecologic examination nor a cognitive disability should be a reason to defer a complete health assessment and physical examination, including a pelvic examination. Health care, including preventive health screening, is essential to enable people with disabilities to live the highest quality of life within the limitations imposed by their disabling conditions. Men and women with disabilities have the same needs and same rights for health care and preventive health screening as others, although in some cases, the consequences of their disability increase rather than decrease their need for health screening and for participation in health-promoting activities (Smeltzer & Sharts-Hopko, 2005). Therefore, it is essential that medical-surgical nurses be knowledgeable about disability and how it affects people across the lifespan and how to provide sensitive and quality nursing care for patients with preexisting as well as new-onset disability. In an effort to address these issues, specific information on health care of people with disabilities has been included throughout this book.

## Home and Community-Based Care

### *Teaching Patients Self-Care*

A major and often overlooked issue in teaching patients about a health problem, a treatment regimen, or health promotion strategies is the need for alternative formats to accommodate people with a variety of disabilities. Patients with disabilities are in need of the same information as other patients; however, they often require large print, Braille, audiotapes, or the assistance of a sign interpreter. Materials may be obtained from a variety of sources for patients who need these teaching strategies and for patients with cognitive impairments due to developmental disabilities or newly acquired disabilities.

Nurses should ensure that all people, whether or not they have disabilities, recognize the warning signs and symptoms of stroke, heart attack, and cancer, as well as how to access help. In addition, nurses should teach all patients who are stroke survivors and those with diabetes how to monitor their own blood pressure or glucose levels.

### *Continuing Care*

When caring for patients with disabilities and helping them plan for discharge and continuing care in the home, it is

important to consider how a particular disability affects a patient's ability to adhere to recommended treatment regimens and to keep follow-up appointments. Furthermore, it is important to consider how the health issue or treatment regimen affects the disability. Although many people with disabilities are independent and able to make decisions, arrangements for transportation, and appointments to accessible facilities, others may have difficulty doing so, particularly if they are experiencing a health problem. The nurse should recognize the effect that the disability has on the patient's ability to follow-up. The nurse should ask the patient whether he or she anticipates having any difficulties arranging for follow-up care. It is important for the nurse to assist the patient with disabilities to identify unmet needs and to find and use resources (community and social resources, financial and transportation services) that enable the patient to obtain needed services while remaining in his or her home, if preferred. The nurse should have a list of accessible sites and services available and share those resources with the patient and family. In collaboration with other health care providers (occupational and physical therapists, speech therapists), the nurse can identify needed home modifications, including those that are simple and inexpensive that will enable the patient to participate in self-care at home.

## CRITICAL THINKING EXERCISES

**1** A 28-year-old woman with three children younger than 4 years of age has recently been diagnosed with multiple sclerosis (MS) following vision loss secondary to optic neuritis. Her neurologist has recommended that she begin injection therapy with one of the disease-modifying agents to minimize the number and severity of MS exacerbations. She is very active in her community and church and states that she cannot fit learning about MS or injection therapy into her very busy life. Further, she states that she doubts that the diagnosis is correct but is not interested in seeking a second opinion or in talking to anyone knowledgeable about MS. Identify approaches you would use to establish a plan of care with her. Link your teaching to the trajectory onset phase of chronic illness. How would your plan of nursing care change in the acute and crisis stages of chronic illness?

EBP **2** A 28-year-old man with Down syndrome has been diagnosed with asthma and has received a prescribed inhaler. He lives in a group home and has had a job at the post office assisting office personnel for the past 5 years. What approaches will you use to teach the patient and other significant people in his life about asthma management? Identify the evidence base for the asthma treatments that you will teach him and any modifications that may be needed in management and in teaching approaches.

EBP **3** A 41-year-old woman with quadriplegia due to spinal cord injury (SCI) has never had a mammography and has not had a gynecologic examination in more than 15 years, before the SCI. During a recent admission for treatment of a secondary condition due to her disability, you decide to encourage her to undergo preventive health screening, including screening for breast, cervical, and colon cancer, as well as for low bone density. In discussing these issues with her, what evidence will you use to provide recommendations for screening? What is the research evidence about the patterns of women with disabilities undergoing preventive health screening and barriers to screening? How would you help prepare her for the health screening tests?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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## RESOURCES

Abledata, http://abledata.com

American Association of the Deaf-Blind, www.aadb.org

American Association on Intellectual and Developmental Disabilities (formerly American Association on Mental Retardation), www.aaidd.org

American Foundation for the Blind, www.afb.org

American Speech-Language-Hearing Association, www.asha.org

Americans With Disabilities Act Information Technology Center, www.adata.org

ARC of the United States, www.thearc.org

Association of Late Deafened Adults, www.alda.org

Centers for Medicare and Medicaid Services, www. cms.hhs.gov

Center for Research on Women with Disabilities (CROWD), www.bcm.edu/crowd

ChronicNet, www.chronicnet.org/chronnet/project.htm (This Web site provides local and national data on chronic care issues and populations.)

National Aphasia Association, www.aphasia.org

National Center for Learning Disabilities, www.ncld.org

North Carolina Office on Disability and Health, www.fpg.unc.edu/~ncodh or www.wch.dhhs.state.nc.us/cay.htm

Through the Looking Glass, www.lookingglass.org

United Cerebral Palsy, www.ucp.org

United Spinal Association, www.unitedspinal.org

Villanova University Health Promotion for Women with Disabilities Project, Villanova University College of Nursing, www.nurseweb.villanova.edu/womenwithdisabilities/welcome.htm



chapter 11

# Principles and Practices of Rehabilitation

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the goals of rehabilitation.
2. Discuss the interdisciplinary approach to rehabilitation.
3. Identify emotional reactions exhibited by patients with disabilities.
4. Use the nursing process as a framework for care of patients with self-care deficits, impaired physical mobility, impaired skin integrity, and altered patterns of elimination.
5. Describe nursing strategies appropriate for promoting self-care through activities of daily living.
6. Describe nursing strategies appropriate for promoting mobility and ambulation and the use of assistive devices.
7. Describe risk factors and related nursing measures to prevent development of pressure ulcers.
8. Incorporate bladder training and bowel training into the plan of care for patients with bladder and bowel problems.
9. Describe the significance of continuity of care and community reentry from the health care facility to the home or extended care facility for patients who need rehabilitative assistance and services.

## GLOSSARY

**activities of daily living (ADLs):** self-care activities including bathing, grooming, dressing, eating, toileting, and bowel and bladder care

**adaptive device:** a type of assistive technology that is used to change the environment or help the person to modify the environment (eg, a ramp that can be used in place of steps for someone in a wheelchair)

**assistive device:** a type of assistive technology that helps people with disabilities perform a given task (eg, a lap board with pictures that is used to assist a person who cannot talk to communicate)

**assistive technology:** any item, piece of equipment, or product system—whether acquired commercially, off the shelf, modified, or customized—that is used to improve the functional capabilities of individuals with disabilities; this term encompasses both assistive devices and adaptive devices

**disability:** restriction or lack of ability to perform an activity in a normal manner, the consequences of impairment in terms of an individual's functional performance and activity; disabilities represent disturbances at the level of the person (eg, bathing, dressing, communication, walking, grooming)

**habilitation:** making able; learning new skills and abilities to meet maximum potential

**impairment:** loss or abnormality of psychological, physiologic, or anatomic structure or function at the organ level (eg, dysphagia, hemiparesis); an abnormality of body structure, appearance, an organ, or system function resulting from any cause

**instrumental activities of daily living (IADLs):** complex aspects of independence including meal preparation, grocery shopping, household management, finances, and transportation

**pressure ulcer:** breakdown of the skin due to prolonged pressure and insufficient blood supply, usually at bony prominences

**rehabilitation:** making able again; relearning skills or abilities or adjusting existing functions

**Rehabilitation** is a dynamic, health-oriented process that helps people with acute or chronic disorders or people with physical, mental, or emotional **disabilities** (restrictions in performance or function in everyday activities) to achieve the greatest possible level of physical, mental, spiritual, social, and economic functioning. The rehabilitation process also helps patients achieve an acceptable quality of life with dignity, self-respect, and independence. During rehabilitation—sometimes called habilitation—patients adjust to disabilities by learning how to use resources and focus on existing abilities. In **habilitation,** abilities, not disabilities, are emphasized.

Rehabilitation is an integral part of nursing because every major illness or injury carries the threat of disability or **impairment,** which involves a loss of function or an abnormality in body structure or function. The principles of rehabilitation are basic to the care of all patients, and rehabilitation efforts should begin during the initial contact with a patient. The goal of rehabilitation is to restore the patient's ability to function independently or at a preillness or preinjury level of functioning as quickly as possible. If this is not possible, the aims of rehabilitation are to maximize independence and prevent secondary disability as well as to promote a quality of life acceptable to the patient.

Rehabilitation services are required by more people than ever before because of advances in technology that save or prolong the lives of seriously ill and injured patients and patients with disabilities. Increasing numbers of patients who are recovering from serious illnesses or injuries are returning to their homes and communities with ongoing needs. Significant disability caused by war and terrorism also increases the demand for rehabilitation services. All patients, regardless of age, gender, ethnic group, socioeconomic status, or diagnosis, have a right to rehabilitation services (Chart 11-1).

### CHART 11-1 *Ethics and Related Issues*

**Are All Persons Entitled to Rehabilitation?**

**Situation**

You work in an area where many illegal aliens and uninsured residents live. Community violence often creates life-threatening and disabling conditions in members of the population. After a victim of violence has been saved and stabilized, the health care team identifies rehabilitation needs. You are concerned about your patient's inability to perform self-care and to demonstrate safe mobility skills.

**Dilemma**

As a health care provider, you are concerned about the community as a whole; costs to the community, and the values of the community. You are also aware of client fiduciary responsibility; you recognize costs to your patient when treatment is provided or not provided.

**Discussion**

1. Who determines the length of stay and level of care?
2. Who will take care of patients who need rehabilitation but who are unable to pay? Is rehabilitation a basic health care need?

A person is considered to have a disability, such as a restriction in performance or function in everyday activities, if he or she has difficulty talking, hearing, seeing, walking, climbing stairs, lifting or carrying objects, performing activities of daily living, doing schoolwork, or working at a job. The disability is severe if the person cannot perform one or more activities, uses an assistive device for mobility, or needs help from another person to accomplish basic activities. The purpose of **adaptive devices** and **assistive devices** is to maximize independence and thereby promote access. A person is also considered severely disabled if he or she receives federal benefits because of an inability to work.

Approximately 1 in 5 Americans over 5 years of age has some form of disability, and 1 in 10 has a severe disability (U.S. Census Bureau, 2006). Approximately 54 to 60 million people are affected by some form of disability, and this number is expected to increase in the coming decades due to the aging of the population. The results of the 2006 American Community Survey indicated that the prevalence of disability in men and boys was higher than among women and girls. Conversely, reported disability rates were higher for women than men 65 years of age and older (43% for women, 40% for men). In this survey, nearly 10 million people identified a self-care deficit requiring personal assistance with one or more **activities of daily living** (ADLs), defined as activities related to personal care; or **instrumental activities of daily living** (IADLs), defined as activities related to independent living (National Center for Health Statistics, 2007) (Chart 11-2). It is estimated that among the U.S. population 15 years of age and older, 2.7 million people use a wheelchair and 9.1 million use an ambulatory aid such as a cane, crutches, or a walker (U.S. Census Bureau, 2002). Use of these devices and other types of **assistive technology** has increased dramatically due to the aging of the population, technologic advances, public policy initiatives, and changes in the delivery and financing of health care (U.S. Census Bureau, 2006).

### Chart 11-2 • *Activities of Daily Living and Independent Activities of Daily Living*

**Activities of Daily Living** (ADLs): Activities related to personal care

- Bathing
- Showering
- Dressing
- Getting in or out of bed or a chair
- Using the toilet
- Eating

**Independent Activities of Daily Living** (IADLs): Skills for independent living

- Cooking
- Cleaning
- Shopping
- Doing laundry
- Managing personal finances
- Developing social and recreational skills
- Handling emergencies

## Americans With Disabilities Act

For years, people with disabilities have been discriminated against in employment, public accommodations, and public and private services, including health care. In 1990, the U.S. Congress passed the Americans With Disabilities Act (ADA) (PL 101-336), which is civil rights legislation designed to provide people with disabilities access to job opportunities and to the community. See Chapter 10 for discussion of the ADA, access to health care and health promotion, and special issues that should be addressed in providing health care to people with disabilities.

## Patients' Reactions to Disability

Disability can occur at any age and may result from an acute incident, such as stroke, traumatic spinal cord injury, or brain injury, or from the progression of a chronic condition, such as arthritis or multiple sclerosis. Certain factors common to both disability and chronic illness may include some functional limitation, interference with daily activities and life roles, an uncertain prognosis, prolonged medical treatment and rehabilitation, psychosocial stress associated with the trauma or disease process, a negative impact on family and friends, and negative economic implications (Livneh & Antonak, 2005). The interaction of these factors has a profound effect on the lives of individuals with chronic illness and disability.

Patients and families who suddenly experience a physically disabling event or the onset of a chronic illness face several psychosocial adjustments. Their reactions and responses to such life-altering illness events influence immediate and long-term rehabilitation processes and the process of adapting to chronic illness and disability. As suggested by Livneh and Antonak (2005), psychosocial adaptation to chronic illness and disability is generally identified by "basic concepts," "chronic illness and disability-triggered reactions," and "chronic illness and disability-associated coping strategies." Basic concepts include stress, crisis, loss and grief, body image, self-concept, stigma, uncertainty and unpredictability, and quality of life. The most frequently reported chronic illness and disability-triggered reactions include shock, which is a short-lived reaction experienced at the onset of a traumatic and sudden injury or the onset of a life-threatening or chronic and debilitating disease; anxiety, which is a panic-like state as the nature and magnitude of the event is processed; denial, which is a defense mechanism used to ward off anxiety and other intense emotions; depression, which reflects the realization of the permanence and magnitude of the chronic illness or disability; anger and hostility that are both self-directed and externalized; and adjustment, which is exemplified by self-acceptance as a person with a chronic illness or disability and marked by reintegration into the community. Finally, chronic illness and disability-associated coping strategies are those psychological strategies that are used to decrease, modify, or diffuse the impact of stressful life events. Individuals with chronic illnesses or disabilities may choose to disengage from the recovery process (eg, through denial or substance abuse) or actively engage in activities to meet challenges associated with the chronic illness or disability (eg, information seeking, problem solving, planning).

All professionals involved in health care, including nurses, should recognize the emotional and psychological needs of patients and should be able to intervene by providing effective information, compassionate communication, and general psychological support (Chart 11-3). The nurse should take time to listen to patients talk about their disabilities; be respectful of their values and beliefs; and understand that grief, anger, regret, resentment, and acceptance are all part of the healing process. Chart 11-4 lists concerns unique to older adults.

### CHART 11-3 NURSING RESEARCH PROFILE
### *Needs of Patients in Rehabilitation*

Sigurgeirsdottir, J. & Halldorsdottir, S. (2007). Existential struggle and self-reported needs of patients in rehabilitation. *Journal of Advanced Nursing, 61*(4), 384–392.

#### Purpose

Nurses need to be able to recognize individual patient needs to plan effective care. Few studies have explored rehabilitation needs from the patient's perspective. This study intended to increase understanding of patients' experiences of rehabilitation and their self-reported rehabilitation needs.

#### Design

The purposive sample for this phenomenological study consisted of 16 in-depth interviews with 12 participants between the ages of 26 and 85 years. Each of these participants had experienced rehabilitation therapy to treat an acute or chronic illness within a recent 2-year time frame. Researchers predetermined that each potential participant was capable of tolerating a 60- to 90-minute interview.

#### Findings

Participants' self-reported needs included individualized caring and emotional support from family, peers, and staff. Patients also expressed a need for a sense of security in a stable and homelike environment, with assistance, help, and presence of supportive others. Finally, participants reported needing goal-oriented and progressive care in which realistic and achievable goals were established. Individualized educational approaches were well received and improved participants' self-esteem.

#### Nursing Implications

Rehabilitation nursing should focus on assessment of existential well-being of patients. This may be fostered by individualizing plans of nursing care. The findings of this study suggest that patients in rehabilitation experience existential struggles, described as struggling with changes to self-identity while trying to maintain characteristics of the "old life" or "old self." This struggle makes patients feel vulnerable. Being attuned to each patient's hierarchy of needs and educational needs may enhance the existential well-being of patients who require rehabilitation.

CHART 11-4 **Concerns of Adults Aging With Disability**

- Loss of independence, which is a source of self-respect and dignity
- Increased potential for discrimination or abuse
- Increased social isolation
- Added burden on spouse, who may also have impaired health
- Less access to community services and health care
- Less access to religious institutions
- Increased vulnerability to declining health secondary to other disorders, reduced physiologic reserve, or preexisting impairments of mobility and balance
- Fears and doubts about ability to learn or relearn self-care activities, exercises, and transfer and independent mobility techniques
- Inadequate support system for successful rehabilitation

The patient's preexisting coping abilities play an important role in the adaptation process. One patient may be particularly independent and determined, whereas another may be dependent and feel powerless. One goal of rehabilitation is to help the patient gain a positive self-image through effective coping. The nurse must recognize different coping abilities and identify when a patient is not coping well or not adjusting to the disability or chronic illness. The patient and family may benefit from participation in a support group or talking with a mental health professional to achieve this goal, and the nurse may need to refer them to someone who can help them with particular challenges. Refer to Chapter 6 for a detailed discussion of adaptive and maladaptive responses to illness.

## The Rehabilitation Team

Rehabilitation is a creative, dynamic process that requires a team of professionals working together with patients and families. The team members represent a variety of disciplines, with each health professional making a unique contribution to the rehabilitation process. In addition to nurses, members of the rehabilitation team may include physicians, nurse practitioners, physiatrists, physical therapists, occupational therapists, recreational therapists, speech-language therapists, psychologists, psychiatric liaison nurses, spiritual advisors, social workers, vocational counselors, orthotists or prosthetists, and sex counselors.

Nurses assume an equal or, depending on the circumstances of the patient, a more critical role than other members of the health care team in the rehabilitation process. The evidence-based plan of care that nurses develop must be approved by the patient and family and is an integral part of the rehabilitation process. The rehabilitation process is cyclical and includes a comprehensive assessment; establishment of short-term, medium-term, and long-term goals; development of a collaborative plan to work toward achieving the goals; and evaluation of progress toward the goals (Booth & Jester, 2007).

In working toward maximizing independence, nurses affirm the patient as an active participant and recognize the importance of informal caregivers in the rehabilitation process. The patient is a key member of the rehabilitation team, the focus of the team's effort, and the one who determines the final outcomes of the process. The patient participates in goal setting, in learning to function using his or her remaining abilities, and in adjusting to living with disabilities. The patient's family is also incorporated into the team. Families are dynamic systems; therefore, the disability of one member affects other family members. Only by incorporating the family into the rehabilitation process can the family system adapt to the change in one of its members. The family provides ongoing support, participates in problem solving, and learns to participate in providing ongoing care.

The nurse develops a therapeutic and supportive relationship with the patient and family. The nurse emphasizes the patient's assets and strengths, positively reinforcing the patient's efforts to improve self-concept and self-care abilities. During nurse–patient interactions, the nurse actively listens, encourages, and shares patient and family successes. Using the nursing process, the nurse develops a plan of care designed to facilitate rehabilitation, restore and maintain optimal health, and prevent complications.

Coping with the disability, fostering self-care, identifying mobility limitations, and managing skin care and bowel and bladder training are areas that frequently require nursing care. The nurse acts as a caregiver, teacher, counselor, patient advocate, case manager, and consultant. The nurse is often responsible for coordinating the total rehabilitative plan and collaborating with and coordinating the services provided by all members of the health care team, including home care nurses, who are responsible for directing patient care after the patient returns home.

## Areas of Specialty Rehabilitation

Although rehabilitation must be a component of every patient's care, specialty rehabilitation programs have been established in general hospitals, free-standing rehabilitation hospitals, and outpatient facilities. The Commission for the Accreditation of Rehabilitation Facilities (CARF) sets standards for these programs and monitors compliance with the standards.

- *Stroke recovery programs* and *traumatic brain injury rehabilitation* emphasize cognitive remediation, helping patients compensate for memory, perceptual, judgment, and safety deficits as well as teaching self-care and mobility skills. Other goals include helping patients swallow food safely and communicate effectively. Neurologic disorders treated in addition to stroke and brain injury include multiple sclerosis, Parkinson's disease, amyotrophic lateral sclerosis, and nervous system tumors.
- *Spinal cord injury rehabilitation* programs promote understanding of the effects and complications of spinal cord injury; neurogenic bowel and bladder management; sexuality and fertility enhancement; self-care, including prevention of skin breakdown; bed mobility and transfers; and driving with adaptive equipment. The programs also focus on vocational assessment,

training, and reentry into employment and the community. There are 16 federally funded designated spinal cord injury centers in the United States.

- *Orthopedic rehabilitation programs* provide comprehensive services to patients with traumatic or nontraumatic amputation, patients undergoing joint replacements, and patients with arthritis. Independence with a prosthesis or new joint is a major goal of these programs. Other goals include pain management, energy conservation, and joint protection.
- *Cardiac rehabilitation* for patients who have had myocardial infarction begins during the acute hospitalization and continues on an outpatient basis. Emphasis is placed on monitored, progressive exercise; nutritional counseling; stress management; sexuality; and risk reduction.
- *Pulmonary rehabilitation* programs may be appropriate for patients with restrictive or chronic obstructive pulmonary disease or ventilator dependency. Respiratory therapists help patients achieve more effective breathing patterns. The programs also teach energy conservation techniques, self-medication, and home ventilatory management.
- *Comprehensive pain management programs* are available for people with chronic pain, especially low back pain. These programs focus on alternative pain treatment modalities, exercise, supportive counseling, and vocational evaluation.
- *Comprehensive burn rehabilitation programs* may serve as step-down units from intensive care burn units. Although rehabilitation strategies are implemented immediately in acute care, a program focused on progressive joint mobility, self-care, and ongoing counseling is imperative for burn patients.
- *Pediatric rehabilitation programs* meet the needs of children with developmental and acquired disabilities, including cerebral palsy, spina bifida, traumatic brain injuries, and spinal cord injuries.

As in all areas of nursing practice, nurses practicing in the area of rehabilitation must be skilled and knowledgeable about the care of patients with substance abuse. For all people with disabilities, including adolescents, nurses must assess actual or potential substance abuse. Fifty percent of spinal cord injuries are related to substance abuse, and approximately 50% of all patients with traumatic brain injury were intoxicated at the time of injury (U.S. Department of Health and Human Services [DHHS], 2006a).

Substance abuse is a critical issue in rehabilitation, especially for people with disabilities who are attempting to gain employment via vocational rehabilitation. The rates of substance abuse, including alcohol abuse, in people with disabilities are two to four times as high as in the general population, and this increased abuse is associated with a number of risks that may have an adverse impact. These risks include medication and health problems, societal enabling (ie, acceptance and tolerance of substance abuse by key social and cultural groups), a lack of identification of potential problems, and a lack of accessible and appropriate prevention and treatment services. Treatment for alcoholism and drug dependencies includes thorough physical and psychosocial evaluations; detoxification; counseling; medical treatment; psychological assistance for patients and families; treatment of any coexisting psychiatric illness; and referral to community resources for social, legal, spiritual, or vocational assistance. The length of treatment and the rehabilitation process depends on the patient's needs. Self-help groups are also encouraged, although attendance at meetings of such groups (eg, Alcoholics Anonymous, Narcotics Anonymous) poses various challenges for people who have neurologic disorders, are permanent wheelchair users, or must adapt to encounters with nondisabled attendees who may not understand disability.

## Assessment of Functional Ability

Comprehensive assessment of functional capacity is the basis for developing a rehabilitation program. Functional capacity is a person's ability to perform ADLs and IADLs (see Chart 11-2).

The nurse observes the patient performing specific activities (eg, eating, dressing) and notes the degree of independence; the time taken; the patient's mobility, coordination, and endurance; and the amount of assistance required. The nurse also carefully assesses joint motion, muscle strength, cardiovascular reserve, and neurologic function, because functional ability depends on these factors as well. Observations are recorded on a functional assessment tool. These tools provide a way to standardize assessment parameters and include a scale or score against which improvements may be measured. They also clearly communicate the patient's level of functioning to all members of the rehabilitation team. Rehabilitation staff members use these tools to provide an initial assessment of the patient's abilities and to monitor the patient's progress in achieving independence.

One of the most frequently used tools to assess the patient's level of independence is the Functional Independence Measure (FIMTM). The FIMTM is a minimum data set, measuring 18 items. The self-care items measured are eating, bathing, grooming, dressing upper body, dressing lower body, toileting, bladder management, and bowel management. The FIMTM addresses transfers and the ability to ambulate and climb stairs and also includes communication and social cognition items. Scoring is based on a seven-point scale, with items used to assess the patient's level of independence. The Alpha FIMTM is used frequently in acute care settings to measure functional abilities within 72 hours of admission.

Although there are many disease-specific tools used to assess the patient's functional ability, some frequently used generic measures include the following:

- The PULSES profile, which is used to assess physical condition (eg, health/illness status), upper extremity functions (eg, eating, bathing), lower extremity functions (eg, transfer, ambulation), sensory function (eg, vision, hearing, speech), bowel and bladder function (ie, control of bowel or bladder), and situational factors (eg, social and financial support). Each of these areas is rated on a scale from one (independent) to four (greatest dependency).
- The Barthel Index, which is used to measure the patient's level of independence in ADLs, continence,

toileting, transfers, and ambulation (or wheelchair mobility). This scale does not address communicative or cognitive abilities.
- The Patient Evaluation Conference System (PECS), which contains 15 categories, is a comprehensive assessment scale that includes such areas as medications, pain, nutrition, use of assistive devices, psychological status, vocation, and recreation.

A detailed functional evaluation of secondary conditions related to the patient's disability, such as muscle atrophy and deconditioning, skin integrity, bowel and bladder control, and sexual function, together with residual strengths unaffected by disease or disability, is necessary. In addition, the nurse assesses the patient's physical, mental, emotional, spiritual, social, and economic status, and cultural and familial environment. These elements may provide a context to the functional findings and influence the rehabilitation plan. For example, the patient's perception of what it means to have a disability and the implications this might have on familial and social roles can influence the rehabilitation process.

## NURSING PROCESS

### The Patient With Self-Care Deficits in Activities of Daily Living

ADLs are those self-care activities that the patient must accomplish each day to meet personal needs; they include personal hygiene/bathing, dressing/grooming, feeding, and toileting. Many patients cannot perform such activities easily. An ADL program is started as soon as the rehabilitation process begins, because the ability to perform ADLs is frequently the key to independence, return to the home, and reentry into the community.

#### Assessment

The nurse must observe and assess the patient's ability to perform ADLs to determine the level of independence in self-care and the need for nursing intervention. Chart 11-5 depicts indications of potential problems in function or movement. The activity of bathing requires obtaining bath water and items used for bathing (eg, soap, washcloth), washing, and drying the body after bathing. Dressing requires getting clothes from the closet, putting on and taking off clothing, and fastening the clothing. Self-feeding requires using utensils to bring food to the mouth and chewing and swallowing the food. The activity of toileting includes removing clothing to use the toilet, cleansing oneself, and readjusting clothing. Grooming activities include combing hair, brushing one's teeth, shaving or applying makeup, and handwashing. Patients who can sit up and raise their hands to their head can begin self-care activities. Assistive devices are often essential in achieving some level of independence in ADLs.

The nurse should also be aware of the patient's medical conditions or other health problems, the effect that they have on the ability to perform ADLs, and the family's involvement in the patient's ADLs. This information is valuable in setting goals and developing the plan of care to maximize self-care.

#### Nursing Diagnosis

Based on the assessment data, major nursing diagnoses may include the following:

- Self-care deficit: bathing/hygiene, dressing/grooming, feeding, toileting

#### Planning and Goals

The major goals include performing the following activities independently or with assistance, using adaptive or assistive devices as appropriate: bathing/hygiene, dressing/grooming, feeding, and toileting. Another goal is patient expression of

CHART 11-5

### *Assessment of Potential Problems in Function or Movement*

Be alert for the following behaviors, which may indicate problems in function or movement:

- Holding onto a handrail to pull the body while going up stairs
- Holding onto a bedside rail or bedcovers to pull to sitting in bed
- Leaning to one side and using both hands on the handrail while going down the stairs or a ramp
- Holding onto furniture or doorways and watching the feet while walking in the house
- Lifting a leg (or arm) by using the other leg (or arm) as support or by lifting with the pants leg (or sleeve)
- Tilting the head to reach the back or side of the hair while grooming
- Pushing up, rocking forward and back, and/or leaning the body over for momentum ("nose over toes") when rising to stand from a chair
- Leaning over from the waist without bending the knees and then using one hand on the thigh, as if it were a prop, to assist in moving to the upright position
- Turning to reach for an object and then using the other arm or an object to support the reaching arm at the elbow or wrist
- Positioning a chair before sitting down by using the front or back of the knees and then using the back of the knees to guide sitting down; using the torso and hips to lean against a table or chair
- Reaching and leaning with the body rather than with an arm
- Walking with a lean to one side, a limp, a waddle, or other variation of a gait
- Scanning (ie, observing or being aware of surroundings) ineffectively while eating or grooming
- Rolling or scooting the body, sliding forward in a seat, or other maneuvers to move off a bed or out of a chair

Adapted from Hoeman, S. P. (2008). *Rehabilitation nursing: Prevention, intervention, and outcomes* (4th ed.). St. Louis, MO: Mosby.

satisfaction with the extent of independence achieved in self-care activities.

## Nursing Interventions

Repetition, practice, and demonstrations help patients achieve maximum independence in personal care activities. The nurse's role is to provide an optimal learning environment that minimizes distractions. The nurse can identify the patient's optimal time to work on activities, encourage concentration, identify endurance issues that may affect safety, and provide cues and reminders to patients with specific disabilities (eg, hemiparesis or hemineglect) (Hoeman, 2008). Patients with impaired mobility, sensation, strength, or dexterity may need to use assistive devices to accomplish self-care.

### *Fostering Self-Care Abilities*

A patient's approach to self-care may be affected by altered or impaired mobility and influenced by family or cultural expectations. The inability to perform self-care as carried out previously may lead to ineffective coping behaviors such as social isolation, dependency on caregivers, or depression. The nurse must motivate the patient to learn and accept responsibility for self-care. It helps to encourage an "I'd rather do it myself" attitude. The nurse must also help the patient identify the safe limits of independent activity; knowing when to ask for assistance is particularly important.

The nurse teaches, guides, and supports the patient who is learning or relearning how to perform self-care activities while maintaining a focus on patient strengths and optimal level of function. Consistency in instructions and assistance given by health care providers facilitates the learning process. Recording the patient's performance provides data for evaluating progress and may be used as a source for motivation and morale building. Guidelines for teaching about ADLs are presented in Chart 11-6.

### Chart 11-6• *Teaching About Activities of Daily Living*

1. Define the goal of the activity with the patient. Be realistic. Set short-term goals that can be accomplished in the near future.
2. Identify several approaches to accomplish the task (eg, there are several ways to put on a given garment).
3. Select the approach most likely to succeed.
4. Specify the approach on the patient's plan of care and the patient's level of accomplishment on the progress notes.
5. Identify the motions necessary to accomplish the activity (eg, to pick up a glass, extend arm with hand open; place open hand next to glass; flex fingers around glass; move arm and hand holding glass vertically; flex arm toward body).
6. Focus on gross functional movements initially, and gradually include activities that use finer motions (eg, buttoning clothes, eating with a fork).
7. Encourage the patient to perform the activity up to maximal capacity within the limitations of the disability.
8. Monitor the patient's tolerance.
9. Minimize frustration and fatigue.
10. Support the patient by giving appropriate praise for effort put forth and for acts accomplished.
11. Assist the patient to perform and practice the activity in real-life situations and in a safe environment.

Often, a simple maneuver requires concentration and the exertion of considerable effort on the part of the patient with a disability; therefore, self-care techniques need to be adapted to accommodate the lifestyle of individual patients. There is usually more than one way to accomplish a self-care activity, and common sense and a little ingenuity may promote increased independence. For example, a person who cannot quite reach his or her head may be able to do so by leaning forward. Encouraging the patient to participate in a support group may also help the patient discover creative solutions to self-care problems.

Preexisting cultural norms may influence the degree of self-care the patient is willing to consider. Cultural and ethnic beliefs about hygiene can vary among individuals and families. It is important for the nurse to recognize these beliefs, work through any issues with the patient and family, and communicate pertinent findings to the rehabilitation team.

### *Recommending Adaptive and Assistive Devices*

If the patient has difficulty performing an ADL, an adaptive or assistive device (self-help device) may be useful. A large variety of adaptive devices are available commercially or can be constructed by the nurse, occupational therapist, patient, or family. These devices may include built-up handles on toothbrushes or razors; long, curved handles on mirrors or shoe horns; suction cups to hold items in place; shower chairs; raised toilet seats; and universal cuffs to grip self-care items. Some of these are shown in Figure 11-1. To assist premenopausal women with managing menstruation, clothing adaptations (eg, Velcro crotch flaps for ease of access), mirrors, self-sticking sanitary pads, packaged wipes, and loose underwear may be used.

*NURSING ALERT*

**People who take anticoagulant medication should be encouraged to use an electric razor. Women may wish to consider depilatory creams or electrolysis.**

A wide selection of computerized devices is available, or devices can be designed to help individual patients with severe disabilities to function more independently. The ABLEDATA project (see Resources list at the end of this chapter) offers a computerized listing of commercially available aids and equipment for patients with disabilities.

The nurse should be alert to "gadgets" coming on the market and evaluate their potential usefulness. The nurse must exercise professional judgment and caution in recommending devices, because in the past, unscrupulous vendors have marketed unnecessary, overly expensive, or useless items to patients.

### *Helping Patients Accept Limitations*

If the patient has a severe disability, independent self-care may be an unrealistic goal; in this situation, the nurse teaches the patient how to direct his or her own care. The patient




**Figure 11-1** Adaptive devices. **A,** Feeding tools. **B,** Raised toilet seat. **C,** Shower chair.

may require a personal attendant to perform ADLs. Family members may not be appropriate for providing bathing/hygiene, dressing/grooming, feeding, and toileting assistance, and spouses may have difficulty providing bowel and bladder care for patients and maintaining the role of sexual partners. If a personal caregiver is necessary, the patient and family members must learn how to manage an employee effectively. The nurse helps the patient accept self-care dependency. Independence in other areas, such as social interaction, should be emphasized to promote a positive self-concept.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Demonstrates independent self-care in bathing/hygiene or with assistance, using adaptive devices as appropriate
   a. Bathes self at maximal level of independence
   b. Uses adaptive and assistive devices effectively
   c. Reports satisfaction with level of independence in bathing/hygiene
2. Demonstrates independent self-care in dressing/grooming or with assistance, using adaptive devices as appropriate
   a. Dresses/grooms self at maximal level of independence
   b. Uses adaptive devices effectively
   c. Reports satisfaction with level of independence in dressing/grooming
   d. Demonstrates increased interest in appearance
3. Demonstrates independent self-care in feeding or with assistance, using adaptive and assistive devices as appropriate
   a. Feeds self at maximal level of independence
   b. Uses adaptive and assistive devices effectively
   c. Demonstrates increased interest in eating
   d. Maintains adequate nutritional intake
4. Demonstrates independent self-care in toileting or with assistance, using adaptive and assistive devices as appropriate
   a. Toilets self at maximal level of independence
   b. Uses adaptive and assistive devices effectively
   c. Indicates positive feelings regarding level of toileting independence
   d. Experiences adequate frequency of bowel and bladder elimination
   e. Does not experience incontinence, constipation, urinary tract infection, or other complications

## NURSING PROCESS

### The Patient With Impaired Physical Mobility

Problems commonly associated with immobility include weakened muscles, joint contracture, and deformity. Each joint of the body has a normal range of motion; if the range is limited, the functions of the joint and the

muscles that move the joint are impaired, and painful deformities may develop. The nurse must identify patients at risk for such complications. The nurse needs to assess, plan, and intervene to prevent complications of immobility.

Another problem frequently seen in rehabilitation nursing is an altered ambulatory/mobility pattern. Patients with disabilities may be either temporarily or permanently unable to walk independently and unaided. The nurse assesses the mobility of the patient and designs care that promotes independent mobility within the prescribed therapeutic limits. If a patient cannot exercise and move his or her joints through their full range of motion, contractures may develop. A contracture is a shortening of the muscle and tendon that leads to deformity and limits joint mobility. When the contracted joint is moved, the patient experiences pain; in addition, more energy is required to move when joints are contracted.

## Assessment

At times, mobility is restricted because of pain, paralysis, loss of muscle strength, systemic disease, an immobilizing device (eg, cast, brace), or prescribed limits to promote healing. Assessment of mobility includes positioning, ability to move, muscle strength and tone, joint function, and the prescribed mobility limits. The nurse must collaborate with physical therapists or other team members to assess mobility.

During position change, transfer, and ambulation activities, the nurse assesses the patient's abilities, the extent of disability, and residual capacity for physiologic adaptation. The nurse observes for orthostatic hypotension, pallor, diaphoresis, nausea, tachycardia, and fatigue.

In addition, the nurse assesses the patient's ability to use various assistive devices that promote mobility. If the patient cannot ambulate without assistance, the nurse assesses the patient's ability to balance, transfer, and use assistive devices (eg, crutches, walker). Crutch walking requires high energy expenditure and produces considerable cardiovascular stress; therefore, people with reduced exercise capacity, decreased arm strength, and problems with balance because of aging or multiple diseases may be unable to use them. A walker is more stable and may be a better choice for such patients. If the patient uses an orthosis (an external appliance that provides support, prevents or corrects joint deformities, and improves function), the nurse monitors the patient for effective use and potential problems associated with its use.

## Nursing Diagnosis

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired physical mobility
- Activity intolerance
- Risk for injury
- Risk for disuse syndrome
- Impaired walking
- Impaired wheelchair mobility
- Impaired bed mobility

## Planning and Goals

The major goals may include absence of contracture and deformity, maintenance of muscle strength and joint mobility, independent mobility, increased activity tolerance, and prevention of further disability.

## Nursing Interventions

### *Positioning to Prevent Musculoskeletal Complications*

Deformities and contractures can often be prevented by proper positioning. Maintaining correct body alignment when the patient is in bed is essential regardless of the position selected. During each patient contact, the nurse evaluates the patient's position and assists the patient to achieve and maintain proper positioning and alignment. The most common positions that patients assume in bed are supine (dorsal), side-lying (lateral), and prone. The nurse helps the patient assume these positions and uses pillows to support the body in correct alignment. At times, a splint (eg, wrist or hand splint) may be made by the occupational therapist to support a joint and prevent deformity. The nurse must ensure proper use of the splint and provide skin care.

**PREVENTING EXTERNAL ROTATION OF THE HIP.** The patient who is in bed for an extended period of time may develop external rotation deformity of the hip because the ball-and-socket joint of the hip tends to rotate outward when the patient lies on his or her back. A trochanter roll (ie, a flannel sheet or bath towel folded in thirds lengthwise and rolled toward the patient or a commercially manufactured roll) extending from the crest of the ilium to the midthigh prevents this deformity; with correct placement, it serves as a mechanical wedge under the projection of the greater trochanter.

**PREVENTING FOOTDROP.** Footdrop is a deformity in which the foot is plantar flexed (the ankle bends in the direction of the sole of the foot). If the condition continues without correction, the patient will not be able to hold the foot in a normal position and will be able to walk only on his or her toes, without touching the ground with the heel of the foot. The deformity is caused by contracture of both the gastrocnemius and soleus muscles. Damage to the peroneal nerve or loss of flexibility of the Achilles tendon may also result in footdrop. To prevent this disabling deformity, the patient is positioned to sit at a 90-degree angle in a wheelchair with his or her feet on the footrests or flat on the floor.

> *NURSING ALERT*
>
> **Patients should be encouraged to wear shoes for support and protection to prevent footdrop.**

When the patient is supine in bed, padded splints or protective boots are used to keep the patient's feet at right angles to the legs. Frequent skin inspection of the feet must also be performed to determine whether positioning devices have created any unwanted pressure areas.

The patient is encouraged to perform the following ankle exercises several times each hour: dorsiflexion and plantar flexion of the feet, flexion and extension (curl and stretch) of the toes, and eversion and inversion of the feet at the ankles. The nurse provides frequent passive range-of-motion exercises if the patient cannot perform active exercises.

### NURSING ALERT

**Prolonged bed rest, lack of exercise, incorrect positioning in bed, and the weight of bedding that forces the toes into plantar flexion must be avoided to prevent footdrop.**

### *Maintaining Muscle Strength and Joint Mobility*

Optimal function depends on the strength of the muscles and joint motion, and active participation in ADLs promotes maintenance of muscle strength and joint mobility. Range-of-motion exercises and specific therapeutic exercises may be included in the nursing plan of care.

PERFORMING RANGE-OF-MOTION EXERCISES. Range of motion involves moving a joint through its full range in all appropriate planes (Chart 11-7). To maintain or increase the motion of a joint, range-of-motion exercises are initiated as soon as the patient's condition permits. The exercises are planned for individual patients to accommodate the wide variation in the degrees of motion that people of varying body builds and age groups can attain (Chart 11-8).

Range-of-motion exercises may be active (performed by the patient under the supervision of the nurse), assisted

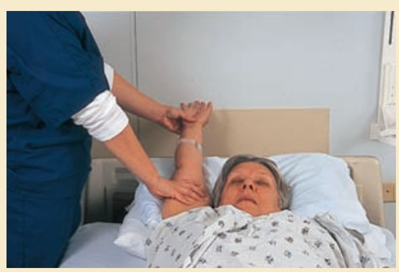
### Chart 11-7 • *Range-of-Motion Terminology*

**Abduction:** movement away from the midline of the body
**Adduction:** movement toward the midline of the body
**Flexion:** bending of a joint so that the angle of the joint diminishes
**Extension:** the return movement from flexion; the joint angle is increased
**Rotation:** turning or movement of a part around its axis
  **Internal:** turning inward, toward the center
  **External:** turning outward, away from the center
**Dorsiflexion:** movement that flexes or bends the hand back toward the body or the foot toward the leg
**Palmar flexion:** movement that flexes or bends the hand in the direction of the palm
**Plantar flexion:** movement that flexes or bends the foot in the direction of the sole
**Pronation:** rotation of the forearm so that the palm of the hand is down
**Supination:** rotation of the forearm so that the palm of the hand is up
**Opposition:** touching the thumb to each fingertip on same hand
**Inversion:** movement that turns the sole of the foot inward
**Eversion:** movement that turns the sole of the foot outward

### Chart 11-8 • *Performing Range-of-Motion Exercises*



Abduction of shoulder. Move arm from side of body to above the head, then return arm to side of body or neutral position (adduction).



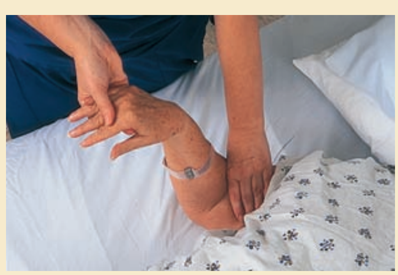
Forward flexion of shoulder. Move arm forward and upward until it is alongside of head.



Flexion of elbow. Bend elbow, bringing forearm and hand toward shoulder, then return forearm and hand to neutral position (arm straight).



Internal rotation of shoulder. With arm at shoulder height, elbow bent at a 90-degree angle, and palm toward feet, turn upper arm until palm and forearm point backward.



Pronation of forearm. With elbow at waist and bent at a 90-degree angle, turn hand so that palm is facing down.



Wrist extension.

*Continued on following page*

## Chart 11-8 • *Performing Range-of-Motion Exercises* (Continued)



External rotation of shoulder. With arm at shoulder height, elbow bent at a 90-degree angle, and palm toward feet, turn upper arm until the palm and forearm point forward.



Supination of forearm. With elbow at waist and arm bent at a 90-degree angle, turn hand so that palm is facing up.



Flexion of wrist. Bend wrist so that palm is toward forearm. Straighten to a neutral position.



Ulnar deviation. Move hand sideways so that the side of hand on which the little finger is located moves toward forearm.



Extension of fingers.



Internal-external rotation of hip. Turn leg in an inward motion so that toes point in. Turn leg in an outward motion so that toespoint out.



Radial deviation. Move hand sideways so that side of hand on which thumb is located moves toward forearm.



To perform abduction-adduction of hip, move leg outward from the body as far as possible, as shown. Return leg from abducted position to neutral position and across the other leg as far as possible.



Hyperextension of hip. Place the patient in a prone position, and move leg backward from the body as far as possible.



Thumb opposition. Move thumb out and around to touch little finger.



Flexion of the hip and the knee. Bend hip by moving the leg forward as far as possible. Return leg from the flexed position to the neutral position.



Dorsiflexion of foot. Move foot up and toward the leg. Then move the foot down and away from the leg (plantar flexion).

Continued

## Chart 11-8 • *Performing Range-of-Motion Exercises* (Continued)



Inversion and eversion of foot. Move foot so that sole is facing outward (eversion). Then move foot so that sole is facing inward (inversion).



Flexion of toes. Bend the toes toward the ball of foot.



Extension of toes. Straighten toes and pull them toward the leg as far as possible.

(with the nurse helping if the patient cannot do the exercise independently), or passive (performed by the nurse). Unless otherwise prescribed, a joint should be moved through its range of motion three times, at least twice a day. The joint to be exercised is supported, the bones above the joint are stabilized, and the body part distal to the joint is moved through the range of motion of the joint. For example, the humerus must be stabilized while the radius and ulna are moved through their range of motion at the elbow joint.

A joint should not be moved beyond its free range of motion; the joint is moved to the point of resistance and stopped at the point of pain. If muscle spasms are present, the joint is moved slowly to the point of resistance. Gentle, steady pressure is then applied until the muscle relaxes, and the motion is continued to the joint's final point of resistance.

To perform assisted or passive range-of-motion exercises, the patient must be in a comfortable supine position with the arms at the sides and the knees extended. Good body posture is maintained during the exercises. The nurse also uses good body mechanics during the exercise session.

**PERFORMING THERAPEUTIC EXERCISES.** Therapeutic exercises are prescribed by the physician and performed with the assistance and guidance of the physical therapist or nurse. The patient should have a clear understanding of the goal of the prescribed exercise. Written instructions about the frequency, duration, and number of repetitions, as well as simple line drawings of the exercise, help ensure adherence to the exercise program. Return demonstration of the exercises also helps the patient and family to follow the instructions correctly.

When performed correctly, exercise assists in maintaining and building muscle strength, maintaining joint function, preventing deformity, stimulating circulation, developing endurance, and promoting relaxation. Exercise is also valuable in helping restore motivation and the well-being of the patient. Weight-bearing exercises may slow the bone loss that occurs with disability. There are five types of exercise: passive, active-assistive, active, resistive, and isometric. The description, purpose, and action of each of these exercises are summarized in Table 11-1.

### *Promoting Independent Mobility*

When the patient's condition stabilizes, his or her physical condition permits, and the patient is able to stand, the patient is assisted to sit up on the side of the bed and then to stand. Tolerance of this activity is assessed. Orthostatic (postural) hypotension may develop when the patient assumes a vertical position. Because of inadequate vasomotor reflexes, blood pools in the splanchnic (visceral or intestinal) area and in the legs, resulting in inadequate cerebral circulation. If indicators of orthostatic hypotension (eg, drop in blood pressure, pallor, diaphoresis, nausea, tachycardia, dizziness) are present, the activity is stopped, and the patient is assisted to a supine position in bed.

Some disabling conditions, such as spinal cord injury, acute brain injury, and other conditions that require extended periods in the recumbent position, prevent the patient from assuming an upright position at the bedside. Several strategies can be used to help the patient assume a 90-degree sitting position. A reclining wheelchair with elevating leg rests allows a slow and controlled progression from a supine position to a 90-degree sitting position. A tilt table (a board that can be tilted in 5- to 10-degree increments from a horizontal to a vertical position) may also be used. The tilt table promotes vasomotor adjustment to positional changes and helps patients with limited standing balance and limited weight-bearing activities avoid the decalcification of bones and low bone mass associated with disuse syndrome and lack of weight-bearing exercise. Physical therapists may use a tilt table for patients who have not been upright due to illness or disability. Gradual elevation of the head of the bed may help. When getting patients with spinal cord injury out of bed, it is important to gradually raise the head of the bed to a 90-degree angle; this may take approximately 10 to 15 minutes.

Graduated compression stockings are used to prevent venous stasis. For some patients, a compression garment (leotard) or snug-fitting abdominal binder and elastic compression bandaging of the legs are needed to prevent venous stasis and orthostatic hypotension. When the patient is standing, the feet are protected with a pair of properly fitted shoes. Extended periods of standing are avoided because of venous pooling and pressure on the soles of the feet. The nurse monitors the patient's blood pressure and pulse and observes for signs and

**Table 11-1 THERAPEUTIC EXERCISES**

| | Description | Purposes | Action |
|---|---|---|---|
| *Passive* | An exercise carried out by the therapist or the nurse without assistance from the patient | To retain as much joint range of motion as possible; to maintain circulation | Stabilize the proximal joint and support the distal part; move the joint smoothly, slowly, and gently through its full range of motion; avoid producing pain. |
| *Active-assistive* | An exercise carried out by the patient with the assistance of the therapist or the nurse | To encourage normal muscle function | Support the distal part, and encourage the patient to take the joint actively through its range of motion; give no more assistance than is necessary to accomplish the action; short periods of activity should be followed by adequate rest periods. |
| *Active* | An exercise accomplished by the patient without assistance; activities include turning from side to side and from back to abdomen and moving up and down in bed | To increase muscle strength | When possible, active exercise should be performed against gravity; the joint is moved through full range of motion without assistance; make sure that the patient does not substitute another joint movement for the one intended. |
| *Resistive* | An active exercise carried out by the patient working against resistance produced by either manual or mechanical means | To provide resistance to increase muscle power | The patient moves the joint through its range of motion while the therapist resists slightly at first and then with progressively increasing resistance; sandbags and weights can be used and are applied at the distal point of the involved joint; the movements should be performed smoothly. |
| *Isometric or muscle setting* | Alternately contracting and relaxing a muscle while keeping the part in a fixed position; this exercise is performed by the patient | To maintain strength when a joint is immobilized | Contract or tighten the muscle as much as possible without moving the joint, hold for several seconds, then let go and relax; breathe deeply. |

symptoms of orthostatic hypotension and cerebral insufficiency (eg, the patient reports feeling faint and weak), which suggest intolerance of the upright position. If the patient does not tolerate the upright position, the nurse should return the patient to the reclining position and elevate his or her legs.

**ASSISTING PATIENTS WITH TRANSFER.** A transfer is movement of the patient from one place to another (eg, bed to chair, chair to commode, wheelchair to tub). As soon as the patient is permitted out of bed, transfer activities are started. The nurse assesses the patient's ability to participate actively in the transfer and determines, in conjunction with occupational therapists or physical therapists, the adaptive equipment required to promote independence and safety. A lightweight wheelchair with brake extensions, removable and detachable arm rests, and leg rests minimizes structural obstacles during the transfer. Tub seats or benches make transfers in and out of the tub easier and safer. Raised, padded commode seats may also be warranted for patients who must avoid flexing the hips greater than 90 degrees when transferring to a toilet. It is important that the nurse teach the patient hip precautions (ie, no adduction past the midline, no flexion greater than 90 degrees, and no internal rotation); abduction pillows can be used to keep the hip in correct alignment if precautions are warranted.

It is important that the patient maintain muscle strength and, if possible, perform push-up exercises to strengthen the arm and shoulder extensor muscles. The push-up exercise requires the patient to sit upright in bed; a book is placed under each of the patient's hands to provide a hard surface, and the patient is instructed to push down on the book, raising the body. The nurse should encourage the patient to raise and move the body in different directions by means of these push-up exercises.

The nurse or physical therapist teaches the patient how to transfer. There are several methods of transferring from the bed to the wheelchair when the patient cannot stand, and the technique chosen should take into account the patient's abilities and disabilities. It is helpful for the nurse to demonstrate the technique. If the physical therapist is involved in teaching the patient to transfer, the nurse and physical therapist must collaborate so that consistent instructions are given to the patient. During transfer, the nurse assists and coaches the patient. Figure 11-2 shows weight-bearing and non–weight-bearing transfer.

If the patient's muscles are not strong enough to overcome the resistance of body weight, a polished lightweight board (transfer board, sliding board) may be used to bridge the gap between the bed and the chair. The patient slides across on the board with or without assistance from a caregiver. This board may also be used to transfer the patient from the chair to the toilet or bathtub bench. It is important to avoid the effects of shear on the patient's skin while

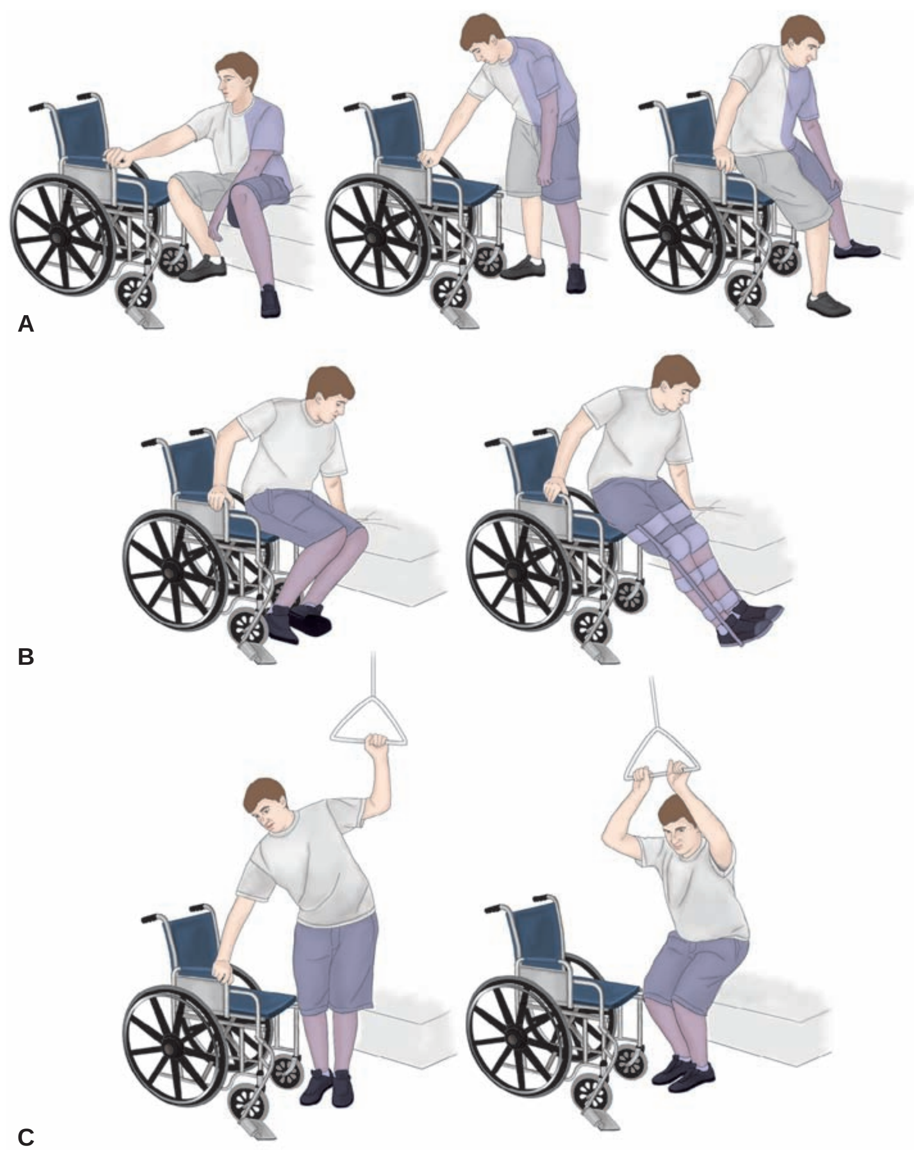



**Figure 11-2** Methods of patient transfer from the bed to a wheelchair. The wheelchair is in a locked position. Colored areas indicate non–weight-bearing body parts. **A,** Weight-bearing transfer from bed to chair. The patient stands up, pivots until his back is opposite the new seat, and sits down. **B,** (*Left*) Non–weight-bearing transfer from chair to bed. (*Right*) With legs braced. **C,** (*Left*) Non–weight-bearing transfer, combined method. (*Right*) Non–weight-bearing transfer, pull-up method. One of the wheelchair arms is removed to make getting in and out of the chair easier.

sliding across the board. The nurse should make sure that the patient's fingers do not curl around the edge of the board during the transfer, because the patient's body weight can crush the fingers as he or she moves across the board. Safety is a primary concern during a transfer, and the following guidelines are recommended:

- Wheelchairs and beds must be locked before transfer begins.
- Detachable arm and foot rests are removed to make getting in and out of the chair easier.
- One end of the transfer board is placed under the buttocks and the other end on the surface to which the transfer is being made (eg, the chair).
- The patient is instructed to lean forward, push up with his or her hands, and then slide across the board to the other surface.

Nurses frequently assist weak and incapacitated patients out of bed. The nurse supports and gently assists the patient during position changes, protecting the patient from injury. The nurse avoids pulling on a weak or paralyzed upper extremity to prevent dislocation of the shoulder. The patient is assisted to move toward the stronger side.

In the home setting, getting in and out of bed and performing chair, toilet, and tub transfers are difficult for patients with weak muscles and loss of hip, knee, and ankle motion. A rope attached to the headboard of the bed enables a patient to move toward the center of the bed, and the use of a rope attached to the footboard facilitates getting in and out of bed. The height of a chair can be raised with cushions on the seat or with hollowed-out blocks placed under the chair legs. Grab bars can be attached to the wall near the toilet and tub to provide leverage and stability.

**PREPARING FOR AMBULATION.** Regaining the ability to walk is a prime morale builder. However, to be prepared for ambulation—whether with a brace, walker, cane, or crutches—the patient must strengthen the muscles required. Therefore, exercise is the foundation of preparation. The nurse and physical therapist instruct and supervise the patient in these exercises.

For ambulation, the quadriceps muscles, which stabilize the knee joint, and the gluteal muscles are strengthened. To perform quadriceps-setting exercises, the patient contracts the quadriceps muscle by attempting to push the popliteal area against the mattress and at the same time raising the heel. The patient maintains the muscle contraction for a count of five and relaxes for a count of five. The exercise is repeated 10 to 15 times hourly. Exercising the quadriceps muscles prevents flexion contractures of the knee.

In gluteal setting, the patient contracts or "pinches" the buttocks together for a count of five, relaxes for a count of five; the exercise is repeated 10 to 15 times hourly. If assistive devices (ie, walker, cane, crutches) will be used, the muscles of the upper extremities are exercised and strengthened. Push-up exercises are especially useful. While in a sitting position, the patient raises the body by pushing the hands against the chair seat or mattress. The patient should be encouraged to do push-up exercises while in a prone position also. Pull-up exercises done on a trapeze while lifting the body are also effective for conditioning. The patient is taught to raise the arms above the head and then lower them in a slow, rhythmic manner while holding weights. Gradually, the weight is increased. The hands are strengthened by squeezing a rubber ball.

Typically, the physical therapist designs exercises to help the patient develop sitting and standing balance, stability, and coordination needed for ambulation. After sitting and standing balance is achieved, the patient is able to use parallel bars. Under the supervision of the physical therapist, the patient practices shifting weight from side to side, lifting one leg while supporting weight on the other, and then walking between the parallel bars.

A patient who is ready to begin ambulation must be fitted with the appropriate assistive device, instructed about the prescribed weight-bearing limits (eg, non–weight-bearing, partial weight-bearing ambulation), and taught how to use the device safely. Figure 11-3 illustrates some of the more common assistive devices used in rehabilitation settings. The nurse continually assesses the patient for stability and adherence to weight-bearing precautions and protects the patient from falling. The nurse provides contact guarding by holding on to a gait belt that the patient wears around the waist. The patient should wear sturdy, well-fitting shoes and be advised of the dangers of wet or highly polished floors and throw rugs. The patient should also learn how to ambulate on inclines, uneven surfaces, and stairs.



**Figure 11-4** Crutch walking. The tripod position for basic crutch stance.




**Figure 11-3** Mechanical aids to walking. **A,** Walker. **B,** Three types of canes.

### *Ambulating With an Assistive Device: Crutches, a Walker, or a Cane*

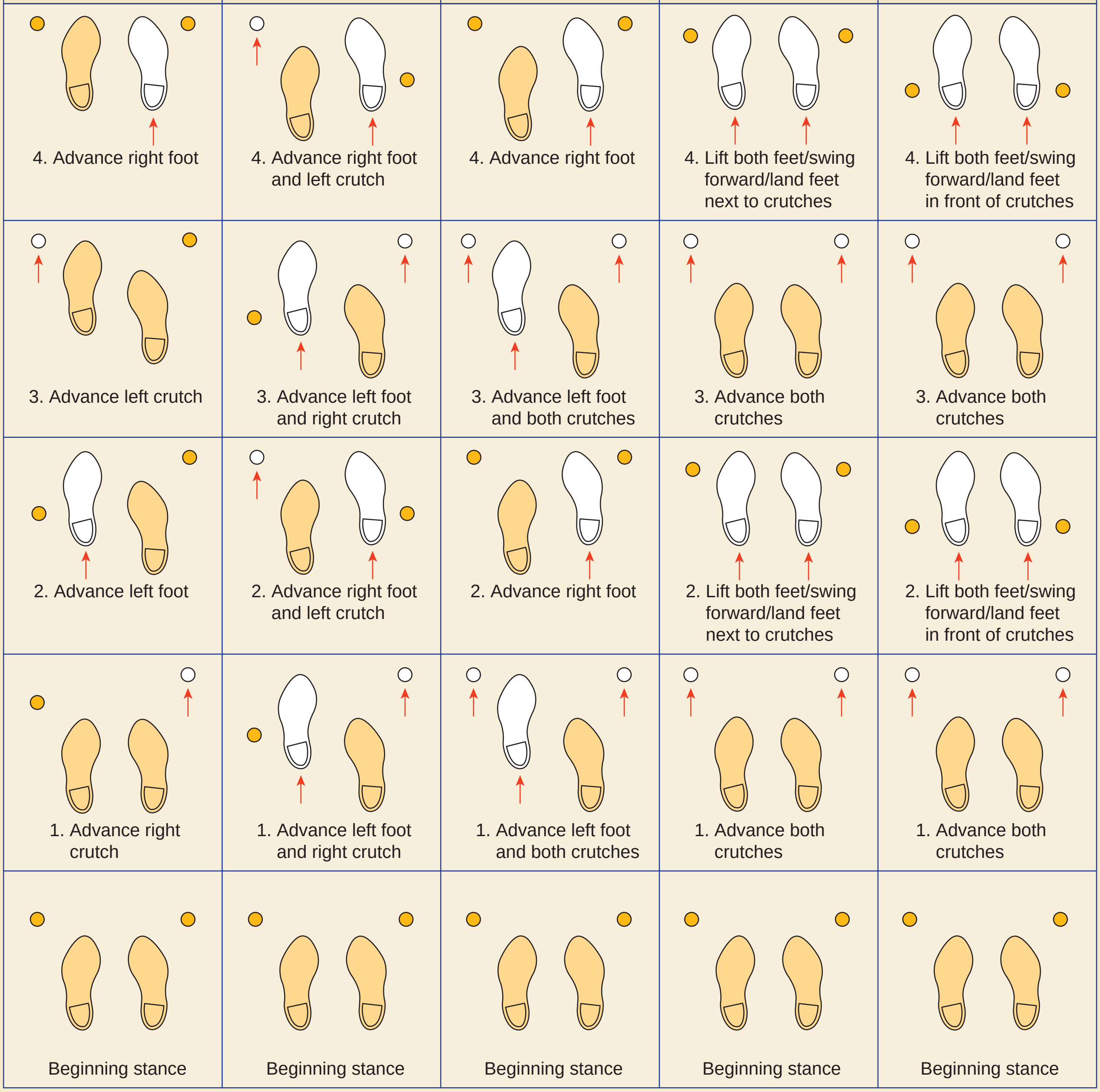
Crutches are for partial weight-bearing or non–weight-bearing ambulation. Good balance, adequate cardiovascular reserve, strong upper extremities, and erect posture are essential for crutch walking. Ambulating a functional distance (at least the length of a room or house) or maneuvering stairs on crutches requires significant arm strength, because the arms must bear the patient's weight (Fig. 11-4). The nurse or physical therapist determines which gait is best (Chart 11-9).

A walker provides more support and stability than a cane or crutches. A pick-up walker is best for patients with poor balance and poor cardiovascular reserve, and a rolling walker, which allows automatic walking, is best for patients who cannot lift. A cane helps the patient walk with balance and support and relieves the pressure on weight-bearing joints by redistributing weight.

Before patients can be considered to be independent in walking with crutches, a walker, or a cane, they should learn to sit, stand from sitting, and go up and down stairs using the device. Table 11-2 describes how patients can ambulate and maneuver using each of the three devices.

## Chart 11-9 • *Crutch Gaits*

Shaded areas are weight bearing. Arrow indicates advance of foot or crutch. (Read chart from bottom, starting with beginning stance.)



| 4-POINT GAIT | 2-POINT GAIT | 3-POINT GAIT | SWING-TO | SWING-THROUGH |
|---|---|---|---|---|
| • Partial weight bearing both feet<br>• Maximal support provided<br>• Requires constant shift of weight | • Partial weight bearing both feet<br>• Provides less support<br>• Faster than a 4-point gait | • Non–weight bearing<br>• Requires good balance<br>• Requires arm strength<br>• Faster gait<br>• Can use with walker | • Weight bearing both feet<br>• Provides stability<br>• Requires arm strength<br>• Can use with walker | • Weight bearing<br>• Requires arm strength<br>• Requires coordination/ balance<br>• Most advanced gait |
| 4. Advance right foot | 4. Advance right foot and left crutch | 4. Advance right foot | 4. Lift both feet/swing forward/land feet next to crutches | 4. Lift both feet/swing forward/land feet in front of crutches |
| 3. Advance left crutch | 3. Advance left foot and right crutch | 3. Advance left foot and both crutches | 3. Advance both crutches | 3. Advance both crutches |
| 2. Advance left foot | 2. Advance right foot and left crutch | 2. Advance right foot | 2. Lift both feet/swing forward/land feet next to crutches | 2. Lift both feet/swing forward/land feet in front of crutches |
| 1. Advance right crutch | 1. Advance left foot and right crutch | 1. Advance left foot and both crutches | 1. Advance both crutches | 1. Advance both crutches |
| Beginning stance | Beginning stance | Beginning stance | Beginning stance | Beginning stance |

**Table 11-2 NURSING ACTIONS INVOLVED IN USING ASSISTIVE DEVICES**

| | Crutches | Walker | Cane |
|---|---|---|---|
| **Patient Preparation** | | | |
| Adjusting device to fit patient | Measure patient standing or lying down:<br>If standing, set crutch length approximately 5 cm (2 inches) below axilla.<br>If lying down, measure from anterior fold of axilla to sole of the foot and add 5 cm.<br>If using patient's height, subtract 40 cm (16 inches) to obtain crutch height.<br>Adjust hand grip to allow 20 to 30 degrees of flexion at elbow.<br>Use foam rubber pad on underarm piece to relieve pressure of crutch. | Adjust height to individual patient.<br>Patient's arms should be in 20 to 30 degrees of flexion at elbows when hands are resting on hand grips. | With patient flexing elbow at 30-degree angle, hold handle of cane level with greater trochanter and place tip of cane 15 cm (6 inches) lateral to base of fifth toe.<br>Fit cane with gently flaring tip that has flexible, concentric rings to provide stability, absorb shock, and enable greater speed and less fatigue with walking. |
| Assessment | Assess safety. Crutches should have large rubber tips, and patients should wear firm-soled, well-fitting shoes.<br>Assess balance by asking patient to stand on unaffected leg by a chair.<br>Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary. | Assess safety. Patients should wear sturdy, well-fitting shoes.<br>Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary. | Assess safety. Patients should wear sturdy, well-fitting shoes.<br>Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary. |
| Interventions and patient teaching | Assist with balance by using a transfer belt or holding patient near waist. Have patient practice shifting weight and maintaining balance.<br>Protect patient from falls.<br>To maximize stability, encourage patient to use tripod stance, with crutches to the front and sides of toes<br>Have patient perform prescribed preparatory exercises to strengthen shoulder girdle and upper extremity muscles.* | Walk with patient, holding at waist if needed for balance.<br>Instruct patient to never pull self up using walker and to look up when walking.<br>Discuss full, partial, or non-weight bearing as prescribed.<br>Protect patient from falls. | Walk with patient, holding at waist if needed for balance.<br>Have patient hold cane in hand opposite to affected extremity, if possible, to widen the base of support and reduce stress on involved extremity.<br>Instruct patient to move opposite arm and leg together.<br>Protect patient from falls. |
| **Ambulation** | | | |
| Gait/action used | Determine which gait is best (see Chart 11-9)**<br>Four-point<br>Three-point<br>Two-point<br>Swing-to<br>Swing-through | Instruct patient to:<br>Pick-up walker: lift device and move it forward with each step.<br>Rolling walker: roll device forward and walk automatically. | Instruct patient to:<br>Advance cane at same time that affected leg is moved forward.<br>Keep cane fairly close to body to prevent leaning.<br>Bear down on cane when unaffected extremity begins swing phase. |
| Sitting | Instruct patient to:<br>Grasp hand piece for control.<br>Bend forward slightly while assuming sitting position.<br>Place affected leg forward to prevent weight bearing and flexion while sitting. | Instruct patient to hold walker on hand grips for stability. | |
| Standing | Instruct patient to:<br>Move forward to edge of chair, keep unaffected leg slightly under seat.<br>Place both crutches on side of affected extremity.<br>Push down on hand piece while rising to standing position. | Instruct patient to:<br>Push off chair or bed to come to a standing position.<br>Lift walker, placing it in front of self while leaning slightly forward.<br>Walk into walker, supporting weight on hands when advancing.<br>Balance on feet.<br>Lift walker and place it in front of self again.<br>Continue pattern. | Instruct patient to:<br>Push off chair or bed to come to a standing position.<br>Hold cane for stability.<br>Step forward on unaffected extremity.<br>Swing cane and affected extremity forward in a normal walking gait. |
| Going down stairs | Instruct patient to:<br>Walk forward as far as possible.<br>Advance crutches to lower step; advance affected leg, then unaffected leg. | | Instruct patient to:<br>Step down on unaffected extremity.<br>Place the cane and then affected extremity on down step. |

*Continued*

**Table 11-2 NURSING ACTIONS INVOLVED IN USING ASSISTIVE DEVICES (Continued)**

| | Crutches | Walker | Cane |
|---|---|---|---|
| Going up stairs | Instruct patient to:<br>Advance unaffected leg first up next step.<br>Advance crutches and affected extremity.<br>Unaffected leg goes up first and comes down first. | n/a | Instruct patient to:<br>Step up on unaffected extremity.<br>Place cane and affected extremity up on step. |

*For patients who cannot support their weight through the wrist and hand because of arthritis or fracture, platform crutches that support the forearm and allow the weight to be borne through the elbow are available. If weight is borne on the axilla, the pressure of the crutch can damage the brachial plexus nerves, producing "crutch paralysis."

**Teach patient two gaits so that he or she can change from one to another to avoid fatigue. Also, a faster gait can be used when walking an uninterrupted distance and a slower gait can be used for short distances or in crowded places.

#### *Assisting Patients With an Orthosis or Prosthesis*

Orthoses and prostheses are designed to facilitate mobilization and to maximize the patient's quality of life. An orthosis is an external appliance that provides support, prevents or corrects deformities, and improves function. Orthoses include braces, splints, collars, corsets, and supports that are designed and fitted by orthotists or prosthetists. Static orthoses (no moving parts) are used to stabilize joints and prevent contractures. Dynamic orthoses are flexible and are used to improve function by assisting weak muscles. A prosthesis is an artificial body part; it may be internal, such as an artificial knee or hip joint, or external, such as an artificial leg or arm.

In addition to learning how to apply and remove the orthosis and maneuver the affected body part correctly, patients must learn how to properly care for the skin that comes in contact with the appliance. Skin problems or pressure ulcers may develop if the device is applied too tightly or too loosely, or if it is adjusted improperly. The nurse instructs the patient to clean and inspect the skin daily, to make sure the brace fits snugly without being too tight, to check that the padding distributes pressure evenly, and to wear a cotton garment without seams between the orthosis and the skin.

If the patient has had an amputation, the nurse promotes tissue healing, uses compression dressings to promote residual limb shaping, and minimizes contracture formation. A permanent prosthetic limb cannot be fitted until the tissue has healed completely and the residual limb shape is stable and free of edema. The nurse also helps the patient cope with the emotional issues surrounding loss of a limb and encourages acceptance of the prosthesis. The prosthetist, nurse, and physician collaborate to provide instructions related to skin care and care of the prosthesis.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Demonstrates improved physical mobility
   a. Maintains muscle strength and joint mobility
   b. Does not develop contractures
   c. Participates in exercise program
2. Transfers safely
   a. Demonstrates assisted transfers
   b. Performs independent transfers
3. Ambulates with maximum independence
   a. Uses ambulatory aid safely
   b. Adheres to weight-bearing prescription
   c. Requests assistance as needed
4. Demonstrates increased activity tolerance
   a. Does not experience episodes of orthostatic hypotension
   b. Reports absence of fatigue with ambulatory efforts
   c. Gradually increases distance and speed of ambulation

## NURSING PROCESS

### The Patient With Impaired Skin Integrity

**Pressure ulcers** are localized areas of necrotic soft tissue that occur when pressure applied to the skin over time is greater than normal capillary closure pressure, which is about 32 mm Hg. Critically ill patients have a lower capillary closure pressure and a greater risk of pressure ulcers. Patients who are prone to pressure ulcers include those confined to bed for long periods, those with motor or sensory dysfunction, and those who experience muscular atrophy and reduction of padding between the overlying skin and the underlying bone.

The Healthcare Cost and Utilization Project (HCUP) reported that 455,000 hospitalizations annually in the United States are complicated by pressure ulcers (Russo & Elixhauser, 2006); this represents a 63% increase over a 10-year period. The average length of stay for hospitalizations related to pressure ulcers is 13 days, with an average treatment cost of nearly $37,800 for each affected patient. All possible efforts to prevent skin breakdown must be made because the treatment of pressure ulcers is costly in terms of health care dollars and quality of life for patients at risk.

The initial sign of pressure is erythema (redness of the skin) caused by reactive hyperemia, which normally resolves in less than 1 hour. Unrelieved pressure results in tissue ischemia or anoxia. The cutaneous tissues become broken or destroyed, leading to progressive destruction and necrosis of underlying soft tissue, and the resulting pressure ulcer is painful and slow to heal.

CHART 11-10

### Risk Factors for Pressure Ulcers

- Prolonged pressure on tissue
- Immobility, compromised mobility
- Loss of protective reflexes, sensory deficit/loss
- Poor skin perfusion, edema
- Malnutrition, hypoproteinemia, anemia, vitamin deficiency
- Friction, shearing forces, trauma
- Incontinence of urine or feces
- Altered skin moisture: excessively dry, excessively moist
- Advanced age, debilitation
- Equipment: casts, traction, restraints

## Assessment

Immobility, impaired sensory perception or cognition, decreased tissue perfusion, decreased nutritional status, friction and shear forces, increased moisture, and age-related skin changes all contribute to the development of pressure ulcers. Chart 11-10 lists risk factors for pressure ulcers.

### *Immobility*

When a person is immobile and inactive, pressure is exerted on the skin and subcutaneous tissue by objects on which the person rests, such as a mattress, chair seat, or cast. The development of pressure ulcers is directly related to the duration of immobility: If pressure continues long enough, small vessel thrombosis and tissue necrosis occur and a pressure ulcer results. Weight-bearing bony prominences are most susceptible to pressure ulcer development because they are covered only by skin and small amounts of subcutaneous tissue. Susceptible areas include the sacrum and coccygeal areas, ischial tuberosities (especially in people who sit for prolonged periods), greater trochanter, heel, knee, malleolus, medial condyle of the tibia, fibular head, scapula, and elbow (Fig. 11-5).

### *Impaired Sensory Perception or Cognition*

Patients with sensory loss, impaired level of consciousness, or paralysis may not be aware of the discomfort associated with prolonged pressure on the skin and therefore may not change their position themselves to relieve the pressure. This prolonged pressure impedes blood flow, reducing nourishment of the skin and underlying tissues. A pressure ulcer may develop in a short period of time.

### *Decreased Tissue Perfusion*

Any condition that reduces the circulation and nourishment of the skin and subcutaneous tissue (altered peripheral tissue perfusion) increases the risk of pressure ulcer development. Patients with diabetes mellitus have compromised microcirculation. Similarly, patients with edema have impaired circulation and poor nourishment of the skin tissue. Obese patients have large amounts of poorly vascularized adipose tissue, which is susceptible to breakdown.

### *Decreased Nutritional Status*

Nutritional deficiencies, anemias, and metabolic disorders also contribute to development of pressure ulcers. Anemia, regardless of its cause, decreases the blood's oxygen-carrying ability and predisposes the patient to pressure ulcers. Patients who have low protein levels or who are in a negative nitrogen balance experience tissue wasting and inhibited tissue repair. Serum albumin and prealbumin levels are sensitive indicators of protein deficiency. Serum albumin levels of less than 3 g per mL are associated with hypoalbuminemic tissue edema and increased risk of pressure ulcers. Prealbumin levels are more sensitive indicators of protein status than albumin levels, but they are more costly to assess. The nurse should assess the patient's prealbumin and albumin values and electrolyte panel. Specific nutrients, such as vitamin C and trace minerals, are needed for tissue maintenance and repair.

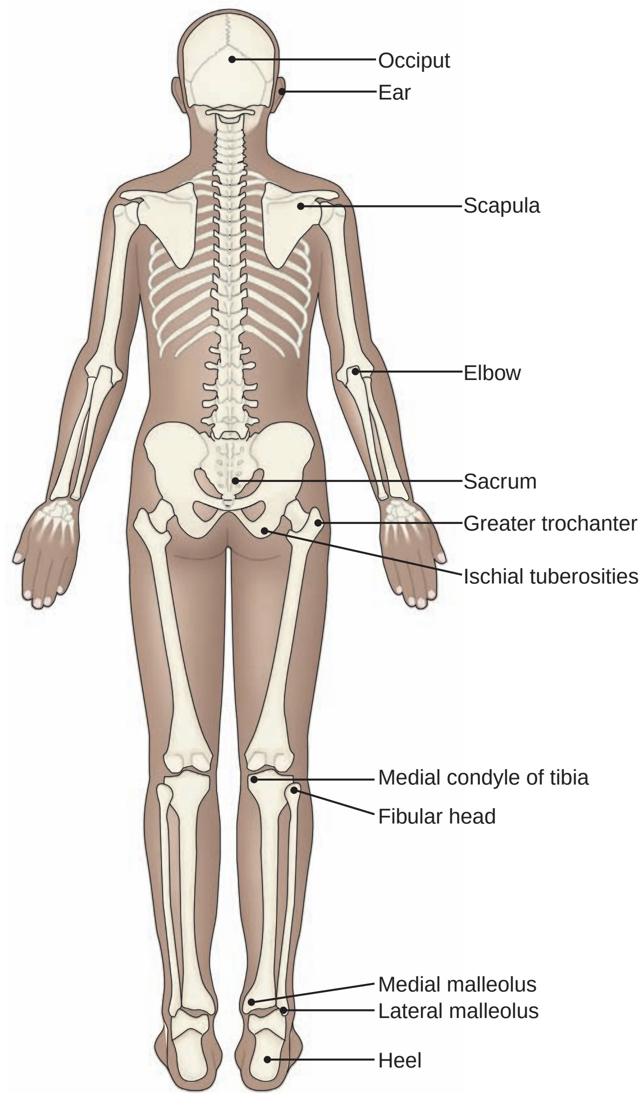



**Figure 11-5** Areas susceptible to pressure ulcers.

### *Friction and Shear*

Mechanical forces also contribute to the development of pressure ulcers. Friction is the resistance to movement that occurs when two surfaces are moved across each other. Shear is created by the interplay of gravitational forces (forces that push the body down) and friction. When shear occurs, tissue layers slide over one another, blood vessels stretch and twist, and the microcirculation of the skin and subcutaneous tissue is disrupted. Evidence of deep tissue damage may be slow to develop and may present through the development of a sinus tract. The sacrum and heels are most susceptible to the

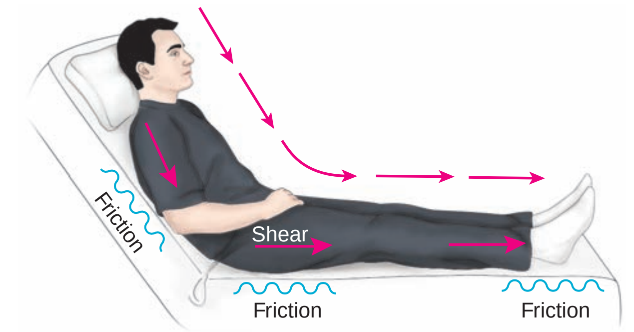



**Figure 11-6** Mechanical forces contribute to pressure ulcer development. As the person slides down or is improperly pulled up in bed, *friction* resists this movement. *Shear* occurs when one layer of tissue slides over another, disrupting microcirculation of skin and subcutaneous tissue.

effects of shear. Pressure ulcers from friction and shear occur when the patient slides down in bed (Fig. 11-6) or when the patient is positioned or moved improperly (eg, dragged up in bed). Spastic muscles and paralysis increase the patient's vulnerability to pressure ulcers related to friction and shear.

### *Increased Moisture*

Prolonged contact with moisture from perspiration, urine, feces, or drainage produces maceration (softening) of the skin. The skin reacts to the caustic substances in the excreta or drainage and becomes irritated. Moist, irritated skin is more vulnerable to pressure breakdown. Once the skin breaks, the area is invaded by microorganisms (eg, streptococci, staphylococci, *Pseudomonas aeruginosa*, *Escherichia coli*), and infection occurs. Foul-smelling infectious drainage is present. The lesion may enlarge and allow a continuous loss of serum, which may further deplete the body of essential protein needed for tissue repair and maintenance. The lesion may continue to enlarge and extend deep into the fascia, muscle, and bone, with multiple sinus tracts radiating from the pressure ulcer. With extensive pressure ulcers, life-threatening infections and sepsis may develop, frequently from gram-negative organisms.

### *Gerontologic Considerations*

In older adults, the skin has diminished epidermal thickness, dermal collagen, and tissue elasticity. The skin is drier as a result of diminished sebaceous and sweat gland activity. Cardiovascular changes result in decreased tissue perfusion. Muscles atrophy and bone structures become prominent. Diminished sensory perception and reduced ability to reposition oneself contribute to prolonged pressure on the skin. Therefore, older adults are more susceptible to pressure ulcers, which cause pain, suffering, and reduced quality of life.

### *Nursing Actions Related to Assessment*

In assessing patients for potential risk of pressure ulcer development, the nurse assesses the patient's mobility, sensory perception, cognitive abilities, tissue perfusion, nutritional status, friction and shear forces, sources of moisture on the skin, and age. Nursing actions include:

- Assess total skin condition at least twice a day.
- Inspect each pressure site for erythema.
- Assess areas of erythema for blanching response.
- Palpate the skin for increased warmth.
- Inspect for dry skin, moist skin, and breaks in skin.
- Note drainage and odor.
- Evaluate level of mobility.
- Note safety and assistive devices (eg, restraints, splints).
- Evaluate circulatory status (eg, peripheral pulses, edema).
- Assess neurovascular status.
- Determine presence of incontinence.
- Evaluate nutritional and hydration status.
- Review the results of the patient's laboratory studies, including hematocrit, hemoglobin, electrolytes, albumin, transferrin, and creatinine.
- Note present health problems.
- Review current medications.

Scales such as the Braden scale (Table 11-3) or Norton scale may be used to facilitate systematic assessment and quantification of a patient's risk for pressure ulcer, although the nurse should recognize that the reliability of these scales is not well established for all patient populations. If a pressure area is noted, the nurse notes size and location and uses a grading system to describe severity (Chart 11-11).

The appearance of purulent drainage or foul odor suggests an infection. With an extensive pressure ulcer, deep pockets of infection are often present. Drying and crusting of exudate may be present. Infection of a pressure ulcer may advance to osteomyelitis, pyarthrosis (pus formation within a joint cavity), sepsis, and septic shock.

## Nursing Diagnosis

Based on the assessment data, the nursing diagnoses may include the following:

- Risk for impaired skin integrity
- Impaired skin integrity related to immobility, decreased sensory perception, decreased tissue perfusion, decreased nutritional status, friction and shear forces, excessive moisture, or advanced age

## Planning and Goals

The major goals may include relief of pressure, improved mobility, improved sensory perception, improved tissue perfusion, improved nutritional status, minimized friction and shear forces, dry surfaces in contact with skin, and healing of pressure ulcer, if present.

## Nursing Interventions

### *Relieving Pressure*

Frequent changes of position are needed to relieve and redistribute the pressure on the patient's skin and to promote blood flow to the skin and subcutaneous tissues. This can be accomplished by teaching the patient to change position or by turning and repositioning the patient. The patient's family members should be taught how to position and turn the patient at home to prevent pressure ulcers. Shifting weight allows the blood to flow into the ischemic areas and helps tissues recover from the effects of pressure.

For patients who spend long periods in a wheelchair, pressure can be relieved by:

- Push-ups: The patient pushes down on armrests and raises buttocks off the seat of the chair (Fig. 11-7).
- One half push-up: The patient repeats the push-up on the right side and then the left, pushing up on one side by pushing down on the armrest.

**Table 11-3 BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK**

Patient's Name ______________________________ Evaluator's Name_____________________________________________

| | | | | | Date of Assessment | | | |
|---|---|---|---|---|---|---|---|---|
| **SENSORY PERCEPTION**<br>Ability to respond meaningfully to pressure- related discomfort | **1. Completely Limited**<br>Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of consciousness or sedation<br>OR<br>limited ability to feel pain over most of body. | **2. Very Limited**<br>Responds only to painful stimuli. Cannot communicate discomfort except by moaning or rest-lessness<br>OR<br>has a sensory impairment that limits the ability to feel pain or discomfort over ½ of body. | **3. Slightly Limited**<br>Responds to verbal commands, but cannot always communicate discomfort or the need to be turned.<br>OR<br>has some sensory impairment that limits ability to feel pain or discomfort in 1 or 2 extremities. | **4. No Impairment**<br>Responds to verbal commands. Has no sensory deficit that would limit ability to feel or voice pain or discomfort. | | | | |
| **MOISTURE**<br>Degree to which skin is exposed to moisture | **1. Constantly Moist**<br>Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned. | **2. Very Moist**<br>Skin is often, but not always, moist. Linen must be changed at least once a shift. | **3. Occasionally Moist:**<br>Skin is occasionally moist, requiring an extra linen change approximately once a day. | **4. Rarely Moist**<br>Skin is usually dry, linen only requires changing at routine intervals. | | | | |
| **ACTIVITY**<br>Degree of physical activity | **1. Bedfast**<br>Confined to bed. | **2. Chairfast**<br>Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted into chair or wheelchair. | **3. Walks Occasionally**<br>Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair. | **4. Walks Frequently**<br>Walks outside room at least twice a day and inside room at least once every two hours during waking hours. | | | | |
| **MOBILITY**<br>Ability to change and control body position | **1. Completely Immobile**<br>Does not make even slight changes in body or extremity position without assistance. | **2. Very Limited**<br>Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently. | **3. Slightly Limited**<br>Makes frequent though slight changes in body or extremity position independently. | **4. No Limitation**<br>Makes major and frequent changes in position without assistance. | | | | |
| **NUTRITION**<br>Usual food intake pattern | **1. Very Poor**<br>Never eats a complete meal. Rarely eats more than a 1/3 of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement<br>OR<br>is NPO and/or maintained on clear liquids or IVs for more than 5 days. | **2. Probably Inadequate**<br>Rarely eats a complete meal and generally eats only about 1/2 of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement.<br>OR<br>receives less than optimum amount of liquid diet or tube feeding. | **3. Adequate**<br>Eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products) per day. Occasionally will refuse a meal, but will usually take a supplement when offered<br>OR<br>is on a tube feeding or TPN regimen, which probably meets most of nutritional needs | **4. Excellent**<br>Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation. | | | | |
| **FRICTION AND SHEAR** | **1. Problem**<br>Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. | **2. Potential Problem**<br>Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against | **3. No Apparent Problem**<br>Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. | | | | | |

*Continued*

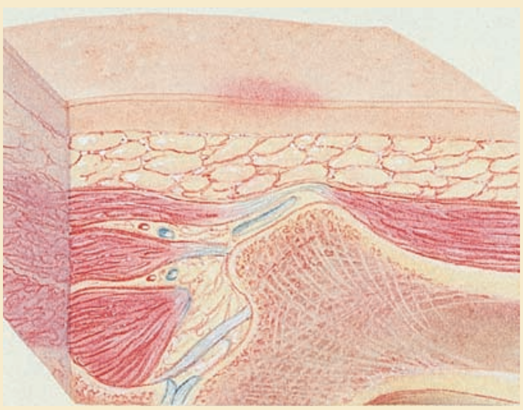
**Table 11-3 BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK (Continued)**

Patient's Name ______________________ Evaluator's Name______________________________

| | | | | Date of Assessment | | | | |
|---|---|---|---|---|---|---|---|---|
| | Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction. | sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down. | Maintains good position in bed or chair. | | | | | |
| | | | | Total Score | | | | |

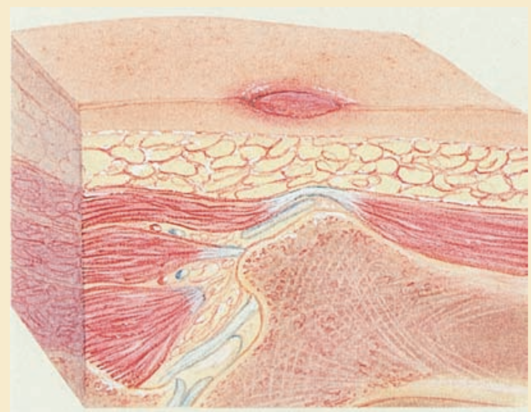


## Chart 11-11 • *Stages in the Development or Pressure Ulcers*



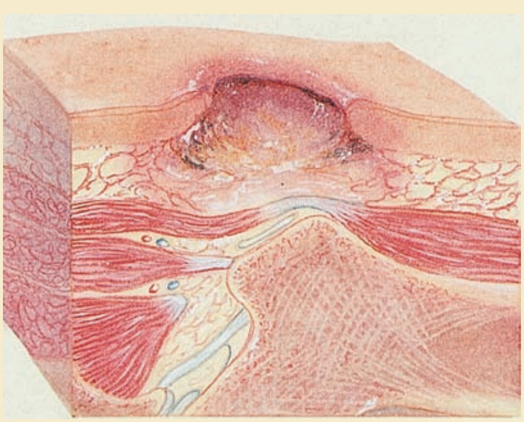
**Stage I**

- Area of erythema
- Erythema does not blanch with pressure
- Skin temperature elevated
- Tissue swollen and congested
- Patient complains of discomfort
- Erythema progresses to dusky blue-gray



**Stage II**

- Skin breaks
- Abrasion, blister, or shallow crater
- Edema persists
- Ulcer drains
- Infection may develop
- Partial-thickness wound



**Stage III**

- Ulcer extends into subcutaneous tissue
- Necrosis and drainage continue
- Infection develops
- Full-thickness wound



**Stage IV**

- Ulcer extends to underlying muscle and bone
- Deep pockets of infection develop
- Necrosis and drainage continue
- Full-thickness wound

From Weber, J. W. & Kelley, J. (2003). *Health assessment in nursing* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins.



**Figure 11-7** Wheelchair push-up to prevent ischial pressure ulcers. These push-ups should become an automatic routine (every 15 minutes) for the person with paraplegia. The person should stay up, out of contact with the seat for several seconds. The wheels are kept in the locked position during the exercise.

- Moving side to side: The patient moves from one side to the other while sitting in the chair.
- Shifting: The patient bends forward with the head down between the knees (if able) and constantly shifts in the chair.

*Positioning the Patient*

The degree of ability to move independently, the comfort, fatigue, loss of sensation, overall physical and mental status, and specific disorder, influences plans for changing position. Patients should be positioned laterally, prone, and dorsally in sequence unless a position is not tolerated or is contraindicated. Generally, those who experience discomfort after 30 to 60 minutes of lying prone need to be repositioned. The recumbent position is preferred to the semi-Fowler's position because of increased supporting body surface area in this position.

Patients able to shift their weight every 15 to 20 minutes and move independently may change total position every 2 to 4 hours. Indications for routine repositioning every 2 hours or more frequently include loss of sensation, paralysis, coma, and edema.

In addition to regular turning, small shifts of body weight, such as repositioning of an ankle, elbow, or shoulder, are necessary. The skin is inspected at each position change and assessed for temperature elevation. If redness or heat is noted or if the patient complains of discomfort, pressure on the area must be relieved.

Another way to relieve pressure over bony prominences is the bridging technique, accomplished through the correct positioning of pillows. Just as a bridge is supported on pillars to allow traffic to move underneath, the body can be supported by pillows to allow for space between bony prominences and the mattress. A pillow or commercial heel protector may be used to support the heels off the bed when the patient is supine. Placing pillows superior and inferior to the sacrum relieves sacral pressure. Supporting the patient in a 30-degree side-lying position avoids pressure on the trochanter. In elderly patients, frequent small shifts of body weight may be effective. Placing a small rolled towel or sheepskin under a shoulder or hip allows a return of blood flow to the skin in the area on which the patient is sitting or lying. The towel or sheepskin is moved around the patient's pressure points in a clockwise fashion. A turning schedule can help the family keep track of the patient's turns.

*Using Pressure-Relieving Devices*

At times, special equipment and beds may be needed to help relieve the pressure on the skin. This is particularly important for patients who cannot get out of bed and who have risk factors for pressure ulcer development. These devices are designed to provide support for specific body areas or to distribute pressure evenly.

A patient who sits in a wheelchair for prolonged periods should have wheelchair cushions fitted and adjusted on an individualized basis, using pressure measurement techniques as a guide to selection and fitting. The aim is to redistribute pressure away from areas at risk for ulcers, but no cushion can eliminate excessive pressure completely. The patient should be reminded to shift weight frequently and to rise for a few seconds every 15 minutes while sitting in a chair (see Fig. 11-7).

Static support devices (eg, high-density foam, air, or liquid mattress overlays) distribute pressure evenly by bringing more of the patient's body surface into contact with the supporting surface. Gel-type flotation pads and air-fluidized beds reduce pressure. The weight of a body floating on a fluid system is evenly distributed over the entire supporting surface. Therefore, as the body sinks into the fluid, additional surface becomes available for weight bearing, body weight per unit area is decreased, and there is less pressure on the body parts.

Soft, moisture-absorbing padding is also useful because the softness and resilience of padding provide for more even distribution of pressure and the dissipation and absorption of moisture, along with freedom from wrinkles and friction. Bony prominences may be protected by gel pads, sheepskin padding, or soft foam rubber beneath the sacrum, the trochanters, heels, elbows, scapulae, and back of the head when there is pressure on these sites.

Specialized beds are designed to prevent pressure on the skin. Air-fluidized beds allow the patient to float. Dynamic support surfaces, such as low air-loss pockets, alternately inflate and deflate sections to change support pressure for very high-risk patients who are critically ill and debilitated and cannot be repositioned to relieve pressure. Oscillating or kinetic beds change pressure by means of rocking movements of the bed that redistribute the patient's weight and stimulate circulation. These beds may be used with patients who have injuries due to multiple trauma. A systematic review of 59 randomized controlled trials has suggested that specialized beds, which are more expensive than mattress overlays, are no more effective at preventing pressure ulcers than the overlays (Reddy, Gill & Rochon, 2006).

#### *Improving Mobility*

The patient is encouraged to remain active and is ambulated whenever possible. When sitting, the patient is reminded to change positions frequently to redistribute weight. Active and passive exercises increase muscular, skin, and vascular tone. For patients at risk for pressure ulcers, turning and exercise schedules are essential: repositioning must occur around the clock.

#### *Improving Sensory Perception*

The nurse helps the patient recognize and compensate for altered sensory perception. Depending on the origin of the alteration (eg, decreased level of consciousness, spinal cord lesion), specific interventions are selected. Strategies to improve cognition and sensory perception may include stimulating the patient to increase awareness of self in the environment, encouraging the patient to participate in self-care, or supporting the patient's efforts toward active compensation for loss of sensation (eg, a patient with paraplegia lifting up from the sitting position every 15 minutes). A patient with quadriplegia should be weight-shifted every 30 minutes while sitting in a wheelchair. When decreased sensory perception exists, the patient and caregivers are taught to inspect potential pressure areas visually every morning and evening, using a mirror if necessary, for evidence of pressure ulcer development.

#### *Improving Tissue Perfusion*

Activity, exercise, and repositioning improve tissue perfusion. Massage of erythematous areas is avoided because damage to the capillaries and deep tissue may occur.

> *NURSING ALERT*
>
> **The nurse should avoid massaging reddened areas because this may increase the damage to already traumatized skin and tissue.**

In patients who have evidence of compromised peripheral circulation (eg, edema), positioning and elevation of the edematous body part to promote venous return and diminish congestion improve tissue perfusion. In addition, the nurse or family must be alert to environmental factors (eg, wrinkles in sheets, pressure of tubes) that may contribute to pressure on the skin and diminished circulation and remove the source of pressure.

#### *Improving Nutritional Status*

The patient's nutritional status must be adequate and a positive nitrogen balance must be maintained because pressure ulcers develop more quickly and are more resistant to treatment in patients with nutritional disorders. A high-protein diet with protein supplements may be helpful. Iron preparations may be necessary to raise the hemoglobin concentration so that tissue oxygen levels can be maintained within acceptable limits. Ascorbic acid (vitamin C) is necessary for tissue healing. Other nutrients associated with healthy skin include vitamin A, B vitamins, zinc, and sulfur. With adequate nutrition and hydration, the skin can remain healthy, and damaged tissues can be repaired (Table 11-4).

To assess the patient's nutritional status in response to therapeutic strategies, the nurse monitors the patient's hemoglobin, prealbumin level, and body weight weekly. Nutritional assessment is described in further detail in Chapter 5.

#### *Reducing Friction and Shear*

Shear occurs when patients are pulled, allowed to slump, or move by digging heels or elbows into the mattress. Raising the head of the bed by even a few centimeters increases the shearing force over the sacral area; therefore, the semireclining position is avoided in patients at risk. Proper positioning with adequate support is also important when the patient is sitting in a chair.

> *NURSING ALERT*
>
> **To avoid shearing forces when repositioning patients, the nurse must lift and avoid dragging patients across a surface. Lift devices should be used to prevent occupational injuries.**

#### *Minimizing Irritating Moisture*

Continuous moisture on the skin must be prevented by meticulous hygiene measures. It is important to pay special attention to skin folds, including areas under the breasts, arms, and groin, and between the toes. Perspiration, urine, stool, and drainage must be removed from the skin promptly. The soiled skin should be washed immediately

**Table 11-4 NUTRITIONAL REQUIREMENTS TO PROMOTE HEALING OF PRESSURE ULCERS**

| Nutrient | Rationale | Recommended Amount |
|---|---|---|
| Protein | Tissue repair | 1.25–1.50 g/kg/day |
| Calories | Spare protein<br>Restore normal weight | 30–35 calories/kg/day |
| Water | Maintain homeostasis | 1 mL/calorie fed or 30 mL/kg/day |
| Multivitamin | Promote collagen formation | 1 daily |
| Vitamin C | Promote collagen synthesis<br>Support integrity of capillary wall | 500–1000 mg daily |
| Zinc sulfate | Cofactor for collagen formation and protein synthesis<br>Normal lymphocyte and phagocyte response | 220 mg daily |
| Vitamin A | Stimulate epithelial cells<br>Stimulate immune response<br>*Caution:* An excess can cause an excessive inflammatory response that could impair healing | |

with mild soap and water and blotted dry with a soft towel. The skin may be lubricated with a bland lotion to keep it soft and pliable. Drying agents and powders are avoided. Topical barrier ointments (eg, petroleum jelly) may be helpful in protecting the skin of patients who are incontinent.

Absorbent pads that wick moisture away from the body should be used to absorb drainage. Patients who are incontinent need to be checked regularly and have their wet incontinence pads and linens changed promptly. Their skin needs to be cleansed and dried promptly.

### *Promoting Pressure Ulcer Healing*

Regardless of the stage of the pressure ulcer, the pressure on the area must be eliminated because the ulcer will not heal until all pressure is removed. The patient must not lie or sit on the pressure ulcer, even for a few minutes. Individualized positioning and turning schedules must be written in the plan of nursing care and followed meticulously.

In addition, inadequate nutritional status and fluid and electrolyte abnormalities must be corrected to promote healing. Wounds from which body fluids and protein drain place the patient in a catabolic state and predispose to hypoproteinemia and serious secondary infections. Protein deficiency must be corrected to promote the healing of the pressure ulcer. Carbohydrates are necessary to "spare" the protein and to provide an energy source. Vitamin C and trace elements, especially zinc, are necessary for collagen formation and wound healing.

**DEEP TISSUE INJURY.** Deep tissue injury (DTI) is a localized area of discolored, purple, intact skin, or blood-filled blister that is due to underlying soft tissue damage from pressure or shear. DTIs may be preceded by reports of localized pain or detection of skin with underlying tissue that feels firm, mushy, boggy, or warmer or colder than adjacent skin. These tissue injuries may evolve rapidly, and immediate pressure relief to the affected area is indicated.

**STAGE I PRESSURE ULCERS.** To permit healing of stage I pressure ulcers, the pressure is removed to allow increased tissue perfusion, nutritional and fluid and electrolyte balance are maintained, friction and shear are reduced, and moisture to the skin is avoided.

**STAGE II PRESSURE ULCERS.** Stage II pressure ulcers typically have broken skin and present with a red-pink wound bed. However, intact, serum-filled blisters or ruptured blisters are sometimes apparent. In addition to measures listed for stage I pressure ulcers, a moist environment, in which migration of epidermal cells over the ulcer surface occurs more rapidly, should be provided to aid wound healing. The ulcer is gently cleansed with sterile saline solution. Use of a heat lamp to dry the open wound is avoided, as is use of antiseptic solutions that damage healthy tissues and delay wound healing. Semipermeable occlusive dressings, hydrocolloid wafers, or wet saline dressings are helpful in providing a moist environment for healing and in minimizing the loss of fluids and proteins from the body.

**STAGES III AND IV PRESSURE ULCERS.** Stages III and IV pressure ulcers are characterized by extensive tissue damage. In addition to the measures listed for stage I, these advanced, draining, necrotic pressure ulcers must be cleaned (débrided) to create an area that will heal. Necrotic, devitalized tissue favors bacterial growth, delays granulation, and inhibits healing. Wound cleaning and dressing are uncomfortable; therefore, the nurse must prepare the patient for the procedure by explaining what will occur and administering prescribed analgesia.

Débridement may be accomplished by wet-to-damp dressing changes, mechanical flushing of necrotic and infective exudate, application of prescribed enzyme preparations that dissolve necrotic tissue, or surgical dissection. If an eschar (dry scab) covers the ulcer, it is removed surgically to ensure a clean, vitalized wound. Exudate may be absorbed by dressings or special hydrophilic powders, beads, or gels. Cultures of infected pressure ulcers are obtained to guide the selection of antibiotic therapy.

After the pressure ulcer is clean, a topical treatment is prescribed to promote granulation. New granulation tissue must be protected from reinfection, drying, and damage, and care should be taken to prevent pressure and further trauma to the area. Dressings, solutions, and ointments applied to the ulcer should not disrupt the healing process. For chronic, noninfected ulcers that are healing by secondary intention (healing of an open wound from the base upward by laying down new tissue), vacuum-assisted closure (VAC) or hyperbaric oxygen treatment may be used. VAC involves the use of a negative-pressure sponge dressing in the wound to increase blood flow, increasing formation of granulation tissue and nutrient uptake and decreasing bacterial load. Hyperbaric oxygen therapy involves either the application of topical oxygen at increased pressure directly to the wound or placing the patient into a hyperbaric oxygen chamber. Both methods of hyperbaric oxygen therapy promote wound healing by stimulating new vascular growth and aiding in the preservation of damaged tissue (Roecki-Wiedmann, Bennett & Kranke, 2005).

Multiple agents and protocols are used to treat pressure ulcers, but consistency is an important key to success. Objective evaluation of the pressure ulcer (eg, measurement of the size and depth of the pressure ulcer, inspection for granulation tissue) for response to the treatment protocol must be made every 4 to 6 days. Taking photographs at weekly intervals is a reliable strategy for monitoring the healing process, which may take weeks to months.

Surgical intervention is necessary when the ulcer is extensive, when complications (eg, fistula) exist, and when the ulcer does not respond to treatment. Surgical procedures include débridement, incision and drainage, bone resection, and skin grafting. Osteomyelitis is a common complication of wounds of stage IV depth. See Chapter 68 for more information on osteomyelitis.

### *Preventing Recurrence*

Recurrence of pressure ulcers should be anticipated; therefore, active, preventive intervention and frequent continuing assessments are essential. The patient's tolerance for sitting or lying on the healed pressure area is increased gradually by increasing the time that pressure is allowed on the area in 5- to 15-minute increments. The patient is taught to increase mobility and to follow a regimen of turning, weight-shifting, and repositioning. The patient teaching plan includes strategies to reduce the risk of pressure

ulcers and methods to detect, inspect, and minimize pressure areas. Early recognition and intervention are keys to long-term management of potential impaired skin integrity.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Maintains intact skin
   a. Exhibits no areas of nonblanchable erythema at bony prominences
   b. Avoids massage of bony prominences
   c. Exhibits no breaks in skin
2. Limits pressure on bony prominences
   a. Changes position every 1 to 2 hours
   b. Uses bridging techniques to reduce pressure
   c. Uses special equipment as appropriate
   d. Raises self from seat of wheelchair every 15 minutes
3. Increases mobility
   a. Performs range-of-motion exercises
   b. Adheres to turning schedule
   c. Advances sitting time as tolerated
4. Has improved sensory and cognitive ability
   a. Demonstrates improved level of consciousness
   b. Remembers to inspect potential pressure ulcer areas every morning and evening
5. Demonstrates improved tissue perfusion
   a. Exercises to increase circulation
   b. Elevates body parts susceptible to edema
6. Attains and maintains adequate nutritional status
   a. Verbalizes the importance of protein and vitamin C in diet
   b. Eats diet high in protein and vitamin C
   c. Exhibits hemoglobin, electrolyte, prealbumin, transferrin, and creatinine levels at acceptable levels
7. Avoids friction and shear
   a. Avoids semireclining position
   b. Uses heel protectors when appropriate
   c. Lifts body instead of sliding across surfaces
8. Maintains clean, dry skin
   a. Avoids prolonged contact with wet or soiled surfaces
   b. Keeps skin clean and dry
   c. Uses lotion to keep skin lubricated

# NURSING PROCESS

## The Patient With Altered Elimination Patterns

Urinary incontinence and bowel incontinence or constipation and impaction are problems that often occur in patients with disabilities. Incontinence curtails the person's independence, causing embarrassment and isolation. It occurs in as much as 15% of the community-based elderly population, and nearly 50% of nursing home residents have bowel or bladder incontinence or both (Taylor & Kuchel, 2006). In addition, constipation may be a problem in patients with disabilities. Complete and predictable evacuation of the bowel is the goal. If a bowel routine is not established, the patient may experience abdominal distention; small, frequent oozing of stool; or impaction.

## Assessment

Urinary incontinence may result from multiple causes, including urinary tract infection, detrusor instability, bladder outlet obstruction or incompetence, neurologic impairment, bladder spasm or contracture, and inability to reach the toilet in time. Urinary incontinence can be classified as urge, reflex, stress, functional, or total:

- *Urge incontinence:* involuntary elimination of urine associated with a strong perceived need to void
- *Reflex (neurogenic) incontinence:* associated with a spinal cord lesion that interrupts cerebral control, resulting in no sensory awareness of the need to void
- *Stress incontinence:* associated with weakened perineal muscles that permit leakage of urine when intra-abdominal pressure is increased (eg, with coughing or sneezing)
- *Functional incontinence:* incontinence in patients with intact urinary physiology who experience mobility impairment, environmental barriers, or cognitive problems and cannot reach and use the toilet before soiling themselves
- *Total incontinence:* occurs in patients who cannot control excreta because of physiologic or psychological impairment; management of the excreta is an essential focus of nursing care.

The health history is used to explore bladder and bowel function, symptoms associated with dysfunction, physiologic risk factors for elimination problems, perception of micturition (urination, or voiding) and defecation cues, and functional toileting abilities. Previous and current fluid intake and voiding patterns may be helpful in designing the plan of nursing care. A record of times of voiding and amounts voided is kept for at least 48 hours. In addition, episodes of incontinence and associated activity (eg, coughing, sneezing, lifting), fluid intake time and amount, and medications are recorded. This record is analyzed and used to determine patterns and relationships of incontinence to other activities and factors.

The ability to get to the bathroom, manipulate clothing, and use the toilet are important functional factors that may be related to incontinence. Related cognitive functioning (perception of need to void, verbalization of need to void, and ability to learn to control urination) must also be assessed. In addition, the nurse reviews the results of the diagnostic studies (eg, urinalysis, urodynamic tests, postvoiding residual volumes).

Bowel incontinence and constipation may result from multiple causes, such as diminished or absent sphincter control, cognitive or perceptual impairment, neurogenic factors, diet, and immobility. The origin of the bowel problem must be determined. The nurse assesses the patient's normal bowel patterns, nutritional patterns, use of laxatives, gastrointestinal problems (eg, colitis), bowel sounds, anal reflex and tone, and functional abilities. The character and frequency of bowel movements are recorded and analyzed.

## Nursing Diagnosis

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired urinary elimination
- Urinary retention
- Bowel incontinence

## Planning and Goals

The major goals may include control of urinary incontinence or urinary retention, control of bowel incontinence, and regular elimination patterns.

## Nursing Interventions

### *Promoting Urinary Continence*

After the nature of the urinary incontinence has been identified, a plan of nursing care is developed based on analysis of the assessment data. Various approaches to promote urinary continence have been developed. Most approaches attempt to condition the body to control urination or to minimize the occurrence of unscheduled urination. Selection of the approach depends on the cause and type of the incontinence. For the program to be successful, participation by the patient and a desire to avoid incontinence episodes are crucial; an optimistic attitude with positive feedback for even slight gains is essential for success. Accurate recording of intake and output and of the patient's response to selected strategies is essential for evaluation.

At no time should the fluid intake be restricted to decrease the frequency of urination. Sufficient fluid intake (2000 to 3000 mL per day, according to patient needs) must be ensured. To optimize the likelihood of voiding as scheduled, measured amounts of fluids may be administered about 30 minutes before voiding attempts. In addition, most of the fluids should be consumed before evening to minimize the need to void frequently during the night.

**NURSING ALERT**

**Carbonated soft drinks, milk shakes, alcohol, tomato juice, and citrus fruit juices are alkaline-producing drinks that promote bacterial growth in the urine. Patients should be encouraged to drink more acid-producing fluids (eg, cranberry and cranapple juice) to reduce the chance of urinary tract infection. Water is a preferred fluid because it flushes the kidneys and bladder.**

The goal of bladder training is to restore the bladder to normal function. Bladder training can be used with cognitively intact patients experiencing urge incontinence. A voiding and toileting schedule is developed based on analysis of the assessment data. The schedule specifies times for the patient to try to empty the bladder using a bedpan, toilet, or commode. Privacy should be provided during voiding efforts. The interval between voiding times in the early phase of the bladder training period is short (90 to 120 minutes). The patient is encouraged not to void until the specified voiding time. Voiding success and episodes of incontinence are recorded. As the patient's bladder capacity and control increase, the interval is lengthened. Usually, there is a temporal relationship between drinking, eating, exercising, and voiding. Alert patients can participate in recording intake, activity, and voiding and can plan the schedule to achieve maximum continence. Barrier-free access to the toilet and modification of clothing can help patients with functional incontinence achieve self-care in toileting and continence.

Habit training is used to try to keep patients dry by strict adherence to a toileting schedule and may be successful with stress, urge, or functional incontinence. If the patient is confused, caregivers take the patient to the toilet according to the schedule before involuntary voiding occurs. Simple cuing and consistency promote success. Periods of continence and successful voiding are positively reinforced.

Biofeedback is a system through which patients learn to consciously contract urinary sphincters and control voiding cues. Cognitively intact patients who have stress or urge incontinence may gain bladder control through biofeedback.

Pelvic floor exercises (Kegel exercises) strengthen the pubococcygeus muscle. The patient is instructed to tighten the pelvic floor muscles for 4 seconds 10 times, and this is repeated 4 to 6 times a day. Stopping and starting the stream during urination is recommended to increase control. Daily practice is essential. These exercises are helpful for cognitively intact women who experience stress incontinence.

Suprapubic tapping or stroking of the inner thigh may produce voiding by stimulating the voiding reflex arc in patients with reflex incontinence. However, this method is not always effective, due to a lack of detrusor sphincter muscle coordination. As the bladder reflexively contracts to expel urine, the bladder sphincter reflexively closes, producing a high residual urine volume and an increased incidence of urinary tract infection.

Intermittent self-catheterization is an appropriate alternative for managing reflex incontinence, urinary retention, and overflow incontinence due to an overdistended bladder. The nurse emphasizes regular emptying of the bladder rather than sterility. Patients with disabilities may reuse and clean catheters with bleach or hydrogen peroxide solutions or soap and water and may use a microwave oven to sterilize catheters. Aseptic intermittent catheterization technique is required in health care institutions because of the potential for bladder infection from resistant organisms. Intermittent self-catheterization may be difficult for patients with limited mobility, dexterity, or vision; however, family members can be taught the procedure.

Self-catheterization is also particularly pertinent for patients with spinal cord injury, because most of these patients do not have voluntary control of urination. Even those patients with spinal cord injuries who can voluntarily void should measure their residual urine (the amount of urine that remains in the bladder after voluntary or involuntary voiding) by self-catheterization.

Indwelling catheters are avoided if at all possible because of the high incidence of urinary tract infections with their use. Short-term use may be needed during treatment of severe skin breakdown due to continued incontinence. Patients with disabilities who cannot perform intermittent self-catheterization may elect to use suprapubic catheters for long-term bladder management. Suprapubic catheters are easier to maintain than indwelling catheters. A daily fluid intake of 3000 mL is encouraged.

External catheters (condom catheters) and leg bags to collect spontaneous voidings are useful for male patients with reflex or total incontinence. The appropriate design and size must be chosen for maximal success, and the patient or caregiver must be taught how to apply the condom catheter and how to provide daily hygiene, including skin inspection. Instruction on emptying the leg bag must also be provided, and modifications can be made for patients with limited hand dexterity.

Incontinence pads (briefs) may be useful at times for patients with stress or total incontinence to protect clothing, but they should be avoided whenever possible. Incontinence pads only manage, rather than solve, the incontinence problem. Also, they have a negative psychological effect on patients, because many people think of the pads as diapers. Every effort should be made to reduce the incidence of incontinence episodes through the other methods that have been described. When incontinence pads are used, they should wick moisture away from the body to minimize contact of moisture and excreta with the skin. Wet incontinence pads must be changed promptly, the skin cleansed, and a moisture barrier applied to protect the skin. It is important for the patient's self-esteem to avoid use of the term *diapers*.

#### Promoting Bowel Continence

The goals of a bowel training program are to develop regular bowel habits and to prevent uninhibited bowel elimination. Regular, complete emptying of the lower bowel results in bowel continence. A bowel-training program takes advantage of the patient's natural reflexes. Regularity, timing, nutrition and fluids, exercise, and correct positioning promote predictable defecation.

The nurse records defecation time, character of stool, nutritional intake, cognitive abilities, and functional self-care toileting abilities for 5 to 7 days. Analysis of this record is helpful when designing a bowel program for patients with fecal incontinence.

Consistency in implementing the plan is essential. A regular time for defecation is established, and attempts at evacuation should be made within 15 minutes of the designated time daily. Natural gastrocolic and duodenocolic reflexes occur about 30 minutes after a meal; therefore, after breakfast is one of the best times to plan for bowel evacuation. However, if the patient had a previously established habit pattern at a different time of day, it should be followed.

The anorectal reflex may be stimulated by a rectal suppository (eg, glycerin) or by mechanical stimulation (eg, digital stimulation with a lubricated gloved finger or anal dilator). Mechanical stimulation should be used only in patients with a disability who have no voluntary motor function and no sensation as a result of injuries above the sacral segments of the spinal cord, such as patients with quadriplegia, high paraplegia, or severe brain injuries. The technique is not effective in patients who do not have an intact sacral reflex arc (eg, those with flaccid paralysis). Mechanical stimulation, suppository insertion, or both should be initiated about 30 minutes before the scheduled bowel elimination time, and the interval between stimulation and defecation is noted for subsequent modification of the bowel program. Once the bowel routine is well established, stimulation with a suppository may not be necessary.

The patient should assume the normal squatting position and be in a private bathroom for defecation if at all possible, although a padded commode chair or bedside toilet is an alternative. An elevated toilet seat is a simple modification that may make use of the toilet easier for the patient with a disability. Seating time is limited in patients who are at risk for skin breakdown. Bedpans should be avoided. A patient with a disability who cannot sit on a toilet should be positioned on the left side with legs flexed and the head of the bed elevated 30 to 45 degrees to increase intra-abdominal pressure. Protective padding is placed behind the buttocks. When possible, the patient is instructed to bear down and to contract the abdominal muscles. Massaging the abdomen from right to left facilitates movement of feces in the lower tract.

#### Preventing Constipation

The record of bowel elimination, character of stool, food and fluid intake, level of activity, bowel sounds, medications, and other assessment data are reviewed to develop the plan of care. Multiple approaches may be used to prevent constipation. The diet should include adequate intake of high-fiber foods (vegetables, fruits, bran) to prevent hard stools and to stimulate peristalsis. Daily fluid intake should be 2 to 3 L unless contraindicated. Drinking prune juice (120 mL) 30 minutes before a meal once daily is helpful in some cases when constipation is a problem. Physical activity and exercise are encouraged, as is self-care in toileting. Patients are encouraged to respond to the natural urge to defecate. Privacy during toileting is provided. Stool softeners, bulk-forming agents, mild stimulants, and suppositories may be prescribed to stimulate defecation and to prevent constipation.

## Evaluation

#### Expected Patient Outcomes

Expected patient outcomes may include:

1. Demonstrates control of bowel and bladder function
   a. Experiences no episodes of incontinence
   b. Avoids constipation
   c. Achieves independence in toileting
   d. Expresses satisfaction with level of bowel and bladder control
2. Achieves urinary continence
   a. Uses therapeutic approach that is appropriate to type of incontinence
   b. Maintains adequate fluid intake
   c. Washes and dries skin after episodes of incontinence
3. Achieves bowel continence
   a. Participates in bowel program
   b. Verbalizes need for regular time for bowel evacuation
   c. Modifies diet to promote continence
   d. Uses bowel stimulants as prescribed and needed
4. Experiences relief of constipation
   a. Uses high-fiber diet, fluids, and exercise to promote defecation
   b. Responds to urge to defecate

## Disability and Sexuality Issues

An important issue confronting patients with disabilities, and a vital component of self-concept, is sexuality. Sexuality involves not only biologic sexual activity but also one's concept of masculinity or femininity. It affects the way people react to others and are perceived by them, and it is expressed not only by physical intimacy but also by caring and emotional intimacy.

Sexuality problems experienced by patients with disabilities include limited access to information about sexuality, lack of opportunity to form friendships and loving relationships, impaired self-image, and low self-esteem. People with disabilities may have physical and emotional difficulties that interfere with sexual activities. For example, diabetes and spinal cord injury may affect the ability of men to have erections. Patients who have suffered a heart attack or stroke may fear having a life-threatening event (eg, another heart attack or stroke) during sexual activity. Some patients may fear loss of bowel or bladder control during intimate moments. Changes in desire for sex and in the quality of sexual activities can occur for the patient and partner who may be too involved as a caregiver to have the desire and energy for sexual activities. However, a loss of sexual function does not necessarily correspond to a loss of sexual feeling. The physical and emotional aspects of sexuality, despite physical loss of function, continue to be important for people with disabilities.

Unfortunately, society and some health care providers contribute to these problems by ignoring the patient's sexuality and by viewing people with disabilities as asexual. Health care providers' own discomfort and lack of knowledge related to sexuality issues prevent them from providing patients with disabilities and their partners with interventions that promote healthy intimacy. Nurses caring for people with disabilities must recognize and address sexual issues to promote feelings of self-worth. The nurse should give the patient "permission" to discuss sexuality concerns and show a willingness to listen and help the patient overcome these concerns. In the case of a couple coping with disability, this may take the form of a simple comment, such as "Other people in your situation have expressed concern about how this disability may affect their own sexuality, feelings toward each other, and intimate aspects of their relationship. If either of you has these kinds of concerns, I am here to listen." The nurse also plays a key role in providing appropriate patient education about how specific disabilities affect sexual function. For example, arthritis produces fatigue and morning stiffness, making planned afternoon sex a better alternative; spinal cord injury impairs erections and ejaculations; and traumatic brain injury may produce an increased or decreased interest in sexual behavior. Classes, books, movies, and support groups are useful tools to help patients learn about sexuality and disability. When open discussion and education about disability and sexuality do not result in the patient achieving his or her sexuality goals, the nurse should refer the patient for ongoing counseling with a sex counselor or therapist. The patient may need training in communication and in social and assertiveness skills to develop desired relationships. Support and advocacy groups such as the National Peer Support Network of the National Spinal Cord Injury Association (see Resources list at the end of this chapter) provide excellent information resources that relate to issues such as sexuality for patients, families, and nurses.

## Fatigue

People with disabilities frequently experience fatigue, which may impede functional recovery and full reintegration into family and community roles. For example, patients with strokes may experience fatigue and a subsequent lack of endurance that affects their ability to participate in normal daily activities (Schepers, Visser-Meily, Ketelaar, et al., 2006). Physical and emotional weariness may be caused by discomfort and pain associated with a chronic health problem, deconditioning associated with prolonged periods of bed rest and immobility, impaired motor function requiring excessive expenditure of energy to ambulate, and the frustrations of performing ADLs. Ineffective coping with the disability, unresolved grief, disordered sleep patterns, and depression can also contribute to fatigue, which may interfere with active engagement in the rehabilitation process. The patient is encouraged to use coping strategies to manage the psychological impact of the disability and pain management techniques to control the associated discomforts (see Chapter 13 for a discussion of pain management). In addition, the nurse can teach the patient to manage fatigue through priority setting and energy-conserving techniques (Chart 11-12).

## Complementary and Alternative Therapies

People with disabilities may seek a variety of different therapies. For some people, therapeutic horseback riding affects all body systems. Instructors are certified through the North American Riding for the Handicapped Association. Pet therapy and canine companion programs have reduced stress and promoted coping for many people with disabilities. Some animals, including simian monkeys, can pick up the phone, retrieve small assistive devices, assist with drinking beverages, or assist with activating emergency calls. The service animals provide companionship as well as physical assistance for elderly people and people with disabilities who may live alone.

Nurses can encourage people with disabilities to take advantage of community programs. T'ai chi classes improve muscle strength, balance, and coordination and can help prevent falls in the elderly. People with disabilities, including wheelchair users, can participate in T'ai chi classes for improved balance, coordination, muscle strength and control, and a sense of well-being.

Daily journal writing has helped depressed people and their families overcome many emotionally draining reactions to adverse circumstances. Nurses are instrumental in teaching patients and family members this cost-effective technique. Relaxation exercises can also be taught by the nurse and encouraged in all settings, including the hospital, rehabilitation setting, outpatient areas, and the home.

CHART 11-12 PATIENT EDUCATION
**Learning to Cope With Disabilities**

**Take Control of Your Life**

- Face the reality of your disability.
- Emphasize areas of strength.
- Remain outward looking.
- Seek inventive ways to tackle problems.
- Share concerns and frustrations.
- Maintain and improve general health.
- Plan for recreation.

**Have Well-Defined Goals and Priorities**

- Keep priorities in order; eliminate nonessential activities.
- Plan and pace your activities.

**Organize Your Life**

- Plan each day.
- Organize work.
- Perform tasks in steps.
- Distribute heavy work throughout the day or week.

**Conserve Energy**

- Rest before undertaking difficult tasks.
- Stop the activity before fatigue occurs.
- Continue with an exercise conditioning program to strengthen muscles.

**Control Your Environment**

- Try to be well organized.
- Keep possessions in the same place, so that they can be found with a minimum of effort.
- Store equipment (personal care, crafts, work) in a box or basket.
- Use energy-conservation and work-simplification techniques.
- Keep work within easy reach and in front of you.
- Use adaptive equipment, self-help aids, and labor-saving devices.
- Recruit assistance from others; delegate when necessary.
- Take safety precautions.

## Promoting Home and Community-Based Care

An important goal of rehabilitation is to assist the patient to return to the home environment after learning to manage the disability. A referral system maintains continuity of care when the patient is transferred to the home or to a long-term care facility. The plan for discharge is formulated when the patient is first admitted to the hospital, and discharge plans are made with the patient's functional potential in mind.

### Teaching Patients Self-Care

Significant expenditures of time and resources are necessary to ensure that patients gain the skills and confidence to self-manage their health effectively after discharge from the hospital. Formal programs provide patients with effective strategies for interpreting and managing disease-specific issues and skills needed for problem solving, as well as building and maintaining self-awareness and self-efficacy. Self-care programs often use multifaceted approaches, including didactic teaching, group sessions, individual learning plans, and Web-based resources. When planning the approach to self-care, it is important that the nurse consider the individual patient's knowledge, experience, social and cultural background, level of formal education, and psychological status. The preparation for self-care must also be spread out over the course of the recovery period and it must be monitored and updated regularly as aspects of self-care are mastered by the patient. Preparation for self-care is also highly relevant for informal caregivers of patients in rehabilitation.

When a patient is discharged from acute care or a rehabilitation facility, informal caregivers, typically family members, often assume the care and support of the patient. Although the most obvious care tasks involve physical care (eg, personal hygiene, dressing, meal preparation), other elements of the caregiving role include psychosocial support and a commitment to this supportive role. Thus, it is necessary to assess the patient's support system (family, friends) well in advance of discharge. The attitudes of family and friends toward the patient, his or her disability, and the return home are important in making a successful transition to home. Not all families can carry out the arduous programs of exercise, physical therapy, and personal care that the patient may need. They may not have the resources or stability to care for family members with a severe disability. The physical, emotional, economic, and energy strains of a disabling condition may overwhelm even a stable family. Members of the rehabilitation team must not judge the family but rather should provide supportive interventions that help the family to attain its highest level of function.

The family members need to know as much as possible about the patient's condition and care so that they do not fear the patient's return home. The nurse develops methods to help the patient and family cope with problems that may arise. An ADL checklist individualized for the patient and family can be developed to make certain that the family is proficient in assisting the patient with certain tasks (Chart 11-13).

### Continuing Care

A home care nurse may visit the patient in the hospital, interview the patient and the family, and review the ADL sheet to learn which activities the patient can perform. This helps ensure that continuity of care is provided and that the patient does not regress, but instead maintains the independence gained while in the hospital or rehabilitation setting. The family may need to purchase, borrow, or improvise needed equipment, such as safety rails, a raised toilet seat or commode, or a tub bench. Ramps may need to be built or doorways widened to allow full access.

Family members are taught how to use equipment and are given a copy of the equipment manufacturer's instruction booklet, the names of resource people, lists of equipment-related supplies, and locations where they may be obtained. A written summary of the care plan is included in family teaching. The patient and family members are re-

CHART 11-13 HOME CARE CHECKLIST

### *Managing the Therapeutic Regimen at Home*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State the impact of disability on physiologic functioning. | ✔ | ✔ |
| • State changes in lifestyle necessary to maintain health. | ✔ | ✔ |
| • State the name, dose, side effects, frequency, and schedule for all medications. | ✔ | ✔ |
| • State how to obtain medical supplies after discharge. | ✔ | ✔ |
| • Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization: | ✔ | ✔ |
| [ ] Wheelchair—manual/power<br>[ ] Cushion<br>[ ] Grab bars<br>[ ] Sliding board<br>[ ] Mechanical lift<br>[ ] Raised padded commode seat<br>[ ] Padded commode wheelchair<br>[ ] Bedside toilet<br>[ ] Crutches<br>[ ] Walker<br>[ ] Prosthesis<br>[ ] Orthosis<br>[ ] Specialty bed | | |
| • Demonstrate usage of adaptive equipment for activities of daily living:<br>[ ] Long-handled sponge<br>[ ] Reacher<br>[ ] Universal cuff<br>[ ] Plate mat and guard<br>[ ] Rocker-knife, spork, weighted utensils<br>[ ] Special closures for clothing<br>[ ] Other | ✔ | ✔ |
| • Demonstrate mobility skills:<br>[ ] Transfers: bed to chair; in and out of toilet and tub; in and out of car<br>[ ] Negotiate ramps, curbs, stairs<br>[ ] Assume sitting from supine position<br>[ ] Turn side to side in bed<br>[ ] Maneuver wheelchair; manage arm and leg rests; lock brakes<br>[ ] Ambulate safely using assistive devices<br>[ ] Perform range-of-motion exercises<br>[ ] Perform muscle-strengthening exercises | ✔ | ✔ |
| • Demonstrate skin care:<br>[ ] Inspect bony prominences every morning and evening<br>[ ] Identify stage I pressure ulcer and actions to take if present<br>[ ] Change dressings for stage II to IV pressure ulcers<br>[ ] State dietary requirements to promote healing of pressure ulcers<br>[ ] Demonstrate pressure relief at prescribed intervals<br>[ ] State sitting schedule and demonstrate weight lifts in wheelchair<br>[ ] Demonstrate adherence to bed turning schedule, bed positioning, and use of bridging techniques<br>[ ] Apply and wear protective boots at prescribed times<br>[ ] Demonstrate correct wheelchair sitting posture<br>[ ] Demonstrate techniques to avoid friction and shear in bed<br>[ ] Demonstrate proper hygiene to maintain skin integrity | ✔ | ✔ |
| • Demonstrate bladder care:<br>[ ] State schedule for voiding, toileting, and catheterization<br>[ ] Identify relationship of fluid intake to voiding and catheterization schedule<br>[ ] State how to perform pelvic floor exercises<br>[ ] Demonstrate clean self-intermittent catheterization and care of catheterization equipment<br>[ ] Demonstrate indwelling catheter care<br>[ ] Demonstrate application of external condom catheter<br>[ ] Demonstrate application, emptying, and cleaning of urinary drainage bag<br>[ ] Demonstrate application of incontinence pads and performance of perineal hygiene<br>[ ] State signs and symptoms of urinary tract infection | ✔ | ✔ |
| • Demonstrate bowel care:<br>[ ] State optimum dietary intake to promote evacuation<br>[ ] Identify schedule for optimum bowel evacuation<br>[ ] Demonstrate techniques to increase intra-abdominal pressure; Valsalva maneuver; abdominal massage; leaning forward | ✔ | ✔ |

*Continued*

CHART 11-13 HOME CARE CHECKLIST
*Managing the Therapeutic Regimen at Home* (Continued)

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| [ ] Demonstrate techniques to stimulate bowel movements: ingesting warm liquids; digital stimulation; insertion of suppositories<br>[ ] Demonstrate optimum position for bowel evacuation: on toilet with knees higher than hips; left side in bed with knees flexed and head of bed elevated 30 to 45 degrees<br>[ ] Identify complications and corrective strategies for bowel retraining: constipation, impaction, diarrhea, hemorrhoids, rectal bleeding, anal tears | | |
| • Identify community resources for peer and family support:<br>[ ] Identify phone numbers of support groups for people with disabilities<br>[ ] State meeting locations and times | ✔ | ✔ |
| • Demonstrate how to access transportation:<br>[ ] Identify locations of wheelchair accessibility for public buses or trains<br>[ ] Identify phone numbers for private wheelchair van<br>[ ] Contact Division of Motor Vehicles for handicapped parking permit<br>[ ] Contact Division of Motor Vehicles for driving test when appropriate<br>[ ] Identify resources for adapting private vehicle with hand controls or wheelchair lift | ✔ | ✔ |
| • Identify vocational rehabilitation resources:<br>[ ] State name and phone number of vocational rehabilitation counselor<br>[ ] Identify educational opportunities that may lead to future employment | ✔ | ✔ |
| • Identify community resources for recreation:<br>[ ] State local recreation centers that offer programs for people with disabilities<br>[ ] Identify leisure activities that can be pursued in the community | ✔ | ✔ |
| • Identify the need for health promotion and screening activities: | ✔ | ✔ |

minded about the importance of routine health screening and other health promotion strategies.

A network of support services and communication systems may be required to enhance opportunities for independent living. The nurse uses collaborative, administrative skills to coordinate these activities and pull together the network of care. The nurse also provides skilled care, initiates additional referrals when indicated, and serves as a patient advocate and counselor when obstacles are encountered. The nurse continues to reinforce prior teaching and helps the patient to set and achieve attainable goals. The degree to which the patient adapts to the home and community environment depends on the confidence and self-esteem developed during the rehabilitation process and on the acceptance, support, and reactions of family members, employers, and community members.

There is a growing trend toward independent living by people with severe disabilities, either alone or in groups that share resources. Preparation for independent living should include training in managing a household and working with personal care attendants as well as training in mobility. The goal is integration into the community—living and working in the community with accessible housing, employment, public buildings, transportation, and recreation.

State rehabilitation administration agencies provide services to assist people with disabilities in obtaining the help they need to engage in gainful employment. These services include diagnostic, medical, and mental health services. Counseling, training, placement, and follow-up services are available to help people with disabilities select and obtain jobs.

If the patient is transferred to a long-term care facility, the transition is planned to promote continued progress. Independence gained continues to be supported, and progress is fostered. Adjustment to the facility is promoted through communication. Family members are encouraged to visit, to be involved, and to take the patient home on weekends and holidays if possible.

## CRITICAL THINKING EXERCISES

EBP **1** A 40-year-old unmarried man with a 15-year history of multiple sclerosis (MS) is admitted to your rehabilitation nursing unit. He currently has secondary-progressive MS with many disabling symptoms. He is heavily dependent on his family, home nursing staff, a personal assistant, and rehabilitation professionals. His secondary conditions include bladder and bowel dysfunction, visual impairment, impaired mobility caused by spasticity and paralysis of his lower limbs, severe fatigue, tremor, and pain. What is the nursing role in preventing pressure ulcers from developing in this patient? Describe the instructions you would give the patient, family, and home care providers about the prevention of pressure ulcers. What is the evidence that supports the appropriateness of these instructions, and how strong is this evidence? What criteria did you use to determine the strength of the evidence for interventions that assist in the prevention of pressure ulcers?

**2** A 45-year-old married woman who is recovering from a spinal epidural abscess has just been admitted to your medical-surgical unit. She has undergone surgical excision of the abscess and continues to be treated with antibiotics via a peripherally inserted central catheter. Her

ongoing problems include pain, impaired physical mobility, urinary retention, and nutritional deficits. How does a functional assessment tool help determine the patient's level of functioning? In discussing the patient's level of functioning with the rehabilitation team, describe the kinds of self-care activities that you would include in your rehabilitation plan for the patient and family. How important would it be to include a psychosocial assessment in the rehabilitation plan and why?

**3** A 78-year-old woman who resides in a nursing home is admitted to your medical-surgical unit following surgical treatment for a fractured hip. The overall goal of rehabilitation is to regain prefracture function. What short-term goals of the rehabilitation process would support improvement in functional return? How would you promote early mobilization? What assessments are important to consider when coordinating a rehabilitation plan with the interdisciplinary team?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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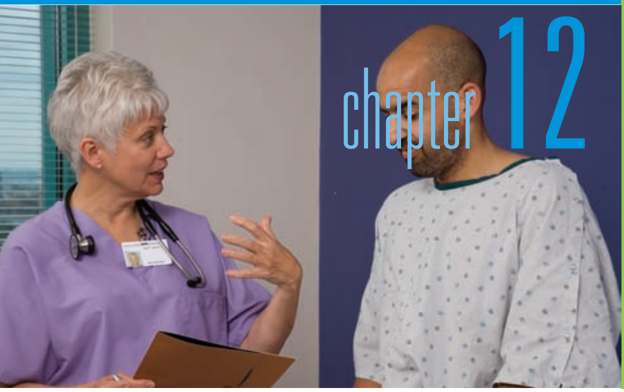
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## RESOURCES

ABLEDATA, www.abledata.com
Agency for Healthcare Research and Quality, www.ahrq.gov
American Association of People with Disabilities (AAPD), www.aapd.com
American Society of Addiction Medicine, www.asam.org
Assistive Technology Industry Association, www.atia.org
Association of Rehabilitation Nurses, www.rehabnurse.org
Canine Companions for Independence, www.caninecompanions.org
Council for Disability Rights, www.disabilityrights.org
National Association on Alcohol, Drugs and Disability. NAADD, www.naadd.org
National Center for Health Statistics, www.cdc.gov/nchs
National Center for the Dissemination of Disability Research 2004–2005, www.ncddr.org
National Council on Alcoholism and Drug Dependence, Inc., www.ncadd.org
National Council on Disability, www.ncd.gov
National Rehabilitation Information Center (NARIC), www.naric.com
National Spinal Cord Injury Association (NSCIA), www.spinalcord.org
Sexuality and Information and Education Council of the U.S. (SIECUS), www.siecus.org
Stroke Engine, McGill University general information, www.medicine.mcgill.ca/Strokengine/index-en.html
Substance Abuse Resources and Disability Issues, www.med.wright.edu
U.S. Census Bureau, www.census.gov
U.S. Department of Health and Human Services, www.hhs.gov




# Health Care of the Older Adult

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Describe the aging American population based on demographic trends.

**2** Describe the significance of preventive health care and health promotion for the elderly.

**3** Compare and contrast the physiologic aspects of aging in older adults with those of middle-age adults.

**4** Identify the common physical and mental health problems of aging and their effects on the functioning of older people and their families.

**5** Identify the role of the nurse in meeting the health care needs of the older patient.

**6** Specify nursing implications related to medication therapy in older people.

**7** Examine the concerns of older people and their families in the home and community, in the acute care setting, and in the long-term care facility.

**8** Discuss the potential economic effect on health care of the large aging population in America.

## GLOSSARY

**activities of daily living (ADLs):** basic personal care activities; bathing, dressing, grooming, eating, toileting, and transferring

**advance directive:** a formal, legally endorsed document that provides instructions for care ("living will")

**ageism:** a bias that discriminates, stigmatizes, and disadvantages older people based solely on their chronologic age

**comorbidity:** having more than one illness at the same time (eg, diabetes mellitus and congestive heart failure)

**delirium:** an acute, confused state that begins with disorientation that if not immediately evaluated and treated, can progress to changes in level of consciousness, irreversible brain damage, and sometimes death

**dementia:** broad term for a syndrome characterized by a general decline in higher brain functioning, such as reasoning, with a pattern of eventual decline in ability to perform even basic activities of daily living, such as toileting and eating

**depression:** the most common affective (mood) disorder of old age; results from changes in reuptake of the neurochemical serotonin in response to chronic illness and emotional stresses related to the physical and social changes associated with the aging process

**durable power of attorney:** a formal, legally endorsed document that identifies a proxy decision maker who can make decisions if the signer becomes incapacitated

**elder abuse:** the physical, emotional, or financial harm to an elderly person by one or more of the individual's children, caregivers, or others; includes neglect

**instrumental activities of daily living (IADLs):** activities that are essential for independent living, such as shopping, cooking, housework, using the telephone, managing medications and finances, and being able to travel by car or public transportation

**orientation:** a person's ability to recognize who and where he or she is in a time continuum; used to evaluate one's basic cognitive status

**polypharmacy:** the administration of multiple medications at the same time; common in older persons with several chronic illnesses

**presbycusis:** the decreased ability to hear high-pitched tones that naturally begins in midlife as a result of irreversible inner ear changes

**presbyopia:** the decrease in visual accommodation that occurs with advancing age

**sundowning:** increased confusion at night

Aging, the normal process of time-related change, begins with birth and continues throughout life. Americans are living longer, and thus the number of older Americans is the most rapidly expanding segment of the population. Therefore, whenever nurses work with an adult population, they are likely to encounter a majority of elderly patients. This chapter presents theories of aging, normal age-related changes, health problems associated with aging, and ways nurses can address the health issues of older adults.

## Overview of Aging

### Demographics of Aging

Life expectancy, the average number of years that a person can be expected to live, has risen dramatically in the past 100 years. The proportion of Americans 65 years of age and older has tripled in the past 100 years (4.1% in 1900 to 12.4% of the population in 2006) (U.S. Census Bureau, 2007). By 2030, it is estimated that 20% of Americans will be 65 years of age or older (Fig. 12-1). In 1900, the average life expectancy was 47 years, but by 2004, that figure had increased to 77.8 years. As the older population increases, the number of people who live to a very old age is dramatically increasing. In 1950, there were 3.8 million elderly people older than 75 years of age; this was 2.6% of the total population. This number is estimated to increase to about 20 million in 2010 (6.8% of total), to 33 million in 2030 (9.2%), and to almost 50 million in 2050 (11.6%) (National Center for Health Statistics [NCHS], 2006).

The older population is becoming more diverse, reflecting changing demographics in the United States. Although the older population will increase in number for all racial and ethnic groups, the rate of growth is projected to be fastest in the Hispanic population, in which it is expected to increase from 6 million in 2004 to an estimated 17.5 million by 2050 (NCHS, 2006). Proportionally, there will be a significant decline in the percentage of the white non-Hispanic population. By 2030, it is estimated that the white non-Hispanic population will decrease to 72% of the elderly population; 11% will be Hispanic, 10% black, and 5% Asian (Centers for Disease Control and Prevention [CDC], 2007a).

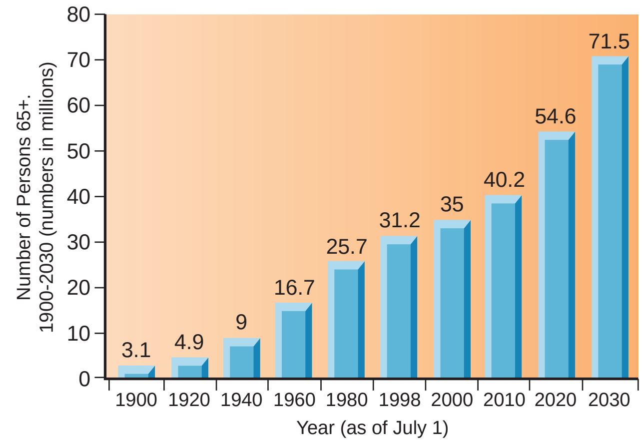



**Figure 12-1** Profile of Americans age 65 years and older based on data from the U.S. Bureau of the Census. Data from 1900 to the present are used to predict the millions of Americans age 65 years and older in the year 2030. From www.aoa.gov/aoa/stats/profile/default.htm

Although the majority of older adults enjoy good health, in national surveys as many as 20% of adults 65 years of age and older report a chronic disability. Chronic disease is the major cause of disability; heart disease, cancer, and stroke continued to be the three leading causes of death in people 65 years of age and older in the United States (Table 12-1). In 2005, Alzheimer's disease and diabetes mellitus ranked as the fifth and sixth causes of disease, respectively (NCHS, 2006). See Chapter 10 for a further discussion of chronic illness and disability.

### Health Status of the Older Adult

The majority of deaths in the United States occur in people 65 years of age and older, and half of these are caused by heart disease and cancer. However, due to improvements in the prevention and early detection and treatment of diseases, there has been a noticeable impact on the health of people 65 years of age and older. In the past 50 years, there has been a decline in overall deaths and, specifically, deaths from heart disease and more recently cancer. Between 2003 and 2004, there was a significant decline in all of the top 10 leading causes of death; deaths

**Table 12-1** DEATH RATES FOR THE 10 LEADING CAUSES OF DEATH IN PEOPLE AGE 65 YEARS AND OLDER IN 2004

| Rank | Cause of Death | Rate (per 100,000) |
|---|---|---|
| | All causes | 4698.8 |
| 1 | Heart diseases | 1898.7 |
| 2 | Malignant neoplasms | 1051.7 |
| 3 | Cerebrovascular diseases | 346.2 |
| 4 | Chronic obstructive pulmonary diseases and allied conditions | 284.3 |
| 5 | Alzheimer's disease | 170.6 |
| 6 | Diabetes mellitus | 146.0 |
| 7 | Pneumonia and influenza | 139.0 |
| 8 | Nephritis, nephrotic syndrome, and nephrosis | 93.8 |
| 9 | Accidents (unintentional injuries) | 93.7 |
| 10 | Septicemia | 68.6 |

From National Center for Health Statistics, Health, United States (NCHS), 2006. Available at: www.cdc.gov/nchs/data/hus/hus06.pdf

from heart disease declined 6.4% and those from cancer declined 2.9% (NCHS, 2006).

In 2006, more than 70% of noninstitutionalized older Americans reported their health to be very good or excellent. Men and women reported comparable levels of health; however, positive health reports declined with advancing age, and a greater number of African American and Hispanic or Latinos were less likely to report good health than their Caucasian or Asian counterparts. But even among people 75 years of age and over, the majority remain functionally independent, and the proportion of older Americans with limitations in activities is declining (CDC, 2007a). These declines in limitations reflect recent trends in health promotion and disease prevention activities, such as improved nutrition, decreased smoking, increased exercise, and early detection and treatment of risk factors such as hypertension and elevated serum cholesterol levels.

Many chronic conditions commonly found among older people can be managed, limited, and even prevented. Older people are more likely to maintain good health and functional independence if encouraged to do so and if appropriate community-based support services are available (King, 2006; Miller, 2009). Nurses are challenged to promote positive lifelong health behaviors among all populations because the impact of unhealthy behaviors and choices can result in chronic disease.

## Nursing Care of the Older Adult

Gerontology, the scientific study of the aging process, is a multidisciplinary field that draws from the biologic, psychological, and sociologic sciences. Geriatrics is the practice (medical or nursing) that focuses on the physiology, pathology, diagnosis, and management of the disorders and diseases of older adults. Because aging is a normal process, care for the elderly cannot be limited to one discipline but is best provided through a cooperative effort. An interdisciplinary approach to providing care combines expertise and resources to provide comprehensive geriatric assessment and intervention. Nurses collaborate with the team to obtain appropriate services for patients and provide a holistic approach to care.

Gerontologic or geriatric nursing is the field of nursing that specializes in the care of the elderly. The Standards and Scope of Gerontological Nursing Practice were originally developed in 1969 by the American Nurses Association and revised in 2001. The nurse gerontologist can be either a specialist or a generalist providing comprehensive nursing care to older people by combining the basic nursing process of assessment, diagnosis, planning, implementation, and evaluation with a specialized knowledge of aging. Gerontological nursing is provided in acute care, skilled and assisted living, the community, and home settings. The goals of care include promoting and maintaining functional status and helping older adults identify and use their strengths to achieve optimal independence.

Nurses who are certified in gerontology have specialized knowledge of the acute and chronic changes specific to older people. The use of gerontologic advanced practice nurses in long-term care has proved to be very effective; when they use current scientific knowledge about clinical problems to collaborate with nursing home staff, significantly less deterioration in the overall health issues of patients occurs (Krichbaum, 2007; Krichbaum, Pearson, Savik, et al., 2005).

Nurses who work in all areas of adult medical-surgical nursing encounter elderly patients. They must be knowledgeable and skilled in meeting the needs of older patients. It is important that nurses and caregivers who work with patients who are older understand that aging is not synonymous with disease and that the effects of the aging process alone are not the primary contributors to disability and disease. As research and scientific knowledge increase, it is becoming apparent that aging is a highly complex process.

Functional assessment is a common framework for assessing elderly people. Age-related changes, as well as additional risk factors such as disease and the effects of medications, can result in a negative impact on function. Assessing the functional consequences of aging and proposing practical interventions help maintain and improve the health of the elderly. The goal is to help older people maintain maximum functional level and dignity despite physical, social, and psychological losses. Early intervention can prevent complications of many health problems and help maximize the quality of life.

## Theories of Aging

Aging has been defined chronologically by the passing of time—subjectively, as in how a person feels, and functionally, as in changes in physical or mental capabilities. The many theories of aging attempt to provide a framework in which to understand aging from different perspectives. Each theory is useful to the clinician because it provides a framework and insight into the differences among elderly patients. In addition to the biologic, developmental, and sociologic theories of aging, Miller (2009) developed the functional consequences theory, which challenges nurses to consider the effects of normal age-related changes as well as the damage incurred through disease or environmental and behavioral risk factors when planning care. Miller suggests that nurses can alter the outcome for patients through nursing interventions that address the consequences of these changes. Age-related changes and risk factors may negatively interfere with patient outcomes and actually impair patient activity and quality of life. For example, normal age-related changes in vision may increase sensitivity to glare. Alterations in the environment that reduce glare may enhance patient comfort and safety. In contrast, the development of cataracts, which is not a normal age-related change, also may increase sensitivity to glare. The nurse must differentiate between normal age-related changes that cannot be reversed and risk factors that can be modified. Doing so is useful in designing appropriate nursing interventions that have a positive impact on patient outcomes for the elderly—most importantly, for quality of life.

# *Age-Related Changes*

The well-being of older people depends on physical, psychosocial, mental, social, economic, and environmental factors. A total assessment includes an evaluation of all major body systems, social and mental status, and the ability of

a person to function independently despite having a chronic illness or disability.

## Physical Aspects of Aging

As previously mentioned, intrinsic aging (from within the person) refers to those changes caused by the normal aging process that are genetically programmed and essentially universal within a species. Universality is the major criterion used to distinguish normal aging from pathologic changes associated with illness. However, people age quite differently and at different rates, so chronologic age is often less predictive of obvious aging characteristics than other factors, such as one's genetics and lifestyle. For example, extrinsic aging results from influences outside the person. Air pollution and excessive exposure to sunlight are examples of extrinsic factors that may hasten the aging process and that can be eliminated or reduced.

Cellular and extracellular changes of old age cause a change in physical appearance and a decline in function. Measurable changes in shape and body makeup occur. The body's ability to maintain homeostasis becomes increasingly diminished with cellular aging, and organ systems cannot function at full efficiency because of cellular and tissue deficits. Cells become less able to replace themselves, and they accumulate a pigment known as lipofuscin. A degradation of elastin and collagen causes connective tissue to become stiffer and less elastic. These changes result in diminished capacity for organ function and increased vulnerability to disease and stress.

Table 12-2 summarizes the signs and symptoms of age-related changes in the functioning of body systems. More in-depth information about age-related changes can be found in the chapters pertaining to each organ system. Specifics of diseases, medical and surgical management, as well as nursing interventions are also presented in the related chapters.

### Cardiovascular System

Heart disease is the leading cause of death in the elderly. Heart failure is the leading cause of hospitalization among Medicare recipients, and it is also a major cause of morbidity and mortality among the elderly population in the United States. Age-related changes reduce the efficiency of the heart and contribute to decreased compliance of the heart muscle. These changes include myocardial hypertrophy, which changes left ventricular strength and function; fibrosis and stenosis of the valves; and decreased pacemaker cells (Neal-Boylan, 2007). As a result, the heart valves become thicker and stiffer, and the heart muscle and arteries lose their elasticity, resulting in a reduced stroke volume. Calcium and fat deposits accumulate within arterial walls, and veins become increasingly tortuous, increasing arterial resistance; this increases the workload of the heart.

It is difficult to differentiate between age-related and disease-related changes in cardiovascular function because of the significant influence of behavioral factors on cardiovascular health. When cross-cultural studies are conducted, cardiovascular changes that in the past were thought to be age related do not consistently appear. For example, the higher blood pressure found in older adults in Western societies does not occur in less-developed societies and may be a result of different lifestyle behaviors rather than normal age-related changes (Miller, 2009). Under normal circumstances, the cardiovascular system can adapt to the normal age-related changes, and an older person is unaware of any significant decline in cardiovascular performance. However, when challenged, the cardiovascular system of an older person is less efficient under conditions of stress and exercise and when life-sustaining activities are needed.

Careful assessment of older people is necessary because they often present with different symptoms than those seen in younger patients. Older people are more likely to have dyspnea or neurologic symptoms associated with heart disease, and they may experience mental status changes or report vague symptoms such as fatigue, nausea, and syncope. Rather than the typical substernal chest pain associated with myocardial ischemia, older patients may report burning or sharp pain or discomfort in an area of the upper body. Complicating the assessment is the fact that many elderly patients have more than one underlying disease. When a patient complains about symptoms related to digestion and breathing and upper extremity pain, cardiac disease must be considered. The absence of chest pain in an older patient is not a reliable indicator of the absence of heart disease.

Hypotension may be a concern. The risk of orthostatic and postprandial hypotension increases significantly after 75 years of age (Miller, 2009). A patient experiencing hypotension should be counseled to rise slowly (from a lying, to a sitting, to a standing position), to avoid straining when having a bowel movement, and to consider having five or six small meals each day, rather than three, to minimize the hypotension that can occur after a large meal. Extremes in temperature, including hot showers and whirlpool baths, should be avoided.

### Respiratory System

The respiratory system is the one system that seems to be the most able to compensate for the functional changes of aging. In general, healthy, nonsmoking, older adults show very little decline in respiratory function; however, there are substantial individual variations. The age-related changes that do occur are subtle and gradual, and healthy older adults are able to compensate for these changes. Diminished respiratory efficiency as well as reduced maximal inspiratory and expiratory force may occur as a result of calcification and weakening of the muscles of the chest wall. Lung mass decreases, and residual volume increases (Bickley, 2007).

Conditions of stress, such as illness, may increase the demand for oxygen and affect the overall function of other systems. Like cardiovascular diseases, respiratory diseases manifest more subtly in older adults than in younger adults and do not necessarily follow the typical pattern of cough, chills, and fever. Older adults may exhibit headache, weakness, lethargy, anorexia, dehydration, and mental status changes (Miller, 2009).

Smoking is the most significant risk factor for respiratory and other diseases. Therefore, a major focus of health promotion activities should be on smoking cessation and avoidance of environmental smoke. Pneumonia and influenza together are the fifth leading cause of death in people older than 65 years of age (NCHS, 2006). Education to promote the use of recommended vaccines is an essential nursing intervention. A pneumococcal vaccine that

**Table 12-2 AGE-RELATED CHANGES IN BODY SYSTEMS AND HEALTH PROMOTION STRATEGIES**

| Changes | Subjective and Objective Findings | Health Promotion Strategies |
|---|---|---|
| **Cardiovascular System** | | |
| Decreased cardiac output; diminished ability to respond to stress; heart rate and stroke volume do not increase with maximum demand; slower heart recovery rate; increased blood pressure | Complaints of fatigue with increased activity<br>Increased heart rate recovery time<br>Optimal blood pressure ≤120/80 mm Hg<br>Prehypertension<br>>120–139/80–89 mm Hg<br>Hypertension ≥140/90 mm Hg | Exercise regularly; pace activities; avoid smoking; eat a low-fat, low-salt diet; participate in stress-reduction activities; check blood pressure regularly; medication compliance; weight control |
| **Respiratory System** | | |
| Increase in residual lung volume; decrease in muscle strength, endurance, and vital capacity; decreased gas exchange and diffusing capacity; decreased cough efficiency | Fatigue and breathlessness with sustained activity; decreased respiratory excursion and chest/lung expansion with less effective exhalation; difficulty coughing up secretions | Exercise regularly; avoid smoking; take adequate fluids to liquefy secretions; receive yearly influenza immunization and pneumonia vaccine at 65 years of age; avoid exposure to upper respiratory tract infections |
| **Integumentary System** | | |
| Decreased subcutaneous fat, interstitial fluid, muscle tone, glandular activity, sensory receptors resulting in decreased protection against trauma and sun exposure, and temperature extremes; diminished secretion of natural oils and perspiration; capillary fragility | Thin, wrinkled, and dry skin; complaints of injuries, bruises, and sunburn; complaints of intolerance to heat; bone structure is prominent | Limit solar exposure to 10–15 minutes daily for vitamin D (use protective clothing and sunscreen); dress appropriately for temperature; maintain a safe indoor temperature; take shower rather than hot tub bath if possible; lubricate skin with lotions that contain petroleum or mineral oil |
| **Reproductive System** | | |
| *Female:* Vaginal narrowing and decreased elasticity; decreased vaginal secretions<br>*Male:* Less firm testes and decreased sperm production<br>*Male and Female:* Slower sexual response | *Female:* Painful intercourse; vaginal bleeding following intercourse; vaginal itching and irritation; delayed orgasm<br>*Male:* Delayed erection and achievement of orgasm | May require vaginal estrogen replacement; gynecology/urology follow-up; use a lubricant with sexual intercourse |
| **Musculoskeletal System** | | |
| Loss of bone density; loss of muscle strength and size; degenerated joint cartilage | Height loss; prone to fractures; kyphosis; back pain; loss of strength, flexibility, and endurance; joint pain | Exercise regularly; eat a high-calcium diet; limit phosphorus intake; take calcium and vitamin D supplements as prescribed |
| **Genitourinary System** | | |
| *Male:* Benign prostatic hyperplasia | Urinary retention; irritative voiding symptoms including frequency, feeling of incomplete bladder emptying, multiple nighttime voidings | *Male:* Limit drinking in evening (eg, caffeinated beverages, alcohol); do not wait long periods between voiding and empty bladder all the way when passing urine. |
| *Female:* Relaxed perineal muscles, detrusor instability (urge incontinence), urethral dysfunction (stress urinary incontinence) | Urgency/frequency syndrome, decreased "warning time," drops of urine lost with cough, laugh, position change | *Female:* Wear easily manipulated clothing; drink adequate fluids; avoid bladder irritants (eg, caffeinated beverages, alcohol, artificial sweeteners); pelvic floor muscle exercises, preferably learned via biofeedback; consider urologic workup |
| **Gastrointestinal System** | | |
| Decreased sense of thirst, smell and taste; decreased salivation; difficulty swallowing food; delayed esophageal and gastric emptying; reduced gastrointestinal motility | Risk of dehydration, electrolyte imbalances, and poor nutritional intake; complaints of dry mouth; complaints of fullness, heartburn, and indigestion; constipation, flatulence, and abdominal discomfort | Use ice chips, mouthwash; brush, floss, and massage gums daily; receive regular dental care; eat small, frequent meals; sit up and avoid heavy activity after eating; limit antacids; eat a high-fiber, low-fat diet; limit laxatives; toilet regularly; drink adequate fluids |
| **Nervous System** | | |
| Reduced speed in nerve conduction; increased confusion with physical illness and loss of environmental cues; reduced cerebral circulation (becomes faint, loses balance) | Slower to respond and react; learning takes longer; becomes confused with hospital admission; faintness; frequent falls | Pace teaching; with hospitalization, encourage visitors; enhance sensory stimulation; with sudden confusion, look for cause; encourage slow rising from a resting position |

*Continued*

**Table 12-2 AGE-RELATED CHANGES IN BODY SYSTEMS AND HEALTH PROMOTION STRATEGIES (Continued)**

| Changes | Subjective and Objective Findings | Health Promotion Strategies |
|---|---|---|
| **Special Senses** | | |
| *Vision:* Diminished ability to focus on close objects; inability to tolerate glare; difficulty adjusting to changes of light intensity; decreased ability to distinguish colors | Holds objects far away from face; complains of glare; poor night vision; confuses colors | Wear eyeglasses, use sunglasses outdoors; avoid abrupt changes from dark to light; use adequate indoor lighting with area lights and nightlights; use large-print books; use magnifier for reading; avoid night driving; use contrasting colors for color coding; avoid glare of shiny surfaces and direct sunlight |
| *Hearing:* Decreased ability to hear high-frequency sounds; tympanic membrane thinning and loss of resiliency | Gives inappropriate responses; asks people to repeat words; strains forward to hear | Recommend a hearing examination; reduce background noise; face person; enunciate clearly; speak with a low-pitched voice; use nonverbal cues |
| *Taste and smell:* Decreased ability to taste and smell | Uses excessive sugar and salt | Encourage use of lemon, spices, herbs<br>Recommend smoking cessation |

prevents 85% to 90% of all cases of pneumonia is available, and it is effective in preventing 75% of cases in people older than 65 years of age. Influenza vaccination is less effective in preventing influenza in the elderly than in the younger population, but it reduces influenza-related deaths, hospitalizations, and other complications (Miller, 2009).

Activities that help elderly people maintain adequate respiratory function include regular exercise, appropriate fluid intake, pneumococcal vaccination, yearly influenza immunizations, and avoidance of people who are ill. Hospitalized older adults should be frequently reminded to cough and take deep breaths, particularly postoperatively, because their decreased lung capacity and decreased cough efficiency predispose them to atelectasis and respiratory infections.

### Integumentary System

The functions of the skin include protection, temperature regulation, sensation, and excretion. With aging, changes occur that affect the function and appearance of the skin. There is a decrease of epidermal proliferation, and the dermis becomes thinner. Elastic fibers are reduced in number, and collagen becomes stiffer. Subcutaneous fat diminishes, particularly in the extremities, but gradually increases in other areas, such as the abdomen (men) and thighs (women), leading to an overall increase in body fat in older people (Tabloski, 2006). Decreased numbers of capillaries in the skin result in diminished blood supply. These changes cause a loss of resiliency and wrinkling and sagging of the skin. The skin becomes drier and more susceptible to burns, injury, and infection. Hair pigmentation may change and balding may occur; genetic factors strongly influence these changes. These changes in the integument reduce tolerance to temperature extremes and sun exposure.

Lifestyle practices are likely to have a large impact on skin changes. Therefore, strategies to promote healthy skin function include not smoking, avoiding exposure to the sun, using a sun protection factor (SPF) of 15 or higher, using emollient skin cream containing petrolatum or mineral oil, avoiding hot soaks in the bathtub, and maintaining optimal nutrition and hydration. Older adults should be encouraged to have any changes in the skin examined, because early detection and treatment of precancerous or cancerous lesions are essential for the best outcome.

### Reproductive System

Sexuality is no longer considered pertinent only to the young. However, research about sexuality among the elderly, especially in women, has not been extensive. Ovarian production of estrogen and progesterone ceases with menopause. Changes occurring in the female reproductive system include thinning of the vaginal wall, along with a shortening of the vagina and a loss of elasticity; decreased vaginal secretions, resulting in vaginal dryness, itching, and decreased acidity; involution (atrophy) of the uterus and ovaries; and decreased pubococcygeal muscle tone, resulting in a relaxed vagina and perineum. Without the use of water-soluble lubricants, these changes may contribute to vaginal bleeding and painful intercourse.

In older men, the testes become less firm but men up to 90 years of age continue to produce viable sperm. At about 50 years of age, production of testosterone begins to diminish (Tabloski, 2006). Decreased libido and erectile dysfunction may develop but are more likely to be associated with factors other than age-related changes. These risk factors include cardiovascular disease; neurologic disorders; diabetes; respiratory disease; pain; and medications such as vasodilators, antihypertensive agents, and tricyclic antidepressants.

In both older men and women, it may take longer to become sexually aroused, longer to complete intercourse, and longer before sexual arousal can occur again. Although a less intense response to sexual stimulation and a decline in sexual activity occurs with increasing age, sexual desire does not disappear. Men may experience a decline in sexual function related to health conditions or interference from medications. Women may lose their partner; the absence of a partner is often the primary factor causing lack of sexual activity. Many couples are unaware of the causes of decreased libido or erectile dysfunction and are often reluctant to discuss decreased sexual function. There are many

methods of improving the quality of sexual interactions, but the assessment and communication require sensitivity and expert knowledge in the field of sexual dysfunction. If sexual dysfunction is present, referral to a gynecologist, urologist, or sex therapist may be warranted.

### Genitourinary System

The genitourinary system continues to function adequately in older people, although there is a decrease in kidney mass, primarily because of a loss of nephrons. However, the loss of nephrons does not typically become significant until about 90 years of age, and changes in kidney function vary widely; about one third of elderly people show no decrease in renal function (Tabloski, 2006). Changes in renal function may be due to a combination of aging and pathologic conditions such as hypertension. The changes most commonly seen include a decreased filtration rate, diminished tubular function with less efficiency in resorbing and concentrating the urine, and a slower restoration of acid–base balance in response to stress. In addition, older adults who take medications may experience serious consequences due to decline in renal function because of impaired absorption, decreased ability to maintain fluid and electrolyte balance, and decreased ability to concentrate urine.

Certain genitourinary disorders are more common in older adults than in the general population. At least 1 in 10 older adults in the United States suffers from urinary incontinence, and women are more likely than men to have this disorder. Unfortunately, this condition is often mistakenly viewed as a normal consequence of aging. Costly and embarrassing, it should be evaluated, because in many cases it is reversible or can be treated (Specht, 2005). Urinary incontinence is discussed in more detail in Chapter 45. Benign prostatic hyperplasia (enlarged prostate gland), a common finding in older men, causes a gradual increase in urine retention and overflow incontinence.

Changes in the urinary tract increase the susceptibility to urinary tract infections. Adequate consumption of fluids is an important nursing intervention that reduces the risk of bladder infections and also helps decrease urinary incontinence.

### Gastrointestinal System

Digestion of food is less influenced by age-related changes than by the risk of poor nutrition. Older people can adjust to the age-related changes but may have difficulty purchasing, preparing, and enjoying their meals. The sense of smell diminishes as a result of neurologic changes and environmental factors such as smoking, medications, and vitamin $B_{12}$ deficiencies. The ability to recognize sweet, sour, bitter, or salty foods diminishes over time, altering satisfaction with food. Salivary flow does not decrease in healthy adults, but about 30% of older people may experience a dry mouth as a result of medications and diseases (Miller, 2009). Difficulties with chewing and swallowing are generally associated with disease.

Experts disagree on the extent of gastric changes that occur as a result of normal aging. However, there does appear to be a modest slowing of gastric motility, which results in delayed emptying of stomach contents and early satiety (feeling of fullness). Diminished secretion of gastric acid and pepsin, seemingly the result of pathologic conditions rather than normal aging, reduces the absorption of iron, calcium, and vitamin $B_{12}$. Absorption of nutrients in the small intestine, particularly calcium and vitamin D, appears to diminish with age. Functions of the liver, gallbladder, and pancreas are generally maintained, although absorption and tolerance to fat may decrease. The incidence of gallstones and common bile duct stones increases progressively with advancing years.

Difficulty in swallowing, or dysphagia, increases with age and is a major health care problem in elderly patients. Normal aging alters some aspects of the swallowing function, and it is a frequent complication of stroke and a significant risk factor for development of pneumonia. This serious condition can be life-threatening. It is caused by interruption or dysfunction of neural pathways, such as can occur with stroke. Dysphagia may also result from dysfunction of the striated and smooth muscles of the gastrointestinal tract in patients with Parkinson's disease and in patients with disorders such as multiple sclerosis, poliomyelitis, and amyotrophic lateral sclerosis (ie, Lou Gehrig's disease). Aspiration of food or fluid is the most serious complication and can occur in the absence of coughing or choking.

Constipation is a common pathologic condition that affects as many as 80% of institutionalized and 45% of community-dwelling elderly people (Miller, 2009). Symptoms of mild constipation are abdominal discomfort and flatulence, and more serious constipation leads to fecal impaction that contributes to diarrhea around the impaction, fecal incontinence, and obstruction. Predisposing factors for constipation include lack of dietary bulk, prolonged use of laxatives, use of some medications, inactivity, insufficient fluid intake, and excessive dietary fat. Ignoring the urge to defecate may also be a contributing factor.

Practices that promote gastrointestinal health include regular tooth brushing and flossing; receiving regular dental care; eating small, frequent meals; avoiding heavy activity after eating; eating a high-fiber, low-fat diet; drinking enough fluids; and avoiding the use of laxatives and antacids. Understanding that there is a direct correlation between loss of smell and taste perception and food intake helps caregivers intervene to maintain elderly patients' nutritional health.

### Nutritional Health

The social, psychological, and physiologic functions of eating influence the dietary habits of older people. Increasing age alters nutrient requirements; the elderly require fewer calories and a more nutrient-rich, healthy diet in response to alterations in body mass and a more sedentary lifestyle. Recommendations include reducing fat intake while consuming sufficient protein, vitamins, minerals, and dietary fiber for health and disease prevention. Decreased physical activity and a slower metabolic rate reduce the number of calories needed by older adults to maintain an ideal weight. As previously stated, age-related changes that alter pleasure in eating include a decrease in taste and smell. Older people are likely to maintain a taste for sweetness but require more sugar to achieve a sweet flavor. They also may lose the ability to differentiate sour, salty, and bitter tastes. Apathy, immobility, depression, loneliness, poverty, inadequate

knowledge, and poor oral health also contribute to suboptimal nutrient intake. Budgetary constraints and physical limitations may interfere with food shopping and meal preparation.

Health promotion includes encouraging a varied diet that is low in sodium and saturated fats and high in vegetables, fruits, and fish. Education regarding healthy foods versus foods with inadequate nutrients is helpful. The incidence of obesity in Americans as old as 80 years of age has reached epidemic proportions, and this greatly increases the incidence of chronic disease such as diabetes and cardiovascular diseases.

No more than 30% of dietary calories should be consumed as fat. Protein intake may need to be increased in later adulthood to maintain adequate nitrogen equilibrium (DiMaria-Ghalili & Amella, 2005). Carbohydrates, a major source of energy, should supply 55% to 60% of the daily calories. Simple sugars should be avoided, and complex carbohydrates should be encouraged. Potatoes, whole grains, brown rice, and fruit are sources of minerals, vitamins, and fiber and should be encouraged. Drinking 8 to 10 eight-ounce glasses of water per day is recommended unless contraindicated by a medical condition. A multivitamin each day helps meet daily nutritional needs. Adults older than 50 years of age should have a daily calcium intake to 1200 g, and 600 IU of vitamin D to maintain bone heath (Miller, 2009).

Undernutrition may also be a problem for older adults; as many as 40% to 60% of hospitalized and 40% to 85% of nursing home patients are malnourished. A recent unintentional weight loss may be a result of an illness or other factors, such as depression, that may have serious consequences and affect a person's ability to maintain health and fight illness (Martin, Kayser-Jones, Stotts, et al., 2007). Many people are unaware of dietary deficits. Nurses are in an ideal position to identify nutritional problems among their patients and to work within the patient's own framework of knowledge of his or her health status to improve health behaviors. Chapter 5 provides more information on nutritional assessment.

### Sleep

Sleep disturbances affect more than 50% of adults 65 years of age or older. The elderly tend to take longer to fall asleep, awaken more easily and frequently, and spend less time in deep sleep. Consequently, they may feel that their sleep is less satisfactory (Miller, 2009). Although older adults require as much sleep as younger people, they may experience variations in their normal sleep–wake cycles, and the lack of quality sleep at night often creates the need for napping during the day. Older people are more likely to awaken because of factors such as noise, pain, or nocturia.

The incidence of sleep apnea (a sleep disorder characterized by brief periods in which respirations are absent) increases with age. Having insomnia symptoms and a sleep-related disorder (snoring, choking, or pauses in breathing) is associated with significantly impaired daytime functioning and longer psychomotor reaction times compared with having either condition (Cole & Richards, 2007; Gooneratne, Gehrman, Nkwuo, et al., 2006). Sleep apnea is discussed in more detail in Chapter 22.

The nurse is the caregiver who observes patients while they are sleeping. The nurse can observe problems and also recommend sleep hygiene behaviors such as avoiding use of the bed for activities other than sleeping (or sex), maintaining a consistent bedtime routine, avoiding or limiting daytime napping, limiting alcohol intake to one or two drinks a day, and avoiding caffeine and nicotine after noon.

### Musculoskeletal System

Intact musculoskeletal and neurologic systems are essential for the maintenance of safe mobility, performance of **activities of daily living** (ADLs) (basic personal care activities), and **instrumental activities of daily living** (IADLs) (activities that are essential for independent living), thus allowing older adults to remain safe and live independently in the community. Age-related changes that affect mobility include alterations in bone remodeling, leading to decreased bone density, loss of muscle mass, deterioration of muscle fibers and cell membranes, and degeneration in the function and efficiency of joints. These factors are discussed in detail in Unit 15.

Without exercise, a gradual, progressive decrease in bone mass begins before 40 years of age. The cartilage of joints also progressively deteriorates in middle age. Degenerative joint disease is found in most adults older than 70 years of age, and weight-bearing joint and back pain is a common complaint. Excessive loss of bone density results in osteoporosis, which leads to potentially life-altering hip and vertebral fractures. Osteoporosis is preventable.

The axiom "use it or lose it" is very relevant to the physical capacity of older adults. Nurses play an important role by encouraging older adults to participate in a regular exercise program (Chart 12-1). The benefits of regular exercise cannot be overstated. Aerobic exercises are the foundation of programs of cardiovascular conditioning, but resistance and strength training as well as flexibility exercises are essential components of an exercise program. Even late in life, in adults who are very old and frail, it is generally believed that exercise has the benefits of increasing strength, aerobic capacity, flexibility, and balance (Fahlman, Topp, McNevin, et al., 2007).

### Nervous System

Homeostasis is difficult to maintain with aging, but most older people function adequately and retain their cognitive and intellectual abilities in the absence of pathologic changes. However, normal aging changes in the nervous system can affect all parts of the body.

The structure and function of the nervous system change with advanced age, and a reduction in cerebral blood flow accompanies nervous system changes. Reports of the loss of nerve cells are highly varied with variations in neuron loss in different parts of the brain (Mauk, 2006). The loss of nerve cells contributes to a progressive loss of brain mass.

In addition, the synthesis and metabolism of the major neurotransmitters are also reduced. Because nerve impulses are conducted more slowly, older people take longer to respond and react. The autonomic nervous system performs less efficiently, and postural hypotension, which causes people to lose consciousness or feel lightheaded when standing up quickly, may occur. Neurologic changes can affect gait

CHART 12-1 NURSING RESEARCH PROFILE
### Structured Exercise

Fahlman, M. M., Topp, R., McNevin, N., et al. (2007). Assessing the benefits of an aerobic plus resistance training program. *Journal of Gerontological Nursing, 33*(6), 33–39.

**Purpose**

This study examined the effects of a 16-week exercise program designed to increase aerobic capacity, muscular strength, and endurance among community-dwelling older adults. The participants reported and demonstrated limited functional ability, such as being unable to climb 26 steps in less than 12.6 seconds (the average speed for people 65 years of age and older).

**Design**

The 79 adults, with an average age of 75 years (range 65 to 92 years), had not been in an exercise program previously. They were randomly divided into an exercise group and a control group. The control group was told that the exercise program was delayed, whereas the exercise group participated in a 25-minute group walk and two sets of 12 repetitions of 13 different resistance exercises three times a week for 16 weeks. The distance participants were able to walk in a 6-minute period was used to measure endurance and strength testing was preformed in the legs and the arms.

**Findings**

The findings demonstrated that a structured 16-week exercise program in older adults with limited functional ability led to an increase of functional ability such as endurance and strength when compared with the control group. Participants in the exercise group increased their 6-minute walk distance by 12%, their leg strength by 9%, and their arm strength by 6% compared to baseline measurements.

**Nursing Implications**

This study supports the value of exercise in maintaining basic functional ability and demonstrates that older adults can increase their functional ability for muscle strength and for endurance with a regular structured exercise program. Maintaining muscle strength, cardiovascular endurance, and balance enable the older person to maintain independence into old age. Nurses can be proactive by keeping patients out of bed and moving, recommending ongoing exercise to older patients, and identifying patients who are demonstrating a functional decline and referring them to moderate exercise programs geared toward older adults.

and balance, which may interfere with mobility and safety. Nurses must advise elderly people to allow a longer time to respond to a stimulus and to move more deliberately.

This slowed reaction time puts older people at risk for falls and injuries, as well as driving errors. Even though older adults spend less time driving compared with younger people, elderly people are just as likely to be involved in motor vehicle crashes that result in serious injury or death. Elderly people who are driving unsafely should receive a driving fitness evaluation (Miller, 2009). This is often administered by an occupational therapist in conjunction with a neuropsychologist, who conducts more detailed cognitive testing.

Mental function is threatened by physical or emotional stresses. A sudden onset of confusion may be the first symptom of an infection or change in physical condition (eg, pneumonia, urinary tract infection, medication interactions, and dehydration).

### *Sensory System*

People interact with the world through their senses. Sensory losses associated with old age affect all sensory organs, and it can be devastating not to be able to see to read or watch television, hear conversation well enough to communicate, or discriminate taste well enough to enjoy food. Nearly half of older men and one third of older women report difficulty hearing without a hearing aid. Sixteen percent of older men and 19% of older women report difficulty seeing, even with corrective lenses (Federal Interagency Forum on Aging-Related Statistics, 2008). An uncompensated alteration in a sensory loss negatively affects the functional ability and quality of life of the older adult.

#### Sensory Loss Versus Sensory Deprivation

Sensory loss can often be compensated for by assistive devices such as glasses and hearing aids. In contrast, sensory deprivation is the absence of stimuli in the environment or the inability to interpret existing stimuli (perhaps as a result of a sensory loss). Sensory deprivation can lead to boredom, confusion, irritability, disorientation, and anxiety. A decline in sensory input can mimic a decline in cognition that is in fact not present. Meaningful sensory stimulation provided to the older person is often helpful in correcting this problem. In some situations, one sense can substitute for another in observing and interpreting stimuli. Nurses can enhance sensory stimulation in the environment with colors, pictures, textures, tastes, smells, and sounds. The stimuli are most meaningful if they are interpreted to older people and if the stimuli are changed often. Cognitively impaired people tend to respond well to touch and to familiar music.

#### Vision

As new cells form on the outside surface of the lens of the eye, the older central cells accumulate and become yellow, rigid, dense, and cloudy, leaving only the outer portion of the lens elastic enough to change shape (accommodate) and focus at near and far distances. As the lens becomes less flexible, the near point of focus gets farther away. This condition, **presbyopia,** usually begins in the fifth decade of life and requires the person to wear reading glasses to magnify objects. In addition, the yellowing, cloudy lens cause light to scatter and make the older person sensitive to glare. The ability to discern blue from green decreases. The pupil dilates slowly and less completely because of increased stiffness of the muscles of the iris, so the older person takes more time to adjust when going to and from

light and dark settings and needs brighter light for close vision. Pathologic visual conditions are not a part of normal aging, but the incidence of eye disease (most commonly cataracts, glaucoma, diabetic retinopathy, and age-related macular degeneration) increases in older people.

Age-related macular degeneration is the primary cause of vision loss in the elderly. More than 25% of people older than 75 years of age have some signs of this disease, and 6% to 8% have advanced disease associated with severe vision loss. Macular degeneration does not affect peripheral vision, which means that it does not cause blindness. However, it affects central vision, color perception, and fine detail, greatly affecting common visual skills such as reading, driving, and seeing faces. Risk factors include sunlight exposure, cigarette smoking, and heredity, and people with fair skin and blue eyes may be at increased risk. Sunglasses and hats with visors provide some protection, and stopping smoking is paramount in preventing the disease. Although there is no definitive treatment and no cure that restores vision, several treatment options are available, depending on factors such as the location of the abnormal blood vessels. Injected medication in conjunction with photodynamic therapy has demonstrated improved outcomes in clinical trials for the wet type of acute macular degeneration (Blick, Keating & Wagstaff, 2007). The earlier this condition is diagnosed, the greater the chances of preserving sight. More information on altered vision can be found in Chapter 58.

### Hearing

Auditory changes begin to be noticed at about 40 years of age. Environmental factors, such as exposure to noise, medications, and infections, as well as genetics, may contribute to hearing loss as much as age-related changes. **Presbycusis** is a gradual, sensorineural loss that progresses from the loss of the ability to hear high-frequency tones to a generalized loss of hearing. It is attributed to irreversible inner ear changes. Older people often cannot follow conversation because tones of high-frequency consonants (the sounds *f, s, th, ch, sh, b, t, p*) all sound alike. Hearing loss may cause older people to respond inappropriately, misunderstand conversation, and avoid social interaction. This behavior may be erroneously interpreted as confusion. Wax buildup or other correctable problems may also be responsible for hearing difficulties. A properly prescribed and fitted hearing aid may be useful in reducing some types of hearing deficits. Chapter 59 discusses alterations in hearing.

### Taste and Smell

Of the four basic tastes (sweet, sour, salty, and bitter), sweet tastes are particularly dulled in older people. Blunted taste may contribute to the preference for salty, highly seasoned foods, but herbs, onions, garlic, and lemon can be used as substitutes for salt to flavor food.

Changes in the sense of smell are related to cell loss in the nasal passages and in the olfactory bulb in the brain. Environmental factors such as long-term exposure to toxins (eg, dust, pollen, and smoke) contribute to the cellular damage.

## Psychosocial Aspects of Aging

Successful psychological aging is reflected in the ability of older people to adapt to physical, social, and emotional losses and to achieve life satisfaction. Because changes in life patterns are inevitable over a lifetime, older people need resiliency and coping skills when confronting stresses and change. A positive self-image enhances risk taking and participation in new, untested roles.

Although attitudes toward older people differ in ethnic subcultures, a subtle theme of **ageism**—prejudice or discrimination against older people—predominates in our society, and many myths surround aging. Ageism is based on stereotypes, simplified and often untrue beliefs that reinforce society's negative image of older people. Although older people make up an extremely heterogeneous and increasingly a racially and ethnically diverse group, negative stereotypes are attributed to all older people.

Fear of aging and the inability of many to confront their own aging process may trigger ageist beliefs. Retirement and perceived nonproductively are also responsible for negative feelings, because a younger working person may falsely see older people as not contributing to society, as draining economic resources, and may actually feel that they are in competition with children for resources. Concern about the large numbers of elderly leaving the workforce (baby boomers begin to turn age 65 in 2011) is fueling this debate.

Many negative images are so common in society that the elderly themselves often believe and perpetuate them. An understanding of the aging process and respect for each person as an individual can dispel the myths of aging. If the elderly are treated with dignity and encouraged to maintain autonomy, the quality of their lives will improve.

### *Stress and Coping in the Older Adult*

Coping patterns and the ability to adapt to stress develop over the course of a lifetime and remain consistent later in life. Experiencing success in younger adulthood helps a person develop a positive self-image that remains solid through old age. A person's abilities to adapt to changes, make decisions, and respond predictably are also determined by past experiences. A flexible, well-functioning person will probably continue as such. However, losses may accumulate within a short period of time and may become overwhelming. The older person often has fewer choices and diminished resources to deal with stressful events. Common stressors of old age include normal aging changes that impair physical function, activities, and appearance; disabilities from injury or chronic illness; social and environmental losses related to loss of income and decreased ability to perform previous roles and activities; and the deaths of significant others. Many older adults rely strongly on their spiritual beliefs for comfort during stressful times.

### *Living Arrangements*

Most older people want to remain in their own homes; in fact, they function best in their own environment. The family home and familiar community may have strong emotional significance for them, and this should not be ignored. However, with advanced age and increasing disability, adjustments to the environment may be required to allow older adults to remain in their own homes or apartments. Additional family support or more formal support such as Meals on Wheels or transportation services may be necessary to compensate for declining function and mobility.

Many elderly people have more than adequate financial resources and good health even until very late in life; therefore, they have many housing options. More than 90% of the elderly live in the community, with a relatively small percentage (4.5%) of elderly residing in nursing homes, and a comparable percentage (5%) living in some type of senior housing. Eighty percent of those older than 65 years of age own their homes. At this time, 30.1% of noninstitutionalized elderly people live alone. Of the elderly people who live alone in the community, widowed women predominate. Seventy-two percent of men older than 65 years of age are married compared with 42% of women in the same age group. Among those 85 years of age or older, about 50% of the men are married compared with 13% of the women. This difference in marital status is a result of several factors: women have a longer life expectancy than men; women tend to marry older men; and women tend to remain widowed, whereas men often remarry (Administration on Aging [AoA], 2006).

Older people tend to relocate in response to changes in their lives such as retirement or widowhood, a significant deterioration in health, or disability. The type of housing they choose depends on their reason for moving (Hooyman & Kiyak, 2005). For example, there has been a significant increase in the elderly population in the "Sun Belt"—in the states of Florida, California, Texas, and Arizona—as relatively young older adults (60 to 74 years of age) and recent retirees move to warmer climates and retirement communities. With increasing disability and illness, elderly people may move to retirement facilities or assisted living communities that provide some support such as meals, transportation, and housekeeping but allow them to live somewhat independently. If they develop a serious illness or disability and can no longer live independently or semi-independently, they may need to move to a setting where additional support is available. Older people may move in with a relative or to a nursing home or an assisted living facility near a child's home.

Sometimes older adults or couples move in with adult children. This can be a rewarding experience as the children, their parents, and the grandchildren interact and share household responsibilities (Fig. 12-2). It can also be stressful, depending on family dynamics. Adult children and their older parents may choose to pool their financial resources by moving into a house that has an attached "in-law suite." This arrangement provides security for the older adult and privacy for both families.

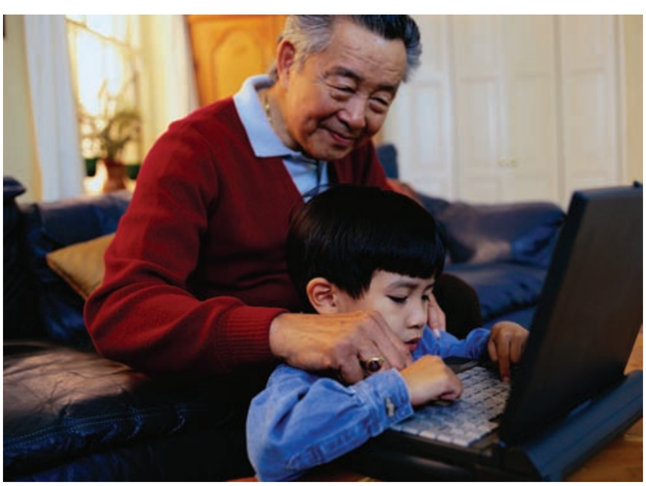


**Figure 12-2** Families are an important source of psychosocial and physical support for elderly people and youngsters alike. Caring interaction among grandchildren, grandparents, and other family members typically contributes to the health of all.

Unfortunately, many elderly people and their adult children make housing decisions in times of crisis, such as during a serious illness or after the death of a spouse. Older people and their families often are unaware of all of the ramifications of shared housing and assuming care for an increasingly dependent person. Families can be helped by anticipatory guidance and long-term planning before a crisis occurs. Older adults should participate in decisions that affect them as much as possible.

### Continuing Care Retirement Communities

Continuing care retirement communities (CCRCs) provide three levels of living arrangements and care and are becoming more popular. CCRCs consist of independent single-dwelling houses or apartments for people who can manage all of their day-to-day needs; assisted living apartments for those who need limited assistance with their daily living needs; and skilled nursing services when continuous nursing assistance is required. CCRCs usually contract for a large down payment before the resident moves into the community. This payment gives a person or couple the option of residing in the same community from the time of total independence through the need for assisted or skilled nursing care. Decisions about living arrangements and health care can be made before any decline in health status occurs. CCRCs also provide continuity at a time in an older adult's life when many other factors, such as health status, income, and availability of friends and family members, may be changing.

### Assisted Living Facilities

Assisted living facilities are an option when an older person's physical or cognitive changes necessitate at least minimal supervision or assistance. Assisted living allows for a degree of independence while providing minimal nursing assistance with administration of medication, assistance with ADLs, or other chronic health care needs. Other services, such as laundry, cleaning, and meals, may also be included.

### Long-Term Care Facilities

Many types of nursing homes, nursing facilities, or long-term care facilities offer continuous nursing care. Contrary to the myth of family abandonment and the fear of "ending up in a nursing home," the actual percentage of long-term nursing home residents has declined, from 5.4% in 1985 to 4.5% in 2005 (AoA, 2006). However, the actual number of elderly people who reside in long-term care facilities has risen due to the large increase in the aging population and the use of nursing homes today for short-term rehabilitation.

Short-term nursing home care is often reimbursed by Medicare if the patient is recovering from an acute illness such as a stroke, myocardial infarction, or cancer and requires skilled nursing care or therapy for recuperation. Usually, if an older adult suffers a major health event and is hospitalized and then goes to a nursing facility, Medicare

covers the cost of the first 30 to 90 days in a skilled nursing facility if ongoing therapy is needed. The requirement for continued Medicare coverage during this time is documentation of persistent improvement in the condition that requires therapy, most often physical therapy, occupational therapy, respiratory therapy, and cognitive therapy. Some adults choose to have long-term care insurance as a means of paying, at least in part, for the cost of these services should they become necessary. For elderly people who are living in nursing homes and who are medically stable, even though they may have multiple chronic and debilitating health issues, costs are primarily paid out-of-pocket by the patient. Family members are not responsible for nursing home costs. When a person's financial resources become exhausted as a result of prolonged nursing home care, the patient, the institution, or both may apply for Medicaid reimbursement.

An increasing number of skilled nursing facilities offer subacute care. This area of the facility offers a high level of nursing care that may either avoid the need for a resident to be transferred to a hospital from the nursing home or allow a hospitalized patient to be transferred back to the nursing facility sooner.

### The Role of the Family

Planning for care and understanding the psychosocial issues confronting older people must be accomplished within the context of the family. If dependency needs occur, the spouse often assumes the role of primary caregiver. In the absence of a surviving spouse, an adult child usually assumes caregiver responsibilities and may eventually need help in providing or arranging for care and support.

Two common myths in American society are that adult children and their aged parents are socially alienated, and that adult children abandon their parents when health and other dependency problems arise. In reality, the family has been and continues to be an important source of support for older people; similarly, older family members provide a great deal of support to younger family members.

Although adult children are not financially responsible for their older parents, social attitudes and cultural values often dictate that adult children should provide services and assume the burden of care if their aged parents cannot care for themselves. Among the elderly who need assistance, about 11% of Medicare enrollees received assistance from informal (family and friends) or formal sources (service provider agencies). More than 90% of this population received some or all of their care from informal caregivers. Fewer than 10% received services only from the formal network (AoA, 2006).

Caregiving, which may continue for many years, can become a source of family stress. For prolonged periods, it is not uncommon for caregivers to neglect their own emotional and health needs. In addition, because many people tend to have children later in life, they may face the competing demands of caring for their aging parents while caring for their own dependent children. Furthermore, because of smaller family sizes, fewer numbers of siblings are available to help with parental care issues. If community agencies or adult children cannot provide care, elders are at high risk for institutionalization.

## Cognitive Aspects of Aging

Cognition can be affected by many variables, including sensory impairment, physiologic health, environment, and psychosocial influences. Older adults may experience temporary changes in cognitive function when hospitalized or admitted to skilled nursing facilities, rehabilitation centers, or long-term care facilities. These changes are related to differences in the environment or in medical therapy or to alteration in role performance. Despite myths to the contrary, smoking does not improve cognition, mood, or decrease stress in older adults (Cataldo, 2007).

### Intelligence

When intelligence test scores from people of all ages are compared, test scores for older adults show a progressive decline beginning in midlife. However, research has shown that environment and health have a considerable influence on scores, and that certain types of intelligence (eg, spatial perceptions and retention of nonintellectual information) decline, whereas others (eg, problem-solving ability based on past experiences, verbal comprehension, mathematical ability) do not. Cardiovascular health, a stimulating environment, high levels of education, occupational status, and income all appear to have a positive effect on intelligence scores in later life.

### Learning and Memory

According to Hooyman and Kiyak (2005), significant age-related declines in intelligence, learning, and memory are not inevitable. These authors summarized the major studies on cognitive function in later years and provided the following overview.

Many factors affect the ability of older people to learn and remember and to perform well in testing situations. Older adults who have higher levels of education, good sensory function, good nutrition, and jobs that require complex problem-solving skills continue to demonstrate intelligence, memory, and the capacity for learning. Part of the challenge in testing older adults is determining what is actually being tested (eg, speed of response) and whether the test results are indicative of a normal age-related change, a sensory deficit, or poor health. However, age differences continue to emerge even with untimed tests and when the tests are controlled for variations in motor and sensory function. In general, there is a decline in fluid intelligence, the biologically determined intelligence used for flexibility in thinking and problem solving. Crystallized intelligence, that gained through education and lifelong experiences (eg, verbal skills), remains intact. This is termed the *classic aging pattern of intelligence*. Despite these slight declines, many older people continue to learn and participate in varied educational experiences.

Good health and motivation are important influences on learning. Nurses can support the processes by which older adults learn by using the following strategies:

- Supply mnemonics to enhance recall of related data
- Encourage ongoing learning
- Link new information with familiar information
- Use visual, auditory, and other sensory cues
- Encourage learners to wear prescription glasses and hearing aids

- Provide glare-free lighting
- Provide a quiet, nondistracting environment
- Set short-term goals with input from the learner
- Keep teaching periods short
- Pace learning tasks according to the endurance of the learner
- Encourage verbal participation by learners
- Reinforce successful learning in a positive manner

## Pharmacologic Aspects of Aging

Because an increasing number of chronic conditions affect older people, they use more medications than any other age group. Older adults constitute only about 13% of the U.S. population, but they use 25% to 30% of all prescription medications and 40% of all nonprescription medications (Fulmer & Conchita, 2005). Although these medications improve health and well-being by relieving pain and discomfort, treating chronic illnesses, and curing infectious processes, adverse drug reactions are common because of medication interactions, multiple medication effects, incorrect dosages, and the use of multiple medications (**polypharmacy**). On average, the elderly, especially those people 85 years of age or older, take between five and eight medications each day (Cefalu, 2006). The potential for drug–drug interactions increases with increased medication use and with multiple coexisting diseases (**comorbidity**) that affect the absorption, distribution, metabolism, and elimination of the medications. Such interactions are responsible for numerous emergency department and physician visits, which cost billions of dollars annually.

Medications such as antipsychotics, anticoagulants, diuretics, and antiepileptics carry high risks for older patients and are often inappropriately prescribed (Cefalu, 2006). In one study of 50 patients 65 years of age or older, one or more potentially inappropriate medications were prescribed for 25% of the patients. The most common drug classes prescribed were psychotropic and anti-inflammatory agents (Maio, Hartman, Poston, et al., 2006). An effective resource for identifying potentially risky drug interactions and adverse effects in older adults is *Beers' Criteria for Potentially Inappropriate Medication Use in the Elderly* (Fick, Cooper, Wade, et al., 2003).

Any medication is capable of altering nutritional status, and the nutritional health of the elderly person may already be compromised by a marginal diet or by chronic disease and its treatment. Medications can affect the appetite, cause nausea and vomiting, irritate the stomach, cause constipation or diarrhea, and decrease absorption of nutrients. In addition, these medications may alter electrolyte balance as well as carbohydrate and fat metabolism. For example, antacids cause thiamine deficiency; laxatives diminish absorption; antibiotics and phenytoin (Dilantin) reduce utilization of folic acid; and phenothiazines, estrogens, and corticosteroids increase food intake and cause weight gain.

Combining multiple medications with alcohol, as well as with over-the-counter and herbal medications, complicates the problem. For example, St. John's wort, a common herbal supplement used for mild depression, decreases the anticoagulant effect of warfarin (Coumadin) and interacts with many other medications metabolized in the liver (Fitzgerald, 2007).

### Altered Pharmacokinetics

Alterations in absorption, metabolism, distribution, and excretion occur as a result of normal aging and may also result from drug and food interactions. Absorption may be affected by changes in gastric pH and a decrease in gastrointestinal motility. Drug distribution may be altered as a result of decrease in body water and increase in body fat. Normal age-related changes and diseases that alter blood flow, liver and renal function, or cardiac output may affect distribution and metabolism (Table 12-3).

### Nursing Implications

Prescription principles that have been identified as appropriate for older patients include "start low and go slow" and keep the medication regimen as simple as possible (Fulmer & Conchita, 2005). A comprehensive assessment that begins with a thorough medication history, including use of alcohol, recreational drugs, and over-the-counter and herbal medications, is essential. It is best to ask the patient or reliable informants to provide all medications for review. Ascertaining the patient's understanding of when and how to take each medication as well as the purpose of each medication allows the nurse to assess the patient's knowledge about and compliance with the medication regimen. The patient's beliefs and concerns about the medications should be identified. It is helpful to ask patients if they believe that a given medication is helpful.

Noncompliance leads to significant morbidity and mortality among the elderly. Among people 60 years of age and older, reports of noncompliance with medication regimens range from 14% to 77% depending on the disease and the measurement method (Chia, 2006). The many contributing factors include the number of medications prescribed, the complexity of the regimen, difficulty opening containers, inadequate patient education, financial cost, and the disease or medication interfering with the patient's life. Furthermore, visual and hearing problems may make it difficult to read or to hear directions.

Multifaceted interventions tailored to the individual patient are the most effective strategies in improving compliance. The following steps can help patients manage their medications and improve compliance:

- Explain the purpose, adverse effects, and dosage of each medication.
- Provide the medication schedule in writing.
- Encourage the use of standard containers without safety lids (if there are no children in the household).
- Suggest the use of a multiple-day, multiple-dose medication dispenser to help the patient adhere to the medication schedule.
- Destroy or remove old, unused medications.
- Encourage the patient to inform the primary health care provider about the use of over-the-counter medications and herbal agents, alcohol, and recreational drugs.
- Encourage the patient to keep a list of all medications, including over-the-counter and herbal medications, in his or her purse or wallet to share with the primary care provider at each visit and in case of an emergency.

**Table 12-3 ALTERED DRUG RESPONSES IN OLDER PEOPLE**

| Age-Related Changes | Effect of Age-Related Change | Applicable Medications |
|---|---|---|
| **Absorption** | | |
| Reduced gastric acid; increased pH (less acid) | Rate of drug absorption—possibly delayed | Vitamins |
| Reduced gastrointestinal motility; prolonged gastric emptying | Extent of drug absorption—not affected | Calcium |
| **Distribution** | | |
| Decreased albumin sites | Serious alterations in drug binding to plasma proteins (the unbound drug gives the pharmacologic response); highly protein-bound medications have fewer binding sites, leading to increased effects and accelerated metabolism and excretion | Selected highly protein-binding medications:<br>Oral anticoagulants (warfarin)<br>Oral hypoglycemic agents (sulfonylureas)<br>Barbiturates<br>Calcium channel blockers<br>Furosemide (Lasix)<br>Nonsteroidal anti-inflammatory drugs (NSAIDs)<br>Sulfonamides<br>Quinidine<br>Phenytoin (Dilantin) |
| Reduced cardiac output | Decreased perfusion of many bodily organs | |
| Impaired peripheral blood flow | Decreased perfusion | |
| Increased percentage of body fat | Proportion of body fat increases with age, resulting in increased ability to store fat-soluble medications; this causes drug accumulation, prolonged storage, and delayed excretion | Selected fat-soluble medications:<br>Barbiturates<br>Diazepam (Valium)<br>Lidocaine<br>Phenothiazines (antipsychotics)<br>Ethanol<br>Morphine |
| Decreased lean body mass | Decreased body volume allows higher peak levels of medications | |
| **Metabolism** | | |
| Decreased cardiac output and decreased perfusion of the liver | Decreased metabolism and delay of breakdown of medications, resulting in prolonged duration of action, accumulation, and drug toxicity | All medications metabolized by the liver |
| **Excretion** | | |
| Decreased renal blood flow; loss of functioning nephrons; decreased renal efficiency | Decreased rates of elimination and increased duration of action; danger of accumulation and drug toxicity | Selected medications with prolonged action:<br>Aminoglycoside antibiotics<br>Cimetidine (Tagamet)<br>Chlorpropamide (Diabinase)<br>Digoxin<br>Lithium<br>Procainamide |

- Review the medication schedule periodically and update it as necessary.
- Recommend using one supplier for prescriptions; pharmacies frequently track patients and are likely to notice a prescription problem such as duplication or contraindications in the medication regimen.
- If the patient's competence is doubtful, identify a reliable family member or friend who might monitor the patient for compliance.

## Mental Health Problems in the Older Adult

Changes in cognitive ability, excessive forgetfulness, and mood swings are not a part of normal aging. These symptoms should not be dismissed as age-related changes; a thorough assessment may reveal a treatable, reversible physical or mental condition. Changes in mental status may be related to many factors, such as alterations in diet and fluid and electrolyte balance, fever, or low oxygen levels associated with many cardiovascular and pulmonary diseases. Cognitive changes may be reversible when the underlying condition is identified and treated. However, the susceptibility to depression, delirium, and incidence of dementia increases with age. Older adults are less likely than younger people to acknowledge or seek treatment for mental health symptoms. Therefore, health professionals must recognize, assess, refer, collaborate, treat, and support older adults who exhibit noticeable changes in intellect or affect.

### Depression

**Depression** is the most common affective or mood disorder of old age. About 15% of older Americans suffer from

depression, and of those, 3% to 26% are elderly residing in the community. The incidence of depression is higher among the hospitalized elderly (23%) and ranges from 16% to 30% among nursing home residents (Greenberg, 2007).

Depression among the elderly can follow a major precipitating event or loss and is often related to chronic illness or pain. It may also be secondary to a medication interaction or an undiagnosed physical condition. Signs of depression include feelings of sadness, fatigue, diminished memory and concentration, feelings of guilt or worthlessness, sleep disturbances, appetite disturbances with excessive weight loss or gain, restlessness, impaired attention span, and suicidal ideation. Even mild depression with symptoms that do not meet the criteria for a major depression reduces quality of life and function (Evans, 2007). The risk of suicide increases in depressed patients, especially elderly Caucasian and Asian American men. Seventy-five percent of elderly adults who committed suicide had visited their physician 1 month prior to the suicide, and 39% had seen a physician within the week (Salzman, 2006). This supports the need for routine assessment of patients for depression and risk for suicide. Geriatric depression may be confused with dementia. However, the cognitive impairment resulting from depression is a result of apathy rather than decline in brain function. When depression and medical illnesses coexist, as they often do, neglect of the depression can impede physical recovery. Assessing the patient's mental status, including depression, is vital and must not be overlooked. Two commonly used assessment tools are the Mini Mental Status Examination (MMSE) and the Geriatric Depression Scale (GDS) (Charts 12-2 and 12-3).

Depression is highly responsive to treatment but is often not recognized and therefore is undertreated. Initial management involves evaluation of the patient's medication regimen and eliminating or changing any medications that contribute to depression. Furthermore, treatment of underlying medical conditions that may produce depressive symptoms may alleviate the depression. For mild depression, nonpharmacologic measures such as exercise, bright lighting, increasing interpersonal interactions, cognitive therapy, and reminiscence therapy are effective (Evans, 2007). However for major depression, antidepressants and short-term psychotherapy, particularly in combination, are effective in the elderly. Newer atypical antidepressants, such as bupropion (Wellbutrin), venlafaxine (Effexor), mirtazapine (Remeron), and nefazodone (Serzone), as well as selective serotonin reuptake inhibitors, such as paroxetine (Paxil), may be used (Butcher & McGonigal-Kenney, 2005).

Tricyclic antidepressants can be an effective medication for depression in some patients. However, medications with anticholinergic, cardiac, and orthostatic adverse effects, as well as interactions with other medications, should be used with care to avoid medication toxicity, hypotensive events, and falls. It may take 4 to 6 weeks for symptoms to diminish, and during this period, nurses should offer support and encouragement. In life-threatening cases, electroconvulsive therapy has proved effective.

### Chart 12-2 • *Mini Mental Status Examination Sample Items*

**Orientation to Time**

"What is the date?"

**Registration**

"Listen carefully. I am going to say three words. You say them back after I stop. Ready? Here they are . . . APPLE (pause), PENNY (pause), TABLE (pause). Now repeat those words back to me." [Repeat up to five times, but only score the first trial.]

**Naming**

"What is this?" [Point to a pencil.]

**Reading**

"Please read this and do what it says." [Show examinee the words on the stimulus form.] CLOSE YOUR EYES.



#### *Alcohol and Drug Abuse*

Alcohol and drug abuse may be related to depression, and its incidence is significant in the elderly population. Thirty-six percent of adults 65 years of age and older report that they are current drinkers. Excessive drinking in people 55 to 64 years of age of all ethnic backgrounds has reportedly decreased from 12% to approximately 7% (CDC, 2007a).

Alcohol abuse is especially dangerous in older people because of age-related changes in renal and liver function as well as the high risk of interactions with prescription medications and the resultant adverse effects. Alcohol-related and drug-related problems in older people often remain hidden because many older adults deny their habit when questioned. Assessing for drug and alcohol use with direct questions in a nonaccusatory manner should be part of the routine physical assessment. More information and specific assessment tools can be found in Chapter 5.

## Delirium

**Delirium,** often called acute confusional state, begins with confusion and progresses to disorientation. It is a common and life-threatening complication for the hospitalized elderly and the most frequent complication of hospitalization, occurring in 15% to 53% of older people postoperatively and in 70% to 87% of those in intensive care (Inouye, 2006). Patients may experience an altered level of consciousness, ranging from stupor (hypoalert–hypoactive) to excessive activity (hyperalert–hyperactive); alternatively, they may have a combination of these two types (mixed). Thinking is disorganized, and the attention span is short. Hallucinations, delusions, fear, anxiety, and paranoia may also be evident. Patients who tend to be hyperalert and hyperactive demand more attention from nurses and thus are easier to diagnose, whereas those who are hypoalert or hypoactive tend to be less problematic and pose diagnostic difficulties. Recognition of delirium can also be complicated in

## Chart 12-3 • *Geriatric Depression Scale*

Choose the best answer for how you felt this past week.

| Item | | |
|---|---|---|
| *1. Are you basically satisfied with your life? | YES | NO |
| 2. Have you dropped many of your activities and interests? | YES | NO |
| 3. Do you feel that your life is empty? | YES | NO |
| 4. Do you often get bored? | YES | NO |
| *5. Are you hopeful about the future? | YES | NO |
| 6. Are you bothered by thoughts you can't get out of your head? | YES | NO |
| *7. Are you in good spirits most of the time? | YES | NO |
| 8. Are you afraid that something bad is going to happen to you? | YES | NO |
| *9. Do you feel happy most of the time? | YES | NO |
| 10. Do you often feel helpless? | YES | NO |
| 11. Do you often get restless and fidgety? | YES | NO |
| 12. Do you prefer to stay at home, rather than going out and doing new things? | YES | NO |
| 13. Do you frequently worry about the future? | YES | NO |
| 14. Do you feel you have more problems with memory than most? | YES | NO |
| *15. Do you think it is wonderful to be alive now? | YES | NO |
| 16. Do you often feel downhearted and blue? | YES | NO |
| 17. Do you feel pretty worthless the way you are now? | YES | NO |
| 18. Do you worry a lot about the past? | YES | NO |
| *19. Do you find life very exciting? | YES | NO |
| 20. Is it hard for you to get started on new projects? | YES | NO |
| *21. Do you feel full of energy? | YES | NO |
| 22. Do you feel that your situation is hopeless? | YES | NO |
| 23. Do you think that most people are better off than you are? | YES | NO |
| 24. Do you frequently get upset over little things? | YES | NO |
| 25. Do you frequently feel like crying? | YES | NO |
| 26. Do you have trouble concentrating? | YES | NO |
| *27. Do you enjoy getting up in the morning? | YES | NO |
| 28. Do you prefer to avoid social gatherings? | YES | NO |
| *29. Is it easy for you to make decisions? | YES | NO |
| *30. Is your mind as clear as it used to be? | YES | NO |

Score: _____ (*Number of "depressed" answers*)

**Norms**

Normal: 5 ± 4
Mildly depressed: 15 ± 6
Very depressed: 23 ± 5

* Appropriate (nondepressed) answers = yes; all others = no.

Yesavage, J., Brink, T. L., Rose, T. L., et al. (1983). Development and validation of a geriatric screening scale: A preliminary report. *Journal of Psychiatric Research, 17*(1), 37–49. Reprinted with permission from Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 OBW,

patients with the mixed type of disorders. Patients with the hypoalert–hypoactive type of delirium have higher mortality rates and even poorer outcomes of care because the delirium tends not to be recognized and treated (Forrest, Willis, Holm, et al., 2007).

Attentive clinical assessment is essential because delirium is sometimes mistaken for dementia; Table 12-4 compares dementia and delirium. It helps to know an individual patient's usual mental status and whether the changes noted are long term, which probably represents dementia, or are abrupt in onset, which is more likely delirium.

Delirium occurs secondary to a number of causes, including physical illness, medication or alcohol toxicity, dehydration, fecal impaction, malnutrition, infection, head trauma, lack of environmental cues, and sensory deprivation or overload. Older adults are particularly vulnerable to acute confusion because of their decreased biologic reserve and the large number of medications they may take. Nurses must recognize the implications of the acute symptoms of delirium and report them immediately. Because of the acute and unexpected onset of symptoms and the unknown underlying cause, delirium is a medical emergency. If the delirium goes unrecognized and the underlying cause is not treated, permanent, irreversible brain damage or death can follow.

The most effective strategy is prevention, which may be achievable in 30% to 40% of cases (Inuoye, 2006). Prevention includes therapeutic activities for cognitive impairment, early mobilization, controlling pain, minimizing the use of psychoactive drugs, preventing sleep deprivation, enhancing communication methods (particularly eye glasses and hearing aids) for vision and hearing impairment, maintaining oxygen levels and fluid and electrolyte balance, and preventing surgical complications (Vance, Webb, Marceaux, et al., 2008).

Once delirium occurs, treatment of the underlying cause is most important. Therapeutic interventions vary depending on the cause. Delirium increases the risk of falls; therefore, management of patient safety and behavioral problems is essential. Because medication interactions and

**Table 12-4 SUMMARY OF DIFFERENCES BETWEEN DEMENTIA AND DELIRIUM**

| | Dementia | | |
|---|---|---|---|
| | **Alzheimer's Disease (AD)** | **Vascular (Multi-Infarct) Dementia** | **Delirium** |
| Etiology | Early onset (familial, genetic [chromosomes 14, 19, 21])<br>Late onset sporadic | Cardiovascular (CV) disease<br>Cerebrovascular disease<br>Hypertension | Drug toxicity and interactions; acute disease; trauma; chronic disease exacerbation<br>Fluid and electrolyte disorders |
| Risk factors | Advanced age; genetics | Preexisting CV disease | Preexisting cognitive impairment |
| Occurrence | 50–60% of dementias | 20% of dementias | 6%–56% among hospitalized people. |
| Onset | Slow | Often abrupt<br>Follows a stroke or transient ischemic attack | Rapid, acute onset<br>A harbinger of acute medical illness |
| Age of onset (yr) | Early onset AD: 30s–65<br>Late onset AD: 65+<br>Most commonly: 85+ | Most commonly 50–70 yr | Any age, but predominantly in older persons |
| Gender | Males and females equally | Predominantly males | Males and females equally |
| Course | Chronic, irreversible; progressive, regular, downhill | Chronic, irreversible<br>Fluctuating, stepwise progression | Acute onset<br>Hypoalert–hypoactive<br>Hyperalert–hyperactive<br>Mixed hypo–hyper |
| Duration | 2–20 yr | Variable; years | Lasts 1 day to 1 month |
| Symptom progress | Onset insidious. *Early*—mild and subtle<br>*Middle and late*—intensified<br>Progression to death (infection or malnutrition) | Depends on location of infarct and success of treatment; death due to underlying CV disease | Symptoms are fully reversible with adequate treatment; can progress to chronicity or death if underlying condition is ignored |
| Mood | Early depression (30%) | Labile: mood swings | Variable |
| Speech/language | Speech remains intact until late in disease<br>*Early*—mild anomia (cannot name objects); deficits progress until speech lacks meaning; echoes and repeats words and sounds; mutism | May have speech deficit/aphasia depending on location of lesion | Fluctuating; often cannot concentrate long enough to speak<br>May be somnolent |
| Physical signs | *Early*—no motor deficits<br>*Middle*—apraxia (70%) (cannot perform purposeful movement)<br>*Late*—Dysarthria (impaired speech)<br>*End stage*—loss of all voluntary activity; positive neurologic signs | According to location of lesion: focal neurologic signs, seizures<br>Commonly exhibits motor deficits | Signs and symptoms of underlying disease |
| Orientation | Becomes lost in familiar places (topographic disorientation)<br>Has difficulty drawing three-dimensional objects (visual and spatial disorientation)<br>Disorientation to time, place, and person—with disease progression | | May fluctuate between lucidity and complete disorientation to time, place, and person |
| Memory | Loss is an early sign of dementia; loss of recent memory is soon followed by progressive decline in recent and remote memory | | Impaired recent and remote memory; may fluctuate between lucidity and confusion |
| Personality | Apathy, indifference, irritability<br>*Early disease*—social behavior intact; hides cognitive deficits<br>*Advanced disease*—disengages from activity and relationships; suspicious; paranoid delusions caused by memory loss; aggressive; catastrophic reactions | | Fluctuating; cannot focus attention to converse; alarmed by symptoms (when lucid); hallucinations; paranoid |
| Functional status, activities of daily living | Poor judgment in everyday activities; has progressive decline in ability to handle money, use telephone, function in home and workplace | | Impaired |
| Attention span | Distractable; short attention span | | Highly impaired; cannot maintain or shift attention |
| Psychomotor activity | Wandering, hyperactivity, pacing, restlessness, agitation | | Variable; alternates between high agitation, hyperactivity, restlessness, and lethargy |
| Sleep–wake cycle | Often impaired; wandering and agitation at nighttime | | Takes brief naps throughout day and night |

toxicity are often implicated, nonessential medications should be discontinued. Nutritional and fluid intake should be supervised and monitored. The environment should be quiet and calm. To increase function and comfort, the nurse provides familiar environmental cues and encourages family members or friends to touch and talk to the patient (Fig. 12-3). Ongoing mental status assessments using prior mental cognitive status as a baseline are helpful in evaluating responses to treatment and upon admission to a hospital or extended-care facility. If the underlying problem is adequately treated, the patient often returns to baseline within several days. Several resources specific to delirium



**Figure 12-3** Talking to family members may increase the comfort of patients with delirium.

are included in the Resource section at the end of the chapter.

## Dementia

The cognitive, functional, and behavioral changes that characterize **dementia** eventually destroy a person's ability to function. The symptoms are usually subtle in onset and often progress slowly until they are obvious and devastating. The two most common types of dementia are Alzheimer's disease (AD), which accounts for 50% to 60% of cases, and vascular or multi-infarct dementia, which accounts for 10% to 20% of cases. Other non-Alzheimer dementias include Parkinson's disease, acquired immunodeficiency syndrome (AIDS)-related dementia, and Pick's disease; these types of dementia account for fewer than 15% of cases (National Institute of Neurological Disorders and Stroke [NINDS], 2006). Approximately one in seven Americans 71 years of age and older has dementia; 2.4 million people with dementia have AD (Guralnik, Fried, Simonsick, et al., 2007).

### *Alzheimer's Disease*

AD is a progressive, irreversible, degenerative neurologic disease that begins insidiously and is characterized by gradual losses of cognitive function and disturbances in behavior and affect. Although AD can occur in people as young as 40 years of age, it is uncommon before 65 years of age. Although the prevalence of AD increases dramatically with increasing age, affecting as many as half of those 85 years of age and older, it is important to note that AD is not a normal part of aging. Without a cure or any preventive measures, it is estimated that 13.2 million Americans will have this disease by 2050 (NIA, 2007).

There are numerous theories about the cause of age-related cognitive decline. Although the greatest risk factor for AD is increasing age, many environmental, dietary, and inflammatory factors also may determine whether a person suffers from this cognitive disease. AD is a complex brain disorder caused by a combination of various factors that may include genetics, neurotransmitter changes, vascular abnormalities, stress hormones, circadian changes, head trauma, and the presence of seizure disorders.

AD can be classified into two types: familial or early-onset AD and sporadic or late-onset AD. Familial AD is rare, accounting for less than 10% of all cases, and is frequently associated with genetic mutations. It occurs in middle-aged adults. If family members have at least one other relative with AD, then there is a familial component, which nonspecifically includes both environmental triggers and genetic determinants.

#### Pathophysiology

Specific neuropathologic and biochemical changes are found in patients with AD. These include neurofibrillary tangles (tangled masses of nonfunctioning neurons) and senile or neuritic plaques (deposits of amyloid protein, part of a larger protein called amyloid precursor protein in the brain). The neuronal damage occurs primarily in the cerebral cortex and results in decreased brain size. Similar changes are found in the normal brain tissue of older adults, but to a lesser extent. Cells that use the neurotransmitter acetylcholine are principally affected by AD. At the biochemical level, the enzyme active in producing acetylcholine, which is specifically involved in memory processing, is decreased.

Scientists have been studying complex neurodegenerative diseases such as AD and have focused on two key issues: whether a gene might influence a person's overall risk of developing the disease, and whether a gene might influence some particular aspect of a person's risk, such as the age at which the disease begins (age at onset). There are genetic differences in early-onset and late-onset forms of AD. Researchers are conducting tests to explain what predisposes people to develop the plaques and neurofibrillary tangles that can be seen at autopsy in the brains of patients with AD. Understanding the complex ways in which aging and genetic and nongenetic factors affect brain cells over time, eventually leading to AD, continues to increase. Researchers have discovered how amyloid plaques form and cause neuronal death, the possible relationship between various forms of tau protein and impaired function, the roles of inflammation and oxidative stress, and the contribution of brain infarctions to the disease (NIA, 2007).

#### Clinical Manifestations

In the early stages of AD, forgetfulness and subtle memory loss occur. Patients may experience small difficulties in work or social activities but have adequate cognitive function to compensate for the loss and continue to function independently. With further progression of AD, the deficits can no longer be concealed. Forgetfulness is manifested in many daily actions; patients may lose their ability to recognize familiar faces, places, and objects, and they may become lost in a familiar environment. They may repeat the same stories because they forget that they have already told them. Trying to reason with people with AD and using reality **orientation** only increase their anxiety without increasing function. Conversation becomes difficult, and word-finding difficulties occur. The ability to formulate concepts and think abstractly disappears; for example, a patient can interpret a proverb only in concrete terms. Patients are often unable to recognize the consequences of their actions and therefore exhibit impulsive behavior. For example, on a hot

day, a patient may decide to wade in the city fountain fully clothed. Patients have difficulty with everyday activities, such as operating simple appliances and handling money.

Personality changes are also usually evident. Patients may become depressed, suspicious, paranoid, hostile, and even combative. Progression of the disease intensifies the symptoms: speaking skills deteriorate to nonsense syllables, agitation and physical activity increase, and patients may wander at night. Eventually, assistance is needed for most ADLs, including eating and toileting, because dysphagia and incontinence develop. The terminal stage, in which patients are usually immobile and require total care, may last months or years. Occasionally, patients may recognize family members or caregivers. Death occurs as a result of complications such as pneumonia, malnutrition, or dehydration.

### Assessment and Diagnostic Findings

A definitive diagnosis of AD can be made only at autopsy, but an accurate clinical diagnosis can be made in about 90% of cases. The most important goal is to rule out other causes of dementia or reversible causes of confusion, such as other types of dementia, depression, delirium, alcohol or drug abuse, or inappropriate drug dosage or drug toxicity (NIA, 2007). AD is a diagnosis of exclusion, and a diagnosis of probable AD is made when the medical history, physical examination, and laboratory tests have excluded all known causes of other dementias.

The health history—including medical history, family history, social and cultural history, and medication history—and the physical examination, including functional and mental health status, are essential to the diagnosis of probable AD. Diagnostic tests, including complete blood count, chemistry profile, and vitamin $B_{12}$ and thyroid hormone levels, as well as screening with electroencephalography, computed tomography (CT), magnetic resonance imaging (MRI), and examination of the cerebrospinal fluid may all refute or support a diagnosis of probable AD.

Depression can closely mimic early-stage AD and coexists in many patients. Therefore, assessing the patient for underlying depression is important to rule this out. Tests such as the MMSE (see Chart 12-2) are useful for screening (Borson, Scanlan, Watanabe, et al., 2005). Both CT and MRI of the brain are useful for excluding hematoma, brain tumor, stroke, normal-pressure hydrocephalus, and atrophy but are not reliable in making a definitive diagnosis of AD. Infections and physiologic disturbances, such as hypothyroidism, Parkinson's disease, and vitamin $B_{12}$ deficiency, can cause cognitive impairment that may be misdiagnosed as AD. Biochemical abnormalities can be excluded through examination of the blood and cerebrospinal fluid.

### Medical Management

The primary goal is to manage the cognitive and behavioral symptoms. There is no cure and no way to slow the progression of the disease. Four U.S. Food and Drug Administration (FDA)–approved medications are available to treat AD symptoms; however, none of these agents stops the progression of the disease. The cholinesterase inhibitors (CEIs) donepezil hydrochloride (Aricept), rivastigmine tartrate (Exelon), galantamine hydrobromide (Razadyne [formerly known as Reminyl]), and tacrine (Cognex) enhance acetylcholine uptake in the brain, thus maintaining memory skills for a period of time; these medications are used for mild to moderate symptoms. Donepezil and the newest medication memantine (Namenda), a receptor agonist, can be used for management of moderate to severe symptoms (NIA, 2007). Cognitive ability may improve within 6 to 12 months of therapy, but cessation of the medications results in disease progression and cognitive decline. It is recommended that treatment continue at least through the moderate stage of the illness. Combination of a CEI with memantine may be useful for mild to moderate cognitive symptoms (Evans, 2007).

Behavioral problems such as agitation and psychosis can be managed by behavioral and psychosocial therapies. Associated depression and behavioral problems can also be treated pharmacologically if other interventions fail. Because symptoms change over time, all patients with AD who take medications should be reevaluated routinely, and the nurse should document and report both positive or negative responses to medications (Evans, 2007).

### Nursing Management

Nurses play an important role in the recognition of dementia, particularly in hospitalized elderly, by assessing for signs (eg, repeating or asking the same thing over and over, getting lost) during the nursing admission assessment (Maslow & Mezey, 2008). Nursing interventions for dementia are aimed at promoting patient function and independence for as long as possible. Other important goals include promoting the patient's physical safety, promoting independence in self-care activities, reducing anxiety and agitation, improving communication, providing for socialization and intimacy, promoting adequate nutrition, promoting balanced activity and rest, and supporting and educating family caregivers. These nursing interventions apply to all patients with dementia, regardless of cause.

***Supporting Cognitive Function.*** Because dementia of any type is degenerative and progressive, patients display a decline in cognitive function over time. In the early phase of dementia, minimal cuing and guidance may be all that are needed for the patient to function fairly independently for a number of years. However, as the patient's cognitive ability declines, family members must provide more and more assistance and supervision. A calm, predictable environment helps people with dementia interpret their surroundings and activities. Environmental stimuli are limited, and a regular routine is established. A quiet, pleasant manner of speaking, clear and simple explanations, and use of memory aids and cues help minimize confusion and disorientation and give patients a sense of security. Prominently displayed clocks and calendars may enhance orientation to time. Color-coding the doorway may help patients who have difficulty locating their room. Active participation may help patients maintain cognitive, functional, and social interaction abilities for a longer period. Physical activity and communication have also been demonstrated to slow some of the cognitive decline of AD.

***Promoting Physical Safety.*** A safe home and hospital environment allows the patient to move about as freely as possible and relieves the family of constant worry about safety. To prevent falls and other injuries, all obvious hazards are removed and hand rails are installed in the home. A hazard-

free environment allows the patient maximum independence and a sense of autonomy. Adequate lighting, especially in halls, stairs, and bathrooms, is necessary. Nightlights are helpful, particularly if the patient has increased confusion at night (**sundowning**). Driving is prohibited, and smoking is allowed only with supervision. The patient may have a short attention span and be forgetful. Wandering behavior can often be reduced by gentle persuasion or distraction. Restraints should be avoided because they increase agitation. Doors leading from the house must be secured. Outside the home, all activities must be supervised to protect the patient, and the patient should wear an identification bracelet or neck chain in case of separation from the caregiver.

***Promoting Independence in Self-Care Activities.*** Pathophysiologic changes in the brain make it difficult for people with AD to maintain physical independence. Patients should be assisted to remain functionally independent for as long as possible. One way to do this is to simplify daily activities by organizing them into short, achievable steps so that the patient experiences a sense of accomplishment. Frequently, occupational therapists can suggest ways to simplify tasks or recommend adaptive equipment. Direct patient supervision is sometimes necessary, but maintaining personal dignity and autonomy is important for people with AD, who should be encouraged to make choices when appropriate and to participate in self-care activities as much as possible.

***Reducing Anxiety and Agitation.*** Despite profound cognitive losses, patients are sometimes aware of their diminishing abilities. Patients need constant emotional support that reinforces a positive self-image. When loss of skills occurs, goals are adjusted to fit the patient's declining ability.

The environment should be kept familiar and noise-free. Excitement and confusion can be upsetting and may precipitate a combative, agitated state known as a catastrophic reaction (overreaction to excessive stimulation). The patient may respond by screaming, crying, or becoming abusive (physically or verbally); this may be the patient's only way of expressing an inability to cope with the environment. When this occurs, it is important to remain calm and unhurried. Forcing the patient to proceed with the activity only increases the agitation. It is better to postpone the activity until later, even to another day. Frequently, the patient quickly forgets what triggered the reaction. Measures such as moving to a familiar environment, listening to music, stroking, rocking, or distraction may quiet the patient. Structuring activity is also helpful. Becoming familiar with a particular patient's predicted responses to certain stressors helps caregivers avoid similar situations.

Patients with dementia who have progressed to the late stages of the disease often reside in nursing homes and are predominantly cared for by unlicensed assistive personnel (UAP). Dementia education for caregivers is essential to minimize patient agitation and can be effectively taught by geriatric advanced nurse practitioners.

***Improving Communication.*** To promote the patient's interpretation of messages, the nurse should remain unhurried and reduce noises and distractions. Use of clear, easy-to-understand sentences to convey messages is essential because patients frequently forget the meaning of words or have difficulty organizing and expressing thoughts. In the earlier stages of dementia, lists and simple written instructions that serve as reminders may be helpful. In later stages, the patient may be able to point to an object or use nonverbal language to communicate. Tactile stimuli, such as hugs or hand pats, are usually interpreted as signs of affection, concern, and security.

***Providing for Socialization and Intimacy Needs.*** Because socialization with friends can be comforting, visits, letters, and phone calls are encouraged. Visits should be brief and nonstressful; limiting visitors to one or two at a time helps reduce overstimulation. Recreation is important, and people with dementia are encouraged to participate in simple activities. Realistic goals for activities that provide satisfaction are appropriate. Hobbies and activities such as walking, exercising, and socializing can improve the quality of life. The nonjudgmental friendliness of a pet may provide stimulation, comfort, and contentment. Care of plants or of a pet can also be satisfying and an outlet for energy.

AD does not eliminate the need for intimacy. Patients and their spouses may continue to enjoy sexual activity. Spouses should be encouraged to talk about any sexual concerns, and sexual counseling may be necessary. Simple expressions of love, such as touching and holding, are often meaningful.

***Promoting Adequate Nutrition.*** Mealtime can be a pleasant social occasion or a time of upset and distress, and it should be kept simple and calm, without confrontations. Patients prefer familiar foods that look appetizing and taste good. To avoid any "playing" with food, one dish is offered at a time. Food is cut into small pieces to prevent choking. Liquids may be easier to swallow if they are converted to gelatin. Hot food and beverages are served warm, and the temperature of the foods should be checked to prevent burns.

When lack of coordination interferes with self-feeding, adaptive equipment is helpful. Some patients may do well eating with a spoon or with their fingers. If this is the case, an apron or a smock, rather than a bib, is used to protect clothing. As deficits progress, it may become necessary to feed the patient. Forgetfulness, disinterest, dental problems, lack of coordination, overstimulation, and choking all serve as barriers to good nutrition and hydration.

***Promoting Balanced Activity and Rest.*** Many patients with dementia exhibit sleep disturbances, wandering, and behaviors that may be considered inappropriate. These behaviors are most likely to occur when there are unmet underlying physical or psychological needs. Caregivers must identify the needs of patients who are exhibiting these behaviors because further health decline may occur if the source of the problem is not corrected. Adequate sleep and physical exercise are essential. If sleep is interrupted or the patient cannot fall asleep, music, warm milk, or a back rub may help the patient relax. During the day, patients should be encouraged to participate in exercise because a regular pattern of activity and rest enhances nighttime sleep. Long periods of daytime sleeping are discouraged.

***Supporting Home and Community-Based Care.*** The emotional burden on the families of patients with all types of

dementia is enormous. The physical health of the patient is often very stable, and the mental degeneration is gradual. Family members may cling to the hope that the diagnosis is incorrect and that their relative will improve with greater effort. Family members are faced with numerous difficult decisions (eg, when the patient should stop driving, when to assume responsibility for the patient's financial affairs). Aggression and hostility exhibited by the patient are often misunderstood by families or caregivers, who feel unappreciated, frustrated, and angry. Feelings of guilt, nervousness, and worry contribute to caregiver fatigue, depression, and family dysfunction.

Neglect or abuse of the patient can occur, and this has been documented in home situations as well as in institutions. If neglect or abuse of any kind—including physical, emotional, sexual, or financial abuse—is suspected, the local adult protective services agency must be notified. The role of the nurse is to report the suspected abuse, not to prove it.

The Alzheimer's Association is a coalition of family members and professionals who share the goals of family support and service, education, research, and advocacy. Family support groups, respite (relief) care, and adult day care may be available through different community resources, such as the Area Agency on Aging, in which concerned volunteers are trained to provide structure to caregiver support groups. Respite care is a commonly provided service in which caregivers can get away from the home for short periods while someone else tends to the needs of the patient.

#### Vascular Dementia

Vascular dementia, formerly known as multi-infarct dementia, affects about 10% to 20% of people with dementia, and the rate is higher in men than women (NIH, 2007). Vascular dementia tends to have a more abrupt onset than AD, and it is characterized by an uneven, stepwise downward decline in mental function associated with a vascular incident such as a subclinical stroke. The clinical course of this type of dementia is unpredictable; as a result, it is sometimes confused with AD, paranoia, or delirium. Diagnosis may be even more difficult if a patient has vascular dementia as well as AD.

Because vascular dementia is associated with hypertension and cardiovascular disease, risk factors (eg, hypercholesterolemia, history of smoking, diabetes mellitus) are similar. Prevention and management are also similar. Therefore, measures to decrease blood pressure and lower cholesterol levels may prevent future mini-infarcts.

## Geriatric Syndromes

Elderly people tend to acquire multiple problems and illnesses as they age. The decline of physical function leads to a loss of independence and increasing frailty as well as to susceptibility to both acute and chronic health problems, which generally result from several factors rather than from a single cause. When combined with a decrease in host resistance, these factors can lead to illness or injury. A number of problems commonly experienced by the elderly are becoming recognized as geriatric syndromes. These conditions do not fit into discrete disease categories. Examples include frailty, delirium, falls, urinary incontinence, and pressure ulcers (Inouye, Studenski, Tinetti, et al., 2007). Although these conditions may develop slowly, the onset of symptoms is often acute. Furthermore, the presenting symptoms may appear in other body systems before becoming apparent in the affected system. For example, an elderly patient may present with confusion, and the underlying disease may be a urinary tract infection, dehydration, or a heart attack.

The term *frail* is used to describe elderly people who are at highest risk for adverse health outcomes. The most widely used criteria include weight loss, weakness, exhaustion or poor endurance, slowness, and low activity (Bergman, Ferucci, Hogan, et al., 2007). For all geriatric syndromes, older age, functional impairment, cognitive impairment, and impaired mobility are risk factors. Research suggests that frail older adults are at increased risk for falls, hospitalization, disability, and mortality (Inouye, et al., 2007).

### Impaired Mobility

The causes of decreased mobility are many and varied. Common causes include strokes, Parkinson's disease, diabetic neuropathy, cardiovascular compromise, osteoarthritis, osteoporosis, and sensory deficits. To avoid the downward spiral of immobility, elderly people should be encouraged to stay as active as possible. During illness, bed rest should be kept to a minimum, even in hospitalized patients, because even brief periods of bed rest quickly lead to deconditioning and, consequently, to a wide range of complications (Wallace & Skelkey, 2008). When bed rest cannot be avoided, patients should perform active range-of-motion and strengthening exercises with the unaffected extremities, and nurses or family caregivers should perform passive range-of-motion exercises on the affected extremities. Frequent position changes help offset the hazards of immobility. Both the health care staff and the patient's family can assist in maintaining the current level of mobility.

### Dizziness

Older people frequently seek help for dizziness, which presents a particular challenge because there are numerous possible causes. For many, the problem is complicated by an inability to differentiate between true dizziness (a sensation of disorientation in relation to position) and vertigo (a spinning sensation). Other similar sensations include near-syncope and disequilibrium. The causes for these sensations range in severity from minor (eg, buildup of ear wax) to severe (eg, dysfunction of the cerebral cortex, cerebellum, brainstem, proprioceptive receptors, or vestibular system). Even a minor reversible cause, such as ear wax impaction, can result in a loss of balance and a subsequent fall and injury. Because dizziness has many predisposing factors, nurses should seek to identify any potentially treatable factors related to the condition.

### Falls and Falling

Injuries rank ninth as a cause of death for older people, and falls are the leading cause of injury in the elderly, accounting for 34% of emergency department visits for men and 48% for women 65 years of age or older (NCHS, 2006). Between 35% and 40% of community-dwelling elderly people and 60% of nursing home residents fall annually, and about half fall multiple times. The incidence of falls rises with increasing

age. It tends to be highest in people who are 85 years of age and older, and outcomes are worst in these adults. Yet fall prevention strategies, which are estimated to prevent 30% of falls, have largely been neglected in clinical practice; only 37% of primary care providers ask their patients about falls (Inouye, et al., 2007). Some causes of falls are treatable.

Although most falls by elderly adults do not result in injury, between 5% and 10% of elderly people who fall sustain serious injury. The most common fracture occurring from falls is hip fracture, which results from both osteoporosis and the situation that provoked the fall. Many older adults who fall and sustain a hip fracture are unable to regain their prefracture ability. Overall, older women who fall sustain a greater degree of injury than do older men.

Causes of falls are multifactorial. Both extrinsic factors such as changes in the environment or poor lighting and intrinsic factors such as physical illness, neurologic changes, or sensory impairment play a role. Mobility difficulties, medication effects, foot problems or unsafe footwear, postural hypotension, visual problems, and tripping hazards are common, treatable causes. Polypharmacy, medication interactions, and use of alcohol precipitate falls by causing drowsiness, decreased coordination, and postural hypotension. Falls have physical dangers as well as serious psychological and social consequences. It is not uncommon for an older person who has experienced a fall to become fearful and lose self-confidence.

Nurses can encourage older adults and their families to make lifestyle and environmental changes to prevent falls. Adequate lighting with minimal glare and shadow can be achieved through the use of small area lamps, indirect lighting, sheer curtains to diffuse direct sunlight, dull rather than shiny surfaces, and nightlights. Sharply contrasting colors can be used to mark the edges of stairs. Grab bars by the bathtub, shower, and toilet are useful. Loose clothing, improperly fitting shoes, scatter rugs, small objects, and pets create hazards and increase the risk for falls. Older adults function best in familiar settings when the arrangement of furniture and objects remains unchanged.

In institutionalized elderly people, physical restraints (lap belts; geriatric chairs; vest, waist, and jacket restraints) and chemical restraints (medications) precipitate many of the injuries they were meant to prevent. Documented injuries and deaths resulting from these restraints include strangulation, vascular and neurologic damage, pressure ulcers, skin tears, fractures, increased confusion, and significant emotional trauma. The time required to supervise restrained patients adequately is better used addressing the unmet need that provoked the behavior that resulted in the use of restraint. Because of the overwhelming negative consequences of restraint use, accrediting agencies of nursing homes and acute care facilities now maintain stringent guidelines concerning their use.

## Urinary Incontinence

Urinary incontinence may be acute, occurring during an illness, or may develop chronically over a period of years. Older patients often do not report this very common problem unless specifically asked. Transient causes may be attributed to ***d***elirium and ***d***ehydration; ***r***estricted mobility and restraints; ***i***nflammation, ***i***nfection, and ***i***mpaction; and ***p***harmaceuticals and ***p***olyuria (the acronym *drip* may be used to remember them). Once identified, the causative factor can be eliminated. Incontinence may also be a result of neurologic or structural abnormalities. Urinary incontinence has been associated with depression and low self-esteem and may reduce the patient's quality of life by causing restriction in social activities.

The pelvic floor serves as the supporting mechanism or "hammock" for the bladder, uterus, and rectum. It may have become weakened as a result of pregnancy, labor and delivery, prior pelvic surgeries, or activities that required prolonged standing or lifting. Dysfunction of the pelvic floor can be greatly improved with Kegel exercises. Other measures that help prevent episodes of incontinence include having quick access to toilet facilities and wearing clothing that can be unfastened easily.

Patients with incontinence should be urged to seek help from appropriate health care providers because incontinence can be both emotionally devastating and physically debilitating. Nurses who specialize in behavioral approaches to urinary incontinence management can help patients regain full continence or significantly improve the level of continence. Although medications such as anticholinergics may decrease some of the symptoms of urge incontinence (detrusor instability), the adverse effects of these medications (dry mouth, slowed gastrointestinal motility, and confusion) may make them inappropriate choices for the elderly. Various surgical procedures are also used to manage urinary incontinence, particularly stress urinary incontinence.

Detrusor hyperactivity with impaired contractility is a type of urge incontinence that is seen predominantly in the elderly population. In this variation of urge incontinence, patients have no warning that they are about to urinate. They often void only a small volume of urine or none at all and then experience a large volume of incontinence after leaving the bathroom. The nursing staff should be familiar with this form of incontinence and should not show disapproval when it occurs. Many patients with dementia suffer from this type of incontinence, because both incontinence and dementia are a result of dysfunction in similar areas of the brain. Prompted, timed voiding can be of assistance in these patients, although clean intermittent catheterization may be necessary because of postvoid residual urine (see Chapter 45).

## Increased Susceptibility to Infection

Infectious diseases present a significant threat of morbidity and mortality to older people, in part because of the blunted response of host defenses caused by a reduction in both cell-mediated and humoral immunity (see Chapters 50 and 51). Age-related loss of physiologic reserve and chronic illnesses also contribute to increased susceptibility. Pneumonia, urinary tract infections, tuberculosis (TB), gastrointestinal infections, and skin infections are some of the common infections in older people.

The effects of influenza and pneumococcal infections on older people are also significant. An estimated 5% to 20% of Americans have influenza each year; more than 200,000 are hospitalized with influenza-related complications, and more than 35,000 die (CDC, 2007b). An estimated 175,000 hospitalizations for pneumococcal pneumonia oc-

cur in the United States each year, and more than 6000 people die from invasive pneumococcal disease. More than half of the deaths occur in adults who had not received the recommended vaccination against pneumococcal disease (National Foundation for Infectious Disease, 2007).

The influenza and the pneumococcal vaccinations lower the risks of hospitalization and death in elderly people. The influenza vaccine, which is prepared yearly to adjust for the specific immunologic characteristics of the influenza viruses at that time, should be administered annually in autumn. The pneumococcal vaccine, which has 23 type-specific capsular polysaccharides, should be administered every 5 years. Both of these injections can be received at the same time in separate injection sites. Nurses should urge older people to be vaccinated. All health care providers working with older people or high-risk chronically ill people should also be immunized.

TB affects a significant number of older adults. Case rates for TB are highest among those who are 65 or older, with the exception of people with human immunodeficiency virus (HIV) infection. Nursing home residents account for the majority of the cases of TB in older adults. Much of the infection rate is attributed to reactivation of old infection. Pulmonary TB and extrapulmonary TB often have subtle, nonspecific symptoms. This is of particular concern in nursing homes because an active case of TB places patients and staff at risk for infection.

CDC guidelines suggest that all patients newly admitted to nursing homes have a Mantoux (purified protein derivative [PPD]) test unless there is a history of TB or a previous positive response. All patients whose tests are negative (a positive test is indicated by induration of more than 10 mm at 48 to 72 hours) should have a second test in 1 to 2 weeks. The first PPD serves to boost the suppressed immune response that may occur in older people. Chest x-rays and possibly sputum studies should be used to follow-up on PPD-positive responders and converters. For positive converters, a course of preventive therapy for 6 to 9 months with isoniazid (INH) is effective in eliminating active disease. All patients who test negative should be periodically retested (see Chapter 23).

AIDS occurs across the age spectrum. It is increasingly recognized that AIDS does not spare the older segment of society, and many who are living with HIV/AIDS are aging. In the past, male homosexual contact and blood transfusions were the predominant modes of transmission among older patients. Transmission by contaminated blood is now rare and the predominant mode of transmission in older people now is by sexual contact. The most common AIDS-indicator disease in older people is *Pneumocystis* pneumonia (PCP). Wasting syndrome and HIV encephalopathy are also common in older people with HIV infection.

## Altered Pain and Febrile Responses

Many altered physical, emotional, and systemic reactions to disease are attributed to age-related changes in older people. Physical indicators of illness that are useful and reliable in young and middle-age people cannot be relied on for the diagnosis of potential life-threatening problems in older adults. The response to pain in older people may be lessened because of reduced acuity of touch, alterations in neural pathways, and diminished processing of sensory data.

Many older adults who are experiencing a myocardial infarction do not have chest pain. Hiatal hernia or upper gastrointestinal distress is often the cause of chest pain. Acute abdominal conditions may go unrecognized in elderly people because of atypical signs and absence of pain.

The baseline body temperature for older people is about 1°F lower than it is for younger people. In the event of illness the body temperature of an older person may not be high enough to qualify as a traditionally defined fever. A temperature of 37.8°C (100°F), in combination with systemic symptoms, may signal infection. A temperature of 38.3°C (101°F) almost certainly indicates a serious infection that needs prompt attention. A blunted fever in the face of an infection often indicates a poor prognosis. Temperatures rarely exceed 39.5°C (103°F). Nurses must be alert to other subtle signs of infection, such as mental confusion, increased respirations, tachycardia, and skin color.

## Altered Emotional Impact

The emotional component of illness in older people may differ from that in younger people. Many elderly people equate good health with the absence of old age and believe "you are as old as you feel." An illness that requires hospitalization or a change in lifestyle is an imminent threat to well-being. Admission to the hospital is often feared and actively avoided. Older people admitted to the hospital are at high risk for disorientation, confusion, change in level of consciousness, and other symptoms of delirium, as well as anxiety and fear. In addition, economic concerns and fear of becoming a burden to families often lead to high anxiety in older people. Nurses must recognize the implications of fear, anxiety, and dependency in elderly patients. They should encourage autonomy, independent decision making, and early mobilization. A positive and confident demeanor in nurses and family members promotes a positive mental outlook in elderly patients.

## Altered Systemic Response

In an elderly person, illness has far-reaching repercussions. The decline in organ function that occurs in every system of the aging body eventually depletes the body's ability to respond at full capacity. Illness places new demands on body systems that have little or no reserve to meet the crisis. Homeostasis, the ability of the body to maintain an internal balance of function and chemical composition, is jeopardized. Older people may be unable to respond effectively to an acute illness or, if a chronic health condition is present, they may be unable to sustain appropriate responses over a long period. Furthermore, their ability to respond to definitive treatment is impaired. The altered responses of older adults reinforce the need for nurses to monitor all body system functions closely, being alert to signs of impending systemic complication.

# Other Aspects of Health Care of the Older Adult

## Elder Neglect and Abuse

Older adults who live in communities and institutions can be at risk for abuse and neglect. Because of different defini-

tions and terminology and the pattern of underreporting, a clear picture of the incidence and prevalence of abuse among the elderly is lacking. Furthermore, one of the major barriers to fully understanding **elder abuse** is that most professionals in all professions, including law enforcement, are not equipped to recognize and report this type of abuse (Wood, 2006). Both victims and perpetrators are reluctant to report the abuse, and clinicians are unaware of the frequency of the problems.

Neglect is the most common type of abuse. Other forms of abuse include physical, emotional, sexual, and financial abuse. Contributing factors include a family history of violence, mental illness, and drug or alcohol abuse, as well as financial dependency on the older person. In addition, diminished cognitive and physical function or disruptive and abusive behavior on the part of the older person can lead to caregiver strain and emotional exhaustion. Elderly people with disabilities of all types are at increased risk for abuse from family members and paid caregivers.

Nurses should be alert to possible elder abuse and neglect. During the health history, in a private portion of the interview, the elderly person should be asked about abuse. Most states require that care providers, including nurses, report suspected abuse. Preventive action should be taken when caregiver strain is evident, before elder abuse occurs. Early detection and intervention may provide sufficient resources to the family or person at risk to ensure patient safety. Interdisciplinary team members, including the psychologist, social worker, or chaplain, can be enlisted to help the caregiver develop self-awareness, increased insight, and an understanding of the disease or aging process. Community resources such as caregiver support groups, respite services, and local offices of Area Agencies on Aging are useful for both the elderly person and the caregiver.

## Social Services

Since the 1960s, many programs have been instituted for older Americans, including Medicare, Medicaid, the Older Americans Act, Supplemental Security Income (SSI), Social Security amendments, Section 202 housing, and Title XX social services legislation. These federal programs have dramatically increased health care options and financial support for elderly Americans. The Older Americans Act mandated creation of a federal aging network, resulting in the establishment of the Area Agencies on Aging (AAAs), a national system of social services and network providing many community services for the elderly. Each state has an advisory network that is charged with overseeing statewide planning and advocacy for the elderly throughout the state. Among the services provided by the AAAs are assessment of need, information and referral, case management, transportation, outreach, homemaker services, day care, nutritional education and congregate meals, legal services, respite care, senior centers, and part-time community work. The AAAs target low-income, ethnic minority, rural-living, and frail elders who are at risk for institutionalization; however, the assessment and information services are available to all elderly people (Hooyman & Kiyak, 2005). Similar services such as homemaker, home health aide, and chore services can be obtained at an hourly rate through these agencies or through local community nursing services if the family does not meet the low-income criteria. Informal sources of help, such as family, friends, mail carriers, church members, and neighbors, can all keep an informal watch on community-dwelling senior citizens.

Other community support services are available to help older people outside the home. Senior centers have social and health promotion activities, and some provide a nutritious noontime meal. Adult day care facilities offer daily supervision and social opportunities for elderly people who cannot be left alone. Adult day care services, although expensive, provide respite and enable family members to carry on daily activities while the older person is at the day care center.

## Health Care Costs of Aging

Health care is a major expenditure for the elderly, especially for those with chronic illness and limited financial resources. The elderly, who make up about 13% of the population, consume more than 30% of health care costs, particularly in the last year of life (Hooyman & Kiyak, 2005).

The two major programs that finance health in the United States are Medicare and Medicaid, both of which are overseen by the Centers for Medicaid and Medicare Services (CMS). Both programs cover acute care needs such as inpatient hospitalization, physician care, outpatient care, home health services, and skilled nursing care in a nursing facility. Medicare is federally funded, whereas Medicaid is administered by states; therefore, eligibility and reimbursements for Medicaid services vary from state to state. For older adults with limited incomes, even with the support of Medicare or Medicaid, paying out-of-pocket expenses can be a hardship. Out-of-pocket health care expenses represents 28% of the income of poor and near-poor elderly people (Federal Interagency Forum on Aging-Related Statistics, 2008). Despite the recent additional Medicare prescription benefit plan, out-of-pocket expenditures and prescription costs are burdensome. As more and more people in the United States become eligible for publicly funded health programs, there are serious concerns about whether sufficient health services will be available.

## Home Health Care

Use of home care services and skilled nursing home care increases with age. Because of the rapidly growing elderly population and the availability of Medicare funding for acute care, home health care in the United States has rapidly expanded. In 2003, home care reimbursement represented 3% of the total Medicare budget (Federal Interagency Forum on Aging-Related Statistics, 2008).

Home care involves the individual patient, the family, and caregivers. Home care nurses are generally considered skilled generalists who are holistic in their approach to care. In addition to providing skilled nursing care, home care nurses also consider the needs of the family and the impact of the environment and community on the patient situation, and they identify areas for collaboration and referral. Care is episodic (periodic short visits). Home care agencies generally offer several services, including skilled nursing; hospice care; physical, occupational, and speech therapy; and home health aide and homemaker services. Consultation with specialists in nutrition, cardiac, diabetic, and

wound care is available. As hospital stays have shortened, the acuity level of home care patients has risen dramatically. "High-tech" therapies such as infusion therapy are frequently available. The primary goal is to promote optimal health and independent function in the home for both patients and their families.

## Hospice Services

Hospice is a program of supportive and palliative services for terminally ill patients and their families that includes physical, psychological, social, and spiritual care. In most cases, patients are not expected to live longer than 6 months. The goal of hospice is to improve the quality of life by focusing on symptom management, pain control, and emotional support. Under Medicare and Medicaid, medical and nursing services are provided to keep patients as pain free and comfortable as possible. Hospice services may be incorporated into the care of residents in long-term care facilities and include care for end-stage dementia and other chronic diseases such as end-stage congestive heart disease.

Home care and hospice nurses are in a unique position to facilitate discussions about a patient's wishes and goals at the end of life. Too often, discussion regarding end-of-life care is postponed until a crisis occurs, making it difficult or impossible for the patient to be an active participant in the discussion. Home health nurses can assist patients and families by identifying options and initiating conversation about preparing an end-of-life plan. For an in-depth discussion of hospice care, see Chapter 17.

## Aging with a Disability

As the life expectancy of people with all types of physical, cognitive, and mental disabilities has increased, individuals must deal with the normal changes associated with aging in addition to their preexisting disabilities. There are still large gaps in our understanding of the interaction between disabilities and aging, including how this interaction varies depending on the type and degree of disability and other factors such as socioeconomics and gender. For adults without disabilities, the changes associated with aging may be minor inconveniences. For adults with disorders such as polio, multiple sclerosis, and cerebral palsy, aging may lead to greater disability. In addition, many people with disabilities are greatly concerned and fearful about what will happen to them as they age and whether assistance will be available when they need care.

It has been proposed that nurses view people with disabilities as capable, responsible individuals who are able to function effectively despite having a disability. Both the interface and the biopsychosocial models of disability can serve as a basis for the role of nurses as advocates for removal of barriers to health care (Smeltzer, 2007). Use of such models would also encourage public policies that support full participation of all citizens through greater availability of personal assistants and affordable and accessible transportation. Other disability models are discussed in Chapter 10.

Today, children born with intellectual and physical disabilities and those who acquire them early in life are also living into middle and older age. Often, their care has been provided by the family, primarily by the parents. As parents age and can no longer provide the needed care, they seek additional help with the care or long-term care alternatives for their children. However, few services are available at present to support a smooth transition between caregiving by parents and then by others. Research and public policy must focus on supports and interventions that allow people with disabilities who are aging to increase or maintain function within their personal environment as well as in the outside community. Important questions include who will provide the care and how will it be financed. The National Institute on Aging has identified aging with a disability as a focus and is striving to provide streamlined information and access to those with a disability and their family caregivers (Guralnik, et al., 2007).

# *Ethical and Legal Issues Affecting the Older Adult*

Nurses play an important role in supporting and informing patients and families when making treatment decisions. This nursing role becomes even more important in the care of aging patients who are facing life-altering and possibly end-of-life decisions. There is the potential for loss of rights, victimization, and other serious problems if a patient has not made plans for personal and property management in the event of disability or death. As advocates, nurses should encourage end-of-life discussions and educate older people to prepare advance directives before incapacitation (Bickley, 2007).

An **advance directive** is a formal, legally endorsed document that provides instructions for care (living will) or names a proxy decision maker (**durable power of attorney**). It is to be implemented if the signer becomes incapacitated. This written document must be signed by the person and by two witnesses, and a copy should be given to the physician and placed in the medical record. The person must understand that the advance directive is not meant to be used only when certain (or all) types of medical treatment are withheld; rather, it allows for a detailed description of all health care preferences, including full use of all available medical interventions. The health care proxy may have the authority to interpret the patient's wishes on the basis of medical circumstances and is not restricted to the decisions or situations stated in the living will, such as whether life-sustaining treatment can be withdrawn or withheld.

When such serious decisions are made, possibilities exist for significant conflict of values among patients, family members, health care providers, and the legal representative. Autonomy and self-determination are Western concepts, and people from different cultures may view advance directives as a method for denial of care. Elderly people from some cultures may be unwilling to consider the future, or they may wish to protect relatives and not want them to be informed about a serious illness. Nurses can facilitate the decision-making process by being sensitive to the complexity of patients' values and respecting their decisions. Directives must be focused on the wishes

CHART 12-4

## Ethics and Related Issues

**Should an Elderly Person be Allowed to Refuse Treatment When That Treatment is Likely to Extend the Person's Life?**

The patient is an 88-year-old man with an extensive cardiac history who has been a resident of a skilled nursing facility for the past 3 years. Comorbid conditions include type 2 diabetes (15 years) and severe peripheral vascular disease. For 6 months the patient has suffered from a serious left leg wound that has not responded to treatment and that has become much worse over the past 2 months. At this point, the leg is gangrenous to above the ankle, and the normal course of treatment would be to remove the leg above the circulatory problem. However, the patient is refusing surgery and states that he wants "to die with all of my limbs intact." The patient has been assessed with mild to moderate dementia and has named his daughter as his durable power of attorney. The nurses on the unit, the daughter, and the primary care physician all realize that an amputation is necessary to save the patient's life.

**Dilemma**

Several ethical issues are relevant to the resolution of the situation. The obligation to respect the patient's autonomy in the decision to refuse an amputation puts his life at risk. However, after hearing about the need for surgery and the likely outcome without the surgery, he continues to state, "I want to die with all of my limbs intact." The daughter and some of the nurses who care for the patient question the his ability to make such a decision.

**Discussion**

1. What are the ethical issues in this case study?
2. What arguments would you offer *against* the surgery?
3. What arguments would you offer *in favor of* the surgery?
4. What arguments would you offer *against* and *in favor of* supporting the patient in his decision to refuse the surgery?

of the patient, not those of the family or the designated proxy (Chart 12-4).

If no advance arrangement has been made and the older person appears unable to make decisions, the court may be petitioned for a competency hearing. If the court rules that an elderly person is incompetent, the judge appoints a guardian—a third party who is given powers by the court to assume responsibility for making financial or personal decisions for that person.

People with communication difficulties or mild dementia may be viewed as incapable of self-determination. Most people with mild dementia have sufficient cognitive capability to make some, but perhaps not all, decisions. For example, a patient may be able to identify a proxy decision maker yet be unable to select specific treatment options. People with mild dementia may be competent to understand the nature and significance of such decisions.

In 1990, the Patient Self-Determination Act (PSDA), a federal law, was enacted to require patient education about advance directives at the time of hospital admission, as well as documentation of this education. Nursing homes are also mandated to enhance residents' autonomy by increasing their involvement in health care decision making. A growing body of research indicates that nursing homes implement the PSDA more vigorously than hospitals. However, in both settings, the documentation and placement of advance directives in the medical record and the education of patients about advance directives vary considerably. Periodically it is important to ensure that the directives reflect the current wishes of the patient and that all providers have a copy so they are aware of the patient's wishes.

## CRITICAL THINKING EXERCISES

**1** You are a new nurse manager on a busy unit where the majority of patients are older than 65 years of age. Summarize the current demographics of aging and theories of aging that are important to include in an educational program for the staff. What will be the aims of the program? Who would you involve in its planning?

EBP **2** You are conducting an admission assessment on a 68-year-old man admitted for a planned knee replacement. His wife reports that he has become confused in the past 3 days. What is the evidence base that indicates the differences between dementia and AD? What is the strength of the evidence? Based on this evidence-based information, what assessment parameters would you evaluate? What information should you provide to the patient's wife? What actions are indicated?

**3** As a home care nurse, you are visiting an 88-year-old patient who has a paid caregiver. You have begun to suspect elder abuse. Identify your state requirements for reporting suspected elder abuse. What other team members and community resources could be used to support the patient and the caregiver? What actions are indicated?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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## RESOURCES

Administration on Aging (AoA), www.aoa.dhhs.gov
Alzheimer's Association, www.alz.org
American Association for Geriatric Psychiatry (AAGP), www.aagpgpa.org
American Association of Homes and Services for the Aging, www.aahsa.org
American Association of Retired Persons (AARP), www.aarp.org
American Federation for Aging Research (AFAR), www.afar.org
American Geriatrics Society, www.americangeriatrics.org
Association for Gerontology in Higher Education (AGHE), www.aghe.org
Children of Aging Parents (CAPS), www.caps4caregivers.org

Family Caregiver Alliance (FCA), www.caregiver.org
Gerontological Society of America (GSA), www.geron.org
Hospital Elder Life Program (HELP), www.hospitalelderlifeprogram.org
John A. Hartford Foundation: Institute for Geriatric, Nursing New York University College of Nursing NY, www.consultgerirn.org
National Caucus and Center for the Black Aged (NCBA), www.ncba-aged.org
National Council on the Aging, www.ncoa.org
National Gerontological Nursing Association National Office, www.ngna.org
National Institute on Aging (NIA). The Alzheimer's Disease Education and Referral (ADEAR) Center, www.nia.nih.gov/Alzheimers
NIA Alzheimer's Disease Education and Referral (ADEAR) Center; www.nia.nih.gov/alzheimers
Alzheimer's Association Safe Return (program for locating lost patients), www.GeroNurseOnline.org

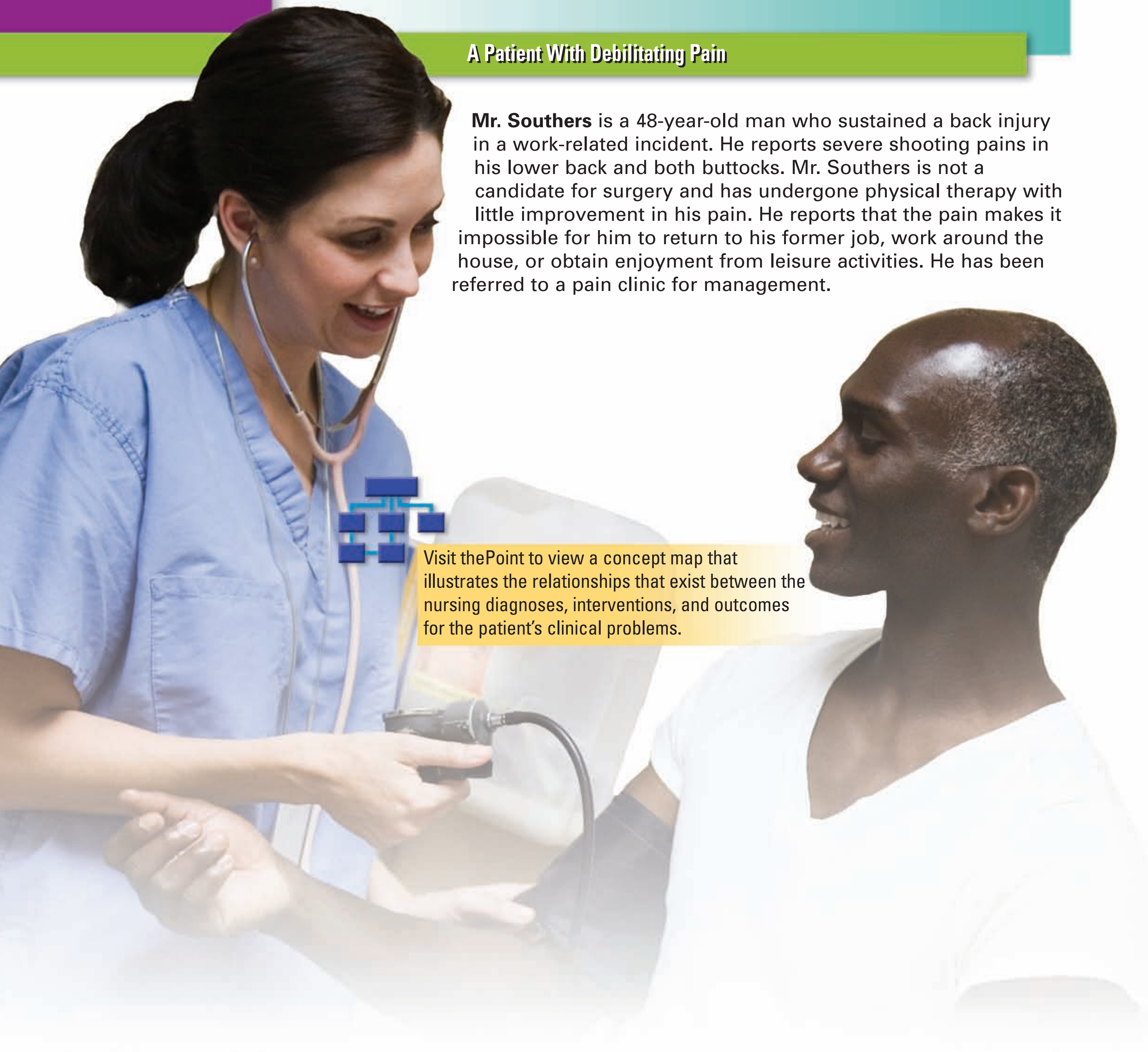
unit 3

# Concepts and Challenges in Patient Management

## Case Study • Applying Concepts from NANDA, NIC, and NOC

### A Patient With Debilitating Pain

**Mr. Southers** is a 48-year-old man who sustained a back injury in a work-related incident. He reports severe shooting pains in his lower back and both buttocks. Mr. Southers is not a candidate for surgery and has undergone physical therapy with little improvement in his pain. He reports that the pain makes it impossible for him to return to his former job, work around the house, or obtain enjoyment from leisure activities. He has been referred to a pain clinic for management.



Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **CHRONIC PAIN**—Unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage; sudden or slow onset of any intensity from mild to severe, constant or recurring, without an anticipated or predictable end and a duration of greater than 6 months | **PAIN MANAGEMENT**—Alleviation of pain or reduction in pain to a level of comfort that is acceptable to the patient | **PAIN LEVEL**—Severity of observed or reported pain |
| **RISK FOR POWERLESSNESS**—At risk for perceived lack of control over a situation and/or one's ability to significantly affect an outcome | **MEDICATION MANAGEMENT**—Facilitation of safe and effective use of prescribed or over-the-counter medicine | **COMFORT LEVEL**—Extent of positive perception of physical and psychological ease |
| | **SIMPLE RELAXATION THERAPY**—Use of techniques to encourage and elicit relaxation for the purpose of decreasing undesirable signs and symptoms such as pain, muscle tension, or anxiety | **PAIN CONTROL**—Personal actions to control pain |
| | **SIMPLE GUIDED IMAGERY**—Purposeful use of imagination to achieve relaxation and/or direct attention away from undesirable sensations | **PAIN: DISRUPTIVE EFFECTS**—Severity of observed or reported disruptive effects of chronic pain on daily functioning |
| | **EMOTIONAL SUPPORT**—Provision of reassurance, acceptance, and encouragement during times of stress | **PAIN: ADVERSE PSYCHOLOGICAL RESPONSE**—Severity of observed or reported adverse responses to physical pain |
| | **SELF-ESTEEM ENHANCEMENT**—Assisting a patient to increase his or her personal judgment of self-worth | |


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chapter 13

# Pain Management

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare characteristics of acute pain, chronic pain, and cancer pain.
2. Describe the negative consequences of pain.
3. Describe the pathophysiology of pain.
4. Describe factors that can alter the perception of pain.
5. Demonstrate appropriate use of pain measurement instruments.
6. Explain the physiologic basis of pain relief interventions.
7. Explain the impact of aging on pain.
8. Discuss when opioid tolerance may be a problem.
9. Identify appropriate pain relief interventions for selected groups of patients.
10. Compare the various types of neurosurgical procedures used to treat intractable pain.
11. Develop a plan to prevent and treat the adverse effects of analgesic agents.
12. Use the nursing process as a framework for the care of patients with pain.

## GLOSSARY

**addiction:** a behavioral pattern of substance use characterized by a compulsion to take the substance (drug or alcohol) primarily to experience its psychic effects

**agonist:** a substance that when combined with the receptor produces the drug effect or desired effect. Endorphins and morphine are agonists on the opioid receptors

**algogenic:** causing pain

**antagonist:** a substance that blocks or reverses the effects of the agonist by occupying the receptor site without producing the drug effect

**balanced analgesia:** using more than one form of analgesia concurrently to obtain more pain relief with fewer side effects

## GLOSSARY *(Continued)*

**breakthrough pain:** a sudden and temporary increase in pain occurring in a patient being managed with opioid analgesia

**dependence:** occurs when a patient who has been taking opioids experiences a withdrawal syndrome when the opioids are discontinued; often occurs with opioid tolerance and does not indicate an addiction

**endorphins and enkephalins:** morphinelike substances produced by the body. Primarily found in the central nervous system, they have the potential to reduce pain

**nociception:** activation of sensory transduction in nerves by thermal, mechanical, or chemical energy impinging on specialized nerve endings; the nerves involved convey information about tissue damage to the central nervous system

**nociceptor:** a receptor preferentially sensitive to a noxious stimulus

**non-nociceptor:** nerve fiber that usually does not transmit pain

**opioid:** a morphinelike compound that produces bodily effects including pain relief, sedation, constipation, and respiratory depression

**pain:** an unpleasant sensory and emotional experience resulting from actual or potential tissue damage

**pain threshold:** the point at which a stimulus is perceived as painful

**pain tolerance:** the maximum intensity or duration of pain that a person is able to endure

**patient-controlled analgesia (PCA):** self-administration of analgesic agents by a patient instructed about the procedure

**placebo effect:** analgesia that results from the expectation that a substance will work, not from the actual substance itself

**prostaglandins:** chemical substances that increase the sensitivity of pain receptors by enhancing the pain-provoking effect of bradykinin

**referred pain:** pain perceived as coming from an area different from that in which the pathology is occurring

**sensitization:** a heightened response seen after exposure to a noxious stimulus. Response to the same stimulus is to feel more pain

**tolerance:** occurs when a person who has been taking opioids becomes less sensitive to their analgesic properties (and usually side effects); characterized by the need for increasing doses to maintain the same level of pain relief

**Pain** is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage (Merskey & Bogduk, 1994). It is the most common reason for seeking health care (Shi, Langer, Cohen, et al., 2007). Pain occurs as the result of many disorders, diagnostic tests, and treatments; it disables and distresses more people than any single disease. Because nurses spend more time with patients in pain than other health care providers do, nurses need to understand the pathophysiology of pain, the physiologic and psychological consequences of acute and chronic pain, and the methods used to treat pain. Nurses encounter patients in pain in a variety of settings, including acute care, outpatient, and long-term care settings, as well as in the home. Therefore, they must have the knowledge and skills to assess pain, to implement pain relief strategies, and to evaluate the effectiveness of these strategies, regardless of setting.

## Importance of Pain Assessment and Management

Pain management is considered such an important part of care that it is referred to as "the fifth vital sign" to emphasize its significance and to increase the awareness among health care professionals of the importance of effective pain management (American Pain Society, 2003). Identifying pain as the fifth vital sign suggests that the assessment of pain should be as automatic as taking a patient's blood pressure and pulse. The Joint Commission (2005, p.1) standards state that "pain is assessed in all patients" and that "patients have the right to appropriate assessment and management of pain."

Documentation of pain assessment is now as important as documentation of the "traditional" vital signs. The American Nurses Association and the American Society for Pain Management Nursing (2005) published standards that indicated that nurses must document assessment of the patient's pain in the medical record.

The American Pain Foundation developed the Pain Care Bill of Rights, which addresses the importance of pain management (Chart 13-1). To date, California is the only state to have enacted a Pain Patient's Bill of Rights. In addition, the U.S. Congress identified 2000 to 2010 as the Decade of Pain Control and Research. The National Pain Care Policy Act of 2007 was designed to address the barriers to pain management by improving pain research, education, access, outreach, and care through creating a pain and palliative care research and quality program within the Agency for Healthcare Research and Quality (AHRQ).

## Types of Pain

Pain is categorized according to its duration, location, and etiology. Three basic categories of pain are generally recognized: acute pain, chronic (nonmalignant) pain, and cancer-related pain. The International Association for the Study of Pain Web site provides ongoing updates on pain terminology and treatment (see Web site listed under Resources at the end of this chapter).

### Chart 13-1 • *Pain Care Bill of Rights*

Although not always required by law, these are the rights you should expect, and if necessary demand, for your pain care.

As a person with pain, you have the right to:

- Have your report of pain taken seriously and be treated with dignity and respect by doctors, nurses, pharmacists, and other health care professionals.
- Have your pain thoroughly assessed and promptly treated.
- Be informed by your health care provider about what may be causing the pain, possible treatments, and the benefits, risks, and cost of each.
- Participate actively in decisions about how to manage your pain.
- Have your pain reassessed regularly and your treatment adjusted if your pain has not been eased.
- Be referred to a pain specialist if your pain persists.
- Get clear and prompt answers to your questions, take time to make decisions, and refuse a particular type of treatment if you choose.

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## Classic Categories of Pain

### Acute Pain

Usually of recent onset and commonly associated with a specific injury, acute pain indicates that damage or injury has occurred. Pain is significant in that it draws attention to its existence and teaches people to avoid similar potentially painful situations. If no lasting damage occurs and no systemic disease exists, acute pain usually decreases as healing occurs. For definitional purposes, acute pain can last from seconds to 6 months. However, the traditional 6-month time frame is controversial because many acute injuries heal within a few weeks and most heal by 6 weeks. In a situation in which healing is expected within 3 weeks and a patient continues to be in pain, the pain should be considered chronic, and appropriate treatment should be used.

### Chronic Pain

Chronic pain is constant or intermittent pain that persists beyond the expected healing time and that can seldom be attributed to a specific cause or injury. It may have a poorly defined onset, and it is often difficult to treat because the cause or origin may be unclear. Although acute pain may be a useful signal that something is wrong, chronic pain usually becomes a problem in its own right.

Chronic pain is pain that lasts for 6 months or longer, although 6 months is an arbitrary period for differentiating between acute and chronic pain, as previously noted. An episode of pain may assume the characteristics of chronic pain before 6 months have elapsed, or some types of pain may remain primarily acute in nature for longer than 6 months. Nevertheless, after 6 months, most pain experiences are accompanied by problems related to the pain itself. Chronic pain serves no useful purpose. If it continues, it may become a patient's primary disorder.

Nurses may come in contact with patients with chronic pain when these patients are admitted to the hospital for treatment or when they are seen out of the hospital for home care. Frequently, nurses are called on in community-based settings to assist patients in managing pain.

#### Cancer-Related Pain

Pain associated with cancer may be acute or chronic. Pain resulting from cancer is so ubiquitous that when cancer patients are asked about possible outcomes, pain is reported to be the most feared outcome (Munoz Sastre, Albaret, Maria Raich Escursell, et al., 2006). Pain in patients with cancer can be directly associated with the cancer (eg, bony infiltration with tumor cells or nerve compression), a result of cancer treatment (eg, surgery or radiation), or not associated with the cancer (eg, trauma). However, most pain associated with cancer is a direct result of tumor involvement. Cancer pain management is discussed in Chapter 16.

### Pain Classified by Location

Pain can also be categorized according to location (eg, pelvic pain, headache, chest pain). This type of categorization aids in communication about and treatment of the pain. For example, chest pain may suggest acute coronary syndrome (ACS) and indicates the need for diagnostic evaluation and treatment according to cardiac care standards as appropriate.

### Pain Classified by Etiology

Pain can also be categorized by etiology (Chart 13-2). Burn pain and postherpetic neuralgia are examples of pain described in terms of their cause. Clinicians often can predict the course of pain and plan effective treatment using this categorization.

## Harmful Effects of Pain

Regardless of its nature, pattern, or cause, pain that is inadequately treated has harmful effects beyond the suffering it causes. For example, unrelieved pain is associated with sleep alterations. Sleep deprivation affects the pain experience. Research suggests that patients with sleep deprivation frequently display hyposomnia (ie, little sleep), fatigue, chronic pain, and depression (Gevirtz, 2007). Analgesics may also be less effective if patients experience sleep deprivation.

### Effects of Acute Pain

Unrelieved acute pain can affect the pulmonary, cardiovascular, gastrointestinal, endocrine, and immune systems. The stress response ("neuroendocrine response to stress") that occurs with trauma also occurs with other causes of severe pain. The widespread endocrine, immunologic, and inflammatory changes that occur with stress can have significant negative effects. This is particularly harmful in patients whose health is already compromised by age, illness, or injury.

The stress response generally consists of increased metabolic rate and cardiac output, impaired insulin response, increased production of cortisol, and increased retention of fluids (see Chapter 6 for details about the stress response). The stress response may increase the risk of physiologic disorders (eg, myocardial infarction, pulmonary infection, venous thromboembolism, prolonged paralytic ileus). Patients with severe pain and associated stress may be unable to take deep breaths and may experience increased fatigue and decreased mobility. Although these effects may be tolerated by young, healthy people, they may hamper recovery in elderly, debilitated, or critically ill people. Effective pain relief may result in faster recovery and improved outcomes.

### Effects of Chronic Pain

Like acute pain, chronic pain also has adverse effects. Suppression of the immune function associated with chronic pain may promote tumor growth. In addition, chronic pain often results in depression and disability. Although health care providers may express concern about high dosages of opioid medications required to relieve chronic pain in some patients, it is safe to use gradually increased dosages of these medications to control progressive chronic pain. In fact, failure to administer adequate pain relief may be unsafe because of the consequences of unrelieved pain.

Regardless of how patients cope with chronic pain, pain that lasts for an extended period can result in disability. Patients with a number of chronic pain syndromes report depression, anger, and fatigue (Norelli & Harju, 2008). Patients may be unable to continue the activities and interpersonal relationships they engaged in before the pain began. Disabilities may range from an impaired ability to participate in physical activities to an inability to take care of personal needs, such as dressing or eating. Nurses should understand the effects of chronic pain on patients and families and should be knowledgeable about pain relief strategies and appropriate resources to assist effectively with pain management.

## Pathophysiology of Pain

The sensory experience of pain depends on the interaction between the nervous system and the environment. The processing of noxious stimuli and the resulting perception of pain involve the peripheral and central nervous systems.

### Nociceptors

Neurologic transmission of pain is also referred to as **nociception. Nociceptors** are neuronal receptors involved in the transmission of pain perceptions to and from the brain that respond to biochemical mediators or noxious stimuli. They are free nerve endings in the skin that respond only to intense, potentially damaging stimuli. Such stimuli may be mechanical, thermal, or chemical in nature. The joints, skeletal muscle, fascia, tendons, and cornea also have nociceptors with the potential to transmit stimuli that produce pain. However, the large internal organs (viscera) do not contain nerve endings that respond only to painful stimuli. Pain originating in these organs results from intense stimulation of receptors that have other purposes. For example, inflammation, stretching, ischemia, dilation, and spasm of the internal organs all cause an intense response in these multipurpose fibers and can cause severe pain.

Nociceptors are part of complex multidirectional pathways. These nerve fibers branch very near their origin in the

## Chart 13-2 • *Pain Syndromes and Unusual Severe Pain Problems*

### Complex Regional Pain Syndrome

*Complex regional pain syndrome* (CRPS) describes a variety of painful conditions that often follow an injury. It refers to a group of conditions previously described as causalgia, reflex sympathetic dystrophy (RSD), and other diagnoses. The magnitude and duration of the pain far exceed the expected duration and often result in significant impairment of motor function. There are two categories of CRPS: type I and type II. CRPS type I, the most common type, is characterized by unexplained diffuse burning pain, usually in the periphery of an extremity. RSD is categorized as CRPS type I and occurs after a relatively minor trauma (Quisel, Gill, & Witherell, 2005). Pain is accompanied by weakness, a change in skin color and temperature relative to the other extremity, limited range of motion, hyperesthesia, hypoesthesia, edema, altered hair growth, and sweating.

Pain, which worsens with movement, cutaneous stimulation, or stress, often occurs after surgery or trauma to the extremity but is not limited to the area of surgery or trauma. CRPS type I is usually managed through a pain clinic. Currently, regional sympathetic blockade and regional intravenous (IV) bretylium offer promise for relief. Tricyclic antidepressants may be tried as well.

CRPS type II refers to causalgia. Type II is more likely to develop after trauma with detectable peripheral nerve lesions (Quisel, et al., 2005). The pain is characterized as burning and hyperpathia in an extremity after partial injury to a nerve or one of its major branches.

### Postmastectomy Pain Syndrome

*Postmastectomy pain syndrome* (PMP) occurs after mastectomy with node dissection but is not necessarily related to the continuation of disease. Characterized by the sensation of constriction accompanied by a burning, prickling, or numbness in the posterior arm, axilla, or chest wall, PMP is often aggravated by movement of the shoulder, resulting in a frozen shoulder from immobilization.

### Fibromyalgia (Fibrositis)

*Fibromyalgia,* a chronic pain syndrome characterized by generalized musculoskeletal pain, trigger points, stiffness, fatigability, and sleep disturbances, is aggravated by stress and overexertion. Treatment consists of nonsteroidal anti-inflammatory drugs (NSAIDs), trigger-point injections with local anesthetic agents, tricyclic antidepressant medications, stress reduction, and regular exercise (Gevirtz, 2007).

### Hemiplegia-Associated Shoulder Pain

*Hemiplegia-associated shoulder pain* is a pain syndrome that affects as many as 80% of stroke patients. It may result from stretching of the shoulder joint due to the uncompensated pull of gravity on the impaired arm. It may be preventable with functional electrical stimulation of involved shoulder muscles.

### Sickle Cell Disease and Pain

Pain experienced by patients with sickle cell disease results from venous occlusion caused by the sickle shape of the blood cells, impaired circulation to a muscle or organ, ischemia, and infarction. Acute pain may be managed with IV opioid analgesics administered according to a schedule or by a patient-controlled analgesia (PCA) pump and NSAIDs. Warm soaks and elevating the affected body part may help as well. Meperidine (Demerol) therapy is not recommended in patients with compromised renal function, nor is cold therapy. Patients with sickle cell disease may have a long history of chronic pain. Some issues related to their history include tolerance, possible long-term drug dependence, racial prejudice, and inadequate pain treatment.

### Acquired Immunodeficiency Syndrome-Related Pain

As acquired immunodeficiency syndrome (AIDS) progresses, so do problems that produce increasing amounts of pain, such as neuropathy, esophagitis, headaches, postherpetic pain, and abdominal, back, bone, and joint pain (Douaihy, Stowell, Kohnen, et al., 2007). Pain relief interventions are individualized and may consist of NSAIDs; long-lasting opioids, such as fentanyl patches; and topical lidocaine. Tricyclic antidepressant medications may provide comfort in neuropathic and postherpetic pain.

### Burn Pain

Possibly the most severe pain, burn pain requires accurate assessment by all health care professionals to effectively manage it. Besides administration of IV opioid analgesic agents, current therapies to relieve or control pain in burn patients include débridement under general anesthesia; anxiety reduction; intervention with PCA devices, such as a handheld nitrous oxide delivery system; and cognitive techniques, particularly hypnosis.

### Guillain-Barré Syndrome and Pain

A progressive, inflammatory disorder of the peripheral nervous system, Guillain-Barré syndrome is characterized by flaccid paralysis accompanied by paresthesia and pain—muscle pain and severe, unrelenting, burning pain. Complaints of severe pain may be difficult to accept in the face of the characteristic flaccid facial response; therefore, the nurse must be sensitive and learn to disregard nonverbal cues that contradict the verbal report of pain. Treatment interventions include NSAIDs for muscle pain and opioids if NSAIDs are ineffective. Causalgia and neurogenic pain may be relieved by systemic or epidural opioids or, possibly, antiseizure agents or tricyclic antidepressant medications. To relieve the burning, some patients beg to have windows opened and clothing removed, even in cold weather. This suggests that gentle ice massage may help. Research is needed, however, to test its effectiveness.

skin and send fibers to local blood vessels, mast cells, hair follicles, and sweat glands. When these fibers are stimulated, histamine is released from mast cells, causing vasodilation. Nociceptors respond to high-intensity mechanical, thermal, and chemical stimuli. Some receptors respond to only one type of stimulus, and others, called polymodal nociceptors, respond to all three types. These highly specialized neurons transfer the mechanical, thermal, or chemical stimulus into electrical activity or action potentials (Porth & Matfin, 2009).

The cutaneous fibers located more centrally further branch and communicate with the paravertebral sympathetic chain of the nervous system and with large internal organs. As a result of the connections among these nerve

fibers, pain is often accompanied by vasomotor, autonomic, and visceral effects. For example, gastrointestinal peristalsis may decrease or cease in a patient with severe acute pain.

## Peripheral Nervous System

A number of **algogenic** (pain-causing) substances that affect the sensitivity of nociceptors are released into the extracellular tissue as a result of tissue damage. Histamine, bradykinin, acetylcholine, serotonin, and substance P are chemicals that increase the transmission of pain. **Prostaglandins** are a group of chemical substances that are believed to increase the sensitivity of pain receptors by enhancing the pain-provoking effect of bradykinin. These chemical mediators also cause vasodilation and increased vascular permeability, resulting in redness, warmth, and swelling of the injured area.

Once nociception is initiated, the nociceptive action potentials are transmitted in the peripheral nervous system. The first-order neurons travel from the periphery (skin, cornea, visceral organs) to the spinal cord via the dorsal horn. There are two main types of fibers involved in the transmission of nociception. Smaller, myelinated Aδ (A delta) fibers transmit nociception rapidly, which produces the initial "fast pain." Type C fibers are larger, unmyelinated fibers that transmit what is called "second pain." This type of pain has dull, aching, or burning qualities that last longer than the initial fast pain. The type and concentration of nerve fibers to transmit pain vary by tissue type.

If there is repeated C-fiber stimulation, a greater response is noted in dorsal horn neurons, causing the person to perceive more pain. In other words, the same noxious stimulus produces hyperalgesia, and the person reports greater pain than was felt at the first stimulus. For this reason, it is important to treat patients with analgesic agents when they first feel pain. Patients require less medication and experience more effective pain relief if analgesia is administered before they become sensitized to the pain.

Chemicals that reduce or inhibit the transmission or perception of pain include **endorphins** and **enkephalins.** These morphinelike neurotransmitters are endogenous (produced by the body). They are examples of substances that reduce nociceptive transmission when applied to certain nerve fibers. The term *endorphin* is a combination of two words: endogenous and morphine. Endorphins and enkephalins are found in heavy concentrations in the central nervous system (CNS), particularly the spinal and medullary dorsal horn, periaqueductal gray matter, hypothalamus, and amygdala. Morphine and other opioid medications act at receptor sites to suppress the excitation initiated by noxious stimuli. The binding of opioids to receptor sites is responsible for the effects noted after their administration. Each receptor (mu, kappa, delta) responds differently when activated (Porth & Matfin, 2009).

## Central Nervous System

After tissue injury occurs, nociception to the spinal cord via the Aδ and C fibers continues. The fibers enter the dorsal horn, which is divided into laminae based on cell type. The laminae II cell type is commonly referred to as the substantia gelatinosa. In the substantia gelatinosa are projections that relay nociception to other parts of the spinal cord (Fig. 13-1).

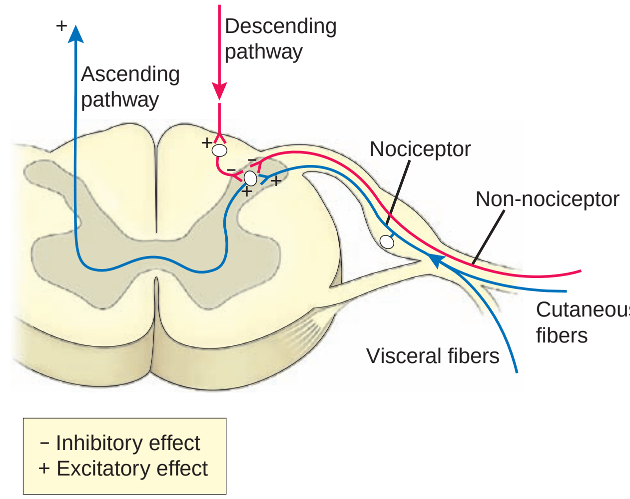



**Figure 13–1** Representative nociception system, showing ascending and descending sensory pathways of the dorsal horn.

Nociception continues from the spinal cord to the reticular formation, thalamus, limbic system, and cerebral cortex. Here nociception is localized, and its characteristics become apparent, including the intensity. The involvement of the reticular formation, limbic, and reticular activating systems is responsible for the individual variations in the perception of noxious stimuli. People may report the same stimulus differently based on their anxiety level, past experiences, and expectations. This is a result of the conscious perception of pain.

For pain to be consciously perceived, neurons in the ascending system must be activated. Activation occurs as a result of input from the nociceptors located in the skin and internal organs. Once activated, the inhibitory interneuronal fibers in the dorsal horn inhibit or turn off the transmission of noxious stimulating information in the ascending pathway.

### *Descending Control System*

The descending control system is a system of fibers that originate in the lower and midportion of the brain (specifically, in the periaqueductal gray matter) and terminate on the inhibitory interneuronal fibers in the dorsal horn of the spinal cord. This system is always active; it prevents continuous transmission of painful stimuli, partly through the action of the endorphins. As nociception occurs, the descending control system is activated to inhibit pain.

Cognitive processes may stimulate endorphin production in the descending control system. The effectiveness of this system is illustrated by the effects of distraction. The distractions provided by visitors or a favorite TV show may increase activity in the descending control system. Therefore, patients who have visitors may not report pain, because activation of the descending control system results in less noxious or painful information being transmitted to consciousness. Once the distraction by the visitors ends, activity in the descending control system decreases, resulting in increased transmission of painful stimuli.

The interconnections between the descending neuronal system and the ascending sensory tract are called inhibitory interneuronal fibers. These fibers contain enkephalins and

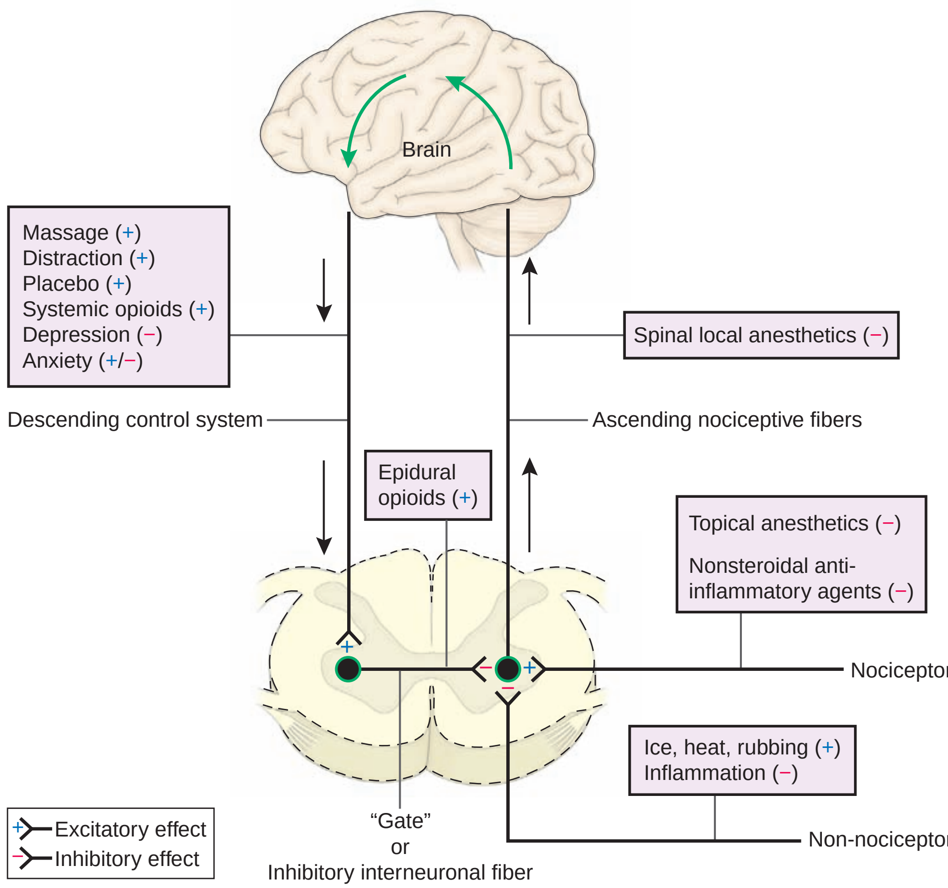



**Figure 13-2** A schematic representation of the gate control system and aspects of the nociceptive system. The nervous system is made up of stimulatory and inhibitory fibers. For example, stimulation of the nociceptor results in the transmission of an impulse that will be interpreted as pain. When it is stimulated, it will stimulate transmission at the next fiber junction (represented as +>–). The interneuronal fiber is an inhibitory neuron (–>–). When it is stimulated, it, in turn, inhibits or shuts off transmission at the next junction. So a placebo has a (+) stimulatory effect on the descending control system, which has a stimulatory effect (+) on the interneuronal fiber, which has an inhibitory effect (–) on the ascending control system. A topical anesthetic has an inhibitory effect (–) on nerve transmission at the nociceptor level, and a spinal anesthetic has the same impact (–) on the ascending nociceptive fibers.

are primarily stimulated through the activity of **non-nociceptor** peripheral fibers (fibers that normally do not transmit painful or noxious stimuli) in the same receptor field as the pain receptor, and descending fibers, grouped together in a system called descending control. The enkephalins and endorphins are thought to inhibit pain impulses by stimulating the inhibitory interneuronal fibers, which in turn reduce the transmission of noxious impulses via the ascending system (Porth & Matfin, 2009).

## Gate Control Theory

The classic gate control theory of pain, described by Melzack and Wall in 1965, was the first to clearly articulate the existence of a pain-modulating system (Melzack, 1996). This theory proposed that stimulation of the skin evokes nervous impulses that are then transmitted by three systems located in the spinal cord. The substantia gelatinosa in the dorsal horn, the dorsal column fibers, and the central transmission cells act to influence nociceptive impulses. The noxious impulses are influenced by a "gating mechanism." Stimulation of the large-diameter fibers inhibits the transmission of pain, thus "closing the gate." Conversely, when smaller fibers are stimulated, the gate is opened. The gating mechanism is influenced by nerve impulses that descend from the brain. This theory proposes a specialized system of large-diameter fibers that activate selective cognitive processes via the modulating properties of the spinal gate. Figure 13-2 shows a schematic representation of a gate control system and nociceptive pathways.

The gate control theory was the first theory to suggest that psychological factors play a role in the perception of pain. The theory guided research toward identifying cognitive-behavioral approaches to pain management. Therefore, this theory helps explain how interventions such as distraction and music therapy relieve pain.

Melzack (1996) extended the gate control theory after studying phantom limb pain. He proposed that a large, widespread network of neurons exists that consists of loops between the thalamus and cortex and between the cortex and the limbic system. Melzack labeled this network the neuromatrix. As information is processed in the neuromatrix, a characteristic pattern emerges. This pattern, referred to as the neurosignature, is a continuous outflow from the neuromatrix. Melzack (1996) theorized that, in the absence of modulating inputs from the missing limb, the active neuromatrix produces a neurosignature pattern that is perceived as pain. The neuromatrix theory highlights the role of the brain in sustaining the experience of pain.

## Factors Influencing Pain Response

Several factors, including past experiences with pain, anxiety, culture, age, gender, genetics, and expectations about pain relief, influence a person's experience of pain. These factors may increase or decrease perception of pain, increase or decrease tolerance for pain, and affect responses to pain.

## Past Experience

It is tempting to expect that people who have had multiple or prolonged experiences with pain will be less anxious and more tolerant of pain than those who have had little experience with pain. However, this is not true for many people. The more experience a person has had with pain, the more frightened he or she is likely to be about subsequent painful events. The person may be less able to tolerate pain; that is, he or she wants relief from pain sooner, before it becomes severe. This reaction is more likely to occur if the person has received inadequate pain relief in the past. A person with repeated pain experiences may have learned to fear the escalation of pain and its inadequate treatment. Once a person experiences severe pain, he or she knows just how severe it can be. Conversely, a person who has never had severe pain may have no fear of such pain.

The way a person responds to pain is a result of many separate painful events during a lifetime. For some, past pain may have been constant and unrelenting, as in chronic pain. Such people may become irritable, withdrawn, and depressed.

The undesirable effects that may result from previous experience point to the need for the nurse to be aware of the patient's past experiences with pain. If pain is relieved promptly and adequately, the person may be less fearful of future pain and better able to tolerate it.

## Anxiety and Depression

Although it is commonly believed that anxiety increases pain, this is not necessarily true. Anxiety that is relevant or related to the pain may increase the patient's perception of pain. For example, the patient who was treated 2 years ago for breast cancer and now has hip pain may fear that the pain indicates metastasis. In this case, the anxiety may result in increased pain. Anxiety that is unrelated to the pain may distract the patient and may actually decrease the perception of pain. For example, a mother who is hospitalized with complications from abdominal surgery and is anxious about her children may perceive less pain as her anxiety about her children increases.

The most effective way to relieve pain is by directing the treatment at the pain rather than at the anxiety. The routine use of antianxiety medications to treat anxiety in patients with pain may prevent patients from reporting pain because of sedation and may impair their ability to take deep breaths, get out of bed, and cooperate with the treatment plan.

Just as anxiety is associated with pain because of concerns and fears about the underlying disease, depression is associated with chronic pain and unrelieved cancer pain. In cases of chronic pain, the incidence of depression is increased (Youssef, Atienza, Langseder, et al., 2008). Depression is associated with major life changes caused by the limiting effects of chronic pain, including unemployment, disability, and possibly imminent death. Unrelieved cancer pain drastically interferes with the patient's quality of life, and relieving the pain may also help treat the depression.

## Culture

Beliefs about pain and how to respond to it differ from one culture to the next. Early in childhood, people learn from those around them what responses to pain are acceptable or unacceptable. For example, a child may learn that a sports injury is not expected to hurt as much as a comparable injury caused by a motor vehicle crash. The child also learns what stimuli are expected to be painful and what behavioral responses are acceptable. These beliefs vary from one culture to another; therefore, people from different cultures who experience the same intensity of pain may not report it or respond to it in the same ways.

Cultural factors must be taken into account to manage pain effectively. Many studies have examined the cultural aspects of pain. Inconsistent results, methodologic weaknesses or flaws, and failure of many researchers to carefully distinguish ethnicity, culture, and race make it difficult to interpret the findings of many of these studies. Factors that help explain differences between cultural groups include age, gender, education level, and income. In addition, the degree to which patients identify with a culture influences the degree to which they will adopt new health behaviors or rely on traditional health beliefs and practices. Other factors that affect the patients' responses to pain include their interactions with the health care system and their health care providers (Ludwig-Beymer, 2008). Patients from some cultures may feel frustrated and powerless if they feel that their clinicians do not appreciate the magnitude of their pain.

The cultural expectations and values of nurses may differ from those of other cultures and may include avoiding exaggerated expressions of pain, such as excessive crying and moaning; seeking immediate relief from pain; and giving complete descriptions of the pain. Whereas patients of one cultural background may moan and complain about pain, refuse pain relief measures that do not cure the cause of the pain, or use adjectives such as "unbearable" in describing the pain, patients of another cultural background may behave in a quiet, stoic manner rather than express the pain loudly. The nurse must react to the person's perception of pain and not to the person's behavior, because the behavior may differ from the nurse's cultural expectations.

Recognizing the values of one's own culture and learning how these values differ from those of other cultures helps avoid evaluating the patient's behavior on the basis of one's own cultural expectations and values (Mitchell, 2008). The nurse who recognizes cultural differences has a greater understanding of the patient's pain, is more accurate in assessing pain and behavioral responses to pain, and is more effective at relieving pain.

Regardless of the patient's culture, the nurse should learn about that particular culture and be aware of power and communication issues that affect care outcomes. The nurse should avoid stereotyping the patient by culture and provide individualized care rather than assuming that a patient of a specific culture will exhibit more or less pain. In addition to avoiding stereotyping, health care providers should individualize the amount of medications or therapy according to the information provided by the patient (Good & Sukhee, 2008). The nurse should recognize that stereotypes exist and become sensitive to how stereotypes negatively affect care. In turn, patients must be instructed about how and what to communicate about their pain.

## Gerontologic Considerations

Aging seems to influence the functional features of the nervous system as evidenced by a loss of myelinated and unmyelinated fibers in the peripheral nervous system. The decrease in myelinated fibers is partly responsible for causing a

decrease in expression of the major myelin proteins. This causes a gradual reduction in endoneural blood flow with increasing age, which may contribute to reduced peripheral nerve function and diminished pain perception. However, McCleane (2008) asserts that if pain perception is diminished in elderly patients, it is most likely secondary to a disease process, such as diabetes, rather than to the effects of normal aging. A lack of sufficiently strong research-based evidence limits making definitive associations between aging and pain perceptions.

Although many elderly people seek health care because of pain, others are reluctant to seek help even when in severe pain because they consider pain to be part of normal aging. Assessment of pain in older adults may be difficult because of the physiologic, psychosocial, and cognitive changes that often accompany aging. Research has revealed that a large number of residents in long-term care facilities reported being in pain daily; this pain is often described as excruciating and is often unrelieved without treatment (Sawyer, Lillis, Bodner, et al., 2007). It contributes to depression, sleep disturbances, delayed rehabilitation, malnutrition, and cognitive dysfunction (McCleane, 2008).

Older people may respond differently to pain than younger people. Because elderly people have a slower metabolism and a greater ratio of body fat to muscle mass compared to younger people, small doses of analgesic agents may be sufficient to relieve pain, and these doses may be effective longer. Elderly patients deal with pain based on their lifestyle, personality, and cultural background. Many elderly people fear addiction and, as a result, do not report that they are in pain or ask for medication to relieve pain. Others fail to seek care because they fear that the pain may indicate serious illness or that pain relief will result in a loss of independence.

Elderly patients must receive adequate pain relief after surgery or trauma. When an elderly person becomes confused after surgery or trauma, the confusion is often attributed to medications, which are then inappropriately discontinued. However, confusion in the elderly may also result from untreated and unrelieved pain. In some cases, postoperative confusion clears once the pain is relieved. Judgments about pain and the adequacy of treatment should be based on the patient's report of pain and pain relief rather than on age.

### Gender

The results of studies of gender in regard to pain levels and response to pain have been inconsistent. In some studies, women consistently reported higher pain intensity, pain unpleasantness, frustration, and fear, compared to men (Wise, Price, Myers, et al., 2002). Men and women are thought to be socialized to respond differently and differ in their expectations about pain.

## The Nurse's Role in Assessment and Care of Patients with Pain

The highly subjective nature of pain means that pain assessment and management present challenges for all clinicians. Assessment and management of pain require that the nurse has a good rapport with the person in pain.

### Assessment

The International Association for the Study of Pain's definition of pain that was identified at the beginning of this chapter encompasses the multidimensional nature of pain (Merskey & Bogduk, 1994). A broad definition of pain is, "whatever the person says it is, existing whenever the experiencing person says it does" (McCaffery & Pasero, 1999, p.17). This definition emphasizes the highly subjective nature of pain and pain management. Patients are the best authority on the existence of their own pain. Therefore, validation of the existence of pain is based on the patient's report that it exists.

Although it is important to believe patients who report pain, it is equally important to be alert to patients who deny pain in situations where pain would be expected. A nurse who suspects pain in a patient who denies it should explore with the patient the reason for suspecting pain, such as the fact that the disorder or procedure is usually painful or that the patient grimaces when moving or avoids movement. For example, it is not uncommon for a patient recovering from a total joint replacement to deny feeling "pain," but on further questioning he or she will readily admit to having a "terrible ache or pressure, but I wouldn't call it pain." From then on, when evaluating this person's pain, the nurse would use the patient's words rather than the word "pain."

It may also be helpful to explore why the patient may be denying that he or she is in pain. Some people deny pain because they fear the treatment that may result if they report or admit pain. Others deny pain for fear of becoming addicted to opioids if these medications are prescribed.

In assessing a patient with pain, the nurse reviews the patient's description of the pain and other factors that may influence pain (see previous discussion), as well as the patient's response to pain relief strategies. Documentation of the pain level as rated on a pain scale becomes part of the patient's medical record, as does the record of the pain relief obtained from interventions.

Pain assessment includes determining what level of pain relief the acutely ill patient believes is needed to recover quickly or improve function, or what level of relief the chronically or terminally ill patient requires to maintain comfort. Part of a thorough pain assessment includes assessing the patient's expectations and misconceptions about pain (Chart 13-3). People who understand that pain relief not only contributes to comfort but also hastens recovery are more likely to request or self-administer treatment appropriately.

#### *Characteristics of Pain*

Pain assessment begins by careful patient observation, noting overall posture and presence or absence of overt pain behaviors. In addition, it is essential to ask the patient to describe, in his or her own words, the specifics of the pain. The words used to describe the pain may point toward the cause. For example, the classic description of chest pain that results from a myocardial infarction includes pressure or squeezing on the chest. A detailed history should follow the initial description of pain. The factors to consider in a complete pain assessment are the intensity, timing, location, quality, personal meaning of pain; aggravating and alleviating factors; and pain behaviors.

**Chart 13-3 • *Common Concerns and Misconceptions About Pain and Analgesia***

- Complaining about pain will distract my doctor from his primary responsibility—curing my illness.
- Pain is a natural part of aging.
- I don't want to bother the nurse—he/she is busy with other patients.
- Pain medicine can't really control pain.
- People get addicted to pain medicine easily.
- It is easier to put up with pain than with the side effects that come from pain medicine.
- Good patients avoid talking about pain.
- Pain medicine should be saved in case the pain gets worse.
- Pain builds character. It's good for you.
- Patients should expect to have pain; it's part of almost every hospitalization.

Adapted with permission from Gordon, D. B. & Ward, S. E. (1995). Correcting patient misconceptions about pain. *American Journal of Nursing, 95*(7), 43–45.

### Intensity

The intensity of pain ranges from none to mild discomfort to excruciating. There is no correlation between reported intensity and the stimulus that produced it. The reported intensity is influenced by the person's **pain threshold,** the smallest stimulus for which a person reports pain, and **pain tolerance,** the maximum amount of pain a person can tolerate. To understand variations, the nurse can ask about the present pain intensity as well as the least and the worst pain intensity. Various scales and surveys are helpful to patients trying to describe pain intensity (see later discussion of instruments for assessing pain).

### Timing

Sometimes the cause of pain can be determined when time aspects are known. Therefore, the nurse inquires about the onset, duration, relationship between time and intensity (eg, at what time the pain is the worst), and changes in rhythmic patterns. The nurse asks the patient if the pain began suddenly or increased gradually. Sudden pain that rapidly reaches maximum intensity is indicative of tissue injury, and immediate intervention is necessary. Pain from ischemia gradually increases and becomes intense over a longer time. The chronic pain of rheumatoid arthritis illustrates the usefulness of determining the relationship between time and intensity because people with rheumatoid arthritis usually report that pain is worse during the night.

### Location

Having the patient point to the area of the body involved best determines the location of pain. Some general assessment forms include drawings of human figures, on which the patient is asked to shade in the area involved. This is especially helpful if the pain radiates (**referred pain**). The shaded figures are helpful in determining the effectiveness of treatment or change in the location of pain over time.

### Quality

The nurse asks the patient to describe the pain in his or her own words without offering clues. For example, the nurse asks the patient to describe what the pain feels like. The nurse must give the patient sufficient time to describe the pain, and the nurse must record all words in the answer. If the patient cannot describe the quality of the pain, the nurse can suggest words such as burning, aching, throbbing, or stabbing. It is important to document the exact words used by the patient to describe the pain and which words were suggested by the nurse conducting the assessment.

### Personal Meaning

Pain means different things to different people; as a result, patients experience pain differently. The meaning of the pain experience helps the clinician understand how the patient is affected and assists in planning treatment. It is important to ask how the pain affects the person's daily life. Some people with pain can continue to work or study, whereas others may be disabled by their pain, thus affecting their financial situation. For some patients, the recurrence of pain may mean worsening of disease, such as the spread of cancer.

### Aggravating and Alleviating Factors

The nurse asks the patient what, if anything, makes the pain worse and what makes it better and asks specifically about the relationship between activity and pain. This helps detect factors associated with pain. For example, in a patient with advanced metastatic cancer, pain with coughing may signal spinal cord compression. The nurse ascertains whether environmental factors influence pain because they may easily be changed to help the patient. For example, making the room warmer may help a patient relax and may decrease the person's pain. Finally, the nurse asks the patient whether the pain is influenced by or affects the quality of sleep or anxiety. Both can significantly affect pain intensity and the quality of life.

Knowledge of alleviating factors assists the nurse in developing a treatment plan. Therefore, it is important to ask about the patient's use of medications (prescribed and over-the-counter [OTC]), including amount and frequency. In addition, the nurse asks if herbal remedies, nonpharmacologic interventions, or alternative therapies have been used and whether or not they were successful. This information assists the nurse in determining teaching needs.

### Pain Behaviors

When experiencing pain, people express pain through many different behaviors. Nonverbal and behavioral expressions of pain are not consistent or reliable indicators of the quality or intensity of pain, and they should not be used to determine the presence of or the severity of pain experienced. A patient may grimace, cry, rub the affected area, guard the affected area, or immobilize it. Others may moan, groan, grunt, or sigh. Not all patients exhibit the same behaviors, and there may be different meanings associated with the same behavior.

Sometimes in nonverbal patients, pain behaviors are used as a proxy to assess pain. It is unwise to make judgments and formulate treatment plans based on behaviors that may or may not indicate pain. In unconscious patients, pain should be assumed to be present and treated (Robinson, Vollmer,

Jirka, et al., 2008). All patients have a right to adequate pain management.

Physiologic responses to pain, such as tachycardia, hypertension, tachypnea, pallor, diaphoresis, mydriasis, hypervigilance, and increased muscle tone, are related to stimulation of the autonomic nervous system. These responses are short-lived as the body adapts to the stress. These physiologic signs could be the result of a change in the patient's condition, such as the onset of hypovolemia. Use of physiologic signs to indicate pain is unreliable. Although it is important to observe for any and all pain behaviors, the absence of these behaviors does not indicate an absence of pain.

## *Instruments for Assessing the Perception of Pain*

Only the patient can accurately describe and assess his or her pain. Clinicians consistently underestimate patients' levels of pain. Therefore, a number of pain assessment tools have been developed to assist in the assessment of the patient's perception of pain. Such tools may be used to document the need for intervention, to evaluate the effectiveness of the intervention, and to identify the need for alternative or additional interventions if the initial intervention is ineffective in relieving the pain. For a pain assessment tool to be useful, it must require little effort on the part of the patient, be easy to understand and use, be easily scored, and be sensitive to small changes in the characteristic being measured.

### Visual Analogue Scales and Other Intensity Scales

Visual analogue scales (VASs) are useful in assessing the intensity of pain (Fig. 13-3). One version of the scale includes a horizontal 10-cm line with anchors (ends) indicating the extremes of pain. The patient is asked to place a mark indicating where the current pain lies on the line. The left anchor usually represents "none" or "no pain," whereas the right anchor usually represents "severe" or "worst possible pain." To score the results, a ruler is placed along the line, and the distance the patient marked from the left or low end is measured and reported in millimeters or centimeters.

Some patients (eg, children, elderly patients, visually or cognitively impaired patients) may find it difficult to use an unmarked VAS. In those circumstances, ordinal scales, such as a simple descriptive pain intensity scale or a 0-to-10 numeric pain intensity scale, may be used (see Fig. 13-3).

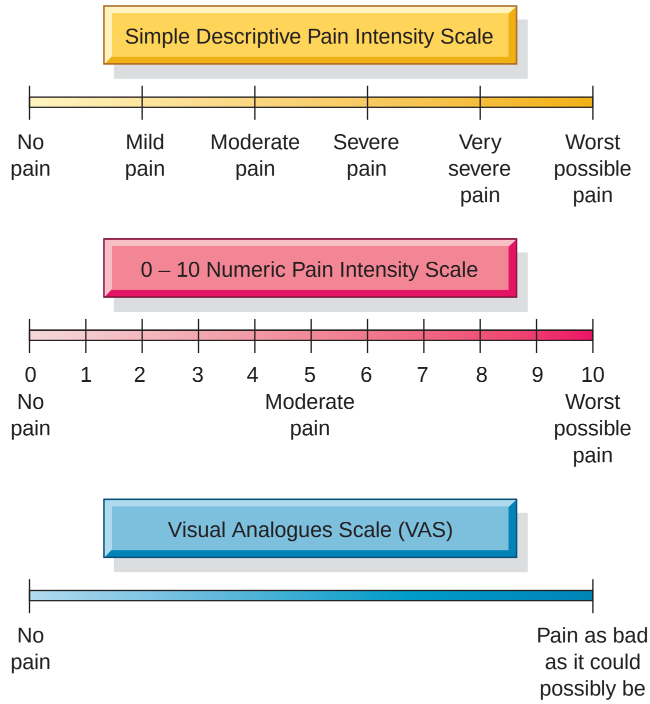



**Figure 13-3** Examples of pain intensity scales.

### Faces Pain Scale–Revised

This instrument has six faces depicting expressions that range from contented to obvious distress (Fig. 13-4). The patient is asked to point to the face that most closely resembles the intensity of his or her pain.

### Using Pain Assessment Scales

Using a written scale to assess pain may not be possible if a person is seriously ill, is in severe pain, or has just returned from surgery. In these cases, the nurse can ask the patient, "On a scale of 0 to 10, 0 being no pain and 10 being pain as bad as it can be, how bad is your pain now?" For patients who have difficulty with a 0-to-10 scale, a 0-to-5 scale may be tried. Whichever scale is used, it should be used consistently. Ideally, the nurse teaches the patient how to use the pain scale before the pain occurs (eg, before surgery). The

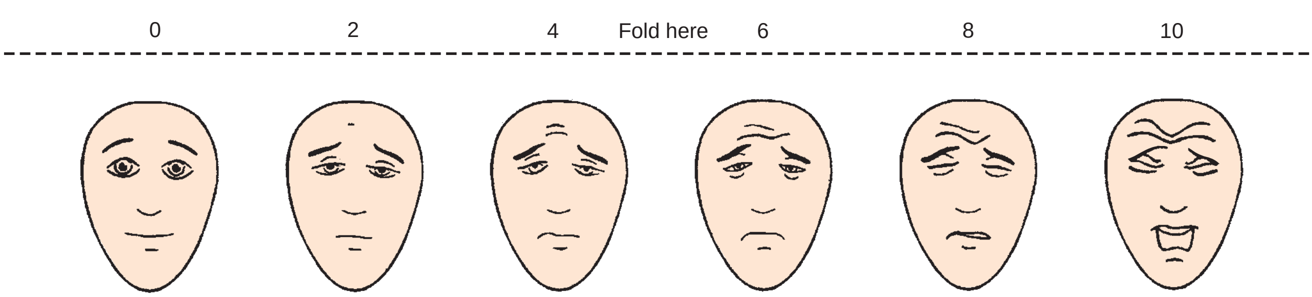



**Figure 13-4** Faces Pain Scale–Revised. This pain scale is especially suited for helping children describe pain. Instructions for using this scale follow: "These faces show how much something can hurt. This face (*point to left-most face*) shows *no pain.* The faces show more and more pain (*point to each from left to right*) up to this one (*point to right-most face*). It shows *very much pain.* Point to the face that shows how much you hurt (right now)." Score the chosen face 0, 2, 4, 6, 8, or 10, counting left to right, so 0 = no pain and 10 = very much pain. Do not use words like "happy" or "sad." This scale is intended to measure how children feel inside, not how their face looks. (From the *Pediatric Pain Sourcebook.* Original Copyright © 2001. Used with permission of the International Association for the Study of Pain and the Pain Research Unit, Sydney Children's Hospital, Randwick NSW 2031, Australia.)

patient's numerical rating is documented and used to assess the effectiveness of pain relief interventions.

If a patient does not speak English or cannot clearly communicate information needed to manage pain, an interpreter or translator should be consulted and a method established for pain assessment. Often a chart can be constructed with English words on one side and the foreign language on the other. The patient can then point to the corresponding word to tell the nurse about the pain.

When people with pain are cared for at home by family caregivers or home care nurses, a pain scale may help assess the effectiveness of the interventions if the scale is used before and after the interventions are implemented. The patient and family caregivers can be taught to use a pain scale to assess and manage the patient's pain. Scales that address the location and pattern of pain may be useful in identifying new sources or sites of pain in chronically or terminally ill patients and in monitoring changes in the patient's level of pain. For example, a home care nurse who sees a patient only periodically may benefit from consulting the patient's or family's written record of the pain scores to evaluate how effective the pain management strategies have been over time.

### Guidelines for Assessing Pain in Patients With Disabilities

Alternative forms of communication may be necessary for people with sensory impairments or other disabilities. For people who are blind and who know how to read Braille, pain assessment instruments can be obtained in Braille. In addition, there is now computer software that allows written documents to be scanned and converted into Braille. If these programs are not available, agencies that provide services for people who are blind may be able to assist in developing Braille versions.

For people who are deaf or hard of hearing, outside interpreters (ie, not family members) should be used. Other useful communication strategies may include sign language, written notes, or pictures. When writing notes on a "magic slate" or making written notes, it is necessary to make every effort to guard the patient's privacy and confidentiality. For people with disabilities that result in communication impairment, computer-generated speech may be useful.

## Nursing Care

The role of the nurse in pain management is to perform pain assessment, identify goals for pain management, provide patient teaching, perform physical care, help relieve pain by administering pain-relieving interventions (including both pharmacologic and nonpharmacologic approaches), assess the effectiveness of those interventions, monitor for adverse effects, and serve as an advocate for the patient when the prescribed intervention is ineffective in relieving pain. Figure 13-5 depicts a pathway that can be used at the time of assessment to direct clinical decisions for pain management. Specific pain management strategies are discussed later in the chapter.

### Identifying Goals for Pain Management

The information the nurse obtains from the pain assessment is used to identify goals for managing pain. These goals are shared and validated with the patient. For a few patients, the goal may be complete elimination of the pain. However, this expectation may be unrealistic. Other goals may include a decrease in the intensity, duration, or frequency of pain and a decrease in the negative effects of the pain. For example, pain may have a negative effect by interfering with sleep and thereby hamper recovery from an acute illness or decrease appetite. In such instances, the goals might be to sleep soundly and to take adequate nutrition. Chronic pain may affect the patient's quality of life by interfering with work, interpersonal relationships, or sleep. Therefore, a goal might be to decrease time lost from work, to increase the quality of interpersonal relationships, or to improve the quality of sleep.

To determine the goal, a number of factors are considered. The first factor is the severity of the pain as judged by the patient. The second factor is the anticipated harmful effects of pain. Patients with other serious health issues are at much greater risk for harmful effects of pain than are young, healthy patients. The third factor is the anticipated duration of the pain. In patients with pain from a disease such as cancer, the pain may be prolonged, possibly for the remainder of the patient's life. Therefore, interventions will be needed for some time and should not detract from the patient's quality of life. A different set of interventions is required if the pain is likely to last for only a few days or weeks.

In patients receiving palliative care who had pain when they were conscious, it should be assumed that the pain persists even if the patient cannot communicate. Often family members can be taught what behaviors to look for to assess for pain (eg, a furrowed brow, stiffening of a part of the body, or moaning).

The goals for the patient may be accomplished by pharmacologic or nonpharmacologic means, but most success is achieved with a combination of these methods. In the acute stages of illness, the patient may be unable to participate actively in relief measures, but when sufficient mental and physical energy is present, the patient may learn self-management techniques to relieve the pain. Therefore, as the patient progresses through the stages of recovery, increased patient use of self-management pain relief measures may be a goal.

### Establishing the Nurse–Patient Relationship and Teaching

A positive nurse–patient relationship and teaching are key to caring for patients with pain, because open communication and patient cooperation are essential to success. A positive nurse–patient relationship characterized by trust is essential. By acknowledging that the patient has pain, the nurse often helps reduce the patient's anxiety. Occasionally, a patient who fears that no one believes that he or she has pain feels relieved to know that the nurse can be trusted to believe that the pain exists.

Teaching is equally important, because the patient or family may be responsible for managing the pain at home and preventing or managing side effects. Teaching the patient about pain and strategies to relieve it may reduce pain in the absence of other pain relief measures and may enhance the effectiveness of the pain relief measures used.

The nurse also provides information by explaining how pain can be controlled. For example, the patient should be informed that pain should be reported in the early stages.

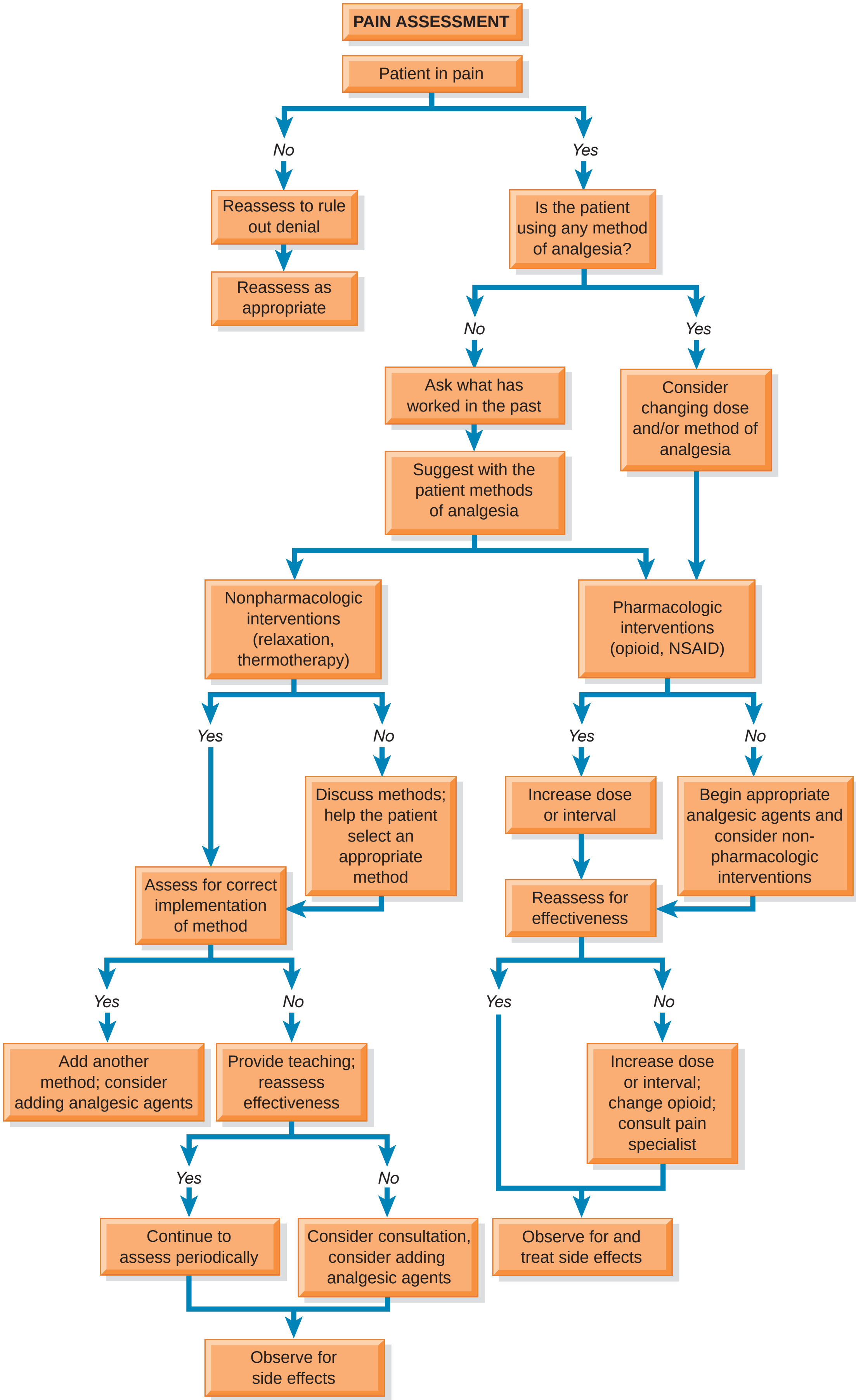



**Figure 13-5** Pain assessment pathway. NSAID, nonsteroidal anti-inflammatory drug.

When the patient waits too long to report pain, **sensitization** may occur, and the pain may be so intense that it is difficult to relieve. The phenomenon of sensitization is important in effective pain management. A heightened response is seen after exposure to a noxious stimulus; as a result, the response to that stimulus is greater, causing the person to feel more pain. When health care providers assess and treat pain before it becomes severe, sensitization is diminished or avoided, and less medication is needed.

#### Providing Physical Care

Patients in pain may be unable to participate in the usual activities of daily living or to perform usual self-care and may need assistance to carry out these activities. Patients are usually more comfortable when physical and self-care needs have been met and efforts have been made to ensure as comfortable a position as possible. A fresh gown and change of bed linens, along with efforts to make the person feel refreshed (eg, brushing teeth, combing hair), often increase the level of comfort and improve the effectiveness of the pain relief measures.

In acute, long-term, and home settings, the nurse who provides physical care to patients also has the opportunity to perform complete assessments and to identify problems that may contribute to the patient's discomfort and pain. Appropriate and gentle physical touch during care may be reassuring and comforting. If topical treatments such as fentanyl (an opioid analgesic) patches or intravenous (IV) or intraspinal catheters are used, the skin around the patch or catheter should be assessed for integrity during physical care.

#### Managing Anxiety Related to Pain

Anxiety may affect the patient's response to pain. A patient who anticipates pain may become increasingly anxious. Teaching the patient about the nature of the impending painful experience and the ways to reduce pain often decreases anxiety; people who experience pain use previously learned strategies to reduce anxiety and pain. Learning about measures to relieve pain may lessen the threat of pain and give the patient a sense of control. The patient's anxiety may be reduced by explanations that point out the degree of pain relief that can be expected from each measure. For example, a patient who is informed that an intervention may not eliminate pain completely is less likely to become anxious when a certain amount of pain persists.

A patient who is anxious about pain may be less tolerant of the pain, which in turn may increase his or her anxiety level. To prevent the pain and anxiety from escalating, the anxiety-producing cycle must be interrupted. Pain relief measures should be used before pain becomes severe. Many patients believe that they should not request pain relief measures until they cannot tolerate the pain, making it difficult for medications to provide relief. It is important to explain to all patients that pain relief or control is more successful if such measures begin before the pain becomes unbearable.

## Pain Management Strategies

Reducing pain to a "tolerable" level was once considered the goal of pain management. However, even patients who have described pain relief as adequate often report disturbed sleep and marked distress because of pain. In view of the harmful effects of pain and inadequate pain management, the goal of tolerable pain has been replaced by the goal of relieving the pain. Pain management strategies include both pharmacologic and nonpharmacologic approaches. These approaches are selected on the basis of the requirements and goals of particular patients. Chart 13-4 provides a discussion of pain management for patients at the end of life. Appropriate analgesic medications are used as prescribed. They are not considered a last resort to be used only when other pain relief measures fail. As previously discussed, any intervention is most successful if it is initiated before pain sensitization occurs, and the greatest success is usually achieved if several interventions are applied simultaneously.

## PHARMACOLOGIC INTERVENTIONS

Pharmacologic management of pain is accomplished in collaboration with physicians, patients, and often families. A physician or nurse practitioner prescribes specific medications for pain or may insert an IV line for administration of analgesic medications. Alternatively, an anesthesiologist or nurse anesthetist may insert an epidural catheter for administration of such analgesic agents. However, it is the nurse who maintains the analgesia, assesses its effectiveness, and reports whether the intervention is ineffective or produces side effects.

Close collaboration and effective communication among health care providers are necessary. In the home setting, the family often manages the patient's pain and assesses the effectiveness of pharmacologic interventions, and the home care nurse evaluates the adequacy of pain relief strategies and the ability of the family to manage the pain. Home care nurses reinforce teaching and ensure communication among patients, family care providers, physicians, pharmacists, and other health care providers involved in the care of patients.

### Premedication Assessment

Before administering any medication, the nurse should ask the patient about allergies to medications and the nature of any previous allergic responses. True allergic or anaphylactic responses to opioids are rare, but it is not uncommon for patients to report an allergy to one of the opioids. On further questioning, the nurse often learns that the extent of the allergy is "itching" or "nausea and vomiting." These responses are not allergies; rather, they are side effects that can be managed while the patient's pain is relieved. The patient's description of responses or reactions should be documented and reported before medication is administered.

The nurse obtains the patient's medication history (eg, current, usual, or recent use of prescription or OTC medications or herbal agents), along with a history of health disorders. Certain medications, herbal agents, or conditions may affect the analgesic medication's effectiveness or its metabolism and excretion or may produce adverse interactions (Table 13-1). Before administering analgesic agents, the nurse should assess the patient's pain status, including the intensity of current pain, changes in pain intensity after the previous dose of medication, and side effects of the medication.

It is also critical to assess the patient's ethnic and racial background, because there appears to be a higher frequency

## Chart 13-4 • *Pain at the End of Life*

Pain is one of the most feared symptoms at the end of life. Many patients experience pain as a terminal illness progresses. The inadequate treatment of cancer pain has been well documented. In the classic Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) (1995), investigators noted that nearly 40% of severely chronically ill and older patients who died in hospitals suffered moderate to severe pain in the last 3 days of life. The suffering caused by unrelieved pain touches all aspects of quality of life (activity, appetite, sleep) and can weaken an already fatigued person. Unrelieved pain can create anxiety and depression, negatively affect relationships, and promote thoughts of suicide.

The Joint Commission's pain standards issued in January 2001 present a unique opportunity to improve care for hospitalized patients. Even though hospices and palliative care agencies are not subject to review by the Joint Commission, many patients with chronic illness who are receiving palliative care may be hospitalized at various times. The standards emphasize pain assessment, patient and family education, continuity of care for symptom management, and evaluation of interventions.

### Barriers to Pain Management

Current barriers to pain management include lack of education, lack of access to opioids, fear of addiction, and legal issues.

#### Lack of Education

Strategies to increase health care professionals' knowledge about pain, pain assessment, and pain management in general and at the end of life are needed to ensure that a patient's pain is effectively addressed. Many studies have increased what is known about pain and pain management. However, the information from these studies must be disseminated to health care providers to be translated into evidence-based practice. Health care professionals, including nurses, must remain current about the pharmacokinetics and pharmacodynamics of analgesic agents and about new technologies to deliver analgesic medications. Continuing education (CE) can be obtained through conferences, journal articles, and online programs. Studies are needed to evaluate the effect that educational interventions have on health care providers' knowledge about pain and their ability to manage pain effectively (Gunnarsdottir, Donovan & Ward, 2003).

#### Accessibility of Opioids

The lack of access to opioids is another barrier to adequate pain relief. Patients may have difficulty affording medications. Some pharmacists, fearing crime, paperwork, and regulatory oversight, may not stock opioids or may keep limited quantities on hand. Some insurance companies limit the types of medications they will reimburse and the amount and frequency of renewal of analgesics.

#### Addiction Fears

The fear of addiction plays a role even at the end of life. Family members may be hesitant to assist the patient in pain management for fear of the social stigma of addiction. This causes needless pain and suffering. Some health care providers continue to have unfounded fears of contributing to a patient's risk for addiction when administering opioids.

#### Legal Barriers

Legislative issues play a role in the inadequate management of pain. Many states are enacting intractable pain statutes to reduce physicians' fear of civil or criminal liability or disciplinary action for aggressively managing pain. The tracking system by the Drug Enforcement Agency, however, acts as a deterrent since opioids prescribed by physicians can be tracked. Some physicians fear that prescribing "too many" opioids could be interpreted as treating an addicted patient.

#### Other Issues Related to Pain Management

Pain management at the end of life requires comprehensive pain assessment and pain management, even though assessment may be hampered by confusion, delirium, or unconsciousness. Caregivers are taught to observe for signs of restlessness or facial expressions as a "proxy" indicator of pain.

Analgesic agents should be titrated to find the most effective dose and the best-tolerated route. The nurse and family members should assess the effectiveness of the current pain therapy. If the pain is not relieved, a larger dose of medication may be necessary. If the pain continues, another medication may be needed or the patient should be given a different analgesic agent. This process requires frequent assessment to effectively manage pain. The analgesic agent or treatment should be appropriate for the type of pain. For example, neuropathic pain, usually described as burning, tingling, numbness, shooting, stabbing, or electric, requires a different treatment approach than acute pain.

Nonpharmacologic approaches, such as guided imagery and relaxation, can be used to decrease pain and help the patient cope. Careful patient positioning and environmental control are other methods to increase patient comfort.

Respiratory depression should be assessed because, over time, the patient's risk for this side effect increases. The rate, depth, and level of consciousness should be monitored to determine whether respiratory depression is occurring and requires treatment. A respiratory rate of 6/min or greater is usually adequate. If respiratory depression occurs, a decrease in the opioid dose may be indicated. Frequent stimulation to encourage deep breathing may be required until the opioid is metabolized. In the last few days of life, the patient may become restless, which is an indicator of pain. The need to increase the opioid to provide pain relief and the respiratory effects of opioids are considered in decision making. However, comfort should be a priority in the case of a person who clearly is at the end of life.

Side effects from analgesics must be managed. A careful bowel regimen involving diet, bowel stimulants, stool softeners, and/or osmotic agents must be instituted to prevent constipation. Vigilance in the assessment, management, and treatment of other side effects is similar to that included in previous discussions.

Careful assessment and management of pain at the end of life can make a "good" death possible by helping patients realize the goal of adequate pain relief throughout the dying process.

**Table 13-1 ADVERSE INTERACTIONS OF HERBAL SUBSTANCES OR FOODS WITH ANALGESIC AGENTS**

| Analgesic Agent | Herb or Food | Effect |
|---|---|---|
| NSAIDs | Ginkgo, garlic, ginger, bilberry, dongquai, feverfew, ginseng, turmeric, meadowsweet, willow | Enhanced risk for bleeding |
| Acetaminophen | Ginkgo and possibly some of the above-mentioned herbs | Enhanced risk for bleeding |
| | Echinacea, kava, willow, meadowsweet | Increased potential for hepatotoxicity and nephrotoxicity |
| Opioids | Valerian, kava, chamomile | Increased central nervous system depression |
| | Ginseng | Inhibits analgesic effects |
| Alfentanil, fentanyl, sufentanil | Grapefruit juice | Inhibits the cytochrome P450 3A4 enzyme in the liver, blocking metabolism of the drug |

NSAID, nonsteroidal anti-inflammatory drugs.
From Abebe, W. (2002). Herbal medication: Potential for adverse interactions with analgesic drugs. *Journal of Clinical Pharmacologic Therapies, 27*(6), 391–401; and Karch, A. (2004). The grapefruit challenge. *American Journal of Nursing, 104*(12), 33–35.

of poor drug metabolizers among Caucasian people compared with Asian American and African American people. Genetic factors play a role in the varied responses to nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids seen in patients (Desmeules, Piguet, Ehret, et al., 2004). The most extensively studied genetic variation in humans is in the metabolism of codeine. Drug metabolism involves genetically controlled enzyme activity for absorption, distribution, inactivation, and excretion. In both experimental and clinical pain, a polymorphism (deoxyribonucleic acid [DNA] proteins with variant alleles) in CYP2D6 (encoding cytochrome P450) results both in poor metabolism and poor analgesic efficacy. People who are "poor metabolizers" do not demethylate codeine to morphine; therefore, they do not experience its analgesic effects. See Chapter 9 for further discussion of genetics.

## Agents Used to Treat Pain

The three general categories of analgesic agents are **opioids,** NSAIDs, and local anesthetics. These agents work by different mechanisms. Other adjunctive agents such as antidepressant and anticonvulsant medications may also be used.

### *Opioid Analgesic Agents*

The goal of administering opioids is to relieve pain and improve quality of life; therefore, the route, dose, and frequency of administration are determined on an individual basis. Factors that are considered in determining the route, dose, and frequency of medication include the characteristics of the pain (eg, its expected duration and severity), the overall status of the patient, the patient's response to analgesic medications, and the patient's report of pain. Opioids can be administered by various routes—oral, IV, subcutaneous, intraspinal, intranasal, rectal, and transdermal. Although the oral route is usually preferred for opioid administration, oral opioids must be given frequently enough and in large enough doses to be effective. Opioid analgesic agents given orally may provide a more consistent serum level than those given intramuscularly.

#### Adverse Effects

With the administration of opioids by any route, side effects must be considered and anticipated. Clinicians who take steps to minimize the side effects increase the likelihood that the patient will receive adequate pain relief without interrupting therapy to treat the effects.

***Respiratory Depression and Sedation.*** Respiratory depression is the most serious adverse effect of opioid analgesic agents administered by IV, subcutaneous, or epidural routes. However, it is relatively rare because doses administered through these routes are small, and tolerance to respiratory depressant effects increases if the dose is increased slowly. The risk of respiratory depression increases with age and with the concomitant use of other opioids or other CNS depressant medications. The risk of respiratory depression also increases when the epidural catheter is placed in the thoracic area and when the intra-abdominal or intrathoracic pressure is increased.

A patient who receives opioids by any route must be assessed frequently for changes in respiratory status. Specific notable changes are shallow respirations and decreasing respiratory rate. Despite the risks associated with their use, IV and epidural opioids are considered safe, with the risks related to epidural administration no greater than those related to IV or other systemic routes of administration. Sedation, which may occur with any method of administering opioids, is likely to occur when opioid doses are increased. However, patients often develop tolerance quickly, so that in a short time they are no longer sedated by the dose that initially caused sedation. Increasing the time between doses or reducing the dose temporarily, as prescribed, usually prevents deep sedation from occurring. Patients at risk for sedation must be monitored closely for changes in respiratory status. Patients are also at risk for problems associated with sedation and immobility. The nurse must initiate strategies to prevent complications such as pressure ulcers.

***Nausea and Vomiting.*** Nausea and vomiting may occur with opioid use. Usually these effects occur some hours after the initial injection. Patients, especially postoperative patients, may not think to tell the nurse that they are nauseated, particularly if the nausea is mild. However, a patient receiving opioids should be assessed for nausea and vomiting, which may be triggered by a position change and may be prevented by having the patient change positions slowly. Adequate hydration and the administration of antiemetic agents may also decrease the incidence of nausea. Opioid-induced nausea and vomiting often subside within a few days.

***Constipation.*** Constipation, a common side effect of opioid use, may become so severe that the patient is forced to choose between relief of pain and relief of constipation. This situation can occur in patients after surgery and in patients receiving large doses of opioids to treat cancer-related pain. Preventing constipation must be a high priority in all patients receiving opioids. Whenever a patient receives opioids, a bowel regimen should begin at the same time. Tolerance to this side effect does not occur; rather, constipation persists even with long-term use of opioids.

Several strategies may help prevent and treat opioid-related constipation. Mild laxatives and a high intake of fluid and fiber may be effective in managing mild constipation. Unless contraindicated, a mild laxative and a stool softener should be administered on a regular schedule. However, continued severe constipation often requires the use of a stimulating cathartic agent, such as senna derivatives (Senokot) or bisacodyl (Dulcolax). If oral agents fail, rectal suppositories may be used. Two new agents, alvimopan (Entereg) and methylnaltrexone (Relistor), appear promising for patients with severe opioid-induced constipation because they work as antagonistic agents on the peripheral opioid receptors in the bowel to counteract opioid-induced delays in gastrointestinal motility. These medications do not reverse the analgesic effects of the opioids (Thomas, 2008).

***Pruritus.*** When asked about drug allergies, patients with previous hospital experience (especially for surgery) may report that they are "allergic" to morphine. This report should be thoroughly investigated. Commonly, this "allergy" is described as itching only. Pruritus (itching) is a frequent side effect of opioids administered by any route, but it is not an allergic reaction. It can be relieved by administering prescribed antihistamines. Epidurally administered opioids may also cause urinary retention. The patient should be monitored and may require urinary catheterization. Small doses of naloxone (Narcan) may be prescribed to relieve these problems in patients who are receiving epidural opioids for the relief of acute postoperative pain.

### Opioid Use With Selected Conditions and Medications

A number of factors may influence the safety and effectiveness of opioid administration. Opioid analgesic agents are primarily metabolized by the liver and excreted by the kidney. Therefore, metabolism and excretion of analgesic medications are impaired in patients with liver or kidney disease, increasing the risk of cumulative or toxic effects. In addition, normeperidine, a metabolite of meperidine (Demerol), may rapidly or unexpectedly accumulate to toxic levels. This is more likely to occur in patients with impaired kidney function and may result in seizures in susceptible patients. Many institutions no longer stock meperidine because of the risks associated with the metabolite normeperidine and because many physicians do not prescribe a high enough dose for it to be effective.

Patients with untreated hypothyroidism are more susceptible to the analgesic effects and side effects of opioids. In contrast, patients with hyperthyroidism may require larger doses for pain relief. Patients with a decreased respiratory reserve from disease or aging may be more susceptible to the depressant effects of opioids and must be carefully monitored for respiratory depression.

Patients who are dehydrated are at increased risk for the hypotensive effects of opioids. Patients who become hypotensive after the administration of an opioid should be kept recumbent and rehydrated unless fluids are contraindicated. Patients who are dehydrated are also more likely to experience nausea and vomiting with opioid use. Rehydration usually relieves these symptoms.

Patients receiving certain other medications, such as monoamine oxidase inhibitors, phenothiazines, or tricyclic antidepressants, may have an exaggerated response to the depressant effects of opioids. Patients taking these medications should receive small doses of opioids and must be monitored closely. Continued pain in these patients indicates that a therapeutic level of the analgesic has not been achieved. Patients must be monitored for sedation even if an analgesic effect has not been obtained.

### Inadequate Pain Relief

One factor commonly associated with ineffective pain relief is an inadequate dose of opioid. This is most likely to occur when the caregiver underestimates the patient's pain or fails to consider differences in absorption and action after a change in the route of administration. Consequently, the patient receives doses that are too small to be effective and, possibly, too infrequent to relieve pain. For example, if opioid delivery is changed from the IV route to the oral route, the oral dose must be approximately three times greater than that given parenterally to provide relief. Because of differences in absorption of orally administered opioids among individuals, patients must be assessed carefully to ensure that the pain is relieved (Chart 13-5).

Effects of opioid analgesic medications must be monitored, especially when the first dose is given or when the

**CHART 13-5** *Ethics and Related Issues*

#### Inadequate Pain Management

**Situation**

When taking over the care of ethnic minority patients at the change of shift from a particular colleague, you usually find these patients to be in a great deal of postoperative pain. Your nonsystematic observations have led you to conclude that these patients receive only a small portion of the analgesia prescribed for them. You have heard a nurse colleague state a belief that people of certain ethnic groups have "no pain tolerance" and are "just looking for drugs."

**Dilemma**

Racial biases are difficult to deal with and change. To confront this nurse may not alter the behavior but will certainly disrupt the working relationships on the unit. It would be easier to look the other way. On the other hand, you believe that the nurse is giving inadequate and unethical care to selected patients and placing them at greater risk for postoperative complications.

**Discussion**

- What information would you need to collect before acting?
- From whom could you seek counsel?
- Are the two aspects of the dilemma equally important?

dose is changed or given more frequently. The time, date, patient's pain rating (scale of 0 to 10), analgesic agent, other pain relief measures, side effects, and patient activity are recorded. For example, when the first dose of an analgesic is administered, the nurse should record a pain rating score, blood pressure, and respiratory and pulse rates (all of which are considered "vital signs"). If the pain has not decreased in 30 minutes (sooner if an IV route is used) and the patient is reasonably alert and has a satisfactory respiratory status, blood pressure, and pulse rate, then some change in analgesia is indicated. Although the dose of analgesic medication is safe for this patient, it is ineffective in relieving the pain. Therefore, another dose of medication may be indicated. In such instances, the nurse consults with the physician to determine what further action is warranted.

Table 13-2 lists opioids and dosages that are equivalent to morphine. It serves only as a guide; the doses listed are not necessarily the most appropriate doses for all patients.

**Table 13-2 SELECTED OPIOID ANALGESIC AGENTS COMMONLY USED FOR MODERATE AND SEVERE PAIN IN ADULTS**

| | Starting Dose (milligrams) | | | |
|---|---|---|---|---|
| **Name** | **Moderate Pain** | **Severe Pain** | **Comments** | **Precautions and Contraindications** |
| Morphine | — | 30–60 (oral)<br>10 (parenteral) | Acts as an agonist at specific opioid receptors in the CNS to produce analgesia, euphoria, and sedation. | Use with caution, especially in elderly patients, very ill patients, and those with respiratory impairment. Major risks include respiratory depression, apnea, circulatory depression, and respiratory arrest, shock, and cardiac arrest. Obtain history of hypersensitivity to opioids. Monitor patient closely. If prescribed in correct dose, oral preparations (MS Contin) are effective in treating moderate and severe pain. |
| Codeine | 15–30 (oral) | 60 (oral) up to 360/24 h | Acts as an agonist at specific opioid receptors in the CNS to produce analgesia, euphoria, and sedation. Is also an antitussive. 10% of people lack the enzyme needed to make codeine active. Codeine may cause more nausea and constipation per unit of analgesia than other mu agonist opioids. | Many preparations of codeine and the other opioids in this table are combinations with nonopioid analgesic agents. Caution must be used in patients with impaired ventilation, bronchial asthma, increased intracranial pressure, or impaired liver function and in elderly and very ill patients. |
| Oxycodone (OxyContin) | 5 (oral) | 10–20 (oral) | Acts as an agonist at specific opioid receptors in the CNS to produce analgesia, euphoria, and sedation. | Caution must be used in patients with impaired ventilation, bronchial asthma, increased intracranial pressure, or impaired liver function and in elderly and very ill patients. |
| Meperidine (Demerol) | 50 (oral) | 300 (oral)<br>75 (parenteral) | Acts as an agonist at specific opioid receptors in the CNS to produce analgesia, euphoria, and sedation. Shorter acting than morphine. Meperidine is biotransformed to normeperidine, a toxic metabolite. | Normeperidine, a toxic metabolic of meperidine, accumulates with repetitive dosing, causing CNS excitation. High risk for seizures. Should be avoided in patients with impaired renal function who are receiving MAO inhibitors. Is irritating to tissues with repeated intramuscular injections. Chronic use should be avoided. Should not be used for more than 1 or 2 days. |
| Propoxyphene (Darvon) | 65–130 (oral) | — | Weak analgesic; acts as an agonist at specific opioid receptors in the CNS to produce analgesia, euphoria, and sedation. Many preparations include nonopioid analgesic agents; biotransformed to potentially toxic metabolite (norpropoxphene). | Accumulation of propoxyphene and toxic metabolites occurs with repetitive dosing. Overdose is complicated by seizures. Propoxyphene is not recommended for older adults or patients with renal impairment. |
| Hydrocodone (Vicodin) | 5–10 (oral) | — | — | Most preparations are combined with nonopioid analgesic agents. |
| Tramadol (Ultram) | 50–100 (oral) | — | Unique mechanism; analgesia results from the synergy of two mechanisms. Maximum dose is 400 mg/day. | Most common side effects are dizziness, nausea, constipation, and somnolence. Lowers seizure threshold. |

CNS, central nervous system; MAO, monoamine oxidase.

Adapted from American Pain Society. (2003). *Principles of analgesic use in the treatment of acute pain and cancer pain* (5th ed.). Glenview, IL: American Pain Society; and Karch, A. M. (2005). *Lippincott's nursing drug guide*. Philadelphia: Lippincott Williams & Wilkins.

However, the table does give clinicians some idea of equivalency between two different opioids. After administering the first dose of an opioid, clinicians should conduct a complete pain assessment to determine the efficacy of that dose. In general, no recalculation needs to be done when changing from one brand of an agent to another brand of the same medication, with the exception of extended-release oral morphine. Currently, four brands of extended-release morphine (Avinza, MS Contin, Oramorph, and Kadian) are commonly used by patients with cancer. Although these agents come in the same dosage form and contain the same drug, they are not therapeutically equivalent because they use different release mechanisms. Patients who need to change brands should be monitored carefully both for overdose and for inadequate pain relief.

#### Tolerance and Addiction

There is no maximum safe dosage of opioids, nor is there any easily identifiable therapeutic serum level. Both the maximal safe dosage and the therapeutic serum level are relative and individual. **Tolerance** (the need for increasing doses of opioids to achieve the same therapeutic effect) develops in almost all patients taking opioids for extended periods. Patients requiring opioids over a long term, especially patients with cancer, need increasing doses to relieve pain. After the first few weeks of therapy, their dosing requirements usually level off. Patients who become tolerant to the analgesic effects of large doses of morphine may obtain pain relief by changing to a different opioid. Symptoms of physical dependence may occur when the opioids are discontinued; dependence often occurs with opioid tolerance and does not indicate an addiction.

> *NURSING ALERT*
>
> **Although patients may need increasing levels of opioids, they are not addicted. Physical tolerance usually occurs in the absence of addiction. Tolerance to opioids is common and becomes a problem primarily in terms of delivering or administering the medication (eg, how to administer very large doses of morphine to a patient). On the other hand, addiction is rare and should not be the primary concern of nurses caring for patients in pain.**

**Addiction** is a behavioral pattern of substance use characterized by a compulsion to take the substance (drug or alcohol) primarily to experience its psychic effects. Fear that patients will become addicted or dependent on opioids has contributed to inadequate treatment of pain. This fear may be expressed by health care providers as well as patients and their families and results from lack of knowledge about the low risk of addiction.

Addiction after therapeutic opioid administration is so negligible that it should not be a consideration when caring for patients in pain. Therefore, patients and health care providers should be dissuaded from withholding opioid analgesics because of concerns about addiction.

When caring for people with a known history of addiction, nurses should consider that each individual person has the right to be treated for pain. The American Society for Pain Management Nursing (2005) developed a position paper on pain management of patients with addictive disease. It stressed education, communication about methods for pain management, and methods to safely discontinue opioids in this patient population. The opioids should be tapered slowly to prevent withdrawal symptoms.

### *Nonsteroidal Anti-inflammatory Drugs*

NSAIDs are thought to decrease pain by inhibiting cyclooxygenase (COX), the enzyme involved in the production of prostaglandin from traumatized or inflamed tissues. There are two types of COX, COX-1, and COX-2.

COX-1 mediates prostaglandin formation involved in the maintenance of physiologic functions, such as gastric mucosal blood flow and platelet aggregation. Inhibition of COX-1 results in gastric ulceration, bleeding, and renal damage.

COX-2 mediates prostaglandin formation that results in symptoms of pain, inflammation, and fever. Therefore, inhibition of COX-2 is desirable. Celecoxib (Celebrex) is the only COX-2 inhibitor that is currently approved by the U.S. Food and Drug Administration (FDA). Several COX-2 inhibitors (rofecoxib [Vioxx], valdecoxib [Bextra]) are no longer available because of their cardiovascular effects.

Ibuprofen (Advil, Motrin), another NSAID, blocks both COX-1 and COX-2, is effective in relieving mild to moderate pain, and has a low incidence of adverse effects. Aspirin, the oldest NSAID, also blocks COX-1 as well as COX-2; however, because it causes frequent and severe side effects, aspirin is infrequently used to treat significant acute or chronic pain.

NSAIDs are very helpful in treating arthritic diseases and may be especially powerful in treating cancer-related bone pain. They have been effectively combined with opioids to treat postoperative and other severe pain. The use of NSAIDs in combination with opioids relieves pain more effectively than opioids alone. In such cases, patients may obtain pain relief with decreased doses of opioid and with fewer side effects. In addition, intraoperative administration of NSAIDs reportedly improves postoperative pain control after abdominal hysterectomy surgery (Krenzischek, Dunwoody, Polomano, et al., 2008). A regimen of a fixed-dose, periodically dosed NSAID (eg, every 4 hours) and a separately administered fluctuating dose of opioid may be effective in managing moderate to severe cancer pain. In more severe pain, the opioid dose is also fixed, with an additional fluctuating dose as needed for **breakthrough pain** (a sudden increase in pain despite the administration of pain-relieving medications). These regimens result in better pain relief with fewer opioid-related side effects (Krenzischek, et al., 2008).

Most patients tolerate NSAIDs well. However, those with impaired kidney function may require a smaller dose and must be monitored closely for side effects. Likewise, these medications should be administered with caution in dehydrated and elderly patients. Patients taking NSAIDs bruise easily because these agents have some anticoagulant effects. Furthermore, NSAIDs may displace other medications, such as warfarin (Coumadin), from receptor sites on plasma proteins and increase their effects. Because, high doses or prolonged use can irritate the stomach and result in

gastrointestinal bleeding, monitoring for gastrointestinal bleeding is indicated (Krenzischek, et al., 2008).

### Local Anesthetic Agents

Local anesthetics work by blocking nerve conduction when applied directly to the nerve fibers. They can be applied directly to the site of injury (eg, a topical anesthetic spray for sunburn) or directly to nerve fibers by injection or at the time of surgery. They can also be administered through an epidural catheter.

Local anesthetic agents have been successful in reducing the pain associated with thoracic or upper abdominal surgery when injected by the surgeon intercostally. Local anesthetic agents are rapidly absorbed into the bloodstream, resulting in decreased availability at the surgical or injury site and an increased anesthetic level in the blood, increasing the risk of toxicity. Therefore, a vasoconstrictive agent (eg, epinephrine or phenylephrine) is added to the anesthetic agent to decrease its systemic absorption and maintain its concentration at the surgical or injury site.

#### Topical Application

A topical anesthetic agent known as eutectic mixture or emulsion of local anesthetics, or EMLA cream, has been effective in preventing the pain associated with invasive procedures such as lumbar puncture or the insertion of IV lines. To be effective, EMLA must be applied to the site 60 to 90 minutes before the procedure.

A lidocaine 5% (Lidoderm) patch can be effective in treating the pain associated with postherpetic neuralgia (Meier, Wasner, Kuntzer, et al., 2003). Currently, this is its only use approved by the FDA. The patch acts locally by targeting damaged nerves responsible for discharging pain impulses. Because the lidocaine 5% patch does not cause sensory block in the area of application, it has a wide margin of safety. The recommended dose is one to three patches at a time applied for 12 hours daily.

#### Intraspinal Administration

Intermittent or continuous administration of local anesthetic agents through an epidural catheter has been used for years to produce anesthesia during surgery. Although the administration of local anesthetic agents in the spinal canal is still largely confined to acute pain, such as postoperative pain and pain associated with labor and delivery, the epidural administration of local anesthetic agents for pain management is increasing.

A local anesthetic agent administered through an epidural catheter is applied directly to the nerve root. The anesthetic agent can be administered continuously in low doses, intermittently on a schedule, or on demand as the patient requires it, and it is often combined with the epidural administration of opioids. Surgical patients treated with this combination experience fewer complications after surgery, ambulate sooner, and have shorter hospital stays than patients who receive standard therapy (Polomano, Rathmell, Krenzischek, et al., 2008).

### Tricyclic Antidepressant Agents and Antiseizure Medications

Pain of neurologic origin (eg, causalgia, tumor impingement on a nerve, postherpetic neuralgia) is difficult to treat and in general is not responsive to opioid therapy. If these pain syndromes are accompanied by dysesthesia (burning or cutting pain), they may be responsive to a tricyclic antidepressant or an antiseizure agent. When indicated, tricyclic antidepressant agents, such as amitriptyline (Elavil) or imipramine (Tofranil), are prescribed in doses considerably smaller than those generally used for depression. Patients need to know that a therapeutic effect may not occur until they have taken the medication for 3 weeks. Antiseizure medications such as phenytoin (Dilantin) or carbamazepine (Tegretol) also are used in doses lower than those prescribed for seizure disorders. Because a variety of medications can be tried, nurses should be familiar with the possible side effects and should teach patients and families how to recognize these effects.

## Approaches for Using Analgesic Agents

Medications are most effective when the dose and interval between doses are individualized to meet the needs of a particular patient. The only safe and effective way to administer analgesic medications is by asking the patient to rate the pain and by observing the response to medications.

### Balanced Analgesia

Pharmacologic interventions are most effective when a multimodal or balanced analgesia approach is used. **Balanced analgesia** refers to the use of more than one form of analgesia concurrently to obtain more pain relief with fewer side effects. These agents work by different mechanisms. Using two or three types of agents simultaneously can maximize pain relief while minimizing the potentially toxic effects of any one agent. When one agent is used alone, it usually must be used in a higher dose to be effective. In other words, although it might require 15 mg of morphine to relieve a certain pain, it may take only 8 mg of morphine plus 30 mg of ketorolac (Toradol, an NSAID) to relieve the same pain.

### Pro Re Nata

In the past, analgesic agents were prescribed *pro re nata* (PRN), or "as needed." The standard practice was for the nurse to wait for the patient to complain of pain and then administer analgesia. As a result, many patients remained in pain because they did not know they needed to ask for medication or waited until the pain became intolerable.

By its very nature, the PRN approach to analgesia leaves patients sedated or in severe pain much of the time. To receive pain relief from an opioid analgesic, the serum level of that opioid must be maintained at a minimum therapeutic level (Fig. 13-6). By the time the patient complains of pain, the serum opioid concentration is below the therapeutic level. From the time the patient requests pain medication until the nurse administers it, the patient's serum levels continue to decrease. The lower the serum opioid level, the more difficult it is to achieve the therapeutic level with the next dose. Using this outdated method, the only way to ensure significant periods of analgesia is to give doses large enough to produce periodic sedation.

### Preventive Approach

The preventive approach to relieving pain by administering analgesic agents is most effective because a therapeutic serum level of medication is maintained. With the preventive

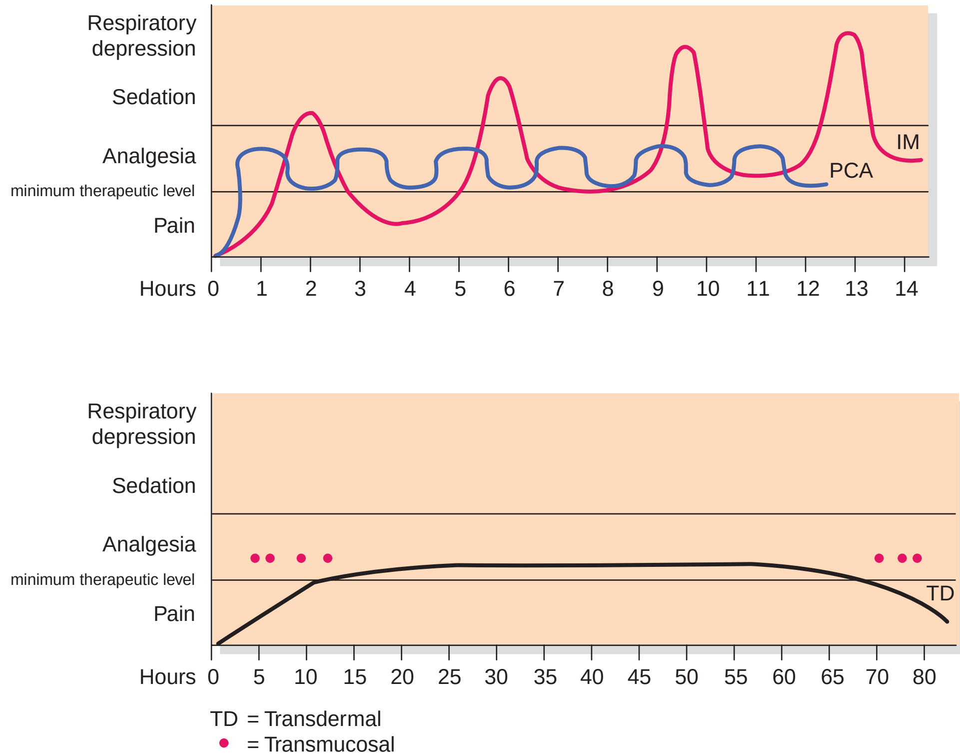



**Figure 13-6** Relationship of mode of delivery of analgesia to serum analgesic level. *Top:* intramuscular (IM) and intravenous patient-controlled analgesia (PCA). *Bottom:* transdermal (TD) and transmucosal (•) delivery.

approach, analgesic agents are administered at set intervals so that the medication acts before the pain becomes severe and before the serum opioid level decreases to a subtherapeutic level.

Administering analgesic medication on a timed basis, rather than on the basis of a patient's report of pain, prevents the serum drug level from falling to subtherapeutic levels. For example, a patient takes prescribed morphine or a prescribed NSAID (eg, ibuprofen) every 4 hours rather than waiting until the pain is severe. If the pain is likely to occur around the clock or for a substantial portion of a 24-hour period, a regular around-the-clock schedule of administering analgesia may be indicated. Even if the analgesic agent is prescribed PRN, it can be administered on a preventive basis before the patient is in severe pain, as long as the prescribed interval between doses is observed. The preventive approach reduces the peaks and troughs in the serum level and provides more pain relief with fewer adverse effects (Chart 13-6).

Smaller doses of medication are needed with the preventive approach, because the pain does not escalate to a level of severe intensity. Therefore, a preventive approach may result in the administration of less medication over a 24-hour period, helping prevent tolerance to analgesic agents and decreasing the severity of side effects (eg, sedation, constipation). Better pain control can be achieved with a preventive approach, reducing the amount of time patients are in pain.

In using the preventive approach, the nurse assesses the patient for sedation before administering the next dose. The goal is to provide analgesia before the pain becomes severe. It is not safe to medicate the patient with opioids repeatedly if the patient is sedated or not in pain. It may be necessary to decrease the dosage of the opioid analgesic medication so that the patient receives pain relief with less sedation.

### *Patient-Controlled Analgesia*

Used to manage postoperative pain as well as persistent pain, **patient-controlled analgesia** (PCA) allows patients to control the administration of their own medication within predetermined safety limits. This approach can be used with oral analgesic agents as well as with continuous infusions of opioid analgesic agents by IV, subcutaneous, or epidural routes. PCA can be used in hospitals or in home settings (Pasero & McCaffery, 2005).

The PCA pump permits the patient to self-administer continuous infusions of medication (basal rates) safely and to administer extra medication (bolus doses) with episodes of increased pain or painful activities. A patient experiencing pain can administer small amounts of medication directly into his or her IV, subcutaneous, or epidural catheter by pressing a button. The pump then delivers a preset amount of medication.

A PCA pump is electronically controlled by a timing device. The timer can be programmed to prevent additional doses from being administered until a specified time period has elapsed (lock-out time) and until the first dose has had time to exert its maximal effect. Even if the patient pushes the button multiple times in rapid succession, no additional doses are released. If another dose is required at the end of the delay period, the button must be pushed again to receive the dose. Patients who are controlling their own opioid administration usually become sedated and stop pushing the button before any significant respiratory depression occurs. Nevertheless, assessment of respiratory status remains a major nursing role.

CHART 13-6

## NURSING RESEARCH PROFILE

### PRN Range Opioid Analgesic Orders

Gordon, D., Pellino, T. A., Higgins, A. G., et al. (2008). Nurses' opinions on appropriate administration of PRN range opioid analgesic orders for acute pain. *Pain Management Nursing, 9*(3), 131–140.

**Purpose**

Opioids are commonly used to treat moderate to severe pain. A common clinical practice is the use of "as-needed" or "PRN" range orders. This type of prescription can cause two sources of confusion, namely, which dose to give within the ordered range and the total time interval in which the maximum dose can be administered. The purpose of this study was to:

1. Determine how much agreement exists among nurses about the timing and dosing of analgesic agents ordered with a PRN range order.
2. Identify respondent characteristics, such as education, years of nursing experience, and attendance at a pain education event, that affect the knowledge and comfort of the nurse in titrating these opioids.
3. Identify factors nurses consider when selecting a dose to administer from a range order.

**Design**

An Internet survey was conducted in one midwestern medical center and a multihospital system. The survey contained 15 questions and took 10 to 15 minutes to complete. It contained four vignettes whereby the respondent was asked what dose of analgesic agent would be chosen and the timing between the doses. E-mail notifications of the survey were sent to the midwestern medical center. The multihospital system did not have individual e-mail accounts for nurses so the researchers posted a message about the survey on the institution's home Web page.

**Findings**

A sample of 602 nurses participated. Forty-one percent of the nurses ($n = 247$) reported no knowledge about an existing policy concerning PRN range orders that could direct their practice. Forty-three percent ($n = 259$) of the respondents had some form of pain education and 2% ($n = 12$) were certified in pain management.

An increase in nurses' comfort level with opioid titration was positively associated with increased experience. Attendance at a pain course was positively associated with higher titration to comfort levels.

The factors nurses considered in opioid administration, in decreasing order of frequency, were sedation level, pain intensity, respiratory rate, and the patient's response to prior dosing. The sedation level of monitoring was chosen first by 56% ($n = 337$) of the respondents. Thus, 44% ($n = 265$) considered sedation levels as of less importance. One quarter of the nurses ($n = 150$) consistently chose responses that would delay or underdose patients. Twenty-one percent of the nurses ($n = 126$) replied that they would give a dose that was less than the prescribed minimum. Because the Internet was used, there is possible bias among the respondents and one cannot generalize the findings to all nurses.

**Nursing Implications**

The authors recommended that nurses closely examine the pharmacokinetics of opioids to understand when they peak and trough. Clearer understanding and communication about range orders between nurses and other health care professionals are needed. Clear, evidence-based guidelines should be established to guide nurses in the titration of PRN doses of opioids.

To initiate PCA or any analgesia used at home or in the hospital, it is important to avoid playing "catch-up." Pain should be brought under control before PCA starts, often by the use of an initial, larger bolus dose or loading dose or by administering repeated bolus doses of an IV opioid over short periods until the pain is relieved. Then, after pain control is achieved, the pump is programmed to deliver small doses of medication at preset intervals. The goal is to achieve a minimum therapeutic level of analgesia and to allow the patient to maintain that level by using the PCA pump. The patient is instructed not to wait until the pain is severe before pushing the button to obtain a bolus dose. The patient is also reminded not to become so distracted by an activity or visitor that he or she forgets to self-administer a prescribed dose of medication. One potential drawback to distraction is that the patient who is using a PCA pump may not self-administer any analgesia during the time of effective distraction. When distraction ends suddenly (eg, a movie ends, visitors leave), the patient may be left without a therapeutic serum opioid level. When intermittent distraction is used for pain relief, a continuous low-level basal infusion of opioid through the PCA pump may be prescribed so that, after the distraction ends, it will not be necessary to try to "catch up."

A continuous infusion plus bolus doses may be effective with patients who have cancer and require large doses of analgesia and with postsurgical patients. Although this allows more uninterrupted sleep, the risk of sedation increases, especially when the patient has minimal or decreasing pain.

Patients who use PCA achieve better pain relief and often require less pain medication than those who are treated in the PRN fashion (Costa & Coleman, 2008). Because the patient can maintain a near-constant level of medication, the periods of severe pain and sedation that occur with the PRN regimen are avoided. If PCA is to be used in the patient's home, the patient and family are taught about the operation of the pump as well as the side effects of the medication and strategies to manage them (Pasero & McCaffery, 2005).

Patients might not be able to activate their PCA pumps and other people may administer their analgesia by PCA pumps, a situation known as "PCA by proxy." The American Society for Pain Management Nursing supports the safe practice of authorized agent-controlled analgesia (AACA), in which the analgesic agent is administered by a proxy who is specially trained. The American Society for Pain Management Nursing does not condone unauthorized dosing by proxy, which increases the risk for potential harm to the patient (Wuhrman, Cooney, Dunwoody, et al., 2007). AACA involves selecting and educating an appropriate person, typically a family member. Health care agencies and

hospitals that promote AACA usually develop policies that stipulate the roles and responsibilities of the prescriber, the nurse, and the caregiver who provides the analgesia via the PCA. The medical order in the chart should note the name of the authorized proxy.

*NURSING ALERT*

**Family members who are not authorized agents are cautioned not to push the button for a patient, especially if the patient is asleep, because this overrides some of the safety features of the PCA system. The nurses retain the responsibility for monitoring the patient.**

## Routes of Administration

The route selected for administration of an analgesic agent depends on the condition of the individual patient and the desired effect of the medication. Analgesic agents can be administered by parenteral, oral, rectal, transdermal, transmucosal, intraspinal, or epidural routes. Each method of administration has advantages and disadvantages. The route chosen should be based on patient need.

### Parenteral Route

Parenteral administration (intramuscular, IV, or subcutaneous) of the analgesic medication produces effects more rapidly than oral administration, but these effects are of shorter duration. Parenteral administration may be indicated if the patient is not permitted oral intake or is vomiting. Medication administered by the intramuscular route enters the bloodstream more slowly than medication given IV and is metabolized slowly. The rate of absorption may be erratic, depending on the site selected and the amount of body fat.

The IV route is the preferred parenteral route in most acute care situations because it is much more comfortable for patients. In addition, peak serum levels and pain relief occur more rapidly and more reliably. Because most analgesic medications peak rapidly (usually within minutes) and are metabolized quickly, an appropriate IV dose is smaller and is prescribed at shorter intervals than an intramuscular dose.

Many commonly prescribed analgesics, including opioids, may be administered by IV push or slow push (eg, over a 5- to 10-minute period) or by continuous infusion with a pump. Continuous infusion provides a steady level of analgesia and is indicated when pain occurs over a 24-hour period, such as after surgery for the first day or two, or in a patient with prolonged pain who cannot tolerate medication by other routes. The dose of analgesic agent is calculated carefully to relieve pain without producing respiratory depression and other side effects.

The subcutaneous route for infusion of opioid analgesic agents is used for patients with severe pain such as cancer pain. In addition, it is particularly useful for patients with limited IV access who cannot take oral medications and for patients who are managing their pain at home. The subcutaneous route is often an effective and convenient way to manage pain, but the dose of opioid that can be infused through this route is limited because of the small volume that can be administered at one time into the subcutaneous tissue.

### Oral Route

Oral administration is preferred over parenteral administration if the patient can tolerate medication by mouth, because it is easy and noninvasive. Severe pain can be relieved with oral opioids if the doses are high enough (see Table 13-2). In terminally ill patients with prolonged pain, doses may be gradually increased as the disease progresses and causes more pain or as the patient develops a tolerance to the medication. If higher doses are increased gradually, they usually provide additional pain relief without producing respiratory depression or sedation. If the route of administration is changed from a parenteral route to the oral route at a dose that is not equivalent in strength (equianalgesic), the smaller oral dose may result in a withdrawal reaction and recurrence of pain.

### Rectal Route

The rectal route may be indicated in patients who cannot take medications by any other route. The rectal route may also be indicated for patients with bleeding problems, such as hemophilia. The onset of action of opioids administered rectally is unclear but is delayed compared with other routes of administration. Similarly, the duration of action is prolonged.

### Transdermal Route

The transdermal route is used to achieve a consistent opioid serum level through absorption of the medication via the skin. It is most often used in the home or hospice care settings for patients with cancer. Transdermal opioids include fentanyl (Duragesic) and buprenorphine (Buprenex), which are marketed as patches consisting of a reservoir containing the medication and a porous membrane.

Fentanyl was the first commercially available transdermal opioid (Chart 13-7). When the fentanyl transdermal system

**Chart 13-7 •** ***Safe Use of Transdermal Fentanyl***

The U.S. Food and Drug Administration issued a public health advisory in 2005 about the use of fentanyl skin patches and warned patients and health care providers about the need for the patches to be used as intended. The advisory also included precautions about safe storage and disposal of fentanyl skin patches:

- Fentanyl skin patches are very strong opioids and should always be prescribed at the lowest dose needed for pain relief. They should be used only for patients with chronic pain that is not well controlled with shorter-acting opioids.
- Patients should be cautioned that a sudden and possibly dangerous rise in the level of fentanyl in their blood can occur with use of alcohol or other medications that affect brain function; an increase in body temperature or exposure to heat; or use of other medicines that affect the metabolism of fentanyl.
- Patients should be informed about signs and symptoms of fentanyl overdose (ie, shallow or difficult breathing; fatigue, extreme sleepiness, or sedation; inability to think, talk, or walk normally; and feeling faint, dizzy, or confused).

is first applied to the skin, fentanyl, which is fat soluble, binds to the skin and fat layers. Then it is slowly and systemically absorbed. Therefore, there is a delay in effect while the dermal layer is being saturated. A drug reservoir actually forms in the upper layer of skin. This results in a slowly rising serum level and a slow tapering of the serum level once the patch is removed (see Fig. 13-6). Because it takes 12 to 24 hours for the fentanyl levels to gradually increase after application of the first patch, the last dose of sustained-release morphine should be administered at the same time the first patch is applied (D'Arcy, 2005a, 2005b; Pasero, 2005). Transdermal fentanyl is associated with slightly less constipation than oral opioids. Absorption is increased in febrile patients. A heating pad should never be applied to the area where the patch is applied. Transdermal fentanyl is much more expensive than sustained-release morphine, but it is less costly than methods that deliver parenteral opioids.

Buprenorphine, another transdermal system, is available in three strengths. It has many of the same advantages as fentanyl and has been shown in limited clinical studies to be associated with a high level of patient adherence and improved quality of life (Poulain, Denier, Douma, et al., 2008).

Once it is determined that switching from other routes of morphine administration to a transdermal system is appropriate, the correct dosage or strength for the patch must be calculated. If the patient uses an opioid other than morphine, conversion to milligrams of oral morphine is the first step. After determining how many milligrams of morphine (or morphine equivalents) the patient has been using over 24 hours, an initial dose of transdermal fentanyl or buprenorphine is calculated (Johnson, Fudala & Payne, 2005). Patients switched from morphine to transdermal patches of either fentanyl or buprenorphine should be assessed not only for pain and potential side effects but also for dependence, reflected by withdrawal symptoms, which may consist of shivering, a feeling of coldness, sweating, headache, and paresthesia (Johnson, et al., 2005). Patients may require short-acting opioids for breakthrough pain before the systemic opioid delivered through the transdermal system reaches a therapeutic level.

*NURSING ALERT*

**Conversion tables available for the transdermal systems should be used only to establish the initial dose of the transdermal fentanyl or buprenorphine when patients switch from oral morphine to the transdermal route of delivery (and not vice versa). If these tables are inappropriately used to determine the dosages of oral morphine for patients who have been receiving transdermal fentanyl or buprenorphine, many patients will not achieve satisfactory analgesia and will require an increase in their opioid dose to treat breakthrough pain.**

*NURSING ALERT*

**If the conversion table or equation is used incorrectly to calculate a morphine dose, there is a risk of overdose. If a patient requires a change from transdermal fentanyl or buprenorphine back to oral or IV morphine (as in the case of surgery), the patch should be removed and IV morphine administered on an as-needed basis. Before a new patch is applied, the patient should be carefully checked for any older, forgotten patches, which should be removed and discarded. Patches should be replaced every 72 hours.**

### Transmucosal Route

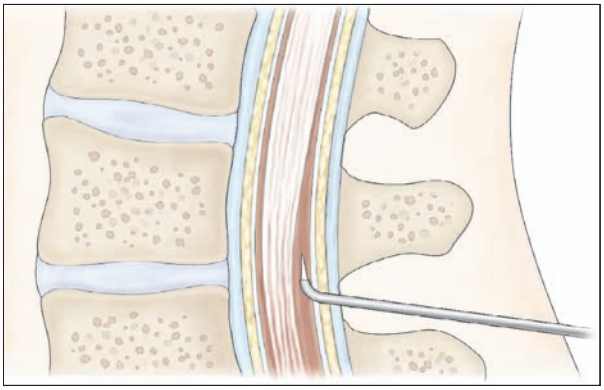
Patients with cancer pain who are being cared for at home may be receiving continuous opioids using sustained-release morphine, hydromorphone, oxycodone, transdermal fentanyl or buprenorphine, or other medications. These patients often experience short episodes of severe pain (eg, after coughing or moving), or they may experience sudden increases in their baseline pain resulting from a change in their condition. These periods, called breakthrough pain, can be well managed with an oral dose of a short-acting transmucosal opioid that has a rapid onset of action. Available transmucosal opioids are fentanyl, buprenorphine, sufentanil, and methadone.

Currently, butorphanol (Stadol), fentanyl (Duragesic, Sublimaze), sufentanil (Sufenta), and morphine are the only approved transmucosal opioid analgesic agents commercially available in the form of nasal sprays. Butorphanol is a complex medication that simultaneously acts to induce or promote (**agonist**) and inhibit or reverse (**antagonist**) opioid effects. It works like an opioid agonist and an opioid antagonist at the same time. Butorphanol in any form cannot be combined with other opioids (eg, for cancer breakthrough pain), because the antagonist component blocks the action of the opioids the patient is already receiving. The principal use of this agent is for brief, moderate to severe pain, such as migraine headaches.

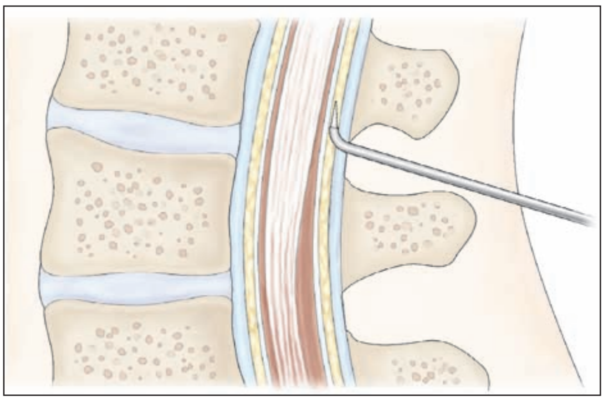
Intranasal morphine is useful in cancer-related breakthrough pain. When it is given in this form, analgesia is achieved within 5 to 10 minutes, resulting in significant decreases in pain intensity and high patient satisfaction (Fitzgibbon, Morgan, Dockter, et al., 2003).

### Intraspinal and Epidural Routes

Infusion of opioids or local anesthetic agents into the subarachnoid space (intrathecal space or spinal canal) or epidural space has been used for effective control of pain in postoperative patients and those with chronic pain unrelieved by other methods. A catheter is inserted into the subarachnoid or the epidural space at the thoracic or lumbar level for administration of opioid or anesthetic agents (Fig. 13-7). With intrathecal administration, medication infuses directly into the subarachnoid space and cerebrospinal fluid, which surrounds the spinal cord. With epidural administration, medication is deposited in the dura of the spinal canal and diffuses into the subarachnoid space. It is believed that



A



B

**Figure 13-7** Placement of intraspinal catheters for administration of analgesic medications: **A,** intrathecal route; **B,** epidural route.

pain relief from intraspinal administration of opioids is based on the existence of opioid receptors in the spinal cord.

Infusion of opioids and local anesthetic agents through an intrathecal or epidural catheter results in pain relief with fewer side effects, including sedation, than with systemic analgesia. Adverse effects associated with intraspinal administration include spinal headache resulting from loss of spinal fluid when the dura is punctured. This is more likely to occur in younger patients (less than 40 years of age). The dura must be punctured with the intrathecal route, and dural puncture may occur inadvertently with the epidural route. If dural puncture inadvertently occurs, spinal fluid seeps out of the spinal canal. The resultant headache is likely to be more severe with an epidural needle because it is larger than a spinal needle, and therefore more spinal fluid escapes.

Respiratory depression generally peaks 6 to 12 hours after epidural opioids are administered, but it can occur earlier or up to 24 hours after the first injection. Depending on the lipophilicity (affinity for body fat) of the opioid injected, the time frame for respiratory depression can be short or long. Morphine is hydrophilic, and the time for peak effect is longer than that of fentanyl, which is lipophilic. The patient should be monitored closely for at least 24 hours after the first injection and longer if changes in respiratory status or level of consciousness occur. Opioid antagonist agents such as naloxone (Narcan) must be available for IV use if respiratory depression occurs.

The patient is also observed for urinary retention, pruritus, nausea, vomiting, and dizziness. Precautions must be taken to avoid infection at the catheter site and catheter displacement. Only medications without preservatives should be administered into the subarachnoid or epidural space because of the potential neurotoxic effects of preservatives.

For patients who have persistent, severe pain that fails to respond to other treatments, or who obtain pain relief only with the risk of serious side effects, medication administered by a long-term intrathecal or epidural catheter may be effective. After the physician tunnels the catheter through the subcutaneous tissue and places the inlet (or port) under the skin, the medication is injected through the skin into the inlet and catheter, which delivers the medication directly into the epidural space. It may be necessary to inject the medication several times a day to maintain an adequate level of pain relief.

For patients who require more frequent doses or continuous infusions of opioid analgesic agents to relieve pain, an implantable infusion device or pump may be used to administer the medication continuously. The medication is administered at a small, constant dose at a preset rate into the epidural or subarachnoid space. The reservoir of the infusion device stores the medication for slow release and needs to be refilled every 1 or 2 months, depending on the patient's needs. This eliminates the need for repeated injections through the skin.

Another delivery method of epidural morphine provides effective analgesia for patients who have undergone major surgical procedures. A single-dose extended-release epidural morphine (DepoDur) is administered into the epidural space at the lumbar level immediately prior to surgery. The morphine is released slowly from microvesicular liposomes. One dose of 5 to 15 mg is absorbed around the epidural space and systemically. DepoDur has been shown to provide up to 48 hours of postoperative analgesia. Although supplemental analgesic agents may be needed, patients who have received DepoDur tend to report less intense pain and greater satisfaction with pain relief (Gambling, Hughes, Martin, et al., 2005). Side effects are similar to those of other epidural opioids (ie, nausea, vomiting, pruritus, and hypotension); its use is contraindicated in patients with allergy to morphine, respiratory depression, severe asthma or upper airway obstruction, and circulatory shock.

*NURSING ALERT*

**Epidural catheters inserted for pain control are usually managed by nurses. Baseline information necessary to provide safe and effective pain control includes the level or site of catheter insertion, the medications (eg, local anesthetic agents, opioids) that have been administered, and the medications anticipated in the future. The infusion rate is increased with caution when anesthetic agents are combined with opioids. Sensory deficits can occur, and patients must be assessed frequently. An infusion with a lower concentration of anesthetic agent allows for administration of a greater concentration of opioid with a lower risk of sensory deficits.**

**Nursing Management**

Headache resulting from spinal fluid loss may be delayed. Therefore, the nurse needs to assess regularly for headache after either type of catheter is placed. If headache develops, the patient should remain flat in bed and should be given large amounts of fluids (provided the medical condition allows), and the physician should be notified. An epidural blood patch may be performed to reduce leakage of spinal fluid.

Cardiovascular effects (hypotension and decreased heart rate) may result from dilation of the vasculature in the lower extremities. Therefore, the nurse should assess frequently for decreases in blood pressure, pulse rate, and urine output.

Urinary retention and pruritus may develop, and the physician may prescribe small doses of naloxone to combat these effects. The nurse administers these doses in continuous IV infusions that are small enough to reverse the side effects of the opioids without reversing the analgesic effects. Diphenhydramine (Benadryl) may also be used to relieve opioid-related pruritus. Patients who receive epidural analgesic agents at home and their families must be taught how to administer the prescribed medication using sterile technique and how to assess for infection. Patients and families also need to learn how to recognize side effects and what to do about them. Respiratory depression is uncommon, but urinary retention may be a problem, and patients and families must be prepared to deal with it if it occurs. Implanted analgesic delivery systems can be safely and confidently used at home if health care personnel are available for consultation and, possibly, intervention on short notice.

## Placebo Effect

A **placebo effect** occurs when a person responds to the medication or other treatment because of an expectation that the treatment will work rather than because it should work. Simply receiving a medication or treatment may produce positive effects. The placebo effect results from natural (endogenous) production of endorphins in the descending control system. It is a true physiologic response that can be reversed by naloxone, an opioid antagonist (Kaptchuk, Kelly, Deykin, et al., 2008).

A patient's positive expectations about treatment may increase the effectiveness of a medication or other intervention. Often, the more cues the patient receives about the intervention's effectiveness, the more effective it is. Patients who are told that a medication is expected to relieve pain are more likely to experience pain relief than those who are told that a medication is unlikely to have any effect.

Hrobjartsson and Gotzsche (2006) reviewed the methods used in over 50 studies whose aim was to examine the placebo effect. They concluded that what is commonly called a placebo effect may be an actual analgesic effect.

The American Society for Pain Management Nursing (2005) contends that placebos (tablets or injections with no active ingredients) should not be used to assess or manage pain in any patient, regardless of age or diagnosis. Furthermore, this group recommends that all health care institutions have policies in place prohibiting the use of placebos for this purpose. Nurses and other health care providers should be taught about effective pain management and these policies should be disseminated (Chart 13-8).

### Chart 13-8 • *Administration of Placebos*

Because of misperceptions about placebos and the placebo effect, it is important to keep in mind some specific principles and guidelines:

- A placebo effect is *not* an indication that the person does not have pain; rather, it is a true physiologic response.
- Placebos (tablets or injections with no active ingredients) should *never* be used to test the person's truthfulness about pain or as the first line of treatment.
- A positive response to a placebo (eg, reduction in pain) should *never* be interpreted as an indication that the person's pain is not real.
- A patient should *never* be given a placebo as a substitute for an analgesic medication. Although a placebo can produce analgesia, patients receiving a placebo may report that their pain is relieved or that they feel better simply to avoid disappointing the nurse.

## Gerontologic Considerations

Physiologic changes in older adults require that analgesic agents be administered with caution. Drug interactions are more likely to occur in older adults because of the higher incidence of chronic illness and the increased use of prescription and OTC medications. Although the elderly population is an extremely heterogeneous group, differences in response to pain or medications by patients over this 40-year span (approximately 60 to 100 years) are more likely to be due to chronic illness or other individual factors than to age. Before administering opioid and nonopioid analgesic agents to elderly patients, the nurse should obtain a careful medication history to identify potential drug interactions (see Table 13-1).

Elderly patients are more sensitive to medications and at an increased risk for drug toxicity (McCleane, 2008). Liver, renal, and gastrointestinal functions are decreased in elderly patients, resulting in changes in the absorption and metabolism of medications. In addition, changes in body weight, protein stores, and distribution of body fluid alter the distribution of medications in the body. Consequently, medications are not metabolized as quickly, and blood levels of the medications remain higher for a longer period.

Opioid and nonopioid analgesic medications can be administered to elderly patients but must be used cautiously because of the increased susceptibility to depression of both the nervous and the respiratory systems. Although there is no reason to avoid opioids in patients simply because they are elderly, meperidine (Demerol) should be avoided because its active and neurotoxic metabolite, normeperidine, is more likely to accumulate and cause CNS excitation and seizures. In addition, because of decreased binding of meperidine by plasma proteins, blood concentrations of the medication twice those found in younger patients may occur.

In many cases, the initial dose of analgesic medication prescribed for elderly patients is the same as that for younger patients, or slightly smaller than the normal dose, but because

of slowed metabolism and excretion related to aging, the safe interval for subsequent doses may be longer (or prolonged). The American Geriatrics Society (AGS) (2002) has published clinical practice guidelines for managing persistent pain in elderly patients. As always, the best guide to pain management and administration of analgesic agents in all patients, regardless of age, is what the individual patient says. Elderly patients may obtain more pain relief for a longer time than younger patients do from the same dose. As a result, smaller and less frequent doses of analgesics may be required.

## Promoting Home and Community-Based Care

In preparing the patient and family to manage pain at home, the patient and family should be taught and guided about what type of pain or discomfort to expect, how long the pain is expected to last, and when the pain indicates a problem that should be reported. People who have experienced pain as a result of injury, illness, a medical procedure, or surgery will probably receive one or more prescriptions for analgesic medication for use at home.

### *Teaching Patients Self-Care*

The patient and family must understand the purpose of each medication, the appropriate time to use it, the associated side effects, and the strategies that can be used to prevent these problems. The patient and family often need reassurance that pain can be successfully managed at home.

Inadequate control of pain at home is a common reason people seek health care or are readmitted to the hospital. When persistent pain exists, anxiety and fear are often intensified at the time the patient is about to return home. The patient and family are instructed about the techniques for assessing pain, using pain assessment tools, and administering medications to relieve pain. These instructions are given verbally and in writing (Chart 13-9).

CHART 13-9 PATIENT EDUCATION

**At-Home Pain Management Plan**

Pain control plan for ______________________________

**At home, I will take the following medicines for pain control:**

| Medicine | How to take | How many | How often | Comments |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Medicines that I may take to help treat side effects:**

| Side effect | Medicine | How to take | How many | How often | Comments |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

**Constipation is a very common problem when taking opioid medications. Activities aimed at prevention include:**

- Increase fluid intake (8 to 10 glasses of fluid).
- Exercise regularly.
- Increase fiber in the diet (bran, fresh fruits, vegetables).
- Use a mild laxative, such as milk of magnesia, if no bowel movement in 3 days.
- Take ______________ every day at ______________ (time) with a full glass of water.
- Use a glycerin suppository every morning (this may help make a bowel movement less painful).

**Nondrug pain control methods:**

______________________________

______________________________

**Additional instructions:**

______________________________

______________________________

______________________________

**Important phone numbers:**

Your doctor ______________________ Your nurse ______________________

Your pharmacy ______________________ Emergencies ______________________

Call your doctor or nurse immediately if your pain increases or if you have a new pain. Also call your doctor early for refill of pain medicines. Do not let your medicines get below 3 or 4 days' supply.

From Agency for Health Care Policy and Research. (1994). *Management of cancer pain.* Clinical Practice Guidelines. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services.

Opportunities are provided for the patient and family members to practice administering the medication until they are comfortable and confident with the procedure. They are instructed about the risks of respiratory and CNS depression associated with opioids and ways to assess for these complications. If the medications cause other predictable effects, such as constipation, the instructions include measures for preventing and treating the problem, as previously described. Steps are taken to ensure that the needed medications are available from the local pharmacy so that the patient receives the medication when required. If the patient is expected to require opioid analgesic agents at home, during discharge planning the nurse should consider the ability of the patient and family to administer opioids as prescribed and should take steps to ensure that the required medications will be available to the patient. Many pharmacies, especially those in smaller rural areas or inner cities, may not stock large amounts of opioids. Therefore, arrangements for obtaining these prescription medications must be made ahead of time.

Education for patients and families must stress the need for keeping analgesic agents away from children, who might mistake them for candy. Elderly patients may become lax about this because no children live in the home, but visiting children can be placed at risk. In addition, analgesic medications should be stored safely in their original containers and clearly labeled. They should be stored out of sight to prevent others from taking them for their own use or diverting them to others.

#### Continuing Care

If parenteral or intraspinal analgesia will be administered at home, the patient should be referred to a home care nurse. This nurse will make a home visit to assess the patient and to determine whether the pain management program is being implemented and the technique for injecting or infusing the analgesic agent is being carried out safely and effectively. If the patient has an implanted infusion pump in place, the nurse examines the condition of the pump or injection site and may refill the reservoir with medication as prescribed or may supervise family members in this procedure. The nurse assesses for any change in the patient's need for analgesic medications, and, in collaboration with the physician, the nurse may assist the patient and family in modifying the medication dose. These efforts enable the patient to obtain adequate pain relief while remaining at home and with family.

## NONPHARMACOLOGIC INTERVENTIONS

### Activities to Promote Comfort

Analgesic medication is the most powerful tool for pain relief that is available, but it is not the only one. Nonpharmacologic nursing activities can assist in pain relief, usually with low risk to the patient. Although such measures are not a substitute for medication, they may be appropriate to relieve episodes of pain lasting only seconds or minutes. In instances of severe pain that lasts for hours or days, combining nonpharmacologic interventions with medications may be the most effective way to relieve pain.

#### Massage

The gate control theory of pain proposes that stimulation of fibers that transmit nonpainful sensations can block or decrease the transmission of pain impulses. Several nonpharmacologic pain relief strategies, including rubbing the skin and using heat and cold, are based on this theory.

Massage, which is generalized cutaneous stimulation of the body, often concentrates on the back and shoulders. A massage does not specifically stimulate the nonpain receptors in the same receptor field as the pain receptors, but it may have an impact through the descending control system (see previous discussion). Massage also promotes comfort because it produces muscle relaxation (Adams & Arminio, 2008).

#### Thermal Therapies

Ice and heat therapies may be effective pain relief strategies in some circumstances; however, their effectiveness and mechanisms of action need further study. Proponents believe that ice and heat stimulate the nonpain receptors in the same receptor field as the injury.

For greatest effect, ice should be placed on the injury site immediately after injury or surgery. Ice therapy after joint surgery can significantly reduce the amount of analgesic medication required. Ice therapy may also relieve pain if applied later. Care must be taken to assess the skin before treatment and to protect the skin from direct application of the ice. Ice should be applied to an area for no longer than 15 to 20 minutes at a time and should be avoided in patients with compromised circulation (Adams & Arminio, 2008). Long applications of ice may result in frostbite or nerve injury.

Application of heat increases blood flow to an area and contributes to pain reduction by speeding healing. Both dry and moist heat may provide some analgesia, but their mechanisms of action are not well understood. Both ice and heat therapy must be applied carefully and monitored closely to avoid injuring the skin. Neither therapy should be applied to areas with impaired circulation or used in patients with impaired sensation.

> *NURSING ALERT*
>
> **Heat should not be applied to a painful area that is the site of acute untreated infection (eg, mastitis, tooth abscess), because it may cause increased pain with increased blood flow to the site.**

#### Transcutaneous Electrical Nerve Stimulation

Transcutaneous electrical nerve stimulation (TENS) uses a battery-operated unit with electrodes applied to the skin to produce a tingling, vibrating, or buzzing sensation in the area of pain. It has been used in both acute and chronic pain relief and is thought to decrease pain by stimulating the nonpain receptors in the same area as the fibers that transmit the pain. This mechanism is consistent with the gate control theory of pain and explains the effectiveness of cutaneous stimulation when applied in the same area as an injury. For example, when TENS is used in a postoperative patient, the electrodes are placed around the surgical wound. Other possible explanations for the effectiveness of TENS are the placebo effect (the

patient expects it to be effective) and release of endorphins and enkephalins (Adams & Arminio, 2008).

### Distraction

Distraction helps relieve both acute and chronic pain (Porth & Matfin, 2009). Distraction, which involves focusing the patient's attention on something other than the pain, may be the mechanism responsible for other effective cognitive techniques. Distraction is thought to reduce the perception of pain by stimulating the descending control system, resulting in fewer painful stimuli being transmitted to the brain. The effectiveness of distraction depends on the patient's ability to receive and create sensory input other than pain. Distraction techniques may range from simple activities, such as watching TV or listening to music, to highly complex physical and mental exercises. Pain relief generally increases in direct proportion to the patient's active participation, the number of sensory modalities used, and interest in the stimuli. Therefore, the stimulation of sight, sound, and touch is likely to be more effective in reducing pain than is the stimulation of a single sense.

Visits from family and friends can be effective in relieving pain. Watching an action-packed movie on a large screen through headphones may be effective (provided the patient finds it acceptable). Others may benefit from games and activities (eg, chess, crossword puzzles) that require concentration. Not all patients obtain pain relief with distraction, especially those in severe pain. Severe pain may prevent patients from concentrating well enough to participate in complex physical or mental activities.

### Relaxation Techniques

Skeletal muscle relaxation is believed to reduce pain by relaxing tense muscles that contribute to the pain. Research findings support the use of relaxation in relieving postoperative pain. Kwekkeboom, Wanta, and Bumpus (2008) reported greater pain control and less pain intensity among patients with cancer who used relaxation techniques compared to those who did not use these techniques.

A simple relaxation technique consists of abdominal breathing at a slow, rhythmic rate. The patient may close both eyes and breathe slowly and comfortably. A constant rhythm can be maintained by counting silently and slowly with each inhalation ("in, two, three") and exhalation ("out, two, three"). When teaching this technique, the nurse may count out loud with the patient at first. Slow, rhythmic breathing may also be used as a distraction technique. Relaxation techniques, as well as other noninvasive pain relief measures, may require practice before the patient becomes skilled in using them. Patients who already know a relaxation technique may need to be reminded to use it to reduce or prevent increased pain.

Almost all people with chronic pain benefit from some method of relaxation. Regular relaxation periods may help combat the fatigue and muscle tension that occur with and increase chronic pain.

### Guided Imagery

Guided imagery is using one's imagination to achieve a specific positive effect. Guided imagery for relaxation and pain relief may consist of combining slow, rhythmic breathing with a mental image of relaxation and comfort (Kwekkeboom, et al., 2008). The nurse instructs the patient to close both eyes and breathe slowly in and out. With each slowly exhaled breath, the patient imagines muscle tension and discomfort being breathed out, carrying away pain and tension and leaving behind a relaxed and comfortable body. With each inhaled breath, the patient imagines healing energy flowing to the area of discomfort.

If guided imagery is to be effective, it requires a considerable amount of time to explain the technique and time for the patient to practice it. Usually, the patient is asked to practice guided imagery for about 5 minutes, three times a day. Several days of practice may be needed before the intensity of pain is reduced. Many patients experience the relaxing effects of guided imagery the first time they try it. Pain relief can continue for hours after the imagery is used. Patients should be informed that guided imagery may work only for some people; it should be used only in combination with other forms of treatment that have demonstrated effectiveness.

### Hypnosis

Hypnosis, which has been effective in relieving pain or decreasing the amount of analgesic agents required in patients with acute and chronic pain, may promote pain relief in particularly difficult situations (eg, burns). The mechanism by which hypnosis acts is unclear. Its effectiveness depends on the hypnotic susceptibility of the individual (DePascalis, Bellusci, Gallo, et al., 2004). In some cases, hypnosis may be effective in the first session, with effectiveness increasing in additional sessions. In other cases, hypnosis does not work at all. Usually, hypnosis must be induced by specially skilled people (a psychologist or a nurse with specialized training in hypnosis). Some patients may learn to perform self-hypnosis.

### Music Therapy

Music therapy is an inexpensive and effective therapy for the reduction of pain and anxiety. Research among elderly Korean and American women who had gynecologic surgery demonstrated decreased pain among those patients who received a music therapy intervention (Good & Sukhee, 2008).

### Alternative Therapies

People suffering chronic, debilitating pain are often desperate. They may try anything, recommended by anyone, at any price. Information about an array of potential therapies can be found on the Internet and in the self-help section of many bookstores. Therapies recommended for pain from these sources include, but are not limited to, chelation, therapeutic touch, herbal therapy, reflexology, magnetic therapy, electrotherapy, polarity therapy, acupressure, emu oil, pectin therapy, aromatherapy, homeopathy, and macrobiotic dieting. Many of these "therapies" (with the exception of macrobiotic dieting) are probably not harmful. However, they have yet to be proved effective by the standards used to evaluate the effectiveness of medical and nursing interventions. The National Institutes of Health has established an office to examine the effectiveness of complementary and alternative therapies.

Despite the lack of scientific evidence that these alternative therapies are effective, patients may find any one of them helpful via the placebo response. Problems arise when

patients do not obtain relief but are deprived of conventional therapy because the alternative therapy "should be helping," or when patients abandon conventional therapy for alternative therapy. In addition, few alternative therapies are free. Desperate patients may risk financial ruin seeking alternative therapies that are ineffective.

It is important when caring for patients who are using or considering using untested therapies (often referred to as alternative therapies) not to diminish the patient's hope and the potential placebo response. This must be weighed against the nurse's responsibility to protect the patient from costly and potentially harmful and dangerous therapies that the patient is not in a position to evaluate scientifically.

Nurses should help patients and families understand scientific research and how it differs from anecdotal evidence. Without diminishing the placebo effects that may occur, the nurse encourages the patient to assess the effectiveness of the therapy, continually using standard pain assessment techniques. In addition, patients are encouraged to combine alternative therapies with conventional therapies.

## Neurologic and Neurosurgical Approaches to Pain Management

In some situations, especially with long-term and severe intractable pain, usual pharmacologic and comfort methods of pain relief are ineffective. In those situations, neurologic and neurosurgical approaches to pain management may be considered. Intractable pain refers to pain that cannot be relieved satisfactorily by the usual approaches, including medications. Such pain often is the result of malignancy (especially of the cervix, bladder, prostate, and lower bowel), but it may occur in other conditions, such as postherpetic neuralgia, trigeminal neuralgia, spinal cord arachnoiditis, and uncontrollable ischemia and other forms of tissue destruction.

Neurologic and neurosurgical methods available for pain relief include (1) stimulation procedures (intermittent electrical stimulation of a tract or center to inhibit the transmission of pain impulses), (2) administration of intraspinal opioids (see previous discussion), and (3) interruption of the tracts conducting the pain impulse from the periphery to cerebral integration centers. Stimulation of nerves with minute amounts of electricity is used if other pharmacologic and nonpharmacologic treatments fail to provide adequate relief. These treatments are reversible. If they need to be discontinued, the nervous system continues to function. However, methods that involve interruption of the tracts are destructive procedures. They are used only after other methods of pain relief have failed, because their effects are permanent.

### *Stimulation Procedures*

Electrical stimulation, or neuromodulation, is a method of suppressing pain by applying controlled low-voltage electrical pulses to the different parts of the nervous system. Electrical stimulation is thought to block painful stimuli (the gate control theory). This pain-modulating technique is administered by many modes. TENS (discussed earlier) and dorsal spinal cord stimulation are the most common types of electrical stimulation used. There are also brain-stimulating techniques, in which electrodes are implanted in the periventricular area of the posterior third ventricle, allowing the patient to stimulate this area to produce analgesia.

Spinal cord stimulation is a technique used for the relief of chronic, intractable pain; ischemic pain; and pain from angina. A surgically implanted device allows the patient to apply pulsed electrical stimulation to the dorsal aspect of the spinal cord to block pain impulses (Varma, 2005). (The largest accumulation of afferent fibers is found in the dorsal column of the spinal cord.) The dorsal column stimulation unit consists of a radiofrequency stimulation transmitter, a transmitter antenna, a radiofrequency receiver, and a stimulation electrode. The battery-powered transmitter and antenna are worn externally; the receiver and electrode are implanted. A laminectomy, which is the surgical removal of a posterior portion of the vertebra, is performed above the highest level of pain input, and the electrode is placed in the epidural space over the posterior column of the spinal cord. (The placement of the stimulating systems varies.) A subcutaneous pocket is created over the clavicular area or at some other site for placement of the receiver. The two are connected through a subcutaneous tunnel. Careful patient selection is necessary, and not all patients receive total pain relief.

Deep brain stimulation is performed for special pain problems if there is no response to the usual techniques of pain control. Under local anesthesia, electrodes are introduced through a burr hole in the skull and inserted into a selected site in the brain, depending on the location or type of pain. After the effectiveness of stimulation is confirmed, the implanted electrode is connected to a radiofrequency device or pulse-generator system operated by external telemetry (Varma, 2005). It is used for patients with neuropathic pain that may be caused by damage or injury from a stroke, brain or spinal cord injuries, or phantom limb pain. Use of deep brain stimulation is effective for chronic cluster headaches (Magis, Allena, DePasqua, et al., 2007).

### *Interruption of Pain Pathways*

Pain-conducting fibers can be interrupted at any point from their origin to the cerebral cortex. Some part of the nervous system is destroyed, resulting in varying amounts of neurologic deficit and incapacity. In time, pain usually returns due to either regeneration of axonal fibers or the development of alternative pain pathways. Destructive procedures used to interrupt the transmission of pain include cordotomy and rhizotomy. These procedures are offered if it is thought that the patient is near the end of life and the procedure will result in an improved quality of life (Varma, 2005). Often these procedures can provide pain relief for the duration of the patient's life. The use of other methods to interrupt pain transmission is decreasing, because intraspinal therapies and newer pain management treatments are available.

#### Cordotomy

Cordotomy is the division of certain tracts of the spinal cord (Fig. 13-8). It may be performed percutaneously, by the open method after laminectomy, or by other techniques. Cordotomy is performed to interrupt the transmission of pain. Care is taken to destroy only the sensation of pain, leaving motor functions intact.

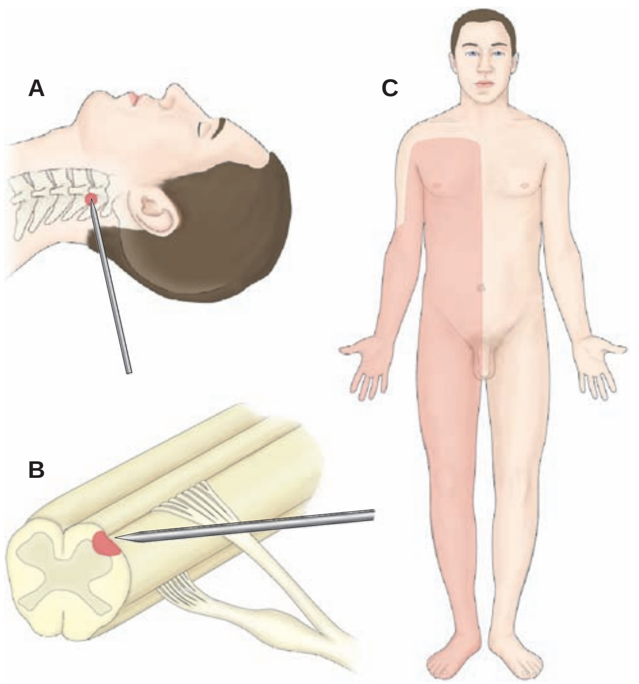



**Figure 13-8** **A,** Site of percutaneous C1–C2 cordotomy. **B,** Lesion produced by percutaneous C1–C2 cordotomy. **C,** Extent of analgesia produced by left C1–C2 percutaneous cordotomy.

### Rhizotomy

Sensory nerve roots are destroyed where they enter the spinal cord. A lesion is made in the dorsal root to destroy neuronal dysfunction and reduce nociceptive input. With the advent of microsurgical techniques, the complications are few, with mild sensory deficits and mild weakness (Fig. 13-9).

#### *Nursing Interventions*

With each of these procedures, the patient is provided with written and verbal instructions about the intervention's expected effect on pain and on possible untoward consequences. The patient is monitored for specific effects of each method of pain intervention, both positive and negative. The specific nursing care of patients who undergo neurologic and neurosurgical procedures for the relief of chronic pain depends on the type of procedure performed, its effectiveness in relieving the pain, and the changes in neurologic function that accompany the procedure. After the procedure, the patient's pain level and neurologic function are assessed. Other nursing interventions that may be indicated include positioning, turning and skin care, bowel and bladder management, and interventions to promote patient safety. Pain management remains an important aspect of nursing care with each of these procedures.

## *Evaluating Pain Management Strategies*

An important aspect of caring for patients in pain is reassessing the pain after the intervention has been implemented. Its effectiveness is based on the patient's assessment of pain, using pain assessment tools. If the intervention was ineffective, the nurse should consider other measures. If these are ineffective, pain relief goals need to be reassessed in collaboration with the physician. The nurse serves as the patient's advocate in obtaining additional pain relief.

After interventions have had a chance to work, the nurse asks the patient to rate the intensity of pain. The nurse repeats this assessment at appropriate intervals after the intervention and compares the result with the previous rating. These assessments indicate the effectiveness of the pain relief measures and provide a basis for continuing or modifying the plan of care. A plan of nursing care for a patient with pain is given in Chart 13-10. Expected patient outcomes include the following:

**Relief of pain,** evidenced when the patient
- Rates pain at a lower intensity (on a scale of 0 to 10) after intervention
- Rates pain at a lower intensity for longer periods

**Correct administration of prescribed analgesic medications,** evidenced when the patient or family
- States correct dose of medication
- Administers correct dose using correct procedure
- Identifies side effects of medication

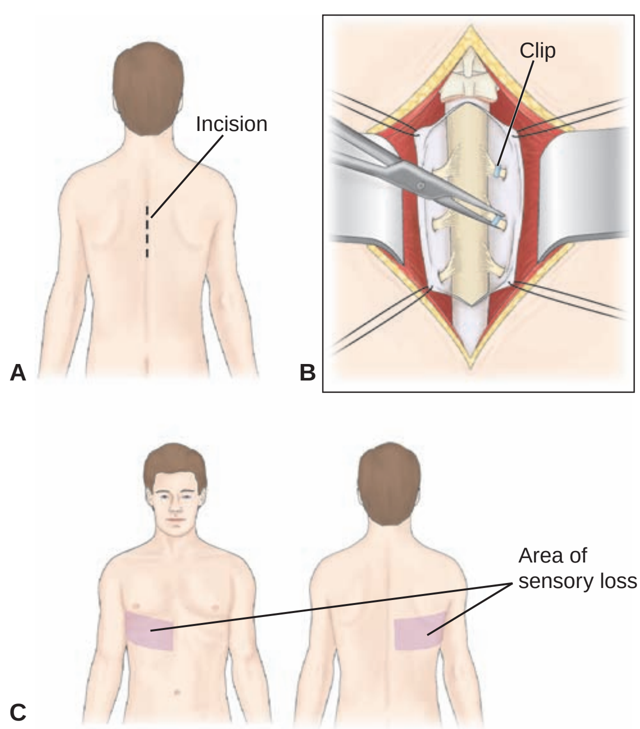



**Figure 13-9** A rhizotomy may be performed surgically, percutaneously, or chemically, depending on a patient's condition and needs. The procedure is usually performed to relieve severe chest pain, for example, from lung cancer. In a surgical rhizotomy **(A),** the spinal roots **(B)** are divided and banded with a clip to form a lesion and produce subsequent loss of sensation **(C)**. Adapted with permission from Loeser, J. D. (Ed.) (2000). *Bonica's management of pain* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins.

CHART 13-10

## PLAN OF NURSING CARE
### *Care of the Patient With Pain*

**Nursing Diagnosis:** Pain
**Goal:** Relief of pain or decrease in intensity of pain

| Nursing Interventions | Rationale |
|---|---|
| 1. Reassure patient that you know pain is real and will assist him or her in dealing with it. | 1. Fear that pain will not be accepted as real increases tension and anxiety and decreases pain tolerance. |
| 2. Use pain assessment scale to identify intensity of pain. | 2. A pain assessment scale provides baseline for assessing changes in pain level and evaluating interventions. |
| 3. Assess and record pain and its characteristics: intensity, location, quality, frequency, and duration. | 3. Data assist in evaluating pain and pain relief and identifying multiple sources and types of pain. |
| 4. Administer balanced analgesic agents as prescribed to promote optimal pain relief. | 4. Analgesic agents are more effective if administered early in the pain cycle. Simultaneous use of analgesic agents that work on different portions of the nociceptive system will provide greater pain relief with fewer side effects. |
| 5. Readminister pain assessment scale. | 5. This permits assessment of effectiveness of analgesia and identifies need for further action if ineffective. |
| 6. Document severity of patient's pain on chart. | 6. This assists in demonstrating the need for additional analgesic agents or alternative approach to pain management. |
| 7. Obtain additional prescriptions as needed. | 7. Inadequate pain relief results in an increased stress response, suffering, and prolonged hospitalizations. |
| 8. Identify and encourage patient to use strategies that have been successful with previous pain. | 8. This encourages use of pain relief strategies familiar to and accepted by patient. |
| 9. Teach patient additional strategies to relieve pain and discomfort: distraction, relaxation, cutaneous stimulation, etc. | 9. Use of these strategies along with analgesia may produce more effective pain relief. |
| 10. Instruct patient and family about potential side effects of analgesic agents and their prevention and management. | 10. Anticipating and preventing side effects enable the patient to continue analgesia without interruption because of side effects. |

**Expected Outcomes**

- Reports relief that pain is accepted as real and that he or she will receive assistance in pain relief
- Reports lower intensity of pain and discomfort after interventions implemented
- Reports less disruption from pain and discomfort after use of intervention
- Uses pain medication as prescribed
- Identifies effective pain relief strategies
- Demonstrates use of new strategies to relieve pain and reports their effectiveness
- Experiences minimal side effects of analgesia without interruption to treat side effects
- Increases interactions with family and friends

- Describes actions taken to prevent or correct side effects

**Use of nonpharmacologic pain strategies as recommended,** evidenced when the patient:

- Reports practice of nonpharmacologic strategies
- Describes expected outcomes of nonpharmacologic strategies

**Minimal effects of pain and minimal side effects of interventions,** evidenced when the patient:

- Participates in activities important to recovery (eg, drinking fluids, coughing, ambulating)
- Participates in activities important to self and to family (eg, family activities, interpersonal relationships, parenting, social interaction, recreation, work)
- Reports adequate sleep and absence of fatigue and constipation

## CRITICAL THINKING EXERCISES

EBP **1** A 44-year-old man is admitted to a university hospital with a traumatic amputation of his left lower leg as a result of a motor vehicle crash. He is transferred to an orthopedic unit postoperatively after emergent débridement and revision of his stump. He received 2 mg of morphine IV prior to leaving the postanesthesia care unit 45 minutes ago. After assessing his vital signs and incisional dressing, the nurse notes that the patient rates his pain intensity as an 8 on a 0-to-10 scale (0 = no pain and 10 = pain as bad as could be). His analgesia orders include IV morphine delivered by PCA pump with a basal rate of 1 mg/h and additional 1 to 2 mg that may be delivered on demand (ie, self-administered) with a lock-out set so that

no more than 4 mg may be administered per hour. Identify the evidence base and strength of the evidence that would guide the nurse to decide how much morphine to administer to this patient.

**2** An 85-year-old woman is admitted to a medical-surgical unit complaining of a sudden onset of very sharp and severe pain in her left flank. A computed tomography scan revealed renal calculi in her left ureter. Upon the initial nursing assessment, the patient is noted to be grimacing and gently rocking side to side on the bed. She does not respond to questions about whether or not she is experiencing pain. Rather, she reaches for her IV catheter and attempts to pull it out. Attempts to orient the patient fail. What methods would you recommend to assess this patient's pain? Describe how you would address pain relief for this patient and give the rationale for your actions. Who would you consult to help with this patient's pain management?

EBP **3** A 22-year-old man is admitted to the hospital after a motor vehicle crash. He has a Glasgow Coma Scale score of 7. He is intubated and placed on a ventilator to provide adequate oxygenation. He has multiple lacerations and contusions on his arms and legs. A computed tomography scan shows large hematomas to the front and back of his skull. Discuss how pain can be assessed and managed for this patient. The resident physician tells you not to administer any analgesic medications to this patient because it might hamper performing a neurologic examination. What is the strength of the evidence that either supports or refutes withholding analgesic medications from patients with these types of injuries?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

## REFERENCES AND SELECTED READINGS

**Asterisk indicates nursing reseach.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Academy of Pain Management, www.aapainmanage.org

American Chronic Pain Association, www.theacpa.org

American Pain Foundation, www.painfoundation.org

American Pain Society, www.ampainsoc.org

American Society for Pain Management Nursing, www.aspmn.org

Capps/Rogers National Pain Care Policy Act of 2007: Summary of HR 2294, www.ampainsoc.or/advocacy/downloads/PCPA2007Summary7-13-07_110748.pdf

National Hospice and Palliative Care Organization, www.nhpco.org

"Pain Control": A monthly column in *American Journal of Nursing,* www.ajnonline.com

Reflex Sympathetic Dystrophy Syndrome Association, www.rsds.org



# chapter 14

# Fluid and Electrolytes: Balance and Disturbance

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Differentiate between osmosis, diffusion, filtration, and active transport.
2. Describe the role of the kidneys, lungs, and endocrine glands in regulating the body's fluid composition and volume.
3. Identify the effects of aging on fluid and electrolyte regulation.
4. Plan effective care of patients with the following imbalances: fluid volume deficit and fluid volume excess; sodium deficit (hyponatremia) and sodium excess (hypernatremia); potassium deficit (hypokalemia) and potassium excess (hyperkalemia).
5. Describe the cause, clinical manifestations, management, and nursing interventions for the following imbalances: calcium deficit (hypocalcemia) and calcium excess (hypercalcemia); magnesium deficit (hypomagnesemia) and magnesium excess (hypermagnesemia); phosphorus deficit (hypophosphatemia) and phosphorus excess (hyperphosphatemia); chloride deficit (hypochloremia) and chloride excess (hyperchloremia).
6. Explain the roles of the lungs, kidneys, and chemical buffers in maintaining acid–base balance.
7. Compare metabolic acidosis and alkalosis with regard to causes, clinical manifestations, diagnosis, and management.
8. Compare respiratory acidosis and alkalosis with regard to causes, clinical manifestations, diagnosis, and management.
9. Interpret arterial blood gas measurements.
10. Identify a safe and effective procedure of venipuncture.
11. Describe measures used for preventing complications of intravenous therapy.

## GLOSSARY

**acidosis:** an acid–base imbalance characterized by an increase in $H^+$ concentration (decreased blood pH). A low arterial pH due to reduced bicarbonate concentration is called metabolic acidosis; a low arterial pH due to increased $PCO_2$ is respiratory acidosis

**active transport:** physiologic pump that moves fluid from an area of lower concentration to one of higher concentration; active transport requires adenosine triphosphate for energy

**alkalosis:** an acid–base imbalance characterized by a reduction in $H^+$ concentration (increased blood pH). A high arterial pH with increased bicarbonate concentration is called metabolic alkalosis; a high arterial pH due to reduced $PCO_2$ is respiratory alkalosis

**diffusion:** the process by which solutes move from an area of higher concentration to one of lower concentration; does not require expenditure of energy

**homeostasis:** maintenance of a constant internal equilibrium in a biologic system that involves positive and negative feedback mechanisms

**hydrostatic pressure:** the pressure created by the weight of fluid against the wall that contains it. In the body, hydrostatic pressure in blood vessels results from the weight of fluid itself and the force resulting from cardiac contraction

**hypertonic solution:** a solution with an osmolality higher than that of serum

**hypotonic solution:** a solution with an osmolality lower than that of serum

**isotonic solution:** a solution with the same osmolality as serum and other body fluids. Osmolality falls within normal range for serum (280 to 300 mOsm/kg)

**osmolality:** the number of osmoles (the standard unit of osmotic pressure) per kilogram of solution. Expressed as mOsm/kg, osmolality is used more often than the term *osmolarity* to evaluate serum and urine

**osmolarity:** the number of osmoles (the standard unit of osmotic pressure) per liter of solution. It is expressed as milliosmoles per liter (mOsm/L); describes the concentration of solutes or dissolved particles

**osmosis:** the process by which fluid moves across a semipermeable membrane from an area of low solute concentration to an area of high solute concentration; the process continues until the solute concentrations are equal on both sides of the membrane

**tonicity:** fluid tension within the extracellular fluid or intracellular fluid that describes the relationship between the solutes and water, primarily determined by fluid osmolality

Fluid and electrolyte balance is a dynamic process that is crucial for life and **homeostasis.** Potential and actual disorders of fluid and electrolyte balance occur in every setting, with every disorder, and with a variety of changes that affect healthy people (eg, increased fluid and sodium loss with strenuous exercise and high environmental temperature, inadequate intake of fluid and electrolytes) as well as those who are ill.

## Fundamental Concepts

Nurses need an understanding of the physiology of fluid and electrolyte balance and acid–base balance to anticipate, identify, and respond to possible imbalances. Nurses also must use effective teaching and communication skills to help prevent and treat various fluid and electrolyte disturbances.

### Amount and Composition of Body Fluids

Approximately 60% of the weight of a typical adult consists of fluid (water and electrolytes). Factors that influence the amount of body fluid are age, gender, and body fat. In general, younger people have a higher percentage of body fluid than older people, and men have proportionately more body fluid than women. People who are obese have less fluid than those who are thin, because fat cells contain little water. The skeleton also has a low water content. Muscle, skin, and blood have the highest amount of water.

Body fluid is located in two fluid compartments: the intracellular space (fluid in the cells) and the extracellular space (fluid outside the cells). Approximately two thirds of body fluid is in the intracellular fluid (ICF) compartment and is located primarily in the skeletal muscle mass. Approximately one third is in the extracellular fluid (ECF) compartment.

The ECF compartment is further divided into the intravascular, interstitial, and transcellular fluid spaces. Circulatory and neurologic symptoms, physical examination findings, and laboratory test results can be used to identify the compartment from which fluid is lost (McPhee, Papadakis & Tierney, 2007). The intravascular space (the fluid within the blood vessels) contains plasma, the effective circulating volume. Approximately 3 L of the average 6 L of blood volume is made up of plasma. The remaining 3 L is made up of erythrocytes, leukocytes, and thrombocytes. The interstitial space contains the fluid that surrounds the cell and totals about 11 to 12 L in an adult. Lymph is an interstitial fluid. The transcellular space is the smallest division of the ECF compartment and contains approximately 1 L. Examples of transcellular fluids include cerebrospinal, pericardial, synovial, intraocular, and pleural fluids; sweat; and digestive secretions. As the next section describes, the ECF transports electrolytes; it also carries other substances, such as enzymes and hormones.

Body fluid normally moves between the two major compartments or spaces in an effort to maintain an equilibrium between the spaces. Loss of fluid from the body can disrupt this equilibrium. Sometimes fluid is not lost from the body but is unavailable for use by either the ICF or ECF. Loss of ECF into a space that does not contribute to equilibrium between the ICF and the ECF is referred to as a third-space fluid shift, or “third spacing” for short (Holcomb, 2008).

Early evidence of a third-space fluid shift is a decrease in urine output despite adequate fluid intake. Urine output decreases because fluid shifts out of the intravascular space; the kidneys then receive less blood and attempt to compensate by decreasing urine output. Other signs and symptoms of third spacing that indicate an intravascular fluid volume deficit include increased heart rate, decreased blood pressure, decreased central venous pressure, edema, increased body weight, and imbalances in fluid intake and output (I&O). Third-space shifts occur in patients who have hypocalcemia, decreased iron intake, severe liver diseases, alcoholism, hypothyroidism, malabsorption, immobility,, burns, and cancer (Holcomb, 2008).

#### Electrolytes

Electrolytes in body fluids are active chemicals (cations that carry positive charges and anions that carry negative charges). The major cations in body fluid are sodium, potassium, calcium, magnesium, and hydrogen ions. The major anions are chloride, bicarbonate, phosphate, sulfate, and proteinate ions.

These chemicals unite in varying combinations. Therefore, electrolyte concentration in the body is expressed in terms of milliequivalents (mEq) per liter, a measure of chemical activity, rather than in terms of milligrams (mg), a unit of weight. More specifically, a milliequivalent is defined as being equivalent to the electrochemical activity of 1 mg of hydrogen. In a solution, cations and anions are equal in milliequivalents per liter.

Electrolyte concentrations in the ICF differ from those in the ECF, as reflected in Table 14-1. Because special tech-

**Table 14-1 APPROXIMATE MAJOR ELECTROLYTE CONTENT IN BODY FLUID**

| Electrolytes | mEq/L |
|---|---|
| **Extracellular Fluid (Plasma)** | |
| ***Cations*** | |
| Sodium ($Na^+$) | 142 |
| Potassium ($K^+$) | 5 |
| Calcium ($Ca^{++}$) | 5 |
| Magnesium ($Mg^{++}$) | 2 |
| Total cations | 154 |
| ***Anions*** | |
| Chloride ($Cl^-$) | 103 |
| Bicarbonate ($HCO_3^-$) | 26 |
| Phosphate ($HPO_4^-$) | 2 |
| Sulfate ($SO_4^-$) | 1 |
| Organic acids | 5 |
| Proteinate | 17 |
| Total anions | 154 |
| **Intracellular Fluid** | |
| ***Cations*** | |
| Potassium ($K^+$) | 150 |
| Magnesium ($Mg^{++}$) | 40 |
| Sodium ($Na^+$) | 10 |
| Total cations | 200 |
| ***Anions*** | |
| Phosphates and sulfates | 150 |
| Bicarbonate ($HCO_3^-$) | 10 |
| Proteinate | 40 |
| Total anions | 200 |

niques are required to measure electrolyte concentrations in the ICF, it is customary to measure the electrolytes in the most accessible portion of the ECF, namely, the plasma.

Sodium ions, which are positively charged, far outnumber the other cations in the ECF. Because sodium concentration affects the overall concentration of the ECF, sodium is important in regulating the volume of body fluid. Retention of sodium is associated with fluid retention, and excessive loss of sodium is usually associated with decreased volume of body fluid.

As shown in Table 14-1, the major electrolytes in the ICF are potassium and phosphate. The ECF has a low concentration of potassium and can tolerate only small changes in potassium concentrations. Therefore, release of large stores of intracellular potassium, typically caused by trauma to the cells and tissues, can be extremely dangerous.

The body expends a great deal of energy maintaining the high extracellular concentration of sodium and the high intracellular concentration of potassium. It does so by means of cell membrane pumps that exchange sodium and potassium ions. Normal movement of fluids through the capillary wall into the tissues depends on **hydrostatic pressure** (the pressure exerted by the fluid on the walls of the blood vessel) at both the arterial and the venous ends of the vessel and the osmotic pressure exerted by the protein of plasma. The direction of fluid movement depends on the differences in these two opposing forces (hydrostatic versus osmotic pressure).

## Regulation of Body Fluid Compartments

### *Osmosis and Osmolality*

When two different solutions are separated by a membrane that is impermeable to the dissolved substances, fluid shifts through the membrane from the region of low solute concentration to the region of high solute concentration until the solutions are of equal concentration. This diffusion of water caused by a fluid concentration gradient is known as **osmosis** (Fig. 14-1A). The magnitude of this force depends on the number of particles dissolved in the solutions, not on their weights. The number of dissolved particles contained in a unit of fluid determines the osmolality of a solution, which influences the movement of fluid between the fluid compartments (Goertz, 2006). **Tonicity** is the ability of all the solutes to cause an osmotic driving force that promotes water movement from one compartment to another. The control of tonicity determines the normal state of cellular hydration and cell size. Sodium, mannitol, glucose, and sorbitol are effective osmoles (capable of affecting water movement). Three other terms are associated with osmosis: osmotic pressure, oncotic pressure, and osmotic diuresis.

- Osmotic pressure is the amount of hydrostatic pressure needed to stop the flow of water by osmosis. It is

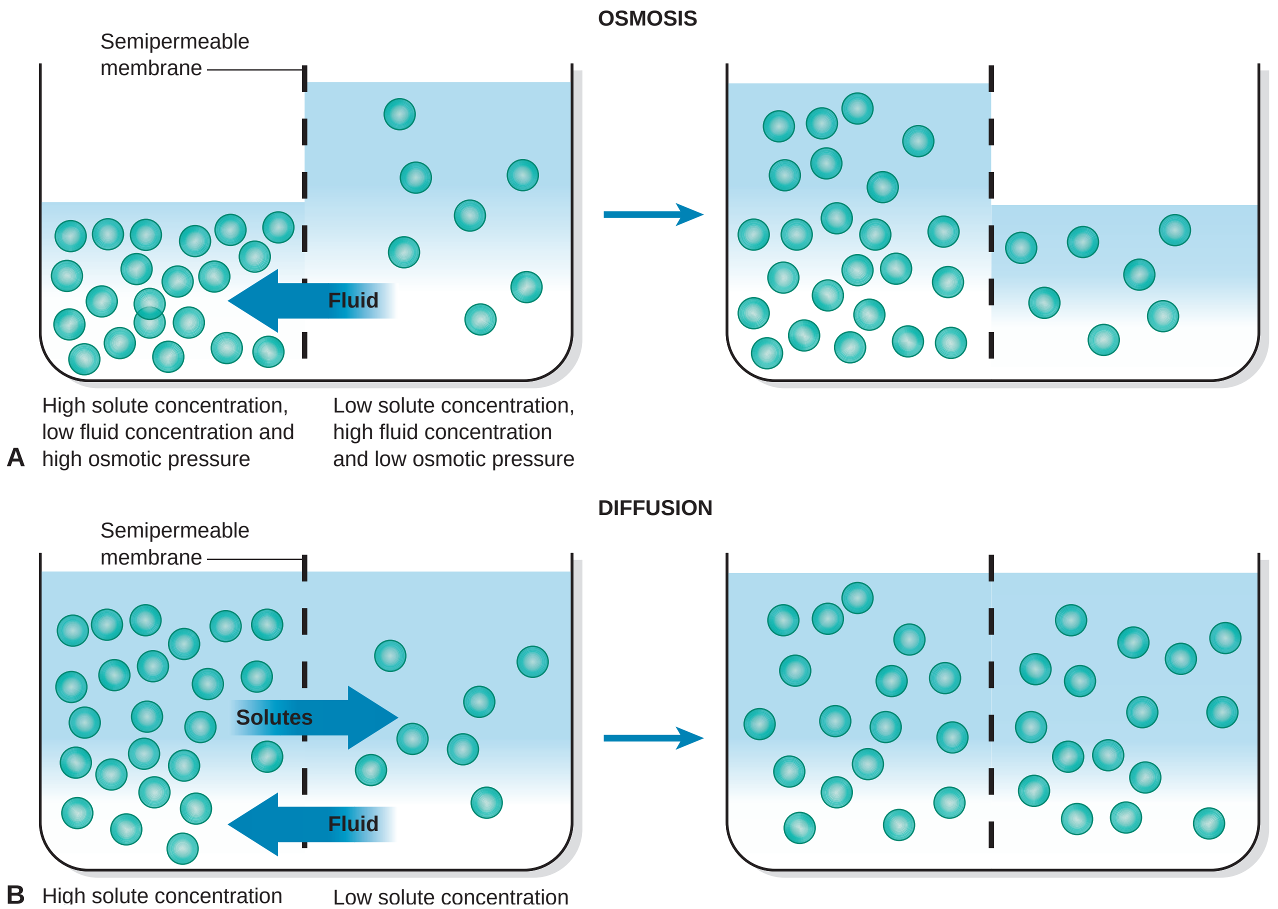



**Figure 14-1** **A,** Osmosis: movement of fluid from an area of lower solute concentration to an area of higher solute concentration with eventual equalization of the solute concentrations. **B,** Diffusion: movement of solutes from an area of greater concentration to an area of lesser concentration, leading ultimately to equalization of the solute concentrations.

primarily determined by the concentration of solutes.

- Oncotic pressure is the osmotic pressure exerted by proteins (eg, albumin).
- Osmotic diuresis is the increase in urine output caused by the excretion of substances such as glucose, mannitol, or contrast agents in the urine.

### Diffusion

**Diffusion** is the natural tendency of a substance to move from an area of higher concentration to one of lower concentration (see Fig. 14-1B). It occurs through the random movement of ions and molecules (Porth & Matfin, 2009). Examples of diffusion are the exchange of oxygen and carbon dioxide between the pulmonary capillaries and alveoli and the tendency of sodium to move from the ECF compartment, where the sodium concentration is high, to the ICF, where its concentration is low.

### Filtration

Hydrostatic pressure in the capillaries tends to filter fluid out of the intravascular compartment into the interstitial fluid. Movement of water and solutes occurs from an area of high hydrostatic pressure to an area of low hydrostatic pressure. The kidneys filter approximately 180 L of plasma per day. Another example of filtration is the passage of water and electrolytes from the arterial capillary bed to the interstitial fluid; in this instance, the hydrostatic pressure results from the pumping action of the heart.

### Sodium–Potassium Pump

As previously stated, the sodium concentration is greater in the ECF than in the ICF, and because of this, sodium tends to enter the cell by diffusion. This tendency is offset by the sodium–potassium pump that is maintained by the cell membrane and actively moves sodium from the cell into the ECF. Conversely, the high intracellular potassium concentration is maintained by pumping potassium into the cell. By definition, **active transport** implies that energy must be expended for the movement to occur against a concentration gradient.

## Systemic Routes of Gains and Losses

Water and electrolytes are gained in various ways. Healthy people gain fluids by drinking and eating, and their daily average intake and output of water are approximately equal (Table 14-2).

**Table 14-2 AVERAGE DAILY INTAKE AND OUTPUT IN AN ADULT**

| Intake (mL) | | Output (mL) | |
|---|---|---|---|
| Oral liquids | 1300 | Urine | 1500 |
| Water in food | 1000 | Stool | 200 |
| Water produced by metabolism | 300 | Insensible | |
| | | Lungs | 300 |
| | | Skin | 600 |
| Total gain* | 2600 | Total loss* | 2600 |

*Approximate volumes.

**NURSING ALERT**

**When fluid balance is critical, all routes of systemic gain and loss must be recorded and all volumes compared. Organs of fluid loss include the kidneys, skin, lungs, and gastrointestinal (GI) tract.**

### Kidneys

The usual daily urine volume in the adult is 1 to 2 L. A general rule is that the output is approximately 1 mL of urine per kilogram of body weight per hour (1 mL/kg/h) in all age groups.

### Skin

Sensible perspiration refers to visible water and electrolyte loss through the skin (sweating). The chief solutes in sweat are sodium, chloride, and potassium. Actual sweat losses can vary from 0 to 1000 mL or more every hour, depending on factors such as the environmental temperature. Continuous water loss by evaporation (approximately 600 mL/day) occurs through the skin as insensible perspiration, a nonvisible form of water loss. Fever greatly increases insensible water loss through the lungs and the skin, as does loss of the natural skin barrier (eg, through major burns).

### Lungs

The lungs normally eliminate water vapor (insensible loss) at a rate of approximately 300 mL every day. The loss is much greater with increased respiratory rate or depth, or in a dry climate.

### Gastrointestinal Tract

The usual loss through the GI tract is 100 to 200 mL daily, even though approximately 8 L of fluid circulates through the GI system every 24 hours. Because the bulk of fluid is normally reabsorbed in the small intestine, diarrhea and fistulas cause large losses.

## Laboratory Tests for Evaluating Fluid Status

**Osmolality** is the concentration of fluid that affects the movement of water between fluid compartments by osmosis. Osmolality measures the solute concentration per kilogram in blood and urine. It is also a measure of a solution's ability to create osmotic pressure and affect the movement of water. Serum osmolality primarily reflects the concentration of sodium, although blood urea nitrogen (BUN) and glucose also play a major role in determining serum osmolality. Urine osmolality is determined by urea, creatinine, and uric acid. When measured with serum osmolality, urine osmolality is the most reliable indicator of urine concentration. Osmolality is reported as milliosmoles per kilogram of water (mOsm/kg) (Goertz, 2006).

In healthy adults, serum osmolality is 280 to 300 mOsm/kg, and normal urine osmolality is 200 to 800 mOsm/kg (Goertz, 2006). Sodium predominates in ECF osmolality and holds water in this compartment. Factors that increase and decrease serum and urine osmolality are identified in Chart 14-1. Serum osmolality may be measured directly through laboratory tests or estimated at the

**Chart 14-1 • *Factors Affecting Serum and Urine Osmolality***

| Fluid | Factors Increasing Osmolality | Factors Decreasing Osmolality |
|---|---|---|
| Serum (280–300 mOsm/kg water) | • Severe dehydration<br>• Free water loss<br>• Diabetes insipidus<br>• Hypernatremia<br>• Hyperglycemia<br>• Stroke or head injury<br>• Renal tubular necrosis<br>• Consumption of methanol or ethylene glycol (antifreeze) | • Fluid volume excess<br>• Syndrome of inappropriate antidiuretic hormone (SIADH)<br>• Renal failure<br>• Diuretic use<br>• Adrenal insufficiency<br>• Hyponatremia<br>• Overhydration<br>• Paraneoplastic syndrome associated with lung cancer |
| Urine (200–800 mOsm/kg water) | • Fluid volume deficit<br>• SIADH<br>• Congestive heart failure<br>• Acidosis<br>• Prerenal failure | • Fluid volume excess<br>• Diabetes insipidus<br>• Hyponatremia<br>• Aldosteronism<br>• Pyelonephritis<br>• Acute tubular necrosis |

bedside by doubling the serum sodium level or by using the following formula:

$$Na^{+} \times 2 = \frac{\text{Glucose}}{18} + \frac{\text{BUN}}{3}$$
$$= \text{Approximate value of serum osmolality}$$

**Osmolarity,** another term that describes the concentration of solutions, is measured in milliosmoles per liter (mOsm/L). However, the term osmolality is used more often in clinical practice. The calculated value usually is within 10 mOsm of the measured osmolality.

Urine specific gravity measures the kidneys' ability to excrete or conserve water. The specific gravity of urine is compared to the weight of distilled water, which has a specific gravity of 1.000. The normal range of urine specific gravity is 1.010 to 1.025. Urine specific gravity can be measured at the bedside by placing a calibrated hydrometer or urinometer in a cylinder of approximately 20 mL of urine. Specific gravity can also be assessed with a refractometer or dipstick with a reagent for this purpose. Specific gravity varies inversely with urine volume; normally, the larger the volume of urine, the lower the specific gravity is. Specific gravity is a less reliable indicator of concentration than urine osmolality; increased glucose or protein in urine can cause a falsely elevated specific gravity. Factors that increase or decrease urine osmolality are the same as those for urine specific gravity.

BUN is made up of urea, which is an end product of the metabolism of protein (from both muscle and dietary intake) by the liver. Amino acid breakdown produces large amounts of ammonia molecules, which are absorbed into the bloodstream. Ammonia molecules are converted to urea and excreted in the urine. The normal BUN is 10 to 20 mg/dL (3.6 to 7.2 mmol/L). The BUN level varies with urine output. Factors that increase BUN include decreased renal function, GI bleeding, dehydration, increased protein intake, fever, and sepsis. Those that decrease BUN include end-stage liver disease, a low-protein diet, starvation, and any condition that results in expanded fluid volume (eg, pregnancy).

Creatinine is the end product of muscle metabolism. It is a better indicator of renal function than BUN because it does not vary with protein intake and metabolic state. The normal serum creatinine is approximately 0.7 to 1.4 mg/dL (62 to 124 mmol/L); however, its concentration depends on lean body mass and varies from person to person. Serum creatinine levels increase when renal function decreases.

Hematocrit measures the volume percentage of red blood cells (erythrocytes) in whole blood and normally ranges from 42% to 52% for males and 35% to 47% for females. Conditions that increase the hematocrit value are dehydration and polycythemia, and those that decrease hematocrit are overhydration and anemia.

Urine sodium values change with sodium intake and the status of fluid volume: As sodium intake increases, excretion increases; as the circulating fluid volume decreases, sodium is conserved. Normal urine sodium levels range from 75 to 200 mEq/24 hours (75 to 200 mmol/24 hours). A random specimen usually contains more than 40 mEq/L of sodium. Urine sodium levels are used to assess volume status and are useful in the diagnosis of hyponatremia and acute renal failure.

## Homeostatic Mechanisms

The body is equipped with remarkable homeostatic mechanisms to keep the composition and volume of body fluid within narrow limits of normal. Organs involved in homeostasis include the kidneys, lungs, heart, adrenal glands, parathyroid glands, and pituitary gland (Porth & Matfin, 2009).

### *Kidney Functions*

Vital to the regulation of fluid and electrolyte balance, the kidneys normally filter 180 L of plasma every day in the adult and excrete 1 to 2 L of urine. They act both autonomously and in response to bloodborne messengers, such as aldosterone and antidiuretic hormone (ADH) (Porth & Matfin, 2009). Major functions of the kidneys in maintaining normal fluid balance include the following:

- Regulation of ECF volume and osmolality by selective retention and excretion of body fluids

- Regulation of normal electrolyte levels in the ECF by selective electrolyte retention and excretion
- Regulation of pH of the ECF by retention of hydrogen ions
- Excretion of metabolic wastes and toxic substances

Given these functions, failure of the kidneys results in multiple fluid and electrolyte abnormalities.

### Heart and Blood Vessel Functions

The pumping action of the heart circulates blood through the kidneys under sufficient pressure to allow for urine formation. Failure of this pumping action interferes with renal perfusion and thus with water and electrolyte regulation.

### Lung Functions

The lungs are also vital in maintaining homeostasis. Through exhalation, the lungs remove approximately 300 mL of water daily in the normal adult. Abnormal conditions, such as hyperpnea (abnormally deep respiration) or continuous coughing, increase this loss; mechanical ventilation with excessive moisture decreases it. The lungs also play a major role in maintaining acid–base balance.

### Pituitary Functions

The hypothalamus manufactures ADH, which is stored in the posterior pituitary gland and released as needed to conserve water. Functions of ADH include maintaining the osmotic pressure of the cells by controlling the retention or excretion of water by the kidneys and by regulating blood volume (Fig. 14-2).

### Adrenal Functions

Aldosterone, a mineralocorticoid secreted by the zona glomerulosa (outer zone) of the adrenal cortex, has a profound effect on fluid balance. Increased secretion of aldosterone causes sodium retention (and thus water retention) and potassium loss. Conversely, decreased secretion of aldosterone causes sodium and water loss and potassium retention.

Cortisol, another adrenocortical hormone, has less mineralocorticoid action. However, when secreted in large quantities (or administered as corticosteroid therapy), it can also produce sodium and fluid retention.

### Parathyroid Functions

The parathyroid glands, embedded in the thyroid gland, regulate calcium and phosphate balance by means of parathyroid hormone (PTH). PTH influences bone resorption, calcium absorption from the intestines, and calcium reabsorption from the renal tubules.

### Other Mechanisms

Changes in the volume of the interstitial compartment within the ECF can occur without affecting body function. However, the vascular compartment cannot tolerate change as readily and must be carefully maintained to ensure that tissues receive adequate nutrients.

#### Baroreceptors

The baroreceptors are located in the left atrium and the carotid and aortic arches. These receptors respond to changes in the circulating blood volume and regulate sympathetic and parasympathetic neural activity as well as endocrine activities (Rottmann, 2007).

As arterial pressure decreases, baroreceptors transmit fewer impulses from the carotid and the aortic arches to the vasomotor center. A decrease in impulses stimulates the sympathetic nervous system and inhibits the parasympathetic nervous system. The outcome is an increase in cardiac rate, conduction, and contractility and an increase in circulating blood volume. Sympathetic stimulation constricts renal arterioles; this increases the release of aldosterone, decreases glomerular filtration, and increases sodium and water reabsorption.

#### Renin–Angiotensin–Aldosterone System

Renin is an enzyme that converts angiotensinogen, a substance formed by the liver, into angiotensin I (Porth & Matfin, 2009). Renin is released by the juxtaglomerular cells of the kidneys in response to decreased renal perfusion. Angiotensin-converting enzyme (ACE) converts angiotensin I to angiotensin II. Angiotensin II, with its vasoconstrictor properties, increases arterial perfusion pressure and stimulates thirst. As the sympathetic nervous system is stimulated, aldosterone is released in response to an increased release of renin. Aldosterone is a volume regulator and is also released as serum potassium increases, serum sodium decreases, or adrenocorticotropic hormone (ACTH) increases.

#### Antidiuretic Hormone and Thirst

ADH and the thirst mechanism have important roles in maintaining sodium concentration and oral intake of fluids. Oral intake is controlled by the thirst center located in the hypothalamus (Porth & Matfin, 2009). As serum concentration or osmolality increases or blood volume decreases, neurons in the hypothalamus are stimulated by intracellular dehydration; thirst then occurs, and the person increases his or her intake of oral fluids. Water excretion is controlled by ADH, aldosterone, and baroreceptors, as mentioned previously. The presence or absence of ADH is the most significant factor in determining whether the urine that is excreted is concentrated or dilute.

#### Osmoreceptors

Located on the surface of the hypothalamus, osmoreceptors sense changes in sodium concentration. As osmotic pressure increases, the neurons become dehydrated and quickly release impulses to the posterior pituitary, which increases the release of ADH, which then travels in the blood to the kidneys, where it alters permeability to water, causing increased reabsorption of water and decreased urine output. The retained water dilutes the ECF and returns its concentration to normal. Restoration of normal osmotic pressure provides feedback to the osmoreceptors to inhibit further ADH release (see Fig. 14-2).

#### Release of Atrial Natriuretic Peptide

Atrial natriuretic peptide (ANP), also called atrial natriuretic factor, is a peptide that is synthesized, stored, and released by muscle cells of the atria of the heart in response to several factors. These factors include increased atrial pressure, angiotensin II stimulation, endothelin (a powerful vasoconstrictor of vascular smooth muscle peptide released from damaged endothelial cells in the kidneys or other tissues), and

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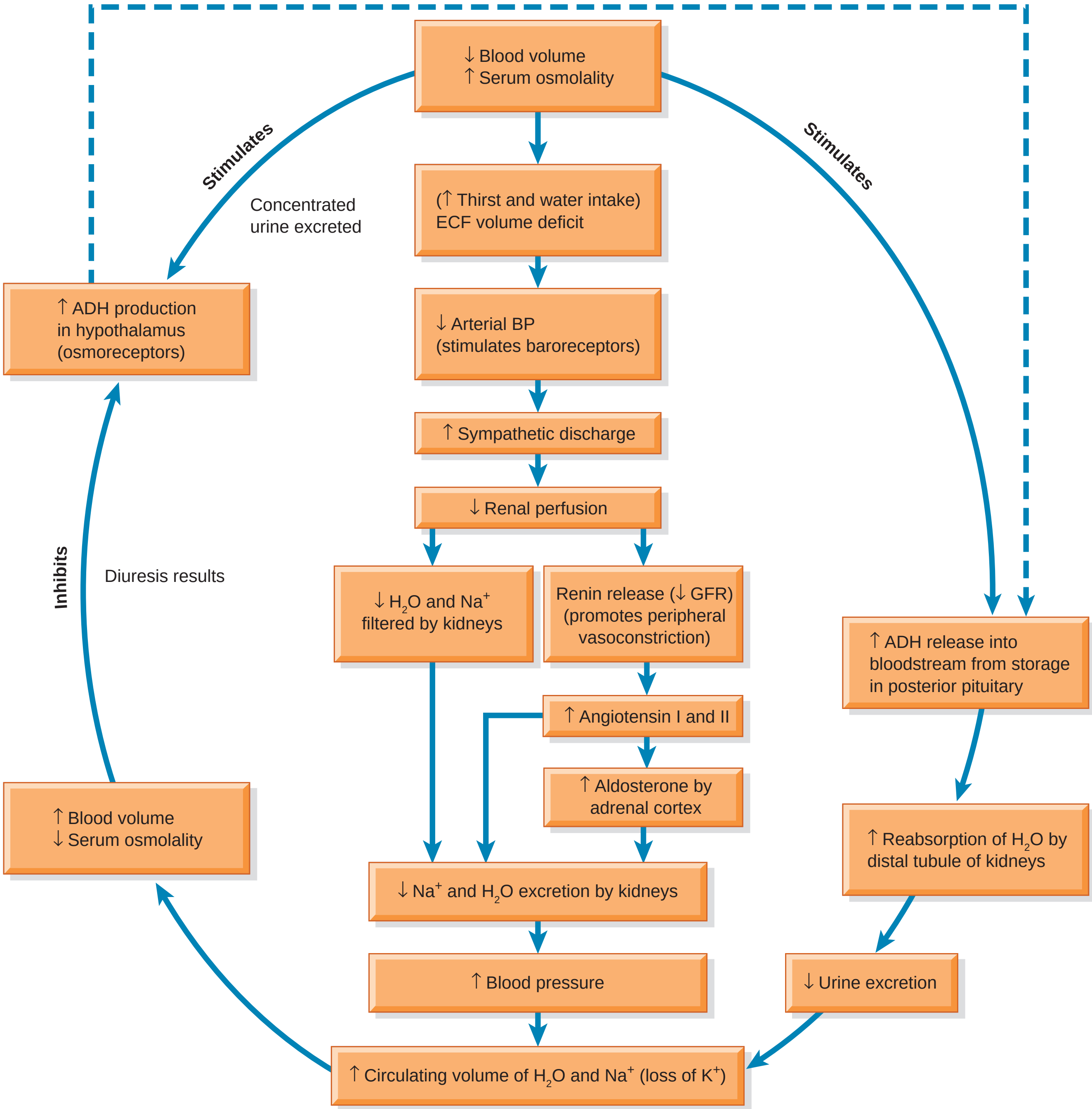



**Figure 14-2** Fluid regulation cycle. ADH, antidiuretic hormone; BP, blood pressure; ECF, extracellular fluid; GFR, glomerular filtration rate.

sympathetic stimulation (Porth & Matfin, 2009). In addition, any condition that results in volume expansion (exercise, pregnancy), hypoxia, or increased cardiac filling pressures (eg, high sodium intake, heart failure, chronic renal failure, atrial tachycardia, or use of vasoconstrictor agents such as epinephrine) increases the release of ANP. The action of ANP is the direct opposite of the renin–angiotensin–aldosterone system; ANP decreases blood pressure and volume (Fig. 14-3). The ANP measured in plasma is normally 20 to 77 pg/mL (20 to 77 ng/L). This level increases in acute heart failure, paroxysmal supraventricular tachycardia, hyperthyroidism, subarachnoid hemorrhage, and small cell lung cancer. The level decreases in chronic heart failure and with the use of medications such as urea (Ureaphil) and prazosin (Minipress).

## Gerontologic Considerations

Normal physiologic changes of aging, including reduced cardiac, renal, and respiratory function and reserve and alterations in the ratio of body fluids to muscle mass, may

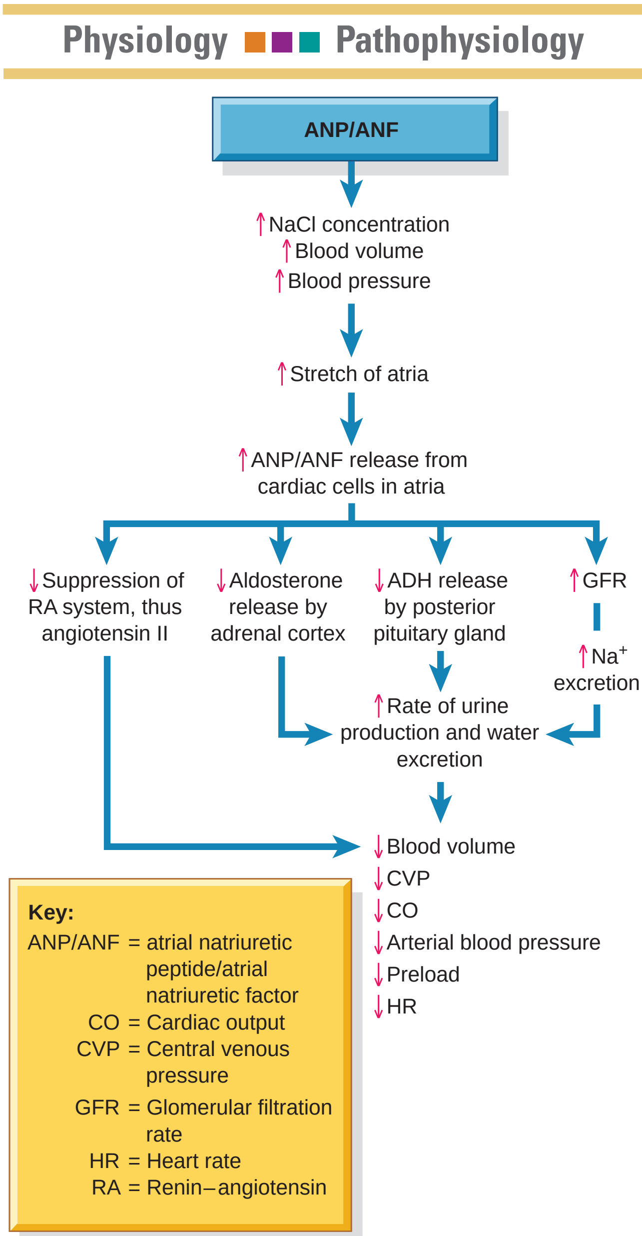



**Figure 14-3** Role of ANP in maintenance of fluid balance.

alter the responses of elderly people to fluid and electrolyte changes and acid–base disturbances. Decreased respiratory function can cause impaired pH regulation in older adults with major illness or trauma. Renal function declines with age, as do muscle mass and daily exogenous creatinine production. Therefore, high-normal and minimally elevated serum creatinine values may indicate substantially reduced renal function in older adults.

In addition, the use of multiple medications by older adults can affect renal and cardiac function, thereby increasing the likelihood of fluid and electrolyte disturbances. Routine procedures, such as the vigorous administration of laxatives or enemas before colon x-ray studies, may produce a serious fluid volume deficit, necessitating the use of intravenous (IV) fluids to prevent hypotension and other effects of hypovolemia.

Alterations in fluid and electrolyte balance that may produce minor changes in young and middle-aged adults may produce profound changes in older adults. In many elderly patients, the clinical manifestations of fluid and electrolyte disturbances may be subtle or atypical. For example, fluid deficit may cause delirium in the elderly person (see Chapter 12), whereas in the young or middle-aged person the first sign commonly is increased thirst. Rapid infusion of an excessive volume of IV fluids may produce fluid overload and cardiac failure in elderly patients. These reactions are likely to occur more quickly and with the administration of smaller volumes of fluid than in healthy young and middle-aged adults because of the decreased cardiac reserve and reduced renal function that accompany aging. Dehydration in the elderly is common as a result of decreased kidney mass, decreased glomerular filtration rate, decreased renal blood flow, decreased ability to concentrate urine, inability to conserve sodium, decreased excretion of potassium, and a decrease of total body water (Powers & Daly, 2007).

# FLUID VOLUME DISTURBANCES

## *Hypovolemia*

Fluid volume deficit (FVD), or hypovolemia, occurs when loss of ECF volume exceeds the intake of fluid. It occurs when water and electrolytes are lost in the same proportion as they exist in normal body fluids, so that the ratio of serum electrolytes to water remains the same. FVD (hypovolemia) should not be confused with dehydration, which refers to loss of water alone, with increased serum sodium levels. FVD may occur alone or in combination with other imbalances. Unless other imbalances are present concurrently, serum electrolyte concentrations remain essentially unchanged.

### Pathophysiology

FVD results from loss of body fluids and occurs more rapidly when coupled with decreased fluid intake. FVD can also develop with a prolonged period of inadequate intake. Causes of FVD include abnormal fluid losses, such as those resulting from vomiting, diarrhea, GI suctioning, and sweating; decreased intake, as in nausea or lack of access to fluids (Heitz & Horne, 2005); and third-space fluid shifts, or the movement of fluid from the vascular system to other body spaces (eg, with edema formation in burns, ascites with liver dysfunction). Additional causes include diabetes insipidus, adrenal insufficiency, osmotic diuresis, hemorrhage, and coma.

### Clinical Manifestations

FVD can develop rapidly, and its severity depends on the degree of fluid loss. Clinical signs and symptoms include acute weight loss; decreased skin turgor; oliguria; concentrated urine; orthostatic hypotension due to volume depletion; a weak, rapid heart rate; flattened neck veins; increased temperature; thirst; decreased or delayed capillary refill; decreased central venous pressure; cool, clammy, pale skin related to peripheral vasoconstriction; anorexia; nausea; lassitude; muscle weakness; and cramps.

## Assessment and Diagnostic Findings

Laboratory data useful in evaluating fluid volume status include BUN and its relation to serum creatinine concentration. A volume-depleted patient has a BUN elevated out of proportion to the serum creatinine (ratio greater than 20:1). The BUN can be elevated because of dehydration or decreased renal perfusion and function. The cause of hypovolemia may be determined through the health history and physical examination. Also, the hematocrit level is greater than normal because there is a decreased plasma volume (Powers & Daly, 2007).

Serum electrolyte changes may also exist. Potassium and sodium levels can be reduced (hypokalemia, hyponatremia) or elevated (hyperkalemia, hypernatremia).

- Hypokalemia occurs with GI and renal losses.
- Hyperkalemia occurs with adrenal insufficiency.
- Hyponatremia occurs with increased thirst and ADH release.
- Hypernatremia results from increased insensible losses and diabetes insipidus.

Urine specific gravity is increased in relation to the kidneys' attempt to conserve water and is decreased with diabetes insipidus. Aldosterone is secreted when fluid volume is low causing reabsorption of sodium and chloride, resulting in decreased urinary sodium and chloride. Urine osmolality can be greater than 450 mOsm/kg, because the kidneys try to compensate by conserving water. Normal values for laboratory data are listed in Appendix A.

## Gerontologic Considerations

Increased sensitivity to fluid and electrolyte changes in elderly patients requires careful assessment of intake and output of fluids from all sources, assessment of changes in daily weight, careful monitoring of side effects and interactions of medications, and prompt reporting and management of disturbances. It is necessary to monitor skin turgor serially to detect subtle changes. However, assessment of skin turgor is not as valid in the elderly because the skin has lost some of its elasticity; therefore, other assessment measures (eg, slowness in filling of veins of the hands and feet) become more useful in detecting FVD. Skin turgor is best tested over the forehead or the sternum in elderly patients, because alterations in skin elasticity are less marked in these areas.

The nurse also performs a functional assessment of the ability of the elderly patient to determine fluid and food needs and to obtain adequate intake in addition to other assessments discussed earlier in this chapter. For example, is the patient cognitively intact, able to ambulate and to use both arms and hands to reach fluids and foods, and able to swallow? Results of this assessment have a direct bearing on how the patient will be able to meet his or her own need for fluids and foods. During an elderly patient's hospital stay, the nurse provides fluids if the patient is unable to carry out self-care activities.

The nurse should also recognize that some elderly patients deliberately restrict their fluid intake to avoid embarrassing episodes of incontinence. In this situation, the nurse identifies interventions to deal with the incontinence, such as encouraging the patient to wear protective clothing or devices, to carry a urinal in the car, or to pace fluid intake to allow access to toilet facilities during the day. Elderly people without cardiovascular or renal dysfunction should be reminded to drink adequate fluids, particularly in very warm or humid weather.

## Medical Management

When planning the correction of fluid loss for the patient with FVD, the primary health care provider considers the maintenance requirements of the patient and other factors (eg, fever) that can influence fluid needs. If the deficit is not severe, the oral route is preferred, provided the patient can drink. However, if fluid losses are acute or severe, the IV route is required. Isotonic electrolyte solutions (eg, lactated Ringer's solution, 0.9% sodium chloride) are frequently used to treat the hypotensive patient with FVD because they expand plasma volume. As soon as the patient becomes normotensive, a hypotonic electrolyte solution (eg, 0.45% sodium chloride) is often used to provide both electrolytes and water for renal excretion of metabolic wastes. These and additional fluids are listed in Table 14-3.

Accurate and frequent assessments of I&O, weight, vital signs, central venous pressure, level of consciousness, breath sounds, and skin color should be performed to determine when therapy should be slowed to avoid volume overload. The rate of fluid administration is based on the severity of loss and the patient's hemodynamic response to volume replacement (Porth & Matfin, 2009).

If the patient with severe FVD is not excreting enough urine and is therefore oliguric, the primary health care provider needs to determine whether the depressed renal function is caused by reduced renal blood flow secondary to FVD (prerenal azotemia) or, more seriously, by acute tubular necrosis from prolonged FVD. The test used in this situation is referred to as a fluid challenge test. During a fluid challenge test, volumes of fluid are administered at specific rates and intervals while the patient's hemodynamic response to this treatment is monitored (ie, vital signs, breath sounds, sensorium, central venous pressure, urine output).

An example of a typical fluid challenge involves administering 100 to 200 mL of normal saline solution over 15 minutes. The goal is to provide fluids rapidly enough to attain adequate tissue perfusion without compromising the cardiovascular system. The response by a patient with FVD but normal renal function is increased urine output and an increase in blood pressure and central venous pressure.

Shock can occur when the volume of fluid lost exceeds 25% of the intravascular volume, or when fluid loss is rapid. Shock and its causes and treatment are discussed in detail in Chapter 15.

## Nursing Management

To assess for FVD, the nurse monitors and measures fluid I&O at least every 8 hours, and sometimes hourly. As FVD develops, body fluid losses exceed fluid intake through excessive urination (polyuria), diarrhea, vomiting, or other mechanisms. Once FVD has developed, the kidneys attempt to conserve body fluids, leading to a urine output of less than 30 mL/h in an adult. Urine in this instance is concentrated and represents a healthy renal response. Daily body weights are monitored; an acute loss of 0.5 kg (1 lb)

**Table 14-3 SELECTED WATER AND ELECTROLYTE SOLUTIONS**

| Solution | Comments |
|---|---|
| **Isotonic Solutions**<br>0.9% NaCl (isotonic, also called normal saline [NS])<br>$Na^+$ 154 mEq/L<br>$Cl^-$ 154 mEq/L<br>(308 mOsm/L)<br>Also available with varying concentrations of dextrose (the most frequently used is a 5% dextrose concentration) | • An isotonic solution that expands the extracellular fluid (ECF) volume, used in hypovolemic states, resuscitative efforts, shock, diabetic ketoacidosis, metabolic alkalosis, hypercalcemia, mild $Na^+$ deficit<br>• Supplies an excess of $Na^+$ and $Cl^-$; can cause fluid volume excess and hyperchloremic acidosis if used in excessive volumes, particularly in patients with compromised renal function, heart failure, or edema<br>• Not desirable as a routine maintenance solution, as it provides only $Na^+$ and $Cl^-$ (and these are provided in excessive amounts)<br>• When mixed with 5% dextrose, the resulting solution becomes hypertonic in relation to plasma and, in addition to the above described electrolytes, provides 170 cal/L<br>• Only solution that may be administered with blood products<br>• Tonicity similar to plasma |
| Lactated Ringer's solution (Hartmann's solution)<br>$Na^+$ 130 mEq/L<br>$K^+$ 4 mEq/L<br>$Ca^{++}$ 3 mEq/L<br>$Cl^-$ 109 mEq/L<br>Lactate (metabolized to bicarbonate)<br>28 mEq/L (274 mOsm/L)<br>Also available with varying concentrations of dextrose (the most common is 5% dextrose) | • An isotonic solution that contains multiple electrolytes in roughly the same concentration as found in plasma (note that solution is lacking in $Mg^{++}$): provides 9 cal/L<br>• Used in the treatment of hypovolemia, burns, fluid lost as bile or diarrhea, and for acute blood loss replacement<br>• Lactate is rapidly metabolized into $HCO_3^-$ in the body. Lactated Ringer's solution should not be used in lactic acidosis because the ability to convert lactate into $HCO_3^-$ is impaired in this disorder.<br>• Not to be given with a pH > 7.5 because bicarbonate is formed as lactate breaks down, causing alkalosis<br>• Should not be used in renal failure because it contains potassium and can cause hyperkalemia<br>• Tonicity similar to plasma |
| 5% dextrose in water ($D_5W$)<br>No electrolytes<br>50 g of dextrose | • An isotonic solution that supplies 170 cal/L and free water to aid in renal excretion of solutes<br>• Used in treatment of hypernatremia, fluid loss, and dehydration<br>• Should not be used in excessive volumes in the early postoperative period (when antidiuretic hormone secretion is increased due to stress reaction)<br>• Should not be used solely in treatment of fluid volume deficit, because it dilutes plasma electrolyte concentrations<br>• Contraindicated in head injury because it may cause increased intracranial pressure<br>• Should not be used for fluid resuscitation because it can cause hyperglycemia<br>• Should be used with caution in patients with renal or cardiac disease because of risk of fluid overload<br>• Electrolyte-free solutions may cause peripheral circulatory collapse, anuria in patients with sodium deficiency, and increased body fluid loss.<br>• Converts to hypotonic solution as dextrose is metabolized by body. Over time, $D_5W$ without NaCl can cause water intoxication (intracellular fluid volume excess [FVE]) because the solution is hypotonic.<br>• Fluid therapy for an extended period of time without electrolytes may result in hypokalemia |
| **Hypotonic Solutions**<br>0.45% NaCl (half-strength saline)<br>$Na^+$ 77 mEq/L<br>$Cl^-$ 77 mEq/L<br>(154 mOsm/L)<br>Also available with varying concentrations of dextrose (the most common is a 5% concentration) | • Provides $Na^+$, $Cl^-$, and free water<br>• Free water is desirable to aid the kidneys in elimination of solute.<br>• Lacking in electrolytes other than $Na^+$ and $Cl^-$<br>• When mixed with 5% dextrose, the solution becomes slightly hypertonic to plasma and in addition to the above-described electrolytes provides 170 cal/L.<br>• Used to treat hypertonic dehydration, $Na^+$ and $Cl^-$ depletion, and gastric fluid loss<br>• Not indicated for third-space fluid shifts or increased intracranial pressure<br>• Administer cautiously, because it can cause fluid shifts from vascular system into cells, resulting in cardiovascular collapse and increased intracranial pressure. |
| **Hypertonic Solutions**<br>3% NaCl (hypertonic saline)<br>$Na^+$ 513 mEq/L<br>$Cl^-$ 513 mEq/L<br>(1026 mOsm/L) | • Used to increase ECF volume, decrease cellular swelling<br>• Highly hypertonic solution used only in critical situations to treat hyponatremia<br>• Must be administered slowly and cautiously, because it can cause intravascular volume overload and pulmonary edema<br>• Supplies no calories<br>• Assists in removing intracellular fluid excess |
| 5% NaCL (hypertonic solution)<br>$Na^+$ 855 mEq/L<br>$Cl^-$ 855 mEq/L<br>(1710 mOsm/L) | • Highly hypertonic solution used to treat symptomatic hyponatremia<br>• Administer slowly and cautiously, because it can cause intravascular volume overload and pulmonary edema.<br>• Supplies no calories |
| **Colloid Solutions**<br>Dextran in NS or 5% $D_5W$<br>Available in low-molecular-weight (Dextran 40) and high-molecular-weight (Dextran 70) forms | • Colloid solution used as volume/plasma expander for intravascular part of ECF<br>• Affects clotting by coating platelets and decreasing ability to clot<br>• Remains in circulatory system up to 24 h<br>• Used to treat hypovolemia in early shock to increase pulse pressure, cardiac output, and arterial blood pressure<br>• Improves microcirculation by decreasing red blood cell aggregation<br>• Contraindicated in hemorrhage, thrombocytopenia, renal disease, and severe dehydration<br>• Not a substitute for blood or blood products |

represents a fluid loss of approximately 500 mL. (One liter of fluid weighs approximately 1 kg, or 2.2 lb.)

Vital signs are closely monitored. The nurse observes for a weak, rapid pulse and orthostatic hypotension (ie, a decrease in systolic pressure exceeding 15 mm Hg when the patient moves from a lying to a sitting position). A decrease in body temperature often accompanies FVD, unless there is a concurrent infection.

Skin and tongue turgor are monitored on a regular basis. In a healthy person, pinched skin immediately returns to its normal position when released. This elastic property, referred to as turgor, is partially dependent on interstitial fluid volume. In a person with FVD, the skin flattens more slowly after the pinch is released. In a person with severe FVD, the skin may remain elevated for many seconds. Tissue turgor is best measured by pinching the skin over the sternum, inner aspects of the thighs, or forehead. Tongue turgor is not affected by age (see previous Gerontologic Considerations), and evaluating this may be more valid than evaluating skin turgor. In a normal person, the tongue has one longitudinal furrow. In the person with FVD, there are additional longitudinal furrows and the tongue is smaller, because of fluid loss. The degree of oral mucous membrane moisture is also assessed; a dry mouth may indicate either FVD or mouth breathing.

Urine concentration is monitored by measuring the urine specific gravity. In a volume-depleted patient, the urine specific gravity should be greater than 1.020, indicating healthy renal conservation of fluid.

Mental function is eventually affected in severe FVD as a result of decreasing cerebral perfusion. Decreased peripheral perfusion can result in cold extremities. In patients with relatively normal cardiopulmonary function, a low central venous pressure is indicative of hypovolemia. Patients with acute cardiopulmonary decompensation require more extensive hemodynamic monitoring of pressures in both sides of the heart to determine if hypovolemia exists.

#### Preventing Hypovolemia

To prevent FVD, the nurse identifies patients at risk and takes measures to minimize fluid losses. For example, if the patient has diarrhea, measures should be implemented to control diarrhea and replacement fluids administered. This includes administering antidiarrheal medications and small volumes of oral fluids at frequent intervals.

#### Correcting Hypovolemia

When possible, oral fluids are administered to help correct FVD, with consideration given to the patient's likes and dislikes. The type of fluid the patient has lost is also considered and fluids most likely to replace the lost electrolytes are appropriate. If the patient is reluctant to drink because of oral discomfort, the nurse assists with frequent mouth care and provides nonirritating fluids. The patient may be offered small volumes of oral rehydration solutions (eg, Rehydralyte, Elete, Cytomax). These solutions provide fluid, glucose, and electrolytes in concentrations that are easily absorbed. If nausea is present, antiemetics may be needed before oral fluid replacement can be tolerated.

If the deficit cannot be corrected by oral fluids, therapy may need to be initiated by an alternative route (enteral or parenteral) until adequate circulating blood volume and renal perfusion are achieved. Isotonic fluids are prescribed to increase ECF volume.

## Hypervolemia

Fluid volume excess (FVE), or hypervolemia, refers to an isotonic expansion of the ECF caused by the abnormal retention of water and sodium in approximately the same proportions in which they normally exist in the ECF. It is always secondary to an increase in the total body sodium content, which, in turn, leads to an increase in total body water. Because there is isotonic retention of body substances, the serum sodium concentration remains essentially normal.

### Pathophysiology

FVE may be related to simple fluid overload or diminished function of the homeostatic mechanisms responsible for regulating fluid balance. Contributing factors can include heart failure, renal failure, and cirrhosis of the liver. Another contributing factor is consumption of excessive amounts of table or other sodium salts. Excessive administration of sodium-containing fluids in a patient with impaired regulatory mechanisms may predispose him or her to a serious FVE as well (Heitz & Horne, 2005).

### Clinical Manifestations

Clinical manifestations of FVE result from expansion of the ECF and include edema, distended neck veins, and crackles (abnormal lung sounds). Other manifestations include tachycardia; increased blood pressure, pulse pressure, and central venous pressure; increased weight; increased urine output; and shortness of breath and wheezing.

### Assessment and Diagnostic Findings

Laboratory data useful in diagnosing FVE include BUN and hematocrit levels. In FVE, both of these values may be decreased because of plasma dilution. Other causes of abnormalities in these values include low protein intake and anemia. In chronic renal failure, both serum osmolality and the sodium level are decreased due to excessive retention of water. The urine sodium level is increased if the kidneys are attempting to excrete excess volume. A chest x-ray may reveal pulmonary congestion. Hypervolemia occurs when aldosterone is chronically stimulated (ie, cirrhosis, heart failure, and nephrotic syndrome). Therefore, the urine sodium level does not increase in these conditions.

### Medical Management

Management of FVE is directed at the causes, and if related to excessive administration of sodium-containing fluids, discontinuing the infusion may be all that is needed. Symptomatic treatment consists of administering diuretics and restricting fluids and sodium.

### Pharmacologic Therapy

Diuretics are prescribed when dietary restriction of sodium alone is insufficient to reduce edema by inhibiting the reabsorption of sodium and water by the kidneys. The choice of diuretic is based on the severity of the hypervolemic state, the degree of impairment of renal function, and the potency of the diuretic. Thiazide diuretics block sodium reabsorption in the distal tubule, where only 5% to 10% of filtered sodium is reabsorbed. Loop diuretics, such as furosemide (Lasix), bumetanide (Bumex), or torsemide (Demadex), can cause a greater loss of both sodium and water because they block sodium reabsorption in the ascending limb of the loop of Henle, where 20% to 30% of filtered sodium is normally reabsorbed. Generally, thiazide diuretics, such as hydrochlorothiazide (HydroDIURIL) or metolazone (Mykrox, Zaroxolyn), are prescribed for mild to moderate hypervolemia and loop diuretics for severe hypervolemia.

Electrolyte imbalances may result from the effect of the diuretic. Hypokalemia can occur with all diuretics except those that work in the last distal tubule of the nephrons. Potassium supplements can be prescribed to avoid this complication. Hyperkalemia can occur with diuretics that work in the last distal tubule (eg, spironolactone [Aldactone]), especially in patients with decreased renal function. Hyponatremia occurs with diuresis due to increased release of ADH secondary to reduction in circulating volume. Decreased magnesium levels occur with administration of loop and thiazide diuretics due to decreased reabsorption and increased excretion of magnesium by the kidney.

Azotemia (increased nitrogen levels in the blood) can occur with FVE when urea and creatinine are not excreted due to decreased perfusion by the kidneys and decreased excretion of wastes. High uric acid levels (hyperuricemia) can also occur from increased reabsorption and decreased excretion of uric acid by the kidneys.

### Dialysis

If renal function is so severely impaired that pharmacologic agents cannot act efficiently, other modalities are considered to remove sodium and fluid from the body. Hemodialysis or peritoneal dialysis may be used to remove nitrogenous wastes and control potassium and acid–base balance, and to remove sodium and fluid. Continuous renal replacement therapy may also be required. See Chapter 44 for a discussion of these treatment modalities.

### Nutritional Therapy

Treatment of FVE usually involves dietary restriction of sodium. An average daily diet not restricted in sodium contains 6 to 15 g of salt, whereas low-sodium diets can range from a mild restriction to as little as 250 mg of sodium per day, depending on the patient's needs. A mild sodium-restricted diet allows only light salting of food (about half the usual amount) in cooking and at the table, and no addition of salt to commercially prepared foods that are already seasoned. Of course, foods high in sodium must be avoided. It is the sodium salt, sodium chloride, rather than sodium itself that contributes to edema. Therefore, patients are instructed to read food labels carefully to determine salt content.

Because about half of ingested sodium is in the form of seasoning, seasoning substitutes can play a major role in decreasing sodium intake. Lemon juice, onions, and garlic are excellent substitute flavorings, although some patients prefer salt substitutes. Most salt substitutes contain potassium and must therefore be used cautiously by patients taking potassium-sparing diuretics (eg, spironolactone, triamterene [Dyrenium], amiloride [Midamor]). They should not be used at all in conditions associated with potassium retention, such as advanced renal disease. Salt substitutes containing ammonium chloride can be harmful to patients with liver damage.

In some communities, the drinking water may contain too much sodium for a sodium-restricted diet. Depending on its source, water may contain as little as 1 mg or more than 1500 mg of sodium per quart. Patients may need to use distilled water if the local water supply is very high in sodium. Bottled water can have a sodium content that ranges from 0 to 1200 mg/L; therefore, if sodium is restricted, the label must be carefully examined for sodium content before purchasing and drinking bottled water. Also, patients on sodium-restricted diets should be cautioned to avoid water softeners that add sodium to water in exchange for other ions, such as calcium. Protein intake may be increased in patients who are malnourished or who have low serum protein levels in an effort to increase capillary oncotic pressure and pull fluid out of the tissues into vessels for excretion by the kidneys.

## Nursing Management

To assess for FVE, the nurse measures I&O at regular intervals to identify excessive fluid retention. The patient is weighed daily, and rapid weight gain is noted. An acute weight gain of 2.2 lb (1 kg) is equivalent to a gain of approximately 1 L of fluid. Breath sounds are assessed at regular intervals in at-risk patients, particularly if parenteral fluids are being administered. The nurse monitors the degree of edema in the most dependent parts of the body, such as the feet and ankles in ambulatory patients and the sacral region in patients confined to bed. Pitting edema is assessed by pressing a finger into the affected part, creating a pit or indentation that is evaluated on a scale of 1+ (minimal) to 4+ (severe). Peripheral edema is monitored by measuring the circumference of the extremity with a tape marked in millimeters (Weber & Kelley, 2007).

### Preventing Hypervolemia

Specific interventions vary with the underlying condition and the degree of FVE. However, most patients require sodium-restricted diets in some form, and adherence to the prescribed diet is encouraged. Patients are instructed to avoid over-the-counter medications without first checking with a health care provider, because these substances may contain sodium. If fluid retention persists despite adherence to a prescribed diet, hidden sources of

sodium, such as the water supply or use of water softeners, should be considered.

#### Detecting and Controlling Hypervolemia

It is important to detect FVE before the condition becomes severe. Interventions include promoting rest, restricting sodium intake, monitoring parenteral fluid therapy, and administering appropriate medications.

Regular rest periods may be beneficial, because bed rest favors diuresis of edema fluid. The mechanism is probably related to diminished venous pooling and the subsequent increase in effective circulating blood volume and renal perfusion. Sodium and fluid restriction should be instituted as indicated. Because most patients with FVE require diuretics, the patient's response to these agents is monitored. The rate of parenteral fluids and the patient's response to these fluids are also closely monitored. If dyspnea or orthopnea is present, the patient is placed in a semi-Fowler's position to promote lung expansion. The patient is turned and repositioned at regular intervals because edematous tissue is more prone to skin breakdown than normal tissue. Because conditions predisposing to FVE are likely to be chronic, patients are taught to monitor their response to therapy by documenting fluid I&O and body weight changes. The importance of adhering to the treatment regimen is emphasized.

#### Teaching Patients About Edema

Because edema is a common manifestation of FVE, patients need to recognize its symptoms and understand its importance. The nurse gives special attention to edema when teaching the patient with FVE. Edema can occur as a result of increased capillary fluid pressure, decreased capillary oncotic pressure, or increased interstitial oncotic pressure, causing expansion of the interstitial fluid compartment (Porth & Matfin, 2009). Edema can be localized (eg, in the ankle, as in rheumatoid arthritis) or generalized (as in cardiac and renal failure). Severe generalized edema is called *anasarca*.

Edema occurs when there is a change in the capillary membrane, increasing the formation of interstitial fluid or decreasing the removal of interstitial fluid. Sodium retention is a frequent cause of the increased ECF volume. Burns and infection are examples of conditions associated with increased interstitial fluid volume. Obstruction to lymphatic outflow, a plasma albumin level less than 1.5 to 2 g/dL, or a decrease in plasma oncotic pressure contributes to increased interstitial fluid volume. The kidneys retain sodium and water when there is decreased ECF volume as a result of decreased cardiac output from heart failure. A thorough medication history is necessary to identify any medications that could cause edema, such as nonsteroidal anti-inflammatory drugs (NSAIDs), estrogens, corticosteroids, and antihypertensive agents.

Ascites is a form of edema in which fluid accumulates in the peritoneal cavity; it results from nephrotic syndrome, cirrhosis, and some malignant tumors. The patient commonly reports shortness of breath and a sense of pressure because of pressure on the diaphragm.

The goal of treatment is to preserve or restore the circulating intravascular fluid volume. Thus, in addition to treating the cause of the edema, other treatments may include diuretic therapy, restriction of fluids and sodium, elevation of the extremities, application of anti-embolism stockings, paracentesis, dialysis, and continuous renal replacement therapy in cases of renal failure or life-threatening fluid volume overload (see Chapter 44).

## ELECTROLYTE IMBALANCES

Disturbances in electrolyte balances are common in clinical practice and must be corrected (Table 14-4).

### Sodium Imbalances

Sodium is the most abundant electrolyte in the ECF; its concentration ranges from 135 to 145 mEq/L (135 to 145 mmol/L) and it is the primary determinant of ECF volume and osmolality. Sodium has a major role in controlling water distribution throughout the body, because it does not easily cross the cell wall membrane and because of its abundance and high concentration in the body. Sodium is regulated by ADH, thirst, and the renin–angiotensin–aldosterone system. A loss or gain of sodium is usually accompanied by a loss or gain of water. Sodium also functions in establishing the electrochemical state necessary for muscle contraction and the transmission of nerve impulses (Criddle, 2006; Hayes, 2007a).

The syndrome of inappropriate secretion of antidiuretic hormone (SIADH) may be associated with sodium imbalance. When there is a decrease in the circulating plasma osmolality, blood volume, or blood pressure, arginine vasopressin (AVP) is released from the posterior pituitary. Oversecretion of AVP can cause SIADH. Patients who are at risk are the elderly, those with acquired immunodeficiency syndrome (AIDS), those on mechanical ventilation, and people taking selective serotonin reuptake inhibitors (SSRIs) (Haskal, 2007; Rottmann, 2007).

Sodium imbalance can develop under simple or complex circumstances. The two most common sodium imbalances are sodium deficit and sodium excess.

## SODIUM DEFICIT (HYPONATREMIA)

Hyponatremia refers to a serum sodium level that is less than 135 mEq/L (135 mmol/L) (Criddle, 2006). Plasma sodium concentration represents the ratio of total body sodium to total body water. A decrease in this ratio can occur because of a low total body sodium with a lesser reduction in total body water, a normal total body sodium content with excess total body water, or an excess of total body sodium with an even greater excess of total body water. A hyponatremic state can be superimposed on an existing FVD or FVE.

**Table 14-4 MAJOR FLUID AND ELECTROLYTE IMBALANCES**

| Imbalance | Contributing Factors | Signs/Symptoms and Laboratory Findings |
|---|---|---|
| Fluid volume deficit (hypovolemia) | Loss of water and electrolytes, as in vomiting, diarrhea, fistulas, fever, excess sweating, burns, blood loss, gastrointestinal suction, and third-space fluid shifts; and decreased intake, as in anorexia, nausea, and inability to gain access to fluid. Diabetes insipidus and uncontrolled diabetes mellitus also contribute to a depletion of extracellular fluid volume. | Acute weight loss, ↓ skin turgor, oliguria, concentrated urine, weak rapid pulse, capillary filling time prolonged, low CVP, ↓ blood pressure, flattened neck veins, dizziness, weakness, thirst and confusion, ↑ pulse, muscle cramps, sunken eyes<br>*Labs indicate:* ↑ hemoglobin and hematocrit, ↑ serum and urine osmolality and specific gravity, ↓ urine sodium, ↑ BUN and creatinine, ↑ urine specific gravity and osmolality |
| Fluid volume excess (hypervolemia) | Compromised regulatory mechanisms, such as renal failure, heart failure, and cirrhosis; overzealous administration of sodium-containing fluids; and fluid shifts (ie, treatment of burns). Prolonged corticosteroid therapy, severe stress, and hyperaldosteronism augment fluid volume excess. | Acute weight gain, peripheral edema and ascites, distended jugular veins, crackles, elevated CVP, shortness of breath, ↑ blood pressure, bounding pulse and cough, ↑ respiratory rate<br>*Labs indicate:* ↓ hemoglobin and hematocrit, ↓ serum and urine osmolality, ↓ urine sodium and specific gravity |
| Sodium deficit (hyponatremia)<br>Serum sodium <135 mEq/L | Loss of sodium, as in use of diuretics, loss of GI fluids, renal disease, and adrenal insufficiency. Gain of water, as in excessive administration of $D_5W$ and water supplements for patients receiving hypotonic tube feedings; disease states associated with SIADH such as head trauma and oat-cell lung tumor; medications associated with water retention (oxytocin and certain tranquilizers); and psychogenic polydipsia. Hyperglycemia and heart failure cause a loss of sodium. | Anorexia, nausea and vomiting, headache, lethargy, dizziness, confusion, muscle cramps and weakness, muscular twitching, seizures, papilledema, dry skin, ↑ pulse, ↓ BP, weight gain, edema<br>*Labs indicate:* ↓ serum and urine sodium, ↓ urine specific gravity and osmolality |
| Sodium excess (hypernatremia)<br>Serum sodium >145 mEq/L | Water deprivation in patients unable to drink at will, hypertonic tube feedings without adequate water supplements, diabetes insipidus, heatstroke, hyperventilation, watery diarrhea, burns, and diaphoresis. Excess corticosteroid, sodium bicarbonate, and sodium chloride administration, and salt water near-drowning victims | Thirst, elevated body temperature, swollen dry tongue and sticky mucous membranes, hallucinations, lethargy, restlessness, irritability, focal or grand mal seizures, pulmonary edema, hyperreflexia, twitching, nausea, vomiting, anorexia, ↑ pulse, and ↑ BP<br>*Labs indicate:* ↑ serum sodium, ↓ urine sodium, ↑ urine specific gravity and osmolality, ↓ CVP |
| Potassium deficit (hypokalemia)<br>Serum potassium <3.5 mEq/L | Diarrhea, vomiting, gastric suction, corticosteroid administration, hyperaldosteronism, carbenicillin, amphotericin B, bulimia, osmotic diuresis, alkalosis, starvation, diuretics, and digoxin toxicity | Fatigue, anorexia, nausea and vomiting, muscle weakness, polyuria, decreased bowel motility, ventricular asystole or fibrillation, paresthesias, leg cramps, ↓ BP, ileus, abdominal distention, hypoactive reflexes. *ECG:* flattened T waves, prominent U waves, ST depression, prolonged PR interval |
| Potassium excess (hyperkalemia)<br>Serum potassium >5.0 mEq/L | Pseudohyperkalemia, oliguric renal failure, use of potassium-conserving diuretics in patients with renal insufficiency, metabolic acidosis, Addison's disease, crush injury, burns, stored bank blood transfusions, rapid IV administration of potassium, and certain medications such as ACE inhibitors, NSAIDs, cyclosporine | Muscle weakness, tachycardia → bradycardia, dysrhythmias, flaccid paralysis, paresthesias, intestinal colic, cramps, abdominal distention, irritability, anxiety. *ECG:* tall tented T waves, prolonged PR interval and QRS duration, absent P waves, ST depression |
| Calcium deficit (hypocalcemia)<br>Serum calcium <8.5 mg/dL | Hypoparathyroidism (may follow thyroid surgery or radical neck dissection), malabsorption, pancreatitis, alkalosis, vitamin D deficiency, massive subcutaneous infection, generalized peritonitis, massive transfusion of citrated blood, chronic diarrhea, decreased parathyroid hormone, diuretic phase of renal failure, ↑ $PO_4$, fistulas, burns, alcoholism | Numbness, tingling of fingers, toes, and circumoral region; positive Trousseau's sign and Chvostek's sign; seizures, carpopedal spasms, hyperactive deep tendon reflexes, irritability, bronchospasm, anxiety, impaired clotting time, ↓ prothrombin, diarrhea, ↓ BP. *ECG:* prolonged QT interval and lengthened ST<br>*Labs indicate:* ↓ $Mg^{++}$ |
| Calcium excess (hypercalcemia)<br>Serum calcium >10.5 mg/dL | Hyperparathyroidism, malignant neoplastic disease, prolonged immobilization, overuse of calcium supplements, vitamin D excess, oliguric phase of renal failure, acidosis, corticosteroid therapy, thiazide diuretic use, increased parathyroid hormone, and digoxin toxicity | Muscular weakness, constipation, anorexia, nausea and vomiting, polyuria and polydipsia, dehydration, hypoactive deep tendon reflexes, lethargy, deep bone pain, pathologic fractures, flank pain, calcium stones, hypertension. *ECG:* shortened ST segment and QT interval, bradycardia, heart blocks |
| Magnesium deficit (hypomagnesemia)<br>Serum magnesium <1.8 mg/dL | Chronic alcoholism, hyperparathyroidism, hyperaldosteronism, diuretic phase of renal failure, malabsorptive disorders, diabetic ketoacidosis, refeeding after starvation, parenteral nutrition, chronic laxative use, diarrhea, acute myocardial infarction, heart failure, decreased serum $K^+$ and $Ca^{++}$ and certain pharmacologic agents (such as gentamicin, cisplatin, and cyclosporine) | Neuromuscular irritability, positive Trousseau's and Chvostek's signs, insomnia, mood changes, anorexia, vomiting, increased tendon reflexes, and ↑ BP. *ECG:* PVCs, flat or inverted T waves, depressed ST segment, prolonged PR interval, and widened QRS |

*Continued*

**Table 14-4 MAJOR FLUID AND ELECTROLYTE IMBALANCES (Continued)**

| Imbalance | Contributing Factors | Signs/Symptoms and Laboratory Findings |
|---|---|---|
| Magnesium excess (hypermagnesemia) Serum magnesium >2.7 mg/dL | Oliguric phase of renal failure (particularly when magnesium-containing medications are administered), adrenal insufficiency, excessive IV magnesium administration, diabetic ketoacidosis, and hypothyroidism | Flushing, hypotension, muscle weakness, drowsiness, hypoactive reflexes, depressed respirations, cardiac arrest and coma, diaphoresis. *ECG:* tachycardia → bradycardia, prolonged PR interval and QRS, peaked T waves |
| Phosphorus deficit (hypophosphatemia) Serum phosphorus <2.5 mg/dL | Refeeding after starvation, alcohol withdrawal, diabetic ketoacidosis, respiratory and metabolic alkalosis, ↓ magnesium, ↓ potassium, hyperparathyroidism, vomiting, diarrhea, hyperventilation, vitamin D deficiency associated with malabsorptive disorders, burns, acid–base disorders, parenteral nutrition, and diuretic and antacid use | Paresthesias, muscle weakness, bone pain and tenderness, chest pain, confusion, cardiomyopathy, respiratory failure, seizures, tissue hypoxia, and increased susceptibility to infection, nystagmus |
| Phosphorus excess (hyperphosphatemia) Serum phosphorus >4.5 mg/dL | Acute and chronic renal failure, excessive intake of phosphorus, vitamin D excess, respiratory and metabolic acidosis, hypoparathyroidism, volume depletion, leukemia/lymphoma treated with cytotoxic agents, increased tissue breakdown, rhabdomyolysis | Tetany, tachycardia, anorexia, nausea and vomiting, muscle weakness, signs and symptoms of hypocalcemia; hyperactive reflexes; soft tissue calcifications in lungs, heart, kidneys, and cornea |
| Chloride deficit (hypochloremia) Serum chloride <96 mEq/L | Addison's disease, reduced chloride intake or absorption, untreated diabetic ketoacidosis, chronic respiratory acidosis, excessive sweating, vomiting, gastric suction, diarrhea, sodium and potassium deficiency, metabolic alkalosis; loop, osmotic, or thiazide diuretic use; overuse of bicarbonate, rapid removal of ascitic fluid with a high sodium content, intravenous fluids that lack chloride (dextrose and water), draining fistulas and ileostomies, heart failure, cystic fibrosis | Agitation, irritability, tremors, muscle cramps, hyperactive deep tendon reflexes, hypertonicity, tetany, slow shallow respirations, seizures, dysrhythmias, coma *Labs indicate:* ↓ serum chloride, ↓ serum sodium, ↑ pH, ↑ serum bicarbonate, ↑ total carbon dioxide content, ↓ urine chloride level, ↓ serum potassium |
| Chloride excess (hyperchloremia) Serum chloride >108 mEq/L | Excessive sodium chloride infusions with water loss, head injury (sodium retention), hypernatremia, renal failure, corticosteroid use, dehydration, severe diarrhea (loss of bicarbonate), respiratory alkalosis, administration of diuretics, overdose of salicylates, Kayexalate, acetazolamide, phenylbutazone and ammonium chloride use, hyperparathyroidism, metabolic acidosis | Tachypnea, lethargy, weakness, deep rapid respirations, decline in cognitive status, ↓ cardiac output, dyspnea, tachycardia, pitting edema, dysrhythmias, coma *Labs indicate:* ↑ serum chloride, ↑ serum potassium and sodium, ↓ serum pH, ↓ serum bicarbonate, normal anion gap, ↑ urinary chloride level |

↑ increased; ↓ decreased; ACE, angiotensin-converting enzyme; BP, blood pressure; BUN, blood urea nitrogen; CVP, central venous pressure; $D_5W$, dextrose 5% in water; GI, gastrointestinal; IV, intravenous; NSAIDs, nonsteroidal anti-inflammatory drugs; PVCs, premature ventricular contractions; SIADH, syndrome of inappropriate secretion of antidiuretic hormone.

## Pathophysiology

Hyponatremia primarily occurs due to an imbalance of water rather than sodium. The urine sodium assists in differentiating renal from nonrenal causes of hyponatremia. Low urine sodium occurs as the kidney retains sodium to compensate for nonrenal fluid loss (ie, vomiting, diarrhea, sweating). High urine sodium concentration is associated with renal salt wasting (ie, diuretic use). In dilutional hyponatremia, the ECF volume is increased without any edema.

A deficiency of aldosterone, as occurs in adrenal insufficiency, also predisposes to sodium deficiency. In addition, the use of certain medications, such as anticonvulsants (ie, carbamazepine [Tegretol], levetiracetam [Keppra]) and SSRIs (fluoxetine [Sarafem], sertraline [Zoloft], paroxetine [Paxil]), increases the risk of hyponatremia (McPhee, et al., 2007; Rottmann, 2007).

SIADH is seen in hyponatremia as well as hypernatremia. The physiologic disturbances include excessive ADH activity, with water retention and dilutional hyponatremia, and inappropriate urinary excretion of sodium in the presence of hyponatremia. SIADH can be the result of either sustained secretion of ADH by the hypothalamus or production of an ADH-like substance from a tumor (aberrant ADH production). Conditions affecting the central nervous system are associated with SIADH. SIADH is discussed in more detail in Chapter 42.

## Clinical Manifestations

Clinical manifestations of hyponatremia depend on the cause, magnitude, and speed with which the deficit occurs. Poor skin turgor, dry mucosa, headache, decreased saliva production, orthostatic fall in blood pressure, nausea, vomiting, and abdominal cramping occur. Neurologic changes, including altered mental status, status epilepticus, and coma, are probably related to the cellular swelling and cerebral edema associated with hyponatremia. As the extracellular sodium level decreases, the cellular fluid becomes relatively more concentrated and pulls water into the cells (Fig. 14-4). In general, patients with an acute

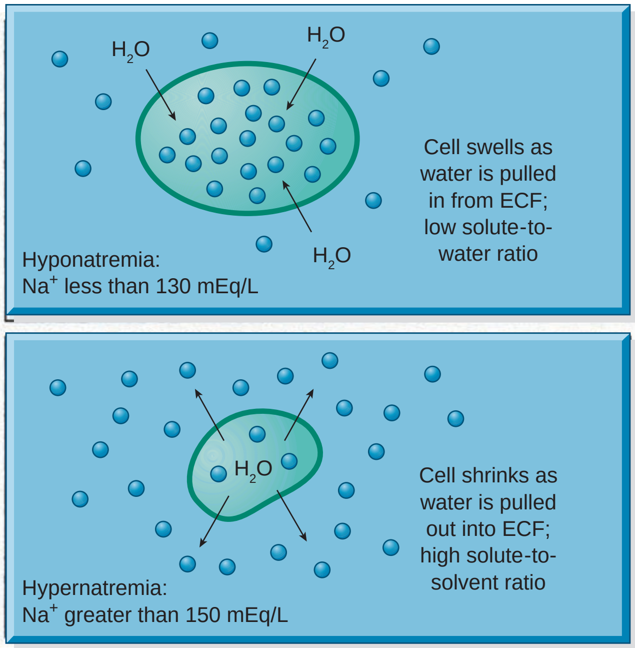



**Figure 14-4** Effect of extracellular sodium level on cell size.

decrease in serum sodium levels have more cerebral edema and higher mortality rates than do those with more slowly developing hyponatremia. Acute decreases in sodium, developing in less than 48 hours, may be associated with brain herniation and compression of midbrain structures. Chronic decreases in sodium, developing over 48 hours or more, can occur in status epilepticus and cerebral pontine myelinolysis.

Features of hyponatremia associated with sodium loss and water gain include anorexia, muscle cramps, and a feeling of exhaustion. The severity of symptoms increases with the degree of hyponatremia and the speed with which it develops. When the serum sodium level decreases to less than 115 mEq/L (115 mmol/L), signs of increasing intracranial pressure, such as lethargy, confusion, muscle twitching, focal weakness, hemiparesis, papilledema, seizures, and death, may occur.

## Assessment and Diagnostic Findings

Assessment includes the history and physical examination, including a focused neurologic examination; evaluation of signs and symptoms as well as laboratory test results; identification of current IV fluids, if applicable; and a review of all medications the patient is taking. Regardless of the cause of hyponatremia, the serum sodium level is less than 135 mEq/L; in SIADH, it may be lower than 100 mEq/L (100 mmol/L). Serum osmolality is also decreased, except in azotemia with the accumulation of toxins. When hyponatremia is due primarily to sodium loss, the urinary sodium content is less than 20 mEq/L (20 mmol/L), suggesting increased proximal reabsorption of sodium secondary to ECF volume depletion, and the specific gravity is low (1.002 to 1.004). However, when hyponatremia is due to SIADH, the urinary sodium content is greater than 20 mEq/L, and the urine specific gravity is usually greater than 1.012. Although the patient with SIADH retains water abnormally and therefore gains body weight, there is no peripheral edema; instead, fluid accumulates inside the cells. This phenomenon sometimes manifests as pitting edema.

## Medical Management

The key to treating hyponatremia is assessment including identifying patients who are at risk and recognizing that the rapidity of the onset of hyponatremia is of primary importance (Haskal, 2007).

### *Sodium Replacement*

The most common treatment for hyponatremia is careful administration of sodium by mouth, nasogastric tube, or a parenteral route. For patients who can eat and drink, sodium is easily replaced, because sodium is consumed abundantly in a normal diet. For those who cannot consume sodium, lactated Ringer's solution or isotonic saline (0.9% sodium chloride) solution may be prescribed. Serum sodium must not be increased by more than 12 mEq/L in 24 hours to avoid neurologic damage due to osmotic demyelination. This condition may occur when the serum sodium concentration is overcorrected (exceeding 140 mEq/L) too rapidly or in the presence of hypoxia or anoxia. It may produce lesions that show symmetric myelin destruction affecting all the fiber tracts that cause paraparesis, dysarthria, dysphagia, and coma (Abbott, Silber, Felber, et al., 2005). The usual daily sodium requirement in adults is approximately 100 mEq, provided there are not excessive losses. Selected water and electrolyte solutions are described in Table 14-3.

In SIADH, the administration of hypertonic saline solution alone cannot change the plasma sodium concentration. Excess sodium would be excreted rapidly in highly concentrated urine. With the addition of the diuretic furosemide (Lasix), urine is not concentrated and isotonic urine is excreted to effect a change in water balance. In patients with SIADH, in whom water restriction is difficult, lithium (Eskalith) or demeclocycline (Declomycin) can antagonize the osmotic effect of ADH on the medullary collecting tubule.

### *Water Restriction*

In a patient with normal or excess fluid volume, hyponatremia is treated by restricting fluid to a total of 800 mL in 24 hours. This is far safer than sodium administration and is usually an effective treatment. However, if neurologic symptoms are severe (eg, seizures, delirium, coma), as well as in traumatic brain injury, it may be necessary to administer small volumes of a hypertonic sodium solution (see Chapter 61) (Mortimer & Jancik, 2006). Incorrect use of these fluids is extremely dangerous, because 1 L of 3% sodium chloride solution contains 513 mEq of sodium and 1 L of 5% sodium chloride solution contains 855 mEq of sodium. The prescribed volume of hypertonic saline administered depends on the patient's weight and on current and desired serum sodium levels (Mortimer & Jancik, 2006). If edema exists alone, sodium is restricted; if edema and hyponatremia occur together, both sodium and water are restricted.

**NURSING ALERT**

**Highly hypertonic sodium solutions (2% to 23% sodium chloride) should be administered only in intensive care settings under close observation, because only small volumes are needed to elevate the serum sodium concentration from a dangerously low level. These fluids are administered slowly and in small volumes, and the patient is monitored closely.**

#### Pharmacologic Therapy

AVP receptor antagonists are new pharmacologic agents that treat hyponatremia by stimulating free water excretion (Haskal, 2007). IV conivaptan hydrochloride (Vaprisol) use is limited to the treatment of hospitalized patients. It may be a useful therapy for those patients with moderate to severe symptomatic hyponatremia, but is contraindicated in patients with seizures, delirium, or coma, which warrant the use of hypertonic saline (Ellison & Berl, 2007; Hayes, 2007a).

### Nursing Management

The nurse needs to identify and monitor patients at risk of hyponatremia. Early detection and treatment of this disorder are necessary to prevent serious consequences. For patients at risk, the nurse monitors fluid I&O as well as daily body weight. It is also necessary to note abnormal losses of sodium or gains of water, as well as GI manifestations such as anorexia, nausea, vomiting, and abdominal cramping. The nurse must be alert for central nervous system changes, such as lethargy, confusion, muscle twitching, and seizures. Neurologic signs are associated with very low sodium levels that have fallen rapidly because of fluid overloading. Serum sodium is monitored very closely in patients who are at risk for hyponatremia; when indicated, urine sodium and specific gravity are also monitored.

Hyponatremia is a frequently overlooked cause of confusion in elderly patients, who have an increased risk of hyponatremia because of decreased renal function and thus inability to excrete excess fluids. Administration of prescribed and over-the-counter (OTC) medications that cause sodium loss or water retention are predisposing factors. A diminished sense of thirst or loss of access to food or fluids may also contribute to the problem.

#### Detecting and Controlling Hyponatremia

For a patient with abnormal losses of sodium who can consume a general diet, the nurse encourages foods and fluids with high sodium content. For example, broth made with one beef cube contains approximately 900 mg of sodium; 8 oz of tomato juice contains approximately 700 mg of sodium. The nurse also needs to be familiar with the sodium content of parenteral fluids (see Table 14-3).

If the primary problem is water retention, it is safer to restrict fluid intake than to administer sodium. In normovolemia or hypervolemia, administration of sodium predisposes a patient to fluid volume overload. In severe hyponatremia, the aim of therapy is to elevate the serum sodium level only enough to alleviate neurologic signs and symptoms. It is generally recommended that the serum sodium concentration be increased to no greater than 125 mEq/L (125 mmol/L) with a hypertonic saline solution.

**NURSING ALERT**

**When administering fluids to patients with cardiovascular disease, the nurse assesses for signs of circulatory overload (eg, cough, dyspnea, puffy eyelids, dependent edema, weight gain in 24 hours). The lungs are auscultated for crackles.**

For the patient taking lithium, the nurse observes for lithium toxicity, particularly when sodium is lost by an abnormal route. In such instances, supplemental salt and fluid are administered. Because diuretics promote sodium loss, the patient taking lithium is instructed not to use diuretics without close medical supervision. For all patients on lithium therapy, adequate salt intake should be ensured.

Excess water supplements are avoided in patients receiving isotonic or hypotonic enteral feedings, particularly if abnormal sodium loss occurs or water is being abnormally retained (as in SIADH). Actual fluid needs are determined by evaluating fluid I&O, urine specific gravity, and serum sodium levels.

## SODIUM EXCESS (HYPERNATREMIA)

Hypernatremia is a serum sodium level higher than 145 mEq/L (145 mmol/L). It can be caused by a gain of sodium in excess of water or by a loss of water in excess of sodium. It can occur in patients with normal fluid volume or in those with FVD or FVE. With a water loss, the patient loses more water than sodium; as a result, the serum sodium concentration increases and the increased concentration pulls fluid out of the cell. This is both an extracellular and an intracellular FVD. In sodium excess, the patient ingests or retains more sodium than water.

### Pathophysiology

A common cause of hypernatremia is fluid deprivation in unconscious patients who cannot perceive, respond to, or communicate their thirst (Porth & Matfin, 2009). Most often affected are very old, very young, and cognitively impaired patients. Administration of hypertonic enteral feedings without adequate water supplements leads to hypernatremia, as does watery diarrhea and greatly increased insensible water loss (eg, hyperventilation, denuding effects of burns). In addition, both central and nephrogenic diabetes insipidus, which is a decreased ability to concentrate urine due to a defect in the kidney tubules that interferes with water reabsorption, result in hypernatremia if the patient does not experience or cannot respond to thirst, or if fluids are excessively restricted.

Less common causes of hypernatremia are heat stroke, near drowning in sea water (which contains a sodium concentration of approximately 500 mEq/L), and malfunction of hemodialysis or peritoneal dialysis systems. IV administration of hypertonic saline or excessive use of sodium bicarbonate also causes hypernatremia (Porth & Matfin, 2009).

## Clinical Manifestations

The clinical manifestations of hypernatremia are primarily neurologic and are due to increased plasma osmolality caused by an increase in plasma sodium concentration. Water moves out of the cell into the ECF, resulting in cellular dehydration and a more concentrated ECF (see Fig. 14-4). Clinically, these changes may be manifested by restlessness and weakness in moderate hypernatremia and by disorientation, delusions, and hallucinations in severe hypernatremia. Dehydration (resulting in hypernatremia) is often overlooked as the primary reason for behavioral changes in elderly patients. If hypernatremia is severe, permanent brain damage can occur (especially in children). Brain damage is due to hemorrhages that result from brain contraction.

A primary characteristic of hypernatremia is thirst. Thirst is such a strong defender of serum sodium levels in healthy people that hypernatremia never occurs unless the person is unconscious or does not have access to water. However, ill people may have an impaired thirst mechanism. Other signs include a dry, swollen tongue and sticky mucous membranes; flushed skin; peripheral and pulmonary edema; postural hypotension; oliguria; and increased muscle tone and deep tendon reflexes (DTRs). Body temperature may increase mildly, but it returns to normal after the hypernatremia is corrected.

## Assessment and Diagnostic Findings

In hypernatremia, the serum sodium level exceeds 145 mEq/L (145 mmol/L) and the serum osmolality exceeds 300 mOsm/kg (300 mmol/L). The urine specific gravity and urine osmolality are increased as the kidneys attempt to conserve water (provided the water loss is from a route other than the kidneys). Patients with nephrogenic or central diabetes insipidus have hypernatremia and produce a dilute urine with a urine osmolality less than 250 mOsm/kg.

## Medical Management

Treatment of hypernatremia consists of a gradual lowering of the serum sodium level by the infusion of a hypotonic electrolyte solution (eg, 0.3% sodium chloride) or an isotonic nonsaline solution (eg, dextrose 5% in water [$D_5W$]). $D_5W$ is indicated when water needs to be replaced without sodium. Clinicians consider a hypotonic sodium solution to be safer than $D_5W$ because it allows a gradual reduction in the serum sodium level, thereby decreasing the risk of cerebral edema. It is the solution of choice in severe hyperglycemia with hypernatremia. A rapid reduction in the serum sodium level temporarily decreases the plasma osmolality below that of the fluid in the brain tissue, causing dangerous cerebral edema. Diuretics also may be prescribed to treat the sodium gain.

There is no consensus about the exact rate at which serum sodium levels should be reduced. As a general rule, the serum sodium level is reduced at a rate no faster than 0.5 to 1 mEq/L/h to allow sufficient time for readjustment through diffusion across fluid compartments. Desmopressin acetate (DDAVP), a synthetic antidiuretic hormone, may be prescribed to treat diabetes insipidus if it is the cause of hypernatremia (Porth & Matfin, 2009).

## Nursing Management

As in hyponatremia, fluid losses and gains are carefully monitored in patients who are at risk for hypernatremia. The nurse should assess for abnormal losses of water or low water intake and for large gains of sodium, as might occur with ingestion of OTC medications that have a high sodium content (eg, Alka-Seltzer). In addition, the nurse obtains a medication history, because some prescription medications have a high sodium content. The nurse also notes the patient's thirst or elevated body temperature and evaluates it in relation to other clinical signs. The nurse monitors for changes in behavior, such as restlessness, disorientation, and lethargy.

### *Preventing Hypernatremia*

The nurse attempts to prevent hypernatremia by providing fluids at regular intervals, particularly in debilitated or unconscious patients who are unable to perceive or respond to thirst. If fluid intake remains inadequate, the nurse consults with the physician to plan an alternative route for intake, either by enteral feedings or by the parenteral route. If enteral feedings are used, sufficient water should be administered to keep the serum sodium and BUN within normal limits. As a rule, the higher the osmolality of the enteral feeding, the greater is the need for water supplementation.

For patients with diabetes insipidus, adequate water intake must be ensured. If the patient is alert and has an intact thirst mechanism, merely providing access to water may be sufficient. If the patient has a decreased level of consciousness or other disability interfering with adequate fluid intake, parenteral fluid replacement may be prescribed. This therapy can be anticipated in patients with neurologic disorders, particularly in the early postoperative period.

### *Correcting Hypernatremia*

When parenteral fluids are necessary for managing hypernatremia, the nurse monitors the patient's response to the fluids by reviewing serial serum sodium levels and by observing for changes in neurologic signs. With a gradual decrease in the serum sodium level, the neurologic signs should improve. Too-rapid reduction in the serum sodium level renders the plasma temporarily hypo-osmotic to the fluid in the brain tissue, causing movement of fluid into brain cells and dangerous cerebral edema.

# *Potassium Imbalances*

Potassium is the major intracellular electrolyte; in fact, 98% of the body's potassium is inside the cells. The remaining 2% is in the ECF and is important in neuromuscular function. Potassium influences both skeletal and cardiac muscle activity. For example, alterations in its concentration change myocardial irritability and rhythm. Under the influence of the sodium–potassium pump, potassium is constantly moving in and out of cells. The normal serum potassium concentration ranges from 3.5 to 5.0 mEq/L (3.5 to 5 mmol/L), and even minor variations are significant. Potassium imbalances are commonly associated with various diseases, injuries, medications (eg, NSAIDs and ACE

inhibitors), and acid–base imbalances (Hayes, 2007b; McPhee, et al., 2007).

To maintain potassium balance, the renal system must function, because 80% of the potassium excreted daily leaves the body by way of the kidneys; the other 20% is lost through the bowel and in sweat. The kidneys regulate potassium balance by adjusting the amount of potassium that is excreted in the urine. As serum potassium levels increase, so does the potassium level in the renal tubular cell. A concentration gradient occurs, favoring the movement of potassium into the renal tubule and excretion of potassium in the urine. Aldosterone also increases the excretion of potassium by the kidney. Because the kidneys do not conserve potassium as well as they conserve sodium, potassium may still be lost in urine in the presence of a potassium deficit.

## POTASSIUM DEFICIT (HYPOKALEMIA)

Hypokalemia (below 3.5 mEq/L [3.5 mmol/L]) usually indicates a deficit in total potassium stores. However, it may occur in patients with normal potassium stores: When **alkalosis** is present, a temporary shift of serum potassium into the cells occurs (see later discussion).

### Pathophysiology

Potassium-losing diuretics, such as the thiazides and loop diuretics, can induce hypokalemia (Baumberger-Henry, 2008). Other medications that can lead to hypokalemia include corticosteroids, sodium penicillin, carbenicillin, and amphotericin B. GI loss of potassium is another common cause of potassium depletion. Vomiting and gastric suction frequently lead to hypokalemia, partly because potassium is actually lost when gastric fluid is lost and because potassium is lost through the kidneys in response to metabolic alkalosis. Because relatively large amounts of potassium are contained in intestinal fluids, potassium deficit occurs frequently with diarrhea, which may contain as much potassium as 30 mEq/L. Potassium deficit also occurs from prolonged intestinal suctioning, recent ileostomy, and villous adenoma (a tumor of the intestinal tract characterized by excretion of potassium-rich mucus).

Alterations in acid–base balance have a significant effect on potassium distribution due to shifts of hydrogen and potassium ions between the cells and the ECF. Respiratory or metabolic alkalosis promotes the transcellular shift of potassium and can have a variable and unpredictable effect on serum potassium (O'Neill, 2007). For example, hydrogen ions move out of the cells in alkalotic states to help correct the high pH, and potassium ions move in to maintain an electrically neutral state (see later discussion of acid–base balance).

Hyperaldosteronism increases renal potassium wasting and can lead to severe potassium depletion. Primary hyperaldosteronism is seen in patients with adrenal adenomas. Secondary hyperaldosteronism occurs in patients with cirrhosis, nephrotic syndrome, heart failure, or malignant hypertension (Heitz & Horne, 2005).

Because insulin promotes the entry of potassium into skeletal muscle and hepatic cells, patients with persistent insulin hypersecretion may experience hypokalemia, which is often the case in patients receiving high-carbohydrate parenteral nutrition.

Patients who do not eat a normal diet for a prolonged period are at risk for hypokalemia. This may occur in debilitated elderly people, patients with alcoholism, and patients with anorexia nervosa. In addition to poor intake, people with bulimia frequently suffer increased potassium loss through self-induced vomiting, misuse of laxatives, diuretics, and enemas. Magnesium depletion causes renal potassium loss and must be corrected first; otherwise, urine loss of potassium will continue.

### Clinical Manifestations

Potassium deficiency can result in widespread derangements in physiologic function. Severe hypokalemia can cause death through cardiac or respiratory arrest. Clinical signs rarely develop before the serum potassium level has decreased to less than 3 mEq/L (3 mmol/L) unless the rate of decline has been rapid. Manifestations of hypokalemia include fatigue, anorexia, nausea, vomiting, muscle weakness, leg cramps, decreased bowel motility, paresthesias (numbness and tingling), and dysrhythmias. If prolonged, hypokalemia can lead to an inability of the kidneys to concentrate urine, causing dilute urine (resulting in polyuria, nocturia) and excessive thirst. Potassium depletion suppresses the release of insulin and results in glucose intolerance. Decreased muscle strength and DTRs can be found on physical assessment.

### Assessment and Diagnostic Findings

In hypokalemia, the serum potassium concentration is less than the lower limit of normal. Electrocardiographic (ECG) changes can include flat T waves or inverted T waves or both, suggesting ischemia, and depressed ST segments (Fig. 14-5). An elevated U wave is specific to hypokalemia. Hypokalemia increases sensitivity to digitalis, predisposing the patient to digitalis toxicity at lower digitalis levels. Metabolic alkalosis is commonly associated with hypokalemia (Her, 2007). This is discussed further in the section on acid–base disturbances in this chapter.

The source of the potassium loss is usually evident from a careful history. However, if the cause of the loss is unclear, a 24-hour urinary potassium excretion test can be performed to distinguish between renal and extrarenal loss. Urinary potassium excretion exceeding 20 mEq/day with hypokalemia suggests that renal potassium loss is the cause.

### Medical Management

If hypokalemia cannot be prevented by conventional measures such as increased intake in the daily diet or by oral potassium supplements for deficiencies, then it is treated cautiously with IV replacement therapy (Hayes, 2007b). Potassium loss must be corrected daily; administration of 40 to 80 mEq/day of potassium is adequate in the adult if there are no abnormal losses of potassium.

For patients who are at risk for hypokalemia, a diet containing sufficient potassium should be provided. Dietary intake of potassium in the average adult is 50 to 100 mEq/day. Foods high in potassium include most fruits and vegetables, legumes, whole grains, milk, and meat.

If dietary intake is inadequate for any reason, the physician may prescribe oral or IV potassium supplements (Muller & Bell, 2008). Many salt substitutes contain 50 to 60 mEq of potassium per teaspoon and may be sufficient to prevent hypokalemia.

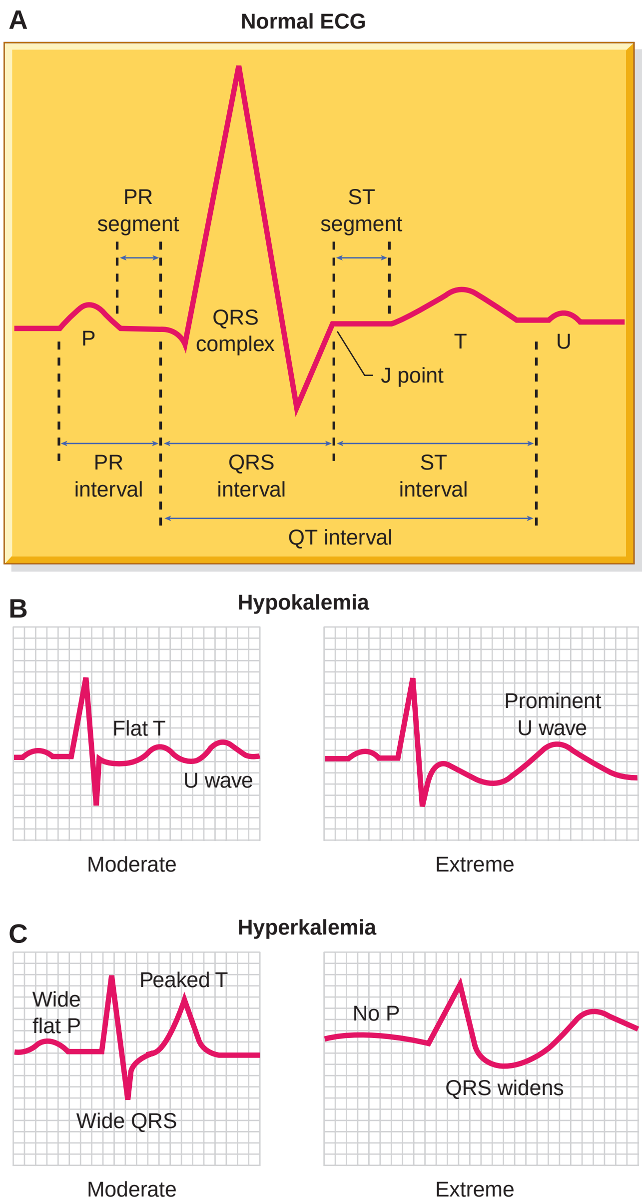



**Figure 14-5** Effect of potassium on the electrocardiogram (ECG). **A,** Normal tracing. **B,** Hypokalemia: serum potassium level below normal. *Left:* Flattening of the T wave and the appearance of a U wave. *Right:* Further flattening with prominent U wave. **C,** Hyperkalemia: serum potassium level above normal. *Left:* Moderate elevation with wide, flat P wave; wide QRS complex; and peaked T wave. *Right:* ECG changes seen with extreme potassium elevation: widening of QRS complex and absence of P wave.

If oral administration of potassium is not feasible, the IV route is indicated. The IV route is mandatory for patients with severe hypokalemia (eg, serum level of 2 mEq/L). Although potassium chloride is usually used to correct potassium deficits, potassium acetate or potassium phosphate may be prescribed.

## Nursing Management

Because hypokalemia can be life-threatening, the nurse needs to monitor for its early presence in patients who are at risk. Fatigue, anorexia, muscle weakness, decreased bowel motility, paresthesias, and dysrhythmias are signals that warrant assessing the serum potassium concentration. When available, the ECG may provide useful information. For example, patients receiving digitalis who are at risk for potassium deficiency should be monitored closely for signs of digitalis toxicity, because hypokalemia potentiates the action of digitalis.

### Preventing Hypokalemia

Prevention may involve encouraging the patient at risk to eat foods rich in potassium (when the diet allows). Sources of potassium include fruit juices and bananas, melon, citrus fruits, fresh and frozen vegetables, fresh meats, milk, and processed foods. If the hypokalemia is caused by abuse of laxatives or diuretics, patient education may help alleviate the problem. Part of the health history and assessment should be directed at identifying problems that are amenable to prevention through education. Careful monitoring of fluid I&O is necessary, because 40 mEq of potassium is lost for every liter of urine output. The ECG is monitored for changes, and arterial blood gas values are checked for elevated bicarbonate and pH levels.

### Correcting Hypokalemia

The oral route is ideal to treat a mild to moderate hypokalemia because oral potassium supplements are absorbed well. Care should be exercised when administering potassium, particularly in older adults, who have lower lean body mass and total body potassium levels and therefore lower potassium requirements. In addition, because of the physiologic loss of renal function with advancing years, potassium may be retained more readily in older than in younger people.

**NURSING ALERT**

**Oral potassium supplements can produce small-bowel lesions; therefore, the patient must be assessed for and cautioned about abdominal distention, pain, or GI bleeding.**

### Administering Intravenous Potassium

Potassium should be administered only after adequate urine flow has been established. A decrease in urine volume to less than 20 mL/h for 2 consecutive hours is an indication to stop the potassium infusion until the situation is evaluated. Potassium is primarily excreted by the kidneys; when oliguria occurs, potassium administration can cause the serum potassium concentration to rise dangerously (Hayes, 2007b).

**NURSING ALERT**

**Potassium is *never* administered by IV push or intramuscularly to avoid replacing potassium too quickly. IV potassium must be administered using an infusion pump.**

Each health care facility has its own standard of care for the administration of potassium, which should be consulted; however, the maximum concentration of potassium that should be administered on a medical-surgical unit through a

peripheral IV line is 20 mEq/100 mL and the rate no faster than 10 to 20 mEq/h. Concentrations of potassium greater than 20 mEq/100 mL should be administered through a central IV catheter using an infusion pump with the patient monitored by ECG. Caution must be used when selecting the correct premixed solution of IV fluid containing potassium chloride as the concentrations range from 10 to 40 mEq/100 mL. Renal function should be monitored through BUN and creatinine levels and urine output if the patient is receiving potassium replacement. During potassium replacement, smooth muscle hyperactivity can lead to hyperactive bowel sounds, a sign of hyperkalemia (Hayes, 2007b).

## POTASSIUM EXCESS (HYPERKALEMIA)

Hyperkalemia (greater than 5.0 mEq/L [5 mmol/L]) seldom occurs in patients with normal renal function (Vacca, 2008). Like hypokalemia, hyperkalemia is often caused by iatrogenic (treatment-induced) causes. Although hyperkalemia is less common than hypokalemia, it is usually more dangerous, because cardiac arrest is more frequently associated with high serum potassium levels.

### Pathophysiology

The three major causes of hyperkalemia are decreased renal excretion of potassium, rapid administration of potassium, and movement of potassium from the ICF compartment to the ECF compartment. Hyperkalemia is commonly seen in patients with untreated renal failure, particularly those in whom potassium levels increase as a result of infection or excessive intake of potassium in food or medications. Patients with hypoaldosteronism or Addison's disease are at risk for hyperkalemia, because deficient adrenal hormones lead to sodium loss and potassium retention.

Medications have been identified as a probable contributing factor in more than 60% of hyperkalemic episodes. Medications commonly implicated are potassium chloride, heparin, ACE inhibitors, NSAIDs, beta-blockers, and potassium-sparing diuretics (Muller & Bell, 2008). Potassium regulation is compromised in acute and chronic renal failure, with a glomerular filtration rate less than 10% to 20% of normal.

Improper use of potassium supplements predisposes all patients to hyperkalemia, especially if salt substitutes are used. Not all patients receiving potassium-losing diuretics require potassium supplements, and patients receiving potassium-conserving diuretics should not receive supplements.

*NURSING ALERT*

**Potassium supplements are extremely dangerous for patients who have impaired renal function and thus decreased ability to excrete potassium. Even more dangerous is the IV administration of potassium to such patients, because serum levels can rise very quickly. Aged (stored) blood should not be administered to patients with impaired renal function, because the serum potassium concentration of stored blood increases due to red blood cell deterioration. It is possible to exceed the renal tolerance of any patient with rapid IV potassium administration, as well as when large amounts of oral potassium supplements are ingested.**

In **acidosis,** potassium moves out of the cells and into the ECF. This occurs as hydrogen ions enter the cells to buffer the pH of the ECF (see later discussion). An elevated ECF potassium level should be anticipated when extensive tissue trauma has occurred, as in burns, crushing injuries, or severe infections. Similarly, it can occur with lysis of malignant cells after chemotherapy (ie, tumor lysis syndrome).

Pseudohyperkalemia (a variation of hyperkalemia) has a number of causes, the most common being the use of a tight tourniquet around an exercising extremity while drawing a blood sample, producing hemolysis of the sample before analysis. Other causes include marked leukocytosis (white blood cell count exceeding 200,000/mm$^3$) and thrombocytosis (platelet count exceeding 1 million/mm$^3$); drawing blood above a site where potassium is infusing; and familial pseudohyperkalemia, in which potassium leaks out of the red blood cells while the blood is awaiting analysis. Lack of awareness of these causes of pseudohyperkalemia can lead to aggressive treatment of a nonexistent hyperkalemia, resulting in serious lowering of serum potassium levels. Therefore, measurements of grossly elevated levels should be verified by retesting.

### Clinical Manifestations

The most important consequence of hyperkalemia is its effect on the myocardium. Cardiac effects of elevated serum potassium are usually not significant when the level is less than 7 mEq/L (7 mmol/L), but they are almost always present when the level is 8 mEq/L (8 mmol/L) or greater. As the plasma potassium level rises, disturbances in cardiac conduction occur. The earliest changes, often occurring at a serum potassium level greater than 6 mEq/L (6 mmol/L), are peaked, narrow T waves; ST-segment depression; and a shortened QT interval. If the serum potassium level continues to increase, the PR interval becomes prolonged and is followed by disappearance of the P waves. Finally, there is decomposition and widening of the QRS complex (see Fig. 14-5). Ventricular dysrhythmias and cardiac arrest may occur at any point in this progression.

Severe hyperkalemia causes skeletal muscle weakness and even paralysis, related to a depolarization block in muscle. Similarly, ventricular conduction is slowed. Although hyperkalemia has marked effects on the peripheral nervous system, it has little effect on the central nervous system. Rapidly ascending muscular weakness leading to flaccid quadriplegia has been reported in patients with very high serum potassium levels. Paralysis of respiratory and speech muscles can also occur. In addition, GI manifestations, such as nausea, intermittent intestinal colic, and diarrhea, may be evident.

### Assessment and Diagnostic Findings

Serum potassium levels and ECG changes are crucial to the diagnosis of hyperkalemia, as discussed previously. Arterial blood gas analysis may reveal both a metabolic and respiratory acidosis. Correcting the acidosis helps correct the hyperkalemia.

### Medical Management

An ECG should be obtained immediately to detect changes. Shortened repolarization and peaked T waves are seen initially. To verify results, a repeat serum potassium

level should be obtained from a vein without an IV infusing a potassium-containing solution.

In nonacute situations, restriction of dietary potassium and potassium-containing medications may correct the imbalance. For example, eliminating the use of potassium-containing salt substitutes in a patient who is taking a potassium-conserving diuretic may be all that is needed to deal with mild hyperkalemia.

Prevention of serious hyperkalemia by the administration, either orally or by retention enema, of cation exchange resins (eg, sodium polystyrene sulfonate [Kayexalate]) may be necessary in patients with renal impairment. Cation exchange resins cannot be used if the patient has a paralytic ileus, because intestinal perforation can occur. Kayexalate binds with other cations in the GI tract and contributes to the development of hypomagnesemia and hypocalcemia; it may also cause sodium retention and fluid overload, and should be used with caution in patients with heart failure.

#### Emergency Pharmacologic Therapy

If serum potassium levels are dangerously elevated, it may be necessary to administer IV calcium gluconate. Within minutes after administration, calcium antagonizes the action of hyperkalemia on the heart, but it does not reduce the serum potassium concentration. Calcium chloride and calcium gluconate are not interchangeable; calcium gluconate contains 4.5 mEq of calcium and calcium chloride contains 13.6 mEq of calcium. Therefore, caution is required.

Monitoring the blood pressure is essential to detect hypotension, which may result from the rapid IV administration of calcium gluconate. The ECG should be continuously monitored during administration; the appearance of bradycardia is an indication to stop the infusion. The myocardial protective effects of calcium last about 30 minutes. Extra caution is required if the patient has been "digitalized" (ie, has received accelerated dosages of a digitalis-based cardiac glycoside to reach a desired serum digitalis level rapidly); parenteral administration of calcium sensitizes the heart to digitalis and may precipitate digitalis toxicity.

IV administration of sodium bicarbonate may be necessary to alkalinize the plasma, cause a temporary shift of potassium into the cells, and furnish sodium to antagonize the cardiac effects of potassium (Vacca, 2008). Effects of this therapy begin within 30 to 60 minutes and may persist for hours; however, they are temporary.

IV administration of regular insulin and a hypertonic dextrose solution causes a temporary shift of potassium into the cells. Glucose and insulin therapy has an onset of action within 30 minutes and lasts for several hours. Loop diuretics, such as furosemide (Lasix), increase excretion of water by inhibiting sodium, potassium, and chloride reabsorption in the ascending loop of Henle and distal renal tubule.

Beta-2 agonists, such as albuterol (Proventil, Ventolin), are highly effective in decreasing potassium, but their use remains controversial, because they can cause tachycardia and chest discomfort (Porth & Matfin, 2009). Beta-2 agonists move potassium into the cells and may be used in the absence of ischemic cardiac disease. Their use is a stopgap measure that only temporarily protects the patient from hyperkalemia. If the hyperkalemic condition is not transient, actual removal of potassium from the body is required through cation exchange resins, peritoneal dialysis, hemodialysis, or other forms of renal replacement therapy.

### Nursing Management

Patients at risk for potassium excess (eg, those with renal failure) need to be identified and closely monitored for signs of hyperkalemia. The nurse observes for signs of muscle weakness and dysrhythmias. The presence of paresthesias and GI symptoms such as nausea and intestinal colic are noted. Serum potassium levels, as well as BUN, creatinine, glucose, and arterial blood gas values, are monitored for patients at risk for developing hyperkalemia (Heitz & Horne, 2005).

#### Preventing Hyperkalemia

Measures are taken to prevent hyperkalemia in patients at risk, when possible, by encouraging the patient to adhere to the prescribed potassium restriction. Potassium-rich foods to be avoided include many fruits and vegetables, legumes, whole-grain breads, meat, milk, eggs, coffee, tea, and cocoa (Dudek, 2006). Conversely, foods with minimal potassium content include butter, margarine, cranberry juice or sauce, ginger ale, gumdrops or jellybeans, hard candy, root beer, sugar, and honey. Labels of cola beverages must be checked carefully because some are high in potassium and some are not.

#### Correcting Hyperkalemia

It is possible to exceed the tolerance for potassium if administered rapidly by the IV route. Therefore, care is taken to administer and monitor potassium solutions closely. Particular attention is paid to the solution's concentration and rate of administration. Potassium is not added to parenteral solutions on the nursing units but in the pharmacy. IV administration is via a volumetric infusion pump (Hayes, 2007b).

It is important to caution patients to use salt substitutes sparingly if they are taking other supplementary forms of potassium or potassium-conserving diuretics (O'Neill, 2007). Also, potassium-conserving diuretics, such as spironolactone (Aldactone), triamterene (Dyrenium), and amiloride (Midamor); potassium supplements; and salt substitutes should not be administered to patients with renal dysfunction. Most salt substitutes contain approximately 50 to 60 mEq of potassium per teaspoon.

## Calcium Imbalances

More than 99% of the body's calcium is located in the skeletal system; it is a major component of bones and teeth. About 1% of skeletal calcium is rapidly exchangeable with blood calcium, and the rest is more stable and only slowly exchanged. The small amount of calcium located outside the bone circulates in the serum, partly bound to protein and partly ionized. Calcium plays a major role in transmitting nerve impulses and helps regulate muscle contraction

and relaxation, including cardiac muscle. Calcium is instrumental in activating enzymes that stimulate many essential chemical reactions in the body, and it also plays a role in blood coagulation. Because many factors affect calcium regulation, both hypocalcemia and hypercalcemia are relatively common disturbances.

The normal total serum calcium level is 8.6 to 10.2 mg/dL (2.2 to 2.6 mmol/L). Calcium exists in plasma in three forms: ionized, bound, and complexed. About 50% of the serum calcium exists in a physiologically active ionized form that is important for neuromuscular activity and blood coagulation; this is the only physiologically and clinically significant form. The normal ionized serum calcium level is 4.5 to 5.1 mg/dL (1.1 to 1.3 mmol/L). Less than half of the plasma calcium is bound to serum proteins, primarily albumin. The remainder is combined with nonprotein anions: phosphate, citrate, and carbonate.

Calcium is absorbed from foods in the presence of normal gastric acidity and vitamin D. It is excreted primarily in the feces, with the remainder excreted in the urine. The serum calcium level is controlled by PTH and calcitonin. As ionized serum calcium decreases, the parathyroid glands secrete PTH. This, in turn, increases calcium absorption from the GI tract, increases calcium reabsorption from the renal tubule, and releases calcium from the bone. The increase in calcium ion concentration suppresses PTH secretion. When calcium increases excessively, the thyroid gland secretes calcitonin, which inhibits calcium reabsorption from bone and decreases the serum calcium concentration.

## CALCIUM DEFICIT (HYPOCALCEMIA)

Hypocalcemia (serum values lower than 8.6 mg/dL [2.15 mmol/L]) occurs in a variety of clinical situations. A patient may have a total body calcium deficit (as in osteoporosis) but a normal serum calcium level. Elderly people and those with disabilities, who spend an increased amount of time in bed, have an increased risk of hypocalcemia, because bed rest increases bone resorption.

### Pathophysiology

Several factors can cause hypocalcemia, including primary hypoparathyroidism and surgical hypoparathyroidism. The latter is far more common. Not only is hypocalcemia associated with thyroid and parathyroid surgery, but it can also occur after radical neck dissection and is most likely in the first 24 to 48 hours after surgery. Transient hypocalcemia can occur with massive administration of citrated blood (ie, massive hemorrhage and shock), because citrate can combine with ionized calcium and temporarily remove it from the circulation.

Inflammation of the pancreas causes the breakdown of proteins and lipids. It is thought that calcium ions combine with the fatty acids released by lipolysis, forming soaps. As a result of this process, hypocalcemia occurs and is common in pancreatitis. Hypocalcemia may be related to excessive secretion of glucagon from the inflamed pancreas, which results in increased secretion of calcitonin.

Hypocalcemia is common in patients with renal failure, because these patients frequently have elevated serum phosphate levels. Hyperphosphatemia usually causes a reciprocal drop in the serum calcium level. Other causes of hypocalcemia include inadequate vitamin D consumption, magnesium deficiency, medullary thyroid carcinoma, low serum albumin levels, alkalosis, and alcohol abuse. Medications predisposing to hypocalcemia include aluminum-containing antacids, aminoglycosides, caffeine, cisplatin, corticosteroids, mithramycin, phosphates, isoniazid, and loop diuretics.

### Clinical Manifestations

Tetany, the most characteristic manifestation of hypocalcemia and hypomagnesemia, refers to the entire symptom complex induced by increased neural excitability. These symptoms are caused by spontaneous discharges of both sensory and motor fibers in peripheral nerves. Sensations of tingling may occur in the tips of the fingers, around the mouth, and, less commonly, in the feet. Spasms of the muscles of the extremities and face may occur. Pain may develop as a result of these spasms. Hyperactive DTRs are another clinical sign associated with tetany.

Trousseau's sign (Fig. 14-6) can be elicited by inflating a blood pressure cuff on the upper arm to about 20 mm Hg above systolic pressure; within 2 to 5 minutes, carpal spasm (an adducted thumb, flexed wrist and metacarpophalangeal joints, extended interphalangeal joints with fingers together) will occur as ischemia of the ulnar nerve develops. Chvostek's sign consists of twitching of muscles enervated by the facial nerve when the region that is about 2 cm anterior to the earlobe, just below the zygomatic arch, is tapped.

Seizures may occur because hypocalcemia increases irritability of the central nervous system as well as of the peripheral nerves (Tocco, 2007). Other changes associated with hypocalcemia include mental changes such as depression, impaired memory, confusion, delirium, and hallucinations. A prolonged QT interval is seen on the ECG due to prolongation of the ST segment, and torsades de pointes, a type of ventricular tachycardia, may occur. Respiratory effects with decreasing calcium include dyspnea and laryngospasm. Signs and symptoms of chronic hypocalcemia include hyperactive bowel sounds, dry and brittle hair and nails, and abnormal clotting.

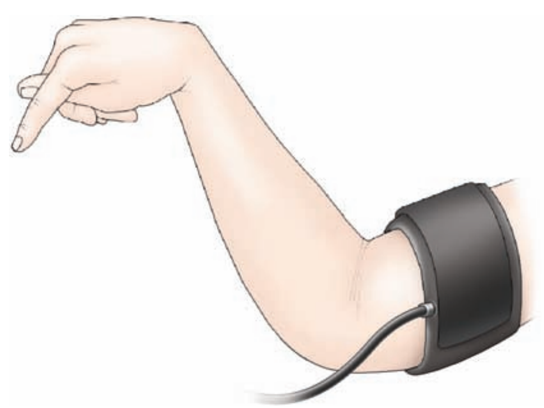


**Figure 14-6** Trousseau's sign. Ischemia-induced carpal spasm can occur with hypocalcemia or hypomagnesemia. Occluding the brachial artery with a blood pressure cuff for 3 minutes can produce carpal spasm (contraction of the fingers and hand), which mimics the spasm that occurs with hypocalcemia or hypomagnesemia.

Osteoporosis is associated with prolonged low intake of calcium and represents a total body calcium deficit, even though serum calcium levels are usually normal. This disorder occurs in millions of Americans and is most common in postmenopausal women. It is characterized by loss of bone mass, which causes bones to become porous and brittle and therefore susceptible to fracture. See Chapter 68 for further discussion of osteoporosis.

## Assessment and Diagnostic Findings

When evaluating serum calcium levels, the serum albumin level and the arterial pH must also be considered. Because abnormalities in serum albumin levels may affect interpretation of the serum calcium level, it may be necessary to calculate the corrected serum calcium if the serum albumin level is abnormal. For every decrease in serum albumin of 1 g/dL below 4 g/dL, the total serum calcium level is underestimated by approximately 0.8 mg/dL. The following is a quick method to calculate the corrected serum calcium level:

$$\text{Measured total serum } Ca^{++} \text{ level (mg/dL)} + 0.8 \times (4.0 - \text{Measured albumin level [g/dL]}) = \text{Corrected total calcium concentration (mg/dL)}$$

An example of the calculations needed to obtain the corrected total serum calcium level is as follows:

A patient's reported serum albumin level is 2.5 g/dL; the reported serum calcium level is 10.5 mg/dL. First, the decrease in serum albumin level from normal (ie, the difference from the normal albumin concentration of 4 g/dL) is calculated: 4 g/dL – 2.5 g/dL = 1.5 g/dL. Next, the following ratio is calculated:

$$0.8 \text{ mg/dL} : 1 \text{ g/dL} = X \text{ mg/dL} : 1.5 \text{ mg/dL}$$
$$X = 0.8 \times 1.5 \text{ mg/dL}$$
$$X = 1.2 \text{ mg/dL calcium}$$

Finally, 1.2 mg/dL is added to 10.5 mg/dL (the reported serum calcium level) to obtain the corrected total serum calcium level: 1.2 mg/dL + 10.5 mg/dL = 11.7 mg/dL.

Clinicians often discount a low serum calcium level in the presence of a similarly low serum albumin level. The ionized calcium level is usually normal in patients with reduced total serum calcium levels and concomitant hypoalbuminemia. When the arterial pH increases (alkalosis), more calcium becomes bound to protein. As a result, the ionized portion decreases. Symptoms of hypocalcemia may occur with alkalosis. Acidosis (low pH) has the opposite effect; that is, less calcium is bound to protein and therefore more exists in the ionized form. However, relatively small changes in serum calcium levels occur in these acid–base abnormalities.

Ideally, the ionized level of calcium should be measured in the laboratory. However, in many laboratories, only the total calcium level is reported; therefore, the concentration of the ionized fraction must be estimated by simultaneous measurement of the serum albumin level. PTH levels are decreased in hypoparathyroidism. Magnesium and phosphorus levels need to be assessed to identify possible causes of decreased calcium.

## Medical Management

Acute symptomatic hypocalcemia is life-threatening and requires prompt treatment with IV administration of a calcium salt (Avent, 2007). Parenteral calcium salts include calcium gluconate, calcium chloride, and calcium gluceptate. Although calcium chloride produces a significantly higher ionized calcium level than calcium gluconate does, it is not used as often because it is more irritating and can cause sloughing of tissue if it infiltrates. Too-rapid IV administration of calcium can cause cardiac arrest, preceded by bradycardia. IV administration of calcium is particularly dangerous in patients receiving digitalis-derived medications, because calcium ions exert an effect similar to that of digitalis and can cause digitalis toxicity, with adverse cardiac effects. Therefore, calcium should be diluted in $D_5W$ and administered as a slow IV bolus or a slow IV infusion using a volumetric infusion pump. The IV site must be observed often for any evidence of infiltration because of the risk of extravasation and resultant cellulitis or necrosis. A 0.9% sodium chloride solution should not be used with calcium because it increases renal calcium loss. Solutions containing phosphates or bicarbonate should not be used with calcium because they cause precipitation when calcium is added. The nurse must clarify with the physician and pharmacist which calcium salt to administer, because calcium gluconate yields 4.5 mEq of calcium and calcium chloride provides 13.6 mEq of calcium. Calcium replacement can cause postural hypotension; therefore, the patient is kept in bed during IV infusion, and blood pressure is monitored.

Vitamin D therapy may be instituted to increase calcium absorption from the GI tract; otherwise, the amount of calcium absorbed may not satisfy the body's calcium requirement. In addition, aluminum hydroxide, calcium acetate, or calcium carbonate antacids may be prescribed to decrease elevated phosphorus levels before treating hypocalcemia in the patient with chronic renal failure. Increasing the dietary intake of calcium to at least 1000 to 1500 mg/day in the adult is recommended. Calcium-containing foods include milk products; green, leafy vegetables; canned salmon; sardines; and fresh oysters. Hypomagnesemia can also cause tetany; if the tetany responds to IV calcium, then a low magnesium level is considered as a possible cause in chronic renal failure.

## Nursing Management

It is important to observe for hypocalcemia in at-risk patients. Seizure precautions are initiated if hypocalcemia is severe. The status of the airway is closely monitored, because laryngeal stridor can occur. Safety precautions are taken, as indicated, if confusion is present.

It is important to teach the patient with hypocalcemia what foods are rich in calcium. The nurse must also advise the patient to consider calcium supplements if sufficient calcium is not consumed in the diet. Such supplements should be taken in divided doses with meals. Alcohol and caffeine in high doses inhibit calcium absorption, and moderate cigarette smoking increases urinary calcium excretion. The patient is also cautioned to avoid the overuse of laxatives and antacids that contain phosphorus, because their use decreases calcium absorption.

# CALCIUM EXCESS (HYPERCALCEMIA)

Hypercalcemia (greater than 10.2 mg/dL [2.6 mmol/L]) is a dangerous imbalance when severe; in fact, hypercalcemic crisis has a mortality rate as high as 50% if not treated promptly.

## Pathophysiology

The most common causes of hypercalcemia are malignancies and hyperparathyroidism. Malignant tumors can produce hypercalcemia by a variety of mechanisms (Stewart, 2005). The excessive PTH secretion associated with hyperparathyroidism causes increased release of calcium from the bones and increased intestinal and renal absorption of calcium. Calcifications of soft tissue occur when the calcium–phosphorus product (serum calcium × serum phosphorus) exceeds 70 mg/dL.

Bone mineral is lost during immobilization, and sometimes this causes elevation of total (and especially ionized) calcium in the bloodstream. However, symptomatic hypercalcemia from immobilization is rare; when it does occur, it is virtually limited to people with high calcium turnover rates (eg, adolescents during a growth spurt). Most cases of hypercalcemia secondary to immobility occur after severe or multiple fractures or spinal cord injury.

Thiazide diuretics can cause a slight elevation in serum calcium levels because they potentiate the action of PTH on the kidneys, reducing urinary calcium excretion. The milk-alkali syndrome has occurred in patients with peptic ulcer treated previously for a prolonged period with milk and alkaline antacids, particularly calcium carbonate. Vitamin A and D intoxication, as well as chronic lithium use and theophylline toxicity, can cause calcium excess. Calcium levels are inversely related to phosphorus levels.

Hypercalcemia reduces neuromuscular excitability because it suppresses activity at the myoneural junction. Decreased tone in smooth and striated muscle may cause symptoms such as muscle weakness, incoordination, anorexia, and constipation. Cardiac standstill can occur when the serum calcium level is about 18 mg/dL (4.5 mmol/L). Calcium enhances the inotropic effect of digitalis; therefore, hypercalcemia aggravates digitalis toxicity.

## Clinical Manifestations

The symptoms of hypercalcemia are proportional to the degree of elevation of the serum calcium level. Anorexia, nausea, vomiting, and constipation are common symptoms of hypercalcemia. Dehydration occurs with nausea, vomiting, anorexia, and calcium reabsorption at the proximal renal tubule. Abdominal and bone pain may also be present. Abdominal distention and paralytic ileus may complicate severe hypercalcemic crisis. Excessive urination due to disturbed renal tubular function produced by hypercalcemia may occur. Severe thirst may occur with polyuria secondary to high solute (calcium) load. Patients with chronic hypercalcemia may develop symptoms similar to peptic ulcer disease because hypercalcemia increases the secretion of acid and pepsin in the stomach.

Confusion, impaired memory, slurred speech, lethargy, acute psychotic behavior, or coma may occur (Stewart, 2005). The more severe symptoms tend to appear when the serum calcium level is approximately 16 mg/dL (4 mmol/L) or higher. However, some patients become profoundly disturbed with serum calcium levels of only 12 mg/dL (3 mmol/L). These symptoms resolve as serum calcium levels return to normal after treatment.

Hypercalcemic crisis refers to an acute rise in the serum calcium level to 17 mg/dL (4.3 mmol/L) or higher. Severe thirst and polyuria are often present. Other findings may include muscle weakness, intractable nausea, abdominal cramps, severe constipation, diarrhea, peptic ulcer symptoms, and bone pain. Lethargy, confusion, and coma may also occur. This condition is dangerous and may result in cardiac arrest.

## Assessment and Diagnostic Findings

The serum calcium level is greater than 10.2 mg/dL (2.6 mmol/L). Cardiovascular changes may include a variety of dysrhythmias (ie, heart blocks) and shortening of the QT interval and ST segment. The PR interval is sometimes prolonged. The double-antibody PTH test may be used to differentiate between primary hyperparathyroidism and malignancy as a cause of hypercalcemia: PTH levels are increased in primary or secondary hyperparathyroidism and suppressed in malignancy. X-rays may reveal bone changes if the patient has hypercalcemia secondary to a malignancy, bone cavitation, or urinary calculi. The Sulkowitch urine test analyzes the amount of calcium in the urine; in hypercalcemia, dense precipitation is observed due to hypercalciuria.

## Medical Management

Therapeutic aims in hypercalcemia include decreasing the serum calcium level and reversing the process causing hypercalcemia. Treating the underlying cause (eg, chemotherapy for a malignancy, partial parathyroidectomy for hyperparathyroidism) is essential.

### *Pharmacologic Therapy*

Measures include administering fluids to dilute serum calcium and promote its excretion by the kidneys, mobilizing the patient, and restricting dietary calcium intake. IV administration of 0.9% sodium chloride solution temporarily dilutes the serum calcium level and increases urinary calcium excretion by inhibiting tubular reabsorption of calcium. Administering IV phosphate can cause a reciprocal drop in serum calcium. Furosemide (Lasix) is often used in conjunction with administration of a saline solution; in addition to causing diuresis, furosemide increases calcium excretion. Although often overlooked, fluids and medications that contain calcium and dietary sources of calcium should be halted (Stewart, 2005).

Calcitonin can be used to lower the serum calcium level and is particularly useful for patients with heart disease or renal failure who cannot tolerate large sodium loads. Calcitonin reduces bone resorption, increases the deposition of calcium and phosphorus in the bones, and increases urinary excretion of calcium and phosphorus (Karch, 2008). Although several forms are available, calcitonin derived from salmon is commonly used. Skin testing for allergy to salmon calcitonin is necessary before the hormone is administered. Systemic allergic reactions are possible because this hormone is a protein; resistance to the medication may develop later because of antibody formation. Calcitonin is administered by intramuscular injection rather than subcutaneously, because patients with hypercalcemia have poor perfusion of subcutaneous tissue.

For patients with cancer, treatment is directed at controlling the condition by surgery, chemotherapy, or radiation therapy. Corticosteroids may be used to decrease bone turnover and tubular reabsorption for patients with sarcoidosis, myelomas, lymphomas, and leukemias; patients with solid tumors are less responsive. Some bisphosphonates (eg, etidronate disodium [Didronel], pamidronate disodium [Aredia], and ibandronate sodium [Boniva]) inhibit osteoclast activity. IV forms can cause fever, transient leukopenia, eye inflammation, nephrotic syndrome, and jaw osteonecrosis (Karch, 2008). Mithramycin, a cytotoxic antibiotic, inhibits bone resorption and thus lowers the serum calcium level. This agent must be used cautiously because it has significant side effects, including thrombocytopenia, nephrotoxicity, rebound hypercalcemia when discontinued, and hepatotoxicity. Inorganic phosphate salts can be administered orally or by nasogastric tube (in the form of Phospho-Soda or Neutra-Phos), rectally (as retention enemas), or intravenously. IV phosphate therapy is used with extreme caution in the treatment of hypercalcemia, because it can cause severe calcification in various tissues, hypotension, tetany, and acute renal failure.

### Nursing Management

It is important to monitor for hypercalcemia in at-risk patients. Interventions such as increasing patient mobility and encouraging fluids can help prevent hypercalcemia, or at least minimize its severity. Hospitalized patients at risk for hypercalcemia should be encouraged to ambulate as soon as possible. Those who are outpatients and receive home care are instructed about the importance of frequent ambulation.

When encouraging oral fluids, the nurse considers the patient's likes and dislikes. Fluids containing sodium should be administered unless contraindicated, because sodium assists with calcium excretion. Patients are encouraged to drink 3 to 4 quarts of fluid daily. Adequate fiber in the diet is encouraged to offset the tendency for constipation. Safety precautions are implemented, as necessary, when mental symptoms of hypercalcemia are present. The patient and family are informed that these mental changes are reversible with treatment. Increased calcium increases the effects of digitalis; therefore, the patient is assessed for signs and symptoms of digitalis toxicity. Because ECG changes (premature ventricular contractions, paroxysmal atrial tachycardia, and heart block) can occur, the cardiac rate and rhythm are monitored for any abnormalities.

# Magnesium Imbalances

Magnesium is the most abundant intracellular cation after potassium. It acts as an activator for many intracellular enzyme systems and plays a role in both carbohydrate and protein metabolism. The normal serum magnesium level is 1.3 to 2.3 mg/dL (0.62 to 0.95 mmol/L). Approximately one third of serum magnesium is bound to protein; the remaining two thirds exists as free cations—the active component ($Mg^{++}$). Magnesium balance is important in neuromuscular function. Because magnesium acts directly on the myoneural junction, variations in the serum level affect neuromuscular irritability and contractility. For example, an excess of magnesium diminishes the excitability of the muscle cells, whereas a deficit increases neuromuscular irritability and contractility. Magnesium produces its sedative effect at the neuromuscular junction, probably by inhibiting the release of the neurotransmitter acetylcholine. It also increases the stimulus threshold in nerve fibers.

Magnesium also affects the cardiovascular system, acting peripherally to produce vasodilation and decreased peripheral resistance. Magnesium is predominantly found in bone and soft tissues and eliminated by the kidneys.

## MAGNESIUM DEFICIT (HYPOMAGNESEMIA)

Hypomagnesemia refers to a below-normal serum magnesium concentration (1.3 mg/dL [0.62 mmol/L]) and is frequently associated with hypokalemia and hypocalcemia. Magnesium is similar to calcium in two aspects: (1) it is the ionized fraction of magnesium that is primarily involved in neuromuscular activity and other physiologic processes, and (2) magnesium levels should be evaluated in combination with albumin levels. About 30% of magnesium is protein bound, principally to albumin. A decreased serum albumin level can, therefore, reduce the measured total magnesium concentration; however, it does not reduce the ionized plasma magnesium concentration.

### Pathophysiology

An important route of magnesium loss is the GI tract. Loss of magnesium from the GI tract may occur with nasogastric suction, diarrhea, or fistulas. Because fluid from the lower GI tract has a higher concentration of magnesium (10 to 14 mEq/L) than fluid from the upper tract (1 to 2 mEq/L), losses from diarrhea and intestinal fistulas are more likely to induce magnesium deficit than are those from gastric suction. Although magnesium losses are relatively small in nasogastric suction, hypomagnesemia occurs if losses are prolonged and magnesium is not replaced through IV infusion. Because the distal small bowel is the major site of magnesium absorption, any disruption in small-bowel function (eg, intestinal resection or inflammatory bowel disease) can lead to hypomagnesemia. Hypomagnesemia is a common yet often overlooked imbalance in acutely and critically ill patients. It may occur with withdrawal from alcohol and administration of tube feedings or parenteral nutrition.

Alcoholism is currently the most common cause of symptomatic hypomagnesemia in the United States. The serum magnesium level should be measured at least every 2 or 3 days in patients undergoing withdrawal from alcohol. The serum magnesium level may be normal on admission but may decrease as a result of metabolic changes, such as the intracellular shift of magnesium associated with IV glucose administration.

During nutritional replacement, the major cellular electrolytes move from the serum to newly synthesized cells. Therefore, if the enteral or parenteral feeding formula is deficient in magnesium content, serious hypomagnesemia will occur. Because of this, serum magnesium levels should be measured at regular intervals in patients who are receiving parenteral or enteral feedings, especially those who have

undergone a period of starvation. Other causes of hypomagnesemia include the administration of aminoglycosides, cyclosporine, cisplatin, diuretics, digitalis, and amphotericin, as well as the rapid administration of citrated blood, especially to patients with renal or hepatic disease. Magnesium deficiency often occurs in diabetic ketoacidosis, secondary to increased renal excretion during osmotic diuresis and shifting of magnesium into the cells with insulin therapy. Other contributing causes are pregnancy, lactation, sepsis, burns, and hypothermia.

### Clinical Manifestations

Clinical manifestations of hypomagnesemia are largely confined to the neuromuscular system. Some are due directly to the low serum magnesium level; others are due to secondary changes in potassium and calcium metabolism. Symptoms do not usually occur until the serum magnesium level has dropped to less than 1 mEq/L (0.5 mmol/L).

Among the neuromuscular changes are hyperexcitability with muscle weakness, tremors, and athetoid movements (slow, involuntary twisting and writhing). Others include tetany, nystagmus, vertigo, generalized tonic–clonic or focal seizures, laryngeal stridor, and positive Chvostek's and Trousseau's signs (see earlier discussion), which occur, in part, because of accompanying hypocalcemia.

Hypomagnesemia may be accompanied by marked alterations in mood. Apathy, depression, apprehension, and extreme agitation have been noted, as well as ataxia, dizziness, insomnia, and confusion. At times, delirium, auditory or visual hallucinations, and frank psychoses may occur.

Magnesium deficiency can disturb the ECG by prolonging the QRS, depressing the ST segment, and predisposing to cardiac dysrhythmias, such as premature ventricular contractions, supraventricular tachycardia, torsades de pointes (a form of ventricular tachycardia), and ventricular fibrillation. Increased susceptibility to digitalis toxicity is associated with low serum magnesium levels. This is important, because patients receiving digoxin are also likely to be receiving diuretic therapy, predisposing them to renal loss of magnesium. Hypercalcemia and hypokalemia may be refractory to correction until the magnesium level is corrected.

### Assessment and Diagnostic Findings

On laboratory analysis, the serum magnesium level is less than 1.3 mg/dL (0.62 mmol/L). Urine magnesium may help identify the cause of magnesium depletion, and levels are measured after a loading dose of magnesium sulfate is administered. Two newer diagnostic techniques (nuclear magnetic resonance spectroscopy and the ion-selective electrode) are sensitive and direct means of measuring ionized serum magnesium levels.

### Medical Management

Mild magnesium deficiency can be corrected by diet alone. Principal dietary sources of magnesium include green leafy vegetables, nuts, seeds, legumes, whole grains, seafood, peanut butter, and cocoa.

If necessary, magnesium salts can be administered orally in an oxide or gluconate form to replace continuous losses but can produce diarrhea. Patients receiving parenteral nutrition require magnesium in the IV solution to prevent hypomagnesemia. IV magnesium sulfate must be administered by an infusion pump and at a rate not to exceed 150 mg/min, or 67 mEq over 8 hours. Overt symptoms of hypomagnesemia are treated with parenteral administration of magnesium. A bolus dose of magnesium sulfate given too rapidly can produce alterations in cardiac conduction leading to heart block or asystole. Vital signs must be assessed frequently during magnesium administration to detect changes in cardiac rate or rhythm, hypotension, and respiratory distress. Monitoring urine output is essential before, during, and after magnesium administration; the physician is notified if urine volume decreases to less than 100 mL over 4 hours. Calcium gluconate must be readily available to treat hypocalcemic tetany or hypermagnesemia.

### Nursing Management

The nurse should be aware of patients at risk for hypomagnesemia and observe them for its signs and symptoms. Patients receiving digitalis are monitored closely, because a deficit of magnesium can predispose them to digitalis toxicity. If hypomagnesemia is severe, seizure precautions are implemented (Tocco, 2007). Other safety precautions are instituted, as indicated, if confusion is observed. Because difficulty in swallowing (dysphagia) may occur in those with magnesium depletion, these patients should be screened for dysphagia.

Teaching plays a major role in treating magnesium deficit, particularly a deficit resulting from abuse of diuretic or laxative medications. In such cases, the nurse instructs the patient about the need to consume magnesium-rich foods. For patients experiencing hypomagnesemia from abuse of alcohol, the nurse provides teaching, counseling, support, and possible referral to alcohol abstinence programs or other professional help.

## MAGNESIUM EXCESS (HYPERMAGNESEMIA)

Hypermagnesemia (serum levels over 2.3 mg/dL [0.95 mmol/L]) is a rare electrolyte abnormality, because the kidneys efficiently excrete magnesium. A serum magnesium level can appear falsely elevated if blood specimens are allowed to hemolyze or are drawn from an extremity with a tourniquet that was applied too tightly.

### Pathophysiology

By far the most common cause of hypermagnesemia is renal failure. In fact, most patients with advanced renal failure have at least a slight elevation in serum magnesium levels. This condition is aggravated when such patients receive magnesium to control seizures.

Hypermagnesemia can occur in patients with untreated diabetic ketoacidosis when catabolism causes the release of cellular magnesium that cannot be excreted because of profound fluid volume depletion and resulting oliguria. A surplus of magnesium can also result from excessive magnesium administered to treat hypertension of pregnancy or to treat low hypomagnesemia. Increased serum magnesium levels can also occur in adrenocortical insufficiency, Addison's disease, or hypothermia. Excessive use of magnesium-

based antacids (eg, Maalox, Riopan, Mylanta) or laxatives (Milk of Magnesia) and medications that decrease GI motility, including opioids and anticholinergics, can also increase serum magnesium levels. Decreased elimination of magnesium or its increased absorption due to intestinal hypomotility from any cause can contribute to hypermagnesemia. Lithium intoxication can also cause an increase in serum magnesium levels. Extensive soft-tissue injury or necrosis as with trauma, shock, sepsis, cardiac arrest, or severe burns can also result in hypermagnesemia (Muller & Bell, 2008).

### Clinical Manifestations

Acute elevation of the serum magnesium level depresses the central nervous system as well as the peripheral neuromuscular junction. At mildly increased levels, there is a tendency for lowered blood pressure because of peripheral vasodilation. Nausea, vomiting, weakness, soft-tissue calcifications, facial flushing, and sensations of warmth may also occur. At higher magnesium concentrations, lethargy, difficulty speaking (dysarthria), and drowsiness can occur. DTRs are lost, and muscle weakness and paralysis may develop. The respiratory center is depressed when serum magnesium levels exceed 10 mEq/L (5 mmol/L). Coma, atrioventricular heart block, and cardiac arrest can occur when the serum magnesium level is greatly elevated and not treated. High levels of magnesium also result in platelet clumping and delayed thrombin formation (Chernecky & Berger, 2007).

### Assessment and Diagnostic Findings

On laboratory analysis, the serum magnesium level is greater than 2.3 mg/dL (0.95 mmol/L). Increased potassium and calcium are present concurrently. As creatinine clearance decreases to less than 3.0 mL/min, the serum magnesium levels increase. ECG findings may include a prolonged PR interval, tall T waves, a widened QRS, and a prolonged QT interval, as well as an atrioventricular block.

### Medical Management

Hypermagnesemia can be prevented by avoiding the administration of magnesium to patients with renal failure and by carefully monitoring seriously ill patients who are receiving magnesium salts. In patients with severe hypermagnesemia, all parenteral and oral magnesium salts are discontinued. In emergencies, such as respiratory depression or defective cardiac conduction, ventilatory support and IV calcium gluconate are indicated. In addition, hemodialysis with a magnesium-free dialysate can reduce the serum magnesium to a safe level within hours. Administration of loop diuretics (Lasix) and sodium chloride or lactated Ringer's IV solution enhances magnesium excretion in patients with adequate renal function. IV calcium gluconate antagonizes the cardiovascular and neuromuscular effects of magnesium.

### Nursing Management

Patients at risk for hypermagnesemia are identified and assessed. If hypermagnesemia is suspected, the nurse monitors the vital signs, noting hypotension and shallow respirations. The nurse also observes for decreased DTRs and changes in the level of consciousness. Medications that contain magnesium are not administered to patients with renal failure or compromised renal function, and patients with renal failure are cautioned to check with their health care providers before taking OTC medications. Caution is essential when preparing and administering magnesium-containing fluids parenterally, because available parenteral magnesium solutions (eg, 2-mL ampules, 50-mL vials) differ in concentration.

## Phosphorus Imbalances

Phosphorus is a critical constituent of all the body's tissues. It is essential to the function of muscle and red blood cells; the formation of adenosine triphosphate (ATP) and of 2,3-diphosphoglycerate, which facilitates release of oxygen from hemoglobin; and the maintenance of acid–base balance, as well as the nervous system and the intermediary metabolism of carbohydrate, protein, and fat. It provides structural support to bones and teeth. Phosphorus is the primary anion of the ICF. About 85% of phosphorus is located in bones and teeth, 14% in soft tissue, and less than 1% in the ECF. The normal serum phosphorus level is 2.5 to 4.5 mg/dL (0.8 to 1.45 mmol/L) in adults.

## PHOSPHORUS DEFICIT (HYPOPHOSPHATEMIA)

Hypophosphatemia is indicated by a value below 2.5 mg/dL (0.8 mmol/L). Although it often indicates phosphorus deficiency, hypophosphatemia may occur under a variety of circumstances in which total body phosphorus stores are normal. Conversely, phosphorus deficiency is an abnormally low content of phosphorus in lean tissues that may exist in the absence of hypophosphatemia. It can be caused by an intracellular shift of potassium from serum into cells, by increased urinary excretion of potassium, or by decreased intestinal absorption of potassium.

### Pathophysiology

Hypophosphatemia may occur during the administration of calories to patients with severe protein–calorie malnutrition. It is most likely to result from overzealous intake or administration of simple carbohydrates. This syndrome can be induced in any person with severe protein–calorie malnutrition (eg, patients with anorexia nervosa or alcoholism, elderly debilitated patients who are unable to eat). As many as 50% of patients hospitalized because of chronic alcoholism have hypophosphatemia.

Marked hypophosphatemia may develop in malnourished patients who receive parenteral nutrition if the phosphorus loss is not corrected. Other causes of hypophosphatemia include heat stroke, prolonged intense hyperventilation, alcohol withdrawal, poor dietary intake, diabetic ketoacidosis, respiratory alkalosis, hepatic encephalopathy, and major thermal burns. Low magnesium levels, low potassium levels, and hyperparathyroidism related to increased urinary losses of phosphorus contribute to hypophosphatemia. Loss of phosphorus through the kidneys also occurs with acute volume expansion, osmotic diuresis, use of carbonic anhydrase inhibitors (acetazolamide

[Diamox]), and some malignancies. Respiratory alkalosis can cause a decrease in phosphorus because of an intracellular shift of phosphorus.

Excess phosphorus binding by antacids may decrease the phosphorus available from the diet to an amount lower than required to maintain serum phosphorus balance. The degree of hypophosphatemia depends on the amount of phosphorus in the diet compared to the dose of antacid. Phosphate can occur with chronic diarrhea or through severe potassium restriction. Vitamin D regulates intestinal ion absorption; therefore, a deficiency of vitamin D may cause decreased calcium and phosphorus levels, which may lead to osteomalacia (softened, brittle bones).

## Clinical Manifestations

Most of the signs and symptoms of phosphorus deficiency appear to result from a deficiency of ATP, 2,3-diphosphoglycerate, or both. ATP deficiency impairs cellular energy resources; diphosphoglycerate deficiency impairs oxygen delivery to tissues, resulting in a wide range of neurologic manifestations, such as irritability, fatigue, apprehension, weakness, numbness, paresthesias, dysarthria, dysphagia, diplopia, confusion, seizures, and coma. Hypoxia leads to an increase in respiratory rate and respiratory alkalosis, causing phosphorus to move into the cells and potentiating hypophosphatemia. Hypophosphatemia may predispose a person to infection. In laboratory animals, hypophosphatemia is associated with depression of the chemotactic, phagocytic, and bacterial activity of granulocytes.

Muscle damage may develop as the ATP level in the muscle tissue declines. Clinical manifestations are muscle weakness, which may be subtle or profound and may affect any muscle group; muscle pain; and at times acute rhabdomyolysis (breakdown of skeletal muscle) (Spradling, 2007). Weakness of respiratory muscles may greatly impair ventilation. Hypophosphatemia also may predispose a person to insulin resistance and thus hyperglycemia. Chronic loss of phosphorus can cause bruising and bleeding from platelet dysfunction.

## Assessment and Diagnostic Findings

On laboratory analysis, the serum phosphorus level is less than 2.5 mg/dL (0.80 mmol/L) in adults. When reviewing laboratory results, the nurse should keep in mind that glucose or insulin administration causes a slight decrease in the serum phosphorus level. PTH levels are increased in hyperparathyroidism. Serum magnesium may decrease due to increased urinary excretion of magnesium. Alkaline phosphatase is increased with osteoblastic activity. X-rays may show skeletal changes of osteomalacia or rickets.

## Medical Management

Prevention of hypophosphatemia is the goal. In patients at risk for hypophosphatemia, serum phosphate levels should be closely monitored and correction initiated before deficits become severe. Adequate amounts of phosphorus should be added to parenteral solutions, and attention should be paid to the phosphorus levels in enteral feeding solutions.

Severe hypophosphatemia is dangerous and requires prompt attention. Aggressive IV phosphorus correction is usually limited to the patient whose serum phosphorus levels decrease to less than 1 mg/dL (0.3 mmol/L) and whose GI tract is not functioning. Possible dangers of IV administration of phosphorus include tetany from hypocalcemia and calcifications in tissues (blood vessels, heart, lung, kidney, eyes) from hyperphosphatemia. IV preparations of phosphorus are available as sodium or potassium phosphate. The rate of phosphorus administration should not exceed 10 mEq/h, and the site should be carefully monitored because tissue sloughing and necrosis can occur with infiltration. In less acute situations, oral phosphorus replacement is usually adequate.

## Nursing Management

The nurse identifies patients who are at risk for hypophosphatemia and monitors them. Because malnourished patients receiving parenteral nutrition are at risk when calories are introduced too aggressively, preventive measures involve gradually introducing the solution to avoid rapid shifts of phosphorus into the cells.

For patients with documented hypophosphatemia, careful attention is given to preventing infection, because hypophosphatemia may alter the granulocytes. In patients requiring correction of phosphorus losses, the nurse frequently monitors serum phosphorus levels and documents and reports early signs of hypophosphatemia (apprehension, confusion, change in level of consciousness). If the patient experiences mild hypophosphatemia, foods such as milk and milk products, organ meats, nuts, fish, poultry, and whole grains should be encouraged. With moderate hypophosphatemia, supplements such as Neutra-Phos capsules (250 mg phosphorus/capsule; 7 mEq sodium and potassium), K-Phos (250 mg phosphorus/tablet; 14 mEq potassium), and Fleet's Phospho-Soda (815 mg phosphorus/5 mL) may be prescribed.

# PHOSPHORUS EXCESS (HYPERPHOSPHATEMIA)

Hyperphosphatemia is a serum phosphorus level that exceeds 4.5 mg/dL (1.45 mmol/L) in adults.

## Pathophysiology

Various conditions can lead to hyperphosphatemia, but the most common is renal failure. Other causes include increased intake, decreased output, or a shift from the intracellular to extracellular space. Conditions such as excessive vitamin D intake, administration of total parenteral nutrition, chemotherapy for neoplastic disease, hypoparathyroidism, metabolic or respiratory acidosis, diabetic ketoacidosis, acute hemolysis, high phosphate intake, profound muscle necrosis, and increased phosphorus absorption may also lead to this phosphorus imbalance. The primary complication of increased phosphorus is metastatic calcification (soft tissue, joints, and arteries), which occurs when the calcium–magnesium product (calcium $\times$ magnesium) exceeds 70 mg/dL.

## Clinical Manifestations

An increased serum phosphorus level causes few symptoms. Symptoms that do occur usually result from decreased calcium levels and soft-tissue calcifications. The most important short-term consequence is tetany. Because of the recip-

rocal relationship between phosphorus and calcium, a high serum phosphorus level tends to cause a low serum calcium concentration. Tetany can result, causing tingling sensations in the fingertips and around the mouth. Anorexia, nausea, vomiting, bone and joint pain, muscle weakness, hyperreflexia, and tachycardia may occur.

The major long-term consequence is soft-tissue calcification, which occurs mainly in patients with a reduced glomerular filtration rate. High serum levels of inorganic phosphorus promote precipitation of calcium phosphate in nonosseous sites, decreasing urine output, impairing vision, and producing palpitations.

### Assessment and Diagnostic Findings

On laboratory analysis, the serum phosphorus level exceeds 4.5 mg/dL (1.5 mmol/L) in adults. The serum calcium level is useful also for diagnosing the primary disorder and assessing the effects of treatments. X-rays may show skeletal changes with abnormal bone development. PTH levels are decreased in hypoparathyroidism. BUN and creatinine levels are used to assess renal function.

### Medical Management

When possible, treatment is directed at the underlying disorder. For example, hyperphosphatemia may be related to volume depletion or respiratory or metabolic acidosis. In renal failure, elevated PTH production contributes to a high phosphorus level and bone disease. Measures to decrease the serum phosphate level and bind phosphorus in the GI tract of these patients include vitamin D preparations, such as calcitriol, which is available in both oral (Rocaltrol) and parenteral (Calcijex, paricalcitol [Zemplar]) forms. IV administration of calcitriol does not increase the serum calcium unless its dose is excessive, thus permitting more aggressive treatment of hyperphosphatemia with calcium-binding antacids (calcium carbonate or calcium citrate). Administration of Amphojel with meals is effective but can cause bone and central nervous system toxicity with long-term use. Restriction of dietary phosphate, forced diuresis with a loop diuretic, volume replacement with saline, and dialysis may also lower phosphorus. Surgery may be indicated for removal of large calcium and phosphorus deposits.

### Nursing Management

The nurse monitors patients at risk for hyperphosphatemia. If a low-phosphorus diet is prescribed, the patient is instructed to avoid phosphorus-rich foods such as hard cheeses, cream, nuts, meats, whole-grain cereals, dried fruits, dried vegetables, kidneys, sardines, sweetbreads, and foods made with milk. When appropriate, the nurse instructs the patient to avoid phosphate-containing substances such as laxatives and enemas. The nurse also teaches the patient to recognize the signs of impending hypocalcemia and to monitor for changes in urine output.

## *Chloride Imbalances*

Chloride, the major anion of the ECF, is found more in interstitial and lymph fluid compartments than in blood. Chloride is also contained in gastric and pancreatic juices, sweat, bile, and saliva. Sodium and chloride make up the largest electrolyte composition of the ECF and assist in determining osmotic pressure. Chloride is produced in the stomach, where it combines with hydrogen to form hydrochloric acid. Chloride control depends on the intake of chloride and the excretion and reabsorption of its ions in the kidneys. A small amount of chloride is lost in the feces.

The normal serum chloride level is 97 to 107 mEq/L (97 to 107 mmol/L). Inside the cell, the chloride level is 4 mEq/L. The serum level of chloride reflects a change in dilution or concentration of the ECF and does so in direct proportion to the sodium concentration. Serum osmolality parallels chloride levels as well. Aldosterone secretion increases sodium reabsorption, thereby increasing chloride reabsorption. The choroid plexus, which secretes cerebrospinal fluid in the brain, depends on sodium and chloride to attract water to form the fluid portion of the cerebrospinal fluid. Bicarbonate has an inverse relationship with chloride. As chloride moves from plasma into the red blood cells (called the chloride shift), bicarbonate moves back into the plasma. Hydrogen ions are formed, which then help release oxygen from hemoglobin. When the level of one of these three electrolytes (sodium, bicarbonate, or chloride) is disturbed, the other two are also affected. Chloride assists in maintaining acid–base balance and works as a buffer in the exchange of oxygen and carbon dioxide in red blood cells. Chloride is primarily obtained from the diet as table salt.

## CHLORIDE DEFICIT (HYPOCHLOREMIA)

Hypochloremia is a serum chloride level below 97 mEq/L (97 mmol/L).

### Pathophysiology

Hypochloremia can occur with GI tube drainage, gastric suctioning, gastric surgery, and severe vomiting and diarrhea. Administration of chloride-deficient IV solutions, low sodium intake, decreased serum sodium levels, metabolic alkalosis, massive blood transfusions, diuretic therapy, burns, and fever may cause hypochloremia. Administration of aldosterone, ACTH, corticosteroids, bicarbonate, or laxatives decreases serum chloride levels as well. As chloride decreases (usually because of volume depletion), sodium and bicarbonate ions are retained by the kidney to balance the loss. Bicarbonate accumulates in the ECF, which raises the pH and leads to hypochloremic metabolic alkalosis.

### Clinical Manifestations

The signs and symptoms of hypochloremia are those of acid–base and electrolyte imbalances. The signs and symptoms of hyponatremia, hypokalemia, and metabolic alkalosis may also be present. Metabolic alkalosis is a disorder that results in a high pH and a high serum bicarbonate level as a result of excess alkali intake or loss of hydrogen ions. With compensation, the partial pressure of carbon dioxide in arterial blood ($PaCO_2$) increases to 50 mm Hg. Hyperexcitability of muscles, tetany, hyperactive DTRs, weakness, twitching, and muscle cramps may result. Hypokalemia can cause hypochloremia, resulting in cardiac dysrhythmias. In

addition, because low chloride levels parallel low sodium levels, a water excess may occur. Hyponatremia can cause seizures and coma.

### Assessment and Diagnostic Findings

In addition to the chloride level, sodium and potassium levels are also evaluated, because these electrolytes are lost along with chloride. Arterial blood gas analysis identifies the acid–base imbalance, which is usually metabolic alkalosis. The urine chloride level, which is also measured, decreases in hypochloremia.

### Medical Management

Treatment involves correcting the cause of hypochloremia and the contributing electrolyte and acid–base imbalances. Normal saline (0.9% sodium chloride) or half-strength saline (0.45% sodium chloride) solution is administered by IV to replace the chloride. If the patient is receiving a diuretic (loop, osmotic, or thiazide), it may be discontinued or another diuretic prescribed.

Ammonium chloride, an acidifying agent, may be prescribed to treat metabolic alkalosis; the dosage depends on the patient's weight and serum chloride level. This agent is metabolized by the liver, and its effects last for about 3 days. Its use should be avoided in patients with impaired liver or renal function.

### Nursing Management

The nurse monitors the patient's I&O, arterial blood gas values, and serum electrolyte levels. Changes in the patient's level of consciousness and muscle strength and movement are reported to the physician promptly. Vital signs are monitored, and respiratory assessment is carried out frequently. The nurse provides and teaches the patient about foods with high chloride content. Foods high in chloride include tomato juice, bananas, dates, eggs, cheese, milk, salty broth, canned vegetables, and processed meats. A person who drinks free water (water without electrolytes) or bottled water and excretes large amounts of chloride needs instruction to avoid drinking this kind of water.

## CHLORIDE EXCESS (HYPERCHLOREMIA)

Hyperchloremia exists when the serum level of chloride exceeds 107 mEq/L (107 mmol/L). Hypernatremia, bicarbonate loss, and metabolic acidosis can occur with high chloride levels.

### Pathophysiology

High serum chloride levels are almost exclusively a result of iatrogenically induced hyperchloremic metabolic acidosis, stemming from excessive administration of chloride relative to sodium, most commonly as 0.9% normal saline solution, 0.45% normal saline solution, or lactated Ringer's solution (Muller & Bell, 2008). This condition can also be caused by the loss of bicarbonate ions via the kidney or the GI tract with a corresponding increase in chloride ions. Chloride ions in the form of acidifying salts accumulate, and acidosis occurs with a decrease in bicarbonate ions. Head trauma, increased perspiration, excess adrenocortical hormone production, and decreased glomerular filtration can lead to a high serum chloride level.

### Clinical Manifestations

The signs and symptoms of hyperchloremia are the same as those of metabolic acidosis: hypervolemia and hypernatremia. Tachypnea; weakness; lethargy; deep, rapid respirations; diminished cognitive ability; and hypertension occur. If untreated, hyperchloremia can lead to a decrease in cardiac output, dysrhythmias, and coma. A high chloride level is accompanied by a high sodium level and fluid retention.

### Assessment and Diagnostic Findings

The serum chloride level is 108 mEq/L (108 mmol/L) or greater, the serum sodium level is greater than 145 mEq/L (145 mmol/L), the serum pH is less than 7.35, and the serum bicarbonate level is less than 22 mEq/L (22 mmol/L). Urine chloride excretion increases.

Calculation of the serum anion gap is important in analyzing acid–base disorders. The sum of all negatively charged electrolytes (anions) equals the sum of all positively charged electrolytes (cations), with several anions that are not routinely measured leading to an anion gap. It is based primarily on three electrolytes: sodium, chloride, and bicarbonate or serum carbon dioxide ($CO_2$). A normal anion gap is 8 to 12 mEq/L (8 to 12 mmol/L). A low anion gap may be attributed to hypoproteinemia, whereas an elevated anion gap can be due to metabolic acidosis.

### Medical Management

Correcting the underlying cause of hyperchloremia and restoring electrolyte, fluid, and acid–base balance are essential. Hypotonic IV solutions may be administered to restore balance. Lactated Ringer's solution may be prescribed to convert lactate to bicarbonate in the liver, which increases the bicarbonate level and corrects the acidosis. IV sodium bicarbonate may be administered to increase bicarbonate levels, which leads to the renal excretion of chloride ions because bicarbonate and chloride compete for combination with sodium. Diuretics may be administered to eliminate chloride as well. Sodium, chloride, and fluids are restricted.

### Nursing Management

Monitoring vital signs, arterial blood gas values, and I&O is important to assess the patient's status and the effectiveness of treatment. Assessment findings related to respiratory, neurologic, and cardiac systems are documented, and changes are discussed with the physician. The nurse teaches the patient about the diet that should be followed to manage hyperchloremia and maintain adequate hydration.

# ACID–BASE DISTURBANCES

Acid–base disturbances are commonly encountered in clinical practice. Identification of the specific acid–base imbalance is important in identifying the underlying cause of the disorder and determining appropriate treatment.

Plasma pH is an indicator of hydrogen ion ($H^+$) concentration. Homeostatic mechanisms keep pH within a normal range (7.35 to 7.45) (Ruholl, 2006; Swiderski & Byrum, 2007). These mechanisms consist of buffer systems, the kidneys, and the lungs. The $H^+$ concentration is extremely im-

portant: The greater the concentration, the more acidic the solution and the lower the pH. The lower the $H^+$ concentration, the more alkaline the solution and the higher the pH. The pH range compatible with life (6.8 to 7.8) represents a 10-fold difference in $H^+$ concentration in plasma.

Buffer systems prevent major changes in the pH of body fluids by removing or releasing $H^+$; they can act quickly to prevent excessive changes in $H^+$ concentration. Hydrogen ions are buffered by both intracellular and extracellular buffers. The body's major extracellular buffer system is the bicarbonate–carbonic acid buffer system, which is assessed when arterial blood gases are measured. Normally, there are 20 parts of bicarbonate ($HCO_3^-$) to one part of carbonic acid ($H_2CO_3$). If this ratio is altered, the pH will change. It is the ratio of $HCO_3^-$ to $H_2CO_3$ that is important in maintaining pH, not absolute values. $CO_2$ is a potential acid; when dissolved in water, it becomes carbonic acid ($CO_2 + H_2O = H_2CO_3$). Therefore, when $CO_2$ is increased, the carbonic acid content is also increased, and vice versa. If either bicarbonate or carbonic acid is increased or decreased so that the 20:1 ratio is no longer maintained, acid–base imbalance results.

Less important buffer systems in the ECF include the inorganic phosphates and the plasma proteins. Intracellular buffers include proteins, organic and inorganic phosphates, and, in red blood cells, hemoglobin.

The kidneys regulate the bicarbonate level in the ECF; they can regenerate bicarbonate ions as well as reabsorb them from the renal tubular cells. In respiratory acidosis and most cases of metabolic acidosis, the kidneys excrete hydrogen ions and conserve bicarbonate ions to help restore balance. In respiratory and metabolic alkalosis, the kidneys retain hydrogen ions and excrete bicarbonate ions to help restore balance. The kidneys obviously cannot compensate for the metabolic acidosis created by renal failure. Renal compensation for imbalances is relatively slow (a matter of hours or days).

The lungs, under the control of the medulla, control the $CO_2$ and thus the carbonic acid content of the ECF. They do so by adjusting ventilation in response to the amount of $CO_2$ in the blood. A rise in the partial pressure of $CO_2$ in arterial blood ($PaCO_2$) is a powerful stimulant to respiration. Of course, the partial pressure of oxygen in arterial blood ($PaO_2$) also influences respiration. However, its effect is not as marked as that produced by the $PaCO_2$.

In metabolic acidosis, the respiratory rate increases, causing greater elimination of $CO_2$ (to reduce the acid load). In metabolic alkalosis, the respiratory rate decreases, causing $CO_2$ to be retained (to increase the acid load) (Swiderski & Byrum, 2007).

## Acute and Chronic Metabolic Acidosis (Base Bicarbonate Deficit)

Metabolic acidosis is a common clinical disturbance characterized by a low pH (increased $H^+$ concentration) and a low plasma bicarbonate concentration. It can be produced by a gain of hydrogen ion or a loss of bicarbonate (Ruholl, 2006; Swiderski & Byrum, 2007). It can be divided clinically into two forms, according to the values of the serum anion gap: high anion gap acidosis and normal anion gap acidosis. The anion gap reflects normally unmeasured anions (phosphates, sulfates, and proteins) in plasma. Measuring the anion gap is essential in analyzing acid–base disorders correctly. The anion gap can be calculated by either one of the following equations:

$$\text{Anion gap} = Na^+ + K^+ - (Cl^- + HCO_3^-)$$
$$\text{Anion gap} = Na^+ - (Cl^- + HCO_3^-)$$

Potassium is often omitted from the equation because of its low level in the plasma; therefore, the second equation is used more often than the first.

The normal value for an anion gap is 8 to 12 mEq/L (8 to 12 mmol/L) without potassium in the equation. If potassium is included in the equation, the normal value for the anion gap is 12 to 16 mEq/L (12 to 16 mmol/L). The unmeasured anions in the serum normally account for less than 16 mEq/L of the anion production. An anion gap greater than 16 mEq (16 mmol/L) suggests excessive accumulation of unmeasured anions. An anion gap occurs because not all electrolytes are measured. More anions are left unmeasured than cations.

### Pathophysiology

Normal anion gap acidosis results from the direct loss of bicarbonate, as in diarrhea, lower intestinal fistulas, ureterostomies, and use of diuretics; early renal insufficiency; excessive administration of chloride; and the administration of parenteral nutrition without bicarbonate or bicarbonate-producing solutes (eg, lactate). Normal anion gap acidosis is also referred to as hyperchloremic acidosis. A reduced or negative anion gap is primarily caused by hypoproteinemia. Disorders that cause a decreased or negative anion gap are rare compared to those related to an increased or high anion gap.

High anion gap acidosis results from excessive accumulation of fixed acid. If increased to 30 mEq/L (30 mmol/L) or more, then a high anion gap metabolic acidosis is present regardless of the values of pH and $HCO_3^-$. High ion gap occurs in ketoacidosis, lactic acidosis, the late phase of salicylate poisoning, uremia, methanol or ethylene glycol toxicity, and ketoacidosis with starvation. The hydrogen is buffered by $HCO_3^-$, causing the bicarbonate concentration to fall. In all of these instances, abnormally high levels of anions flood the system, increasing the anion gap above normal limits.

### Clinical Manifestations

Signs and symptoms of metabolic acidosis vary with the severity of the acidosis but include headache, confusion, drowsiness, increased respiratory rate and depth, nausea, and vomiting. Peripheral vasodilation and decreased cardiac output occur when the pH drops to less than 7. Additional physical assessment findings include decreased blood pressure, cold and clammy skin, dysrhythmias, and shock. Chronic metabolic acidosis is usually seen with chronic renal failure.

### Assessment and Diagnostic Findings

Arterial blood gas measurements are valuable in diagnosing metabolic acidosis. Expected blood gas changes include a low bicarbonate level (less than 22 mEq/L) and a low pH (less than 7.35) (Swiderski & Byrum, 2007). The cardinal

feature of metabolic acidosis is a decrease in the serum bicarbonate level. Hyperkalemia may accompany metabolic acidosis as a result of the shift of potassium out of the cells. Later, as the acidosis is corrected, potassium moves back into the cells and hypokalemia may occur. Hyperventilation decreases the $CO_2$ level as a compensatory action. Calculation of the anion gap is helpful in determining the cause of metabolic acidosis. An ECG detects dysrhythmias caused by the increased potassium.

### Medical Management

Treatment is directed at correcting the metabolic imbalance (Ruholl, 2006). If the problem results from excessive intake of chloride, treatment is aimed at eliminating the source of the chloride. When necessary, bicarbonate is administered. Although hyperkalemia occurs with acidosis, hypokalemia may occur with reversal of the acidosis and subsequent movement of potassium back into the cells. Therefore, the serum potassium level is monitored closely, and hypokalemia is corrected as acidosis is reversed.

In chronic metabolic acidosis, low serum calcium levels are treated before the chronic metabolic acidosis is treated, to avoid tetany resulting from an increase in pH and a decrease in ionized calcium. Alkalizing agents may be administered. Treatment modalities may also include hemodialysis or peritoneal dialysis.

## Acute and Chronic Metabolic Alkalosis (Base Bicarbonate Excess)

Metabolic alkalosis is a clinical disturbance characterized by a high pH (decreased $H^+$ concentration) and a high plasma bicarbonate concentration. It can be produced by a gain of bicarbonate or a loss of $H^+$ (Porth & Matfin, 2009).

### Pathophysiology

Probably the most common cause of metabolic alkalosis is vomiting or gastric suction with loss of hydrogen and chloride ions. The disorder also occurs in pyloric stenosis, in which only gastric fluid is lost. Gastric fluid has an acid pH (usually 1 to 3), and loss of this highly acidic fluid increases the alkalinity of body fluids. Other situations predisposing to metabolic alkalosis include those associated with loss of potassium, such as diuretic therapy that promotes excretion of potassium (eg, thiazides, furosemide), and excessive adrenocorticoid hormones (as in hyperaldosteronism and Cushing's syndrome).

Hypokalemia produces alkalosis in two ways: (1) the kidneys conserve potassium, and therefore $H^+$ excretion increases; and (2) cellular potassium moves out of the cells into the ECF in an attempt to maintain near-normal serum levels (as potassium ions leave the cells, hydrogen ions must enter to maintain electroneutrality). Excessive alkali ingestion from antacids containing bicarbonate or from use of sodium bicarbonate during cardiopulmonary resuscitation can also cause metabolic alkalosis.

Chronic metabolic alkalosis can occur with long-term diuretic therapy (thiazides or furosemide), villous adenoma, external drainage of gastric fluids, significant potassium depletion, cystic fibrosis, and the chronic ingestion of milk and calcium carbonate.

### Clinical Manifestations

Alkalosis is primarily manifested by symptoms related to decreased calcium ionization, such as tingling of the fingers and toes, dizziness, and hypertonic muscles. The ionized fraction of serum calcium decreases in alkalosis as more calcium combines with serum proteins. Because it is the ionized fraction of calcium that influences neuromuscular activity, symptoms of hypocalcemia are often the predominant symptoms of alkalosis. Respirations are depressed as a compensatory action by the lungs. Atrial tachycardia may occur. As the pH increases and hypokalemia develops, ventricular disturbances may occur. Decreased motility and paralytic ileus may also be evident.

Symptoms of chronic metabolic alkalosis are the same as for acute metabolic alkalosis, and as potassium decreases, frequent premature ventricular contractions or U waves are seen on the ECG.

### Assessment and Diagnostic Findings

Evaluation of arterial blood gases reveals a pH greater than 7.45 and a serum bicarbonate concentration greater than 26 mEq/L. The $PaCO_2$ increases as the lungs attempt to compensate for the excess bicarbonate by retaining $CO_2$. This hypoventilation is more pronounced in semiconscious, unconscious, or debilitated patients than in alert patients. The former may develop marked hypoxemia as a result of hypoventilation. Hypokalemia may accompany metabolic alkalosis.

Urine chloride levels may help identify the cause of metabolic alkalosis if the patient's history provides inadequate information. Metabolic alkalosis is the setting in which urine chloride concentration may be a more accurate estimate of fluid volume than the urine sodium concentration. Urine chloride concentrations help to differentiate between vomiting, diuretic therapy, and excessive adrenocorticosteroid secretion as the cause of the metabolic alkalosis. In patients with vomiting or cystic fibrosis, those receiving nutritional repletion, and those receiving diuretic therapy, hypovolemia and hypochloremia produce urine chloride concentrations lower than 25 mEq/L. Signs of hypovolemia are not present, and the urine chloride concentration exceeds 40 mEq/L in patients with mineralocorticoid excess or alkali loading; these patients usually have expanded fluid volume. The urine chloride concentration should be less than 15 mEq/L when decreased chloride levels and hypovolemia occur.

### Medical Management

Treatment of both acute and chronic metabolic alkalosis is aimed at correcting the underlying acid–base disorder (Gennari, 2005; Ruholl, 2006). Because of volume depletion from GI loss, the patient's fluid I&O must be monitored carefully.

Sufficient chloride must be supplied for the kidney to absorb sodium with chloride (allowing the excretion of excess bicarbonate). Treatment also includes restoring normal fluid volume by administering sodium chloride fluids (because continued volume depletion perpetuates the alkalosis). In patients with hypokalemia, potassium is adminis-

tered as KCl to replace both $K^+$ and $Cl^-$ losses. $H_2$ receptor antagonists, such as cimetidine (Tagamet), reduce the production of gastric HCl, thereby decreasing the metabolic alkalosis associated with gastric suction. Carbonic anhydrase inhibitors are useful in treating metabolic alkalosis in patients who cannot tolerate rapid volume expansion (eg, patients with heart failure).

## Acute and Chronic Respiratory Acidosis (Carbonic Acid Excess)

Respiratory acidosis is a clinical disorder in which the pH is less than 7.35 and the $PaCO_2$ is greater than 42 mm Hg. It may be either acute or chronic.

### Pathophysiology

Respiratory acidosis is always due to inadequate excretion of $CO_2$ with inadequate ventilation, resulting in elevated plasma $CO_2$ concentrations and, consequently, increased levels of carbonic acid. In addition to an elevated $PaCO_2$, hypoventilation usually causes a decrease in $PaO_2$. Acute respiratory acidosis occurs in emergency situations, such as acute pulmonary edema, aspiration of a foreign object, atelectasis, pneumothorax, overdose of sedatives, sleep apnea, administration of oxygen to a patient with chronic hypercapnia (excessive $CO_2$ in the blood), severe pneumonia, and acute respiratory distress syndrome. Respiratory acidosis can also occur in diseases that impair respiratory muscles, such as muscular dystrophy, myasthenia gravis, and Guillain-Barré syndrome. Mechanical ventilation may be associated with hypercapnia if the rate of ventilation is inadequate and $CO_2$ retained.

### Clinical Manifestations

Clinical signs in acute and chronic respiratory acidosis vary. Sudden hypercapnia (elevated $PaCO_2$) can cause increased pulse and respiratory rate, increased blood pressure, mental cloudiness, and a feeling of fullness in the head. An elevated $PaCO_2$, greater than 60 mm Hg, causes cerebrovascular vasodilation and increased cerebral blood flow. Ventricular fibrillation may be the first sign of respiratory acidosis in anesthetized patients.

If respiratory acidosis is severe, intracranial pressure may increase, resulting in papilledema and dilated conjunctival blood vessels. Hyperkalemia may result as the hydrogen concentration overwhelms the compensatory mechanisms and $H^+$ moves into cells, causing a shift of potassium out of the cell.

Chronic respiratory acidosis occurs with pulmonary diseases such as chronic emphysema and bronchitis, obstructive sleep apnea, and obesity. As long as the $PaCO_2$ does not exceed the body's ability to compensate, the patient will be asymptomatic. However, if the $PaCO_2$ increases rapidly, cerebral vasodilation will increase the intracranial pressure, and cyanosis and tachypnea will develop. Patients with chronic obstructive pulmonary disease (COPD) who gradually accumulate $CO_2$ over a prolonged period (days to months) may not develop symptoms of hypercapnia because compensatory renal changes have had time to occur.

*NURSING ALERT*

**If the $PaCO_2$ is chronically higher than 50 mm Hg, the respiratory center becomes relatively insensitive to $CO_2$ as a respiratory stimulant, leaving hypoxemia as the major drive for respiration. Oxygen administration may remove the stimulus of hypoxemia, and the patient develops "carbon dioxide narcosis" unless the situation is quickly reversed. Therefore, oxygen is administered only with extreme caution.**

### Assessment and Diagnostic Findings

Arterial blood gas analysis reveals a pH lower than 7.35, a $PaCO_2$ greater than 42 mm Hg, and a variation in the bicarbonate level, depending on the duration of the acute respiratory acidosis. When compensation (renal retention of bicarbonate) has fully occurred, the arterial pH is within the lower limits of normal. Depending on the cause of respiratory acidosis, other diagnostic measures include monitoring of serum electrolyte levels, chest x-ray for determining any respiratory disease, and a drug screen if an overdose is suspected. An ECG to identify any cardiac involvement as a result of COPD may be indicated as well.

### Medical Management

Treatment is directed at improving ventilation; exact measures vary with the cause of inadequate ventilation (Gennari, 2005). Pharmacologic agents are used as indicated. For example, bronchodilators help reduce bronchial spasm, antibiotics are used for respiratory infections, and thrombolytics or anticoagulants are used for pulmonary emboli (see Chapter 25).

Pulmonary hygiene measures are initiated, when necessary, to clear the respiratory tract of mucus and purulent drainage. Adequate hydration (2 to 3 L/day) is indicated to keep the mucous membranes moist and thereby facilitate the removal of secretions. Supplemental oxygen is administered as necessary.

Mechanical ventilation, used appropriately, may improve pulmonary ventilation. Inappropriate mechanical ventilation (eg, increased dead space, insufficient rate or volume settings, high fraction of inspired oxygen [$FiO_2$] with excessive $CO_2$ production) may cause such rapid excretion of $CO_2$ that the kidneys are unable to eliminate excess bicarbonate quickly enough to prevent alkalosis and seizures. For this reason, the elevated $PaCO_2$ must be decreased slowly. Placing the patient in a semi-Fowler's position facilitates expansion of the chest wall.

Treatment of chronic respiratory acidosis is the same as for acute respiratory acidosis.

## Acute and Chronic Respiratory Alkalosis (Carbonic Acid Deficit)

Respiratory alkalosis is a clinical condition in which the arterial pH is greater than 7.45 and the $PaCO_2$ is less than 38 mm Hg. As with respiratory acidosis, acute and chronic conditions can occur.

## Pathophysiology

Respiratory alkalosis is always caused by hyperventilation, which causes excessive "blowing off" of $CO_2$ and, hence, a decrease in the plasma carbonic acid concentration. Causes include extreme anxiety, hypoxemia, early phase of salicylate intoxication, gram-negative bacteremia, and inappropriate ventilator settings that do not match the patient's requirements.

Chronic respiratory alkalosis results from chronic hypocapnia, and decreased serum bicarbonate levels are the consequence. Chronic hepatic insufficiency and cerebral tumors are predisposing factors.

## Clinical Manifestations

Clinical signs consist of lightheadedness due to vasoconstriction and decreased cerebral blood flow, inability to concentrate, numbness and tingling from decreased calcium ionization, tinnitus, and sometimes loss of consciousness. Cardiac effects of respiratory alkalosis include tachycardia and ventricular and atrial dysrhythmias (Heitz & Horne, 2005).

## Assessment and Diagnostic Findings

Analysis of arterial blood gases assists in the diagnosis of respiratory alkalosis. In the acute state, the pH is elevated above normal as a result of a low $PaCO_2$ and a normal bicarbonate level. (The kidneys cannot alter the bicarbonate level quickly.) In the compensated state, the kidneys have had sufficient time to lower the bicarbonate level to a near-normal level. Evaluation of serum electrolytes is indicated to identify any decrease in potassium, as hydrogen is pulled out of the cells in exchange for potassium; decreased calcium, as severe alkalosis inhibits calcium ionization, resulting in carpopedal spasms and tetany; or decreased phosphate due to alkalosis, causing an increased uptake of phosphate by the cells. A toxicology screen should be performed to rule out salicylate intoxication.

Patients with chronic respiratory alkalosis are usually asymptomatic, and the diagnostic evaluation and plan of care are the same as for acute respiratory alkalosis.

## Medical Management

Treatment depends on the underlying cause of respiratory alkalosis. If the cause is anxiety, the patient is instructed to breathe more slowly to allow $CO_2$ to accumulate or to breathe into a closed system (such as a paper bag). A sedative may be required to relieve hyperventilation in very anxious patients. Treatment of other causes of respiratory alkalosis is directed at correcting the underlying problem.

# Mixed Acid–Base Disorders

Patients can simultaneously experience two or more independent acid–base disorders. A normal pH in the presence of changes in the $PaCO_2$ and plasma $HCO_3^-$ concentration immediately suggests a mixed disorder. An example of a mixed disorder is the simultaneous occurrence of metabolic acidosis and respiratory acidosis during respiratory and cardiac arrest. The only mixed disorder that cannot occur is a mixed respiratory acidosis and alkalosis, because it is impossible to have alveolar hypoventilation and hyperventilation at the same time.

## Compensation

Generally, the pulmonary and renal systems compensate for each other to return the pH to normal. In a single acid–base disorder, the system not causing the problem tries to compensate by returning the ratio of bicarbonate to carbonic acid to the normal 20:1. The lungs compensate for metabolic disturbances by changing $CO_2$ excretion. The kidneys compensate for respiratory disturbances by altering bicarbonate retention and $H^+$ secretion.

In respiratory acidosis, excess hydrogen is excreted in the urine in exchange for bicarbonate ions. In respiratory alkalosis, the renal excretion of bicarbonate increases, and hydrogen ions are retained. In metabolic acidosis, the compensatory mechanisms increase the ventilation rate and the renal retention of bicarbonate. In metabolic alkalosis, the respiratory system compensates by decreasing ventilation to conserve $CO_2$ and increase the $PaCO_2$. Because the lungs respond to acid–base disorders within minutes, compensation for metabolic imbalances occurs faster than compensation for respiratory imbalances. Table 14-5 summarizes compensation effects.

## Blood Gas Analysis

Blood gas analysis is often used to identify the specific acid–base disturbance and the degree of compensation that has occurred. The analysis is usually based on an arterial blood sample, but if an arterial sample cannot be obtained, a mixed venous sample may be used. Results of arterial blood gas analysis provide information about alveolar ventilation, oxygenation, and acid–base balance. It is necessary to evaluate the concentrations of serum electrolytes (sodium, potassium, and chloride) and carbon dioxide along with arterial blood gas data, because they are often the first sign of an acid–base disorder. The health history, physical examination, previous blood gas results, and serum electrolytes should always be part of the assessment used to determine the cause of the acid–base disorder (Porth & Matfin, 2009). Responding to isolated sets of blood gas results without these data can lead to serious errors in interpretation. Treatment

**Table 14-5 ACID–BASE DISORDERS AND COMPENSATION**

| Disorder | Initial Event | Compensation |
|---|---|---|
| Respiratory acidosis | ↓ pH, ↑ or normal $HCO_3^-$, ↑ $PaCO_2$ | ↑ Renal acid excretion and ↑ serum $HCO_3^-$ |
| Respiratory alkalosis | ↑ pH, ↓ or normal $HCO_3^-$, ↓ $PaCO_2$ | ↓ Renal acid excretion and ↓ serum $HCO_3^-$ |
| Metabolic acidosis | ↓ pH, ↓ $HCO_3^-$, ↓ or normal $PaCO_2$ | Hyperventilation with resulting ↓ PaCO (conserves $HCO_3^-$) |
| Metabolic alkalosis | ↑ pH, ↑ $HCO_3^-$, ↑ or normal $PaCO_2$ | Hypoventilation with resulting ↑ $PaCO_2$ |

**Table 14-6 NORMAL VALUES FOR ARTERIAL AND MIXED VENOUS BLOOD**

| Parameter | Arterial Blood | Mixed Venous Blood |
|---|---|---|
| pH | 7.35–7.45 | 7.32–7.42 |
| $PaCO_2$ | 35–45 mm Hg | 38–52 mm Hg |
| $PaO_2$* | 70–100 mm Hg | 24–48 mm Hg |
| $HCO_3^-$ | 19–25 mEq/L | 19–25 mEq/L |
| Base excess/deficit | ±5 mEq/L | ±5 mEq/L |
| Oxygen saturation | >90–95% | 40–70% |

*At altitudes of 3000 feet and higher, the values for oxygen are decreased.

of the underlying condition usually corrects most acid–base disorders. Table 14-6 compares normal ranges of venous and arterial blood gas values. See also Chart 14-2.

## Parenteral Fluid Therapy

When no other route of administration is available, fluids are administered by IV in hospitals, outpatient diagnostic and surgical settings, clinics, and homes to replace fluids, administer medications, and provide nutrients.

### Purpose

The choice of an IV solution depends on the purpose of its administration. Generally, IV fluids are administered to achieve one or more of the following goals:

- To provide water, electrolytes, and nutrients to meet daily requirements
- To replace water and correct electrolyte deficits
- To administer medications and blood products

IV solutions contain dextrose or electrolytes mixed in various proportions with water. Pure, electrolyte-free water can never be administered by IV because it rapidly enters red blood cells and causes them to rupture.

### Types of Intravenous Solutions

Solutions are often categorized as **isotonic, hypotonic,** or **hypertonic,** according to whether their total osmolality is the same as, less than, or greater than that of blood, respec-

**CHART 14-2** *Assessing for Arterial Blood Gases*

The following steps are recommended to evaluate arterial blood gas values. They are based on the assumption that the average values are:

pH = 7.4
$PaCO_2$ = 40 mm Hg
$HCO_3^-$ = 24 mEq/L

1. *First, note the pH.* It can be high, low, or normal, as follows:
   pH >7.4 (alkalosis)
   pH <7.4 (acidosis)
   pH = 7.4 (normal)
   A normal pH may indicate perfectly normal blood gases, *or* it may be an indication of a *compensated* imbalance. A compensated imbalance is one in which the body has been able to correct the pH by either respiratory or metabolic changes (depending on the primary problem). For example, a patient with primary metabolic acidosis starts out with a low bicarbonate level but a normal $CO_2$ level. Soon afterward, the lungs try to compensate for the imbalance by exhaling large amounts of $CO_2$ (hyperventilation). As another example, a patient with primary respiratory acidosis starts out with a high $CO_2$ level; soon afterward, the kidneys attempt to compensate by retaining bicarbonate. If the compensatory mechanism is able to restore the bicarbonate–to–carbonic acid ratio back to 20:1, full compensation (and thus normal pH) will be achieved.
2. The next step is to determine the primary cause of the disturbance. This is done by evaluating the $PaCO_2$ and $HCO_3^-$ in relation to the pH.
   **Example: pH >7.4 (alkalosis)**
   a. If the $PaCO_2$ is <40 mm Hg, the primary disturbance is respiratory alkalosis. (This situation occurs when a patient hyperventilates and "blows off" too much $CO_2$. Recall that $CO_2$ dissolved in water becomes carbonic acid, the acid side of the "carbonic acid–bicarbonate buffer system.")
   b. If the $HCO_3^-$ is >24 mEq/L, the primary disturbance is metabolic alkalosis. (This situation occurs when the body gains too much bicarbonate, an alkaline substance. Bicarbonate is the basic or alkaline side of the "carbonic acid–bicarbonate buffer system.")
   **Example: pH <7.4 (acidosis)**
   a. If the $PaCO_2$ is >40 mm Hg, the primary disturbance is respiratory acidosis. (This situation occurs when a patient hypoventilates and thus retains too much $CO_2$, an acidic substance.)
   b. If the $HCO_3^-$ is <24 mEq/L, the primary disturbance is metabolic acidosis. (This situation occurs when the body's bicarbonate level drops, either because of direct bicarbonate loss or because of gains of acids such as lactic acid or ketones.)
3. The next step involves determining if compensation has begun. This is done by looking at the value other than the primary disorder. If it is moving in the same direction as the primary value, compensation is under way. Consider the following gases:

   | | pH | $PaCO_2$ | $HCO_3^-$ |
   |---|---|---|---|
   | (1) | 7.2 | 60 mm Hg | 24 mEq/L |
   | (2) | 7.4 | 60 mm Hg | 37 mEq/L |

   The first set (1) indicates acute respiratory acidosis without compensation (the $PaCO_2$ is high, the $HCO_3^-$ is normal). The second set (2) indicates chronic respiratory acidosis. Note that compensation has taken place; that is, the $HCO_3^-$ has elevated to an appropriate level to balance the high $PaCO_2$ and produce a normal pH.
4. Two distinct acid–base disturbances may occur simultaneously. These can be identified when the pH does not explain one of the changes.
   **Example: Metabolic and respiratory acidosis**
   a. pH 7.2 decreased acid
   b. $PaCO_2$ 52 increased acid
   c. $HCO_3$ 13 decreased acid
5. Evaluate the patient to determine if the clinical signs and symptoms are compatible with acid–base analysis.

tively (see earlier discussion of osmolality). Electrolyte solutions are considered isotonic if the total electrolyte content (anions + cations) is approximately 310 mEq/L, hypotonic if the total electrolyte content is less than 250 mEq/L, and hypertonic if the total electrolyte content is greater than 375 mEq/L. The nurse must also consider a solution's osmolality, keeping in mind that the osmolality of plasma is approximately 300 mOsm/L (300 mmol/L). For example, a 10% dextrose solution has an osmolality of approximately 505 mOsm/L.

### Isotonic Fluids

Fluids that are classified as isotonic have a total osmolality close to that of the ECF and do not cause red blood cells to shrink or swell. The composition of these fluids may or may not approximate that of the ECF. Isotonic fluids expand the ECF volume. One liter of isotonic fluid expands the ECF by 1 L; however, it expands the plasma by only 0.25 L because it is a crystalloid fluid and diffuses quickly into the ECF compartment. For the same reason, 3 L of isotonic fluid is needed to replace 1 L of blood loss. Because these fluids expand the intravascular space, patients with hypertension and heart failure should be carefully monitored for signs of fluid overload.

#### $D_5W$

A solution of $D_5W$ has a serum osmolality of 252 mOsm/L. Once administered, the glucose is rapidly metabolized, and this initially isotonic solution then disperses as a hypotonic fluid, one-third extracellular and two-thirds intracellular. It is essential to consider this action of $D_5W$, especially if the patient is at risk for increased intracranial pressure. During fluid resuscitation, this solution should not be used, because hyperglycemia can result. Therefore, $D_5W$ is used mainly to supply water and to correct an increased serum osmolality. About 1 L of $D_5W$ provides fewer than 200 kcal and is a minor source of the body's daily caloric requirements.

#### Normal Saline Solution

Normal saline (0.9% sodium chloride) solution has a total osmolality of 308 mOsm/L. Because the osmolality is entirely contributed by electrolytes, the solution remains within the ECF. For this reason, normal saline solution is often used to correct an extracellular volume deficit. Although referred to as "normal," it contains only sodium and chloride and is not identical to ECF. It is used with administration of blood transfusions and to replace large sodium losses, such as in burn injuries. It is not used for heart failure, pulmonary edema, renal impairment, or sodium retention. Normal saline does not supply calories.

#### Other Isotonic Solutions

Several other solutions contain ions in addition to sodium and chloride and are somewhat similar to the ECF in composition. Lactated Ringer's solution contains potassium and calcium in addition to sodium chloride. It is used to correct dehydration and sodium depletion and replace GI losses. Lactated Ringer's solution contains bicarbonate precursors as well. These solutions are marketed, with slight variations, under various trade names.

### Hypotonic Fluids

One purpose of hypotonic solutions is to replace cellular fluid, because it is hypotonic compared with plasma. Another is to provide free water for excretion of body wastes. At times, hypotonic sodium solutions are used to treat hypernatremia and other hyperosmolar conditions. Half-strength saline (0.45% sodium chloride) solution, with an osmolality of 154 mOsm/L, is frequently used. Multiple-electrolyte solutions are also available. Excessive infusions of hypotonic solutions can lead to intravascular fluid depletion, decreased blood pressure, cellular edema, and cell damage. These solutions exert less osmotic pressure than the ECF.

### Hypertonic Fluids

When normal saline solution or lactated Ringer's solution contains 5% dextrose, the total osmolality exceeds that of the ECF. However, the dextrose is quickly metabolized, and only the isotonic solution remains. Therefore, any effect on the intracellular compartment is temporary. Similarly, with hypotonic multiple-electrolyte solutions containing 5% dextrose, once the dextrose is metabolized, these solutions disperse as hypotonic fluids. Higher concentrations of dextrose, such as 50% dextrose in water, are strongly hypertonic and must be administered into central veins so that they can be diluted by rapid blood flow.

Saline solutions are also available in osmolar concentrations greater than that of the ECF. These solutions draw water from the ICF to the ECF and cause cells to shrink. If administered rapidly or in large quantity, they may cause an extracellular volume excess and precipitate circulatory overload and dehydration. As a result, these solutions must be administered cautiously and usually only when the serum osmolality has decreased to dangerously low levels. Hypertonic solutions exert an osmotic pressure greater than that of the ECF.

### Other Intravenous Substances

When the patient is unable to tolerate food, nutritional requirements are often met using the IV route. Solutions may include high concentrations of glucose (such as 50% dextrose in water), protein, or fat to meet nutritional requirements (see Chapter 36). The IV route may also be used to administer colloids, plasma expanders, and blood products. Examples of blood products include whole blood, packed red blood cells, albumin, and cryoprecipitate; these are discussed in more detail in Chapter 33.

Many medications are also delivered by the IV route, either by continuous infusion or intermittent bolus directly into the vein. Because IV medications enter the circulation rapidly, administration by this route is potentially very hazardous. All medications can produce adverse reactions; however, medications administered by the IV route can cause these reactions within seconds to minutes after administration, because the medications are delivered directly into the bloodstream. Administration rates and recommended dilutions for individual medications are available in specialized texts pertaining to IV medications and in manufacturers' package inserts; these should be consulted to ensure safe IV administration of medications.

**NURSING ALERT**

**The nurse must assess the patient for a history of allergic reactions to medications. Although this is important when any medication is to be administered, it is even more important with IV administration, because the medication is delivered directly into the bloodstream.**

## Nursing Management of the Patient Receiving Intravenous Therapy

The ability to perform venipuncture to gain access to the venous system for administering fluids and medication is an expected nursing skill in many settings. This responsibility includes selecting the appropriate venipuncture site and type of cannula and being proficient in the technique of vein entry. The nurse should demonstrate competency in and knowledge of catheter placement according to the Nurse Practice Act applicable in his or her state and should follow the rules and regulations, organizational policies and procedures, and practice guidelines of that state's board of nursing (Alexander, 2006).

Infusion therapy is initiated by a health care provider who prescribes the type and amount of solution, additives (if any), and rate of flow. When administering parenteral fluids, the nurse monitors the patient's response to the fluids, considering the fluid volume, the fluid content, and the patient's clinical status.

### Preparing to Administer Intravenous Therapy

Before performing venipuncture, the nurse carries out hand hygiene, applies gloves, and informs the patient about the procedure. The nurse selects the most appropriate insertion site and type of cannula for a particular patient.

### Choosing an Intravenous Site

Many sites can be used for IV therapy, but ease of access and potential hazards vary. Veins of the extremities are designated as peripheral locations and are ordinarily the only sites used by nurses. Because they are relatively safe and easy to enter, arm veins are most commonly used (Fig. 14-7). The metacarpal, cephalic, basilic, and median veins and their branches are recommended sites because of their size and ease of access. Leg veins should rarely, if ever, be used because of the high risk of thromboembolism. Additional sites to avoid include veins distal to a previous IV infiltration or phlebitic area, sclerosed or thrombosed veins, an arm with an arteriovenous shunt or fistula, and an arm affected by edema, infection, blood clot, deformity, severe scarring, or skin breakdown. The arm on the side of a mastectomy is avoided because of impaired lymphatic flow.

Central veins commonly used by physicians include the subclavian and internal jugular veins. It is possible to gain access to (or cannulate) these larger vessels even when peripheral sites have collapsed, and they allow for the administration of hyperosmolar solutions. However, the potential hazards are much greater and include inadvertent entry into an artery or the pleural space.

Ideally, both arms and hands are carefully inspected before a specific venipuncture site that does not interfere with mobility is chosen. For this reason, the antecubital fossa is avoided, except as a last resort. The most distal site of the arm or hand is generally used first, so that subsequent IV access sites can be moved progressively upward. The following factors should be considered when selecting a site for venipuncture:

- Condition of the vein
- Type of fluid or medication to be infused
- Duration of therapy
- Patient's age and size
- Whether the patient is right- or left-handed
- Patient's medical history and current health status
- Skill of the person performing the venipuncture

After applying a tourniquet, the nurse palpates and inspects the vein. The vein should feel firm, elastic, engorged, and round—not hard, flat, or bumpy. Because arteries lie close to veins in the antecubital fossa, the vessel should be palpated for arterial pulsation (even with a tourniquet on), and cannulation of pulsating vessels should be avoided. General guidelines for selecting a cannula include the following:

- Length: 0.75 to 1.25 inches long
- Diameter: narrow diameter of the cannula to occupy minimal space within the vein
- Gauge:
  - 20 to 22 gauge for most IV fluids; a larger gauge for caustic or viscous solutions
  - 14 to 18 gauge for blood administration and for trauma patients and those undergoing surgery
  - 22 to 24 gauge for elderly patients

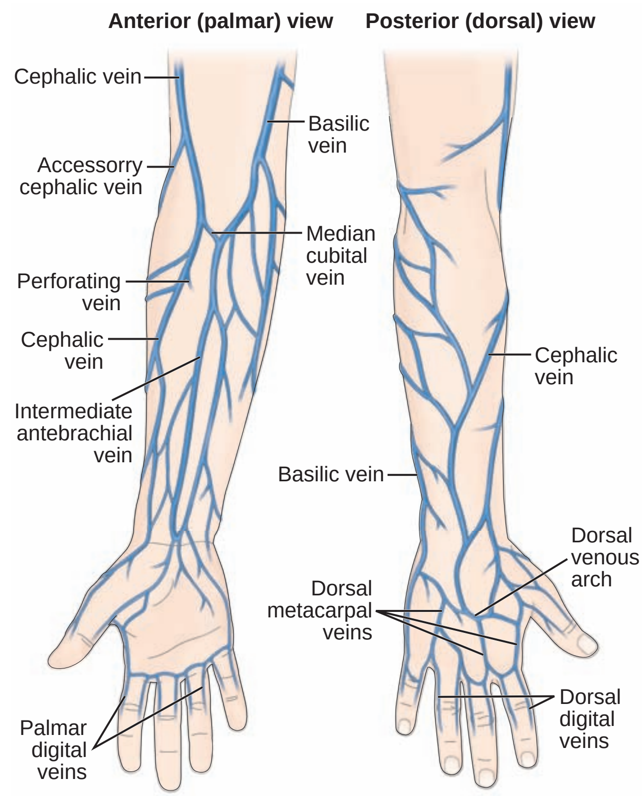



**Figure 14-7** Site selection for peripheral cannulation of veins: anterior (palmar) veins at left, posterior (dorsal) veins at right. Adapted from Agur, A. M. R., Lee, M. J. & Boileau Grant, M. J. (1999). *Grant's atlas of anatomy* (10th ed.). Philadelphia: Lippincott Williams & Wilkins.

Hand veins are easiest to cannulate. Cannula tips should not rest in a flexion area (eg, the antecubital fossa), because this could inhibit the IV flow (Hadaway & Millam, 2007).

### Selecting Venipuncture Devices

Equipment used to gain access to the vasculature includes cannulas, needleless IV delivery systems, and peripherally inserted central catheter (PICC) or midline catheter vascular access devices.

#### Cannulas

Most peripheral access devices are cannulas. They have an obturator inside a tube that is later removed. *Catheter* and *cannula* are terms that are used interchangeably. The main types of cannula devices available are those referred to as winged infusion sets (butterfly) with a steel needle or as over-the-needle catheters with wings; indwelling plastic cannulas that are inserted over a steel needle; and indwelling plastic cannulas that are inserted through a steel needle. Scalp vein or butterfly needles are short steel needles with plastic wing handles. These are easy to insert, but because they are small and nonpliable, infiltration occurs easily. The use of these needles should be limited to obtaining blood specimens or administering bolus injections or infusions lasting only a few hours, because they increase the risk of vein injury and infiltration. Insertion of an over-the-needle catheter requires the additional step of advancing the catheter into the vein after venipuncture. Because these devices are less likely to cause infiltration, they are frequently preferred over winged infusion sets.

Plastic cannulas inserted through a hollow needle are usually called intracatheters. They are available in long lengths and are well suited for placement in central locations. Because insertion requires threading the cannula through the vein for a relatively long distance, these can be difficult to insert. The most commonly used infusion device is the over-the-needle catheter. A hollow metal stylet is preinserted into the catheter and extends through the distal tip of the catheter to allow puncture of the vessel, in an effort to guide the catheter as the venipuncture is performed. The vein is punctured and a flashback of blood appears in the closed chamber behind the catheter hub. The catheter is threaded through the stylet into the vein and the stylet is then removed.

To select the ideal product for use, consideration should be given to which product provides the greatest patient satisfaction and offers quality, cost-effective infusion care. All devices should be radiopaque to determine catheter location by x-ray, if necessary. All catheters increase the risk of thrombus formation to varying degrees. Biocompatibility, another characteristic of a catheter, ensures that inflammation and irritation do not occur. Silicone catheters are the most bioinert catheters available today.

***Needleless Intravenous Delivery Systems.*** In an effort to decrease needlestick injuries and exposure to bloodborne pathogens, the federal government has legislated and agencies have implemented needleless IV delivery systems. These systems have built-in protection against needlestick injuries and provide a safe means of using and disposing of an IV administration set (which consists of tubing, an area for inserting the tubing into the container of IV fluid, and an adapter for connecting the tubing to the needle). Numerous companies produce needleless components. IV line connectors allow the simultaneous infusion of IV medications and other intermittent medications (known as a piggyback delivery) without the use of needles; this method is being used more frequently, moving away from use of the traditional stylet. An example is a self-sheathing stylet that is recessed into a rigid chamber at the hub of the catheter when its insertion is complete. Other designs have placed the stylet at the end of a flexible wire to avoid needlesticks.

Many types of these devices are on the market. Each institution must evaluate products to determine its own needs based on Occupational Safety and Health Administration (OSHA) guidelines and the institution's policies and procedures.

***Peripherally Inserted Central Catheter or Midline Catheter Access Lines.*** Patients who need moderate- to long-term parenteral therapy often receive a PICC or a midline catheter. These catheters are also used for patients with limited peripheral access (eg, obese or emaciated patients, IV/injection drug users) who require IV antibiotics, blood, and parenteral nutrition. For these devices to be used, the veins must be pliable (not sclerosed or hardened) and not subject to repeated puncture. If these veins are damaged, then central venous access via the subclavian or internal jugular vein, or surgical placement of an implanted port or a vascular access device, must be considered as an alternative (Anderson, 2005; Ludeman, 2007). Table 14-7 compares PICC and midline catheters. Both PICC and midline catheters have the advantages of reducing cost, avoiding repeated venipunctures, and decreasing the incidence of catheter-related infections when compared with centrally placed catheters.

The principles for inserting these lines are much the same as those for inserting peripheral catheters; however, their insertion should be undertaken only by practitioners who are experienced and specially skilled in inserting IV lines.

The physician prescribes the line and the solution to be infused. Insertion of either catheter requires sterile technique. The size of the catheter lumen chosen is based on the type of solution, the patient's body size, and the vein to be used. The patient's consent is obtained before use of these catheters. Use of the dominant arm is recommended as the site for inserting the cannula into the superior vena cava to ensure adequate arm movement, which encourages blood flow and reduces the risk of dependent edema.

### Teaching the Patient

Except in emergency situations, the patient should be prepared in advance for an IV infusion. The venipuncture, the expected length of infusion, and activity restrictions are explained. If the patient requires alternative formats (eg, interpreter, large-print written materials) to understand the procedure, these should be provided. Then the patient should have an opportunity to ask questions and express concerns. For example, some patients believe that they will die if small bubbles in the tubing enter their veins.

**Table 14-7 COMPARISON OF PERIPHERALLY INSERTED CENTRAL AND MIDLINE CATHETERS**

| | Peripherally Inserted Central Catheter (PICC) | Midline Catheter |
|---|---|---|
| Indications | Parenteral nutrition; IV fluid replacement; administration of chemotherapy agents, analgesics, and antibiotics; removal of blood specimens; administration of blood products | Parenteral nutrition; IV fluid replacement; administration of analgesics and antibiotics (no solution or medications with a pH <5 or >9 or osmolarity >500 mOsm/L); removal of blood specimens |
| Features | Single-, double-, and triple-lumen catheters available (16–24 gauge) 50–70-cm in length; sizes range from 2–7 Fr | Single- and double-lumen catheters available (16–24 gauge) 7.5–20-cm in length; catheter can increase two gauges in size as it softens |
| Material | Radiopaque, polymer (polyurethane), silastic materials; flexible | Silicone, polyurethane, and their derivatives; available impregnated with heparin to ↓ thrombogenicity (radiopaque or clear, with radiopaque strip) |
| Insertion sites | Venipuncture performed in the antecubital fossa, above or below it into the basilic, cephalic, or axillary veins of the dominant arm. Median basilic is ideal insertion site. | Venipuncture performed 112 inches above or below antecubital fossa through brachial cephalic, basilic, or median cubital vein. |
| Catheter placement | Tip of catheter lies in lower third of superior vena cava. Catheter is placed via median basilic, median cubital, or median cephalic vein at antecubital fossa. | Catheter lies between antecubital area and head of clavicle (tip in axilla region). Tip terminates in the proximal portion of extremity below axilla and proximal to central veins and is advanced 3–10 inches. |
| Insertion method | Sedation and NPO not required. Through-the-needle technique, with or without a guidewire, breakaway needle with introducer or cannula with introducer (peel-away sheath). (A peripherally inserted central catheter can also be used as midline catheter.)<br>Insertion can be accomplished at bedside using sterile technique. Right arm placement is a more direct route to vena cava. Arm to be used should be positioned in abduction to 90-degree angle. Consent is required. Ultrasound-guided placement can allow access to difficult veins at bedside or in x-ray department with fluoroscopy.<br>Catheter may stay in place for up to 12 months. | No separate guidewire or introducer needed. Stiff catheter is passed using catheter advancement tab.<br>Insertion can be accomplished at bedside using sterile technique. Arm to be used should be positioned in abduction to 45-degree angle. Consent is required.<br>The catheter should never be reused. Catheter may stay in place for 2–4 weeks. |
| Potential complications | Malposition, pneumothorax, hemothorax, hydrothorax, dysrhythmias, nerve or tendon damage, respiratory distress, catheter embolism, thrombophlebitis, or catheter occlusion. Compared with centrally placed catheters, venipuncture in antecubital space reduces risk of insertion complications. | Thrombosis, phlebitis, air embolism, infection, vascular perforation, bleeding, catheter transection, occlusion |
| Contraindications | Dermatitis, cellulitis, lymphedema, compromised anatomy, burns, high fluid volume infusions, rapid bolus injections, hemodialysis, and venous thrombosis. No clamping of this catheter or splinting of arm permitted. No blood pressure or tourniquets to be used on extremity where peripherally inserted central catheter is inserted. | Dermatitis, cellulitis, burns, high fluid volume infusions, rapid bolus injection, hemodialysis, and venous thrombosis. No blood pressure or tourniquet to be used on extremity where catheter is placed. Patient should avoid heavy lifting with arm that has catheter. |
| Catheter maintenance | Sterile dressing types and changes are according to agency protocol, training, and competency requirements. Catheter is secured with stabilization device. | Sterile dressing types and changes are according to agency protocol, training, and competency requirements. Catheter must be anchored securely to prevent its dislodgment and can be secured with stabilization device. |
| Postplacement | Chest x-ray needed to confirm placement of catheter tip | Chest x-ray to assess placement may be obtained if unable to flush catheter, if no free flow blood return, if difficulty with catheter advancement, if guidewire is difficult to remove or bent on removal, or catheter migration is suspected. |
| Assessment | Daily measurement of arm circumference (4 inches above insertion site) and length of exposed catheter | Daily measurement of arm circumference (4 inches above insertion site) and length of exposed catheter |
| Removal | Catheter should be removed when no longer indicated for use, if contaminated, or if complications occur.<br>Arm is abducted during removal. Patient should be in dorsal recumbent position with head of bed flat and should perform Valsalva maneuver while catheter is withdrawn.<br>Pressure is applied on removal with sterile dressing and antiseptic ointment to site. Dressing is changed every 24–48 h until epithelialization occurs. | Catheter should be removed when no longer indicated for use, if contaminated, or if complications occur.<br>Arm is abducted during removal. Pull gently from insertion site no more than 1/4–1/2 inch at a time to prevent vasospasm.<br>Pressure is applied on removal with a sterile dressing and antiseptic ointment to site. Dressing is changed every 24–48 h until epithelialization occurs. |

After acknowledging this fear, the nurse can explain that usually only relatively large volumes of air administered rapidly are dangerous.

### Preparing the Intravenous Site

Before preparing the skin, the nurse should ask the patient if he or she is allergic to latex or iodine, products commonly used in preparing the skin for IV therapy. Excessive hair at the selected site may be removed by clipping to increase the visibility of the veins and to facilitate insertion of the cannula and adherence of dressings to the IV insertion site. Because infection can be a major complication of IV therapy, the IV device, the fluid, the container, and the tubing must be sterile. The nurse must perform hand hygiene and put on gloves. Gloves (nonsterile, disposable) must be worn during the venipuncture procedure because of the likelihood of coming into contact with bloodborne pathogens. The insertion site is prepared according to institutional policy (Rosenthal, 2007; Todd, 2006).

### Performing Venipuncture

Guidelines and a suggested sequence for venipuncture are presented in Chart 14-3. For veins that are very small or particularly fragile, modifications in the technique may be necessary. Alternative methods can be found in journal articles or in specialized textbooks on IV therapy. Institutional policies and procedures determine whether all nurses must be certified to perform venipuncture. A nurse certified in IV therapy or an IV team can be consulted to assist with initiating IV therapy. To avoid multiple unsuccessful attempts, causing unnecessary trauma to the patient and limiting future vascular access, no more than two attempts at cannulation by any one nurse should be made (Alexander, 2006).

### Maintaining Therapy

Maintaining an existing IV infusion is a nursing responsibility that demands knowledge of the solutions being administered and the principles of flow. In addition, patients must be assessed carefully for both local and systemic complications.

### Factors Affecting Flow

The flow of an IV infusion is governed by the same principles that govern fluid movement in general:

- Flow is directly proportional to the height of the liquid column. Raising the height of the infusion container may improve a sluggish flow.
- Flow is directly proportional to the diameter of the tubing. The clamp on IV tubing regulates the flow by changing the tubing diameter. In addition, the flow is faster through large-gauge rather than small-gauge cannulas.
- Flow is inversely proportional to the length of the tubing. Adding extension tubing to an IV line decreases the flow.
- Flow is inversely proportional to the viscosity of a fluid. Viscous IV solutions, such as blood, require a larger cannula than do water or saline solutions.

### Monitoring Flow

Because so many factors influence an IV set to gravity flow, a solution does not necessarily continue to run at the speed originally set. Therefore, the nurse monitors IV infusions frequently to make sure that the fluid is flowing at the intended rate. The IV container should be marked to indicate at a glance whether the correct amount has infused. The flow rate is calculated when the solution is originally started and then monitored at least hourly. To calculate the flow rate, the nurse determines the number of drops delivered per milliliter; this varies with equipment and is usually printed on the administration set packaging. A formula that can be used to calculate the drop rate is

$$\text{gtt/mL of infusion set}/60\ (\text{min in 1 hr}) \times \text{total hourly volume} = \text{gtt/min}$$

Flushing of a vascular device is performed to ensure patency and to prevent the mixing of incompatible medications or solutions. This procedure should be carried out at established intervals, according to hospital policy and procedure, especially for intermittently used catheters. Most manufacturers and researchers suggest the use of preservative-free 0.9% sodium chloride for flushing (Alexander, 2006). The volume of the flush solution should be at least twice the volume capacity of the catheter. The catheter should be clamped before the syringe is completely empty and withdrawn to prevent reflux of blood into the lumen, which could cause catheter clotting.

A variety of electronic infusion devices are available to assist in IV fluid delivery. These devices allow more accurate administration of fluids and medications than is possible with routine gravity-flow setups. A pump is a positive-pressure device that uses pressure to infuse fluid at a pressure of 10 psi; newer models use a pressure of 5 psi. The pressure exerted by the pump overrides vascular resistance (increased tubing length, low height of the IV container).

Volumetric pumps calculate the volume delivered by measuring the volume in a reservoir that is part of the set and is calibrated in milliliters per hour (mL/h). A controller is an infusion assist device that relies on gravity for infusion; the volume is calibrated in drops (gtt) per minute. A controller uses a drop sensor to monitor the flow. Factors essential for the safe use of pumps include alarms to signify the presence of air in the IV line or an occlusion. The standard for the accurate delivery of fluid or medication via an electronic IV infusion pump is plus or minus 5%. The manufacturer's directions must be read carefully before use of any infusion pump or controller, because there are many variations in available models. Use of these devices does not eliminate the need for the nurse to monitor the infusion and the patient frequently. The nurse must be knowledgeable about flow control devices and competent regarding their use.

### Discontinuing an Infusion

IV therapy should be discontinued as prescribed by an appropriate health care provider or on assessment by the nurse that contamination, phlebitis, or infiltration has occurred. The removal of an IV catheter is associated with two possible dangers: bleeding and catheter embolism. To prevent excessive bleeding, a dry, sterile pressure dressing should be held over the site as the catheter is removed. Firm pressure is applied until bleeding stops.

If a plastic IV catheter is severed, the loose fragment can travel to the right ventricle and block blood flow. To detect

## CHART 14-3 *Guidelines for Starting an Intravenous Infusion*

### Equipment

- Tourniquet
- Tape
- IV solution, tubing and catheter
- Chlorhexidine gluconate, povidone–iodine, or alcohol swabs
- Nonlatex gloves
- Transparent dressing, bandage, or sterile gauze
- Padded, appropriate-length arm board

### Implementation

| Nursing Action | Rationale |
|---|---|
| 1. Verify prescription for IV therapy, check solution label, and identify patient. Check for allergies (ie, latex, iodine). | 1. Serious errors can be avoided by careful checking. Checking for allergies reduces risk of allergic reaction. |
| 2. Explain procedure to patient. | 2. Knowledge increases patient comfort and cooperation. |
| 3. Perform hand hygiene and put on disposable nonlatex gloves. | 3. Asepsis is essential to prevent infection. Use of nonlatex gloves prevents exposure of nurse to patient's blood and of patient and nurse to latex. |
| 4. Apply a tourniquet 4 to 6 inches above the site and identify a suitable vein. | 4. This will distend the veins and allow them to be visualized. |
| 5. Choose site. Use distal veins of hands and arms first. | 5. Careful site selection will increase likelihood of successful venipuncture and preservation of vein. Using distal sites first preserves sites proximal to the previously cannulated site for subsequent venipunctures. Veins of feet and lower extremity should be avoided due to risk of thrombophlebitis. (In consultation with the physician, the saphenous vein of the ankle or dorsum of the foot may occasionally be used.) |
| 6. Choose IV cannula or catheter. | 6. Length and gauge of cannula should be appropriate for both site and purpose of infusion. The shortest gauge and length needed to deliver prescribed therapy should be used. Inspect the needle or cannula to make sure there are no imperfections. |
| 7. Prepare equipment by connecting infusion bag and tubing, run solution through tubing to displace air, and cover end of tubing. | 7. This prevents delay; equipment must be ready to connect immediately after successful venipuncture to prevent clotting. |
| 8. Raise bed to comfortable working height and position for patient; adjust lighting. Position patient's arm below heart level to encourage capillary filling. Place protective pad on bed under patient's arm. | 8. Proper positioning will increase likelihood of success and provide comfort for patient. |
| 9. Depending on agency policy and procedure, lidocaine 1% (without epinephrine) 0.1–0.2 mL may be injected locally to the IV site or a transdermal analgesic cream (EMLA) may be applied to the site prior to IV placement or blood withdrawal. Alternatively, topical application of lidocaine (Numby Stuff) or an intradermal injection of bacteriostatic 0.9% sodium chloride may be used to produce a local anesthetic effect. | 9. This reduces pain locally from procedure and decreases anxiety about pain. |
| 10. Palpate for a pulse distal to the tourniquet. Ask patient to open and close fist several times or position patient's arm in a dependent position to distend a vein. | 10. The tourniquet should never be tight enough to occlude arterial flow. If a radial pulse cannot be palpated distal to the tourniquet, it is too tight. A new tourniquet should be used for each patient to prevent the transmission of microorganisms. A blood pressure cuff may be used for elderly patients to avoid rupture of the veins. A clenched fist encourages the vein to become round and turgid. Positioning the arm below the level of the patient's heart promotes capillary filling. Warm packs applied for 10 to 20 minutes prior to venipuncture can promote vasodilation. Bedside ultrasound-guided visualization of vein location and assessment of venous pathway and flow using ultrasonic waves may also be used. |

*Continued*

CHART 14-3

## *Guidelines for Starting an Intravenous Infusion* (Continued)

| Nursing Action | Rationale |
|---|---|
| 11. Prepare site by scrubbing with chlorhexidine gluconate or povidone–iodine swabs for 2 to 3 minutes in circular motion, moving outward from injection site. Allow to dry. | 11. Strict asepsis and careful site preparation are essential to prevent infection. |
| a. If the site selected is excessively hairy, clip hair. (Check agency's policy and procedure about this practice.) | a. Hair removal should be performed with scissors or electric clippers. Shaving should not be done with a razor because of the potential for microabrasions that increase the risk of infection. Depilatories should not be used due to the potential for dermal allergic reactions and/or irritation. |
| b. Isopropyl alcohol 70% is an alternative solution that may be used. | |
| 12. With hand not holding the venous access device, steady patient's arm and use finger or thumb to pull skin taut over vessel. | 12. Applying traction to the vein helps to stabilize it. |
| 13. Holding needle bevel up and at 5- to 25-degree angle, depending on the depth of the vein, pierce skin to reach but not penetrate vein. | 13. Bevel-down technique is necessary for small veins to prevent extravasation. One-step method of catheter insertion directly into vein with immediate thrust through the skin is excellent for large veins but may cause a hematoma if used in small veins. |
| 14. Decrease angle of needle further until nearly parallel with skin, then enter vein either directly above or from the side in one quick motion. | 14. Two-stage procedure decreases chance of thrusting needle through posterior wall of vein as skin is entered. No attempt should be made to reinsert the stylet because of risk of severing or puncturing the catheter. |
| 15. If backflow of blood is visible, straighten angle and advance needle. Additional steps for catheter inserted over needle: | 15. Backflow may not occur if vein is small; this position decreases chance of puncturing posterior wall of vein. |
| a. Advance needle 0.6 cm (1/4 to 1/2 inch) after successful venipuncture. | a. Advancing the needle slightly makes certain the plastic catheter has entered the vein. |
| b. Hold needle hub, and slide catheter over the needle into the vein. Never reinsert needle into a plastic catheter or pull the catheter back into the needle. | b. Reinsertion of the needle or pulling the catheter back can sever the catheter, causing catheter embolism. |
| c. Remove needle while pressing lightly on the skin over the catheter tip; hold catheter hub in place. | c. Slight pressure prevents bleeding before tubing is attached. |
| d. Never reinsert a stylet back into a catheter. | d. The stylet can shear off a piece of the plastic if reinserted. |
| e. Never reuse the same catheter. | e. Reusing the same catheter can cause infection. |
| 16. Release tourniquet and attach infusion tubing; open clamp enough to allow drip. | 16. Releasing the tourniquet restores blood flow and avoids potential ischemic damage to the area distal to the IV insertion site. |
| 17. Cover the insertion site with a transparent dressing, bandage, or sterile gauze according to hospital policy and procedure. Tape in place with nonallergenic tape but do not encircle extremity. Tape a small loop of IV tubing onto dressing. | 17. Transparent dressings allow assessment of the insertion site for phlebitis, infiltration, and infection without removing the dressing. Tape applied around extremity can act as a tourniquet and impede blood flow and infusion of fluid. The loop decreases the chance of inadvertent cannula removal if the tubing is pulled. |
| 18. Label with type and length of cannula, date, time, and initials. | 18. Labeling facilitates assessment and safe discontinuation. |
| 19. A padded, appropriate-length arm board may be applied to an area of flexion (neurovascular checks should be performed frequently). | 19. This secures cannula placement and allows correct flow rate (neurovascular checks assess nerve, muscle, and vascular function to be sure function is not affected by immobilization). |
| 20. Calculate infusion rate and regulate flow of infusion. For hourly IV rate use the following formula: gtt/mL of infusion set/60 (min in h) $\times$ total hourly vol = gtt/min | 20. Infusion must be regulated carefully to prevent overinfusion or underinfusion. Calculation of the IV rate is essential for the safe delivery of fluids. Safe administration requires knowledge of the volume of fluid to be infused, total infusion time, and calibration of the administration set (found on the IV tubing package; 10, 12, 15, or 60 drops to deliver 1 mL of fluid). |
| 21. Document date and time therapy initiated; type and amount of solution; additives and dosages; flow rate; gauge, length, and type of vascular access device; catheter insertion site; type of dressing applied; patient response to procedure; patient teaching and name and title of the health care provider who inserted the catheter. | 21. Documentation is essential to promote continuity of care. |
| 22. Discard needles, stylets, or guidewires into a puncture-resistant needle container that meets OSHA guidelines. Remove gloves and perform hand hygiene. | 22. Proper disposal of sharps decreases risk of needlesticks. |

this complication when the catheter is removed, the nurse compares the expected length of the catheter with its actual length. Plastic catheters should be withdrawn carefully and their length measured to detect a fragment that has broken off in the vein. Both of these actions must be documented in the patient's medical record.

Great care must be exercised when using scissors around the dressing site. If the catheter clearly has been severed, the nurse can attempt to occlude the vein above the site by applying a tourniquet to prevent the catheter from entering the central circulation (until surgical removal is possible). The physician must be notified immediately. It is better to prevent a potentially fatal problem than to deal with it after it has occurred. Catheter embolism can be prevented easily by following simple rules:

- Avoid using scissors near the catheter.
- Avoid withdrawing the catheter through the insertion needle.
- Follow the manufacturer's guidelines carefully (eg, cover the needle point with the bevel shield to prevent severing the catheter).

### *Managing Systemic Complications*

IV therapy predisposes the patient to numerous hazards, including both local and systemic complications. Systemic complications occur less frequently but are usually more serious than local complications. They include circulatory overload, air embolism, febrile reaction, and infection.

#### Fluid Overload

Overloading the circulatory system with excessive IV fluids causes increased blood pressure and central venous pressure. Signs and symptoms of fluid overload include moist crackles on auscultation of the lungs, edema, weight gain, dyspnea, and rapid, shallow respirations. Possible causes include rapid infusion of an IV solution or hepatic, cardiac, or renal disease. The risk of fluid overload and subsequent pulmonary edema is especially increased in elderly patients with cardiac disease; this is referred to as circulatory overload. Its treatment includes decreasing the IV rate, monitoring vital signs frequently, assessing breath sounds, and placing the patient in a high Fowler's position. The physician is contacted immediately. This complication can be avoided by using an infusion pump and by carefully monitoring all infusions. Complications of circulatory overload include heart failure and pulmonary edema.

#### Air Embolism

The risk of air embolism is rare but ever-present. It is most often associated with cannulation of central veins. Manifestations of air embolism include palpitations, dyspnea, and cyanosis; hypotension; weak, rapid pulse; loss of consciousness; and chest, shoulder, and low back pain. Treatment calls for immediately clamping the cannula and replacing a leaking or open infusion system, placing the patient on the left side in the Trendelenburg position, assessing vital signs and breath sounds, and administering oxygen. Air embolism can be prevented by using locking adapters on all lines, filling all tubing completely with solution, and using an air detection alarm on an IV infusion pump. Complications of air embolism include shock and death. The amount of air necessary to induce death in humans is not known; however, the rate of entry is probably as important as the actual volume of air.

#### Infection

Pyrogenic substances in either the infusion solution or the IV administration set can cause bloodstream infections (Todd, 2006). Signs and symptoms include an abrupt temperature elevation shortly after the infusion is started, backache, headache, increased pulse and respiratory rate, nausea and vomiting, diarrhea, chills and shaking, and general malaise. In severe sepsis, vascular collapse and septic shock may occur. See Chapter 15 for a discussion of septic shock.

Infection ranges in severity from local involvement of the insertion site to systemic dissemination of organisms through the bloodstream, as in sepsis. Measures to prevent infection are essential at the time the IV line is inserted and throughout the entire infusion. Prevention includes the following:

- Careful hand hygiene before every contact with any part of the infusion system or the patient
- Examining the IV containers for cracks, leaks, or cloudiness, which may indicate a contaminated solution
- Using strict aseptic technique
- Firmly anchoring the IV cannula to prevent to-and-fro motion (eg, a catheter stabilization device will help)
- Inspecting the IV site daily and replacing a soiled or wet dressing with a dry sterile dressing (antimicrobial agents that should be used for site care include 2% tincture of iodine, 10% povidone–iodine, alcohol, or chlorhexidine gluconate, used alone or in combination)
- Disinfecting injection/access ports with antimicrobial solution before and after each use
- Removing the IV cannula at the first sign of local inflammation, contamination, or complication
- Replacing the peripheral IV cannula every 72 to 96 hours, or as indicated (Chart 14-4)
- Replacing the IV cannula inserted during emergency conditions (with questionable asepsis) as soon as possible
- Using a 0.2-μm air-eliminating and bacteria/particulate retentive filter with non–lipid-containing solutions that require filtration. The filter can be added to the proximal or distal end of the administration set. If added to the proximal end between the fluid container and the tubing spike, the filter ensures sterility and particulate removal from the infusate container and prevents inadvertent infusion of air. If added to the distal end of the administration set, it filters air particles and contaminants introduced from add-on devices, secondary administration sets, or interruptions to the primary system. Filters should be located as close to the catheter insertion site as possible (Alexander, 2006)
- Replacing the solution bag and administration set in accordance with agency policy and procedure
- Infusing or discarding medication or solution within 24 hours of its addition to an administration set
- Changing primary and secondary continuous administration sets every 72 hours, intermittent administra-

CHART 14-4 NURSING RESEARCH PROFILE

## When Should a Peripheral IV Catheter Be Changed?

Gallant, P. & Schultz, A. (2006). Evaluation of a visual infusion phlebitis scale for determining appropriate discontinuation of peripheral intravenous catheters. *Journal of Infusion Nursing, 29*(6), 333–345.

**Purpose**

Phlebitis is a common occurrence at peripheral IV sites. It is known that phlebitis is related to certain types of medication, infusates the patient is receiving, and length of time the catheter remains in the vein. Therefore, it has been recommended that peripheral IV sites be rotated at prescribed intervals (eg, 48 to 72 hours) to reduce the rate of phlebitis. This study evaluated the use of a visual infusion phlebitis scale for determining appropriate discontinuation of peripheral IV catheters.

**Design**

A descriptive correlation design was used to compare phlebitis rates between peripheral IV sites that had been indwelling for up to 96 hours with those that had been indwelling for longer than 96 hours. Researchers monitored 851 IV sites in 513 patients in a cardiac surgery critical care unit and in a cardiothoracic stepdown unit. Skin preparation, IV insertion, and dressing site care were according to hospital policy, with insertions initiated using 18-gauge or smaller needles in the antecubital area, forearm, hand, or wrist. Researchers used the Visual Infusion Phlebitis (VIP) scale to rate phlebitis using a range of scores from 0 (no symptoms) to 5 (purulent drainage, redness, and a palpable cord greater than 3 inches). All scores of 2 (pain, redness, warmth, and/or edema extending from 1 to 2 inches above the site) resulted in a change in catheters. The researchers evaluated each IV site daily and documented reasons for removal of catheters, time of catheter removal, and any medications administered through the IV route.

**Findings**

Chi-square analysis demonstrated no statistically significant difference between the two groups in age, gender, or the type of surgery for the patients who had peripheral IV catheters indwelling for less than 96 hours compared with those who had catheters for more than 96 hours. There was a significant increase in the rate of phlebitis in patients who needed IV restarts (13.4%) as compared with a phlebitis rate of 2.7% in patients who had only one IV inserted (no restarts). There was a significant increase in phlebitis rates when certain medications (antibiotics, diltiazem, potassium chloride, and amiodarone) were infused compared with those in which none of these medications was infused. The VIP scale was found to be a reliable and valid method for determining when a peripheral catheter should be removed.

**Nursing Implications**

In the sample studied, the peripheral IV catheters in place for longer than 96 hours did not result in significantly increased rates of phlebitis or greater risk of bacteremia compared to IV lines removed at 96 hours. Routine restarting of IV lines and administration of certain medications increased the risk of phlebitis. The VIP scale was useful for determining when catheters should be removed. Clinical assessment remains essential for safe patient care.

tion sets every 24 hours, or immediately if contamination is suspected (Alexander, 2006)

- Using administration sets with a twist-lock design (Rosenthal, 2007)

### Managing Local Complications

Local complications of IV therapy include infiltration and extravasation, phlebitis, thrombophlebitis, hematoma, and clotting of the needle.

#### Infiltration and Extravasation

Infiltration is the unintentional administration of a nonvesicant solution or medication into surrounding tissue. This can occur when the IV cannula dislodges or perforates the wall of the vein. Infiltration is characterized by edema around the insertion site, leakage of IV fluid from the insertion site, discomfort and coolness in the area of infiltration, and a significant decrease in the flow rate. When the solution is particularly irritating, sloughing of tissue may result. Close monitoring of the insertion site is necessary to detect infiltration before it becomes severe.

Infiltration is usually easily recognized if the insertion area is larger than the same site of the opposite extremity; however, it is not always so obvious. A common misconception is that a backflow of blood into the tubing proves that the catheter is properly placed within the vein. However, if the catheter tip has pierced the wall of the vessel, IV fluid will seep into tissues as well as flow into the vein. Although blood return occurs, infiltration may have occurred as well. A more reliable means of confirming infiltration is to apply a tourniquet above (or proximal to) the infusion site and tighten it enough to restrict venous flow. If the infusion continues to drip despite the venous obstruction, infiltration is present.

As soon as the nurse detects infiltration, the infusion should be stopped, the IV catheter discontinued, and a sterile dressing applied to the site after careful inspection to determine the extent of infiltration. The infiltration of any amount of blood product, irritant, or vesicant is considered the most severe.

The IV infusion should be started in a new site or proximal to the infiltration if the same extremity must be used again. A warm compress may be applied to the site if small volumes of noncaustic solutions have infiltrated over a long period, or if the solution was isotonic with a normal pH; the affected extremity should be elevated to promote the absorption of fluid. If the infiltration is recent and the solution was hypertonic or had an increased pH, a cold compress may be applied to the area. Infiltration can be detected and treated early by inspecting the site every hour for redness, pain, edema, blood return, coolness at the site, and IV fluid leaking from the IV site. Using the appropriate size and type of cannula for the vein prevents this complication. The Infusion Nursing Standards of Practice state that a standard-

CHART 14-5

### Assessing for Infiltration

| Grade | Clinical Criteria |
|---|---|
| 0 | No clinical symptoms |
| 1 | Skin blanched, edema less than 1 inch in any direction, cool to touch, with or without pain |
| 2 | Skin blanched, edema 1 to 6 inches in any direction, cool to touch, with or without pain |
| 3 | Skin blanched, translucent, gross edema greater than 6 inches in any direction, cool to touch, mild to moderate pain, possible numbness |
| 4 | Skin blanched, translucent, skin tight, leaking, skin discolored, bruised, swollen, gross edema greater than 6 inches in any direction, deep pitting tissue edema, circulatory impairment, moderate to severe pain, infiltration of any amount of blood products, irritant, or vesicant |

Adapted from Alexander, M. (2006). Infusion nursing standards of practice. *Journal of Infusion Nursing, 29*(IS), S1–S92.

ized infiltration scale should be used to document the infiltration (Alexander, 2006) (Chart 14-5).

Extravasation is similar to infiltration, with an inadvertent administration of vesicant or irritant solution or medication into the surrounding tissue. Medications such as dopamine, calcium preparations, and chemotherapeutic agents can cause pain, burning, and redness at the site. Blistering, inflammation, and necrosis of tissues can occur. The extent of tissue damage is determined by the concentration of the medication, the quantity that extravasated, the location of the infusion site, the tissue response, and the duration of the process of extravasation.

The infusion must be stopped and the physician notified promptly. The agency's protocol to treat extravasation is initiated; the protocol may specify specific treatments, including antidotes specific to the medication that extravasated, and may indicate whether the IV line should remain in place or be removed before treatment. The protocol often specifies infiltration of the infusion site with an antidote prescribed after assessment by the physician, removal of the cannula, and application of warm compresses to sites of extravasation from vinca alkaloids or cold compresses to sites of extravasation from alkylating and antibiotic vesicants. The affected extremity should not be used for further cannula placement. Thorough neurovascular assessments of the affected extremity must be performed frequently (Hadaway, 2007).

Reviewing the institution's IV policy and procedures and incompatibility charts and checking with the pharmacist before administering any IV medication, whether peripherally or centrally, are recommended to determine incompatibilities and vesicant potential to prevent extravasation. Careful, frequent monitoring of the IV site, avoiding insertion of IV devices in areas of flexion, securing the IV line, and using the smallest catheter possible that accommodates the vein help minimize the incidence and severity of this complication. In addition, when vesicant medication is administered by IV push, it should be given through a side port of an infusing IV solution to dilute the medication and decrease the severity of tissue damage if extravasation occurs. Extravasation is rated as grade 4 on the infiltration scale.

#### Phlebitis

Phlebitis is defined as inflammation of a vein, which can be categorized as chemical, mechanical, or bacterial; however, two or more of these types of irritation often occur simultaneously. Chemical phlebitis can be caused by an irritating medication or solution (increased pH or high osmolality of a solution), rapid infusion rates, and medication incompatibilities. Mechanical phlebitis results from long periods of cannulation, catheters in flexed areas, catheter gauges larger than the vein lumen, and poorly secured catheters. Bacterial phlebitis can develop from poor hand hygiene, lack of aseptic technique, failure to check all equipment before use, and failure to recognize early signs and symptoms of phlebitis. Other factors include poor venipuncture technique, catheter in place for a prolonged period, and failure to adequately secure the catheter. Phlebitis is characterized by a reddened, warm area around the insertion site or along the path of the vein, pain or tenderness at the site or along the vein, and swelling. The incidence of phlebitis increases with the length of time the IV line is in place (see Chart 14-4), the composition of the fluid or medication infused (especially its pH and tonicity), the size and site of the cannula inserted, ineffective filtration, inadequate anchoring of the line, and the introduction of microorganisms at the time of insertion. The Infusion Nursing Society has identified specific standards for assessing phlebitis (Alexander, 2006); these appear in Chart 14-6. Phlebitis is graded according to the most severe presenting indication.

CHART 14-6

### Assessing for Phlebitis

| Grade | Clinical Criteria |
|---|---|
| 0 | No clinical symptoms |
| 1 | Erythema at access site with or without pain |
| 2 | Pain at access site<br>Erythema, edema, or both |
| 3 | Pain at access site<br>Erythema, edema, or both<br>Streak formation<br>Palpable venous cord (1 inch or shorter) |
| 4 | Pain at access site with erythema<br>Streak formation<br>Palpable venous cord (longer than 1 inch)<br>Purulent drainage |

Note: If this scale is not being used in an institution, then the description associated with the number can be used to describe the assessment.

Adapted from Alexander, M. (2006). Infusion nursing standards of practice. *Journal of Infusion Nursing, 29*(1S), S1–S92.

Treatment consists of discontinuing the IV line and restarting it in another site, and applying a warm, moist compress to the affected site. Phlebitis can be prevented by using aseptic technique during insertion, using the appropriate-size cannula or needle for the vein, considering the composition of fluids and medications when selecting a site, observing the site hourly for any complications, anchoring the cannula or needle well, and changing the IV site according to agency policy and procedures.

#### Thrombophlebitis

Thrombophlebitis refers to the presence of a clot plus inflammation in the vein. It is evidenced by localized pain, redness, warmth, and swelling around the insertion site or along the path of the vein, immobility of the extremity because of discomfort and swelling, sluggish flow rate, fever, malaise, and leukocytosis.

Treatment includes discontinuing the IV infusion; applying a cold compress first, to decrease the flow of blood and increase platelet aggregation, followed by a warm compress; elevating the extremity; and restarting the line in the opposite extremity (see Chart 14-4). If the patient has signs and symptoms of thrombophlebitis, the IV line should not be flushed (although flushing may be indicated in the absence of phlebitis to ensure cannula patency and to prevent mixing of incompatible medications and solutions). The catheter should be cultured after the skin around the catheter is cleaned with alcohol. If purulent drainage exists, the site is cultured before the skin is cleaned.

Thrombophlebitis can be prevented by avoiding trauma to the vein at the time the IV line is inserted, observing the site every hour, and checking medication additives for compatibility.

#### Hematoma

Hematoma results when blood leaks into tissues surrounding the IV insertion site. Leakage can result if the opposite vein wall is perforated during venipuncture, the needle slips out of the vein, or insufficient pressure is applied to the site after removal of the needle or cannula. The signs of a hematoma include ecchymosis, immediate swelling at the site, and leakage of blood at the insertion site.

Treatment includes removing the needle or cannula and applying light pressure with a sterile, dry dressing; applying ice for 24 hours to the site to avoid extension of the hematoma; elevating the extremity; assessing the extremity for any circulatory, neurologic, or motor dysfunction; and restarting the line in the other extremity if indicated (see Chart 14-4). A hematoma can be prevented by carefully inserting the needle and by using diligent care with patients who have a bleeding disorder, are taking anticoagulant medication, or have advanced liver disease.

#### Clotting and Obstruction

Blood clots may form in the IV line as a result of kinked IV tubing, a very slow infusion rate, an empty IV bag, or failure to flush the IV line after intermittent medication or solution administrations. The signs are decreased flow rate and blood backflow into the IV tubing.

If blood clots in the IV line, the infusion must be discontinued and restarted in another site with a new cannula and administration set. The tubing should not be irrigated or milked. Neither the infusion rate nor the solution container should be raised, and the clot should not be aspirated from the tubing. Clotting of the needle or cannula may be prevented by not allowing the IV solution bag to run dry, taping the tubing to prevent kinking and maintain patency, maintaining an adequate flow rate, and flushing the line after intermittent medication or other solution administration. In some cases, a specially trained nurse or physician may inject a thrombolytic agent into the catheter to clear an occlusion resulting from fibrin or clotted blood.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

At times, IV therapy must be administered in the home setting, in which case much of the daily management rests with the patient and family. Teaching becomes essential to ensure that the patient and family can manage the IV fluid and infusion correctly and avoid complications. Written instructions as well as demonstration and return demonstration help reinforce the key points for all these functions.

#### Continuing Care

Home infusion therapies cover a wide range of treatments, including antibiotic, analgesic, and antineoplastic medications; blood or blood component therapy; and parenteral nutrition. When direct nursing care is necessary, arrangements are made to have an infusion nurse visit the home and administer the IV therapy as prescribed. In addition to implementing and monitoring the IV therapy, the nurse carries out a comprehensive assessment of the patient's condition and continues to teach the patient and family about the skills involved in overseeing the IV therapy setup. Any dietary changes that may be necessary because of fluid or electrolyte imbalances are explained or reinforced during such sessions.

Periodic laboratory testing may be necessary to assess the effects of IV therapy and the patient's progress. Blood specimens may be obtained by a laboratory near the patient's home, or a home visit may be arranged to obtain blood specimens for analysis.

The nurse collaborates with the case manager in assessing the patient, family, and home environment; developing a plan of care in accordance with the patient's treatment plan and level of ability; and arranging for appropriate referral and follow-up if necessary. Any necessary equipment may be provided by the agency or purchased by the patient, depending on the terms of the home care arrangements. Appropriate documentation is necessary to assist in obtaining third-party payment for the service provided.

## CRITICAL THINKING EXERCISES

**1** A 38-year-old woman is admitted with a chief complaint of shortness of breath and polyuria for the past 6 weeks. She is hypotensive. Her pulse rate is 110 bpm, and her lungs are clear to auscultation. Her laboratory test results are as follows: pH 7.32; sodium 131 mEq/L; glucose 600 mg/dL; $PaCO_2$ 28 mm Hg; potassium 4.5 mEq/L; cre-

atinine 1.4 mg/dL; $HCO_3^-$ 14 mEq/L; chloride 95 mEq/L; BUN 30 mg/dL. What fluid and electrolyte or acid–base disorder is the patient experiencing? What IV fluids would you anticipate being prescribed? Give the rationale for their use. What treatments would address the patient's fluid and electrolyte or acid–base disorders?

**2** A 54-year-old obese man who has smoked one pack per day for the past 25 years has had a productive cough for the last 3 months and shortness of breath with little exertion. His wife complains of his loud snoring. His blood pressure is 130/90 mm Hg and pulse rate 126 bpm. His arterial blood gas results are as follows: pH 7.29; $PaCO_2$ 72 mm Hg; $HCO_3^-$ 34 mEq/L; $PaO_2$ 50 mm Hg. How do you interpret the patient's blood gas values? What treatment would you anticipate?

**3** An 85-year-old woman is brought to the hospital with a decreased fluid intake for the past 4 days and weakness. She is not in respiratory distress. Her laboratory test results are as follows: sodium 145 mEq/L; potassium 1.9 mEq/L; chloride 86 mEq/L; pH 7.58; $PaCO_2$ 49 mm Hg; $HCO_3^-$ 44 mEq/L. What fluid and electrolyte or acid–base disorders is the patient experiencing? Outline the nursing plan of care to address the patient's fluid and electrolyte or acid–base disorders. Give the rationale for the nursing interventions for this patient.

**4** A 58-year-old man on the surgical unit is scheduled for an appendectomy and needs an IV for hydration and administration of preoperative medications. What aspects of the patient history must be assessed prior to administration of IV fluids and mediations? Describe the site selection process and the factors that affect the choice of an IV site. What factors need to be considered in preparing to administer IV therapy to this patient?

EBP **5** A 35-year-old obese woman has been receiving IV therapy for the past 72 hours. The nurse plans to change the IV site today. A nurse on the IV team has suggested the use of clinical assessment criteria to assess the need for the IV change. What is the evidence for use of clinical criteria in this case? What criteria would you use to assess the strength of the evidence for the use of clinical criteria? Which criteria would you use in this patient's case?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing reseach.*
**Double asterisk indicates classic reference.

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## RESOURCE

Infusion Nurses Society, www.ins1.org



chapter 15

# Shock and Multiple Organ Dysfunction Syndrome

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe shock and its underlying pathophysiology.
2. Compare clinical findings of the compensatory, progressive, and irreversible stages of shock.
3. Describe organ dysfunction that may occur with shock.
4. Describe similarities and differences in shock due to hypovolemic, cardiogenic, neurogenic, anaphylactic, and septic shock states.
5. Identify medical and nursing management priorities in treating patients in shock.
6. Identify vasoactive medications used in treating shock, and describe nursing implications associated with their use.
7. Discuss the importance of nutritional support in all forms of shock.
8. Discuss the role of nurses in psychosocial support of patients experiencing shock and their families.
9. Discuss multiple organ dysfunction syndrome.

## GLOSSARY

**anaphylactic shock:** circulatory shock state resulting from a severe allergic reaction producing an overwhelming systemic vasodilation and relative hypovolemia

**biochemical mediators:** messenger substances that may be released by a cell to create an action at that site or be carried by the bloodstream to a distant site before being activated; also called cytokines

**cardiogenic shock:** shock state resulting from impairment or failure of the myocardium

**circulatory shock:** shock state resulting from displacement of blood volume creating a relative hypovolemia and inadequate delivery of oxygen to the cells; also called distributive shock

**colloids:** intravenous solutions that contain molecules that are too large to pass through capillary membranes

**crystalloids:** intravenous electrolyte solutions that move freely between the intravascular compartment and interstitial spaces

**hypovolemic shock:** shock state resulting from decreased intravascular volume due to fluid loss

**multiple organ dysfunction syndrome:** presence of altered function of two or more organs in an acutely ill patient such that interventions are necessary to support continued organ function

**neurogenic shock:** shock state resulting from loss of sympathetic tone causing relative hypovolemia

**septic shock:** circulatory shock state resulting from overwhelming infection causing relative hypovolemia

**shock:** physiologic state in which there is inadequate blood flow to tissues and cells of the body

**systemic inflammatory response syndrome:** overwhelming inflammatory response in the absence of infection causing relative hypovolemia and decreased tissue perfusion

Shock is a life-threatening condition with a variety of underlying causes. It is characterized by inadequate perfusion that, if untreated, results in cell death. The progression of shock is neither linear nor predictable, and shock states, especially septic shock, comprise a current area of aggressive clinical research. Nurses caring for patients with shock and for those at risk for shock must understand the underlying mechanisms of shock and recognize its subtle as well as more obvious signs. Rapid assessment with early recognition and response to shock states is essential to the patient's recovery.

## Overview of Shock

**Shock** can best be defined as a condition in which widespread perfusion to the cells is inadequate to deliver oxygen and nutrients to support vital organs and cellular function (VonRueden, Bolton & Vary, 2008). Adequate blood flow to the tissues and cells requires an adequate cardiac pump, effective vasculature or circulatory system, and sufficient blood volume. If one of these components is impaired, perfusion to the tissues is threatened or compromised. Without treatment, inadequate blood flow to the cells results in poor delivery of oxygen and nutrients, cellular hypoxia, and cell death that progresses to organ dysfunction and eventually death.

Shock affects all body systems. It may develop rapidly or slowly, depending on the underlying cause. During shock, the body struggles to survive, calling on all its homeostatic mechanisms to restore blood flow. Any insult to the body can create a cascade of events resulting in poor tissue perfusion. Therefore, almost any patient with any disease state may be at risk for developing shock. Conventionally, the primary underlying pathophysiologic process and underlying disorder are used to classify the shock state (eg, hypovolemic shock, cardiogenic shock, and circulatory shock [all discussed later in the chapter]).

Regardless of the initial cause of shock, certain physiologic responses are common to all types of shock. These physiologic responses include hypoperfusion of tissues, hypermetabolism, and activation of the inflammatory response. The body responds to shock states by activating the sympathetic nervous system and mounting a hypermetabolic and inflammatory response. Once shock develops, the patient's survival may have more to do with the body's ability to effectively respond to it than with the initial cause of shock. Failure of compensatory mechanisms to effectively restore physiologic balance is the final pathway of all shock states and results in end-organ dysfunction and death (Cocchi, Kimlin, Walsh, et al., 2007; Dellinger, Levy, Carlet, et al., 2008; King, 2007; VonRueden, et al., 2008).

Nursing care of patients with shock requires ongoing systematic assessment. Many of the interventions required in caring for patients with shock call for close collaboration with other members of the health care team and rapid implementation of prescribed therapies. Nurses must anticipate these therapies because they need to be implemented with speed and accuracy.

### Normal Cellular Function

Energy metabolism occurs within the cell, where nutrients are chemically broken down and stored in the form of adenosine triphosphate (ATP). Cells use this stored energy to perform necessary functions, such as active transport, muscle contraction, and biochemical synthesis, as well as specialized cellular functions, such as the conduction of electrical impulses. ATP can be synthesized aerobically (in the presence of oxygen) or anaerobically (in the absence of oxygen). Aerobic metabolism yields far greater amounts of ATP per mole of glucose than does anaerobic metabolism; therefore, it is a more efficient and effective means of producing energy. In addition, anaerobic metabolism results in the accumulation of the toxic end product, lactic acid, which must be removed from the cell and transported to the liver for conversion into glucose and glycogen.

### Pathophysiology

#### Cellular Changes

In shock, the cells lack an adequate blood supply and are deprived of oxygen and nutrients; therefore, they must produce energy through anaerobic metabolism. This results in low energy yields from nutrients and an acidotic intracellular environment. Because of these changes, normal cell function ceases (Fig. 15-1). The cell swells and the cell membrane becomes more permeable, allowing electrolytes and fluids to seep out of and into the cell. The sodium–potassium pump becomes impaired; cell structures, primarily the mitochondria, are damaged; and death of the cell results.

Glucose is the primary substrate required for the production of cellular energy in the form of ATP. In stress states, catecholamines, cortisol, glucagons, and inflammatory cytokines and mediators are released, causing hyperglycemia and insulin resistance to mobilize glucose for cellular metabolism. Activation of these substances promotes gluconeogenesis, which is the formation of glucose from noncarbohydrate sources such as proteins and fats. Glycogen that has been stored in the liver is converted to glucose through glycogenolysis to meet metabolic needs, increasing the blood glucose concentration (ie, hyperglycemia).

Continued activation of the stress response by shock states causes a depletion of glycogen stores, resulting in increased proteolysis and eventual organ failure (Vincent, 2007). The inability of the body to have enough nutrients and oxygen for normal cellular metabolism causes a buildup of metabolic end products in the cells and interstitial spaces. Cellular metabolism is impaired, and a negative feedback loop is initiated.

#### Vascular Responses

Local regulatory mechanisms, referred to as autoregulation, stimulate vasodilation or vasoconstriction in response to **biochemical mediators** (ie, cytokines) released by the cell, communicating the need for oxygen and nutrients (King, 2007). A biochemical mediator is a substance released by a cell or immune cells such as macrophages; the substance triggers an action at a cell site or travels in the bloodstream to a distant site, where it triggers action. Researchers are learning more every day about the physiologic actions of more than 100 known cytokines (VonRueden, et al., 2008).

#### Blood Pressure Regulation

Three major components of the circulatory system—blood volume, the cardiac pump, and the vasculature—must respond effectively to complex neural, chemical, and

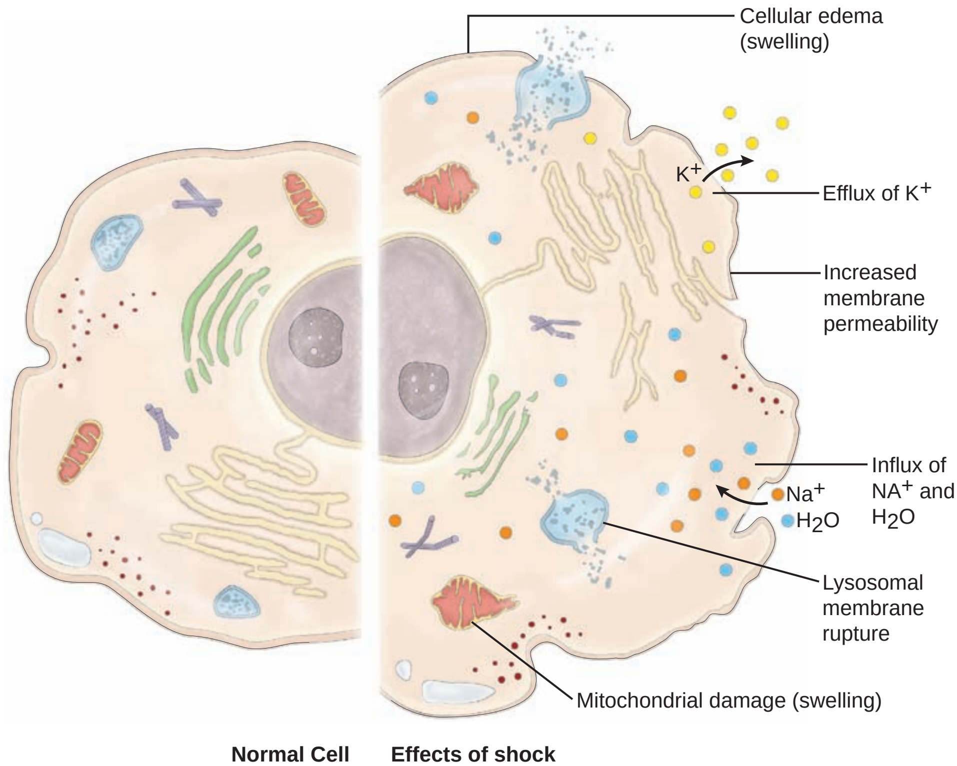



**Figure 15-1** Cellular effects of shock. The cell swells and the cell membrane becomes more permeable; fluids and electrolytes seep from and into the cell. Mitochondria and lysosomes are damaged, and the cell dies.

hormonal feedback systems to maintain an adequate blood pressure (BP) and perfuse body tissues. BP is regulated through a complex interaction of neural, chemical, and hormonal feedback systems affecting both cardiac output and peripheral resistance. This relationship is expressed in the following equation:

Mean arterial BP = Cardiac output × Peripheral resistance

Cardiac output is a product of the stroke volume (the amount of blood ejected from the left ventricle during systole) and heart rate. Peripheral resistance is determined by the diameter of the arterioles.

Tissue perfusion and organ perfusion depend on mean arterial pressure (MAP), or the average pressure at which blood moves through the vasculature. MAP must exceed 65 mm Hg for cells to receive the oxygen and nutrients needed to metabolize energy in amounts sufficient to sustain life (Dellinger, et al., 2008). True MAP can be calculated only by complex methods. Frequently, MAP is calculated by automatic blood pressure machines, however, the nurse must ensure accurate blood pressure measurement is obtained before interpreting data from automated vital sign equipment.

BP is regulated by baroreceptors (pressure receptors) located in the carotid sinus and aortic arch. These pressure receptors are responsible for monitoring the circulatory volume and regulating neural and endocrine activities (see Chapter 14 for further description). When BP drops, catecholamines (epinephrine and norepinephrine) are released from the adrenal medulla. These increase heart rate and cause vasoconstriction, thus restoring BP. Chemoreceptors, also located in the aortic arch and carotid arteries, regulate BP and respiratory rate using much the same mechanism in response to changes in oxygen and carbon dioxide concentrations in the blood. These primary regulatory mechanisms can respond to changes in BP on a moment-to-moment basis.

The kidneys regulate BP by releasing renin, an enzyme needed for the conversion of angiotensin I to angiotensin II, a potent vasoconstrictor. This stimulation of the renin–angiotensin mechanism and the resulting vasoconstriction indirectly lead to the release of aldosterone from the adrenal cortex, which promotes the retention of sodium and water. The increased concentration of sodium in the blood stimulates the release of antidiuretic hormone (ADH) by the pituitary gland. ADH causes the kidneys to retain water further in an effort to raise blood volume and BP. These secondary regulatory mechanisms may take hours or days to respond to changes in BP. The relationship between the initiation of shock and the responsiveness of primary and secondary regulatory mechanisms that compensate for deficits in blood volume, the pumping effectiveness of the heart, or vascular tone, which may result because of the shock state, is noted in Figure 15-2.

## Stages of Shock

Shock is believed to progress along a continuum of stages. Shock can be identified as early or late, depending on the signs and symptoms and the overall severity of organ dysfunction. A convenient way to understand the physiologic responses and subsequent clinical signs and symptoms of shock is to divide the continuum into separate stages: compensatory (stage 1), progressive (stage 2), and irreversible (stage 3). The earlier that medical and nursing

**Physiology ■■■ Pathophysiology**

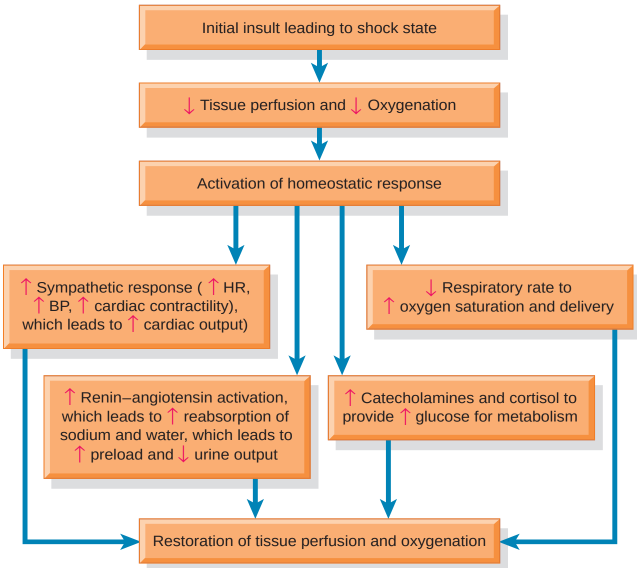



**Figure 15-2** Compensatory mechanisms in shock.

interventions are initiated along this continuum, the greater the patient's chance of survival. Current research is focusing on assessing patients at greatest risk for shock and implementing early and aggressive interventions to reverse tissue hypoxia (King, 2007; Otero, Nguygen, Huang, et al., 2006). Studies suggest that the window of opportunity that increases the likelihood of patient survival occurs when aggressive therapy begins within 6 hours of identifying a shock state, especially septic shock (Otero, et al., 2006; Rivers, McIntyre, Morro, et al., 2005).

## COMPENSATORY STAGE

In the compensatory stage of shock, the BP remains within normal limits. Vasoconstriction, increased heart rate, and increased contractility of the heart contribute to maintaining adequate cardiac output. This results from stimulation of the sympathetic nervous system and subsequent release of catecholamines (epinephrine and norepinephrine). Patients display the often-described "fight or flight" response. The body shunts blood from organs such as the skin, kidneys, and gastrointestinal tract to the brain, heart, and lungs to ensure adequate blood supply to these vital organs. As a result, the skin is cool and clammy, bowel sounds are hypoactive, and urine output decreases in response to the release of aldosterone and ADH.

### Clinical Manifestations

Despite a normal BP, the patient shows numerous clinical signs indicating inadequate organ perfusion (Table 15-1). The result of inadequate perfusion is anaerobic metabolism and a buildup of lactic acid, producing metabolic acidosis. The respiratory rate increases in response to metabolic acidosis. This rapid respiratory rate facilitates removal of excess carbon dioxide but raises the blood pH and often causes a compensatory respiratory alkalosis. The alkalotic state causes mental status changes, such as confusion or combativeness, as well as arteriolar dilation. If treatment begins in this stage of shock, the prognosis for the patient is better than in later stages.

### Medical Management

Medical treatment is directed toward identifying the cause of the shock, correcting the underlying disorder so that shock does not progress, and supporting those physiologic processes that thus far have responded successfully to the threat. Because compensation cannot be maintained indefinitely, measures such as fluid replacement and medication therapy must be initiated to maintain an adequate BP and reestablish and maintain adequate tissue perfusion (Otero, et al., 2006).

### Nursing Management

As stated earlier, intervention as soon as possible along the continuum of shock is the key to improving the patient's prognosis. The nurse must systematically assess the patient at risk for shock to recognize the subtle clinical signs of the compensatory stage before the patient's BP drops. Special considerations related to recognizing early signs of shock in the elderly patient are given in Chart 15-1.

**Table 15-1 CLINICAL FINDINGS IN STAGES OF SHOCK**

| | Stage | | |
|---|---|---|---|
| **Finding** | **Compensatory** | **Progressive** | **Irreversible** |
| Blood pressure | Normal | Systolic <80–90 mm Hg<br>Requires fluids resuscitation to support blood pressure | Requires mechanical or pharmacologic support |
| Heart rate | >100 bpm | >150 bpm | Erratic or asystole |
| Respiratory status | >20 breaths/min<br>$PaCO_2$ <32 mm Hg | Rapid, shallow respirations; crackles<br>$PaO_2$ <80 mm Hg<br>$PaCO_2$ >45 mm Hg | Requires intubation and mechanical ventilation and oxygenation |
| Skin | Cold, clammy | Mottled, petechiae | Jaundice |
| Urinary output | Decreased | 0.5 mL/kg/h | Anuric, requires dialysis |
| Mentation | Confusion | Lethargy | Unconscious |
| Acid–base balance | Respiratory alkalosis | Metabolic acidosis | Profound acidosis |

CHART 15-1

## Recognizing Shock in Older Patients

The physiologic changes associated with aging, coupled with pathologic and chronic disease states, place older people at increased risk for developing a state of shock and possibly multiple organ dysfunction syndrome (MODS). Elderly people can recover from shock if it is detected and treated early with aggressive and supportive therapies. Nurses play an essential role in assessing and interpreting subtle changes in older patients' responses to illness.

- Medications such as beta-blocking agents (metoprolol [Lopressor]) used to treat hypertension may mask tachycardia, a primary compensatory mechanism to increase cardiac output, during hypovolemic states.
- The aging immune system may not mount a truly febrile response (temperature more than 38°C [100.4°F]), but an increasing trend in body temperature should be addressed. The patient may also report increased fatigue and malaise in the absence of a febrile response.
- The heart does not function well in hypoxemic states, and the aging heart may respond to decreased myocardial oxygenation with dysrhythmias that may be misinterpreted as a normal part of the aging process.
- There is a progressive decline in respiratory muscle strength, maximal ventilation, and response to hypoxia. Older patients have a decreased respiratory reserve and decompensate more quickly.
- Changes in mentation may be inappropriately misinterpreted as dementia. Older people with a sudden change in mentation should be aggressively treated for the presence of infection and organ hypoperfusion.

### Monitoring Tissue Perfusion

In assessing tissue perfusion, the nurse observes for changes in level of consciousness, vital signs (including pulse pressure), urinary output, skin, and laboratory values (eg, base deficit and lactic acid levels). In the compensatory stage of shock, serum sodium and blood glucose levels are elevated in response to the release of aldosterone and catecholamines.

The nurse should monitor the patient's hemodynamic status and promptly report deviations to the physician, assist in identifying and treating the underlying disorder by continuous in-depth assessment of the patient, administer prescribed fluids and medications, and promote patient safety. Vital signs are key indicators of hemodynamic status and BP is an indirect measure of tissue hypoxia. The nurse should report a systolic BP lower than 90 mm Hg or a drop in systolic BP of 40 mm Hg from baseline.

Pulse pressure correlates well with stroke volume. Pulse pressure is calculated by subtracting the diastolic measurement from the systolic measurement; the difference is the pulse pressure (Cottingham, 2006). Normally, the pulse pressure is 30 to 40 mm Hg. Narrowing or decreased pulse pressure is an earlier indicator of shock than a drop in systolic BP. Decreased or narrowing pulse pressure, an early indication of decreased stroke volume, is illustrated in the following example:

$$\text{Systolic BP} - \text{Diastolic BP} = \text{Pulse pressure}$$

Normal pulse pressure:

$$120 \text{ mg Hg} - 80 \text{ mm Hg} = 40 \text{ mm Hg}$$

Narrowing of pulse pressure:

$$90 \text{ mm Hg} - 70 \text{ mm Hg} = 20 \text{ mm Hg}$$

Elevation of the diastolic BP with release of catecholamines and attempts to increase venous return through vasoconstriction is an early compensatory mechanism in response to decreased stroke volume, BP, and overall cardiac output.

**NURSING ALERT**

**By the time BP drops, damage has already been occurring at the cellular and tissue levels. Therefore, the patient at risk for shock must be assessed and monitored closely before the BP falls.**

Continuous central venous oximetry ($Sc\bar{v}O_2$) monitoring may be used to evaluate mixed venous blood oxygen saturation and the severity of tissue hypoperfusion states. A central catheter is introduced into the superior vena cava (SVC), and a sensor on the catheter measures the oxygen saturation of the blood in the SVC as blood returns to the heart and pulmonary system for reoxygenation. A normal $Sc\bar{v}O_2$ value is 70% (Goodrich, 2006; Rivers, et al., 2005). Body tissues use approximately 25% of the oxygen delivered to them during normal metabolism. During states of stress, such as shock, more oxygen is consumed and the $Sc\bar{v}O_2$ saturation is lower, indicating that the tissues are consuming more oxygen.

Interventions focus on decreasing tissue oxygen requirements and increasing perfusion to deliver more oxygen to the tissues. For instance, sedating agents may be administered to lower metabolic demands, the patient's pain may be treated with intravenous (IV) opioid agents, or measures to prevent shivering, decrease metabolic demands for oxygen. Supplemental oxygen and mechanical ventilation may be required to increase the delivery of oxygen in the blood. Administration of IV fluids and medications supports blood pressure and cardiac output, and the transfusion of packed red blood cells enhances oxygen transport. Monitoring tissue oxygen consumption with $Sc\bar{v}O_2$ is a minimally invasive measure to more accurately assess tissue oxygenation in the compensatory stage of shock before changes in vital signs detect altered tissue perfusion (Dellinger, et al., 2008; Goodrich, 2006; Otero, et al., 2006).

New technologies allow clinicians to detect changes in tissue perfusion before changes in classic signs (BP, heart rate, and urine output) indicative of hypoperfusion occur.

Two of these technologies include sublingual capnometry and near-infrared spectroscopy. Sublingual capnometry, a noninvasive technology, provides information about the degree of hypoperfusion based on the sublingual partial pressure of carbon dioxide ($PCO_2$) (Goodrich, 2006). A probe is placed under the patient's tongue, and $PCO_2$ levels are derived from the blood flow found in the mucosal bed. During shock, an elevated $PCO_2$ indicates poor tissue perfusion. Near-infrared spectroscopy (NIRS), a continuous noninvasive technology, uses light transmission to measure skeletal muscle oxygenation as an indicator of shock. The NIRS probe is applied to the thenar muscle that is located on the palm of the hand near the thumb, and it measures the oxygen saturation of tissue by determining the amount of infrared light absorption. Low values of tissue oxygenation (eg, less than 80%) indicate severity of shock; the lower the value, the more severe the tissue hypoxia.

Although treatments are prescribed and initiated by the physician, the nurse usually implements them, operates and troubleshoots equipment used in treatment, monitors the patient's status during treatment, and evaluates the immediate effects of treatment. In addition, the nurse assesses the response of the patient and family to the crisis and its treatment.

#### *Reducing Anxiety*

Patients and their families often become anxious and apprehensive when they face a major threat to health and well-being and are the focus of attention of many health care providers. Providing brief explanations about the diagnostic and treatment procedures, supporting the patient during these procedures, and providing information about their outcomes are usually effective in reducing stress and anxiety and thus promoting the patient's physical and mental well-being. Speaking in a calm reassuring voice and using gentle touch also help ease the patient's concerns. These actions may provide comfort for critically ill, frightened patients (Benner, 2004; Duran, Oman, Abel, et al., 2007). Research has repeatedly shown that family members have certain needs during a health-related crisis, including needing honest, consistent, and thorough communication with health care providers; needing physical and emotional closeness to the patient; sensing that health care providers care about their patients; seeing the patient frequently; and knowing exactly what has been done for the patient (Duran, et al., 2007).

The nurse should advocate that family members be present during procedures and while patient care is provided. The presence of family provides a necessary connection and support for the patient during a time of crisis.

#### *Promoting Safety*

The nurse must be vigilant for potential threats to the patient's safety, because a high anxiety level and altered mental status impair judgment. In this stage of shock, patients who were previously cooperative and followed instructions may now disrupt IV lines and catheters and complicate their condition. Therefore, close monitoring and frequent reorientation interventions are essential.

## PROGRESSIVE STAGE

In the second stage of shock, the mechanisms that regulate BP can no longer compensate, and the MAP falls below normal limits. Patients are clinically hypotensive; this is defined as a systolic BP of less than 90 mm Hg or a decrease in systolic BP of 40 mm Hg from baseline (Dellinger, et al., 2008; VonRueden, et al., 2008).

### Pathophysiology

Although all organ systems suffer from hypoperfusion at this stage, several events perpetuate the shock syndrome. First, the overworked heart becomes dysfunctional, the body's inability to meet increased oxygen requirements produces ischemia, and biochemical mediators cause myocardial depression (Dellinger, et al., 2008; Otero, et al., 2006; VonRueden, et al., 2008). This leads to failure of the cardiac pump, even if the underlying cause of the shock is not of cardiac origin. Second, the autoregulatory function of the microcirculation fails in response to the numerous biochemical mediators released by the cells, resulting in increased capillary permeability, with areas of arteriolar and venous constriction further compromising cellular perfusion (King, 2007; VonRueden, et al., 2008). At this stage, the prognosis worsens. The relaxation of precapillary sphincters causes fluid to leak from the capillaries, creating interstitial edema and return of less fluid to the heart. In addition, the inflammatory response to injury is activated, and proinflammatory and anti-inflammatory mediators are released, which activate the coagulation system in an effort to reestablish homeostasis (King, 2007). The body mobilizes energy stores and increases oxygen consumption to meet the increased metabolic needs of the underperfused tissues and cells.

Even if the underlying cause of the shock is reversed, the sequence of compensatory responses to the decrease in tissue perfusion perpetuates the shock state, and a vicious circle ensues. The cellular reactions that occur during the progressive stage of shock are an active area of clinical research. It is believed that the body's response to shock or lack of response in this stage of shock may be the primary factor determining the patient's survival.

### Clinical Manifestations

Chances of survival depend on the patient's general health before the shock state as well as the amount of time it takes to restore tissue perfusion. As shock progresses, organ systems decompensate.

#### *Respiratory Effects*

The lungs, which become compromised early in shock, are affected at this stage. Subsequent decompensation of the lungs increases the likelihood that mechanical ventilation will be needed. Respirations are rapid and shallow. Crackles are heard over the lung fields. Decreased pulmonary blood flow causes arterial oxygen levels to decrease and carbon dioxide levels to increase. Hypoxemia and biochemical mediators cause an intense inflammatory response and pulmonary vasoconstriction, perpetuating pulmonary capillary hypoperfusion and hypoxemia. The hypoperfused alveoli

stop producing surfactant and subsequently collapse. Pulmonary capillaries begin to leak, causing pulmonary edema, diffusion abnormalities (shunting), and additional alveolar collapse. This condition is called acute lung injury (ALI); as ALI continues, interstitial inflammation and fibrosis are common consequences, leading to acute respiratory distress syndrome (ARDS) (Cocci, et al., 2007; Girard, Kess, Fuchs, et al., 2008; Villar, Perez-Mendez, Lopez, et al., 2007). Further explanation of ALI and ARDS, as well as their nursing management, can be found in Chapter 23.

### Cardiovascular Effects

A lack of adequate blood supply leads to dysrhythmias and ischemia. The heart rate is rapid, sometimes exceeding 150 bpm. The patient may complain of chest pain and even suffer a myocardial infarction. Levels of cardiac enzymes (eg, myocardial creatine kinase [CK-MB] and cardiac troponin I [cTn-I]) increase. In addition, myocardial depression and ventricular dilation may further impair the heart's ability to pump enough blood to the tissues to meet oxygen requirements.

New laboratory markers can be used to assess the function of the heart. B-type natriuretic peptide (BNP) is one of these markers. BNP is increased when the ventricle is overdistended; therefore, elevations in BNP can be used to assess ventricular function of patients in shock states (Wilson Tang & Francis, 2005).

### Neurologic Effects

As blood flow to the brain becomes impaired, mental status deteriorates. Changes in mental status occur with decreased cerebral perfusion and hypoxia. Initially, the patient may exhibit subtle changes in behavior or agitation and confusion. Subsequently, lethargy increases, and the patient begins to lose consciousness.

### Renal Effects

When the MAP falls below 70 mm Hg (Cottingham, 2006; Dellinger, et al., 2008; King, 2007; Pinsky, 2007), the glomerular filtration rate of the kidneys cannot be maintained, and drastic changes in renal function occur. Acute renal failure (ARF) may develop. ARF is characterized by an increase in blood urea nitrogen (BUN) and serum creatinine levels, fluid and electrolyte shifts, acid–base imbalances, and a loss of the renal-hormonal regulation of BP. Urinary output usually decreases to less than 0.5 mL/kg/h (or less than 30 mL/h) but may vary depending on the phase of ARF. For further information about ARF, see Chapter 44.

### Hepatic Effects

Decreased blood flow to the liver impairs the ability of liver cells to perform metabolic and phagocytic functions. Consequently, the patient is less able to metabolize medications and metabolic waste products, such as ammonia and lactic acid. Metabolic activities of the liver, including gluconeogenesis and glycogenolysis, are impaired. The patient becomes more susceptible to infection as the liver fails to filter bacteria from the blood. Liver enzymes (aspartate aminotransferase [AST], alanine aminotransferase [ALT], lactate dehydrogenase [LDH]) and bilirubin levels are elevated, and the patient appears jaundiced.

### Gastrointestinal Effects

Gastrointestinal (GI) ischemia can cause stress ulcers in the stomach, putting the patient at risk for GI bleeding. In the small intestine, the mucosa can become necrotic and slough off, causing bloody diarrhea. Beyond the local effects of impaired perfusion, GI ischemia leads to bacterial toxin translocation, in which bacterial toxins enter the bloodstream through the lymphatic system. In addition to causing infection, bacterial toxins can cause cardiac depression, vasodilation, increased capillary permeability, and an intense inflammatory response with activation of additional biochemical mediators. The net result is interference with healthy cellular functioning and their ability to metabolize nutrients (Stapleton, Jones & Heyland, 2007).

### Hematologic Effects

The combination of hypotension, sluggish blood flow, metabolic acidosis, coagulation system imbalance, and generalized hypoxemia can interfere with normal hemostatic mechanisms. In shock states, the inflammatory cytokines activate the clotting cascade, causing deposition of microthrombi in multiple areas of the body and consumption of clotting factors. The alterations of the hematologic system, including imbalance of the clotting cascade, are linked to the overactivation of the inflammatory response of injury (Remick, 2007a; VonRueden, et al., 2008). Disseminated intravascular coagulation (DIC) may occur either as a cause or as a complication of shock. In this condition, widespread clotting and bleeding occur simultaneously. Bruises (ecchymoses) and bleeding (petechiae) may appear in the skin. Coagulation times (eg, prothrombin time [PT], activated partial thromboplastin time [aPTT]) are prolonged. Clotting factors and platelets are consumed and require replacement therapy to achieve hemostasis. Further discussion of DIC appears in Chapter 33.

## Medical Management

Specific medical management in the progressive stage of shock depends on the type of shock and its underlying cause. It is also based on the degree of decompensation in the organ systems. Medical management specific to each type of shock is discussed later in this chapter. Although there are several differences in medical management by type of shock, some medical interventions are common to all types. These include the use of appropriate IV fluids and medications to restore tissue perfusion by the following methods:

- Supporting the respiratory system
- Optimizing intravascular volume
- Supporting the pumping action of the heart
- Improving the competence of the vascular system

Other aspects of management may include early enteral nutritional support, aggressive hyperglycemic control with IV insulin (Hafidh, Reuter, Chassels, et al., 2007; Vanhorebeek, Langouche & Van den Berghe, 2007), and use of antacids, histamine-2 ($H_2$) blockers, or antipeptic agents to reduce the risk of GI ulceration and bleeding.

**NURSING ALERT**

**Tight glycemic control (blood glucose, 80 to 110 mg/dL) has been shown to reduce morbidity and mortality of acutely ill patients.**

## Nursing Management

Nursing care of patients in the progressive stage of shock requires expertise in assessing and understanding shock and the significance of changes in assessment data. Early interventions are essential to the survival of patients; therefore, suspecting that a patient may be in shock and reporting subtle changes in assessment are imperative. Patients in the progressive stage of shock are cared for in the intensive care setting to facilitate close monitoring (hemodynamic monitoring, electrocardiographic [ECG] monitoring, arterial blood gases, serum electrolyte levels, physical and mental status changes); rapid and frequent administration of various prescribed medications and fluids; and possibly interventions with supportive technologies, such as mechanical ventilation, dialysis, and intra-aortic balloon pump.

Working closely with other members of the health care team, the nurse carefully documents treatments, medications, and fluids that are administered, recording the time, dosage or volume, and patient response. In addition, the nurse coordinates both the scheduling of diagnostic procedures that may be carried out at the bedside and the flow of health care personnel involved in the care of patients.

### Preventing Complications

The nurse helps reduce the risk of related complications and monitors the patient for early signs of complications. Monitoring includes evaluating blood levels of medications, observing invasive vascular lines for signs of infection, and checking neurovascular status if arterial lines are inserted, especially in the lower extremities. Simultaneously, the nurse promotes the patient's safety and comfort by ensuring that all procedures, including invasive procedures and arterial and venous punctures, are carried out using correct aseptic techniques and that venous and arterial puncture and infusion sites are maintained with the goal of preventing infection. Nursing interventions that reduce the incidence of ventilator-associated pneumonias must also be implemented. These include frequent oral care, aseptic suction technique, turning, and elevating the head of the bed at least 30 degrees to prevent aspiration (Carson, Tyner, Sanders, et al., 2007; Dellinger, et al., 2008). Positioning and repositioning of the patient to promote comfort and maintain skin integrity are essential.

### Promoting Rest and Comfort

Efforts are made to minimize the cardiac workload by reducing the patient's physical activity and treating pain and anxiety. Promoting patient rest and comfort is a priority. To ensure that the patient obtains as much uninterrupted rest as possible, the nurse performs only essential nursing activities. To conserve the patient's energy, the nurse should protect the patient from temperature extremes (eg, excessive warmth or cold, and shivering), which can increase the metabolic rate and oxygen consumption and thus the cardiac workload. The patient should not be warmed too quickly, and warming blankets should not be applied, because they can cause vasodilation and a subsequent drop in BP.

### Supporting Family Members

Because patients in shock receive intense attention by the health care team, families may be overwhelmed and frightened. Family members may be reluctant to ask questions or seek information for fear that they will be in the way or will interfere with the attention given to the patient. The nurse should make sure that the family is comfortably situated and kept informed about the patient's status. Often, families need advice from the health care team to get some rest; family members are more likely to take this advice if they feel that the patient is being well cared for and that they will be notified of any significant changes in the patient's status. A visit from the hospital chaplain may be comforting and provides some attention to the family while the nurse concentrates on the patient.

# IRREVERSIBLE STAGE

The irreversible (or refractory) stage of shock represents the point along the shock continuum at which organ damage is so severe that the patient does not respond to treatment and cannot survive. Despite treatment, BP remains low. Renal and liver failure, compounded by the release of necrotic tissue toxins, creates an overwhelming metabolic acidosis. Anaerobic metabolism contributes to a worsening lactic acidosis. Reserves of ATP are almost totally depleted, and mechanisms for storing new supplies of energy have been destroyed. Respiratory system failure prevents adequate oxygenation and ventilation despite mechanical ventilatory support, and the cardiovascular system is ineffective in maintaining an adequate MAP for perfusion. Multiple organ dysfunction progressing to complete organ failure has occurred, and death is imminent. Multiple organ dysfunction can occur as a progression along the shock continuum or as a syndrome unto itself and is described in more detail later in this chapter.

## Medical Management

Medical management during the irreversible stage of shock is usually the same as for the progressive stage. Although the patient may have progressed to the irreversible stage, the judgment that the shock is irreversible can be made only retrospectively on the basis of the patient's failure to respond to treatment. Strategies that may be experimental (eg, investigational medications, such as antibiotic agents and immunomodulation therapy) may be tried to reduce or reverse the severity of shock.

## Nursing Management

As in the progressive stage of shock, the nurse focuses on carrying out prescribed treatments, monitoring the patient, preventing complications, protecting the patient from injury, and providing comfort. Offering brief explanations to the patient

about what is happening is essential even if there is no certainty that the patient hears or understands what is being said. Simple comfort measures, including reassuring touches, should continue to be provided despite the patient's nonresponsiveness to verbal stimuli (Benner, 2004, Duran, et al., 2007).

As it becomes obvious that the patient is unlikely to survive, the family must be informed about the prognosis and likely outcome. Opportunities should be provided throughout the patient's care for the family to see, touch, and talk to the patient. Close family friends or spiritual advisors may be of comfort to the family members in dealing with the inevitable death of their loved one. Whenever possible and appropriate, the patient's family should be approached regarding any living wills, advance directives, or other written or verbal wishes the patient may have shared in the event that he or she became unable to participate in end-of-life decisions. In some cases, ethics committees may assist families and health care teams in making difficult decisions.

During this stage of shock, the family may misinterpret the actions of the health care team. They have been told that nothing has been effective in reversing the shock and that the patient's survival is very unlikely, yet they find physicians and nurses continuing to work feverishly on the patient. Distraught, grieving families may interpret this as a chance for recovery when none exists, and family members may become angry when the patient dies. Conferences with all members of the health care team and the family promote better understanding by the family of the patient's prognosis and the purpose for management measures. During these conferences, it is essential to explain that the equipment and treatments being provided are intended for patient comfort and do not suggest that the patient will recover. Family members should be encouraged to express their wishes concerning the use of life-support measures.

## General Management Strategies in Shock

As described previously and in the discussion of types of shock to follow, management in all types and all phases of shock includes the following:

- Support of the respiratory system with supplemental oxygen and/or mechanical ventilation to provide optimal oxygenation (see Chapter 25)
- Fluid replacement to restore intravascular volume
- Vasoactive medications to restore vasomotor tone and improve cardiac function
- Nutritional support to address the metabolic requirements that are often dramatically increased in shock

Therapies described in this section require collaboration among all members of the health care team to ensure that the manifestations of shock are quickly identified and that adequate and timely treatment is instituted to achieve the best outcome possible.

### Fluid Replacement

Fluid replacement, also referred to as fluid resuscitation, is administered in all types of shock. The type of fluids administered and the speed of delivery vary, but fluids are administered to improve cardiac and tissue oxygenation, which in part depends on flow. The fluids administered may include **crystalloids** (electrolyte solutions that move freely between intravascular and interstitial spaces), **colloids** (large-molecule IV solutions), and blood components (packed red blood cells, fresh frozen plasma, and platelets).

#### *Crystalloid and Colloid Solutions*

The best fluid to treat shock remains controversial. In emergencies, the "best" fluid is often the fluid that is readily available. Fluid resuscitation should be initiated early in shock to maximize intravascular volume. There is no consensus regarding whether crystalloids or colloids should be used; however, with crystalloids, more fluid is necessary to restore intravascular volume (Roberts, Alderson, Bunn, et al., 2007).

Crystalloids are electrolyte solutions that move freely between the intravascular compartment and the interstitial spaces. Isotonic crystalloid solutions are often selected because they contain the same concentration of electrolytes as the extracellular fluid and therefore can be given without altering the concentrations of electrolytes in the plasma. IV crystalloids commonly used for resuscitation in hypovolemic shock include 0.9% sodium chloride solution (normal saline) and lactated Ringer's solution (Boswell & Scalea, 2008; Cottingham, 2006). Ringer's lactate is an electrolyte solution containing the lactate ion, which should not be confused with lactic acid. The lactate ion is converted to bicarbonate, which helps buffer the overall acidosis that occurs in shock. A disadvantage of using isotonic crystalloid solutions is that some of the volume administered is lost to the interstitial compartment and some remains in the intravascular compartment. This occurs as a consequence of cellular permeability that occurs during shock. Diffusion of crystalloids into the interstitial space means that more fluid must be administered than the amount lost (Cottingham, 2006; Roberts, et al., 2007).

Care must be taken when rapidly administering isotonic crystalloids to avoid both underresuscitating and overresuscitating the patient in shock. Insufficient fluid replacement is associated with a higher incidence of morbidity and mortality from lack of tissue perfusion, whereas excessive fluid administration can cause systemic and pulmonary edema that progresses to ARDS, abdominal compartment syndrome, and multiple organ dysfunction syndrome (MODS).

Depending on the cause of the hypovolemia, a hypertonic crystalloid solution, such as 3% sodium chloride, is sometimes administered in hypovolemic shock. These solutions exert a large osmotic force that pulls fluid from the intracellular space to the extracellular space to achieve a fluid balance (Cottingham, 2006). This osmotic effect results in fewer fluids being administered to restore intravascular volume. Complications associated with use of hypertonic solutions include excessive serum osmolality, which can cause rapid fluid shifts overwhelming the heart, and hypernatremia.

Generally, IV colloidal solutions are similar to plasma proteins, in that they contain molecules that are too large to pass through capillary membranes. Colloids expand intravascular volume by exerting oncotic pressure, thereby pulling fluid into the intravascular space. Colloidal solutions

have the same effect as hypertonic solutions in increasing intravascular volume, but less volume of fluid is required than with crystalloids. In addition, colloids have a longer duration of action than crystalloids, because the molecules remain within the intravascular compartment longer.

Typically, if colloids are used to treat tissue hypoperfusion, albumin is the agent prescribed. Albumin is a plasma protein; an albumin solution is prepared from human plasma and is heated during production to reduce its potential to transmit disease. The disadvantage of albumin is its high cost compared to crystalloid solutions. Synthetic colloid preparations, such as hetastarch and dextran solution, may also be used for colloid infusions; however, dextran may interfere with platelet aggregation and, therefore, is not indicated if hemorrhage is the cause of the hypovolemic shock or if the patient has a coagulation disorder.

*NURSING ALERT*

**With all colloidal solutions, side effects include the rare occurrence of anaphylactic reactions. Nurses must monitor patients closely.**

### *Complications of Fluid Administration*

Close monitoring of the patient during fluid replacement is necessary to identify side effects and complications. The most common and serious side effects of fluid replacement are cardiovascular overload and pulmonary edema. The patient receiving fluid replacement must be monitored frequently for adequate urinary output, changes in mental status, skin perfusion, and changes in vital signs. Lung sounds are auscultated frequently to detect signs of fluid accumulation. Adventitious lung sounds, such as crackles, may indicate pulmonary edema.

Abdominal compartment syndrome (ACS) is a serious complication that may occur when large volumes of fluid are administered. It may also occur after trauma, abdominal surgery, severe pancreatitis, or sepsis (Brush, 2007). In ACS, fluid leaks into the intra-abdominal cavity, increasing pressure that is displaced onto surrounding vessels and organs. Venous return, preload, and cardiac output are compromised. The pressure also elevates the diaphragm, making it difficult to breathe effectively. The renal system and GI systems also begin to show signs of dysfunction (eg, decreased urine output, absent bowel sounds, intolerance of tube feeding). Abdominal compartment pressure can be measured. Normally, it is 0 to 5 mm Hg, and a pressure of 12 mm Hg is considered to be indicative of intra-abdominal hypertension (Brush, 2007). If ACS is present, interventions that usually include surgical decompression are necessary to relieve the pressure.

*NURSING ALERT*

**When administering large volumes of crystalloid solutions, monitor the lungs for adventitious sounds and signs and symptoms of interstitial edema (eg, abdominal compartment syndrome).**

Often a right atrial pressure line (also known as a central venous pressure [CVP] line) is inserted. In addition to physical assessment, the right atrial pressure value helps in monitoring the patient's response to fluid replacement. A normal right atrial pressure value or CVP is 4 to 12 mm Hg or cm $H_2O$. Several readings are obtained to determine a range, and fluid replacement is continued to achieve a CVP of at least 8 mm Hg (Dellinger, et al., 2008). With newer technologies, right atrial catheters can be placed that allow the monitoring of intravascular pressures and venous oxygen levels. Assessment of venous oxygenation (venous oxygen saturation ([$SvO_2$], or $Sc\bar{v}O_2$ with a CVP line) is helpful in evaluating the adequacy of intravascular volume (Goodrich, 2006; Rivers, et al., 2005). Hemodynamic monitoring with arterial and pulmonary artery lines may be implemented to allow close monitoring of the patient's perfusion and cardiac status as well as response to therapy. For additional information about hemodynamic monitoring, see Chapter 26.

## Vasoactive Medication Therapy

Vasoactive medications are administered in all forms of shock to improve the patient's hemodynamic stability when fluid therapy alone cannot maintain adequate MAP. Specific medications are selected to correct the particular hemodynamic alteration that is impeding cardiac output. These medications help increase the strength of myocardial contractility, regulate the heart rate, reduce myocardial resistance, and initiate vasoconstriction.

Vasoactive medications are selected for their action on receptors of the sympathetic nervous system. These receptors are known as alpha-adrenergic and beta-adrenergic receptors. Beta-adrenergic receptors are further classified as beta-1 and beta-2 adrenergic receptors. When alpha-adrenergic receptors are stimulated, blood vessels constrict in the cardiorespiratory and GI systems, skin, and kidneys. When beta-1 adrenergic receptors are stimulated, heart rate and myocardial contraction increase. When beta-2 adrenergic receptors are stimulated, vasodilation occurs in the heart and skeletal muscles, and the bronchioles relax. The medications used in treating shock consist of various combinations of vasoactive medications to maximize tissue perfusion by stimulating or blocking the alpha- and beta-adrenergic receptors.

When vasoactive medications are administered, vital signs must be monitored frequently (at least every 15 minutes until stable, or more often if indicated). Vasoactive medications should be administered through a central venous line, because infiltration and extravasation of some vasoactive medications can cause tissue necrosis and sloughing. An IV pump or controller should be used to ensure that the medications are delivered safely and accurately.

Individual medication dosages are usually titrated by the nurse, who adjusts drip rates based on the prescribed dose and the patient's response. Dosages are changed to maintain the MAP at a physiologic level that ensures adequate tissue perfusion (usually greater than 65 mm Hg).

*NURSING ALERT*

**Vasoactive medications should never be stopped abruptly, because this could cause severe hemodynamic instability, perpetuating the shock state.**

Dosages of vasoactive medications should be tapered, and the patient should be weaned from medication with frequent monitoring of BP (every 15 minutes). Table 15-2 presents some of the commonly prescribed vasoactive medications used in the treatment of shock. Occasionally, the patient does not respond as expected to vasoactive medications. A current topic of active research is evaluation of patients' adrenal function. Recent studies suggest that critically ill patients should be evaluated for corticosteroid insufficiency, and if this condition is present, corticosteroid replacement (eg, hydrocortisone) should be initiated (Dellinger, et al., 2008).

### Nutritional Support

Nutritional support is an important aspect of care for patients with shock. Increased metabolic rates during shock increase energy requirements and therefore caloric requirements. Patients in shock may require more than 3000 calories daily. The release of catecholamines early in the shock continuum causes depletion of glycogen stores in about 8 to 10 hours. Nutritional energy requirements are then met by breaking down lean body mass. In this catabolic process, skeletal muscle mass is broken down even when the patient has large stores of fat or adipose tissue. Loss of skeletal muscle greatly prolongs the patient's recovery time.

Parenteral or enteral nutritional support should be initiated as soon as possible. Enteral nutrition is preferred, promoting GI function through direct exposure to nutrients and limiting infectious complications associated with parenteral feeding (Vincent, 2007). In addition, glutamine (an essential amino acid during stress), which may be administered in enteral formulas, is important in the immunologic function of the GI tract, providing a fuel source for lymphocytes and macrophages (Stapleton, et al., 2007).

Stress ulcers occur frequently in acutely ill patients because of the compromised blood supply to the GI tract. Therefore, antacids, $H_2$ blockers (eg, famotidine [Pepcid], ranitidine [Zantac]), and proton pump inhibitors (eg, lansoprazole [Prevacid]) are prescribed to prevent ulcer formation by inhibiting gastric acid secretion or increasing gastric pH.

## Hypovolemic Shock

Nurses who care for patients in the different stages of shock must tailor interventions to the type of shock, whether hypovolemic, cardiogenic, or circulatory shock. **Hypovolemic shock**, the most common type of shock, is characterized by decreased intravascular volume. Body fluid is contained in the intracellular and extracellular compartments. Intracellular fluid accounts for about two thirds of the total body water. The extracellular body fluid is found in one of two compartments: intravascular (inside blood vessels) or interstitial (surrounding tissues). The volume of interstitial fluid is about three to four times that of intravascular fluid. Hypovolemic shock occurs when there is a reduction in intravascular volume by 15% to 30%, which represents a loss of 750 to 1500 mL of blood in a 70-kg (154-lb) person (American College of Surgeons, 2006).

### Pathophysiology

Hypovolemic shock can be caused by external fluid losses, as in traumatic blood loss, or by internal fluid shifts, as in severe dehydration, severe edema, or ascites (Chart 15-2). Intravascular volume can be reduced both by fluid loss and by fluid shifting between the intravascular and interstitial compartments.

The sequence of events in hypovolemic shock begins with a decrease in the intravascular volume. This results in decreased venous return of blood to the heart and subsequent decreased ventricular filling. Decreased ventricular filling results in decreased stroke volume (amount of blood ejected from the heart) and decreased cardiac output. When cardiac output drops, BP drops and tissues cannot be adequately perfused (Fig. 15-3).

**Table 15-2 VASOACTIVE AGENTS USED IN TREATING SHOCK**

| Medication | Desired Action in Shock | Disadvantages |
|---|---|---|
| **Inotropic Agents** | | |
| Dobutamine (Dobutrex)<br>Dopamine (Intropin)<br>Epinephrine (Adrenalin)<br>Milrinone (Primacor) | Improve contractility, increase stroke volume, increase cardiac output | Increase oxygen demand of the heart |
| **Vasodilators** | | |
| Nitroglycerin (Tridil)<br>Nitroprusside (Nipride) | Reduce preload and afterload, reduce oxygen demand of heart | Cause hypotension |
| **Vasopressor Agents** | | |
| Norepinephrine (Levophed)<br>Dopamine (Intropin)<br>Phenylephrine (Neo-Synephrine)<br>Vasopressin (Pitressin) | Increase blood pressure by vasoconstriction | Increase afterload, thereby increasing cardiac workload; compromise perfusion to skin, kidneys, lungs, gastrointestinal tract |

**CHART 15-2** ***Risk Factors for Hypovolemic Shock***

| External: Fluid Losses | Internal: Fluid Shifts |
|---|---|
| • Trauma | • Hemorrhage |
| • Surgery | • Burns |
| • Vomiting | • Ascites |
| • Diarrhea | • Peritonitis |
| • Diuresis | • Dehydration |
| • Diabetes insipidus | |

## Medical Management

Major goals in the treatment of hypovolemic shock are to restore intravascular volume to reverse the sequence of events leading to inadequate tissue perfusion, to redistribute fluid volume, and to correct the underlying cause of the fluid loss as quickly as possible. Depending on the severity of shock and the patient's condition, it is likely that efforts will be made to address all three goals simultaneously.

### *Treatment of the Underlying Cause*

If the patient is hemorrhaging, efforts are made to stop the bleeding. This may involve applying pressure to the bleeding site or surgical interventions to stop internal bleeding. If the cause of the hypovolemia is diarrhea or vomiting, medications to treat diarrhea and vomiting are administered while efforts are made to identify and treat the cause.

**Physiology ■■■ Pathophysiology**

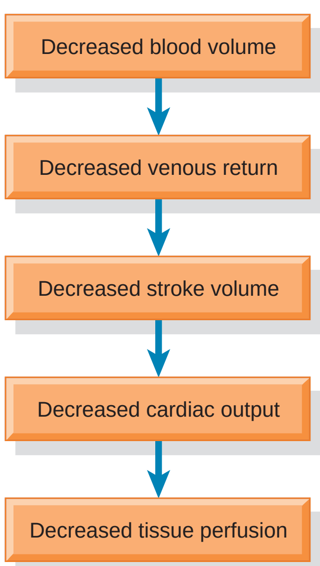



**Figure 15-3** Pathophysiologic sequence of events in hypovolemic shock.

In elderly patients, dehydration may be the cause of hypovolemic shock.

### *Fluid and Blood Replacement*

Beyond reversing the primary cause of the decreased intravascular volume, fluid replacement is of primary concern. At least two large-gauge IV lines are inserted to establish access for fluid administration. Two IV lines allow simultaneous administration of fluid, medications, and blood component therapy if required. Because the goal of the fluid replacement is to restore intravascular volume, it is necessary to administer fluids that will remain in the intravascular compartment to avoid fluid shifts from the intravascular compartment into the intracellular compartment. Table 15-3 summarizes the fluids commonly used in the treatment of shock.

As discussed earlier, crystalloid solutions such as lactated Ringer's solution or 0.9% sodium chloride solution are commonly used to treat hypovolemic shock as large amounts of fluid must be administered to restore intravascular volume. If hypovolemia is primarily due to blood loss, the American College of Surgeons recommends administration of 3 mL of crystalloid solution for each milliliter of estimated blood loss. This is referred to as the 3:1 rule (American College of Surgeons, 2006). Colloid solutions (eg, albumin, hetastarch) may also be used. Dextran is not indicated if the cause of the hypovolemic shock is hemorrhage, because it interferes with platelet aggregation.

Blood products, which are also colloids, may need to be administered, particularly if the cause of the hypovolemic shock is hemorrhage. The decision to give blood is based on the patient's lack of response to only crystalloid resuscitation, the volume of blood lost, the need for hemoglobin to assist with oxygen transport, and the necessity to correct the patient's coagulopathy. It should be noted that research indicates that patients who receive massive blood transfusions to achieve near-normal hemoglobin levels tend to have poorer outcomes than those with low hemoglobin levels (eg, less than 7.0 g/dL) (Dellinger, et al., 2008; Holcomb & Hess, 2006). Packed red blood cells are administered to replenish the patient's oxygen-carrying capacity in conjunction with other fluids that will expand volume. Currently, the need for transfusions is based on the patient's oxygenation needs, which are determined by vital signs, blood gas values, and clinical appearance rather than an arbitrary laboratory value. An area of active research is the development of synthetic forms of blood (ie, compounds capable of carrying oxygen in the same way that blood does) as potential alternatives to blood component therapy.

### *Redistribution of Fluid*

In addition to administering fluids to restore intravascular volume, positioning the patient properly assists fluid redistribution. A modified Trendelenburg position (Fig. 15-4) is recommended in hypovolemic shock. Elevation of the legs promotes the return of venous blood. A full Trendelenburg position makes breathing difficult and does not increase BP or cardiac output (Bridges & Jarquin-Valdivia, 2005).

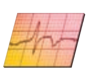
**Table 15-3 FLUID REPLACEMENT IN SHOCK**

Deliver a minimum of 20 mL/kg of crystalloid (or colloid equivalent).

| Fluids | Advantages | Disadvantages |
|---|---|---|
| **Crystalloids** | | |
| 0.9% sodium chloride (normal saline solution) | Widely available, inexpensive | Requires large volume of infusion; can cause hypernatremia, pulmonary edema, abdominal compartment syndrome |
| Lactated Ringer's | Lactate ion helps buffer metabolic acidosis | Requires large volume of infusion; can cause metabolic acidosis, pulmonary edema, abdominal compartment syndrome |
| Hypertonic saline (3%) | Small volume needed to restore intravascular volume | Danger of hypernatremia and cardiovascular compromise from rapid fluid shifts |
| **Colloids** | | |
| Albumin (5%, 25%) | Rapidly expands plasma volume | Expensive; requires human donors; limited supply; can cause heart failure |
| Dextran | Synthetic plasma expander | Interferes with platelet aggregation; not recommended for hemorrhagic shock |
| Hetastarch | Synthetic plasma expander | Prolongs bleeding and clotting times |

### *Pharmacologic Therapy*

If fluid administration fails to reverse hypovolemic shock, then vasoactive medications that prevent cardiac failure are given. Medications are also administered to reverse the cause of the dehydration. For example, insulin is administered if dehydration is secondary to hyperglycemia, desmopressin (DDAVP) is administered for diabetes insipidus, antidiarrheal agents for diarrhea, and antiemetic medications for vomiting.



## Nursing Management

Primary prevention of shock is an essential focus of nursing care. Hypovolemic shock can be prevented in some instances by closely monitoring patients who are at risk for fluid deficits and assisting with fluid replacement before intravascular volume is depleted. In other circumstances, nursing care focuses on assisting with treatment targeted at the cause of the shock and restoring intravascular volume.

General nursing measures include ensuring safe administration of prescribed fluids and medications and documenting their administration and effects. Another important nursing role is monitoring for complications and side effects of treatment and reporting them promptly.

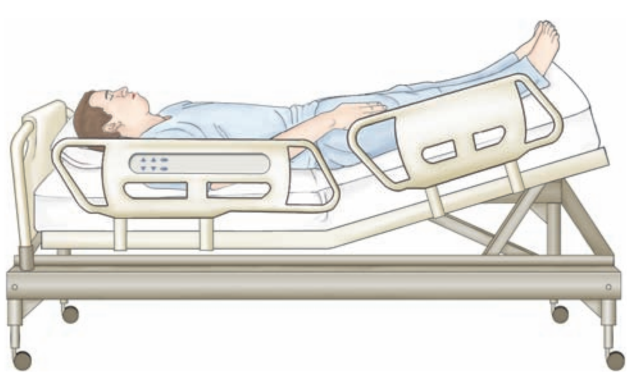


**Figure 15-4** Proper positioning (modified Trendelenburg) for the patient who shows signs of shock. The lower extremities are elevated to an angle of about 20 degrees; the knees are straight, the trunk is horizontal, and the head is slightly elevated.

### *Administering Blood and Fluids Safely*

Administering blood transfusions safely is a vital nursing role. In emergency situations, it is important to acquire blood specimens quickly, to obtain a baseline complete blood count, and to type and cross-match the blood in anticipation of blood transfusions. A patient who receives a transfusion of blood products must be monitored closely for adverse effects (see Chapter 33).

Fluid replacement complications can occur, often when large volumes are administered rapidly. Therefore, the nurse monitors the patient closely for cardiovascular overload, signs of difficulty breathing, and pulmonary edema. The risk of these complications is increased in the elderly and in patients with preexisting cardiac disease. Hemodynamic pressures, vital signs, arterial blood gases, serum lactate levels, hemoglobin and hematocrit levels, and fluid intake and output (I&O) are among the parameters monitored. Temperature should also be monitored closely to ensure that rapid fluid resuscitation does not cause hypothermia. IV fluids may need to be warmed during the administration of large volumes. Physical assessment focuses on observing the jugular veins for distention and monitoring jugular venous pressure. Jugular venous pressure is low in hypovolemic shock; it increases with effective treatment and is significantly increased with fluid overload and heart failure. The nurse must monitor cardiac and respiratory status closely and report changes in BP, pulse pressure, CVP, heart rate and rhythm, and lung sounds to the physician.

### Implementing Other Measures

Oxygen is administered to increase the amount of oxygen carried by available hemoglobin in the blood. A patient who is confused may feel apprehensive with an oxygen mask or cannula in place, and frequent explanations about the need for the mask may reduce some of the patient's fear and anxiety. Simultaneously, the nurse must direct efforts to the safety and comfort of the patient.

# Cardiogenic Shock

**Cardiogenic shock** occurs when the heart's ability to contract and to pump blood is impaired and the supply of oxygen is inadequate for the heart and tissues. The causes of cardiogenic shock are known as either coronary or noncoronary. Coronary cardiogenic shock is more common than noncoronary cardiogenic shock and is seen most often in patients with acute myocardial infarction (MI) resulting in damage to a significant portion of the left ventricular myocardium (Aymong, Ramanathan & Buller, 2007). Patients who experience an anterior wall MI are at greatest risk for cardiogenic shock because of the potentially extensive damage to the left ventricle caused by occlusion of the left anterior descending coronary artery. Noncoronary causes of cardiogenic shock are related to conditions that stress the myocardium (eg, severe hypoxemia, acidosis, hypoglycemia, hypocalcemia, and tension pneumothorax) as well as conditions that result in ineffective myocardial function (eg, cardiomyopathies, valvular damage, cardiac tamponade, dysrhythmias).

## Pathophysiology

In cardiogenic shock, cardiac output, which is a function of both stroke volume and heart rate, is compromised. When stroke volume and heart rate decrease or become erratic, BP falls and tissue perfusion is reduced. Blood supply for tissues and organs and for the heart muscle itself is inadequate, resulting in impaired tissue perfusion. Because impaired tissue perfusion weakens the heart and impairs its ability to pump, the ventricle does not fully eject its volume of blood at systole. As a result, fluid accumulates in the lungs. This sequence of events can occur rapidly or over a period of days (Fig. 15-5).

**Physiology ■■■ Pathophysiology**

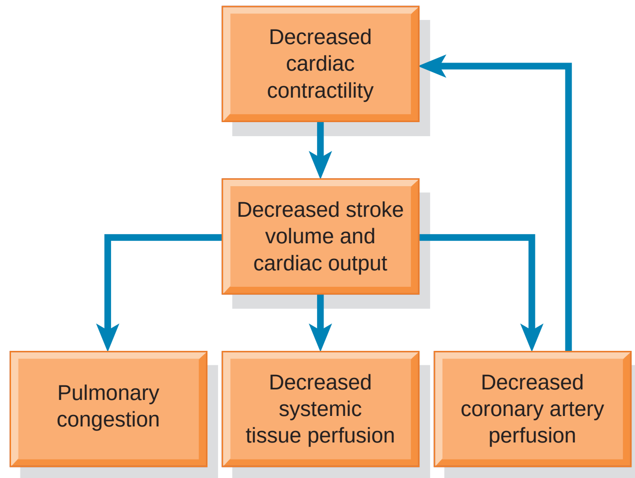



**Figure 15-5** Pathophysiologic sequence of events in cardiogenic shock.

## Clinical Manifestations

Patients in cardiogenic shock may experience the pain of angina, develop dysrhythmias, complain of fatigue, express feelings of doom, and show signs of hemodynamic instability.

## Medical Management

The goals of medical management in cardiogenic shock are to limit further myocardial damage and preserve the healthy myocardium and to improve the cardiac function by increasing cardiac contractility, decreasing ventricular afterload, or both (Aymong, et al., 2007; Iakobishvili & Hasdai, 2007; Mann & Nolan, 2006). In general, these goals are achieved by increasing oxygen supply to the heart muscle while reducing oxygen demands.

### Correction of Underlying Causes

As with all forms of shock, the underlying cause of cardiogenic shock must be corrected. It is necessary first to treat the oxygenation needs of the heart muscle to ensure its continued ability to pump blood to other organs. In the case of coronary cardiogenic shock, the patient may require thrombolytic therapy, a percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) surgery, intra-aortic balloon pump therapy, or some combination of these treatments. In the case of noncoronary cardiogenic shock, interventions focus on correcting the underlying cause, such as replacement of a faulty cardiac valve, correction of a dysrhythmia, correction of acidosis and electrolyte disturbances, or treatment of the tension pneumothorax.

### Initiation of First-Line Treatment

#### Oxygenation

In the early stages of shock, supplemental oxygen is administered by nasal cannula at a rate of 2 to 6 L/min to achieve an oxygen saturation exceeding 90%. Monitoring of arterial blood gas values and pulse oximetry values helps determine whether the patient requires a more aggressive method of oxygen delivery.

#### Pain Control

If a patient experiences chest pain, IV morphine is administered for pain relief. In addition to relieving pain, morphine dilates the blood vessels. This reduces the workload of the heart by both decreasing the cardiac filling pressure (preload) and reducing the pressure against which the heart muscle has to eject blood (afterload). Morphine also decreases the patient's anxiety.

#### Hemodynamic Monitoring

Hemodynamic monitoring is initiated to assess the patient's response to treatment. In many institutions, this is performed in the intensive care unit (ICU), where an arterial line can be inserted. The arterial line enables accurate and

continuous monitoring of BP and provides a port from which to obtain frequent arterial blood samples without having to perform repeated arterial punctures. A multilumen pulmonary artery catheter is inserted to allow measurement of the pulmonary artery pressures, myocardial filling pressures, cardiac output, and pulmonary and systemic resistance. For more information, see Chapter 30.

### Laboratory Marker Monitoring

Laboratory markers for ventricular dysfunction (eg, BNP) and cardiac enzyme levels (CK-MB and cTn-I) are measured, and serial 12-lead ECGs are obtained to assess the degree of myocardial damage. Continuous ECG and ST-segment monitoring is also used to closely monitor the patient for ischemic changes.

### Fluid Therapy

Appropriate fluid administration is also necessary in the treatment of cardiogenic shock. Administration of fluids must be monitored closely to detect signs of fluid overload. Incremental IV fluid boluses are cautiously administered to determine optimal filling pressures for improving cardiac output.

**NURSING ALERT**

**A fluid bolus should never be given rapidly, because rapid fluid administration in patients with cardiac failure may result in acute pulmonary edema.**

### Pharmacologic Therapy

Vasoactive medication therapy consists of multiple pharmacologic strategies to restore and maintain adequate cardiac output. In coronary cardiogenic shock, the aims of vasoactive medication therapy are improved cardiac contractility, decreased preload and afterload, and stabilized heart rate and rhythm.

Because improving contractility and decreasing cardiac workload are opposing pharmacologic actions, two types of medications may be administered in combination: inotropic agents and vasodilators. Inotropic medications increase cardiac output by mimicking the action of the sympathetic nervous system, activating myocardial receptors to increase myocardial contractility (inotropic action) or increasing the heart rate (chronotropic action). These agents may also enhance vascular tone, increasing preload. Vasodilators are used primarily to decrease afterload, reducing the workload of the heart and the oxygen demand. Vasodilators also decrease preload. Medications commonly combined to treat cardiogenic shock include dobutamine, nitroglycerin, and dopamine (see Table 15-2).

***Dobutamine.*** Dobutamine produces inotropic effects by stimulating myocardial beta-receptors, increasing the strength of myocardial activity and improving cardiac output. Myocardial alpha-adrenergic receptors are also stimulated, resulting in decreased pulmonary and systemic vascular resistance (decreased afterload). Dobutamine enhances the strength of cardiac contraction, improving stroke volume ejection and overall cardiac output (Iakobishvili & Hasdai, 2007; Mann & Nolan, 2006).

***Nitroglycerin.*** IV nitroglycerin in low doses acts as a venous vasodilator and therefore reduces preload. At higher doses, nitroglycerin causes arterial vasodilation and therefore reduces afterload as well. These actions, in combination with dobutamine, increase cardiac output while minimizing cardiac workload. In addition, vasodilation enhances blood flow to the myocardium, improving oxygen delivery to the weakened heart muscle (Iakobishvili & Hasdai, 2007).

***Dopamine.*** Dopamine is a sympathomimetic agent that has varying vasoactive effects depending on the dosage. It may be used with dobutamine and nitroglycerin to improve tissue perfusion. Doses of 2 to 8 μg/kg/min improve contractility (inotropic action), slightly increase the heart rate (chronotropic action), and may increase cardiac output. Doses that are higher than 8 μg/kg/min predominantly cause vasoconstriction, which increases afterload and thus increases cardiac workload. Because this effect is undesirable in patients with cardiogenic shock, dopamine doses must be carefully titrated.

Low-dose dopamine (ie, 0.5 to 3.0 μg/kg/min) neither improves renal flow, changes the need for renal support, nor reduces mortality (Freidrich, Adhikari, Herridge, et al., 2005; Iakobishvili & Hasdai, 2007). Thus, low-dose dopamine is no longer recommended. However, some patients respond to lower dosages of dopamine for its inotropic effects (Friedrich, et al., 2005).

In severe metabolic acidosis, which occurs in the later stages of shock, the effectiveness of dopamine is diminished. To maximize the effectiveness of any vasoactive agent, metabolic acidosis must first be corrected (Dellinger, et al., 2008).

***Other Vasoactive Medications.*** Additional vasoactive agents that may be used in managing cardiogenic shock include norepinephrine, epinephrine, milrinone, vasopressin, and phenylephrine. Each of these medications stimulates different receptors of the sympathetic nervous system. A combination of these medications may be prescribed, depending on the patient's response to treatment. All vasoactive medications have adverse effects, making specific medications more useful than others at different stages of shock. Diuretics such as furosemide may be administered to reduce the workload of the heart by reducing fluid accumulation (see Table 15-2).

***Antiarrhythmic Medications.*** Multiple factors, such as hypoxemia, electrolyte imbalances, and acid–base imbalances, contribute to serious cardiac dysrhythmias in all patients with shock. In addition, as a compensatory response to decreased cardiac output and BP, the heart rate increases beyond normal limits. This impedes cardiac output further by shortening diastole and thereby decreasing the time for ventricular filling. Consequently, antiarrhythmic medications are required to stabilize the heart rate. For a full discussion of cardiac dysrhythmias as well as commonly prescribed medications, see Chapter 27. General principles regarding the administration of vasoactive medications are discussed later in this chapter.

### Mechanical Assistive Devices

If cardiac output does not improve despite supplemental oxygen, vasoactive medications, and fluid boluses, mechanical assistive devices are used temporarily to improve the heart's ability to pump. Intra-aortic balloon counterpulsation is one means of providing temporary circulatory

assistance (see Chapter 30). Other means of mechanical assistance include left and right ventricular assist devices (VADs) and total temporary artificial hearts (see Chapters 29 and 30). VADs are utilized frequently as bridge therapy to either recovery or heart transplantation. Another short-term means of providing cardiac or pulmonary support to the patient in cardiogenic shock is through an extracorporeal device similar to the cardiopulmonary bypass (CPB) system used in open-heart surgery (see Chapter 28). CPB is used only in emergency situations until definitive treatment, such as heart transplantation, can be initiated.

## Nursing Management

### Preventing Cardiogenic Shock

Identifying at-risk patients early, promoting adequate oxygenation of the heart muscle, and decreasing cardiac workload can prevent cardiogenic shock. This can be accomplished by conserving the patient's energy, promptly relieving angina, and administering supplemental oxygen. Often, however, cardiogenic shock cannot be prevented. In such instances, nursing management includes working with other members of the health care team to prevent shock from progressing and to restore adequate cardiac function and tissue perfusion.

### Monitoring Hemodynamic Status

A major role of the nurse is monitoring the patient's hemodynamic and cardiac status. Arterial lines and ECG monitoring equipment must be well maintained and functioning properly. The nurse anticipates the medications, IV fluids, and equipment that might be used and is ready to assist in implementing these measures. Changes in hemodynamic, cardiac, and pulmonary status and laboratory values are documented and reported promptly. In addition, adventitious breath sounds, changes in cardiac rhythm, and other abnormal physical assessment findings are reported immediately.

### Administering Medications and Intravenous Fluids

The nurse plays a critical role in the safe and accurate administration of IV fluids and medications. Fluid overload and pulmonary edema are risks because of ineffective cardiac function and accumulation of blood and fluid in the pulmonary tissues. The nurse documents and records medications and treatments that are administered as well as the patient's response to treatment.

The nurse must be knowledgeable about the desired effects as well as the side effects of medications. For example, it is important to monitor the patient for decreased BP after administering morphine or nitroglycerin. Patients receiving thrombolytic therapy must be monitored for bleeding. Arterial and venous puncture sites must be observed for bleeding, and pressure must be applied at the sites if bleeding occurs. Neurologic assessment is essential after the administration of thrombolytic therapy to assess for the potential complication of cerebral hemorrhage associated with this therapy. IV infusions must be observed closely because tissue necrosis and sloughing may occur if vasopressor medications infiltrate the tissues. It is necessary to monitor urine output, BUN, and serum creatinine levels to detect decreased renal function secondary to the effects of cardiogenic shock or its treatment.

### Maintaining Intra-Aortic Balloon Counterpulsation

The nurse plays a critical role in caring for the patient receiving intra-aortic balloon counterpulsation (see Chapter 30). The nurse makes ongoing timing adjustments of the balloon pump to maximize its effectiveness by synchronizing it with the cardiac cycle. The patient is at risk for circulatory compromise to the leg on the side where the catheter for the balloon has been inserted; therefore, the nurse must check the neurovascular status of the lower extremities frequently.

### Enhancing Safety and Comfort

Throughout care, the nurse must take an active role in safeguarding the patient, enhancing comfort, and reducing anxiety. This includes administering medication to relieve chest pain, preventing infection at the multiple arterial and venous line insertion sites, protecting the skin, and monitoring respiratory and renal function. Proper positioning of the patient promotes effective breathing without decreasing BP and may also increase patient comfort while reducing anxiety.

Brief explanations about procedures that are being performed and the use of comforting touch often provide reassurance to the patient and family. The family is usually anxious and benefits from opportunities to see and talk to the patient. Explanations of treatments and the patient's responses are often comforting to family members.

# Circulatory Shock

**Circulatory shock** occurs when blood volume pools in peripheral blood vessels. This abnormal displacement of blood volume causes a relative hypovolemia because not enough blood returns to the heart, which leads to inadequate tissue perfusion. The ability of the blood vessels to constrict helps return the blood to the heart. The vascular tone is determined both by central regulatory mechanisms, as in BP regulation, and by local regulatory mechanisms, as in tissue demands for oxygen and nutrients. Therefore, circulatory shock can be caused either by a loss of sympathetic tone or by release of biochemical mediators from cells.

The varied mechanisms leading to the initial vasodilation in circulatory shock provide the basis for the further subclassification of shock into three types: septic shock, neurogenic shock, and anaphylactic shock. These types of circulatory shock cause variations in the pathophysiologic chain of events and are explained here separately. In all types of circulatory shock, massive arterial and venous dilation promotes peripheral pooling of blood. Arterial dilation reduces systemic vascular resistance. Initially, cardiac output can be high, both from the reduction in afterload (systemic vascular resistance) and from the heart muscle's increased effort to maintain perfusion despite the incompetent vasculature. Pooling of blood in the periphery results in decreased venous return. Decreased venous return results in decreased stroke volume and decreased cardiac output. Decreased cardiac output, in turn, causes decreased BP and ultimately decreased tissue perfusion. Figure 15-6 presents the pathophysiologic sequence of events in circulatory shock.

**Physiology ■■■ Pathophysiology**

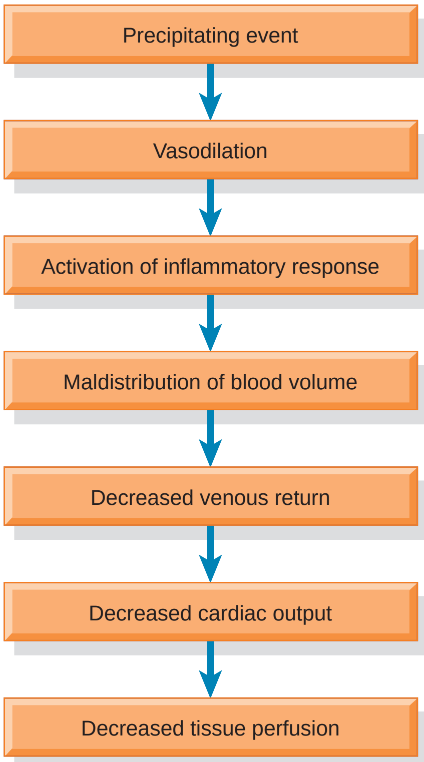



**Figure 15-6** Pathophysiologic sequence of events in circulatory shock.

## SEPTIC SHOCK

**Septic shock**, the most common type of circulatory shock, is caused by widespread infection (Chart 15-3). Despite the increased sophistication of antibiotic therapy, the incidence of septic shock has continued to rise during the past 60 years. It is the most common cause of death in noncoronary ICUs in the United States. Each year, severe sepsis affects an estimated 750,000 people in the United States. As the population ages, the rate is expected to rise to 1 million cases a year by 2010 (Surviving Sepsis Campaign, 2007). Finding and aggressively treating the source of infection and quickly restoring tissue perfusion are important interventions that may positively influence the clinical outcome.

Health care–associated infections (infections not incubating at the time of admission to the health care setting) in critically ill patients that may progress to septic shock most frequently originate (in decreasing order of frequency) in the bloodstream (bacteremia), lungs, and urinary tract (urosepsis) (Arugon & Sole, 2006). Other infections include intra-abdominal infections and wound infections. Of increasing concern are bacteremias associated with intravascular catheters and indwelling urinary catheters (Aragon & Sole, 2006; Institute for Healthcare Improvement [IHI], 2007).

Additional risk factors that contribute to the growing incidence of septic shock are the increased use of invasive procedures and indwelling medical devices; the increased number of antibiotic-resistant microorganisms; and the increasingly older population (Aragon & Sole, 2006; King, 2007). Elderly patients are at particular risk for sepsis because of decreased physiologic reserves and an aging immune system (Marik, 2006). Other patients at risk are those undergoing surgical and other invasive procedures; those with malnutrition or immunosuppression; and those with chronic illness such as diabetes mellitus, hepatitis, chronic renal failure, and immunodeficiency disorders (Aragon & Sole, 2006; King, 2007).

The incidence of septic shock can be reduced by using strict infection control practices, beginning with thorough hand-hygiene techniques (Aragon & Sole, 2006). Other interventions include implementing programs to prevent central line infection; early débriding of wounds to remove necrotic tissue; carrying out standard precautions and adhering to infection control practices, including the use of meticulous aseptic technique; and properly cleaning and maintaining equipment.

A significant body of research has been conducted in the past decade in an effort aimed at reducing the morbidity and mortality caused by septic shock and at clarifying the understanding of sepsis and related disorders (Chart 15-4). In 1991, 2003, and again in early 2008, critical care experts and infectious disease experts systematically reevaluated the body of research and provided evidence-based recommendations for the acute management of patients with sepsis and septic shock (Dellinger, et al., 2008; Vincent & Abraham, 2006).

### Pathophysiology

Gram-negative bacteria traditionally have been the most commonly implicated microorganisms in septic shock. However, there is also an increased incidence of gram-positive bacterial infections, and gram-positive bacteria currently account for 50% of cases of septic shock (Smith & McInnis, 2007). Other infectious agents, such as viruses and fungi, also can cause septic shock. However, it is estimated that 20% to 30% of patients with severe sepsis may never have an identifiable site of infection (King, 2007).

When microorganisms invade body tissues, patients exhibit an immune response. This immune response provokes the activation of biochemical cytokines and mediators associated with an inflammatory response and produces a

**CHART 15-3** *Risk Factors for Circulatory Shock*

**Septic Shock**
- Immunosuppression
- Extremes of age (<1 yr and >65 yr)
- Malnourishment
- Chronic illness
- Invasive procedures

**Neurogenic Shock**
- Spinal cord injury
- Spinal anesthesia
- Depressant action of medications
- Glucose deficiency

**Anaphylactic Shock**
- Penicillin sensitivity
- Transfusion reaction
- Bee sting allergy
- Latex sensitivity
- Severe allergy to some foods or medications

## Chart 15-4 • *Definitions to Promote Recognition and Earlier Treatment of Patients With Sepsis*

Bacteremia: the presence of bacteria in the blood

Infection: the presence of microorganisms that trigger an inflammatory response

Hypotension: a systolic blood pressure $<$90 mm Hg or a drop in systolic blood pressure of $\geq$40 mm Hg from the patient's baseline blood pressure

Systemic inflammatory response syndrome (SIRS): a syndrome resulting from a *severe clinical insult* that initiates an overwhelming inflammatory response by the body; clinical signs and symptoms may include

- Temperature $>$38°C or $<$36°C ($>$100.4°F or $<$96.8°F)
- Heart rate $>$90 bpm
- Respiratory rate $>$20 breaths/min or $PaCO_2$ $<$32 mm Hg
- WBC count $>$12,000 cells/$mm^3$, $<$4000 cells/$mm^3$, or $>$10% immature WBC (bands)

Sepsis: a systemic response to *infection;* manifested by two or more of the SIRS criteria as a consequence of documented or presumed infection

Severe sepsis: the presence of signs and symptoms of sepsis associated with organ dysfunction, hypotension, or hypoperfusion; clinical signs and symptoms include those of sepsis as well as

- Lactic acidosis
- Oliguria
- Altered level of consciousness
- Thrombocytopenia and coagulation disorders
- Altered hepatic function

Septic shock: shock associated with sepsis; characterized by symptoms of sepsis plus hypotension and hypoperfusion despite adequate fluid volume replacement

Multiple organ dysfunction syndrome (MODS): the presence of altered function of one or more organs in an acutely ill patient requiring intervention and support of the organs to achieve physiologic functioning required for homeostasis; clinical signs and symptoms may be

- Cardiovascular: hypotension and hypoperfusion
- Respiratory: hypoxemia, hypercarbia, adventitious breath sounds
- Renal: increased creatinine, decreased urine output
- Hematologic: thrombocytopenia, coagulation abnormalities
- Metabolic: lactic acidemia, metabolic acidosis
- Neurologic: altered level of consciousness
- Hepatic: elevated liver function tests, hyperbilirubinemia

From Levy, M. M., Fink, M. P., Marshall, J. C., et al. (2003). 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. *Critical Care Medicine, 31*(4), 1250–1256; and Dellinger, R. P., Levy, M. M., Carlet, J. M., et al. (2008). Surviving sepsis campaign: International guidelines for management of severe sepsis and septic shock: 2008. *Critical Care Medicine, 36*(1), 296–327.

complex cascade of physiologic events that leads to poor tissue perfusion. Increased capillary permeability, which leads to fluid seeping from the capillaries, and vasodilation are two such effects that interrupt the ability of the body to provide adequate perfusion, oxygen, and nutrients to the tissues and cells. In addition, proinflammatory and anti-inflammatory cytokines released during the inflammatory response activate the coagulation system, which begins to form clots whether or not bleeding is present. The imbalance of the inflammatory response and the clotting and fibrinolysis cascades are considered critical elements of the devastating physiologic progression that occurs in patients with severe sepsis.

Sepsis is an evolving process, with neither clearly definable clinical signs and symptoms nor predictable progression. Initial physiologic changes are subtle. In the early stage of septic shock, BP may remain within normal limits, or the patient may be hypotensive but responsive to fluids. The heart rate increases, progressing to tachycardia. Hyperthermia and fever, with warm, flushed skin and bounding pulses, is evident. The respiratory rate is elevated. Urinary output may remain at normal levels or decrease. GI status may be compromised, as evidenced by nausea, vomiting, diarrhea, or decreased bowel sounds. Signs of hypermetabolism include increased serum glucose and insulin resistance. Subtle changes in mental status, such as confusion or agitation, may be present. The lactate level is elevated because of the maldistribution of blood. Inflammatory markers such as white blood cell counts and C-reactive protein are also elevated (King, 2007).

As sepsis progresses, tissues become less perfused and acidotic, compensation begins to fail, and the patient begins to show signs of organ dysfunction. The cardiovascular system also begins to fail, the BP does not respond to fluid resuscitation and vasoactive agents, and signs of end-organ damage are evident (eg, renal failure, pulmonary failure, hepatic failure). As sepsis progresses to septic shock, the BP drops, and the skin becomes cool, pale, and mottled. Temperature may be normal or below normal. Heart and respiratory rates remain rapid. Urine production ceases, and multiple organ dysfunction progressing to death occurs.

**Systemic inflammatory response syndrome** (SIRS) presents clinically like sepsis and is part of the initial continuum of sepsis. The physiologic presentation of SIRS is similar to sepsis, except there is no identifiable source of infection (Dellinger, et al., 2008; King, 2007). SIRS stimulates an overwhelming inflammatory immunologic and hormonal response similar to that seen in septic patients. Any overwhelming insult stimulates SIRS and may progress to sepsis. Therefore, despite an absence of infection, antibiotic agents may still be administered because of the possibility of unrecognized infection. Additional therapies directed to support patients with SIRS are similar to those for sepsis. If the inflammatory process progresses, septic shock may develop.

### Medical Management

Current treatment of sepsis and septic shock involves identification and elimination of the cause of infection. Current goals are to identify and treat patients in early sepsis within 6 hours to optimize patient outcome (Otero, et al., 2006; Rivers, et al, 2005). Several screening tools can be used to help identify patients with severe sepsis. Chart 15-5 provides key elements that may help identify patients with sepsis and guide interventions in the treatment of severe sepsis and

**Chart 15-5 • *Early Identification and Treatment of Patients with Sepsis and Severe Sepsis***

Questions to ask:

Does the patient meet criteria for systemic inflammatory response syndrome (SIRS) (see Chart 15-4)?

Does the patient have signs or symptoms of infection?

- Positive blood cultures
- Currently receiving antibiotic or antifungal therapy
- Examination or chest x-ray suggestive of pneumonia
- Suspected infected wound, abdomen, urine, or other source of infection

Does the patient have signs of acute organ dysfunction?

- Cardiovascular: systolic BP $<$90 mm Hg or mean arterial pressure (MAP) $<$65 mm Hg, or drop in systolic BP $>$40 mm Hg from baseline BP
  - Is hypotension responsive to fluid resuscitation, or is vasopressor support needed?
  - Is the serum lactate $>$4 mmol/L?
- Respiratory: respiratory rate $>$20 breaths/min or $PaCO_2$ $<$32 mm Hg
  - Is increasing oxygen or mechanical ventilator support needed?
- Renal: urine output $<$0.5 mL/kg/h
- Hematologic: laboratory analysis and signs and symptoms of coagulopathies
- Metabolic: insulin resistance, metabolic acidosis, or serum lactate $>$4 mmol/L
- Hepatic: elevated liver function tests or hyperbilirubinemia
- Central nervous system: changes in level of consciousness ranging from agitation to coma

Early interventions:

- Aggressive fluid resuscitation with 20 mL/kg/h of crystalloid (or colloid equivalent)
  - Give fluids to achieve a target central venous pressure of 8 to 12 mm Hg, MAP $>$65 mm Hg, urine output $>$0.5 mL/kg/h, and an $Sc\bar{v}O_2$ $>$70%
  - Vasopressor agents are used if fluid resuscitation does not restore an effective blood pressure and cardiac output
- Obtain blood, sputum, urine, and wound cultures and administer broad-spectrum antibiotics
- Support the respiratory system with mechanical ventilation
- Transfuse with packed red blood cells when hemoglobin is $<$7 g/dL
- Provide adequate IV sedation; avoid the use of neuromuscular blockade agents when possible
- Control serum glucose $<$150 mg/dL with IV insulin therapy
- Implement interventions and medications to prevent deep vein thrombosis and stress ulcer prophylaxis
- Consider IV steroid therapy if the patient is not responding to fluid resuscitation and vasopressor therapy
- Consider administration of recombinant human activated protein C (drotrecogin alfa) in adult patients with sepsis-induced organ dysfunction with clinical assessment of high risk of death

From Dellinger, R. P., Levy, M. M., Carlet, J. M., et al. (2008). Surviving sepsis campaign: International guidelines for management of severe sepsis and septic shock: 2008. *Critical Care Medicine, 36*(1), 296–327; and Rivers, E. P., McIntyre, L., Morro, D. C., et al. (2005). Early and innovative interventions for severe sepsis and septic shock: Taking advantage of a window of opportunity. *Canadian Medical Association Journal, 173*(9), 1054–1065.

septic shock (Dellinger, et al., 2008; King, 2007; Otero, et al., 2006; Surviving Sepsis Campaign, 2007).

Rapid identification of the infectious source is also a critical element in management. Specimens of blood, sputum, urine, wound drainage, and tips of invasive catheters are collected for culture using aseptic technique. Any potential routes of infection must be identified and treated. IV lines are removed and reinserted at alternate sites. Antibiotic-coated IV central lines may be inserted to decrease the risk of invasive line-related bacteremia in high-risk patients (King, 2007). If possible, urinary catheters are removed. Any abscesses are drained, and necrotic areas are débrided.

Research efforts are focusing on better identification and early aggressive treatment of patients with sepsis, rapid and effective restoration of tissue perfusion, evaluation and treatment of the patient's immune response, and treatment of dysregulation of the coagulation system that seems to occur with severe sepsis (Remick, 2007a).

### Fluid Replacement Therapy

Fluid replacement must be instituted to correct the tissue hypoperfusion that results from the incompetent vasculature and the inflammatory response. Reestablishing tissue perfusion through aggressive fluid resuscitation is the key to management of severe sepsis and septic shock (Dellinger, et al., 2008; Otero, et al., 2006). See Chart 15-5 for a list of the treatment endpoints of fluid resuscitation.

### Pharmacologic Therapy

If the identity of the infecting organism is unknown, broad-spectrum antibiotic agents are started until culture and sensitivity reports are received (Dellinger, et al., 2008; Smith & McInnis, 2007), at which time the antibiotic agents may be changed to agents that are more specific to the infecting organism and less toxic to the patient.

Treatment of the dysregulation of the coagulation system that occurs in patients with severe sepsis and septic shock remains controversial. Nonetheless, current guidelines recommend the administration of recombinant human activated protein C (rhAPC; drotrecogin alfa [Xigris]) to patients with end-organ dysfunction and high risk of death (Dellinger, et al., 2008). In sepsis, an imbalance in proinflammatory mediators activates the coagulation cascade and deposits microthrombi that alter tissue perfusion. Drotrecogin alfa (Xigris) acts as an antithrombotic, anti-inflammatory, and profibrinolytic agent. Drotrecogin alfa acts as an anti-inflammatory cytokine, it stimulates fibrinolysis, restoring balance in the coagulation–anticoagulation homeostatic process of the body's inflammatory response to injury and infection.

Drotrecogin alfa has provided a significant breakthrough in the successful pharmacologic treatment of patients with sepsis. The medication should be administered as early as possible in the sequence of pathophysiologic events of sepsis. It is not without side effects, bleeding being the most common serious effect. Stopping the medication reduces

the risk of bleeding. The patient should be evaluated with regard to the relative risk of bleeding versus the potential benefit from the medication. Drotrecogin alfa is contraindicated in patients with active internal bleeding, recent hemorrhagic stroke, intracranial surgery, or head injury.

#### Nutritional Therapy

Aggressive nutritional supplementation is critical in the management of septic shock, because malnutrition further impairs the patient's resistance to infection. Nutritional supplementation should be initiated within the first 24 hours after ICU admission (Stapleton, et al., 2007), and continuous infusions of insulin are used to control hyperglycemia (Dellinger, et al., 2008; Vanhorebeek, et al., 2007). Enteral feedings are preferred to the parenteral route because of the increased risk of iatrogenic infection associated with IV catheters; however, enteral feedings may not be possible if decreased perfusion to the GI tract reduces peristalsis and impairs absorption.

### Nursing Management

Nurses caring for patients in any setting must keep in mind the risks of sepsis and the high mortality rate associated with sepsis, severe sepsis, and septic shock. All invasive procedures must be carried out with aseptic technique after careful hand hygiene. In addition, IV lines, arterial and venous puncture sites, surgical incisions, traumatic wounds, urinary catheters, and pressure ulcers must be monitored for signs of infection. Nurses need to identify patients who are at particular risk for sepsis and septic shock (ie, elderly and immunosuppressed patients and those with extensive trauma, burns, or diabetes), keeping in mind that these high-risk patients may not develop typical or classic signs of infection and sepsis. For example, confusion may be the first sign of infection and sepsis in elderly patients.

When caring for a patient with septic shock, the nurse collaborates with other members of the health care team to identify the site and source of sepsis and the specific organisms involved. The nurse often obtains appropriate specimens for culture and sensitivity.

Elevated body temperature (hyperthermia) is common with sepsis and raises the patient's metabolic rate and oxygen consumption. Fever is one of the body's natural mechanisms for fighting infections. Therefore, elevated temperatures may not be treated unless they reach dangerous levels (more than 40°C [104°F]) or unless the patient is uncomfortable. Efforts may be made to reduce the temperature by administering acetaminophen or applying a hypothermia blanket. During these therapies, the nurse monitors the patient closely for shivering, which increases oxygen consumption. Efforts to increase comfort are important if the patient experiences fever, chills, or shivering.

The nurse administers prescribed IV fluids and medications, including antibiotic agents and vasoactive medications, to restore vascular volume. Because of decreased perfusion, serum concentrations of antibiotic agents that are normally cleared by the kidneys and liver may increase and produce toxic effects. Therefore, the nurse monitors blood levels (antibiotic agents, BUN, creatinine, white blood cell count, hemoglobin, hematocrit, platelet levels, coagulation studies) and reports changes to the physician. As with other types of shock, the nurse monitors the patient's hemodynamic status, fluid intake and output, and nutritional status. Daily weights and close monitoring of serum albumin and prealbumin levels help determine the patient's protein requirements.

## NEUROGENIC SHOCK

In **neurogenic shock**, vasodilation occurs as a result of a loss of balance between parasympathetic and sympathetic stimulation. Sympathetic stimulation causes vascular smooth muscle to constrict, and parasympathetic stimulation causes vascular smooth muscle to relax or dilate. The patient experiences a predominant parasympathetic stimulation that causes vasodilation lasting for an extended period, leading to a relative hypovolemic state. However, blood volume is adequate, because the vasculature is dilated; the blood volume is displaced, producing a hypotensive (low BP) state. The overriding parasympathetic stimulation that occurs with neurogenic shock causes a drastic decrease in the patient's systemic vascular resistance and bradycardia. Inadequate BP results in the insufficient perfusion of tissues and cells that is common to all shock states.

Neurogenic shock can be caused by spinal cord injury, spinal anesthesia, or other nervous system damage (see Chart 15-3). It may also result from the depressant action of medications or from lack of glucose (eg, insulin reaction or shock). Neurogenic shock may have a prolonged course (spinal cord injury) or a short one (syncope or fainting). Normally, during states of stress, the sympathetic stimulation causes the BP and heart rate to increase. In neurogenic shock, the sympathetic system is not able to respond to body stressors. Therefore, the clinical characteristics of neurogenic shock are signs of parasympathetic stimulation. It is characterized by dry, warm skin rather than the cool, moist skin seen in hypovolemic shock. Another characteristic is hypotension with bradycardia, rather than the tachycardia that characterizes other forms of shock.

### Medical Management

Treatment of neurogenic shock involves restoring sympathetic tone, either through the stabilization of a spinal cord injury or, in the instance of spinal anesthesia, by positioning the patient properly. Specific treatment depends on the cause of the shock. Further discussion of management of patients with a spinal cord injury is presented in Chapter 63. If hypoglycemia (insulin shock) is the cause, glucose is rapidly administered (see Chapter 41).

### Nursing Management

It is important to elevate and maintain the head of the bed at least 30 degrees to prevent neurogenic shock when a patient receives spinal or epidural anesthesia. Elevation of the head helps prevent the spread of the anesthetic agent up the spinal cord. In suspected spinal cord injury, neurogenic shock may be prevented by carefully immobilizing the patient to prevent further damage to the spinal cord.

Nursing interventions are directed toward supporting cardiovascular and neurologic function until the usually transient episode of neurogenic shock resolves. Applying

anti-embolism stockings and elevating the foot of the bed may minimize pooling of blood in the legs. Pooled blood increases the risk of thrombus formation. Therefore, the nurse must check the patient daily for any lower extremity pain, redness, tenderness, and warmth. If the patient complains of pain and objective assessment of the calf is suspicious, the patient should be evaluated for deep vein thrombosis. Administration of heparin or low-molecular-weight heparin (Lovenox) as prescribed, application of anti-embolism stockings, or use of pneumatic compression of the legs may prevent thrombus formation. Passive range of motion of the immobile extremities helps promote circulation.

A patient who has experienced a spinal cord injury may not report pain caused by internal injuries. Therefore, in the immediate postinjury period, the nurse must monitor the patient closely for signs of internal bleeding that could lead to hypovolemic shock.

## ANAPHYLACTIC SHOCK

**Anaphylactic shock** occurs rapidly and is life-threatening. Because anaphylactic shock occurs in patients already exposed to an antigen and who have developed antibodies to it, it can often be prevented. Patients with known allergies should understand the consequences of subsequent exposure to the antigen and should wear medical identification that lists their sensitivities. This could prevent inadvertent administration of a medication that would lead to anaphylactic shock. In addition, patients and families need instruction about emergency use of medications for treatment of anaphylaxis.

Anaphylactic shock is caused by a severe allergic reaction when patients who have already produced antibodies to a foreign substance (antigen) develop a systemic antigen–antibody reaction (see Chart 15-3). This process requires that the patient has previously been exposed to the substance. An antigen–antibody reaction provokes mast cells to release potent vasoactive substances, such as histamine or bradykinin, causing widespread vasodilation and capillary permeability. Characteristics of severe anaphylaxis usually include rapid onset of hypotension, neurologic compromise, respiratory distress, and cardiac arrest (Brown, 2007).

### Medical Management

Treatment of anaphylactic shock requires removing the causative antigen (eg, discontinuing an antibiotic agent), administering medications that restore vascular tone, and providing emergency support of basic life functions. Epinephrine is given for its vasoconstrictive action. Diphenhydramine (Benadryl) is administered to reverse the effects of histamine, thereby reducing capillary permeability. These medications are given intravenously. Nebulized medications, such as albuterol (Proventil), may be given to reverse histamine-induced bronchospasm.

If cardiac arrest and respiratory arrest are imminent or have occurred, cardiopulmonary resuscitation is performed. Endotracheal intubation or tracheotomy may be necessary to establish an airway. IV lines are inserted to provide access for administering fluids and medications. Anaphylaxis and specific chemical mediators are discussed further in Chapter 53.

### Nursing Management

The nurse has an important role in preventing anaphylactic shock. The nurse must assess all patients for allergies or previous reactions to antigens (eg, medications, blood products, foods, contrast agents, latex) and communicate the existence of these allergies or reactions to others. In addition, the nurse assesses the patient's understanding of previous reactions and steps taken by the patient and family to prevent further exposure to antigens. When new allergies are identified, the nurse advises the patient to wear or carry identification that names the specific allergen or antigen.

When administering any new medication, the nurse observes all patients for allergic reactions. This is especially important with IV medications, including antibiotics. Previous adverse drug reactions increase the risk that the patient will develop an undesirable reaction to a new medication. If the patient reports an allergy to a medication, the nurse must be aware of the risks involved in the administration of similar medications.

At hospital and outpatient diagnostic testing sites, the nurse must identify patients who are at risk for anaphylactic reactions to contrast agents (radiopaque, dyelike substances that may contain iodine) used for diagnostic tests. Patients with a known allergy to iodine or fish and those who have had previous allergic reactions to contrast agents are at high risk. This information must be communicated to the staff at the diagnostic testing site, including x-ray personnel. The nurse must be knowledgeable about the clinical signs of anaphylaxis, must take immediate action if signs and symptoms occur, and must be prepared to begin cardiopulmonary resuscitation if cardiorespiratory arrest occurs.

Community health and home care nurses who administer medications, including antibiotic agents, in the patient's home or other settings must be prepared to administer epinephrine subcutaneously or intramuscularly in the event of an anaphylactic reaction.

After recovery from anaphylaxis, the patient and family require an explanation of the event. Furthermore, the nurse provides instruction about avoiding future exposure to antigens and administering emergency medications to treat anaphylaxis (see Chapter 53).

## *Multiple Organ Dysfunction Syndrome*

**Multiple organ dysfunction syndrome** (MODS) is altered organ function in acutely ill patients that requires medical intervention to support continued organ function. It is another phase in the progression of shock states. The actual incidence of MODS is difficult to determine, because it develops with acute illnesses that compromise tissue perfusion. Dysfunction of one organ system is associated with 20% mortality, and if more than four organs fail, the mortality may reach 70% (VonRueden, et al., 2008).

### Pathophysiology

MODS may be a complication of any form of shock caused by inadequate tissue perfusion. The precise mechanism by which MODS occurs remains unknown. However, MODS

frequently occurs toward the end of the continuum of septic shock when tissue perfusion cannot be effectively restored. It is not possible to predict which patients who experience shock will develop MODS, partly because much of the organ damage occurs at the cellular level and therefore cannot be directly observed or measured. However, a pattern of progressive organ dysfunction and failure typically occurs; organ failure usually begins in the lungs, and cardiovascular instability as well as failure of the hepatic, GI, renal, immunologic, and central nervous systems follow (Abraham & Singer, 2007; VonRueden, et al., 2008). Advanced age, malnutrition, and coexisting disease appear to increase the risk of MODS in acutely ill patients.

## Clinical Manifestations

The clinical presentation of MODS is insidious; tissues become hypoperfused at both a microcellular and macrocellular level, eventually causing organ dysfunction that requires intervention to support organ function.

In MODS, the sequence of organ dysfunction varies depending on the patient's primary illness and comorbidities prior to experiencing shock. For simplicity of presentation, the classic pattern is described. Typically, the lungs are the first organs to show signs of dysfunction. The patient experiences progressive dyspnea and respiratory failure requiring intubation and mechanical ventilation (see Chapters 23 and 25). The patient usually remains hemodynamically stable but may require increasing amounts of IV fluids and vasoactive agents to support the BP and cardiac output. Signs of a hypermetabolic state, characterized by hyperglycemia (elevated blood glucose level), hyperlactic acidemia (excess lactic acid in the blood), and increased BUN, are present. The metabolic rate may be 1.5 to 2 times the basal metabolic rate. At this time, there is a severe loss of skeletal muscle mass (autocatabolism) to meet the high energy demands of the body.

After approximately 7 to 10 days, signs of hepatic dysfunction (eg, elevated bilirubin and liver function tests) and renal dysfunction (eg, elevated creatinine and anuria) are evident. As the lack of tissue perfusion continues, the hematologic system becomes dysfunctional, with worsening immunocompromise and increasing risk of bleeding. The cardiovascular system becomes unstable and unresponsive to vasoactive agents, and the patient's neurologic response progresses to a state of unresponsiveness or coma.

The goal of all shock states is to reverse the tissue hypoperfusion and hypoxia. If effective tissue perfusion is restored before organs become dysfunctional, the patient's condition stabilizes. Along the septic shock continuum, the onset of organ dysfunction is an ominous prognostic sign; the more organs that fail, the worse the outcome.

## Medical Management

Prevention remains the top priority in managing MODS. Elderly patients are at increased risk for MODS because of the lack of physiologic reserve and the natural degenerative process, especially immune compromise (Marik, 2006). Early detection and documentation of initial signs of infection are essential in managing MODS in elderly patients. Subtle changes in mentation and a gradual rise in temperature are early warning signs. Other patients at risk for MODS are those with chronic illness, malnutrition, immunosuppression, or surgical or traumatic wounds.

If preventive measures fail, treatment measures to reverse MODS are aimed at (1) controlling the initiating event, (2) promoting adequate organ perfusion, and (3) providing nutritional support.

## Nursing Management

The general plan of nursing care for patients with MODS is the same as that for patients with septic shock. Primary nursing interventions are aimed at supporting the patient and monitoring organ perfusion until primary organ insults are halted. Providing information and support to family members is a critical role of the nurse. It is important that the health care team address end-of-life decisions to ensure that supportive therapies are congruent with the patient's wishes (see Chapter 17).

### *Promoting Communication*

Nurses should encourage frequent and open communication about treatment modalities and options to ensure that the patient's wishes regarding medical management are met. For patients who survive MODS, it is essential that they be informed about the goals of rehabilitation and expectations for progress toward these goals, because massive loss of skeletal muscle mass makes rehabilitation a long, slow process. A strong nurse–patient relationship built on effective communication provides needed encouragement during this phase of recovery.

## *Promoting Home and Community-Based Care*

### Teaching Patients Self-Care

Patients who experience and survive shock may have been unable to get out of bed for an extended period of time and are likely to have a slow, prolonged recovery. The patient and family are instructed about strategies to prevent further episodes of shock by identifying the factors implicated in the initial episode. In addition, the patient and family require instruction about assessments needed to identify the complications that may occur after the patient is discharged from the hospital. Depending on the type of shock and its management, the patient or family may require instruction about treatment modalities such as emergency administration of medications, IV therapy, parenteral or enteral nutrition, skin care, exercise, and ambulation. The patient and family are also instructed about the need for gradual increases in ambulation and other activity. The need for adequate nutrition is another crucial aspect of teaching.

### Continuing Care

Because of the physical toll associated with recovery from shock, patients may be cared for in a long-term care facility or rehabilitation setting after hospital discharge. Alternatively, a referral may be made for home care. The home care nurse assesses the patient's physical status and monitors

recovery. The nurse also assesses the adequacy of treatments that are continued at home and the ability of the patient and family to cope with these treatments. The patient is likely to require close medical supervision until complete recovery occurs. The home care nurse reinforces the importance of continuing medical care and helps the patient and family identify and mobilize community resources.

## CRITICAL THINKING EXERCISES

**1** A patient with a history of severe osteoarthritis is prescribed glucosamine and chondroitin supplements. The patient's chart states that he has no known drug allergies, but he does have food allergies that include shell fish and avocados. Fifteen minutes after the first dose of the medication is administered, the patient complains of anxiety, shortness of breath, and chest discomfort. He is flushed and visibly uncomfortable. What are your nursing priorities in providing care to this patient? What assessment data do you need to obtain to determine if this patient is experiencing cardiogenic or anaphylactic shock? What nursing interventions and medical treatments would you anticipate for cardiogenic shock? What risks did the patient have that may have increased his likelihood of experiencing anaphylactic shock? In terms of anaphylactic shock, what nursing interventions and medical treatments would you anticipate?

EBP **2** An elderly man with a 16-year history of Parkinson's disease is admitted with sudden, increasing confusion and combative behavior. You know that changes in mental status may be an early sign of sepsis in the elderly. How would you assess this patient for the possibility of sepsis? What risk factors place an older patient at higher risk for sepsis? How would you ensure the accuracy of vital signs and interpretation of vital signs in the older patient experiencing sepsis? What is the evidence base for these risk factors? How would the management of the elderly patient differ from that of a younger patient?

**3** A 32-year-old man is admitted with severe pancreatitis. He has a long history of addiction to alcohol and was recently on a "drinking binge." The patient is agitated and exhibiting nervous behavior. His BP is 106/88 mm Hg, heart rate is 126 bpm, respiratory rate is 32 breaths/min, and he has not voided for the past 3 hours. Is the patient most likely experiencing withdrawal from alcohol or a type of shock? Describe the type of shock that poses the greatest risk for this patient. What interventions should you anticipate to prevent the progression of shock or development of MODS? Given the patient's history, what organ(s) is least likely to tolerate prolonged tissue hypoperfusion? What assessment data would you look at to monitor organ dysfunction in this patient?

**4** A 23-year-old patient underwent surgical repair of her shoulder. She had spinal anesthesia for the surgery and currently has a patent epidural catheter for pain management. What types of shock are possible in this patient? What therapy directed at prevention or treatment of shock would you anticipate? Describe the rationale for the therapies that you have identified. How would you use the patient's history and symptom presentation to help you identify shock states? Describe likely symptoms and the underlying pathophysiology of the shock state.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicate nursing research.*


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chapter 16

# Oncology: Nursing Management in Cancer Care

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare the structure and function of the normal cell and the cancer cell.
2. Differentiate between benign and malignant tumors.
3. Identify agents and factors that have been found to be carcinogenic.
4. Describe the significance of health education and preventive care in decreasing the incidence of cancer.
5. Differentiate among the purposes of surgical procedures used in cancer treatment, diagnosis, prophylaxis, palliation, and reconstruction.
6. Describe the roles of surgery, radiation therapy, chemotherapy, targeted therapy, hematopoietic stem cell transplantation, and other therapies in treating cancer.
7. Describe the special nursing needs of patients receiving chemotherapy.
8. Describe nursing care related to common nursing diagnoses associated with cancer: impaired skin integrity, alopecia, nutritional problems, and altered body image.
9. Identify potential complications for the patient with cancer and discuss associated nursing care.
10. Describe the concept of hospice in providing care for patients with advanced cancer.
11. Identify assessment parameters and nursing management of patients with oncologic emergencies.

## GLOSSARY

**alopecia:** hair loss
**anaplasia:** cells that lack normal cellular characteristics and differ in shape and organization with respect to their cells of origin; usually, anaplastic cells are malignant
**apoptosis:** programmed cell death
**benign:** not cancerous; benign tumors may grow but are unable to spread to other areas
**biologic response modifier (BRM) therapy:** use of agents or treatment methods that can alter the immunologic relationship between the tumor and the host to provide a therapeutic benefit
**biopsy:** a diagnostic procedure to remove a small sample of tissue to be examined microscopically to detect malignant cells
**brachytherapy:** delivery of radiation therapy through internal implants
**cancer:** a disease process whereby cells proliferate abnormally, ignoring growth-regulating signals in the environment surrounding the cells
**carcinogenesis:** process of transforming normal cells into malignant cells
**chemotherapy:** use of medications to kill tumor cells by interfering with cellular functions and reproduction
**control:** containment of the growth of cancer cells

## GLOSSARY *(Continued)*

**cure:** prolonged survival and disappearance of all evidence of disease so that the patient has the same life expectancy as anyone else in his or her age group
**cytokines:** substances produced by cells of the immune system to enhance production and functioning of components of the immune system
**dysplasia:** bizarre cell growth resulting in cells that differ in size, shape, or arrangement from other cells of the same type of tissue
**extravasation:** leakage of medication from the veins into the subcutaneous tissues
**grading:** identification of the type of tissue from which the tumor originated and the degree to which the tumor cells retain the functional and structural characteristics of the tissue of origin
**graft-versus-host disease (GVHD):** an immune response initiated by T lymphocytes of donor tissue against the recipient's tissues (skin, gastrointestinal tract, liver); an undesirable response
**graft-versus-tumor effect:** the donor cell response against the malignancy; a desirable response
**hyperplasia:** increase in the number of cells of a tissue; most often associated with periods of rapid body growth
**malignant:** having cells or processes that are characteristic of cancer
**metaplasia:** conversion of one type of mature cell into another type of cell
**metastasis:** spread of cancer cells from the primary tumor to distant sites
**myelosuppression:** suppression of the blood cell–producing function of the bone marrow
**nadir:** lowest point of white blood cell depression after therapy that has toxic effects on the bone marrow
**neoplasia:** uncontrolled cell growth that follows no physiologic demand
**neutropenia:** abnormally low absolute neutrophil count
**oncology:** field or study of cancer
**palliation:** relief of symptoms and promotion of comfort and quality of life
**radiation therapy:** use of ionizing radiation to interrupt the growth of malignant cells
**staging:** process of determining the extent of disease, including tumor size and spread or metastasis to distant sites
**stomatitis:** inflammation of the oral tissues, often associated with some chemotherapeutic agents and radiation therapy to the head and neck region
**targeted therapies:** cancer treatments that seek to minimize the negative effects on healthy tissues by disrupting specific cancer cell functions, such as malignant transformation, communication pathways, processes for growth and metastasis, and genetic coding
**thrombocytopenia:** decrease in the number of circulating platelets; associated with the potential for bleeding
**tumor-specific antigen (TSA):** protein on the membrane of cancer cells that distinguishes the malignant cell from a benign cell of the same tissue type
**vesicant:** substance that can cause tissue necrosis and damage, particularly when extravasated
**xerostomia:** dry oral cavity resulting from decreased function of salivary glands

Cancer is not a single disease with a single cause; rather, it is a group of distinct diseases with different causes, manifestations, treatments, and prognoses. Cancer nursing practice covers all age groups and nursing specialties and is carried out in a variety of health care settings, including the home, community, acute care institutions, outpatient centers, rehabilitation, and long-term care facilities. The scope, responsibilities, and goals of cancer nursing, also called **oncology** nursing, are as diverse and complex as those of any nursing specialty. Because many people associate cancer with pain and death, nurses need to identify their own reactions to cancer and set realistic goals to meet the challenges inherent in caring for patients with cancer. In addition, cancer nurses must be prepared to support patients and families through a wide range of physical, emotional, social, cultural, and spiritual crises.

## Epidemiology of Cancer

Although cancer affects people of all ages, most cancers occur in people older than 65 years of age. Overall, the incidence of cancer is higher in men than in women and higher in industrialized sectors and nations.

More than 1.4 million Americans are diagnosed each year with cancer, affecting one of various body sites (Fig. 16-1). Cancer is second only to cardiovascular disease as a leading cause of death in the United States. Although the numbers of cancer deaths have decreased slightly, more than 560,000 Americans were expected to die from a malignant process in 2008. The leading causes of cancer death in the United States, in order of frequency, are lung, prostate, and colorectal cancer in men and lung, breast, and colorectal cancer in women (Jemal, Siegel, Ward, et al., 2007).

For all cancer sites combined, African American men have a 15% higher incidence rate and a 38% higher death rate than Caucasian men. African American women have a 9% lower incidence rate, but an 18% higher death rate than Caucasian women for all cancer sites combined. Factors contributing to disparities in cancer morbidity and mortality in this group vary by site and are related to exposure, economics, education, access to health care, and other issues that are not clearly understood (Jemal, et al., 2007).

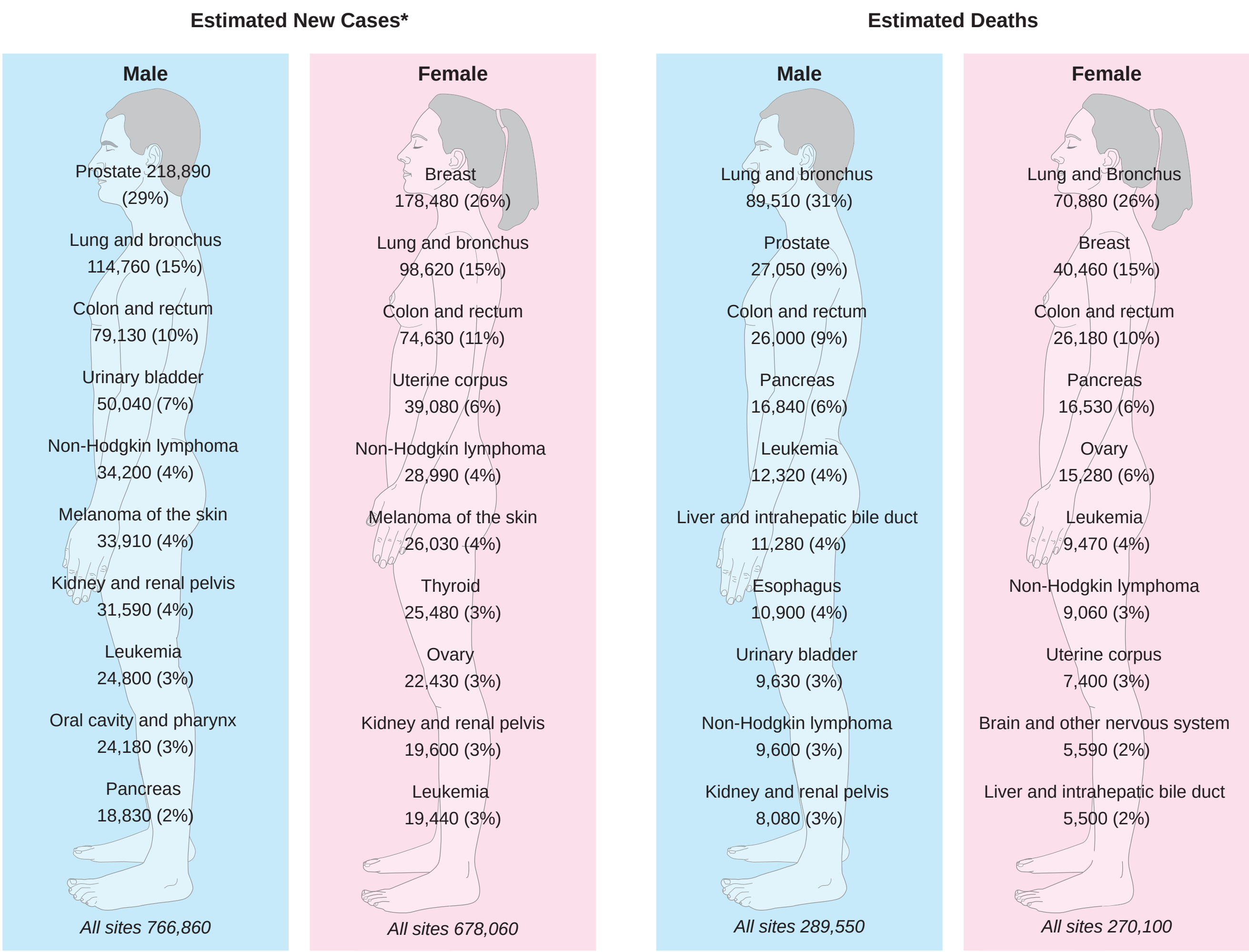



**Figure 16-1** Ten leading types of cancer by gender determined on the basis of estimated new cancer cases and deaths in the United States in 2007.
*Excludes basal and squamous cell skin cancers and in situ cancers except urinary bladder. Note: Percentages may not total 100% because of rounding. Redrawn from Jemal, A., Siegel, R., Ward, E., et al. (2007). Cancer statistics. *CA Cancer Journal for Clinicians, 57*(1), 43–66.

## Pathophysiology of the Malignant Process

**Cancer** is a disease process that begins when an abnormal cell is transformed by the genetic mutation of the cellular DNA. This abnormal cell forms a clone and begins to proliferate abnormally, ignoring growth-regulating signals in the environment surrounding the cell. The cells acquire invasive characteristics, and changes occur in surrounding tissues. The cells infiltrate these tissues and gain access to lymph and blood vessels, which carry the cells to other areas of the body.

### Proliferative Patterns

During the lifespan, various body tissues normally undergo periods of rapid or proliferative growth that must be distinguished from malignant growth activity. Several patterns of cell growth exist: **hyperplasia, metaplasia, dysplasia, anaplasia,** and **neoplasia.** Cancerous cells are described as **malignant** neoplasms. They demonstrate uncontrolled cell growth that follows no physiologic demand (neoplasia). **Benign** (noncancerous) and malignant growths are classified and named by tissue of origin (eg, benign tumors of the meninges are called meningioma and malignant tumors of the meninges are called meningeal sarcoma).

Benign and malignant cells differ in many cellular growth characteristics, including the method and rate of growth, ability to metastasize or spread, general effects, destruction of tissue, and ability to cause death. These differences are summarized in Table 16-1. The degree of anaplasia (cells that lack normal cellular characteristics and differ in shape and organization with respect to their cells of origin) ultimately determines the malignant potential.

### Characteristics of Malignant Cells

Despite their individual differences, all cancer cells share some common cellular characteristics related to the cell membrane, special proteins, the nuclei, chromosomal abnormalities, and the rate of mitosis and growth. The cell membranes are altered in cancer cells, which affect fluid movement in and out of the cell. The cell membrane of malignant cells also contains proteins called **tumor-specific antigens** (eg, carcinoembryonic antigen [CEA] and prostate-specific antigen [PSA]), which develop over time as the cells become less differentiated (mature). These proteins distinguish malignant cells from benign cells of the same tissue type. They may be useful in measuring the extent of disease in a person and in tracking the course of illness during treatment or relapse. Malignant cellular membranes also contain less fibronectin, a cellular cement. They are therefore less cohesive and do not adhere to adjacent cells readily.

Typically, nuclei of cancer cells are large and irregularly shaped (pleomorphism). Nucleoli, structures within the nucleus that house ribonucleic acid (RNA), are larger and more numerous in malignant cells, perhaps because of increased RNA synthesis. Chromosomal abnormalities (translocations, deletions, additions) and fragility of chromosomes are commonly found when cancer cells are analyzed.

Mitosis (cell division) occurs more frequently in malignant cells than in normal cells. As the cells grow and divide, more glucose and oxygen are needed. If glucose and oxygen are unavailable, malignant cells use anaerobic metabolic channels to produce energy, which makes the cells less dependent on the availability of a constant oxygen supply.

### Invasion and Metastasis

Malignant disease processes have the ability to allow the spread or transfer of cancerous cells from one organ or body part to another by invasion and metastasis.

**Table 16-1 CHARACTERISTICS OF BENIGN AND MALIGNANT NEOPLASMS**

| Characteristics | Benign | Malignant |
|---|---|---|
| Cell characteristics | Well-differentiated cells that resemble normal cells of the tissue from which the tumor originated | Cells are undifferentiated and often bear little resemblance to the normal cells of the tissue from which they arose |
| Mode of growth | Tumor grows by expansion and does not infiltrate the surrounding tissues; usually encapsulated | Grows at the periphery and sends out processes that infiltrate and destroy the surrounding tissues |
| Rate of growth | Rate of growth is usually slow | Rate of growth is variable and depends on level of differentiation; the more anaplastic the tumor, the faster its growth |
| Metastasis | Does not spread by metastasis | Gains access to the blood and lymphatic channels and metastasizes to other areas of the body |
| General effects | Is usually a localized phenomenon that does not cause generalized effects unless its location interferes with vital functions | Often causes generalized effects, such as anemia, weakness, and weight loss |
| Tissue destruction | Does not usually cause tissue damage unless its location interferes with blood flow | Often causes extensive tissue damage as the tumor outgrows its blood supply or encroaches on blood flow to the area; may also produce substances that cause cell damage |
| Ability to cause death | Does not usually cause death unless its location interferes with vital functions | Usually causes death unless growth can be controlled |

Reproduced with permission from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

Invasion, which refers to the growth of the primary tumor into the surrounding host tissues, occurs in several ways. Mechanical pressure exerted by rapidly proliferating neoplasms may force fingerlike projections of tumor cells into surrounding tissue and interstitial spaces. Malignant cells are less adherent and may break off from the primary tumor and invade adjacent structures. Malignant cells are thought to possess or produce specific destructive enzymes (proteinases), such as collagenases (specific to collagen), plasminogen activators (specific to plasma), and lysosomal hydrolyses. These enzymes are thought to destroy surrounding tissue, including the structural tissues of the vascular basement membrane, facilitating invasion of malignant cells. The mechanical pressure of a rapidly growing tumor may enhance this process.

Metastasis is the dissemination or spread of malignant cells from the primary tumor to distant sites by direct spread of tumor cells to body cavities or through lymphatic and blood circulation. Tumors growing in or penetrating body cavities may shed cells or emboli that travel within the body cavity and seed the surfaces of other organs. This can occur in ovarian cancer when malignant cells enter the peritoneal cavity and seed the peritoneal surfaces of such abdominal organs as the liver or pancreas. Patterns of metastasis can be partially explained by circulatory patterns and by specific affinity for certain malignant cells to bind to molecules in specific body tissue.

### Lymphatic and Hematogenous Spread

Lymph and blood are key mechanisms by which cancer cells spread. Lymphatic spread (the transport of tumor cells through the lymphatic circulation) is the most common mechanism of metastasis. Tumor emboli enter the lymph channels by way of the interstitial fluid, which communicates with lymphatic fluid. Malignant cells also may penetrate lymphatic vessels by invasion. After entering the lymphatic circulation, malignant cells either lodge in the lymph nodes or pass between the lymphatic and venous circulations. Tumors arising in areas of the body with rapid and extensive lymphatic circulation are at high risk for metastasis through lymphatic channels. Breast tumors frequently metastasize in this manner through axillary, clavicular, and thoracic lymph channels.

Hematogenous spread is the dissemination of malignant cells via the bloodstream and is directly related to the vascularity of the tumor. Few malignant cells can survive the turbulence of arterial circulation, insufficient oxygenation, or destruction by the body's immune system. In addition, the structure of most arteries and arterioles is far too secure to permit malignant invasion. Those malignant cells that do survive are able to attach to endothelium and attract fibrin, platelets, and clotting factors to seal themselves from immune system surveillance. The endothelium retracts, allowing the malignant cells to enter the basement membrane and secrete lysosomal enzymes. These enzymes destroy surrounding body tissues, allowing implantation.

### Angiogenesis

Angiogenesis is the growth of new capillaries from the host tissue by the release of growth factors and enzymes such as vascular endothelial growth factor (VEGF). These proteins rapidly stimulate formation of new blood vessels, which helps malignant cells obtain the necessary nutrients and oxygen. It is also through this vascular network that tumor emboli can enter the systemic circulation and travel to distant sites. Large tumor emboli that become trapped in the microcirculation of distant sites may further metastasize to other sites. Therapies that target VEGF or its receptors are being used to treat many cancers effectively (see Targeted Therapies).

## Carcinogenesis

### Molecular Process

Malignant transformation, or **carcinogenesis,** is thought to be at least a three-step cellular process, involving initiation, promotion, and progression. During *initiation,* initiators (carcinogens), such as chemicals, physical factors, and biologic agents, escape normal enzymatic mechanisms and alter the genetic structure of the cellular DNA. Normally, these alterations are reversed by DNA repair mechanisms or the changes initiate programmed cellular death. Occasionally, cells escape these protective mechanisms, and permanent cellular mutations occur. These mutations usually are not significant to cells until the second step of carcinogenesis.

During *promotion,* repeated exposure to promoting agents (cocarcinogens) causes the expression of abnormal or mutant genetics information even after long latency periods. Latency periods for the promotion of cellular mutations vary with the type of agent and the dosage of the promoter as well as the innate characteristics of the target cell.

Cellular oncogenes are responsible for the vital cellular functions of growth and differentiation. Cellular proto-oncogenes act as an "on switch" for cellular growth. Proto-oncogenes are influenced by multiple growth factors that stimulate cell proliferation, such as epidermal growth factor (EGF) and transforming growth factor alpha. Another proto-oncogene that plays an important role in cancer development is the *k-ras (KRAS2)* oncogene located on chromosome 12.

Just as proto-oncogenes "turn on" cellular growth, cancer suppressor genes "turn off," or regulate, unneeded cellular proliferation. When suppressor genes mutate or lose their regulatory capabilities, malignant cells are allowed to reproduce. The *p53 (TP53)* gene is a tumor suppressor gene that is frequently implicated in many human cancers. This gene determines whether cells will live or die after their DNA is damaged. **Apoptosis** is the innate cellular process of programmed cell death. Alterations in *TP53* may decrease apoptotic signals, thus giving rise to a survival advantage for mutant cell populations. Mutant *TP53* is associated with a poor prognosis and may be associated with determining response to treatment. Once this genetic expression occurs in cells, the cells begin to produce mutant cell populations that are different from their original cellular ancestors.

During *progression,* the altered cells exhibit increased malignant behavior. These cells have a propensity to invade adjacent tissues and to metastasize. Agents that initiate or promote cellular transformation are referred to as carcinogens.

### Etiology

Categories of agents or factors implicated in carcinogenesis include viruses and bacteria, physical agents, chemical agents, genetic or familial factors, dietary factors, and hormonal agents.

### Viruses and Bacteria

Viruses are difficult to evaluate as a cause of human cancers because they are difficult to isolate. However, infectious causes are considered or suspected when specific cancers appear in clusters. Viruses are thought to incorporate themselves in the genetic structure of cells, thus altering future generations of that cell population, perhaps leading to cancer. For example, the Epstein-Barr virus is highly suspect as a cause in Burkitt lymphoma, nasopharyngeal cancers, and some types of non-Hodgkin and Hodgkin lymphoma.

Bacteria have been evaluated as a cause of cancer over the years but with little evidence to support the link of bacteria to cancer. Chronic inflammatory reactions to bacteria and the production of carcinogenic metabolites are possible mechanisms under investigation. In the early 1990s, the International Agency for Research on Cancer (IARC) identified *Helicobacter pylori* (*H. pylori*) as the first bacterium to be termed a definite cause of cancer in humans. *H. pylori* has been associated with an increased incidence of gastric malignancy related to chronic superficial gastritis, with resultant atrophic and metaplastic changes to the gastric mucosa (Schottenfeld & Bebbe-Dimmer, 2006).

### Physical Agents

Physical factors associated with carcinogenesis include exposure to sunlight or radiation, chronic irritation or inflammation, and tobacco use.

Excessive exposure to the ultraviolet rays of the sun, especially in fair-skinned, blue- or green-eyed people, increases the risk of skin cancers. Factors such as clothing styles (sleeveless shirts or shorts); use of sunscreens; occupation; recreational habits; and environmental variables, including humidity, altitude, and latitude, all play a role in the amount of exposure to ultraviolet light.

Exposure to ionizing radiation can occur with repeated diagnostic x-ray procedures or with radiation therapy used to treat disease. Fortunately, improved x-ray equipment minimizes the risk of extensive radiation exposure. Radiation therapy used in disease treatment and exposure to radioactive materials at nuclear weapon manufacturing sites or nuclear power plants are associated with a higher incidence of leukemias, multiple myeloma, and cancers of the lung, bone, breast, thyroid, and other tissues. Background radiation from the natural decay processes that produce radon has also been associated with lung cancer. Homes with high levels of trapped radon should be ventilated to allow the gas to disperse into the atmosphere.

### Chemical Agents

About 75% of all cancers are thought to be related to the environment. Most hazardous chemicals produce their toxic effects by altering DNA structure in body sites distant from chemical exposure. The liver, lungs, and kidneys are the organ systems most often affected, presumably because of their roles in detoxifying chemicals.

Tobacco smoke, thought to be the single most lethal chemical carcinogen, accounts for at least 30% of cancer deaths. Smoking is strongly associated with cancers of the lung, head and neck, esophagus, stomach, pancreas, cervix, kidney, and bladder and with acute myeloblastic leukemia. More than 4,000 individual chemicals have been identified in tobacco and tobacco smoke, including more than 60 chemicals that are known carcinogens. Tobacco may also act synergistically with other substances, such as alcohol, asbestos, uranium, and viruses, to promote cancer development. Chewing tobacco is associated with cancers of the oral cavity, which primarily occurs in men younger than 40 years of age. Considerable research has also substantiated the effect of secondhand cigarette smoke as an environmental risk factor for both smokers and nonsmokers (American Cancer Society [ACS], 2008c;2008d).

Many chemical substances found in the workplace have proved to be carcinogens or cocarcinogens. In the United States, carcinogens are classified by two federal agencies: the National Toxicology Program of the Department of Health and Human Services and the Environmental Protection Agency's Integrated Risk Information System (IRIS). The Centers for Disease Control and Prevention established the National Institute for Occupational Safety and Health to provide occupational exposure limits and guidelines for protection of the workforce as regulated by the Occupational Safety and Health Act of 1970. The extensive list of suspected chemical substances continues to grow and includes aromatic amines and aniline dyes; pesticides and formaldehydes; arsenic, soot, and tars; asbestos; benzene; betel nut and lime; cadmium; chromium compounds; nickel and zinc ores; wood dust; beryllium compounds; and polyvinyl chloride.

### Genetics and Familial Factors

Almost every cancer type has been shown to run in families. This may be due to genetics, shared environments, cultural or lifestyle factors, or chance alone. Genetic factors play a role in cancer cell development. Abnormal chromosomal patterns and cancer have been associated with extra chromosomes, too few chromosomes, or translocated chromosomes. Specific cancers with underlying genetic abnormalities include Burkitt lymphoma, chronic myelogenous leukemia, meningiomas, acute leukemias, retinoblastomas, Wilms tumor, and skin cancers, including malignant melanoma. Additionally, there are syndromes that represent a cluster of cancers that are identified by a specific genetic alteration that is inherited across generations of a family. In these families, the associated genetic mutation is found in all cells and represents an inherited susceptibility to cancer for all family members who carry the mutation.

Approximately 5% of cancers in adults display a pattern of cancers suggestive of a familial predisposition. The hallmarks of families with a hereditary cancer syndrome include cancer in two or more first-degree or second-degree relatives, early onset of cancer in family members younger than 50 years of age, the same type of cancer in several family members, individual family members with more than one type of cancer, and a rare cancer in one or more family members. There is also evidence of an autosomal dominant inheritance pattern of cancers affecting several generations of the family.

Since the early 1990s, there have been considerable advances in the recognition of inherited cancer susceptibility syndromes and in the ability to isolate and identify the inherited genetic mutation responsible for the cancer patterns. Discoveries of mutations in genes related to critical

CHART 16-1

GENETICS IN NURSING PRACTICE

### *Concepts and Challenges in Management of the Patient with Cancer*

Cancer is a genetic disease. Every phase of carcinogenesis is affected by multiple gene mutations. Some of these mutations are inherited (present in germ-line cells), but most (90%) are somatic mutations that are acquired mutations in specific cells. Examples of cancers influenced by genetics include:

- Cowden syndrome
- Familial adenomatous polyposis
- Familial melanoma syndrome
- Hereditary breast and ovarian cancer
- Hereditary nonpolyposis colon cancer
- Neurofibromatosis type 1
- Retinoblastoma

#### Nursing Assessments

**Family History Assessment**

- Obtain information about both maternal and paternal sides of family.
- Obtain cancer history of at least three generations.
- Look for clustering of cancers that occur at young ages, multiple primary cancers in one individual, cancer in paired organs, and two or more close relatives with the same type of cancer suggestive of hereditary cancer syndromes

**Patient Assessment**

- Physical findings that may predispose the patient to cancer, such as multiple colon polyps, suggestive of a polyposis syndrome
- Skin findings, such as atypical moles, that may be related to familial melanoma syndrome
- Multiple *café au lait* spots, axillary freckling, and two or more neurofibromas associated with neurofibromatosis type 1
- Facial trichilemmomas, mucosal papillomatosis, multinodular thyroid goiter or thyroid adenomas, macrocephaly, fibrocystic breasts and other fibromas or lipomas related to Cowden syndrome

#### Management Issues Specific to Genetics

- Assess patient's understanding of genetics factors related to his or her cancer
- Refer for cancer risk assessment when a hereditary cancer syndrome is suspected so that patient and family can discuss inheritance risk with other family members and availability of genetic testing
- Offer appropriate genetics information and resources
- Assess patient's understanding of genetics information
- Provide support to patients and families with known genetic test results for hereditary cancer syndromes
- Participate in the management and coordination of risk-reduction measures for those with known gene mutations

#### Genetics Resources

**American Cancer Society—**offers general information about cancer and support resources for families, www.cancer.org

**Gene Clinics—**a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling, and testing information, www.geneclinics.org

**Genetic Alliance—**a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**National Cancer Institute—**a listing of cancers with clinical summaries and treatment reviews, information on genetic risks for cancer, listing of cancer centers providing genetic cancer risk assessment services, www.cancernet.nci.nih.gov

**National Organization of Rare Disorders—**a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man—**a complete listing of known inherited genetic conditions, www.ncbi.nlm.nih.gov/Omim/mimstats.html

cell control functions, such as tumor suppression, DNA repair mechanisms, and oncogenes, have enabled the appropriate identification of families at risk for these syndromes. Examples of these syndromes include hereditary breast and ovarian cancer syndrome (*BRCA1* and *BRCA2*) and multiple endocrine neoplasia syndrome (*MEN1* and *MEN2*) (Chart 16-1). Cancers associated with familial inheritance syndromes include nephroblastomas, pheochromocytomas, and breast, ovarian, colorectal, stomach, thyroid, renal, prostate, and lung cancers (Nussbaum, McInnes & Willard, 2007).

### Dietary Factors

Dietary factors are also linked to environmental cancers. Dietary substances can be proactive (protective), carcinogenic, or cocarcinogenic. The risk of cancer increases with long-term ingestion of carcinogens or cocarcinogens or chronic absence of protective substances in the diet.

Dietary substances that appear to increase the risk of cancer include fats, alcohol, salt-cured or smoked meats, nitrate-containing and nitrite-containing foods, and red and processed meats. Alcohol increases the risk of cancers of the mouth, pharynx, larynx, esophagus, liver, colorectum, and breast. Alcohol intake should be limited to no more than two drinks per day for men and one drink per day for women. Greater consumption of vegetables and fruits is associated with a decreased risk of lung, esophageal, stomach, and colorectal cancers (Kushi, Byers, Doyle, et al., 2006).

A high caloric dietary intake is also associated with an increased cancer risk. Obesity is clearly associated with endometrial cancer, postmenopausal breast cancers, and colon, esophagus, and kidney cancers. There is evidence that obesity also increases the risk for cancers of the pancreas, gallbladder, thyroid, ovary, cervix, prostate, and for multiple myeloma and Hodgkin lymphoma (Kushi, et al., 2006).

### Hormonal Agents

Tumor growth may be promoted by disturbances in hormonal balance, either by the body's own (endogenous) hormone production or by administration of exogenous hormones. Cancers of the breast, prostate, and uterus are thought to depend on endogenous hormonal levels for growth. Diethylstilbestrol (DES) has long been recognized as a cause of vaginal carcinomas. Oral contraceptives and prolonged estrogen therapy are associated with an increased

incidence of hepatocellular, endometrial, and breast cancers, but they decrease the risk of ovarian cancer. The combination of estrogen and progesterone appears safer than estrogen alone in decreasing the risk of endometrial cancers; however, studies support discontinuing hormonal therapy containing both estrogen and progestin because of the increased risk of breast cancer, coronary heart disease, stroke, and blood clots (Chlebowski, Anderson, Pettinger, et al., 2008).

Hormonal changes related to the female reproductive cycle are also associated with cancer incidence. Early onset of menses under age 12 and delayed onset of menopause after age 55, nulliparity (never giving birth), and delayed childbirth after age 30 are all associated with an increased risk of breast cancer. Increased numbers of pregnancies are associated with a decreased incidence of breast, endometrial, and ovarian cancers.

## Role of the Immune System

In humans, malignant cells are capable of developing on a regular basis. However, some evidence indicates that the immune system can detect the development of malignant cells and destroy them before cell growth becomes uncontrolled. When the immune system fails to identify and stop the growth of malignant cells, clinical cancer develops.

Patients who are immunocompromised have an increased incidence of cancer. Organ transplant recipients who receive immunosuppressive therapy to prevent rejection of the transplanted organ have an increased incidence of lymphoma, Kaposi's sarcoma, squamous cell cancer of the skin, and cervical and anogenital cancers (Herman, Rogers & Ratner, 2007). Patients with immunodeficiency diseases, such as acquired immunodeficiency syndrome (AIDS), have an increased incidence of Kaposi's sarcoma, lymphoma, rectal cancer, and head and neck cancers (Grulich, Vajdic & Cozen, 2007). Some patients who have received alkylating chemotherapeutic agents to treat cancer have an increased incidence of secondary malignancies (Tward, Glenn, Pulsipher, et al., 2007). Autoimmune diseases, such as rheumatoid arthritis and Sjögren syndrome, are associated with increased cancer development (Wolf & Michaud, 2007). Finally, age-related changes, such as declining organ function, increased incidence of chronic diseases, and diminished immunocompetence, may contribute to an increased incidence of cancer in older people.

### *Normal Immune Responses*

Normally, an intact immune system has the ability to combat cancer cells in several ways. Usually, the immune system recognizes as foreign certain antigens on the cell membranes of many cancer cells. These antigens, known as tumor-associated antigens (also called tumor cell antigens), are capable of stimulating both cellular and humoral immune responses.

Along with the macrophages, T lymphocytes, the soldiers of the cellular immune response, are responsible for recognizing tumor-associated antigens. When T lymphocytes recognize tumor antigens, other T lymphocytes that are toxic to the tumor cells are stimulated. These lymphocytes proliferate and are released into the circulation. In addition to possessing cytotoxic (cell-killing) properties, T lymphocytes can stimulate other components of the immune system to rid the body of malignant cells.

Certain lymphokines, which are substances produced by lymphocytes, are capable of killing or damaging various types of malignant cells. Other lymphokines can mobilize other immune system cells, such as macrophages, that disrupt cancer cells. Interferon, a substance produced by the body in response to viral infection, also possesses some antitumor properties. Antibodies produced by B lymphocytes, associated with the humoral immune response, also defend the body against malignant cells. These antibodies act either alone or in combination with the complement system or the cellular immune system.

Natural killer (NK) cells are a major component of the body's defense against cancer. NK cells are a subpopulation of lymphocytes that act by directly destroying cancer cells or by producing lymphokines and enzymes that assist in cell destruction.

### *Immune System Failure*

Several theories explain how malignant cells can survive and proliferate despite the elaborate immune system defense mechanisms. If the body fails to recognize the malignant cell as different from "self" (ie, as nonself or foreign), the immune response may not be stimulated. When tumors do not possess tumor-associated antigens that label them as foreign, the immune response is not alerted. This allows the tumor to grow too large to be managed by normal immune mechanisms.

Tumor antigens may combine with the antibodies produced by the immune system and hide or disguise themselves from normal immune defense mechanisms. These tumor antigen–antibody complexes can suppress further production of antibodies. Tumors can also alter their appearance or produce substances that impair usual immune responses. These substances promote tumor growth and increase the patient's susceptibility to infection. After prolonged contact with a tumor antigen, the body may be depleted of the specific lymphocytes and no longer be able to mount an appropriate immune response.

Abnormal concentrations of host suppressor T lymphocytes may play a role in cancer development. Suppressor T lymphocytes normally assist in regulating antibody production and diminishing immune responses when they are no longer required. Low levels of antibodies and high levels of suppressor cells have been found in patients with multiple myeloma, a cancer associated with hypogammaglobulinemia (low amounts of serum antibodies). Carcinogens, such as viruses and certain chemicals, including chemotherapeutic agents, may weaken the immune system and ultimately enhance tumor growth.

# Detection and Prevention of Cancer

Nurses and physicians have traditionally been involved with tertiary prevention, the care, and rehabilitation of patients after cancer diagnosis and treatment. However, the American Cancer Society, the National Cancer Institute, clinicians, and researchers also place emphasis on primary

CHART 16-2

HEALTH PROMOTION

## *American Cancer Society (ACS) Guidelines on Nutrition and Physical Activity for Cancer Prevention*

**ACS Recommendations for Individual Choices**

- Maintain a healthy weight throughout life
  - Balance caloric intake with physical activity
  - Avoid excessive weight gain throughout the life cycle
  - Achieve and maintain a healthy weight if currently overweight or obese
- Adopt a physically active lifestyle
  - Adults: engage in at least 30 minutes of moderate to vigorous physical activity, above usual activities, on 5 or more days of the week; 45 to 60 minutes of intentional physical activity are preferable
  - Children and adolescents: engage in at least 60 minutes per day of moderate to vigorous physical activity at least 5 days per week
- Consume a healthy diet, with an emphasis on plant sources
  - Choose foods and beverages in amounts that help achieve and maintain a healthy weight
  - Eat five or more servings of a variety of vegetables and fruits each day
  - Choose whole grains in preference to processed (refined) grains
  - Limit consumption of processed and red meats

If you drink alcoholic beverages, limit consumption. Drink no more than one drink per day for women or two per day for men.

**ACS Recommendations for Community Action**

- Public, private, and community organizations should work to create social and physical environments that support the adoption and maintenance of healthful nutrition and physical activity behaviors
- Increase access to healthful foods in schools, worksites, and communities
- Provide safe, enjoyable, and accessible environments for physical activity in schools, and for transportation and recreation in communities

From Kushi, L. H., Byers, T., Doyle, C., et al. (2006). American Cancer Society guidelines on nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer Journal for Clinicians, 56*(5), 254–281, with permission.

and secondary prevention of cancer. Nurses must be aware of factors such as race, cultural influences, access to care, patient–physician and patient–nurse relationships, level of education, income, and age that influence the knowledge, attitudes, and beliefs individuals have about cancer. These factors also may affect the health-promoting behaviors that people practice.

## Primary Prevention

Primary prevention is concerned with reducing the risks of disease through health promotion strategies. It is estimated that almost one third of all cancers worldwide could be prevented through primary prevention efforts (Williams-Brown & Singh, 2005). By acquiring the knowledge and skills necessary to educate the community about cancer risk, nurses in all settings play a key role in cancer prevention. One way to reduce the risk of cancer is to help patients avoid known carcinogens. Another strategy involves encouraging patients to make dietary and lifestyle changes (smoking cessation, decreased caloric intake, increased physical activity) that studies show influence the risk for cancer. Nurses use their teaching and counseling skills to provide patient education and support public education campaigns through organizations, such as the ACS, that guide patients and families in taking steps to reduce cancer risks through health promotion behaviors (Chart 16-2).

Several clinical trials have been conducted to identify medications or supplements that may help reduce the incidence of certain types of cancer. For example, large-scale breast cancer prevention studies supported by the National Cancer Institute (NCI) indicated that chemoprevention with the medication tamoxifen (Nolvadex) can reduce the incidence of breast cancer by 50% in women at high risk for breast cancer (Fisher, Constantino, Wickerham, et al., 2005). Currently, the NCI (2008) lists 110 ongoing clinical trials exploring chemoprevention strategies.

## Secondary Prevention

Secondary prevention programs promote screening and early detection activities such as breast and testicular self-examination and Papanicolaou (Pap) tests. Many organizations conduct cancer screening events that focus on cancers with the highest incidence rates or those that have improved survival rates if diagnosed early, such as breast or prostate cancer. These events offer education and examinations such as mammograms, digital rectal examinations, and PSA blood tests for minimal or no cost. These programs often target people who lack access to health care insurance or who cannot afford to participate on their own.

The evolving understanding of the role of genetics in cancer cell development has contributed to prevention and screening efforts. Many centers across the country are offering innovative cancer risk evaluation programs that provide in-depth screening and follow-up screening for people who are found to be at high risk for cancer. Nurses in all settings can develop programs that identify risks for patients and families and that incorporate teaching and counseling into all educational efforts, particularly for patients and families with a high incidence of cancer. Nurses and physicians can encourage people to comply with detection efforts as suggested by the ACS (Table 16-2).

**Table 16-2 AMERICAN CANCER SOCIETY (ACS) RECOMMENDATIONS FOR THE EARLY DETECTION OF CANCER IN AVERAGE-RISK ASYMPTOMATIC PEOPLE**

| Cancer Site | Population | Test or Procedure | Frequency |
|---|---|---|---|
| Breast | Women, aged ≥20 years | Breast self-examination (BSE) | Beginning in their early 20s, women should be told about the benefits and limitations of BSE. The importance of prompt reporting of any new breast symptoms to a health professional should be emphasized. Women who choose to do BSE should receive instruction and have their technique reviewed on the occasion of a periodic health examination. It is acceptable for women to choose not to do BSE or to do BSE irregularly. |
| | | Clinical breast examination (CBE) | For women in their 20s and 30s, it is recommended that CBE be part of a periodic health examination, preferably at least every 3 years. Asymptomatic women aged ≥40 years should continue to receive a clinical breast examination as part of a periodic health examination, preferably annually. |
| | | Mammography | Begin annual mammography at age 40 years.* |
| Colorectal | Men and women, aged ≥50 years | Fecal occult blood test (FOBT)† *or* fecal immunochemical test (FIT), *or* Flexible sigmoidoscopy, *or* Fecal occult blood test (FOBT)† and flexible sigmoidoscopy,‡ *or* contrast barium enema (DCBE), *or* | Annual, starting at age 50 years<br>Every 5 years, starting at age 50 years<br>Annual FOBT (or FIT) and flexible sigmoidoscopy every 5 years, starting at age 50 years<br>DCBE every 5 years, starting at age 50 years<br>Colonoscopy every 10 years, starting at age 50 years |
| Prostate | Men, aged ≥50 years | Digital rectal examination (DRE) and prostate-specific antigen (PSA) test | The PSA test and the DRE should be offered annually, starting at age 50 years, for men who have a life expectancy of at least 10 years§ |
| Cervix | Women, aged ≥18 years | Pap test | Cervical cancer screening should begin approximately 3 years after a woman begins having vaginal intercourse, but no later than age 21 years. Screening should be done every year with conventional Pap tests or every 2 years using liquid-based Pap tests. At or after age 30 years, women who have had normal test results in a row may get screened every 2 to 3 years with cervical cytology (either conventional or liquid-based Pap test) alone, or every 3 years with a human papillomavirus DNA test, plus cervical cytology. Women aged ≥70 years who have had or more normal Pap tests and no abnormal Pap tests in the 10 years and women who have had a total hysterectomy may choose to stop cervical cancer screening. |
| Endometrial | Women, at menopause | At the time of menopause, women at average risk should be informed about risks and symptoms of endometrial cancer and strongly encouraged to report any unexpected bleeding or spotting to their physicians. | |
| Cancer-related checkup | Men and women, aged ≥20 years | On the occasion of a periodic health examination, the cancer-related check-up should include examination for cancers of the thyroid, testicles, ovaries, lymph nodes, oral cavity, and skin, as well as health counseling about tobacco, sun exposure, diet and nutrition, risk factors, sexual practices, and environmental and occupational exposures. | |

*Beginning at age 40 years, annual clinical breast examination should be performed prior to mammography.

†FOBT, as it is sometimes done in physicians' offices with the single stool sample collected on a fingertip during a DRE, is not an adequate substitute for the recommended at-home procedure of collecting two samples from three consecutive specimens, and is not recommended. Toilet bowl FOBT tests also are not recommended. In comparison with guaiac-based tests for the detection of occult blood, immunochemical tests are more patient-friendly and are likely to be equal or better in sensitivity and specificity. There is no justification for repeating FOBT in response to an initial positive finding. Patients with a positive screening FOBT should undergo colonoscopy.

‡Flexible sigmoidoscopy together with FOBT is preferred compared with FOBT or flexible sigmoidoscopy alone.

§Information should be provided to men about the benefits and limitations of testing so that an informed decision about testing can be made with the clinician's assistance.

From Smith, R. A., Cokkinides, V. & Eyre, H. J. (2007). Cancer screening in the United States, 2007: A review of current guidelines, practices and prospects. *CA Cancer Journal for Clinicians*, *57*(2), 90–104, with permission.

## Diagnosis of Cancer

A cancer diagnosis is based on assessment of physiologic and functional changes and results of the diagnostic evaluation. Patients with suspected cancer undergo extensive testing to (1) determine the presence and extent of tumor, (2) identify possible spread (metastasis) of disease or invasion of other body tissues, (3) evaluate the function of involved and uninvolved body systems and organs, and (4) obtain tissue and cells for analysis, including evaluation of tumor stage and grade. The diagnostic evaluation includes a review of systems, physical examination, imaging studies, laboratory tests of blood, urine and other body fluids, and surgical and pathology reports. Knowledge of suspicious symptoms and of the behavior of particular types of cancer assists in determining relevant diagnostic tests (Table 16-3).

Patients undergoing extensive testing may be fearful of the procedures and anxious about the possible test results. Nurses help relieve the patient's fear and anxiety by explaining the tests to be performed, the sensations likely to be experienced, and the patient's role in the test procedures. The nurse encourages the patient and family to voice their fears about the test results, supports the patient and family throughout the test period, and reinforces and clarifies information conveyed by the physician. The nurse also encourages the patient and family to communicate and share their concerns and to discuss their questions and concerns with one another.

## Tumor Staging and Grading

A complete diagnostic evaluation includes identifying the stage and grade of the tumor. This is accomplished prior to treatment to provide baseline data for evaluating outcomes of therapy and to maintain a systematic and consistent approach to ongoing diagnosis and treatment. Treatment options and prognosis are based on staging and grading.

**Staging** determines the size of the tumor and the existence of local invasion and distant metastasis. Several systems exist for classifying the anatomic extent of disease. The tumor, nodes, and metastasis (TNM) system is frequently used (American Joint Committee on Cancer, 2006) (Chart 16-3). A variety of other staging systems are also used to describe the extent of cancers, such as central nervous system (CNS) cancers, hematologic cancers, and malignant melanoma, which are not well described by the TNM system. Staging systems also provide a convenient shorthand notation that condenses lengthy descriptions into manageable terms for comparisons of treatments and prognoses.

**Table 16-3 DIAGNOSTIC AIDS USED TO DETECT CANCER**

| Test | Description | Examples of Diagnostic Uses |
|---|---|---|
| Tumor marker identification | Analysis of substances found in body—tissues, blood, or other body fluids that are made by the tumor or by the body in response to the tumor | Breast, colon, lung, ovarian, testicular, prostate cancers |
| Genetic profiling | Analysis for the presence of mutations (alterations) in genes found in tumors or body tissues. Assists in diagnosis, selection of treatment, prediction of response to therapy, and risk of progression or recurrence | Breast, lung, kidney, ovarian, brain cancers, leukemia, and lymphoma (many uses of genetic profiling are considered investigational) |
| Mammography | Use of x-ray images of the breast | Breast cancer |
| Magnetic resonance imaging (MRI) | Use of magnetic fields and radiofrequency signals to create sectioned images of various body structures | Neurologic, pelvic, abdominal, thoracic, breast cancers |
| Computed tomography (CT) | Use of narrow-beam x-ray to scan successive layers of tissue for a cross-sectional view | Neurologic, pelvic, skeletal, abdominal, thoracic cancers |
| Fluoroscopy | Use of x-rays that identify contrasts in body tissue densities; may involve the use of contrast agents | Skeletal, lung, gastrointestinal cancers |
| Ultrasonography (ultrasound) | High-frequency sound waves echoing off body tissues are converted electronically into images; used to assess tissues deep within the body | Abdominal and pelvic cancers |
| Endoscopy | Direct visualization of a body cavity or passageway by insertion of an endoscope into a body cavity or opening; allows tissue biopsy, fluid aspiration, and excision of small tumors. Used for diagnostic and therapeutic purposes | Bronchial, gastrointestinal cancers |
| Nuclear medicine imaging | Uses intravenous injection or ingestion of radioisotope substances followed by imaging of tissues that have concentrated the radioisotopes | Bone, liver, kidney, spleen, brain, thyroid cancers |
| Positron emission tomography (PET) | Through the use of a tracer, provides black and white or color-coded images of the biologic activity of a particular area, rather than its structure. Used in detection of cancer or its response to treatment | Lung, colon, liver, pancreatic, head and neck cancers; Hodgkin and non-Hodgkin lymphoma and melanoma |
| PET fusion | Use of a PET scanner and a CT scanner in one machine to provide an image combining anatomic detail, spatial resolution, and functional metabolic abnormalities | See PET |
| Radioimmunoconjugates | Monoclonal antibodies are labeled with a radioisotope and injected intravenously into the patient; the antibodies that aggregate at the tumor site are visualized with scanners | Colorectal, breast, ovarian, head and neck cancers; lymphoma and melanoma |

### Chart 16-3 • *TNM Classification System*

T The extent of the primary tumor
N The absence or presence and extent of regional lymph node metastasis
M The absence or presence of distant metastasis

The use of numerical subsets of the TNM components indicates the progressive extent of the malignant disease.

**Primary Tumor (T)**

Tx Primary tumor cannot be assessed
T0 No evidence of primary tumor
Tis Carcinoma in situ
T1, T2, T3, T4 Increasing size and/or local extent of the primary tumor

**Regional Lymph Nodes (N)**

Nx Regional lymph nodes cannot be assessed
N0 No regional lymph node metastasis
N1, N2, N3 Increasing involvement of regional lymph nodes

**Distant Metastasis (M)**

Mx Distant metastasis cannot be assessed
M0 No distant metastasis
M1 Distant metastasis

From American Joint Committee on Cancer. (2006). *AJCC cancer staging atlas.* Chicago: Springer Science and Business Media, Inc.

**Grading** refers to the classification of the tumor cells. Grading systems seek to define the type of tissue from which the tumor originated and the degree to which the tumor cells retain the functional and histologic characteristics of the tissue of origin (differentiation). Samples of cells used to establish the grade of a tumor may be obtained from tissue scrapings, body fluids, secretions, or washings, biopsy, or surgical excision. This information helps the health care team predict the behavior and prognosis of various tumors. The tumor is assigned a numeric value ranging from I to IV. Grade I tumors, also known as well-differentiated tumors, closely resemble the tissue of origin in structure and function. Tumors that do not clearly resemble the tissue of origin in structure or function are described as poorly differentiated or undifferentiated and are assigned grade IV. These tumors tend to be more aggressive and less responsive to treatment than well-differentiated tumors.

# *Management of Cancer*

Treatment options offered to cancer patients should be based on treatment goals for each specific type of cancer. The range of possible treatment goals may include complete eradication of malignant disease (**cure**), prolonged survival and containment of cancer cell growth (**control**), or relief of symptoms associated with the disease (**palliation**).

The health care team, the patient, and the patient's family must have a clear understanding of the treatment options and goals. Open communication and support are vital as the patient and family periodically reassess treatment plans and goals when complications of therapy develop or disease progresses.

Multiple modalities are commonly used in cancer treatment. A variety of approaches, including surgery, radiation therapy, chemotherapy, and targeted therapies, may be used at various times throughout treatment. Understanding the principles of each and how they interrelate is important in understanding the rationale and goals of treatment.

## Surgery

Surgical removal of the entire cancer remains the ideal and most frequently used treatment method. However, the specific surgical approach may vary for several reasons. Diagnostic surgery is the definitive method of identifying the cellular characteristics that influence all treatment decisions. Surgery may be the primary method of treatment, or it may be prophylactic, palliative, or reconstructive.

### *Diagnostic Surgery*

Diagnostic surgery, such as a **biopsy,** is usually performed to obtain a tissue sample for analysis of cells suspected to be malignant. In most instances, the biopsy is taken from the actual tumor, but in some situations, it is necessary to biopsy lymph nodes near the suspicious tumor. Many cancers can metastasize from the primary site to other areas of the body through the lymphatic circulation. Knowing whether adjacent lymph nodes contain tumor cells helps physicians plan for systemic therapies instead of or in addition to surgery or radiation, to combat tumor cells that have gone beyond the primary tumor site. The use of injectable dyes and nuclear medicine imaging can help the surgeon identify the sentinel lymph node or the initial lymph node to which the primary tumor and surrounding tissue drains. Sentinel lymph node biopsy (SLNB), also known as sentinel lymph node mapping, is a minimally invasive surgical approach that in some instances has replaced more invasive lymph node dissections (lymphadenectomy) and their associated complications such as lymphedema and delayed healing. SLNB has been widely adopted for regional lymph node staging in selected cases of melanoma and breast cancer (Chen, Iddings, Scheri, et al., 2006).

#### Biopsy Types

The three most common biopsy methods are the excisional, incisional, and needle methods (Szopa, 2005). The choice of biopsy is determined by the size and location of the tumor, the type of treatment anticipated if the cancer diagnosis is confirmed, and the need for surgery and general anesthesia. The biopsy method that allows for the least invasive approach while permitting the most representative tissue sample is chosen. Occasionally diagnostic imaging techniques are used to assist in locating the suspicious lesion and to facilitate accurate tissue sampling. The patient and family are given the opportunity and time to discuss the options before definitive plans are made. The nurse serves as the patient's advocate and liaison between the patient and physician to facilitate this process.

Excisional biopsy is most frequently used for easily accessible tumors of the skin, breast, and upper or lower gastrointestinal and upper respiratory tracts. In many cases, the surgeon can remove the entire tumor as well as the surrounding marginal tissues. The removal of normal tissue beyond the tumor area decreases the possibility that residual microscopic disease cells may lead to a recurrence of the tumor. This approach not only provides the pathologist, who

stages and grades the cells, with the entire tissue specimen but also decreases the chance of seeding the tumor (disseminating cancer cells throughout surrounding tissues).

Incisional biopsy is performed if the tumor mass is too large to be removed. In this case, a wedge of tissue from the tumor is removed for analysis. The cells of the tissue wedge must be representative of the tumor mass so that the pathologist can provide an accurate diagnosis. If the specimen does not contain representative tissue and cells, negative biopsy results do not guarantee the absence of cancer.

Excisional and incisional approaches are often performed through endoscopy. However, surgical incision may be required to determine the anatomic extent or stage of the tumor. For example, a diagnostic or staging laparotomy (the surgical opening of the abdomen to assess malignant abdominal disease) may be necessary to assess malignancies such as gastric cancer.

Needle biopsies are performed to sample suspicious masses that are easily accessible, such as some growths in the breasts, thyroid, lung, liver, and kidney. Needle biopsies are most often performed on an outpatient basis. They are fast, relatively inexpensive, easy to perform, and usually require only local anesthesia. In general, the patient experiences slight and temporary physical discomfort. In addition, the surrounding tissues are disturbed only minimally, thus decreasing the likelihood of seeding cancer cells. Needle aspiration biopsy involves aspirating tissue fragments through a needle guided into an area suspected of bearing disease. Occasionally, x-ray, computed tomography (CT) scanning, ultrasonography, or magnetic resonance imaging (MRI) is used to help locate the suspicious area and guide the placement of the needle. In some instances, the aspiration biopsy does not yield enough tissue to permit accurate diagnosis. A needle core biopsy uses a specially designed needle to obtain a small core of tissue. Most often, this specimen is sufficient to permit accurate diagnosis.

### Surgery as Primary Treatment

When surgery is the primary approach in treating cancer, the goal is to remove the entire tumor or as much as is feasible (a procedure sometimes called debulking) and any involved surrounding tissue, including regional lymph nodes.

Two common surgical approaches used for treating primary tumors are local and wide excisions. Local excision, often performed on an outpatient basis, is warranted when the mass is small. It includes removal of the mass and a small margin of normal tissue that is easily accessible. Wide or radical excisions (en bloc dissections) include removal of the primary tumor, lymph nodes, adjacent involved structures, and surrounding tissues that may be at high risk for tumor spread (Szopa, 2005). This surgical method can result in disfigurement and altered functioning, necessitating rehabilitation or reconstructive procedures. However, wide excisions are considered if the tumor can be removed completely and the chances of cure or control are good.

Video-assisted endoscopic surgery is increasingly replacing surgery associated with long incisions and extended recovery periods to minimize surgical trauma and shorten patient recovery time without compromising surgical outcomes (Swanson, Herndon, D'Amico, et al., 2007). In this minimally invasive procedure, an endoscope with intense lighting and an attached multichip mini-camera is inserted into the body through a small incision. The surgical instruments are inserted into the surgical field through one or two additional small incisions, each about 3 cm in length. The camera transmits the image of the involved area to a monitor so the surgeon can manipulate the instruments to perform the necessary procedure. Such surgery is now being used for many thoracic and abdominal surgeries.

Salvage surgery is an additional treatment option that uses an extensive surgical approach to treat the local recurrence of a cancer after the use of a less extensive primary approach. A mastectomy to treat recurrent breast cancer after primary lumpectomy and radiation is an example of salvage surgery.

In addition to surgery that uses surgical blades or scalpels to excise the mass and surrounding tissues, several other types of surgical techniques are available. Table 16-4 identifies these techniques and provides examples of their use in the patient with cancer. A multidisciplinary approach to patient care is essential for the patient undergoing cancer-related surgery. The effects of surgery on the patient's body image, self-esteem, and functional abilities are addressed. If necessary, a plan for postoperative rehabilitation is made before the surgery is performed.

The growth and dissemination of cancer cells may have produced distant micrometastases by the time the patient

**Table 16-4 SELECTED TECHNIQUES USED TO REMOVE OR DESTROY TUMORS**

| Type of Procedure | Description | Examples of Use |
|---|---|---|
| Electrosurgery | Use of an electric current to destroy tumor cells | Basal and squamous cell skin cancers |
| Cryosurgery | Use of liquid nitrogen or a very cold probe to freeze tissue and cause cell destruction | Cervical and prostate cancers |
| Chemosurgery | Use of chemicals or chemotherapy applied directly to tissue to cause destruction | Intraperitoneal chemotherapy for ovarian cancer involving the abdomen and peritoneum |
| Laser surgery | Use of light and energy aimed at an exact tissue location and depth to vaporize cancer cells (also referred to as photocoagulation or photoablation) | Dyspnea associated with endobronchial obstructions |
| Photodynamic therapy | Intravenous administration of a light-sensitizing agent (hematoporphyrin derivative [HPD]) that is taken up by cancer cells, followed by exposure to laser light within 24–48 hours; causes cancer cell death | Palliative treatment of dysphagia associated with esophageal and dyspnea associated with endobronchial obstructions |
| Radiofrequency ablation (RFA) | Uses localized application of thermal energy that destroys cancer cells through heat: temperatures exceed 50°C (122°F) | Nonresectable liver tumors, pain control with bone metastasis |

**Table 16-5 INDICATIONS FOR PALLIATIVE SURGERY**

| Procedure | Indications |
|---|---|
| Pleural drainage tube placement | Pleural effusion |
| Peritoneal drainage tube placement (Tenckhoff catheter) | Ascites |
| Abdominal shunt placement (Levine shunt) | Ascites |
| Pericardial drainage tube placement | Pericardial effusion |
| Colostomy or ileostomy | Bowel obstruction |
| Gastrostomy, jejunostomy tube placement | Upper gastrointestinal tract obstruction |
| Biliary stent placement | Biliary obstruction |
| Bone stabilization | Displaced bone fracture related to metastatic disease |
| Excision of solitary metastatic lesion | Metastatic lung, liver or brain lesion |
| Ureteral stent placement | Ureteral obstruction |
| Nerve block | Pain |
| Cordotomy | Pain |
| Venous access device placement (for administering parenteral analgesics) | Pain |
| Epidural catheter placement (for administering epidural analgesics) | Pain |
| Hormone manipulation (removal of ovaries, testes, adrenals, pituitary) | Tumors that depend on hormones for growth |

seeks treatment. Therefore, attempting to remove wide margins of tissue in the hope of "getting all the cancer" may not be feasible. This reality substantiates the need for a coordinated multidisciplinary approach to cancer therapy.

Once the surgery has been completed, one or more additional (or adjuvant) modalities may be chosen to increase the likelihood of destroying the remaining cancer cells. However, some cancers that are treated surgically in the very early stages (eg, skin and testicular cancers) are considered to be curable without additional therapies.

### Prophylactic Surgery

Prophylactic surgery involves removing nonvital tissues or organs that are at increased risk to develop cancer. The following factors are considered when physicians, nurses, patients, and families discuss possible prophylactic surgery:

- Family history and genetic predisposition
- Presence or absence of symptoms
- Potential risks and benefits
- Ability to detect cancer at an early stage
- The patient's acceptance of the postoperative outcome

Colectomy, mastectomy, and oophorectomy are examples of prophylactic surgeries. Identification of genetic markers indicative of a predisposition to develop some types of cancer plays a role in decisions concerning prophylactic surgeries. However, what is adequate justification for prophylactic surgery remains controversial. For example, several factors are considered when deciding to proceed with a prophylactic mastectomy, including a strong family history of breast cancer; positive *BRCA1* or *BRCA2* findings; an abnormal physical finding on breast examination, such as progressive nodularity and cystic disease; a proven history of breast cancer in the opposite breast; abnormal mammography findings; and abnormal biopsy results (Calhoun & Anderson, 2006). Prophylactic surgery is offered selectively to patients and discussed thoroughly with patients and families. Preoperative teaching and counseling, as well as long-term follow-up, are provided.

### Palliative Surgery

When cure is not possible, the goals of treatment are to make the patient as comfortable as possible and to promote quality of life as defined by the patient and his or her family. Palliative surgery is performed in an attempt to relieve complications of cancer, such as ulceration, obstruction, hemorrhage, pain, and malignant effusion (Table 16-5). Honest and informative communication with the patient and family about the goal of surgery is essential to avoid false hope and disappointment.

### Reconstructive Surgery

Reconstructive surgery may follow curative or radical surgery in an attempt to improve function or obtain a more desirable cosmetic effect. It may be performed in one operation or in stages. The surgeon who will perform the surgery discusses possible reconstructive surgical options with the patient before the primary surgery is performed. Reconstructive surgery may be indicated for breast, head and neck, and skin cancers.

The nurse recognizes the patient's needs and the impact that altered functioning and body image may have on quality of life. The nurse provides the patient and family with opportunities to discuss these issues. The individual needs of the patient undergoing reconstructive surgery must be accurately assessed and addressed.

### Nursing Management in Cancer Surgery

Patients undergoing surgery for cancer require general perioperative nursing care, as described in Unit 4 of this text, along with specific care related to age, organ impairment, nutritional deficits, disorders of coagulation, and altered immunity that may increase the risk of postoperative complications. Combining other treatment methods, such as radiation and chemotherapy, with surgery also contributes to postoperative complications, such as infection, impaired wound healing, altered pulmonary or renal function, and the development of deep vein thrombosis. In these situations, the nurse completes a thorough preoperative assessment for

factors that may affect the patient undergoing the surgical procedure.

Patients who are undergoing surgery for the diagnosis or treatment of cancer may be anxious about the surgical procedure, possible findings, postoperative limitations, changes in normal body functions, and prognosis. The patient and family require time and assistance to deal with the possible changes and outcomes resulting from the surgery.

The nurse provides education and emotional support by assessing the needs of the patient and family and by discussing their fears and coping mechanisms. The nurse encourages the patient and family to take an active role in decision making when possible. If the patient or family asks about the results of diagnostic testing and surgical procedures, the nurse's response is guided by the information the physician has previously conveyed to the patient and family. The patient and family may ask the nurse to explain and clarify information that the physician initially provided but that they did not grasp because they were anxious and overwhelmed at the time. It is important that the nurse communicate frequently with the physician and other members of the health care team to be certain that the information provided is consistent.

Postoperatively, the nurse assesses the patient's responses to the surgery and monitors the patient for possible complications, such as infection, bleeding, thrombophlebitis, wound dehiscence, fluid and electrolyte imbalance, and organ dysfunction. The nurse also provides for the patient's comfort. Postoperative teaching addresses wound care, activity, nutrition, and medication information.

Plans for discharge, follow-up, home care, and treatment are initiated as early as possible to ensure continuity of care from hospital to home or from a cancer referral center to the patient's local hospital and health care provider. Patients and families are encouraged to use community resources such as the American Cancer Society for support and information.

## Radiation Therapy

More than half of patients with cancer receive a form of **radiation therapy** at some point during treatment. Radiation may be used to cure cancer, as in thyroid carcinomas, localized cancers of the head and neck, and cancers of the uterine cervix. Radiation therapy may also be used to control malignant disease when a tumor cannot be removed surgically or when local nodal metastasis is present, or it can be used neoadjuvantly (prior to local definitive treatment) with or without chemotherapy to reduce the size of a tumor to enable surgical resection. Radiation therapy may be used prophylactically to prevent the spread of a primary cancer to a distant area (eg, irradiating the brain to prevent leukemic infiltration or metastatic lung cancer). Palliative radiation therapy is used to relieve the symptoms of metastatic disease, especially when the cancer has spread to the brain, bone, or soft tissue, or to treat oncologic emergencies, such as superior vena cava syndrome, bronchial airway obstruction, or spinal cord compression.

Two types of ionizing radiation—electromagnetic radiation (x-rays and gamma rays) and particulate radiation (electrons, beta particles, protons, neutrons, and alpha particles)—can lead to tissue disruption. The most harmful tissue disruption is the direct alteration of the DNA molecule within the cells of the tissue. Ionizing radiation breaks the strands of the DNA helix, leading to cell death. It can also lead to the formation of free radicals and irreversibly damage DNA. If the DNA is incapable of repair, the cell may die immediately, or it may initiate cellular suicide, a genetically programmed cell death (Bruner, Haas & Gosselin-Acomb, 2006; Yarbro, Hansen-Frogge & Goodman, 2005).

Cells are most vulnerable to the disruptive effects of radiation during DNA synthesis and mitosis (early S, $G_2$, and M phases of the cell cycle). Therefore, those body tissues that undergo frequent cell division are most sensitive to radiation therapy. These tissues include bone marrow, lymphatic tissue, epithelium of the gastrointestinal tract, hair cells, and gonads. Slower-growing tissues and tissues at rest (eg, muscle, cartilage, and connective tissues) are relatively radioresistant (less sensitive to the effects of radiation). However, it is important to remember that radiation therapy is localized treatment, and only the tissues that are within the treatment field will be affected by the radiation therapy.

A radiosensitive tumor is one that can be destroyed by a dose of radiation that still allows for cell regeneration in the normal tissue. Tumors that are well oxygenated also appear to be more sensitive to radiation. In theory, therefore, radiation therapy may be enhanced if more oxygen can be delivered to tumors. In addition, if the radiation is delivered when most tumor cells are cycling through the cell cycle, the number of cancer cells destroyed (cell kill) is maximal. Radiation sensitivity is also enhanced in tumors that are smaller in size and that contain cells that are rapidly dividing (highly proliferative) and poorly differentiated (no longer resembling the tissue of origin) (Bruner, et al., 2006).

Certain chemicals, including chemotherapy agents, act as radiosensitizers and sensitize hypoxic (oxygen-poor) tumors to the effects of radiation therapy. Combinations of chemotherapy and radiation therapy are typically used to take advantage of the radiosensitizing effects of chemotherapy and achieve an improved survival benefit while minimizing side effects of such therapy.

### Radiation Dosage

The radiation dosage depends on the sensitivity of the target tissues to radiation, the size of the tumor, tissue tolerance of the surrounding normal tissues, and critical structures adjacent to the tumor target. The lethal tumor dose is defined as that dose that will eradicate 95% of the tumor yet preserve normal tissue. In external beam radiation, the total radiation dose is delivered over several weeks in daily doses called fractions. This allows healthy tissue to repair and to achieve greater cell kill by exposing more cells to the radiation as they begin active cell division. Repeated radiation treatments over time (fractionated doses) also allow for the periphery of the tumor to be reoxygenated repeatedly, because tumors shrink from the outside inward. This increases the radiosensitivity of the tumor, thereby increasing tumor cell death (Bruner, et al., 2006; Yarbro, et al., 2005).

### Administration of Radiation

Radiation therapy can be administered in a variety of ways depending on the source of radiation used, the location of the tumor, and the type of cancer targeted. The primary

applications include teletherapy (external beam radiation), **brachytherapy** (internal radiation), systemic (radioisotopes), and contact or surface molds.

### External Radiation

External beam radiation therapy (EBRT) is the most commonly used form of radiation therapy. The energy utilized in EBRT is either generated from a linear accelerator or from a unit that generates energy directly from a core source of radioactive material such as a GammaKnife™ unit. Through computerized software programs, both approaches are able to shape an invisible beam of highly charged electrons to penetrate the body and target a tumor with pinpoint accuracy. Depending on the size, shape, and location of the tumor, different energy levels are generated to produce a carefully shaped beam that will destroy the targeted tumor, yet spare the surrounding healthy tissue and vital organs in an effort to reduce the treatment toxicities for the patient. With advances in computer technology, these beams can be shaped to a two-dimensional or three-dimensional shape to conform to the exact shape of the tumor as measured by imaging studies such as positron emission tomography (PET), CT, or MRI scans. Recent treatment enhancements in EBRT include the ability to direct different energy levels at different angles directed at the tumor, called intensity modulated radiation therapy (IMRT), which enables higher doses to be delivered to the tumor while sparing the important healthy structures surrounding the tumor. IMRT can be administered as standard daily fractions or as "hyperfractionated" twice daily fractions, which shortens the duration of the patient's treatment schedule. Image-guided radiation therapy (IGRT) uses continuous monitoring of the tumor with ultrasound or CT scans during the treatment to allow for automatic adjustment of the target as the tumor changes shape or position, again in an effort to spare the healthy surrounding tissue and reduce side effects (Sharpe, Craig & Moseley, 2007). The most recent treatment enhancements now include respiratory–gating, where the treatment delivery is actually synchronized with the patient's respiratory cycle, enabling the beam to be adjusted as the tumor moves (Dawson & Jaffray, 2007).

Gamma rays generated from the spontaneous decay of naturally occurring solid source of radioactivity, such as cobalt-60, is one of the oldest forms of EBRT. With the advent of modern linear accelerators, the use of solid radioactive elements are confined primarily to the GammaKnife™ stereotactic radiosurgery unit, which is used as a one-time, high-dose delivery of EBRT for treatment of benign and malignant intracranial lesions.

Stereotactic body radiotherapy (SBRT) is another form of EBRT using higher doses of radiation to penetrate very deeply into the body to control deep-seated tumors that cannot be treated by other approaches such as surgery. SBRT is delivered with considerably higher treatment fraction doses over a short span of time, usually 1 to 5 treatment days, in contrast to 6 to 8 weeks for conventional EBRT (Timmerman, Kavanagh, Cho, et al., 2007). Specialized linear accelerators with the capability of robotically moving around the patient are used to deliver SBRT, such as the CyberKnife™, Trilogy™, and TomoTherapy™ delivery systems, which are being utilized more commonly in community hospital settings.

Proton therapy is another very different approach to EBRT. Proton therapy utilizes high-linear energy transfer (LET) in the form of charged protons generated by a large magnetic unit called a cyclotron. The advantage of proton therapy is that it is capable of delivering its high-energy dose to a deep-seated tumor, with no energy exiting through the patient's healthy tissue behind the tumor, allowing for treatment of deep tumors in close proximity to critical structures such as the heart or major blood vessels (Thornton, Fitzek, Klein, et al., 2007). Due to the limited number of proton units in the United States, most treatment has been investigational in the area of localized prostate cancer, inoperable early stage lung cancer, uveal melanoma, and head and neck tumors. With recent expansion in the number of proton therapy centers, investigation of treatment advantages utilizing proton therapy will be a research priority in the future (Schulz-Ertner & Tsujii, 2007).

### Internal Radiation

Internal radiation implantation, or brachytherapy, delivers a high dose of radiation to a localized area. The specific radioisotope for implantation is selected on the basis of its half-life, which is the time it takes for half of its radioactivity to decay. Internal radiation can be implanted by means of needles, seeds, beads, or catheters into body cavities (vagina, abdomen, pleura) or interstitial compartments (breast, prostate). Patients may have many fears or concerns about internal radiation and the nurse must be prepared to explain the various approaches and safety precautions that will be used to protect both the patient and the staff.

Brachytherapy may be delivered as a temporary or a permanent implant. Temporary applications may be delivered as high-dose radiation (HDR) for short periods of time or low-dose radiation (LDR) for a more extended period of time. The primary advantage of HDR sources of brachytherapy is that treatment time is shorter, there is reduced exposure to personnel, and the procedure can typically be performed as an outpatient procedure over several days. HDR brachytherapy can be used for intraluminal, interstitial, intracavitary, and surface lesions.

Intraluminal brachytherapy involves the insertion of catheters or hollow tubes into the lumens of organs so that the radioisotope can be delivered as close to the tumor bed as possible. Obstructive lesions in the bronchus, esophagus, or bile duct can be treated with this approach. Contact or surface application is used for treatment of tumors of the eye such as retinoblastoma in children or ocular melanoma in adults.

Intracavitary radioisotopes are frequently used to treat gynecologic cancers. In these malignancies, the radioisotopes are inserted into specially positioned applicators after their placement is verified by x-ray. Treatment can be achieved with either HDR or LDR brachytherapy sources depending on the extent of disease. LDR therapy requires hospitalization as the patient is treated over several days. Nursing care of the hospitalized LDR patient is essential to maximize effective safe delivery of the therapy and prevention of complications. The patient is maintained on bed rest in a specially prepared private room typically for 72 hours and log-rolled to prevent displacement of the intracavitary

delivery device. An indwelling urinary catheter is inserted to ensure that the bladder remains empty. Low-residue diets and antidiarrheal agents are provided to prevent bowel movements during therapy, which would displace the radioisotopes. Visitors and personnel must limit their time and proximity to the patient due to the risk of radiation exposure. HDR intracavitary brachytherapy is typically delivered as an outpatient procedure in the radiation therapy department over several days.

Interstitial implants, used in treating such malignancies as prostate, pancreatic, or breast cancer, may be temporary or permanent, depending on the radioisotopes used. These implants usually consist of seeds, needles, wires, or small catheters positioned to provide a local radiation source and are infrequently dislodged. With internal radiation therapy, the farther the tissue is from the radiation source, the lower the dosage delivered to the tissue. This spares the noncancerous tissue from the radiation dose. Prostate seed therapy is probably the most frequently used type of interstitial brachytherapy, where small radioactive seeds are placed directly into the prostate gland under ultrasound guidance. These seeds are permanently placed and appropriate safety precautions must be employed for several days due to the risk of radiation exposure to others. Recently, partial breast irradiation utilizing a technique for interstitial isotope employing the MammoSite™ device has shown benefit in certain localized breast cancers. MammoSite™ involves the placement of an inflatable balloon within the cavity created after surgical resection of the breast tumor. HDR brachytherapy fractions are delivered via a radioactive seed inserted into the balloon over the course of 5 days. Studies have shown comparable 5-year outcomes for selected patients, with minimal toxicities and excellent cosmesis, when compared with outcomes with whole breast EBRT for postlumpectomy patients. The advantages for patients are reduced treatment time (5 days versus 6 to 8 weeks), less radiation exposure to healthy tissues and adjacent organs (heart and lungs), less skin reaction, and improved cosmesis of the breast. Nursing care for these patients must include instruction in rigorous catheter care and wound management, as the patient is treated as an outpatient with a double-lumen catheter projecting from the breast (Benitez, Keisch, Vicini, et al., 2007).

Systemic brachytherapy involves the IV administration of a therapeutic radioactive isotope targeted to a specific tumor. Radioactive iodine ($I^{131}$) is a widely used form of systemic brachytherapy and is the primary treatment for thyroid cancer. Strontium 89 is utilized for bone metastases, samarium 153 is used for metastatic bone lesions, and phosphorus 32 is used for treatment of malignant ascites associated with ovarian cancer. Radioisotopes are now also being used as radioimmunotherapy for the treatment of refractory non-Hodgkin lymphoma (NHL). Radioimmunotherapy involves the administration of a radionuclide chemically conjugated (bound) to a monoclonal antibody (discussed later in this chapter) that specifically targets NHL tumor cells, delivering the radionuclide directly to the tumor and sparing the surrounding healthy tissue. There are currently two radioimmunotherapy agents available for treatment of NHL: ibritumomab tiuxetan (Zevalin), which utilizes yttrium 90 as the radioactive beta emitting nucleotide, and iodine 131 tositumomab (Bexxar), which utilizes $I^{131}$ as the beta and gamma emitting radionuclide.

### Toxicity

Toxicity of radiation therapy is localized to the region being irradiated. Toxicity may be increased if concomitant chemotherapy is administered. Acute local reactions occur when normal cells in the treatment area are also destroyed and cellular death exceeds cellular regeneration. Body tissues most affected are those that normally proliferate rapidly, such as the skin; the epithelial lining of the gastrointestinal tract, including the oral cavity; and the bone marrow. Altered skin integrity is a common effect and can include **alopecia** (hair loss). Skin reactions are identified and graded by severity along a continuum ranging from erythema and dry desquamation (flaking of skin), to moist desquamation (dermis exposed, skin oozing serous fluid), and potentially, ulceration. Re-epithelialization occurs after treatments have been completed (McQuestion, 2006).

Alterations in oral mucosa secondary to radiation therapy include **stomatitis** (inflammation of the oral tissues), **xerostomia** (dryness of the mouth), change and loss of taste, and decreased salivation. The entire gastrointestinal mucosa may be involved, and esophageal irritation with chest pain and dysphagia may result. Anorexia, nausea, vomiting, and diarrhea may occur if the stomach or colon is in the irradiated field. Symptoms subside and gastrointestinal re-epithelialization occurs after treatments have been completed.

Bone marrow cells proliferate rapidly, and if sites containing bone marrow (eg, the iliac crest, sternum) are included in the radiation field, anemia, leukopenia (decreased white blood cells [WBCs]), and **thrombocytopenia** (a decrease in platelets) may result. The patient is then at increased risk for infection and bleeding until blood cell counts return to normal. Chronic anemia may occur (Bruner, et al., 2006; Yarbro, et al., 2005).

Research to develop cytoprotective agents that can protect normal tissue from radiation damage continues. The most commonly used cytoprotectant is amifostine (Ethyol), which is utilized in head and neck cancer patients to reduce acute and chronic xerostomia while preserving antitumor efficacy (Bruner, et al., 2006; Hogle, 2007).

Certain systemic side effects are also commonly experienced by patients receiving radiation therapy. These side effects include fatigue, malaise, and anorexia and may be secondary to substances released when tumor cells break down. The effects are temporary and most often subside with the cessation of treatment.

Late effects (months to years after treatment) of radiation therapy may also occur in various body tissues. These effects are chronic, usually produce fibrotic changes secondary to a decreased vascular supply, and are irreversible. Severe late effects may affect the lungs, heart, central nervous system, and bladder. Toxicities may intensify when radiation is combined with other treatment modalities.

### Nursing Management in Radiation Therapy

The nurse assesses the patient's skin and oropharyngeal mucosa regularly when radiation therapy is directed to these areas. In addition, nutritional status and general feeling of

well-being are assessed throughout the course of treatment. Evidence-based treatment protocols for nursing management of the toxicities associated with radiation therapy are the focus of nursing research. Assessment and management of these problems are discussed in more detail in the Plan of Nursing Care: The Patient With Cancer (Chart 16-7).

If systemic symptoms, such as weakness and fatigue, occur, the nurse explains that these symptoms are a result of the treatment and do not represent deterioration or progression of the disease. The assessment and nursing management of fatigue is discussed in more detail in the Nursing Care of Patients With Cancer: Fatigue (p. 380).

### Protecting Caregivers

When the patient has a radioactive implant in place, the nurse and other health care providers need to protect themselves as well as the patient from the effects of radiation. Patients receiving internal radiation emit radiation while the implant is in place; therefore, contact with the health care team is guided by principles of time, distance, and shielding to minimize exposure of personnel to radiation. Specific instructions are usually provided by the radiation safety officer from the x-ray department and specify the maximum time that can be spent safely in the patient's room, the shielding equipment to be used, and special precautions and actions to be taken if the implant is dislodged. Safety precautions used in caring for a patient receiving brachytherapy include assigning the patient to a private room, posting appropriate notices about radiation safety precautions, having staff members wear dosimeter badges, making sure that pregnant staff members are not assigned to the patient's care, prohibiting visits by children or pregnant visitors, limiting visits from others to 30 minutes daily, and seeing that visitors maintain a 6-foot distance from the radiation source.

Patients with seed implants typically are able to return home; radiation exposure to others is minimal. Information about any precautions, if needed, is provided to the patient and family members to ensure safety. Depending on the dose and energy emitted by a systemic radionuclide, patients may or may not require special precautions or hospitalization (Bruner, et al., 2006). The nurse should explain the rationale for these precautions to keep the patient from feeling unduly isolated.

## Chemotherapy

In **chemotherapy,** antineoplastic agents are used in an attempt to destroy tumor cells by interfering with cellular functions, including replication. Chemotherapy is used primarily to treat systemic disease rather than localized lesions that are amenable to surgery or radiation. Chemotherapy may be combined with surgery, radiation therapy, or both to reduce tumor size preoperatively (neoadjuvant), to destroy any remaining tumor cells postoperatively (adjuvant), or to treat some forms of leukemia or lymphoma (primary). The goals of chemotherapy (cure, control, palliation) must be realistic because they will determine the medications that are used and the aggressiveness of the treatment plan.

### Cell Kill and the Cell Cycle

Each time a tumor is exposed to a chemotherapy agent, a percentage of the tumor cells (20% to 99%, depending on dosage) is destroyed. Repeated doses of chemotherapy are necessary over a prolonged period to achieve regression of the tumor. Eradication of 100% of the tumor is almost impossible. Instead, the goal of treatment is eradication of enough of the tumor so that the remaining tumor cells can be destroyed by the body's immune system.

Actively proliferating cells within a tumor are the most sensitive to chemotherapeutic agents (the ratio of dividing cells to resting cells is referred to as the growth fraction). Nondividing cells capable of future proliferation are the least sensitive to antineoplastic medications and consequently are potentially dangerous. However, the nondividing cells must be destroyed to eradicate a cancer. Repeated cycles of chemotherapy or sequencing of multiple chemotherapeutic agents are used to kill more tumor cells by destroying these nondividing cells as they begin active cell division.

Reproduction of both healthy and malignant cells follows the cell cycle pattern (Fig. 16-2). The cell cycle time is the time required for one tissue cell to divide and reproduce two identical daughter cells. The cell cycle of any cell has four distinct phases, each with a vital underlying function:

1. $G_1$ phase—RNA and protein synthesis occur
2. S phase—DNA synthesis occurs

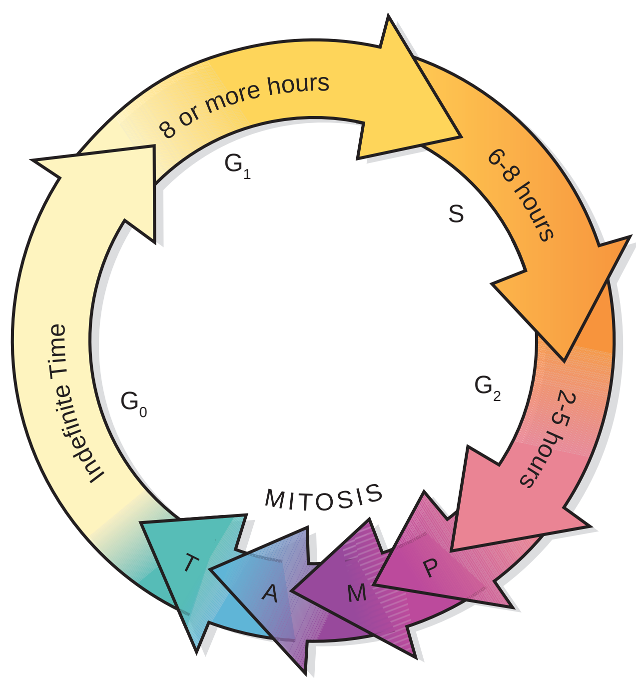



**Figure 16-2** Phases of the cell cycle extend over the interval between the midpoint of mitosis and the subsequent end point in mitosis in a daughter cell. $G_1$ is the postmitotic phase during which ribonucleic acid (RNA) and protein syntheses are increased and cell growth occurs. $G_0$ is the resting, or dormant, phase of the cell cycle. In the S phase, nucleic acids are synthesized and chromosomes are replicated in preparation for cell mitosis. During $G_2$, RNA and protein synthesis occur as in $G_1$. P, prophase; M, metaphase; A, anaphase; T, telophase. Redrawn from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

3. $G_2$ phase—premitotic phase; DNA synthesis is complete, mitotic spindle forms
4. Mitosis—cell division occurs

The $G_0$ phase, the resting or dormant phase of cells, can occur after mitosis and during the $G_1$ phase. Within the $G_0$ phase are those dangerous cells that are not actively dividing but have the potential for replicating. The administration of certain chemotherapeutic agents (as well as some other forms of therapy) is coordinated with the cell cycle.

### Classification of Chemotherapeutic Agents

Chemotherapeutic agents may be classified by their relationship to the cell cycle. Certain chemotherapeutic agents that are specific to certain phases of the cell cycle are termed cell cycle–specific agents. These agents destroy cells that are actively reproducing by means of the cell cycle; most affect cells in the S phase by interfering with DNA and RNA synthesis. Other agents, such as the vinca or plant alkaloids, are specific to the M phase, where they halt mitotic spindle formation. Chemotherapeutic agents that act independently of the cell cycle phases are termed cell cycle–nonspecific agents. These agents usually have a prolonged effect on cells, leading to cellular damage or death. Many treatment plans combine cell cycle–specific and cell cycle–nonspecific agents to increase the number of vulnerable tumor cells killed during a treatment period (Polovich, White & Kelleher, 2005).

Chemotherapeutic agents are also classified by chemical group, each with a different mechanism of action. These include the alkylating agents, nitrosoureas, antimetabolites, antitumor antibiotics, plant alkaloids, hormonal agents, and miscellaneous agents. The classification, mechanism of action, common drugs, cell cycle specificity, and common side effects of selected antineoplastic agents are listed in Table 16-6.

Chemotherapeutic agents from every category may be used to enhance tumor cell kill during therapy by creating multiple cellular lesions. Combined medication therapy relies on agents of differing toxicities and with synergistic actions. Use of combination therapy also prevents the development of drug-resistant mechanisms.

Combining older medications with other agents, such as levamisole (Ergamisole*), leucovorin (Wellcovorin), hormones, or interferons, has shown some benefit in combating resistance of cells to chemotherapeutic agents. Newer investigational agents are being studied for effectiveness in resistant tumor lines.

### Administration of Chemotherapeutic Agents

Chemotherapeutic agents may be administered in the hospital, outpatient center, or home setting by topical, oral, intravenous, intramuscular, subcutaneous, arterial, intracavitary, and intrathecal routes. The route of administration depends on the type of agent; the required dose; and the type, location, and extent of tumor being treated. Guidelines for the safe administration of chemotherapy have been developed by the Oncology Nursing Society (Polovich, et al., 2005). Patient education is essential to maximize safety if chemotherapy is administered in the home (Chart 16-4).

*Ergamisol (without an "e" at end) is not available in U.S.

#### Dosage

Dosage of antineoplastic agents is based primarily on the patient's total body surface area, previous response to chemotherapy or radiation therapy, and function of major organ systems. Dosages are determined to maximize cell kill while minimizing impact on healthy tissues and subsequent toxicities. The therapeutic effect may be compromised if inadequate dosing is required due to toxicities. Modification of dosage is often required if critical laboratory values or the patient's symptoms indicate unacceptable or dangerous toxicities. Various laboratory tests are performed prior to, during, and after chemotherapy to determine optimal treatment options, evaluate the patient's response, and monitor toxicity. Laboratory and physical assessments of the hematologic, hepatic, renal, cardiovascular, and pulmonary systems are critical in evaluating the response to chemotherapy (Duong & Loh, 2006; Nirenburg, Bush, Davis, et al., 2006).

Chemotherapy treatment regimens include standard dosage therapy, dose-dense regimens, and myeloablative regimens with bone marrow or peripheral stem cell transplant. For certain chemotherapeutic agents, there is a maximum lifetime dose limit that must be adhered to because of the danger of long-term irreversible organ complications (eg, because of the risk of cardiomyopathy, doxorubicin [Adriamycin] has a cumulative lifetime dose limit of 550 $mg/m^2$).

#### Extravasation

Antineoplastic chemotherapeutic agents are additionally classified by their potential to damage soft tissue if they inadvertently leak from a vein (**extravasation**). The consequences of extravasation range from mild discomfort to severe tissue destruction, depending on whether the agent is classified as a nonvesicant, irritant, or vesicant. Irritant agents induce inflammatory reactions but usually cause no permanent tissue damage. **Vesicants** are those agents that, if deposited into the subcutaneous tissue (extravasation), cause tissue necrosis and damage to underlying tendons, nerves, and blood vessels. Although the complete mechanism of tissue destruction is unclear, it is known that the pH of many antineoplastic agents is responsible for the severe inflammatory reaction as well as the ability of these agents to bind to tissue DNA. Sloughing and ulceration of the tissue progresses to tissue necrosis and may be so severe that skin grafting may be necessary. The full extent of tissue damage may take several weeks to become apparent. Medications classified as vesicants include many of the commonly used agents: cisplatin (Platinol-AQ), dactinomycin (Cosmegen), daunorubicin (DaunoXome), doxorubicin, nitrogen mustard (Mustargen), mitomycin (Mutamycin), paclitaxel (Taxol), vinblastine (Velban), vincristine (Oncovin), vindesine (Eldisine), and vinorelbine (Navelbine) (Sauerland, Engelking, Wickham, et al., 2006).

Only specially trained physicians and nurses should administer vesicants. Careful selection of peripheral veins, skilled venipuncture, and careful administration of medications are essential. Indications of extravasation during administration of vesicant agents include the following:

- Absence of blood return from the intravenous (IV) catheter
- Resistance to flow of IV fluid
- Burning or pain, swelling or redness at the site

**Table 16-6 ANTINEOPLASTIC AGENTS**

| Drug Class and Examples | Mechanism of Action | Cell Cycle Specificity | Common Side Effects |
|---|---|---|---|
| **Alkylating Agents** | | | |
| Busulfan (Busulfex, Myleran), carboplatin (Paraplatin), chlorambucil (Leukeran), cisplatin (Platinol-AQ), cyclophosphamide (Cytoxan), dacarbazine (DTIC-Dome), hexamethylene amine or altretamine (Hexalen), ifosfamide (Ifex), melphalan (Alkeran), nitrogen mustard (Mustargen), oxaliplatin (Eloxatin), thiotepa (Thioplex) | Alter DNA structure by misreading DNA code, initiating breaks in the DNA molecule, cross-linking DNA strands | Cell cycle–nonspecific | Bone marrow suppression, nausea, vomiting, cystitis (cyclophosphamide, ifosfamide), stomatitis, alopecia, gonadal suppression, renal toxicity (cisplatin) |
| **Nitrosoureas** | | | |
| Carmustine (BCNU [BiCNU, Gliadel]), lomustine or CCNU (CeeNU), semustine (methyl CCNU [MeCCNU]), streptozocin (Zanosar) | Similar to the alkylating agents; cross the blood–brain barrier | Cell cycle–nonspecific | Delayed and cumulative myelosuppression, especially thrombocytopenia; nausea, vomiting |
| **Topoisomerase I Inhibitors** | | | |
| Irinotecan (Camptosar)<br>Topotecan (Hycamtin) | Induce breaks in the DNA strand by binding to enzyme topoisomerase I, preventing cells from dividing | Cell cycle–specific (S phase) | Bone marrow suppression, diarrhea, nausea, vomiting, hepatotoxicity |
| **Antimetabolites** | | | |
| 5-Azacytadine, capecitabine (Xeloda), cytarabine (DepoCyt, Tarabine) edatrexate fludarabine (Fludara), 5-fluorouracil (5-FU), gemcitabine (Gemzar), hydroxyurea (Droxia, Hydrea), cladribine (Leustatin), 6-mercaptopurine (Purinethol), methotrexate (Trexall, Rheumatrex), pentostatin (Nipent), 6-thioguanine (Tabloid) | Interferes with the biosynthesis of metabolites or nucleic acids necessary for RNA and DNA synthesis | Cell cycle–specific (S phase) | Nausea, vomiting, diarrhea, bone marrow suppression, proctitis, stomatitis, renal toxicity (methotrexate), hepatotoxicity |
| **Antitumor Antibiotics** | | | |
| Bleomycin (BLM, Blenoxane), dactinomycin (Cosmegen), daunorubicin (DaunoXome), doxorubicin (Adriamycin), idarubicin (Idamycin), mitomycin (Mutamycin), mitoxantrone (Novantrone), plicamycin (Mithracin) | Interfere with DNA synthesis by binding DNA; prevent RNA synthesis | Cell cycle–nonspecific | Bone marrow suppression, nausea, vomiting, alopecia, anorexia, cardiac toxicity (daunorubicin, doxorubicin) |
| **Mitotic Spindle Poisons** | | | |
| *Plant alkaloids:* etoposide (Toposar), teniposide (Vumon) vinblastine (Velban), vincristine (VCR [Oncovin]), vindesine (Eldisine), vinorelbine (Navelbine) | Arrest metaphase by inhibiting mitotic tubular formation (spindle); inhibit DNA and protein synthesis | Cell cycle–specific (M phase) | Bone marrow suppression (mild with VCR), neuropathies (VCR), stomatitis |
| *Taxanes:* paclitaxel (Taxol), docetaxel (Taxotere) | Arrest metaphase by inhibiting tubulin depolymerization | Cell cycle–specific (M phase) | Bradycardia, hypersensitivity reactions, bone marrow suppression, alopecia, neuropathies |
| **Hormonal Agents** | | | |
| Androgens and antiandrogens, estrogens and antiestrogens, progestins and antiprogestins, aromatase inhibitors, luteinizing hormone–releasing hormone analogues, steroids | Bind to hormone receptor sites that alter cellular growth; block binding of estrogens to receptor sites (antiestrogens); inhibit RNA synthesis; suppress aromatase of P450 system, which decreases level | Cell cycle–nonspecific | Hypercalcemia, jaundice, increased appetite, masculinization, feminization, sodium and fluid retention, nausea, vomiting, hot flashes, vaginal estrogen dryness |
| **Miscellaneous Agents** | | | |
| Asparaginase (Elspar), procarbazine (Matulane) | Unknown or too complex to categorize | Varies | Anorexia, nausea, vomiting, bone marrow suppression, hepatotoxicity, anaphylaxis, hypotension, altered glucose metabolism |

CHART 16-4 **HOME CARE CHECKLIST**
*Chemotherapy Administration*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate how to administer the chemotherapy agent in the home. | ✔ | ✔ |
| • Demonstrate safe disposal of needles, syringes, IV supplies, or unused chemotherapy medications. | ✔ | ✔ |
| • List possible side effects of chemotherapeutic agents. | ✔ | ✔ |
| • List complications of medications necessitating a call to the nurse or physician. | ✔ | ✔ |
| • List complications of medications necessitating a visit to the emergency department. | ✔ | ✔ |
| • List names and telephone numbers of resource personnel involved in care (ie, home care nurse, infusion services, IV vendor, equipment company). | ✔ | ✔ |
| • Explain treatment plan (protocol) and importance of upcoming visits to physician. | ✔ | ✔ |

*NURSING ALERT*

**If extravasation is suspected, the medication administration is stopped immediately, and dependent on the drug, an attempt is made to aspirate any remaining drug from the extravasation site through the existing needle.**

Institutional nursing policies should be available to identify nursing intervention and an extravasation kit should be readily available with all of the emergency equipment and antidote medication, as well as a quick reference for how to properly manage an extravasation of the specific vesicant agent used. Application of heat or cold is very dependent on the drug administered, and nurses should refer to their hospital policy. In general, cold compresses are indicated for doxorubicin extravasation but are of no benefit for taxane or oxaliplatin (Eloxatin) extravasation. Warm compresses are recommended for vinca alkaloid extravasation. Depending on the guidelines for specific agents, extravasation management may include aspiration of any infiltrated medication from the tissues and injection of a neutralizing solution into the area to reduce tissue damage. Selection of the neutralizing solution depends on the extravasated agent. Recent research has suggested that dexrazoxane (Totect) IV infusion for 3 days has benefit in treatment of anthracycline (ie, doxorubicin) extravasation with prevention of tissue necrosis (Schulmeister, 2007). Application of topical ointments, such as dexamethasone (Decadron) ointment, has been reported with variable levels of effectiveness. Recommendations and guidelines for managing vesicant extravasation have been issued by individual medication manufacturers, pharmacies, and the Oncology Nursing Society, and they differ from one medication to the next (Gullatte, 2007; Sauerland, et al., 2006).

Prevention of extravasation is essential and relies on vigilant nursing care. Vesicant chemotherapy should never be administered in peripheral veins involving the hand or wrist. Peripheral administration is permitted for short duration infusions only, and placement of the venipuncture site should be on the forearm area using a soft, plastic catheter. For any frequent, or prolonged administration of antineoplastic vesicants, right atrial silastic catheters, implanted venous access devices, or peripherally inserted central catheters (PICC) should be inserted to promote safety during medication administration and reduce problems with access to the circulatory system (Figs. 16-3 and 16-4). Indwelling or subcutaneous catheters require vigilant nursing care. Complications associated with their use include infection and thrombosis (Arch, 2007).

### Hypersensitivity Reactions

Most of the available chemotherapeutic agents have the potential to cause hypersensitivity reactions; however, the overall incidence of hypersensitivity reactions to these agents is only about 5%. Understanding and managing hypersensitivity reactions is critical when caring for patients receiving chemotherapy because these reactions are potentially

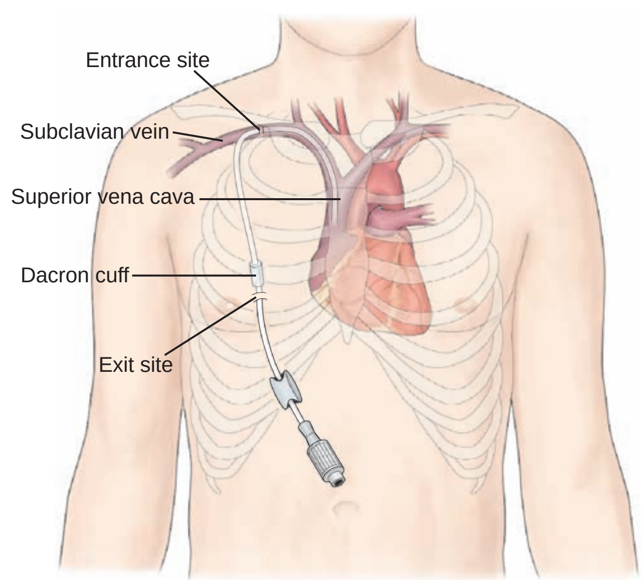



**Figure 16-3** Right atrial catheter. The right atrial catheter is inserted into the subclavian vein and advanced until its tip lies in the superior vena cava just above the right atrium. The proximal end is then tunneled from the entry site through the subcutaneous tissue of the chest wall and brought out through an exit site on the chest. The Dacron cuff anchors the catheter in place and serves as a barrier to infection.

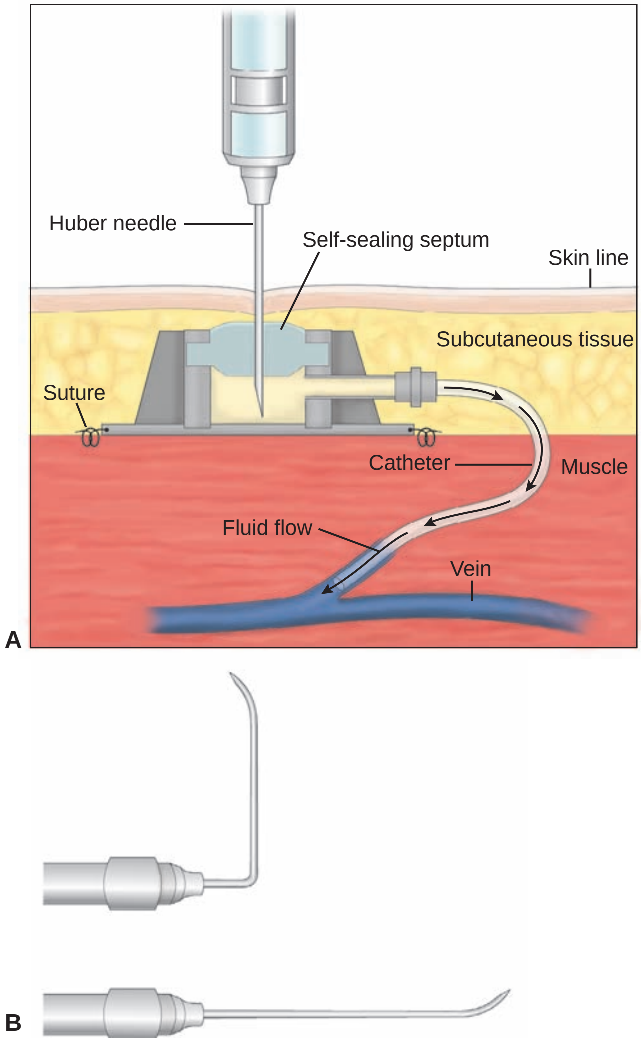



**Figure 16-4** Implanted vascular access device. (**A**) A schematic diagram of an implanted vascular access device used for administration of medications, fluids, blood products, and nutrition. The self-sealing septum permits repeated puncture by Huber needles without damage or leakage. (**B**) Two Huber needles used to enter the implanted vascular port. The 90-degree needle is used for top-entry ports for continuous infusions.

life-threatening. Prevention is the first line of defense, and nurses need to have a clear understanding of which agents have the potential for precipitating hypersensitivity reactions, determining the patient's responses to certain agents via skin testing, and providing appropriate premedication before administering agents with a high potential for causing hypersensitivity reactions. Education of patients should emphasize the importance of adhering to prescribed self-administered premedication before presenting to the infusion center and recognizing and reporting the signs and symptoms to the nurse once their infusion has started. Early intervention can prevent progression of a reaction to systemic anaphylaxis. Most reactions coincide with chemotherapy agent administration, but some reactions can be delayed or occur after several uneventful courses of therapy. Although patients may react to the first infusion of a chemotherapy agent, repeated exposure increases the likelihood of a reaction along with other predisposing risk factors such as preexisting allergic reactions to food, blood products, and other medications. Emergency medication and resuscitation equipment should be easily accessible.

The usual chemotherapy hypersensitivity reaction is categorized as a type I immediate, immunoglobulin E mediated reaction. Type I hypersensitivity reactions may present as a local reaction and then rapidly progress to systemic anaphylaxis, or the initial presentation may be an acute life-threatening anaphylaxis. Symptoms include generalized itching with localized or generalized urticaria; flushing of the face, hands, or feet; chest tightness; agitation; nausea and vomiting; dyspnea and bronchospasm; difficulty speaking; feeling of impending doom; and hypotension (Gobel, 2005; Wilkes & Barton-Burke, 2007). The medication should be discontinued immediately and emergency procedures initiated. Many institutions have developed specific protocols for responding to hypersensitivity reactions including standing orders for administration of emergency medications (de Lemos, 2006). Chapter 53 presents further discussion of allergic reaction.

For some chemotherapeutic agents, especially if they are essential in the treatment plan, desensitization procedures may be possible, and the patient is retreated with the agent at reduced dosages or slower infusion rates. Premedication regimens including corticosteroids, histamine-1 and histamine-2 antagonists, and antipyretics are routinely preadministered for certain chemotherapy agents to prevent or minimize potential reactions.

Doxorubicin or daunorubicin can create localized allergic reactions referred to as flare reaction. Patients typically experience a hot, flushed sensation with urticaria and pruritis. The nurse must confirm that the reaction is indeed a flare and not an extravasation. The infusion can be temporarily discontinued and restarted at a slower infusion rate after consultation with the physician and IV administration of hydrocortisone (Solu-Cortef Hydrocortone).

### Toxicity

Toxicity associated with chemotherapy can be acute or chronic. Cells with rapid growth rates (eg, epithelium, bone marrow, hair follicles, sperm) are very susceptible to damage, and various body systems may be affected as well.

***Gastrointestinal System.*** Nausea and vomiting are the most common side effects of chemotherapy and may persist for as long as 24 to 48 hours after its administration. Delayed nausea and vomiting may persist for as long as 1 week after chemotherapy.

A number of mechanisms are responsible for the occurrence of nausea and vomiting, including activation of receptors found in the chemoreceptor trigger zone (CTZ) of the medulla, stimulation of the peripheral autonomic and vestibular pathways, cognitive stimulation, or a combination of factors. Medications that can decrease nausea and vomiting include serotonin blockers, such as ondansetron (Zofran), granisetron (Kytril), dolasetron (Anzemet), and palonosetron (Aloxi), which block serotonin receptors of the gastrointestinal tract and CTZ, and dopaminergic blockers, such as metoclopramide (Reglan), which block dopamine receptors of the CTZ. Newer agents include

neurokinin 1 receptor antagonists (eg, aprepitant [Emend]), which block the activity of substance P, a potent neurotransmitter involved in stimulating nausea and vomiting (Jordan, Sippel & Schmoll, 2007).

Nausea and vomiting involve multiple pathways; therefore, corticosteroids, phenothiazines, sedatives, and histamines are helpful, especially when used in combination with serotonin blockers to provide improved antiemetic protection. Delayed nausea and vomiting that occur longer than 48 to 72 hours after chemotherapy are troublesome for some patients. To minimize discomfort, some antiemetic medications are necessary for the first week at home after chemotherapy. Nonpharmacologic approaches such as relaxation techniques, imagery, and acupressure (Dribble, Luce, Cooper, et al., 2007) can also help decrease stimuli contributing to symptoms. Small frequent meals, bland foods, and comfort foods may reduce the frequency or severity of these symptoms.

The epithelium that lines the oral cavity is susceptible to the effects of chemotherapy; as a result, stomatitis is common. The entire gastrointestinal tract is susceptible to mucositis (inflammation of the mucosal lining), and diarrhea is a common result. Antimetabolites and antitumor antibiotics are the major culprits in mucositis and other gastrointestinal symptoms, including diarrhea, which can be severe in some patients.

***Hematopoietic System.*** Most chemotherapeutic agents cause **myelosuppression** (depression of bone marrow function), resulting in decreased production of WBCs (leukopenia), granulocytes (neutropenia), red blood cells (RBCs) (anemia), and platelets (thrombocytopenia) and increased risk of infection and bleeding. Depression of these cells is the usual reason for limiting the dose of the chemotherapeutic agents. Myelosuppression is predictable, and patients usually reach their nadir counts (point at which blood counts are lowest) 7 to 14 days after chemotherapy has been administered. At this time nurses anticipate associated toxicities, especially febrile neutropenia (fever associated with neutrophil count less than 1500 cells/mm$^3$). Frequent monitoring of blood cell counts is essential and strategies are implemented to protect patients from infection and injury, particularly while blood cell counts are depressed (Duong & Loh, 2006; Nirenberg, et al., 2006).

Other agents, called colony-stimulating factors (granulocyte colony-stimulating factor [G-CSF] and granulocyte-macrophage colony-stimulating factor [GM-CSF]), can be administered after chemotherapy to stimulate the bone marrow to produce WBCs, especially neutrophils, at an accelerated rate, thus decreasing the duration of neutropenia. G-CSF and GM-CSF decrease the episodes of infection and the need for antibiotics and allow for more timely cycling of chemotherapy with less need to reduce the dosage. Erythropoietin (EPO) stimulates RBC production, thus decreasing the symptoms of chronic anemia and reducing the need for blood transfusions. Interleukin 11 (IL-11) stimulates the production of platelets and can be used to prevent and treat thrombocytopenia (platelet count less than 100,000) but has had limited use because of toxicities such as fatigue, edema, dysrhythmias, and syncope (Burcat & McAdams, 2007; Hurter & Bush, 2007; Nirenberg, et al., 2006).

***Renal System.*** Chemotherapeutic agents can damage the kidneys because of their direct effects during excretion and the accumulation of end products after cell lysis. Cisplatin, methotrexate (Trexall, Rheumatrex), and mitomycin are particularly toxic to the kidneys. Rapid tumor cell lysis after chemotherapy results in increased urinary excretion of uric acid, which can cause renal damage. In addition, intracellular contents are released into the circulation, resulting in hyperkalemia, hyperphosphatemia, and hypocalcemia. (See later discussion of tumor lysis syndrome.)

Monitoring blood urea nitrogen (BUN), serum creatinine, creatinine clearance, and serum electrolyte levels is essential. Adequate hydration, diuresis, alkalinization of the urine to prevent formation of uric acid crystals, and allopurinol may be used to prevent these side effects (Duong & Loh, 2006; Gullatte, 2006). Amifostine has demonstrated an ability to minimize renal toxicities associated with cisplatin, cyclophosphamide (Cytoxan), and ifosfamide (Ifex) therapy (Hogle, 2007).

Hemorrhagic cystitis is a bladder toxicity resulting from cyclophosphamide and ifosfamide therapy. Hematuria can range from microscopic to frank bleeding with symptoms ranging from transient irritative urination, dysuria, suprapubic pain, to life-threatening hemorrhage. Protection of the bladder focuses on aggressive IV hydration, frequent voiding, and diuresis. Mesna (Mesnex) is a cytoprotectant agent that binds with the toxic metabolites of cyclophosphamide or ifosfamide in the kidneys to prevent hemorrhagic cystitis (Hogle, 2007; Wilkes & Barton-Burke, 2007).

***Cardiopulmonary System.*** Anthracyclines (daunorubicin and doxorubicin) are known to cause irreversible cumulative cardiac toxicities, especially when total dosage reaches 600 mg/m$^2$ and 550 mg/m$^2$, respectively. If these agents are administered in the presence of thoracic radiation therapy or other agents with cardiotoxicity potential, their cumulative dose limit is reduced to 450 mg/m$^2$. Dexrazoxane (Zinecard) has been utilized as a cardioprotectant when doxorubicin is needed in individuals who have already received a cumulative dose of 300 mg/m$^2$ and continuation of therapy is deemed beneficial (Wilkes & Barton-Burke, 2007; Hogle, 2007). Cardiac ejection fraction (volume of blood ejected from the heart with each beat) and signs of heart failure must be monitored closely.

Bleomycin (Blenoxane), carmustine (BCNU), and busulfan (Busulfex, Myleran) have cumulative toxic effects on lung function, resulting in pulmonary fibrosis. Therefore, patients are monitored closely for changes in pulmonary function, including pulmonary function test results. Total cumulative doses of bleomycin should not exceed 400 U, and carmustine should not exceed 1400 mg.

Capillary leak syndrome with resultant pulmonary edema is a toxic effect of cytarabine (DepoCyt, Tarabine) (AraC), mitomycin C, cyclophosphamide, and BCNU. Subtle onset of dyspnea and cough may progress rapidly to acute respiratory distress and subsequent respiratory failure (Wilkes & Barton-Burke, 2007).

***Reproductive System.*** Testicular and ovarian function can be affected by chemotherapeutic agents, resulting in possible sterility. Normal ovulation, early menopause, or permanent sterility may occur. In men, temporary or permanent

azoospermia (absence of spermatozoa) may develop. Because treatment may damage reproductive cells, banking of sperm is often recommended for men before treatment is initiated. Patients and their partners need to be informed about potential changes in reproductive function resulting from chemotherapy. They are advised to use reliable methods of birth control while receiving chemotherapy and not to assume that sterility has resulted.

***Neurologic System.*** Chemotherapy-induced neurotoxicity can affect the CNS, peripheral nervous system (PNS), the cranial nerves or a combination; it is a dose-limiting toxicity. The blood–brain barrier can protect the CNS and PNS from the toxic effects of most water soluble chemotherapy agents, but neurotoxicity characterized by metabolic encephalopathy can occur with ifosfamide, high-dose methotrexate, and cytarabine. With repeated doses, the taxanes and plant alkaloids, especially vincristine, can cause peripheral neurologic damage with sensory alterations in the feet and hands. These sensations can be described as tingling, pricking, or numbness of the extremities, burning or freezing pain, sharp, stabbing, or electric shock–like pain and extreme sensitivity to touch. If unreported by patients or undetected, progressive motor axon damage can lead to loss of deep tendon reflexes, with muscle weakness, loss of balance and coordination, and paralytic ileus. Although usually reversible, these side effects may take many months to resolve. Along with the usual paresthesias of the hands and feet, oxaliplatin has a unique and frightening neurotoxicity presentation that is often precipitated by exposure to cold and is characterized by pharyngolaryngeal dysesthesia consisting of lip paresthesia, discomfort or tightness in the back of the throat, inability to breathe, and jaw pain. Patients receiving oxaliplatin must be instructed to avoid drinking cold fluids or going outside with hands and feet exposed to cold temperatures to avoid exacerbation of these symptoms. Cisplatin may cause peripheral neuropathies and hearing loss due to damage to the acoustic nerve (Wilkes & Barton-Burke, 2007). The ability of cytoprotectant agents to prevent these significant neurotoxicities, including amifostine, is being studied (Hogle, 2006; Wilkes & Barton-Burke, 2007).

***Fatigue.*** Fatigue, a distressing side effect for most patients that greatly affects quality of life, can last for months after treatment. Assessment and nursing management of fatigue are discussed in the Nursing Care of Patients With Cancer section of this chapter. In 2006, the Oncology Nursing Society conducted an exhaustive review of evidence-based interventions for fatigue management to provide guidelines for nurses to effectively intervene and assist their patients (Mitchell, Beck, Hood, et al., 2007).

### Nursing Management in Chemotherapy

Nurses play an important role in assessing and managing many of the problems experienced by patients undergoing chemotherapy. Chemotherapeutic agents affect both normal and malignant cells, meaning that these problems are often widespread, affecting many body systems.

#### Assessing Fluid and Electrolyte Status

Anorexia, nausea, vomiting, altered taste, mucositis, and diarrhea put patients at risk for nutritional and fluid and electrolyte disturbances. Therefore, it is important for the nurse to assess the patient's nutritional and fluid and electrolyte status frequently and to use creative ways to encourage an adequate fluid and dietary intake.

#### Modifying Risks for Infection and Bleeding

Suppression of the bone marrow and immune system is expected and frequently serves as a guide in determining appropriate chemotherapy dosage but increases the risk of anemia, infection, and bleeding disorders. Nursing assessment and care address factors that would further increase the patient's risk. The nurse's role in decreasing the risk for infection and bleeding is discussed further in the Nursing Care of Patients With Cancer (see p. 366).

#### Administering Chemotherapy

The local effects of the chemotherapeutic agent are also of concern. The patient is observed closely during its administration because of the risk and consequences of extravasation, particularly of vesicant agent. Local difficulties or problems with administration of chemotherapeutic agents are brought to the attention of the physician promptly so that corrective measures can be taken immediately to minimize local tissue damage. (See previous discussion of extravasation.)

#### Protecting Caregivers

Nurses involved in handling chemotherapeutic agents may be exposed to low doses of the agents by direct contact, inhalation, or ingestion. Urinalyses of personnel repeatedly exposed to cytotoxic agents have demonstrated mutagenic activity. Although long-term studies of nurses who handle chemotherapeutic agents have not been conducted, it is known that chemotherapeutic agents are associated with secondary formation of cancers and chromosome abnormalities. In addition, nausea, vomiting, dizziness, alopecia, and nasal mucosal ulcerations have occurred in health care personnel who have handled chemotherapeutic agents. The Occupational Safety and Health Administration, Oncology Nursing Society, hospitals, and other health care agencies have developed specific precautions for health care providers involved in the preparation and administration of chemotherapy (Chart 16-5) (Polovich, et al., 2005; Wilkes & Barton-Burke, 2007). Nurses must be familiar with their institutional policies regarding personal protective equipment, handling and disposal of chemotherapeutic agents and supplies, and management of accidental spills or exposures. Emergency spill kits should be readily available in any treatment area where chemotherapy is prepared or administered. Precautions must also be taken when handling any bodily fluids or excreta from the patient, as many agents are excreted unaltered in urine and feces. Nurses have a responsibility to educate patients, caregivers, assistive personnel, and housekeepers concerning these precautions.

## Bone Marrow Transplantation

Although surgery, radiation therapy, and chemotherapy have improved survival rates for patients with cancer, many cancers that initially respond to therapy recur. This is true of hematologic cancers that affect the bone marrow and solid tumor cancers treated with lower doses of antineoplastics to

**Chart 16-5 • *Safety in Administering Chemotherapy***

Safety recommendations from the Occupational Safety and Health Administration (OSHA), Oncology Nursing Society (ONS), hospitals, and other health care agencies for the preparation and handling of antineoplastic agents follow:

- Use a biologic safety cabinet for the preparation of all chemotherapy agents.
- Wear surgical gloves when handling antineoplastic agents and the excretions of patients who received chemotherapy.
- Wear disposable, long-sleeved gowns when preparing and administering chemotherapy agents.
- Use Luer-Lok fittings on all intravenous tubing used to deliver chemotherapy.
- Dispose of all equipment used in chemotherapy preparation and administration in appropriate, leak-proof, puncture-proof containers.
- Dispose of all chemotherapy wastes as hazardous materials.

When followed, these precautions greatly minimize the risk of exposure to chemotherapy agents.

spare the bone marrow from larger, ablative doses of chemotherapy or radiation therapy. The role of bone marrow transplantation (BMT) for malignant and some nonmalignant diseases continues to grow.

The process of obtaining donor cells has evolved over the years. Donor cells can be obtained by the traditional harvesting of large amounts of bone marrow tissue under general anesthesia in the operating room. However, a second method, referred to as peripheral blood stem cell transplantation (PBSCT), has gained widespread use. This method of collection uses apheresis of the donor to collect peripheral blood stem cells (PBSCs) for reinfusion. It is a safe and cost-effective means of collection rather than the traditional harvesting of marrow, which requires general anesthesia and an operative procedure.

### Types of Bone Marrow Transplant

Types of BMT based on the source of donor cells include:

- Allogeneic: from a donor other than the patient; donor may be a related donor (ie, family member) or a matched unrelated donor (national bone marrow registry, cord blood registry)
- Autologous: from the patient
- Syngeneic: from an identical twin

Allogeneic BMT (AlloBMT), used primarily for disease of the bone marrow, depends on the availability of a human leukocyte antigen–matched donor. This greatly limits the number of possible transplants. An advantage of AlloBMT is that the transplanted cells should not be immunologically tolerant of a patient's malignancy and should cause a lethal **graft-versus-tumor effect,** in which the donor cells recognize the malignant cells and act to eliminate them.

AlloBMT may involve either ablative (high-dose) or nonablative (mini-dose) chemotherapy. In ablative AlloBMT, the recipient must undergo ablative doses of chemotherapy and possibly total body irradiation to destroy all existing bone marrow and malignant disease. The harvested donor marrow or PBSCs are infused intravenously into the recipients, and they travel to sites in the body where they produce bone marrow and establish themselves. Once engraftment is complete (2 to 4 weeks, sometimes longer), the new bone marrow becomes functional and begins producing RBCs, WBCs, and platelets. In nonablative AlloBMT, the chemotherapy doses are lower and are aimed at suppressing the recipient's immune system to allow engraftment of donor bone marrow or PBSCs. The lower doses of chemotherapy create less organ toxicity and thus can be offered to older patients or those with underlying organ dysfunction for whom high-dose chemotherapy would be prohibitive. After engraftment, it is hoped that the donor cells will create a graft-versus-tumor effect (Rodriguez, Tariman, Enecio, et al., 2007; Saria & Gosselin-Acomb, 2007). Before engraftment, patients are at high risk for infection, sepsis, and bleeding. Side effects of the high-dose chemotherapy and total body irradiation can be acute and chronic. Acute side effects include alopecia, hemorrhagic cystitis, nausea, vomiting, diarrhea, and severe stomatitis. Chronic side effects include sterility, pulmonary dysfunction, cardiac dysfunction, and liver disease.

To prevent **graft-versus-host disease (GVHD),** patients receive immunosuppressant drugs, such as cyclosporine (Sandimmune), methotrexate, tacrolimus (Prograf), or sirolimus (Rapamune). In allogeneic transplant recipients, GVHD occurs when the T lymphocytes from the transplanted donor marrow or PBSCs become activated and mount an immune response against the recipient's tissues (skin, gastrointestinal tract, liver). T lymphocytes respond in this manner because they view the recipient's tissue as "foreign," immunologically different from what they recognize as "self" in the donor. GVHD may occur acutely or chronically. Clinical manifestations of acute GVHD include diffuse rash progressing to blistering and desquamation similar to second-degree burns; mucosal shedding with subsequent diarrhea that may exceed 2 L per day; and biliary stasis with abdominal pain, hepatomegaly, and elevated liver enzymes progressing to obstructive jaundice. GVHD accounts for approximately 10% of all BMT deaths (Saria & Gosselin-Acomb, 2007).

The first 100 days or so after AlloBMT are crucial for patients; the immune system and blood-making capacity (hematopoiesis) must recover sufficiently to prevent infection and hemorrhage. Most acute side effects, such as nausea, vomiting, and mucositis, also resolve in the initial 100 days after transplantation. Patients are also at risk for venous occlusive disease (VOD), a vascular injury to the liver caused by high-dose chemotherapy, leading to hepatic outflow obstruction and portal hypertension, in the first 30 days or so after BMT, acute liver failure, and death (Saria & Gosselin-Acomb, 2007).

Autologous BMT (AuBMT) is considered for patients with disease of the bone marrow who do not have a suitable donor for AlloBMT and for patients who have healthy bone marrow but require bone marrow–ablative doses of chemotherapy to cure an aggressive malignancy. Conditions include non-Hodgkin and Hodgkin lymphoma, multiple myeloma, neuroblastoma, sarcoma, and germ cell tumors. Stem cells are collected from the patient and preserved for reinfusion; if necessary, they are treated to kill any malignant

cells within the marrow, called purging. The patient is then treated with ablative chemotherapy and, possibly, total body irradiation to eradicate any remaining tumor. Stem cells are then reinfused and engrafted. Until engraftment occurs in the bone marrow sites of the body, there is a high risk of infection, sepsis, and bleeding. Acute and chronic toxicities from chemotherapy and radiation therapy may be severe. The risk of VOD is also present after autologous transplantation. No immunosuppressant medications are necessary after AuBMT because the patient does not receive foreign tissue. A disadvantage of AuBMT is the risk that tumor cells may remain in the bone marrow despite high-dose chemotherapy (conditioning regimens).

Syngeneic transplants result in less incidence of GVHD and graft rejection; however, there is also less graft-versus-tumor effect to fight the malignancy. For this reason, even when an identical twin is available for marrow donation, another matched sibling or even an unrelated donor may be the most suitable donor to combat an aggressive malignancy.

### Nursing Management in Bone Marrow Transplantation

Nursing care of patients undergoing BMT is complex and demands a high level of skill. Transplantation nursing can be extremely rewarding yet extremely stressful. The success of BMT is greatly influenced by nursing care throughout the transplantation process.

#### Implementing Pretransplantation Care

All patients must undergo extensive pretransplantation evaluations to assess the current clinical status of the disease. Nutritional assessments, extensive physical examinations, organ function tests, and psychological evaluations are conducted. Blood work includes assessing past antigen exposure (eg, hepatitis virus, cytomegalovirus, herpes simplex virus, human immunodeficiency virus [HIV], and syphilis). The patient's social support systems and financial and insurance resources are also evaluated. Informed consent and patient teaching about the procedure and pretransplantation and posttransplantation care are vital.

#### Providing Care During Treatment

Skilled nursing care is required during the treatment phase of BMT when high-dose chemotherapy (conditioning regimen) and total body irradiation are administered. The acute toxicities of nausea, diarrhea, mucositis, and hemorrhagic cystitis require close monitoring and constant attention by the nurse.

Nursing management during bone marrow infusion or stem cell reinfusions consists of monitoring the patient's vital signs and blood oxygen saturation; assessing for adverse effects, such as fever, chills, shortness of breath, chest pain, cutaneous reactions, nausea, vomiting, hypotension or hypertension, tachycardia, anxiety, and taste changes; and providing ongoing support and patient teaching. During stem cell reinfusion, patients may experience adverse reactions to the cryoprotectant dimethyl sulfoxide (DMSO) used to preserve the harvested stem cells. These reactions may include nausea, vomiting, chills, dyspnea, cardiac dysrhythmias, and hypotension progressing to cardiac or respiratory arrest (Rodriquez, et al., 2007).

Until engraftment of the new marrow occurs, the patient is at high risk for death from sepsis and bleeding. A cluster of symptoms referred to as engraftment syndrome occurs during the neutrophil recovery phase in both allogeneic and autologous transplants. Clinical features of this syndrome vary widely but may include noninfectious fever associated with skin rash, weight gain, diarrhea, and pulmonary infiltrates, with improvement noted after the initiation of corticosteroid therapy rather than antibiotic therapy (Saria & Gosselin-Acomb, 2007). Until engraftment is well established, the patient requires support with blood products and hemopoietic growth factors.

Potential infections may be bacterial, viral, fungal, or protozoan in origin. During the first 30 days following transplant, the patient is most at risk for developing reactivations of viral infections including herpes simplex, Epstein-Barr, cytomegalovirus, and varicella zoster. Mucosal denudement poses a risk for *Candida* yeast infection locally and systemically. Pulmonary toxicities offer the opportunity for fungal infections such as *Aspergillus*. Renal complications arise from the nephrotoxic chemotherapy agents used in the conditioning regimen or those used to treat infection (amphotericin B, aminoglycosides). Tumor lysis syndrome and acute tubular necrosis are also risks after BMT. Nursing assessment for signs of these complications is essential for early identification and treatment (Burcat & McAdams, 2007; Rodriguez, et al., 2007; Saria & Gosselin-Acomb, 2007).

GVHD requires skillful nursing assessment to detect early effects on the skin, liver, and gastrointestinal tract. VOD resulting from the conditioning regimens used in BMT can result in fluid retention, jaundice, abdominal pain, ascites, tender and enlarged liver, and encephalopathy. Pulmonary complications, such as pulmonary edema, interstitial pneumonia, and other pneumonias, often complicate the recovery after BMT (Saria & Gosselin-Acomb, 2007).

#### Providing Posttransplantation Care

***Caring for Recipients.*** Ongoing nursing assessment in follow-up visits is essential to detect late effects of therapy after BMT, which occur 100 days or more after the procedure. Late effects include infections (eg, varicella zoster infection), restrictive pulmonary abnormalities, and recurrent pneumonias. Sterility often results due to total body irradiation as part of the ablative regimen. Chronic GVHD involves the skin, liver, intestine, esophagus, eyes, lungs, joints, and vaginal mucosa. Cataracts may also develop after total body irradiation.

Psychosocial assessments by nursing staff must be ongoing. In addition to the stressors affecting patients at each phase of the transplantation experience, marrow donors and family members also have psychosocial needs that must be addressed.

***Caring for Donors.*** Like BMT recipients, donors also require nursing care. They commonly experience mood alterations, decreased self-esteem, and guilt from feelings of failure if the transplantation fails. Family members must be educated and supported to reduce anxiety and promote coping during this difficult time. In addition, they must also be assisted to maintain realistic expectations of themselves as well as of the patient. As BMT becomes more prevalent, many ethical issues

become apparent, including those related to informed consent, allocation of resources, and quality of life.

## Hyperthermia

Hyperthermia (thermal therapy), the generation of temperatures greater than physiologic fever range (greater than 41.5°C [106.7°F]), has been used for many years to destroy cancerous tumors. Malignant cells may be more sensitive than normal cells to the harmful effects of high temperatures for several reasons. Malignant cells lack the mechanisms necessary to repair damage caused by elevated temperatures. Most tumor cells lack an adequate blood supply to provide needed oxygen during periods of increased cellular demand, such as during hyperthermia. Cancerous tumors lack blood vessels of adequate size for dissipation of heat. In addition, the body's immune system may be indirectly stimulated when hyperthermia is used.

Hyperthermia is most effective when combined with radiation therapy, chemotherapy, or biologic therapy. Hyperthermia and radiation therapy are thought to work well together because hypoxic tumor cells and cells in the S phase of the cell cycle are more sensitive to heat than radiation; the addition of heat damages tumor cells so that they cannot repair themselves after radiation therapy. Hyperthermia is thought to alter cellular membrane permeability when used with chemotherapy, allowing for an increased uptake of the chemotherapeutic agent. Hyperthermia may enhance the function of immune system cells, such as macrophages and T cells (Milani & Noessner, 2006; van der Zee & van Rhoon, 2006).

Heat can be produced by using radiowaves, ultrasound, microwaves, magnetic waves, hot-water baths, or even hot-wax immersions. Hyperthermia may be local or regional, or it may include the whole body. Local or regional hyperthermia may be delivered to a cancerous extremity (for malignant melanoma) by regional perfusion, in which the affected extremity is isolated by a tourniquet and an extracorporeal circulator heats the blood flowing through the affected part. Hyperthermia probes may also be inserted around a tumor in a local area and attached to a heat source during treatment. Chemotherapeutic agents, such as melphalan (Alkeran), may also be heated and instilled into the region's circulating blood. Local or regional hyperthermia may also include infusion of heated solutions into cancerous body organs. Whole body hyperthermia to treat disseminated disease may be achieved by extracorporeal circulation, immersion of the patient in heated water or paraffin, or enclosure in a heated suit (Bruner, et al., 2006; van der Zee & van Rhoon, 2006).

Side effects of hyperthermia treatments include skin burns and tissue damage, fatigue, hypotension, peripheral neuropathies, thrombophlebitis, nausea, vomiting, diarrhea, and electrolyte imbalances. Resistance to hyperthermia may develop during the treatment because cells adapt to repeated thermal insult. Research into the effectiveness of hyperthermia is ongoing.

### *Nursing Management in Hyperthermia*

Although hyperthermia has been used for many years, many patients and their families are unfamiliar with this cancer treatment. Consequently, they need explanations about the procedure, its goals, and its effects. The nurse assesses the patient for adverse effects and acts to reduce the occurrence and severity of adverse effects. Local skin care at the site of the implanted probes is necessary.

## Targeted Therapies

Recent scientific advances have led to an improved understanding of cancer development. Traditional therapies such as chemotherapy and radiation affect all actively proliferating cells. As a result, both healthy cells and malignant cells are subject to harmful systemic effects of treatment. **Targeted therapies** seek to minimize the negative effects on healthy tissues by disrupting specific cancer cell functions such as malignant transformation, cell communication pathways (called signal transduction), processes for growth and metastasis, and genetic coding. Actions of targeted therapies include stimulation or augmentation of immune responses through the use of biologic response modifiers, targeting of cancer cell growth factors, promotion of apoptosis, and genetic manipulation through gene therapy (Khoukaz, 2006; Rieger, 2006). Most of the currently available targeted therapies are categorized as either monoclonal antibodies or small molecule tyrosine kinase inhibitors.

### *Biologic Response Modifiers*

**Biologic response modifier (BRM) therapy** involves the use of naturally occurring or recombinant (reproduced through genetic engineering) agents or treatment methods that can alter the immunologic relationship between the tumor and the cancer patient (host) to provide a therapeutic benefit. Although the mechanisms of action vary with each type of BRM, the goal is to destroy or stop the malignant growth. The basis of BRM treatment lies in the restoration, modification, stimulation, or augmentation of the body's natural immune defenses against cancer (Yarbro, et al., 2005).

#### Nonspecific Biologic Response Modifiers

Some of the early investigations of the stimulation of the immune system involved nonspecific agents such as bacille Calmette-Guérin (BCG) and *Corynebacterium parvum*. When injected into the patient, these agents serve as antigens that stimulate an immune response. The hope is that the stimulated immune system will then eradicate malignant cells. Extensive animal and human investigations with BCG have shown promising results, especially in treating localized malignant melanoma. In addition, BCG bladder instillation (intravesicular) is a standard form of treatment for localized bladder cancer (Creel, 2007). However, use of nonspecific agents in advanced cancer remains limited, and research is ongoing to identify other uses and other agents.

#### Monoclonal Antibodies

Monoclonal antibodies (MoAbs), another type of BRM, have become available through technologic advances, enabling investigators to grow and produce targeted antibodies for specific malignant cells. Theoretically, this type of specificity allows MoAbs to destroy the cancer cells and spare normal cells. The specificity of MoAbs is dependent on identifying key antigen proteins on the surface of tumors that are not present on normal tissues. These targets when

blocked lead to apoptosis by disrupting communication between cells. There are several categories of these tumor-associated antigens: oncofetal antigens such as CEA, a prominent tumor marker identified in colon cancer; growth factors such as EGFs and VEGFs; and oncogenes such as C-*erb* or *Bcr-Abl* (Kay, 2006). MoAbs bind with specific tumor cell antigens and block the ability of the tumor cell to reproduce, or deliver cytotoxic agents directly to the tumor cell causing cell death.

The production of MoAbs involves injecting tumor cells that act as antigens into mice. B cells in the spleen of the mouse produce immunoglobulin antibodies made in response to the injected antigens. Antibody-producing B cells are combined with a cancer cell that has the ability to grow indefinitely in culture medium and continue producing more antibodies.

The combination of spleen cells and the cancer cells is referred to as a hybridoma. From hybridomas that continue to grow in the culture medium, the desired antibodies are harvested, purified, and prepared for diagnostic or therapeutic use (Fig. 16-5). Recent advances in genetic engineering have led to the production of MoAbs with combinations of mouse and human components (*chimeric MoAbs*) or all-human components (*humanized MoAbs*). MoAbs made with human genes have greater immunologic properties and are less likely to cause allergic reactions (Yarbro, et al., 2005).

MoAbs are being used as aids in diagnostic evaluation of both primary and metastatic tumors through radiologic techniques. For example, MoAbs are used to assist in diagnosing ovarian and colorectal cancers. Their use in detecting breast, gastric, and prostate cancers and lymphoma is under investigation. MoAbs are also used in purging residual tumor cells from the bone marrow or peripheral blood of patients who are undergoing BMT or peripheral stem cell rescue after high-dose cytotoxic therapy.

Several MoAbs have been approved for treatment in cancer using a variety of extracellular (outside the cell membrane) and intracellular (inside the cell membrane) targets. Some of the MoAbs are used alone, whereas others are used in combination with agents that facilitate their antitumor actions. For example, gemtuzumab ozogamicin (Mylotarg) is used for the treatment of a specific type of acute myeloid leukemia (Wilkes & Barton-Burke, 2007);

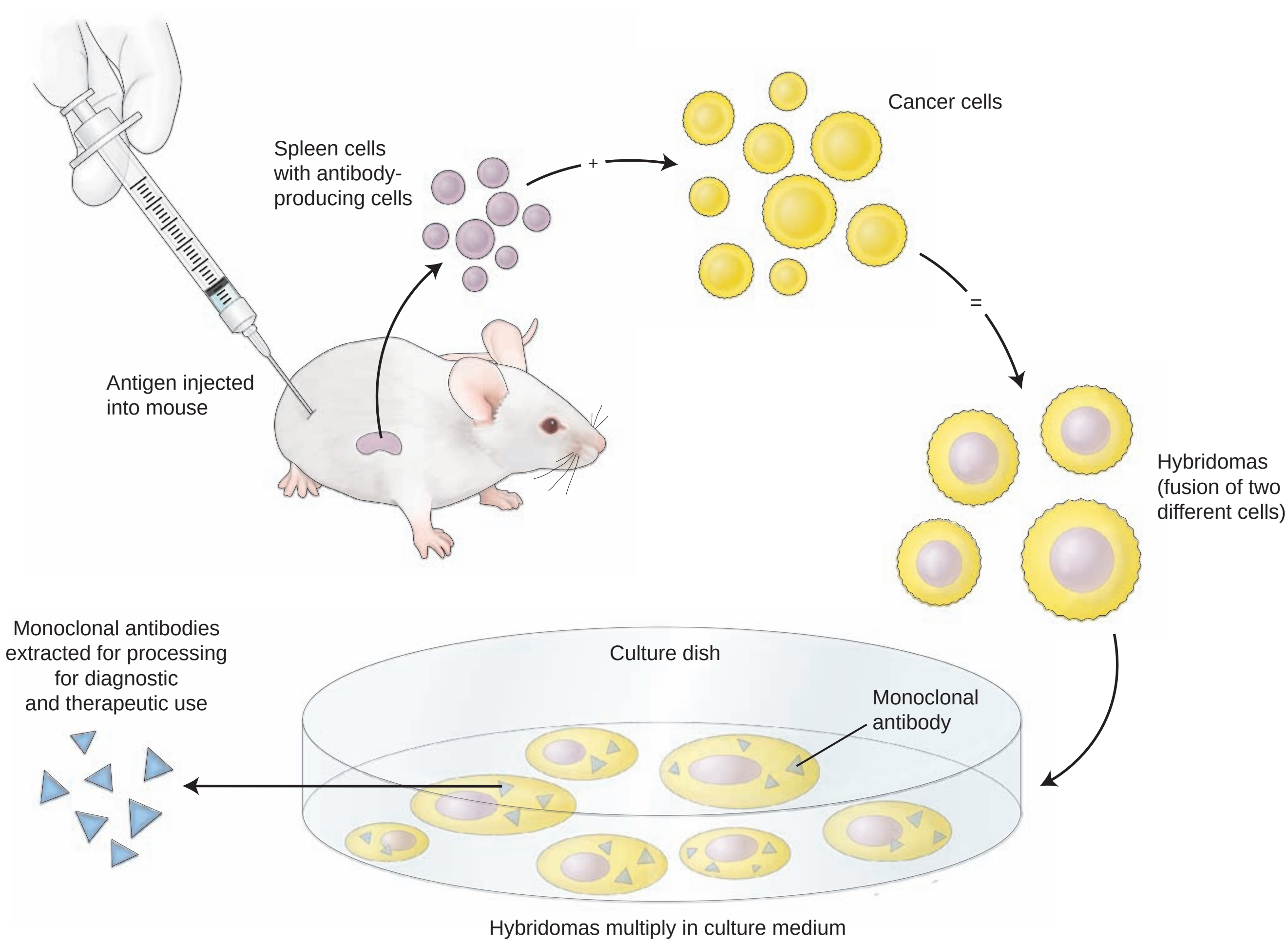



**Figure 16-5** Antibody-producing spleen cells are fused with cancer cells. This process produces cells called hybridomas. These cells, which can grow indefinitely in a culture medium, produce antibodies that are harvested, purified, and prepared for diagnostic or treatment purposes.

ibritumomab-tiuxetan (Zevalin) and tositumomab (Bexxar) are used for the treatment of specific types of non-Hodgkin lymphoma. Some MoAbs target specific genetic mutations expressed by certain tumors, as in chronic myelogenous leukemia with the Philadelphia chromosome abnormality (Bcr-Abl). Imatinib mesylate (Gleevec) was developed to specifically bind with the Bcr-Abl abnormality, thus inhibiting cell proliferation.

Researchers continue to explore the development and use of MoAbs, either alone or in combination with other substances such as radioactive materials, chemotherapeutic agents, toxins, hormones, or other BRMs. Some specific targets for MoAbs under investigation include malignant cell growth factors, cell proteins, and substances that stimulate tumors to develop blood vessels (angiogenesis factors) (Kay, 2006; Wilkes & Barton-Burke, 2007).

***Epidermal Growth Factor Receptors and Tyrosine Kinase Pathways.*** Normal cell growth is regulated by well-defined communication pathways between the environment surrounding the cell and the internal cell environment, the nucleus, and the intracellular cytoplasm. The cell membrane contains important protein receptors that respond to signals transmitted from the external environment and transmit that signal to the internal cell environment using enzymatic pathways called signal transduction pathways. Advances in understanding the genetic nature of cancers have resulted in these protein receptors and the cellular communication pathways to be used as targets for new cancer treatment agents. Much like a lock and key mechanism, new drugs are being developed that will target these specific receptors and pathways and prevent the continued growth of the cancer cells. The family of epidermal growth factor receptors (EGFR) have been proven to be a critical communication pathway. EGFRs are widely expressed by many normal cell types and in certain cancer tumors can be overexpressed or underexpressed (Franson & Lapka, 2005; Viele, 2005). The amount of EGFR that is expressed by a tumor can be measured by reliable laboratory testing. Overexpression of EGFR is associated with advanced tumor stage, more aggressive tumors, a predictor of resistance to standard chemotherapy, and a poor patient prognosis (Oishi, 2008). Recent scientific advances have enabled the development of numerous new targeted therapy drugs that bind to a specific protein receptor or block a specific signal transduction pathway expressed by a tumor but not by a normal cell, enabling a very targeted, specific cell kill. Monoclonal antibodies bind to the extracellular protein receptors and are larger molecules that are administered by IV. Tyrosine kinase inhibitors are smaller molecules that target the intracellular signaling pathways and are given orally. The efficacy of these new targeted agents depends on consistent and reliable delivery, and because they involve the patient's natural immune system they can precipitate very significant adverse events specific to each agent. It is important for nurses to be familiar with the administration issues related to patient education about self-administered oral agents and patient safety related to adverse events (Khoukaz, 2006).

***Vascular Endothelial Growth Factors.*** Angiogenesis requires growth factors, cytokines, enzymes, and proteins, all generated by the tumor to stimulate the formation of new capillaries to deliver oxygen and other nutrients to the hypoxic tumor. The major pathway for angiogenesis is activation of the VEGF family of proteins (Franson & Lapka, 2005; Viele, 2005). VEGF is essential for the growth and proliferation of malignant cells and when activated stimulates growth of new blood vessels. These new blood vessels differ greatly from normal vessels with less well-organized structure, increased permeability allowing migration of tumor cells, and increased interstitial pressure preventing chemotherapy from reaching the tumor. VEGF is overexpressed in many solid tumors and is associated with advanced tumor stage and poor prognosis (Viele, 2005). In colorectal cancer, increased VEGF expression has been correlated with increased vascularity, invasiveness, metastasis, and poor prognosis (Franson & Lapka, 2005).

Bevacizumab (Avastin) is a MoAb directed toward VEGF to prevent the activation of endothelial cells and inhibit growth of new blood vessels. It is currently the only U.S. Food and Drug Administration (FDA)-approved angiogenesis inhibitor and is used for the treatment of colorectal cancer. Research is ongoing to evaluate its effectiveness with other solid tumors. Side effects of bevacizumab include delays in wound healing, hemorrhage, hypertension, thromboembolism and proteinuria. Newer agents such as sorafenib (Nexavar) and sunitinib (Sutent) have shown multitargeted activity against VEGF cell receptors and tyrosine kinase pathways and have been approved for metastatic renal cell carcinoma.

### Cytokines

**Cytokines,** substances produced by cells of the immune system to enhance the production and functioning of components of the immune system, are also the focus of cancer treatment research. Cytokines are grouped into families, such as interferons, interleukins, colony-stimulating factors, and tumor necrosis factors. Colony-stimulating factors have been described earlier in this chapter for their supportive role in myelosuppressive treatment modalities. Refer to Chapter 50 for more detailed discussion of the immune system.

***Interferons.*** Interferons (IFNs) are cytokines with both antiviral and antitumor properties. Multiple antitumor effects of IFNs include antiangiogenesis, direct destruction of tumor cells, inhibition of growth factors, and disruption of the cell cycle. IFN-$\alpha$ is used in treatment of hairy-cell leukemia, Kaposi's sarcoma, chronic myelogenous leukemia, high-grade non-Hodgkin lymphoma, renal cell cancer, cutaneous T-cell lymphoma, and melanoma. IFN is administered by subcutaneous, intramuscular, intravenous, and intracavitary routes. Efforts are under way to establish the effectiveness of IFN in combination with other treatment regimens for treatment of various malignancies.

***Interleukins.*** Interleukins (ILs) are a subgroup of cytokines known as lymphokines and monokines produced by lymphocytes and monocytes. About 25 different ILs have been identified (Yarbro, et al., 2005) that act by signaling and coordinating other cells of the immune system and thus require an intact immune system to achieve their therapeutic effects. IL-2 is an approved treatment option for renal cell

cancer and metastatic melanoma in adults. IL-2 stimulates the production and activation of several different types of lymphocytes, enhances the production of other types of cytokines, and affects both humoral and cell-mediated immunity. Side effects of ILs include flulike symptoms, fatigue, and anorexia as well as serious side effects (eg, profound diarrhea, pulmonary edema, hypotension, and oliguria). When combined with other cytokines, IL-2 can cause hypersensitivity reactions or cardiac dysrhythmias and hypotension (Tyre & Quan, 2007).

Clinical trials are being conducted on the role of ILs in treatment of other cancers. Some early stage clinical trials are assessing their effects when combined with chemotherapy and as growth factors for treatment of myelosuppression after the use of some forms of chemotherapy.

### Retinoids

Retinoids are vitamin A derivatives (retinol, all-*trans*-retinoic acid [ATRA], and 13-*cis*-retinoic acid) that play a role in growth, reproduction, apoptosis, epithelial cell differentiation, and immune function. Retinoids are believed to have a role in cancer prevention as well as treatment. Specific receptors in the cell nucleus are retinoid–dependent, thus when retinoids bind with these receptors, cell differentiation and replication are affected.

ATRA (tretinoin [Renova, Retin-A]) is used in treating acute promyelocytic leukemia, a rare form of leukemia, and cutaneous T-cell lymphoma. Synthetic retinoid agents such as 4HRP (Fenretinide) have been shown to play a role in cellular apoptosis and are being evaluated for prevention of second breast cancers. Retinoids are being tested for treatment of various epithelial cancers, leukemias, melanoma, and neuroblastoma, and for prevention of breast, lung, prostate, and brain cancers (Wilkes & Barton-Burke, 2007; Yarbro, et al., 2005).

### Cancer Vaccines

Cancer vaccines are used to mobilize the body's immune response to recognize and attack cancer cells (Sinkovics & Horvath, 2006). Cancer vaccines contain either portions of cancer cells alone or portions of cells in combination with other substances (adjuvants) that can augment or boost immune responses. *Autologous* vaccines are made from the patient's own cancer cells, which are obtained during diagnostic biopsy or surgery. The cancer cells are killed and prepared for injection back into the patient. *Allogeneic* vaccines are made from cancer cells that are obtained from other people who have a specific type of cancer. These cancer cells are grown in a laboratory and eventually killed and prepared for injection.

*Prophylactic* vaccines are given to prevent disease. Quadrivalent human papillomavirus (HPV) recombinant vaccine (Gardasil) protects against HPV types 6, 11, 16, and 18 associated with common genital warts (type 6 and 11) and development of cervical cancer (type 16 and 18). It is administered over a series of three doses to females aged 9 to 26 (McLemore, 2006).

*Therapeutic* vaccines are given to kill existing cancer cells and to provide long-lasting immunity against further cancer development. Challenges to the therapeutic activity of cancer vaccines include the size of the tumor burden, the mechanisms that allow tumor cells to avoid recognition as "nonself" by the immune system, and immune tolerance as the result of previous exposure to the tumor antigens. Multiple clinical trials are being conducted to develop therapeutic vaccines for cancers of the prostate, breast, kidney, and lung, as well as for melanoma, myeloma, and lymphoma (Schlom, Arlen & Gulley, 2007).

### Nursing Management in Biologic Response Modifier Therapy

Patients receiving BRM therapy have many of the same needs as patients undergoing other cancer treatment. However, manipulation and stimulation of the immune system create unique challenges. Consequently, it is essential for the nurse to assess the need for education, support, and guidance for both the patient and the family and assist in planning and evaluating patient care.

***Monitoring Therapeutic and Adverse Effects.*** The nurse must become familiar with each agent given and its potential effects. Adverse effects such as fever, myalgia, nausea, and vomiting, as seen with IFN therapy, may not be life-threatening. However, the nurse must be aware of the impact of these side effects on the patient's quality of life. Other life-threatening adverse effects (eg, capillary leak syndrome, pulmonary edema, hypotension) may occur with IL-2 therapy.

***Promoting Home and Community-Based Care.*** The nurse teaches patients self-care and assists in providing for continuing care. Some BRMs, such as IFN, EPO, and G-CSF, can be administered by the patient or family members at home. As needed, the nurse teaches the patient and family how to administer these agents through subcutaneous injections. The nurse also provides instructions about side effects and helps the patient and family identify strategies to manage many of the common side effects of BRM therapy, such as fatigue, anorexia, and flulike symptoms.

Referral for home care is usually indicated to monitor the patient's responses to treatment and to continue and reinforce patient and family teaching. During home visits, the nurse assesses the patient's and family members' technique in administering medications. The nurse collaborates with physicians, third-party payors, and pharmaceutical companies to help the patient obtain reimbursement for home administration of BRM therapies. The nurse also reminds the patient about the importance of keeping follow-up appointments with the physician and assesses the patient's need for changes in care.

## Gene Therapy

Gene therapy includes approaches that correct genetic defects or manipulate genes to induce tumor cell destruction in the hope of preventing or combating disease. One of the challenges confronting cancer gene therapy is the multiple somatic mutations involved in the development of a cancer, making it difficult to identify the most effective gene therapy approach.

Considerable advances have been made in the identification of effective tumor cell targets and evaluation of the most appropriate vectors. Vectors serve as a vehicle or carrier that transports a gene into the target cell via the cell

membrane. With the improved understanding of cell surface proteins and signaling pathways, many phase I and phase II studies are currently evaluating the use of target specific vectors to disrupt tumor proliferation. The National Institutes of Health Web site identifies over 300 ongoing gene therapy trials targeting a variety of tumors and tumor cell markers. Examples include CEA, HER2/neu, and herpes simplex vaccine (NIH, 2007).

Viruses have long been hypothesized as an ideal delivery system because of the ease with which they cross the cell membrane and enter the intracellular space; however, their drawback includes their short-lived effect due to the strong immune response. Viruses used as vectors include retroviruses, adenoviruses (common cold virus), vaccinia virus (smallpox vaccine), fowlpox (avian poxvirus), herpes simplex viruses, and Epstein-Barr viruses (Yang, Wang, Zhao, et al., 2007). Clinical research studies are evaluating gene therapy across all cancer sites, including melanoma, prostate cancer, breast cancer, pancreatic cancer, head and neck squamous cell cancer, and non–small cell lung cancer. There are currently no FDA-approved cancer gene therapies in the United States.

Three general approaches have been used in the development of gene therapies, with adenoviruses showing effective promise in each approach.

- *Tumor-directed therapy* is introduction of a therapeutic gene (suicide gene) into tumor cells in an attempt to destroy them. This approach is very challenging because it is difficult to identify which gene would be the most beneficial. In addition, patients with widespread disease would require multiple injections to treat every site of disease.
- *Active immunotherapy* is the administration of genes that will invoke the antitumor responses of the immune system (Liu, 2003).
- *Adoptive immunotherapy* is the administration of genetically altered lymphocytes that are programmed to cause tumor destruction (Yang, et al., 2007).

### Complementary and Alternative Medicine (CAM)

For many patients and their clinicians, a challenge in managing their cancer treatments is in finding the balance between achieving a reasonable quality of life while undergoing potentially toxic and life-saving modalities. Many patients seek a more holistic or nontraditional approach, turning to complementary and alternative therapies while continuing to utilize conventional medicine (Mumber, 2006).

The National Center for Complementary and Alternative Medicine (NCCAM) at the National Institutes of Health defines CAM as diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine. Complementary medicine denotes therapies in conjunction with conventional medicine, whereas alternative medicine denotes therapies used instead of conventional medicine. More recently, the term Integrative Medicine has been used, which denotes a combination of conventional medicine and CAM that have a strong scientific base for use and safety (NCCAM, 2007)

CAM is used by 28% to 85% of patients with cancer (Chart 16-6). More importantly, patients are using CAM but not communicating this to their health care providers either because they were never asked about its use or because they withheld the information fearing that their physicians would not approve (Chong, 2006; Rojas-Cooley & Grant, 2006). Many of the CAM modalities can be a source of comfort and emotional support for the patient, but assessment of CAM use is important for patient safety.

Mind–body and biofield therapies have a holistic focus on channeling positive energy, promoting relaxation, and reducing stress and have been reported as being beneficial to patients as measured by wound healing and reduction in pain, edema, and anxiety (Hibdon, 2005). There is, however, risk associated with some of the CAM modalities. Because of the possibility of herb-vitamin-drug interactions, there is concern about the use of biologicals and dietary supplements, which are not regulated by the FDA nor subjected to rigorous scientific evaluation. Patients often perceive vitamins and dietary supplements as harmless, natural products that have no side effects or potential toxicities. One example of herbal–drug interaction is the effect of St. John's wort on the efficacy of irinotecan (Camptosar), cyclophosphamide, tamoxifen, cyclosporine, warfarin (Coumadin), and indinavir (Crixivan). Each nursing assessment should include an open discussion with patients about their use of CAM. This requires that nurses develop the appropriate familiarity and knowledge related to CAM in order to direct patients to safe, reliable, and credible sources for information.

### Unproven and Unconventional Therapies

Despite increasing 5-year survival rates with the use of traditional methods of treatment, a significant number of patients use or seriously consider using some form of unconventional treatment. Hopelessness, desperation, unmet needs, lack of factual information, and family or social pressures are major factors that motivate patients to seek unconventional methods of treatment and allow them to fall prey to deceptive practices and quackery.

Unconventional treatments are those without scientific evidence of the ability to cure or control cancer. In addition to being ineffective, some unconventional treatments may also be harmful to the patient and may cost thousands of dollars.

In the age of the Internet, patients have unlimited access to frequently unreliable claims of "miracle cures" that range from plant remedies to metabolic therapy using special diets, supplements, or "detoxification" regimens involving unconventional enemas and colonic cleansing procedures. The ACS established a clearinghouse along with NCCAM to investigate and identify potentially dangerous and harmful unproven therapies. ACS maintains this listing on its Web site.

#### Nursing Management in Unconventional Therapies

The most effective way to protect patients and families from fraudulent therapies and questionable cancer cures is to establish a trusting relationship, provide supportive care, and promote hope. Truthful responses given in a nonjudgmental manner to questions and inquiries about unproven methods of cancer treatments may alleviate the fear and guilt on the part of the patient and family that they are not "doing everything we can" to obtain a cure. The nurse should inform the patient and family of the characteristics common to fraudulent therapies so that they will be informed and

CHART 16-6

NURSING RESEARCH PROFILE

### Use of Acupressure to Reduce Chemotherapy-induced Nausea and Vomiting

Dribble, S. L., Luce, J., Cooper, B. A., et al. (2007). Acupressure for chemotherapy-induced nausea and vomiting: A randomized clinical trial. *Oncology Nursing Forum, 34*(4), 813–820.

**Purpose**

The purpose of this study was to compare the effectiveness of acupressure, placebo acupressure, and usual care in reducing chemotherapy-induced nausea and vomiting (CINV) in women with breast cancer. Although significant advances have been made in the medications available to treat CINV, delayed nausea and vomiting continue to be problematic for many patients. Acupressure is a traditional Chinese nonpharmacologic, noninvasive pressure applied by the thumbs, fingers, and hands on the surface of the skin at specific points. The belief is that symptoms such as nausea may be lessened through the use of acupressure.

**Design**

This was a multicenter, longitudinal randomized clinical trial conducted throughout one cycle of highly emetogenic chemotherapy. Ten community oncology programs associated with a major cancer center and nine independent sites located throughout the United States served as the study sites. To be eligible, the women had to be receiving the second or third cycle of chemotherapy classified as moderate to highly emetogenic. In addition, during the previous cycle of chemotherapy, the women had to have experienced at least moderate nausea as measured by the Morrow Assessment of Nausea and Emesis.

A total of 160 women were randomly assigned to one of three intervention groups: acupressure, placebo acupressure, and usual care. Each woman received a prescription for antiemetic therapy to use at home; thus, acupressure was studied in the context of usual clinical care for nausea. The patients in the acupressure groups were taught how to use the actual or placebo acupressure techniques immediately prior to receiving chemotherapy. The acupressure and placebo acupressure groups completed daily logs for 3 weeks and recorded acupressure use as well as medications and other methods used to control their nausea. The usual care group also completed daily logs about efforts used to control nausea. On the eighth day of the chemotherapy cycle, women were reminded to complete the daily logs. Anxiety measures were obtained for all participants using the State-Trait Anxiety Inventory Scale at baseline and at the exit appointment at the time of the next chemotherapy cycle. Demographic data and diagnostic, cancer treatment, and treatment of nausea data were also collected. The occurrence of acute nausea and vomiting on the day of chemotherapy (study day 1) and its occurrence on the 2nd to 11th days after chemotherapy (delayed emesis) were analyzed.

**Findings**

The three groups were similar on demographic variables, disease, and treatment. There were no significant differences in episodes of acute CINV by treatment group. Although episodes of delayed CINV decreased for all three treatment groups over time, women in the acupressure group reported fewer episodes than both the placebo acupressure group and the usual care group. Many of the participants noted that acupressure was most effective when the nausea was mild, but that it was helpful in addition to pharmaceutical agents when the nausea was severe. The researchers also found that 30% of the participants experienced delayed nausea at 11 days after chemotherapy. They concluded that in future studies delayed nausea assessment should extend for at least 11 days versus the usual length of assessment of 5 days. The researchers reported differences in the incidence of CINV by age, with younger women reporting a greater intensity of nausea than older women.

**Nursing Implications**

The results of this study suggest that acupressure may be a valid addition to other interventions for the management of CINV, including CINV that occurred 2 to 11 days after chemotherapy treatment. Acupressure offers a nonpharmacologic, alternative approach to care of a significant problem for many patients. The technique is easily learned without significant expense or prolonged training. Future research might assess the role of acupressure in the treatment of CINV in both genders and for other types of cancer.

cautious when evaluating other forms of "therapy." The nurse also should encourage patients who use unconventional therapies to inform their physicians about such use. This knowledge can help prevent interactions with medications and other therapies that may be prescribed and avoid attributing the side effects of unconventional therapies to prescribed medications.

## Nursing Care of Patients With Cancer

The outlook for patients with cancer has greatly improved because of scientific and technologic advances. However, as a result of the underlying disease or various treatment modalities, patients with cancer may experience a variety of secondary problems such as infection, reduced WBC counts, bleeding, skin problems, nutritional problems, pain, fatigue, and psychological stress. Chart 16-7 provides a nursing care plan for patients with cancer.

### Maintaining Tissue Integrity

Some of the most frequently encountered disturbances of tissue integrity, in addition to stomatitis, include skin and tissue reactions to radiation therapy, alopecia, and metastatic skin lesions.

#### *Stomatitis*

Mucositis is a common side effect of radiation and some types of chemotherapy that may lead to inflammation and ulceration of any portion of the gastrointestinal tract from the oral cavity throughout the alimentary canal. One form of mucositis, stomatitis, is an inflammatory response of the oral tissues that is characterized by mild redness (erythema) and edema or, if severe, by painful ulcerations, bleeding, and secondary infection. Stomatitis commonly develops 5

CHART 16-7

## PLAN OF NURSING CARE
## The Patient With Cancer

**NURSING DIAGNOSIS:** Risk for infection related to inadequate defenses related to myelosuppression secondary to radiation or antineoplastic agents
**GOAL:** Prevention of infection

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess patient for evidence of infection:<br>a. Check vital signs every 4 hours.<br>b. Monitor white blood cell (WBC) count and differential each day.<br>c. Inspect all sites that may serve as entry ports for pathogens (intravenous sites, wounds, skin folds, bony prominences, perineum, and oral cavity). | 1. Signs and symptoms of infection may be diminished in the immunocompromised host. Prompt recognition of infection and subsequent initiation of therapy will reduce morbidity and mortality associated with infection. |
| 2. Report fever (≥38.3°C [101°F] or ≥38°C [100.4°F] for longer than 1 hour), chills, diaphoresis, swelling, heat, pain, erythema, exudate on any body surfaces. Also report change in respiratory or mental status, urinary frequency or burning, malaise, myalgias, arthralgias, rash, or diarrhea. | 2. Early detection of infection facilitates early intervention. |
| 3. Obtain cultures and sensitivities as indicated before initiation of antimicrobial treatment (wound exudate, sputum, urine, stool, blood). | 3. Tests identify the organism and indicate the most appropriate antimicrobial therapy. Use of inappropriate antibiotics enhances proliferation of additional flora and encourages growth of antibiotic-resistant organisms. |
| 4. Initiate measures to minimize infection. | 4. Exposure to infection is reduced. |
| a. Discuss with patient and family<br>(1) Placing patient in private room if absolute WBC count $<1000/mm^3$.<br>(2) Importance of patient avoiding contact with people who have known or recent infection or recent vaccination. | a. Preventing contact with pathogens helps prevent infection. |
| b. Instruct all personnel in careful hand hygiene before and after entering room. | b. Hands are significant source of contamination. |
| c. Avoid rectal or vaginal procedures (rectal temperatures, examinations, suppositories; vaginal tampons). | c. Incidence of rectal and perianal abscesses and subsequent systemic infection is high. Manipulation may cause disruption of membrane integrity and enhance progression of infection. |
| d. Use stool softeners to prevent constipation and straining. | d. Minimizes trauma to tissues. |
| e. Assist patient in practice of meticulous personal hygiene. | e. Prevents skin irritation. |
| f. Instruct patient to use electric razor. | f. Minimizes skin trauma. |
| g. Encourage patient to ambulate in room unless contraindicated. | g. Minimizes chance of skin breakdown and stasis of pulmonary secretions. |
| h. Avoid fresh fruits, raw meat, fish, and vegetables if absolute WBC count $<1000/mm^3$; remove fresh flowers and potted plants. | h. Fresh fruits and vegetables harbor bacteria not removed by ordinary washing. Flowers and potted plants are sources of organisms. |
| i. Each day: change water pitcher, denture cleaning fluids, and respiratory equipment containing water. | i. Stagnant water is a source of infection. |

### Expected Outcomes

- Demonstrates normal temperature and vital signs.
- Exhibits absence of signs of inflammation: local edema, erythema, pain, and warmth.
- Exhibits normal breath sounds on auscultation.
- Takes deep breaths and coughs every 2 hours to prevent respiratory dysfunction and infection.
- Exhibits absence of pathologic bacteria on cultures.
- Avoids contact with others with infections.
- Avoids crowds.
- All personnel carry out hand hygiene after each voiding and bowel movement.
- Excoriation and trauma of skin are avoided.
- Trauma to mucous membranes is avoided (avoidance of rectal thermometers, suppositories, vaginal tampons, perianal trauma).
- Uses recommended procedures and techniques if participating in management of invasive lines or catheters.
- Uses electric razor.
- Is free of skin breakdown and stasis of secretions.
- Adheres to dietary and environmental restrictions.
- Exhibits no signs of septicemia or septic shock.
- Exhibits normal vital signs, cardiac output, and arterial pressures when monitored.
- Demonstrates ability to administer colony-stimulating factor.

*Continued on following page*

CHART 16-7

## PLAN OF NURSING CARE
### *The Patient With Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 5. Assess intravenous sites every day for evidence of infection: | 5. Nosocomial staphylococcal septicemia is closely associated with intravenous catheters. | |
| a. Change peripheral short-term intravenous sites every other day. | a. Incidence of infection is increased when catheter is in place >72 hours. | |
| b. Cleanse skin with povidone-iodine before arterial puncture or venipuncture. | b. Povidone-iodine is effective against many gram-positive and gram-negative pathogens. | |
| c. Change central venous catheter dressings every 48 hours. | c. Allows observation of site and removes source of contamination. | |
| d. Change all solutions and infusion sets every 72–96 hours. | d. Once introduced into the system, microorganisms are capable of growing in infusion sets despite replacement of container and high flow rates. | |
| e. Follow Infusion Nursing Society guidelines for care of peripheral and central venous access devices. | e. Infusion nursing society collaborates with other nursing subspecialties in determining guidelines for intravenous access care. | |
| 6. Avoid intramuscular injections. | 6. Reduces risk for skin abscesses. | |
| 7. Avoid insertion of urinary catheters; if catheters are necessary, use strict aseptic technique. | 7. Rates of infection greatly increase after urinary catheterization. | |
| 8. Teach patient or family member to administer granulocyte (or granulocyte-macrophage) colony-stimulating factor when prescribed. | 8. Granulocyte colony-stimulating factor decreases the duration of neutropenia and the potential for infection. | |
| 9. Advise patient to avoid exposure to animal excreta; discuss dental procedures with physician; avoid vaginal douche; and avoid vaginal or rectal manipulation during sexual contact during period of neutropenia (Marrs, 2006; Zitella, et al., 2006). | 9. Minimizes exposure to potential sources of infection and disruption of skin integrity. | |

**NURSING DIAGNOSIS:** Impaired skin integrity: erythematous and wet desquamation reactions to radiation therapy

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. In erythematous areas: | 1. Care to the affected areas must focus on preventing further skin irritation, drying, and damage. | • Avoids use of soaps, powders, and other cosmetics on site of radiation therapy.<br>• States rationale for special care of skin.<br>• Exhibits minimal change in skin.<br>• Avoids trauma to affected skin region (avoids shaving, constricting and irritating clothing, extremes of temperature, and use of adhesive tape).<br>• Reports change in skin promptly.<br>• Demonstrates proper care of blistered or open areas.<br>• Exhibits absence of infection of blistered and opened areas.<br>• Wound is free from development of eschar. |
| a. Avoid the use of soaps, cosmetics, perfumes, powders, lotions and ointments, deodorants. | a. These substances may cause pain and additional skin irritation and damage. | |
| b. Use only lukewarm water to bathe the area. | b. Avoiding water of extreme temperatures minimizes additional skin damage, irritation and pain. | |
| c. Avoid rubbing or scratching the area. | c. Rubbing and or scratching will lead to additional skin irritation, damage and increased risk of infection. | |
| d. Avoid shaving the area with a straight-edged razor. | d. Use of razors may lead to additional irritation and disruption of skin integrity and increased risk of infection. | |
| e. Avoid applying hot-water bottles, heating pads, ice, and adhesive tape to the area. | e. Avoiding extreme temperatures minimizes additional skin damage, irritation, burns and pain. | |
| f. Avoid exposing the area to sunlight or cold weather. | f. Sun exposure or extreme cold weather may lead to additional skin damage and pain. | |
| g. Avoid tight clothing in the area. Use cotton clothing. | g. Allows air circulation to affected area. | |
| h. Apply vitamin A and D ointment to the area. | h. Aids healing. | |

*Continued*

CHART 16-7

**PLAN OF NURSING CARE**

## *The Patient With Cancer* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. If wet desquamation occurs: | 2. Open weeping areas are susceptible to bacterial infection. Care must be taken to prevent introduction of pathogens. | |
| a. Do not disrupt any blisters that have formed. | a. Disruption of skin blisters disrupts skin integrity and may lead to increased risk of infection. | |
| b. Avoid frequent washing of the area. | b. Frequent washing may lead to increased irritation and skin damage, with increased risk for infection. | |
| c. Report any blistering. | c. Blistering of skin represents progression of skin damage. | |
| d. Use *prescribed* creams or ointments. | d. Decreases irritation and inflammation of the area. | |
| e. If area weeps, apply a nonadhesive absorbent dressing. | e. Enhances drying. | |
| f. If the area is without drainage, use moisture and vapor-permeable dressings such as hydrocolloids and hydrogels on noninfected areas (Swearingen, 2008). | f. Promotes healing. | |
| g. Consult with enterostomal therapist (ET) and physician if eschar forms. | g. Eschar must be removed to promote healing and prevent infection. ET nurses have expertise in the care of wounds. | |

**NURSING DIAGNOSIS:** Impaired oral mucous membrane: stomatitis
**GOAL:** Maintenance of intact oral mucous membranes

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess oral cavity daily. | 1. Provides baseline for later evaluation. | • States rationale for frequent oral assessment and hygiene.<br>• Identifies signs and symptoms of stomatitis to report to nurse or physician.<br>• Participates in recommended oral hygiene regimen.<br>• Avoids mouthwashes with alcohol.<br>• Brushes teeth and mouth with soft toothbrush.<br>• Uses lubricant to keep lips soft and nonirritated.<br>• Avoids hard-to-chew, spicy, and hot foods.<br>• Exhibits clean, intact oral mucosa.<br>• Exhibits no ulcerations or infections of oral cavity.<br>• Exhibits no evidence of bleeding.<br>• Reports absent or decreased oral pain.<br>• Reports no difficulty swallowing.<br>• Exhibits healing (reepithelialization) of oral mucosa within 5 to 7 days (mild stomatitis).<br>• Exhibits healing of oral tissues within 10 to 14 days (severe stomatitis). |
| 2. Instruct patient to report oral burning, pain, areas of redness, open lesions on the lips, pain associated with swallowing, or decreased tolerance to temperature extremes of food. | 2. Identification of initial stages of stomatitis will facilitate prompt interventions, including modification of treatment as prescribed by physician. | |
| 3. Encourage and assist in oral hygiene. | 3. Patients who are having discomfort or pain, or other symptoms related to the disease and treatment may require encouragement and assistance in performing oral hygiene. | |
| **Preventive** | | |
| a. Advise patient to avoid irritants such as commercial mouthwashes, alcoholic beverages, and tobacco. | a. Alcohol content of mouthwashes will dry oral tissues and potentiate breakdown. | |
| b. Brush with soft toothbrush; use nonabrasive toothpaste after meals and bedtime; floss every 24 hours unless painful or platelet count falls below 40,000 cu/mm. | b. Limits trauma and removes debris. | |
| **Mild stomatitis** (generalized erythema, limited ulcerations, small white patches: *Candida*) | | |
| c. Use normal saline mouth rinses every 2 hours while awake; every 6 hours at night. | c. Assists in removing debris, thick secretions, and bacteria. | |
| d. Use soft toothbrush or toothette. | d. Minimizes trauma. | |
| e. Remove dentures except for meals; be certain dentures fit well. | e. Minimizes friction and discomfort. | |
| f. Apply water soluble lip lubricant. | f. Promotes comfort. | |
| g. Avoid foods that are spicy or hard to chew and those with extremes of temperature. | g. Prevents local trauma. | |

*Continued on following page*

CHART 16-7

## PLAN OF NURSING CARE
### *The Patient With Cancer* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Severe stomatitis** (confluent ulcerations with bleeding and white patches covering more than 25% of oral mucosa) | | • Exhibits no bleeding or oral ulceration.<br>• Consumes adequate fluid and food.<br>• Exhibits absence of dehydration and weight loss. |
| h. Obtain tissue samples for culture and sensitivity tests of areas of infection. | h. Assists in identifying need for antimicrobial therapy. | |
| i. Assess ability to chew and swallow; assess gag reflex. | i. Patient may be in danger of aspiration. | |
| j. Use oral rinses (may combine in solution saline, anti-*Candida* agent, such as Mycostatin, and topical anesthetic agent as described below) as prescribed or place patient on side and irrigate mouth; have suction available. | j. Facilitates cleansing, provides for safety and comfort. | |
| k. Remove dentures. | k. Prevents trauma from ill-fitting dentures. | |
| l. Use toothette or gauze soaked with solution for cleansing. | l. Limits trauma, promotes comfort. | |
| m. Use water soluble lip lubricant. | m. Promotes comfort. | |
| n. Provide liquid or pureed diet. | n. Ensures intake of easily digestible foods. | |
| o. Monitor for dehydration. | o. Decreased oral intake and ulcerations potentiate fluid deficits. | |
| 4. Minimize discomfort. | | |
| a. Consult physician for use of topical anesthetic, such as dyclonine and diphenhydramine, or viscous lidocaine. | a. Alleviates pain and increases sense of well-being; promotes participation in oral hygiene and nutritional intake. | |
| b. Administer systemic analgesics as prescribed. | b. Adequate management of pain related to severe stomatitis can facilitate improved quality of life, participation in other aspects of activities of daily living, oral intake and verbal communication. | |
| c. Perform mouth care as described. | c. Promotes removal of debris, healing, and comfort. | |

**NURSING DIAGNOSIS:** Impaired tissue integrity: alopecia
**GOAL:** Maintenance of tissue integrity; coping with hair loss

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Discuss potential hair loss and regrowth with patient and family; advise that hair loss may occur on body parts other than the head. | 1. Provides information so patient and family can begin to prepare cognitively and emotionally for loss. | • Identifies alopecia as potential side effect of treatment.<br>• Identifies positive and negative feelings and threats to self-image.<br>• Verbalizes meaning that hair and possible hair loss have for him or her.<br>• States rationale for modifications in hair care and treatment.<br>• Uses mild shampoo and conditioner and shampoos hair only when necessary.<br>• Avoids hair dryer, curlers, sprays, and other stresses on hair and scalp.<br>• Wears hat or scarf over hair when exposed to sun.<br>• Takes steps to deal with possible hair loss before it occurs; purchases wig or hairpiece. |
| 2. Explore potential impact of hair loss on self-image, interpersonal relationships, and sexuality. | 2. Facilitates coping. | |
| 3. Prevent or minimize hair loss through the following: | 3. Retains hair as long as possible. | |
| a. Use scalp hypothermia and scalp tourniquets, if appropriate. | a. Decreases hair follicle uptake of chemotherapy (not used for patients with leukemia or lymphoma because tumor cells may be present in blood vessels or scalp tissue). | |
| b. Cut long hair before treatment.<br>c. Use mild shampoo and conditioner, gently pat dry, and avoid excessive shampooing.<br>d. Avoid electric curlers, curling irons, dryers, clips, barrettes, hair sprays, hair dyes, and permanent waves.<br>e. Avoid excessive combing or brushing; use wide-toothed comb. | b–e. Minimizes hair loss due to the weight and manipulation of hair. | |

*Continued*

CHART 16-7

## PLAN OF NURSING CARE
### *The Patient With Cancer* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 4. Prevent trauma to scalp. | 4. Preserves tissue integrity. | • Maintains hygiene and grooming.<br>• Interacts and socializes with others.<br>• States that hair loss and necessity of wig are temporary. |
| a. Lubricate scalp with vitamin A and D ointment to decrease itching. | a. Assists in maintaining skin integrity. | |
| b. Have patient use sunscreen or wear hat when in the sun. | b. Prevents ultraviolet light exposure. | |
| 5. Suggest ways to assist in coping with hair loss: | 5. Minimizes change in appearance. | |
| a. Purchase wig or hairpiece before hair loss. | a. Wig that closely resembles hair color and style is more easily selected if hair loss has not begun. | |
| b. If hair loss has occurred, take photograph to wig shop to assist in selection. | b. Facilitates adjustment. | |
| c. Begin to wear wig before hair loss. | c. Enables patient to be prepared for loss and facilitates adjustment. | |
| d. Contact the American Cancer Society for donated wigs, or a store that specializes in this product. | d. Provides options to patient. | |
| e. Wear hat, scarf, or turban. | e. Conceals loss. | |
| 6. Encourage patient to wear own clothes and retain social contacts. | 6. Assists in maintaining personal identity. | |
| 7. Explain that hair growth usually begins again once therapy is completed. | 7. Reassures patient that hair loss is usually temporary. | |

**NURSING DIAGNOSIS:** Imbalanced nutrition, less than body requirements, related to nausea and vomiting
**GOAL:** Patient experiences less nausea and vomiting associated with chemotherapy; weight loss is minimized

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess the patient's previous experiences and expectations of nausea and vomiting, including causes and interventions used. | 1. Identifies patient concerns, misinformation, potential strategies for intervention. Also gives patient sense of empowerment and control. | • Identifies previous triggers of nausea and vomiting.<br>• Exhibits decreased apprehension and anxiety.<br>• Identifies previously used successful interventions for nausea and vomiting.<br>• Reports decrease in nausea.<br>• Reports decrease in incidence of vomiting.<br>• Consumes adequate fluid and food when nausea subsides.<br>• Demonstrates use of distraction, relaxation, and imagery when indicated.<br>• Exhibits normal skin turgor and moist mucous membranes.<br>• Reports no additional weight loss. |
| 2. Adjust diet before and after drug administration according to patient preference and tolerance. | 2. Each patient responds differently to food after chemotherapy. A diet containing foods that relieve the patient's nausea or vomiting is most helpful. | |
| 3. Prevent unpleasant sights, odors, and sounds in the environment. | 3. Unpleasant sensations can stimulate the nausea and vomiting center. | |
| 4. Use distraction, music therapy, biofeedback, self-hypnosis, relaxation techniques, and guided imagery before, during, and after chemotherapy. | 4. Decreases anxiety, which can contribute to nausea and vomiting. Psychological conditioning may also be decreased. | |
| 5. Administer prescribed antiemetics, sedatives, and corticosteroids before chemotherapy and afterward as needed. | 5. Administration of antiemetic regimen before onset of nausea and vomiting limits the adverse experience and facilitates control. Combination drug therapy reduces nausea and vomiting through various triggering mechanisms. | |
| 6. Ensure adequate fluid hydration before, during, and after drug administration; assess intake and output. | 6. Adequate fluid volume dilutes drug levels, decreasing stimulation of vomiting receptors. | |
| 7. Encourage frequent oral hygiene. | 7. Reduces unpleasant taste sensations. | |
| 8. Provide pain relief measures, if necessary. | 8. Increased comfort increases physical tolerance of symptoms. | |

*Continued on following page*

## CHART 16-7 PLAN OF NURSING CARE
### *The Patient With Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 9. Consult with dietician as needed. | 9. Interdisciplinary collaboration essential in addressing complex patient needs. | |
| 10. Assess and address other contributing factors to nausea and vomiting, such as other symptoms, constipation, gastrointestinal irritation, electrolyte imbalance, radiation therapy, medications, and central nervous system metastasis. | 10. Multiple factors may contribute nausea and vomiting. | |

**NURSING DIAGNOSIS:** Imbalanced nutrition: less than body requirements, related to anorexia, cachexia, or malabsorption
**GOAL:** Maintenance of nutritional status and of weight within 10% of pretreatment weight

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Teach patient to avoid unpleasant sights, odors, sounds in the environment during mealtime. | 1. Anorexia can be stimulated or increased with noxious stimuli. | • Patient and family identify minimal nutritional requirements.<br>• Exhibits weight loss no greater than 10% of pretreatment weight.<br>• Reports decreasing anorexia and increased interest in eating.<br>• Demonstrates normal skin turgor.<br>• Identifies rationale for dietary modifications. Patient and family verbalize strategies to address minimize nutritional deficits.<br>• Participates in calorie counts and diet histories.<br>• Uses appropriate relaxation and imagery before meals.<br>• Exhibits laboratory and clinical findings indicative of adequate nutritional intake: normal serum protein and transferrin levels; normal serum iron levels; normal hemoglobin, hematocrit, and lymphocyte levels; normal urinary creatinine levels.<br>• Consumes diet high in required nutrients.<br>• Carries out oral hygiene before meals.<br>• Reports that pain does not interfere with meals.<br>• Reports decreasing episodes of nausea and vomiting.<br>• Participates in increasing levels of activity.<br>• States rationale for use of tube feedings or parenteral nutrition.<br>• Participates in management of tube feedings or parenteral nutrition, if prescribed. |
| 2. Suggest foods that are preferred and well tolerated by the patient, preferably high-calorie and high-protein foods. Respect ethnic and cultural food preferences. | 2. Foods preferred, well tolerated, and high in calories and protein maintain nutritional status during periods of increased metabolic demand. | |
| 3. Encourage adequate fluid intake, but limit fluids at mealtime. | 3. Fluids are necessary to eliminate wastes and prevent dehydration. Increased fluids with meals can lead to early satiety. | |
| 4. Suggest smaller, more frequent meals. | 4. Smaller, more frequent meals are better tolerated because early satiety does not occur. | |
| 5. Promote relaxed, quiet environment during mealtime with increased social interaction as desired. | 5. A quiet environment promotes relaxation. Social interaction at mealtime increases appetite. | |
| 6. If patient desires, serve wine at mealtime with foods. | 6. Wine often may stimulate appetite and add calories. | |
| 7. Consider cold foods, if desired. | 7. Cold, high-protein foods are often more tolerable and less odorous than hot foods. | |
| 8. Encourage nutritional supplements and high-protein foods between meals. | 8. Supplements and snacks add protein and calories to meet nutritional requirements. | |
| 9. Encourage frequent oral hygiene. | 9. Oral hygiene stimulates appetite and increases saliva production. | |
| 10. Provide pain relief measures. | 10. Pain impairs appetite. | |
| 11. Provide control of nausea and vomiting. | 11. Nausea and vomiting increase anorexia. | |
| 12. Increase activity level as tolerated. | 12. Increased activity promotes appetite. | |
| 13. Decrease anxiety by encouraging verbalization of fears, concerns; use of relaxation techniques; imagery at mealtime. | 13. Relief of anxiety may increase appetite. | |
| 14. Position patient properly at mealtime. | 14. Proper body position and alignment are necessary to aid chewing and swallowing. | |
| 15. For collaborative management, provide enteral tube feedings of commercial liquid diets, elemental diets, or blenderized foods as prescribed. | 15. Tube feedings may be necessary in the severely debilitated patient who has a functioning gastrointestinal system. | |
| 16. Provide parenteral nutrition with lipid supplements as prescribed. | 16. Parenteral nutrition with supplemental fats supplies needed calories and proteins to meet nutritional demands, especially in the nonfunctional gastrointestinal system. | |

*Continued*

CHART 16-7

## PLAN OF NURSING CARE
### *The Patient With Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 17. Administer appetite stimulants as prescribed by physician. | 17. Although the mechanism is unclear, medications such as megestrol acetate (Megace) have been noted to improve appetite in patients with cancer and human immunodeficiency virus (HIV) infection. | |
| 18. Encourage family and friends not to nag or cajole patient about eating. | 18. Pressuring patient to eat may cause conflict and unnecessary stress. | |
| 19. Assess and address other contributing factors to nausea, vomiting, and anorexia such as other symptoms, constipation, GI irritation, electrolyte imbalance, radiation therapy, medications, and central nervous system metastasis. | 19. Multiple factors contribute to anorexia and nausea. | |

**NURSING DIAGNOSIS:** Fatigue
**GOAL:** Increased activity tolerance and decreased fatigue level

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage rest periods during the day, especially before and after physical exertion. | 1. During rest, energy is conserved and levels are replenished. Several shorter rest periods may be more beneficial than one longer rest period. | • Reports decreasing levels of fatigue.<br>• Increases participation in activities gradually.<br>• Rests when fatigued.<br>• Reports restful sleep.<br>• Requests assistance with activities appropriately.<br>• Reports adequate energy to participate in activities important to him or her (eg, visiting with family, hobbies).<br>• Consumes diet with recommended protein and caloric intake.<br>• Uses relaxation exercises and imagery to decrease anxiety and promote rest.<br>• Participates in planned exercise program gradually.<br>• Reports no breathlessness during activities.<br>• Exhibits acceptable hemoglobin and hematocrit levels.<br>• Exhibits normal fluid and electrolyte balance.<br>• Reports decreased discomfort.<br>• Exhibits improved mobility. |
| 2. At minimum, promote patient's normal sleep habits. | 2. Sleep helps to restore energy levels. Prolonged napping during day may interfere with sleep habits. | |
| 3. Rearrange daily schedule and organize activities to conserve energy expenditure. | 3. Reorganization of activities can reduce energy losses and stressors. | |
| 4. Encourage patient to ask for others' assistance with necessary chores, such as housework, child care, shopping, cooking. | 4. Conserves energy. | |
| 5. Encourage reduced job workload, if necessary and possible, by reducing number of hours worked per week. | 5. Reducing workload decreases physical and psychological stress and increases periods of rest and relaxation. | |
| 6. Encourage adequate protein and calorie intake. | 6. Protein and calorie depletion decreases activity tolerance. | |
| 7. Encourage use of relaxation techniques, mental imagery. | 7. Promotion of relaxation and psychological rest decreases physical fatigue. | |
| 8. Encourage participation in planned exercise programs. | 8. Proper exercise programs increase endurance and stamina and lower fatigue. | |
| 9. For collaborative management, administer blood products as prescribed. | 9. Lowered hemoglobin and hematocrit predispose patient to fatigue due to decreased oxygen availability. | |
| 10. Assess for fluid and electrolyte disturbances. | 10. May contribute to altered nerve transmission and muscle function. | |
| 11. Assess for sources of discomfort. | 11. Coping with discomfort requires energy expenditure. | |
| 12. Provide strategies to facilitate mobility. | 12. Impaired mobility requires increased energy expenditure. | |

*Continued on following page*

CHART 16-7

## PLAN OF NURSING CARE
## *The Patient With Cancer (Continued)*

**NURSING DIAGNOSIS:** Chronic pain
**GOAL:** Relief of pain and discomfort

### Nursing Interventions

1. Use pain scale to assess pain and discomfort characteristics: location, quality, frequency, duration, etc.
2. Assure patient that you know that pain is real and will assist him or her in reducing it.
3. Assess other factors contributing to patient's pain: fear, fatigue, anger, etc.
4. Administer analgesics to promote optimum pain relief within limits of physician's prescription.
5. Assess patient's behavioral responses to pain and pain experience.
6. Collaborate with patient, physician, and other health care team members when changes in pain management are necessary.
7. Encourage strategies of pain relief that patient has used successfully in previous pain experience.
8. Teach patient new strategies to relieve pain and discomfort: distraction, imagery, relaxation, cutaneous stimulation, etc.

### Rationale

1. Provides baseline for assessing changes in pain level and evaluation of interventions.
2. Fear that pain will not be considered real increases anxiety and reduces pain tolerance.
3. Provides data about factors that decrease patient's ability to tolerate pain and increase pain level.
4. Analgesics tend to be more effective when administered early in pain cycle.
5. Provides additional information about patient's pain.
6. New methods of administering analgesia must be acceptable to patient, physician, and health care team to be effective; patient's participation decreases the sense of powerlessness.
7. Encourages success of pain relief strategies accepted by patient and family.
8. Increases number of options and strategies available to patient.

### Expected Outcomes

- Reports decreased level of pain and discomfort on pain scale.
- Reports less disruption from pain and discomfort.
- Explains how fatigue, fear, anger, etc., contribute to severity of pain and discomfort.
- Accepts analgesia as prescribed.
- Exhibits decreased physical and behavioral signs of pain and discomfort in acute pain (no grimacing, crying, moaning; displays interest in surroundings and activities around him).
- Takes an active role in administration of analgesia.
- Identifies additional effective pain relief strategies.
- Uses alternative pain relief strategies appropriately.
- Reports effective use of new pain relief strategies and decrease in pain intensity.
- Reports that decreased level of pain permits participation in other activities and events.

**NURSING DIAGNOSIS:** Anticipatory grieving related to loss; altered role functioning
**GOAL:** Appropriate progression through grieving process

### Nursing Interventions

1. Encourage verbalization of fears, concerns, and questions regarding disease, treatment, and future implications.
2. Explore previous successful coping strategies.
3. Encourage active participation of patient or family in care and treatment decisions.
4. Visit family frequently to establish and maintain relationships and physical closeness.
5. Encourage ventilation of negative feelings, including projected anger and hostility, within acceptable limits.
6. Allow for periods of crying and expression of sadness.
7. Involve spiritual advisor as desired by the patient and family.
8. Advise professional counseling as indicated for patient or family to alleviate pathologic grieving.
9. Allow for progression through the grieving process at the individual pace of the patient and family.

### Rationale

1. An increased and accurate knowledge base decreases anxiety and dispels misconceptions.
2. Provides frame of reference and examples of coping.
3. Active participation maintains patient independence and control.
4. Frequent contacts promote trust and security and reduce feelings of fear and isolation.
5. This allows for emotional expression without loss of self-esteem.
6. These feelings are necessary for separation and detachment to occur.
7. This facilitates the grief process and spiritual care.
8. This facilitates the grief process.
9. Grief work is variable. Not every person uses every phase of the grief process, and the time spent in dealing with each phase varies with every person. To complete grief work, this variability must be allowed.

### Expected Outcomes

- The patient and family progress through the phases of grief as evidenced by increased verbalization and expression of grief.
- The patient and family identify resources available to aid coping strategies during grieving.
- The patient and family use resources and supports appropriately.
- The patient and family discuss the future openly with each other.
- The patient and family discuss concerns and feelings openly with each other.
- The patient and family use nonverbal expressions of concern for each other.

*Continued*

CHART 16-7

## PLAN OF NURSING CARE
## *The Patient With Cancer* (Continued)

**NURSING DIAGNOSIS:** Disturbed body image and situational low self-esteem related to changes in appearance, function, and roles
**GOAL:** Improved body image and self-esteem

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's feelings about body image and level of self- esteem. | 1. Provides baseline assessment for evaluating changes and assessing effectiveness of interventions. | • Identifies concerns of importance.<br>• Takes active role in activities.<br>• Maintains previous role in decision making.<br>• Verbalizes feelings and reactions to losses or threatened losses.<br>• Participates in self-care activities.<br>• Permits others to assist in care when he or she is unable to be independent.<br>• Exhibits interest in appearance and uses aids (cosmetics, scarves, etc.) appropriately.<br>• Participates with others in conversations and social events and activities.<br>• Verbalizes concern about sexual partner and/or significant others.<br>• Explores alternative ways of expressing concern and affection. |
| 2. Identify potential threats to patient's self-esteem (eg, altered appearance, decreased sexual function, hair loss, decreased energy, role changes). Validate concerns with patient. | 2. Anticipates changes and permits patient to identify importance of these areas to him or her. | |
| 3. Encourage continued participation in activities and decision making. | 3. Encourages and permits continued control of events and self. | |
| 4. Encourage patient to verbalize concerns. | 4. Identifying concerns is an important step in coping with them. | |
| 5. Individualize care for the patient. | 5. Prevents or reduces depersonalization and emphasizes patient's self-worth. | |
| 6. Assist patient in self-care when fatigue, lethargy, nausea, vomiting, and other symptoms prevent independence. | 6. Physical well-being improves self-esteem. | |
| 7. Assist patient in selecting and using cosmetics, scarves, hair pieces, and clothing that increase his or her sense of attractiveness. | 7. Promotes positive body image. | |
| 8. Encourage patient and partner to share concerns about altered sexuality and sexual function and to explore alternatives to their usual sexual expression. | 8. Provides opportunity for expressing concern, affection, and acceptance. | |
| 9. Refer to collaborating specialists as needed. | 9. Interdisciplinary collaboration essential in meeting patient needs. | |

**COLLABORATIVE PROBLEM:** Potential complication: risk for bleeding problems
**GOAL:** Prevention of bleeding

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess for potential for bleeding: monitor platelet count. | 1. Mild risk: 50,000–100,000/mm$^3$ (0.05–0.1 × 10$^{12}$/L)<br>Moderate risk: 20,000–50,000/mm$^3$ (0.02–0.05 × 10$^{12}$/L)<br>Severe risk: less than 20,000/mm$^3$ (0.02 × 10$^{12}$/L) | • Signs and symptoms of bleeding are identified.<br>• Exhibits no blood in feces, urine, or emesis.<br>• Exhibits no bleeding of gums or of injection or venipuncture sites.<br>• Exhibits no ecchymosis (bruising).<br>• Patient and family identify ways to prevent bleeding.<br>• Uses recommended measures to reduce risk of bleeding (uses soft toothbrush, shaves with electric razor only).<br>• Exhibits normal vital signs.<br>• Reports that environmental hazards have been reduced or removed.<br>• Consumes adequate fluid.<br>• Reports absence of constipation.<br>• Avoids substances interfering with clotting.<br>• Absence of tissue destruction. |
| 2. Assess for bleeding: | 2. Early detection promotes early intervention. | |
| a. Petechiae or ecchymosis | a. Indicates injury to microcirculation and larger vessels. | |
| b. Decrease in hemoglobin or hematocrit | b–e. Indicates blood loss. | |
| c. Prolonged bleeding from invasive procedures, venipunctures, minor cuts or scratches | | |
| d. Frank or occult blood in any body excretion, emesis, sputum | | |
| e. Bleeding from any body orifice | | |
| f. Altered mental status | f. Indicates neurologic involvement. | |

*Continued on following page*

CHART 16-7

**PLAN OF NURSING CARE**

## *The Patient With Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Instruct patient and family about ways to minimize bleeding: | 3. Patient can participate in self-protection. | • Exhibits normal mental status and absence of signs of intracranial bleeding.<br>• Avoids medications that interfere with clotting (eg, aspirin).<br>• Absence of epistaxis and cerebral bleeding. |
| a. Use soft toothbrush or toothette for mouth care. | a. Prevents trauma to oral tissues. | |
| b. Avoid commercial mouthwashes. | b. Contain high alcohol content that will dry oral tissues. | |
| c. Use electric razor for shaving. | c. Prevents trauma to skin. | |
| d. Use emery board for nail care. | d. Reduces risk of trauma to nailbeds. | |
| e. Avoid foods that are difficult to chew. | e. Prevents oral tissue trauma. | |
| 4. Initiate measures to minimize bleeding. | 4. Preserves circulating blood volume. | |
| a. Draw all blood for lab work with one daily venipuncture. | a. Minimizes trauma and blood loss. | |
| b. Avoid taking temperature rectally or administering suppositories and enemas. | b. Prevents trauma to rectal mucosa. | |
| c. Avoid intramuscular injections; use smallest needle possible. | c. Prevents intramuscular bleeding. | |
| d. Apply direct pressure to injection and venipuncture sites for at least 5 minores. | d. Minimizes blood loss. | |
| e. Lubricate lips with petrolatum. | e. Prevents skin from drying. | |
| f. Avoid bladder catheterizations; use smallest catheter if catheterization is necessary. | f. Prevents trauma to urethra. | |
| g. Maintain fluid intake of at least 3 L per 24 hours unless contraindicated. | g. Hydration helps to prevent skin drying. | |
| h. Use stool softeners or increase bulk in diet. | h. Prevents constipation and straining that may injure rectal tissue. | |
| i. Avoid medications that will interfere with clotting (eg, aspirin). | i. Minimizes risk of bleeding. | |
| j. Recommend use of water-based lubricant before sexual intercourse. | j. Prevents friction and tissue trauma. | |
| 5. When platelet count is less than 20,000/mm$^3$, institute the following: | 5. Platelet count of less than 20,000/mm$^3$ ($0.02 \times 10^{12}$/L) is associated with increased risk of spontaneous bleeding. | |
| a. Bed rest with padded side rails. | a. Reduces risk of injury. | |
| b. Avoidance of strenuous activity. | b. Increases intracranial pressure and risk of cerebral hemorrhage. | |
| c. Platelet transfusions as prescribed; administer prescribed diphenhydramine hydrochloride (Benadryl) or hydrocortisone sodium succinate (Solu-Cortef) to prevent reaction to platelet transfusion. | c. Allergic reactions to blood products are associated with antigen–antibody reaction that causes platelet destruction. | |
| d. Supervise activity when out of bed. | d. Reduces risk of falls. | |
| e. Caution against forceful nose blowing. | e. Prevents trauma to nasal mucosa and increased intracranial pressure. | |

to 14 days after patients receive certain chemotherapeutic agents, such as doxorubicin and 5-fluorouracil, and BRMs, such as IL-2 and IFN. As many as 40% of patients receiving chemotherapy experience some degree of stomatitis during treatment. Patients receiving high-dose chemotherapy, such as those patients undergoing stem cell transplant, are at increased risk. Stomatitis may also occur after radiation treatments to the head and neck. Oropharyngeal mucositis may be worse in patients with head and neck cancers who receive combined modality therapy of both radiation and chemotherapy (Cady, 2007).

As a result of normal everyday wear and tear, the epithelial cells that line the oral cavity undergo rapid turnover and slough off routinely. Both chemotherapy and radiation lead to the destruction of cells in the oral cavity (Sonis, 2004). This initiates the inflammatory process, leading to further tissue damage and ulceration of oral tissues. Normal flora invade the ulcerations and cause additional damage. Poor oral hygiene, existing dental disease, use of other medications that dry mucous membranes, advanced age, smoking, previous cancer treatment, diminished renal function, and impaired nutritional status further contribute to the severity of stomatitis. Radiation-induced xerostomia (dry mouth) associated with decreased function of the salivary glands may contribute to stomatitis in patients who have received radiation to the head and neck.

Myelosuppression (bone marrow depression), resulting from underlying disease or its treatment, predisposes the patient to oral bleeding and infection. Severe oral pain can significantly affect swallowing, nutritional intake, speech, and a willingness to maintain oral hygiene. As a result of the ability to give higher doses of chemotherapy due to improvements in managing neutropenia with growth factors, stomatitis is a common reason for treatment delays and dose reductions (Cawley & Benson, 2005). Advanced stomatitis may cause or prolong hospitalizations, significantly reduce the patient's quality of life, and ultimately lead to poor patient outcomes (Eilers & Million, 2007).

There is no standard of practice for the assessment of stomatitis. It is important for nurses to assess the oropharyngeal cavity of patients prior to, throughout the course of, and after treatment. It is important that the same tool or method of assessment is used by all clinicians involved in the patient's care. Nursing assessment begins with understanding the patient's usual practices for oral hygiene and identification of individuals at risk for stomatitis. Assessment of the patient's subjective experience and an objective assessment of the oropharyngeal tissues and teeth are important. The patient is also assessed for dehydration, infection, pain, and nutritional impairment resulting from stomatitis.

Optimal, evidence-based prevention and treatment approaches have not yet been identified (Eilers & Million, 2007). Ongoing studies are addressing the inflammation and release of chemical substances that lead to stomatitis. At this time, most clinicians agree that good oral hygiene, including brushing, flossing, and rinsing, is necessary to minimize the risk of oral complications associated with cancer therapies.

Palifermin (Kepivance), a synthetic form of human keratinocyte growth factor, is an IV medication approved by the FDA for treatment of oral mucositis in patients with hematologic cancer who are undergoing chemotherapy and radiation prior to hematopoietic stem cell support. Palifermin promotes epithelial cell repair and more rapid replacement of cells in the mouth and gastrointestinal tract (Oncology Nursing Society, 2006). It is not yet been approved for use in patients with other types of cancer. Careful timing of administration and monitoring are essential for maximum effectiveness and to detect adverse effects.

### Radiation Associated Skin Impairment

Although advances in radiation therapy have resulted in decreased incidence and severity of skin impairments, patients may still develop skin reactions that lead to pain, irritation, pruritis, burning, and diminished quality of life. Nursing care for patients with skin reactions includes maintaining skin integrity, cleansing the skin, promoting comfort, reducing pain, preventing additional trauma, and preventing and managing infection (McQuestion, 2006). Although a variety of methods and products are used in clinical practice for patients with radiation-induced skin reactions, there is limited evidence to support their value. Patients with skin and tissue reactions to radiation therapy require careful skin care to prevent further skin irritation, drying, and damage, as discussed in the nursing care plan (see Chart 16-7), under Impaired skin integrity: erythematous and wet desquamation reactions to radiation therapy.

### Alopecia

The temporary or permanent thinning or complete loss of hair is a potential adverse effect of radiation therapy to the brain and various chemotherapeutic agents. Alopecia usually begins 2 to 3 weeks after the initiation of treatment; regrowth usually begins within 8 weeks after the last treatment. Some patients who undergo radiation to the head may sustain permanent hair loss. Although health care providers may view hair loss as a minor issue, for many patients it is a major assault on body image, resulting in challenges to self-esteem, depression, anxiety, anger, rejection, and isolation. In some cases, patients may initially refuse treatment due to fears regarding hair loss (Nolte, Donnelly, Kelly, et al., 2006). To patients and families, hair loss can serve as a constant reminder of the challenges cancer places on their coping abilities, interpersonal relationships, and sexuality.

Although few studies have addressed methods to minimize the impact of alopecia, nurses provide information about hair loss and support the patient and family in coping with changes in body image, as discussed in the nursing care plan (see Chart 16-7) under Impaired tissue integrity: alopecia.

### Malignant Skin Lesions

Skin lesions may occur with local extension or metastasis of the tumor into the epithelium and its surrounding lymph and blood vessels. Either locally invasive or metastatic cancer to the skin may result in redness (erythema), discolored nodules, or progression to wounds involving edema, exudates, and tissue necrosis. The most extensive lesions may ulcerate with an overgrowth of micro-organisms that result in a very distressing malodor. These lesions are a source of considerable pain, discomfort, and embarrassment.

Ulcerating skin lesions usually indicate widely disseminated disease that is unlikely to be eradicated. Managing these lesions becomes a nursing priority. Nurses carefully assess malignant skin lesions for the size, appearance, condition of the surrounding tissue, odor, bleeding, drainage, and associated pain or other symptoms including evidence of infection. The potential for serious complications such as hemorrhage, vessel compression/obstruction, or airway obstruction should be noted so that the caregiver can be instructed in palliative measures to maintain patient comfort (Seaman, 2006). Since this type of lesion is associated with advanced disease, the nurse assesses the wound for progression over time.

Nursing care also includes cleansing the skin, reducing superficial bacteria, controlling bleeding, reducing odor, protecting the skin from further trauma, and relieving pain. The patient and family require emotional support, assistance, and guidance to care for these skin lesions and to address comfort measures at home. Referral for home care is indicated.

## Promoting Nutrition

### Nutritional Problems

Most patients with cancer experience some weight loss during their illness. Anorexia, malabsorption, and cachexia are common examples of nutritional problems. Impaired nutritional status may contribute to both physical and psychosocial consequences (Chart 16-8). Nutritional concerns include decreased protein and caloric intake, metabolic or mechanical effects of the cancer, systemic disease, side effects of the treatment, or the patient's emotional status.

#### Anorexia

Among the many causes of anorexia in patients with cancer are alterations in taste, manifested by increased salty, sour, and metallic taste sensations, and altered responses to sweet and bitter flavors. Taste changes contribute to decreased appetite and nutritional intake and protein–calorie malnutrition. Taste alterations may result from mineral (eg, zinc) deficiencies, increases in circulating amino acids and cellular metabolites, or the administration of chemotherapeutic agents. Patients undergoing radiation therapy to the head and neck may experience "mouth blindness," which is a severe impairment of taste.

**Chart 16-8 • *Potential Consequences of Impaired Nutrition in Patients With Cancer***

- Decreased survival
- Immune incompetence
- Anemia
- Increased incidence of infection
- Delayed tissue and wound healing
- Fatigue
- Diminished functional ability
- Decreased capacity to continue antineoplastic therapy
- Increased hospital admissions
- Increased length of hospital stay
- Impaired psychosocial functioning

Anorexia may occur because people feel full after eating only a small amount of food. This sense of fullness occurs secondary to a decrease in digestive enzymes, abnormalities in the metabolism of glucose and triglycerides, and prolonged stimulation of gastric volume receptors, which convey the feeling of being full. Psychological distress (eg, fear, pain, depression, and isolation) throughout illness may also have a negative impact on appetite. Patients may develop an aversion to food because of nausea and vomiting associated with treatment.

#### Malabsorption

Many patients with cancer are unable to absorb nutrients from the gastrointestinal system as a result of tumor activity and cancer treatment. Tumors can affect the gastrointestinal activity in several ways. They may impair enzyme production or produce fistulas. Some tumors secrete hormones and enzymes, such as gastrin, that lead to increased gastrointestinal irritation, peptic ulcer disease, and decreased fat digestion. Tumors may interfere with protein digestion.

Chemotherapy and radiation may irritate and damage mucosal cells of the bowel, inhibiting absorption. Radiation therapy has been associated with sclerosis of the blood vessels in the bowel and fibrotic changes in the gastrointestinal tissue. Surgical intervention may change peristaltic patterns, alter gastrointestinal secretions, and reduce the absorptive surfaces of the gastrointestinal mucosa, all leading to malabsorption.

#### Cachexia

Cachexia is common in patients with cancer, especially in advanced disease. Cancer cachexia is related to inadequate nutritional intake, along with increasing metabolic demand, increased energy expenditure due to anaerobic metabolism of the tumor, impaired glucose metabolism, competition of the tumor cells for nutrients, altered lipid metabolism, and a suppressed appetite. In addition, current literature suggests that cachexia in cancer may be related to a cytokine-induced inflammatory response (Tchekmedyian, 2006). Cachexia is characterized by loss of body weight, adipose tissue, visceral protein, and skeletal muscle. Patients with cachexia complain of loss of appetite, early satiety, and fatigue. As a result of protein losses, patients develop anemia and peripheral edema.

Nurses assess patients who are at risk of altered nutritional intake so that appropriate measures may be instituted prior to nutritional decline (Cady, 2007).

### General Nutritional Considerations

Assessment of the patient's nutritional status is conducted at diagnosis and throughout the course of treatment and the disease process. The patient's weight and caloric intake are monitored closely. Diet history, episodes of anorexia, changes in appetite, situations and foods that aggravate or relieve anorexia, and medication history are assessed. Difficulty in chewing or swallowing and the presence of nausea, vomiting, or diarrhea are noted.

Clinical and laboratory data useful in assessing nutritional status include anthropometric measurements (triceps skin fold and middle-upper arm circumference), serum protein levels (albumin and transferrin), serum electrolytes,

lymphocyte count, skin response to intradermal injection of antigens, hemoglobin levels, hematocrit, urinary creatinine levels, and serum iron levels. Whenever possible, every effort is made to maintain adequate nutrition through the oral route. Prokinetic agents such as metoclopramide are used in some settings to increase gastric emptying in patients with early satiety and delayed gastric emptying.

If adequate nutrition cannot be maintained by oral intake, nutritional support via the enteral route may be necessary. Patients with head and neck cancers who receive radiation therapy or some combination of surgery, radiation, and chemotherapy are at particularly high risk for impaired oral intake and inadequate fluid and nutritional status. Increasingly, patients at risk for significantly impaired nutrition have prophylactic percutaneous endoscopic gastrostomy (PEG) tubes inserted prior to initiation of antineoplastic treatment and the onset of weight loss and other consequences of limited oral intake (Cady, 2007). When needed, the patient and family are taught to administer enteral nutrition in the home.

If malabsorption is a problem, enzyme and vitamin replacement may be instituted. Additional strategies include changing the feeding schedule, using simple diets, and relieving diarrhea. If malabsorption is severe, parenteral nutrition may be necessary. However, patients with advanced end-stage cancer, who have a life expectancy of less than 3 months, are usually not considered to be candidates for parenteral nutrition (Mirhosseini, Fainsinger & Baracos, 2005). Parenteral nutrition can be administered in several ways: by a long-term venous access device (eg, right atrial catheter), by an implanted venous port, or by a PICC (Fig. 16-6). The nurse teaches the patient and family to care for the venous access device and to administer parenteral nutrition. Home care nurses may assist with or supervise parenteral nutrition administration in the home.

Interventions to reduce cachexia usually do not prolong survival or improve nutritional status significantly. Before invasive nutritional strategies are instituted, the nurse should assess the patient carefully and discuss options with the patient and family. Creative dietary therapies, enteral (tube) feedings, or parenteral nutrition may be necessary to ensure adequate nutrition. Care is also directed toward preventing trauma, infection, and other complications that increase metabolic demands.

## Relieving Pain

It is estimated that 90% to 95% of patients with progressive cancer experience pain (Stoneberg & von Gunten, 2006). Although the pain may be acute, it is more frequently characterized as chronic. (For more information on cancer-related pain, see Chapter 13.) As in other situations involving pain, the experience of cancer pain is influenced by physical, psychosocial, cultural, and spiritual factors.

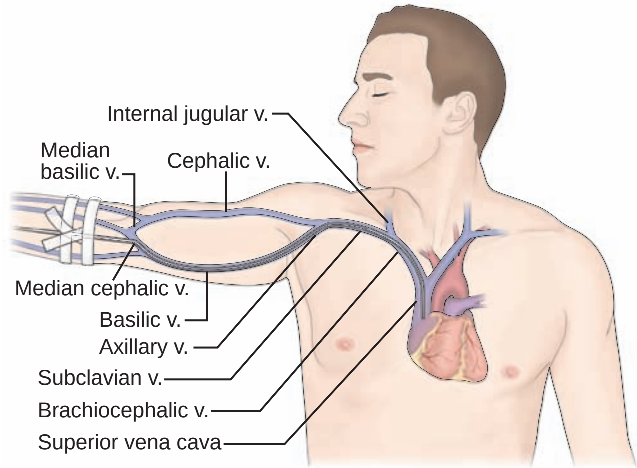



**Figure 16-6** A peripherally inserted central catheter (PICC) is advanced through the cephalic or basilic vein to the axillary, subclavian, or brachiocephalic vein or the superior vena cava.

Cancer can cause pain in various ways (Table 16-7). Pain related to the underlying cancer process accounts for the pain experienced by 75% of all patients with cancer (Abrahm, 2005). Pain is also associated with various cancer treatments. Acute pain is linked with trauma from surgery. Occasionally, chronic pain syndromes, such as postsurgical neuropathies (pain related to nerve tissue injury), occur. Some chemotherapeutic agents cause tissue necrosis, peripheral neuropathies, and stomatitis—all potential sources of pain—whereas radiation therapy can cause pain secondary to skin or organ inflammation. Cancer patients may have other sources of pain, such as arthritis or migraine headaches, that are unrelated to the underlying cancer or its treatment.

The nurse assesses the patient for the source and site of pain as well as those factors that increase the patient's perception of pain, such as fear and apprehension, fatigue, anger, and social isolation. Pain assessment scales (see Chapter 13) are useful for assessing the patient's pain before pain-relieving interventions are instituted and for evaluating the effectiveness of these interventions. Other symptoms that contribute to the pain experience, such as nausea and fatigue, are assessed as well.

**Table 16-7 EXAMPLES OF SOURCES OF CANCER PAIN**

| Source | Descriptions | Underlying Cancer |
|---|---|---|
| Bone metastasis | Throbbing, aching | Breast, prostate, myeloma |
| Nerve compression, infiltration | Burning, sharp, tingling | Breast, prostate, lymphoma |
| Lymphatic or venous obstruction | Dull, aching, tightness | Lymphoma, breast, Kaposi's sarcoma |
| Ischemia | Sharp, throbbing | Kaposi's sarcoma |
| Organ obstruction | Dull, crampy, gnawing | Colon, gastric |
| Organ infiltration | Distention, crampy | Liver, pancreatic |
| Skin inflammation, ulceration, infection, necrosis | Burning, sharp | Breast, head and neck, Kaposi's sarcoma |

In today's society, most people expect pain to disappear or resolve quickly, and in fact it usually does. Although it is often controllable, advanced cancer pain is commonly irreversible and not quickly resolved. For many patients, pain is often seen as a signal that the tumor is growing and that death is approaching. As patients anticipate the pain and their anxiety increases, pain perception heightens, producing fear and further pain. Chronic cancer pain, then, can lead to a cycle progressing from pain to anxiety to fear and back to pain, especially when the pain is not adequately managed. Inadequate pain management is most often the result of misconceptions and insufficient knowledge about pain assessment and pharmacologic interventions on the part of patients, families, and health care providers (Xue, Schulman-Green, Czaplinski, et al., 2007). Chapter 13 provides information concerning factors contributing to the pain experience, pain perception, and tolerance as well as pharmacologic and nonpharmacologic nursing interventions addressing pain. The nursing care plan (see Chart 16-7) also provides strategies for nursing assessment and management.

Inadequate pain management is most often the result of misconceptions and insufficient knowledge about pain assessment and pharmacologic interventions on the part of patients, families, and health care providers (Xue, et al., 2007).

The World Health Organization advocates a three-step approach to treat cancer pain (Fig. 16-7). Analgesics are administered based on the patient's level of pain. A cancer pain algorithm, developed as a set of analgesic guiding principles, is given in Figure 16-8.

No reasonable pharmacologic and nonpharmacologic approaches, even those that may be invasive, should be overlooked because of a poor or terminal prognosis. The nurse helps the patient and family take an active role in managing pain. The nurse provides education and support to correct fears and misconceptions about opioid use. Inadequate pain control leads to a diminished quality of life characterized by suffering, anxiety, fear, immobility, isolation, and depression. Improving the patient's quality of life through palliative care is as important as preventing a painful death.

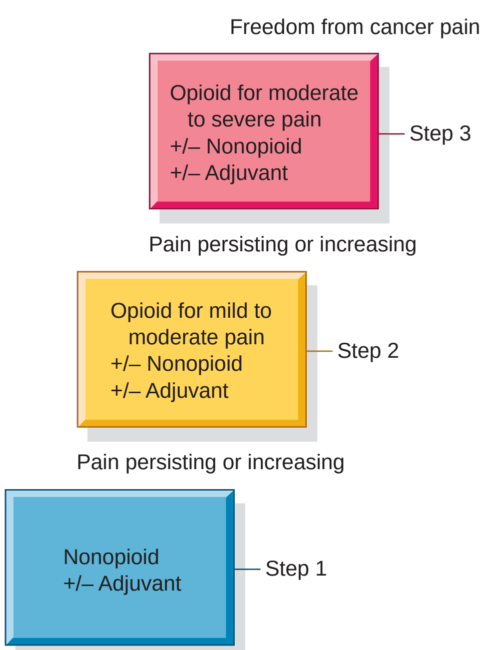



**Figure 16-7** Adapted from the World Health Organization three-step ladder approach to relieving cancer pain. Various opioid (narcotic) and nonopioid medications may be combined with other medications to control pain.

## Decreasing Fatigue

Fatigue is one of the most significant and frequent symptoms experienced by patients receiving cancer therapy. Fatigue also results from the stress of coping with cancer. It does not always signify that the cancer is advancing or that the treatment is failing. Potential factors contributing to the experience of fatigue are summarized in Chart 16-9.

In assessing fatigue the nurse distinguishes between acute fatigue, which occurs after an energy-demanding experience, and cancer-related fatigue, which is defined as "a distressing persistent, subjective sense of tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning" (National Comprehensive Cancer Network, 2006b). Acute fatigue serves a protective function, whereas cancer-related fatigue does not.

Fatigue is distressing for patients with cancer who are receiving treatment, for survivors, and for those in the late stages of disease (Mitchell, et al., 2007). Although patients may describe fatigue in a variety of ways, nurses assess for feelings of weariness, weakness, lack of energy, inability to carry out necessary and valued daily functions, lack of motivation, and inability to concentrate. Several assessment tools, such as a simple visual analogue scale, may be used to assess levels of fatigue (Madden & Newton, 2006). The nurse assesses physiologic and psychological stressors that can contribute to fatigue, including anemia, electrolyte imbalances, organ dysfunction, pain, nausea, dyspnea, constipation, fear, and anxiety.

The role of exercise as a helpful intervention has been supported by several controlled trials (Mitchell, et al., 2007; Young-McCaughan & Arzola, 2007). The nurse assists patients with additional nonpharmacologic strategies to minimize fatigue or help the patient cope with existing fatigue as described in the nursing care plan (see Chart 16-7) under Fatigue. Occasionally pharmacologic interventions are utilized, including antidepressants for patients with depression; anxiolytics for those with anxiety; hypnotics for patients with sleep disturbances; and psychostimulants for some patients with advanced cancer or fatigue that does not respond to other interventions (Abrahm, 2005).

The nurse assists patients with nonpharmacologic strategies to minimize fatigue or help the patient cope with existing fatigue.

## Improving Body Image and Self-Esteem

The nurse identifies potential threats to the patient's body image and assesses the patient's ability to cope with the many assaults to body image experienced throughout the course of disease and treatment. Entry into the health care system is often accompanied by depersonalization. Threats to self-concept occur as the patient faces the realization of illness, disfigurement, possible disability, and death. To accommodate treatments or because of the disease, many patients with cancer are forced to alter their lifestyles. Priorities and values change when body image is threatened.

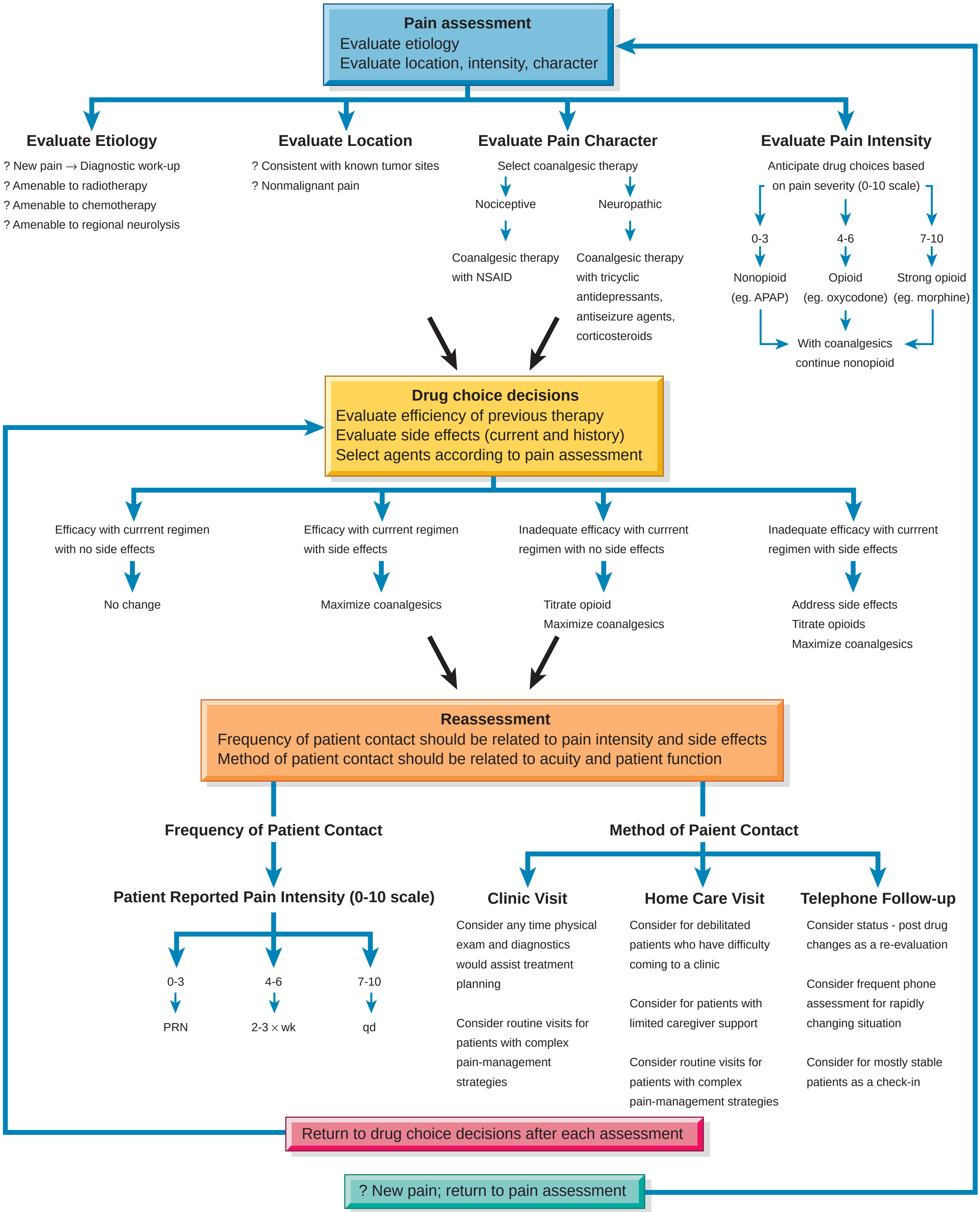



**Figure 16-8** The cancer pain algorithm (highest-level view) is a decision-tree model for pain treatment that was developed as an interpretation of the AHCPR Guideline for Cancer Pain, 1994. Redrawn with permission from DuPen, A. R., DuPen, S., Hansberry, J., et al. (2000). An educational implementation of a cancer pain algorithm for ambulatory care. *Pain Management Nursing, 1*(4), 118.

**Chart 16-9 • *Sources of Fatigue in Cancer Patients***

- Pain, pruritus
- Imbalanced nutrition related to anorexia, nausea, vomiting, cachexia
- Electrolyte imbalance related to vomiting, diarrhea
- Ineffective protection related to neutropenia, thrombocytopenia, anemia
- Impaired tissue integrity related to stomatitis, mucositis
- Impaired physical mobility related to neurologic impairments, surgery, bone metastasis, pain, and analgesic use
- Uncertainty and deficient knowledge related to disease process, treatment
- Anxiety related to fear, diagnosis, role changes, uncertainty of future
- Ineffective breathing patterns related to cough, shortness of breath, and dyspnea
- Disturbed sleep pattern related to cancer therapies, anxiety, and pain

Disfiguring surgery, hair loss, cachexia, skin changes, altered communication patterns, and sexual dysfunction treatment can threaten the patient's self-esteem and body image.

A creative and positive approach is essential when caring for patients with altered body image. Nursing approaches for addressing issues related to body image and self-esteem are and approaches for addressing issues related to body image and self-esteem are also included in the nursing care plan (see Chart 16-7). The nurse serves as a listener and counselor to both the patient and the family. Possible influences of the patient's culture and age are considered when discussing concerns and potential interventions (Romanek, McCaul & Sandgren, 2006).

As a result of the underlying cancer, treatments, and psychosocial responses to the experience, patients may experience a variety of sexuality-based issues. Patients who experience alterations in sexuality and sexual function are encouraged to discuss their concerns. Major barriers to addressing sexual dysfunction in patients with cancer include the lack of assessment tools and evidence-based interventions (Bakewell & Volker, 2005). In addition, nurses and other health care providers often fail to ask patients about sexual concerns, and patients may be hesitant to discuss them. However, standards of oncology nursing practice include the need for nurses to assess patients' sexuality and to help patients and their partners achieve the outcomes of importance to them (Wilmoth, 2006). Nurses who identify physiologic, psychological, or communication difficulties related to sexuality or sexual function are in a key position to help patients seek further specialized evaluation and intervention if necessary.

## Assisting in the Grieving Process

Nurses assess the patient's psychological and mental status as the patient and family face this life-threatening experience, unpleasant diagnostic tests and treatment modalities, and progression of disease. The nurse assesses the patient's mood and emotional reaction to the results of diagnostic testing and prognosis and looks for evidence that the patient is progressing through the stages of grief and can talk about the diagnosis and prognosis with family members.

A cancer diagnosis need not indicate a fatal outcome. Many forms of cancer are curable, while others may be cured or controlled for long periods of time if treated early. Despite these facts, many patients and their families view cancer as a fatal disease that is inevitably accompanied by pain, suffering, debilitation, and emaciation. Grieving is a normal response to these fears and to actual or potential losses: loss of health, normal sensations, body image, social interaction, sexuality, and intimacy. Patients, families, and friends may grieve for the loss of quality time to spend with others, the loss of future and unfulfilled plans, and the loss of control over the patient's body and emotional reactions.

Patients and their families who have just been informed of a cancer diagnosis frequently respond with shock, numbness, and disbelief. It is often during this stage that the patient and family are called on to make important initial decisions about treatment. They require the support of physicians, nurses, and all members of the health care team to make these decisions. The nurse plays an important role in answering any questions the patient and family have and clarifying information provided by physicians. The plan of nursing care addresses anticipatory grieving and nursing strategies for promoting appropriate progression through the grieving process.

If the patient enters the terminal phase of disease, the nurse may realize that the patient and family members are at different stages of grief. In such cases, the nurse helps the patient and family to acknowledge and cope with their reactions and feelings. The nurse also helps the patient and family to explore preferences for issues related to end-of-life care, such as withdrawal of active disease treatment, desire for the use of life-support measures, and symptom management. Support, which can be as simple as holding a patient's hand or just being with a patient at home or at the bedside, often contributes to peace of mind. After the death of a patient with cancer, maintaining contact with surviving family members may help them work through their feelings of loss and grief. See Chapter 17 for further discussion of end-of-life issues.

## Monitoring and Managing Potential Complications

### Infection

For patients in all stages of cancer, the nurse assesses factors that can promote infection. Although the infection-associated mortality rate has decreased, infection remains a major cause of morbidity and mortality in patients with cancer (Zitella, Friese, Hauser, et al., 2006). Factors predisposing patients to infection are summarized in Table 16-8. Often, more than one predisposing factor is present in patients with cancer (Friese, 2007). The nurse monitors laboratory studies to detect early changes in WBC counts. Common sites of infection, such as the pharynx, skin, perianal area, urinary tract, and respiratory tract, are assessed on a regular basis. However, the typical signs of infection (swelling, redness, drainage, and pain) may not occur in immunosuppressed patients because of decreased circulating white blood cells (WBC) (the cause purulent drainage) and a diminished local inflammatory response. Fever may be the only sign of infection (Marrs, 2006). The nurse monitors the patient for sepsis, particularly if invasive catheters or infusion lines are in place.

**Table 16-8 FACTORS PREDISPOSING CANCER PATIENTS TO INFECTION**

| Factors | Underlying Mechanisms |
|---|---|
| Impaired skin and mucous membrane integrity | Loss of body's first line of defense against invading organisms. |
| Chemotherapy | Chemotherapy agents that cause mucositis impair skin and mucous membrane integrity. Organ damage associated with certain agents may also predispose patients to infection. Organ damage such as pulmonary fibrosis or cardiomyopathy that is associated with certain agents may also predispose patients to infection. |
| Radiation therapy | Radiation involving sites of bone marrow production may result in bone marrow suppression. May also lead to impaired tissue integrity. |
| Biologic response modifiers | Some biologic response modifiers may cause bone marrow suppression and organ dysfunction. |
| Malignancy | Malignant cells may infiltrate the bone marrow and interfere with production of white blood cells and lymphocytes. Hematologic malignancies (leukemias and lymphomas) are associated with impaired function and production of blood cells. |
| Malnutrition | Malnutrition results in impaired production and function of cells of the immune response. It may contribute to impaired skin integrity. |
| Medications | Antibiotics disturb the balance of normal flora, allowing them to become pathogenic. This process occurs most commonly in the gastrointestinal tract. Corticosteroids and nonsteroidal anti-inflammatory drugs (NSAIDs) mask inflammatory responses. |
| Urinary catheter | The catheter creates a port and mechanism of entry for organisms. |
| Intravenous catheter | The catheter is a site of entry for organisms. |
| Other invasive procedures (eg, surgery, paracentesis, thoracentesis, drainage tubes, endoscopy, mechanical ventilation) | These procedures create a port of entry and possible introduction of exogenous organisms into the system. |
| Contaminated equipment | Stagnant water in oxygen equipment is associated with growth of microorganisms. |
| Age | Increasing age is associated with declining organ function and decreased production and functioning of the cells of the immune system. |
| Chronic illness | Chronic illness is associated with impaired organ function and altered immune responses. |
| Prior infections | Recent infection may be associated with depleted immune responses and debilitation; prior infections may not have completely resolved; previous use of antibiotics may have altered normal flora allowing flora to become pathogenic. |
| Recent travel | Travel, especially to less developed areas, may have lead to exposure to microbial infection and disease. |
| Pet excreta | Exposure to pet excreta, especially in the immunocompromised patient, may be associated with infections such as *Toxoplasma gondii* (toxoplasmosis). |
| Prolonged hospitalization | Hospitalization allows increased exposure to nosocomial infection and colonization by new organisms. |

WBC function is often impaired in patients with cancer. There are five types of WBCs: neutrophils (granulocytes), lymphocytes, monocytes, basophils, and eosinophils. Neutrophils, which comprise 60% to 70% of all the body's WBCs, serve as the body's primary defense against invading organisms by engulfing and destroying infective organisms through phagocytosis. Both the total WBC count and the concentration of neutrophils are important in determining the patient's ability to fight infection. A decrease in circulating WBCs is referred to as leukopenia. Granulocytopenia is a decrease in neutrophils.

A differential WBC count identifies the relative numbers of WBCs and permits tabulation of polymorphonuclear neutrophils or segmented neutrophils (mature neutrophils, reported as "polys," PMNs, or "segs") and immature forms of neutrophils (reported as bands, metamyelocytes, and "stabs"). The absolute neutrophil count (ANC) is calculated by the following formula:

$$\text{ANC} = \frac{(\text{Total WBC}) \times [\%\ \text{segmented neutrophils} + \text{bands}]}{100}$$

For example, if the total WBC count is 6000 cells/mm$^3$, with segmented neutrophils 25% and bands 25%, the ANC is 3000 cells/mm$^3$.

**Neutropenia,** an abnormally low ANC, is associated with an increased risk for infection. The risk for infection rises as the ANC decreases. As the ANC declines below 1500 cells/mm$^3$, the risk for infection increases. An ANC less than 500 cells/ mm$^3$ reflects a severe risk of infection (Marrs, 2006). **Nadir** is the lowest ANC after myelosuppressive chemotherapy or radiation therapy that suppresses bone marrow function. Febrile patients who are neutropenic are assessed for factors that increase the risk for infection and for sources of infection through cultures of blood, sputum, urine, stool, IV or urinary catheters, and wounds, if appropriate. In addition, a chest x-ray is often obtained to assess for pulmonary infections.

Defense against infection is compromised in many different ways. The integrity of the skin and mucous membranes is challenged by multiple invasive diagnostic and therapeutic procedures, by adverse effects of radiation and chemotherapy, and by the detrimental effects of immobility.

Impaired nutrition as a result of anorexia, nausea, vomiting, diarrhea, and the underlying disease alters the body's ability to combat invading organisms. Medications such as antibiotics disturb the balance of normal flora, allowing the overgrowth of normal flora and pathogenic organisms. Other medications can also alter the immune response (see Chapter 50). Cancer itself may lead to defects in cellular and humoral immunity. Advanced cancer can cause obstruction of the hollow viscera (eg, intestines), blood vessels, and lymphatic vessels, creating a favorable environment for proliferation of pathogenic organisms. In some patients, tumor cells infiltrate bone marrow

and prevent normal production of WBCs. However, most often, a decrease in WBCs is a result of bone marrow suppression after chemotherapy or radiation therapy. Severe neutropenia may necessitate delays in administration of myelosuppressive therapies or treatment dose adjustments, although the use of the hematopoietic growth factors, also called colony-stimulating factors (see previous discussion), has reduced the severity and duration of neutropenia associated with myelosuppressive chemotherapy and radiation therapy. The administration of these factors assists in reducing the risk for infection and, possibly, in maintaining treatment schedules, drug dosages, treatment effectiveness, and quality of life.

Nurses are in a key position to assist in preventing and identifying symptoms of infection, as discussed in the nursing care plan (see Chart 16-7). Although multiple infection control practices are employed, there is a significant lack of evidence to support many of them (Zitella, et al., 2006). Clinical practice guidelines developed by the Oncology Nursing Society (ONS), the Infusion Nurses Society (INS), the National Comprehensive Cancer Network (NCCN), and the American Society of Clinical Oncology (ASCO) are used to guide interventions. Interventions to prevent infection and education formats to teach patients and families about infection are high research priorities.

Gram-positive bacteria (*Streptococcus*, enterococci, and *Staphylococcus* species) and gram-negative organisms (*Escherichia coli, Klebsiella pneumoniae,* and *Pseudomonas aeruginosa*) are the most frequently isolated causes of infection. Fungal organisms, such as *Candida albicans,* also contribute to the incidence of serious infection. Viral infections in immunocompromised patients are caused most often by herpes viruses and respiratory viruses.

Fever is probably the most important sign of infection in immunocompromised patients. In neutropenic patients, any one-time temperature of 38.3°C (101°F) or higher or 38.0°C (100.4°F) or higher for 1 hour or more is reported and dealt with promptly (NCCN, 2008c). Antibiotics may be prescribed to treat infections after cultures of wound drainage, exudates, sputum, urine, stool, or blood are obtained. Careful consideration is given to the underlying malignancy, prior antineoplastic treatment, absolute neutrophil count, comorbidities, and other patient-related factors prior to the identification of the most appropriate initial antibiotic therapy. The NCCN provides guidelines for prevention and treatment of cancer-related infections (NCCN, 2008c). Patients with neutropenia are treated with broad-spectrum antibiotics before the infecting organism is identified because of the high incidence of mortality associated with untreated infection. Broad-spectrum antibiotic therapy targets the most likely major pathogenic organisms. It is important for the nurse to administer these medications promptly and as scheduled to achieve adequate blood levels of the medications. Once the offending organism is identified, more specific antimicrobial therapy is prescribed if appropriate.

### Septic Shock

The nurse assesses the patient frequently for infection and inflammation throughout the course of the disease. Septicemia and septic shock are life-threatening complications that must be prevented or detected and treated promptly. Although all patients with cancer are at risk, patients who are neutropenic or who have hematologic malignancies are at the greatest risk. Patients with signs and symptoms of impending sepsis and septic shock require immediate hospitalization and aggressive treatment in the intensive care setting.

Signs and symptoms of septic shock (see Chapter 15) include altered mental status, either subnormal or elevated temperature, cool and clammy skin, decreased urine output, hypotension, tachycardia, other dysrhythmias, electrolyte imbalances, tachypnea, and abnormal arterial blood gas values. Patients and family members are instructed about signs of septicemia, methods for preventing infection, and actions to take if signs and symptoms of infection or septicemia occur.

Although septic shock is most often associated with overwhelming gram-negative bacterial infections, there is an increasing incidence of gram-positive infections related to the use of long-term venous access devices. Patients with prolonged neutropenia or hematologic malignancies are also more susceptible to fungal and viral sources of sepsis as well. In a patient with impending shock, the nurse monitors temperature and hemodynamic and respiratory status on a frequent basis. Neurologic assessments are carried out to detect changes in orientation and responsiveness. Fluid and electrolyte status is monitored by measuring fluid intake and output and serum electrolytes. Arterial blood gas values and pulse oximetry are monitored to determine tissue oxygenation. Nurses administer IV fluids, blood products, vasopressor and inotropic agents as prescribed to maintain blood pressure and tissue perfusion, as well as broad-spectrum antibiotics, which may be prescribed initially to combat the underlying infection (see Chapter 15). Supplemental oxygen and mechanical ventilation are often necessary. Systemic steroids and drotrecogin alfa (Xigris; recombinant human activated protein C) have been used in some centers for patients who have severe and prolonged septic shock or those that at risk for development of clotting disturbances (Gobel & Peterson, 2006).

### Bleeding and Hemorrhage

Platelets are essential for normal blood clotting and coagulation (hemostasis). Thrombocytopenia, a decrease in the circulating platelet count, is the most common cause of bleeding in patients with cancer and is usually defined as a platelet count of less than 100,000/mm$^3$ ($0.1 \times 10^{12}$/L). When the platelet count decreases to between 20,000 and 50,000/mm$^3$ (0.02 to $0.05 \times 10^{12}$/L), the risk of bleeding increases. Platelet counts lower than 20,000/mm$^3$ ($0.02 \times 10^{12}$/L) are associated with an increased risk for spontaneous bleeding, for which patients require a platelet transfusion.

Thrombocytopenia often results from bone marrow depression after certain types of chemotherapy and radiation therapy and with tumor infiltration of the bone marrow. In some cases, platelet destruction is associated with an enlarged spleen (hypersplenism) and abnormal antibody function, which occur with leukemia and lymphoma. The nursing care plan addresses nursing assessment parameters and interventions for patients at risk for bleeding (see Chart 16-7).

In limited circumstances, the nurse may administer IL-11, which has been approved by the FDA to prevent severe thrombocytopenia and to reduce the need for platelet transfusions after myelosuppressive chemotherapy in patients with nonmyeloid malignancies, as previously described. Additional

medications may be prescribed to address bleeding due to disorders of coagulation.

## Promoting Home and Community-Based Care

### *Teaching Patients Self-Care*

Increasingly, patients with cancer are diagnosed and treated in the outpatient setting with minimal or no period of hospitalization. Nurses in outpatient settings often have the responsibility for patient teaching and for coordinating care in the home. The shift of care from acute care to the home or outpatient setting places a great deal of the responsibility for care on the patient and family; this requires teaching that enables them to provide care. Teaching initially focuses on the most immediate care needs likely to be encountered at home.

Side effects of treatments and changes in the patient's status that should be reported are reviewed verbally and reinforced with written information. Strategies to deal with side effects of treatment are discussed with the patient and family. Other learning needs are based on the priorities conveyed by the patient and family as well as on the complexity of care required in the home.

Technologic advances allow home administration of chemotherapy, parenteral nutrition, blood products, parenteral antibiotics, and analgesics, as well as management of symptoms and care of vascular access devices. Although home care nurses provide care and support for patients receiving this type of care, patients and families need instruction and support to enable them to feel comfortable and proficient in managing these treatments at home. Follow-up visits and telephone calls from the nurse assist in identifying problems and are often reassuring, increasing the patient's and family's comfort in dealing with complex and new aspects of care. Continued contact facilitates evaluation of the patient's progress and assessment of the ongoing needs of the patient and family.

### *Continuing Care*

Referral for home care is often indicated for patients with cancer. The responsibilities of the home care nurse include assessing the home environment, suggesting modifications in the home or in care to help the patient and family address the patient's physical needs, providing physical care, and assessing the psychological and emotional impact of the illness on the patient and family.

Assessing changes in the patient's physical status and reporting relevant changes to the physician help ensure that appropriate and timely modifications in therapy are made. The home care nurse also assesses the adequacy of pain management and the effectiveness of other strategies to prevent or manage the side effects of treatment modalities and disease progression.

It is necessary to assess the patient's and family's understanding of the treatment plan and management strategies and to reinforce previous teaching. The nurse facilitates coordination of patient care by maintaining close communication with all involved health care providers. The nurse may make referrals and coordinate available community resources (eg, local office of the American Cancer Society, home aides, church groups, parish nurses, support groups) to assist patients and caregivers.

## Gerontologic Considerations

More than 60% of all new cancers occur in people older than 65 years of age, and about 70% of all cancer deaths occur in people 65 years of age and older (Lynch, Marcone & Kagan, 2007). The rising numbers of individuals over age 65 with cancer has led to the emergence of geriatric oncology, a multidimensional and multidisciplinary approach to treating growing numbers of older adults with cancer (Lynch, et al., 2007).

Nurses working with the elderly population must understand the normal physiologic changes that occur with aging and the implications for the patient with cancer (Table 16-9). These changes that affect all body systems may ultimately influence elderly patients' responses to cancer treatment (Lichtman, 2006). In addition, many elderly patients have other chronic diseases requiring multiple medications. The existence of comorbidities and multiple medications may contribute to drug interactions and toxicities in elderly patients (Extermann & Hurria, 2007).

The understanding of the effects and tolerance of chemotherapy, biotherapy, and radiation in the elderly is limited because there have been few studies of the effects of cancer treatments in this population (Lichtman, 2006). In addition, the elderly have been underrepresented in oncology clinical trials (Lichtman, Wildiers, Chatelut, et al., 2007). Potential chemotherapy-related toxicities, such as renal impairment, myelosuppression, fatigue, and cardiomyopathy, may increase as a result of declining organ function and diminished physiologic reserves. The recovery of normal tissues after radiation therapy may be delayed, and older patients may experience more severe adverse effects, such as mucositis, nausea and vomiting, and myelosuppression. Because of impaired healing and declining pulmonary and cardiovascular functioning, older patients are slower to recover from surgery. Elderly patients are also at increased risk for complications such as atelectasis, pneumonia, and wound infections.

Several studies have shown that when compared to younger patients, some elderly patients with cancer have received substandard or suboptimal treatment (Bouchardy, Rapiti, Blagojevic, et al., 2007). Access to quality cancer care for elderly patients may be limited by discriminatory or fatalistic attitudes of health care providers, caregivers, and patients themselves. Issues such as the gradual loss of supportive resources, declining health or loss of a spouse, and unavailability of relatives or friends may result in limited access to care and unmet needs for assistance with activities of daily living. In addition, the economic impact of health care may be difficult for those living on fixed incomes.

It is not uncommon for elderly patients to delay reporting symptoms, attributing them to "old age." Many elderly people do not want to report illness for fear of losing their independence or financial security. Sensory losses (eg, hearing and visual losses) and memory deficits are considered when planning patient education, because they may affect the patient's ability to process and retain information. In such cases, the nurse acts as a patient advocate, encouraging independence and identifying resources for support when indicated. Nurses must be aware of the

**Table 16-9 AGE-RELATED CHANGES AND THEIR EFFECTS ON PATIENTS WITH CANCER**

| Age-Related Changes | Implications |
|---|---|
| Impaired immune system | Use special precautions to avoid infection; monitor for atypical signs and symptoms of infection. |
| Altered drug absorption, distribution, metabolism, and elimination | Mandates careful calculation of chemotherapy and frequent assessment for drug response and side effects; dose adjustments may be necessary. |
| Increased prevalence of other chronic diseases | Monitor for effect of cancer or its treatment on patient's other chronic diseases; monitor patient's tolerance for cancer treatment; monitor for interactions with medications used to treat chronic diseases. |
| Diminished renal, respiratory, and cardiac reserve | Be proactive in prevention of decreased renal function, atelectasis, pneumonia, and cardiovascular compromise; monitor for side effects of cancer treatment. |
| Decreased skin and tissue integrity; reduction in body mass; delayed healing | Prevent pressure ulcers secondary to immobility; monitor skin and mucous membranes for changes related to radiation or chemotherapy; monitor nutritional status. |
| Decreased musculoskeletal strength | Prevent falls; assess support for performing activities of daily living in home setting; encourage safe use of assistive mobility devices. |
| Decreased neurosensory functioning: loss of vision, hearing, and distal extremity tactile senses | Provide teaching and instructions modified for patient's hearing and vision changes; provide instruction concerning safety and skin care for distal extremities; assess home for safety. |
| Altered social and economic resources | Assess for financial concerns, living conditions, and resources for support. |
| Potential changes in cognitive and emotional capacity | Provide teaching and support modified for patient's level of functioning and safety. |

special needs of the aging population and work collaboratively with other disciplines to address identified needs.

## Providing Care in Oncologic Emergencies

Table 16-10 discusses nursing and medical care of oncologic emergencies.

## Providing Care of the Patient With Advanced Cancer

Patients with advanced cancer are likely to experience many of the problems previously described, but all to a greater degree. Symptoms of gastrointestinal disturbances, nutritional problems, weight loss, and cachexia make patients more susceptible to skin breakdown, fluid and electrolyte problems, and infection.

Although not all cancer patients experience pain, those who do commonly fear that it will not be adequately treated. Although treatment at this stage of illness is likely to be palliative rather than curative, prevention and appropriate management of problems can improve the patient's quality of life considerably. For example, use of analgesia at set intervals is recommended rather than on an "as needed" basis. Working with the patient and family as well as with other health care providers to manage pain frequently increases the patient's comfort and sense of control. Other medications (eg, sedatives, tranquilizers, muscle relaxants, antiemetics) are added to assist in promoting patient comfort.

If the patient is a candidate for radiation therapy or surgical intervention to relieve pain, the consequences of these procedures (eg, percutaneous nerve block, cordotomy) are explained to the patient and family. Measures are taken to prevent complications that result from altered sensation, immobility, and changes in bowel and bladder function.

With the appearance of each new symptom, patients may fear that the disease is progressing. However, one cannot assume that all symptoms are related to the cancer. The new symptoms are evaluated and treated aggressively if possible to increase the patient's comfort and improve quality of life.

Weakness, immobility, fatigue, and inactivity typically increase with advanced cancer as a result of the disease, treatment, inadequate nutritional intake, or dyspnea. The nurse works with the patient and family to set realistic goals and promote comfort. Measures include use of energy-conserving methods to accomplish tasks and activities that the patient values most.

Efforts are made to provide the patient with as much control and independence as desired but with assurance that support and assistance are available when needed. In addition, health care teams work with the patient and family to ascertain and comply with the patient's wishes about treatment methods and care as the terminal phase of illness and death approach.

### *Hospice*

For many years, society was unable to cope appropriately with patients in the most advanced stages of cancer, and patients died in acute care settings rather than at home or in facilities designed to meet their needs. The needs of patients with terminal illnesses are best met by a comprehensive multidisciplinary specialty program that focuses on quality of life, palliation of symptoms, and provision of psychosocial and spiritual support for patients and families when cure and control of the disease are no longer possible. The concept of hospice best addresses these needs. Most important, the focus of care is on the family, as well as the patient. Hospice care can be provided in several settings: free-standing, hospital-based, and comm unity or home-based settings.

**Table 16-10 ONCOLOGIC EMERGENCIES: MANIFESTATIONS AND MANAGEMENT**

| Emergency | Clinical Manifestations and Diagnostic Findings | Management |
|---|---|---|
| **Superior Vena Cava Syndrome (SVCS)**<br>Compression or invasion of the superior vena cava by tumor, enlarged lymph nodes, intraluminal thrombus that obstructs venous circulation, or drainage of the head, neck, arms, and thorax. Typically associated with lung cancer, SVCS can also occur with breast cancer, Kaposi's sarcoma, thymoma, lymphoma, and mediastinal metastases (Kuzin, 2006). If untreated, SVCS may lead to cerebral anoxia (because not enough oxygen reaches the brain), laryngeal edema, bronchial obstruction, and death. | **Clinical**<br>Gradually or suddenly impaired venous drainage giving rise to:<br>• Progressive shortness of breath (dyspnea), cough, hoarseness, chest pain, and facial swelling<br>• Edema of the neck, arms, hands, and thorax and reported sensation of skin tightness and difficulty swallowing<br>• Possibly engorged and distended jugular, temporal, and arm veins<br>• Dilated thoracic vessels causing prominent venous patterns on the chest wall<br>• Increased intracranial pressure, associated visual disturbances, headache, and altered mental status<br><br>**Diagnostic**<br>Diagnosis is confirmed by:<br>• Clinical findings<br>• Chest x-ray<br>• Thoracic computed tomography (CT) scan<br>• Thoracic magnetic resonance imaging (MRI)<br>Intraluminal thrombosis is identified by venogram. | **Medical**<br>• Radiation therapy to shrink tumor size and relieve symptoms<br>• Chemotherapy for chemosensitive cancers (eg, lymphoma, small cell lung cancer) or when the mediastinum has been irradiated to maximum tolerance (Kuzin, 2006)<br>• Anticoagulant or thrombolytic therapy for intraluminal thrombosis<br>• Percutaneously placed intravascular stents are increasingly being used to reopen the occluded SVC (Kuzin, 2006)<br>• Surgery (less common), such as vena cava bypass graft (synthetic or autologous), to redirect blood flow around the obstruction<br>• Supportive measures such as oxygen therapy, corticosteroids, and diuretics<br><br>**Nursing**<br>• Identify patients at risk for SVCS<br>• Monitor and report clinical manifestations of SVCS<br>• Monitor cardiopulmonary and neurologic status<br>• Avoid upper extremity venipuncture and blood pressure measurement<br>• Facilitate breathing by positioning the patient properly; this helps to promote comfort and reduce anxiety produced by difficulty breathing resulting from progressive edema<br>• Promote energy conservation to minimize shortness of breath<br>• Monitor the patient's fluid volume status and administer fluids cautiously to minimize edema<br>• Assess for thoracic radiation-related problems such as dysphagia (difficulty swallowing) and esophagitis<br>• Monitor for chemotherapy-related problems, such as myelosuppression<br>• Provide postoperative care as appropriate |
| **Spinal Cord Compression**<br>Potentially leading to permanent neurologic impairment and associated morbidity and mortality; compression of the cord and its nerve roots may result from tumor, lymphomas, intervertebral collapse, or interruption of blood supply to the nerve tissues (Kaplan, 2006b).<br>The prognosis depends on the severity and rapidity of onset. About 70% of compressions occur at the thoracic level, 20% in the lumbosacral level, and 10% in the cervical region (Marrs, 2006). Metastasis from breast, lung, kidney, prostate cancers, myeloma, lymphoma to the bone or between the bone and the epidural space are associated with spinal cord compression (Kaplan, 2006b). | **Clinical**<br>• Local inflammation, edema, venous stasis, and impaired blood supply to nervous tissues<br>• Local or radicular back or neck pain along the dermatomal areas innervated by the affected nerve root (Marrs, 2006) (eg, thoracic radicular pain extends in a band around the chest or abdomen)<br>• Pain exacerbated by movement, supine recumbent position, coughing, sneezing, or the Valsalva maneuver<br>• Neurologic dysfunction, and related motor and sensory deficits (numbness, tingling, feelings of coldness in the affected area, inability to detect vibration, loss of positional sense)<br>• Motor loss ranging from subtle weakness to flaccid paralysis<br>• Bladder and/or bowel dysfunction depending on level of compression (above S2, overflow incontinence; from S3 to S5, flaccid sphincter tone, and bowel incontinence) | **Medical**<br>• Radiation therapy to reduce tumor size to halt progression and corticosteroid therapy to decrease inflammation and swelling at the compression site<br>• Surgery to debulk tumor and stabilize the spine if symptoms progress despite radiation therapy or if vertebral fracture or bone fragments lead to additional nerve damage; surgery is also an option when the tumor is not radiosensitive or is located in an area that was previously irradiated (Kaplan, 2006b)<br>• Vertebroplasty is used to stabilize vertebrae when patients have pain without neurologic dysfunction; vertebroplasty involves percutaneous injection of polymethyl methacrylate (PMMA), a bone cement filler, into the vertebral body (Kaplan, 2006b)<br>• Chemotherapy as adjuvant to radiation therapy for patients with lymphoma or small cell lung cancer<br>• *Note:* Despite treatment, patients with poor neurologic function before treatment are less likely to regain complete motor and sensory function; patients who develop complete paralysis usually do not regain all neurologic function (Kaplan, 2006b) |

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**Table 16-10 ONCOLOGIC EMERGENCIES: MANIFESTATIONS AND MANAGEMENT (Continued)**

| Emergency | Clinical Manifestations and Diagnostic Findings | Management |
|---|---|---|
| | **Diagnostic**<br>• Percussion tenderness at the level of compression<br>• Abnormal reflexes<br>• Sensory and motor abnormalities<br>• MRI, spinal cord x-rays, bone scans, and CT scan. CT-guided myelogram is reserved for patients who are unable to undergo MRI (Kaplan, 2006b). | **Nursing**<br>• Perform ongoing assessment of neurologic function to identify existing and progressing dysfunction<br>• Control pain with pharmacologic and nonpharmacologic measures<br>• Prevent complications of immobility resulting from pain and decreased function (eg, skin breakdown, urinary stasis, thrombophlebitis, decreased clearance of pulmonary secretions)<br>• Maintain muscle tone by assisting with range-of-motion exercises in collaboration with physical and occupational therapists<br>• Institute intermittent urinary catheterization and bowel training programs for patients with bladder or bowel dysfunction<br>• Provide encouragement and support to patient and family coping with pain and altered functioning, lifestyle, roles, and independence |
| **Hypercalcemia**<br>In patients with cancer, hypercalcemia is a potentially life-threatening metabolic abnormality resulting when the calcium released from the bones is more than the kidneys can excrete or the bones can reabsorb. It may result from:<br>• Production of cytokines, hormonal substances and growth factors by cancer cells, or by the body in response to substances produced by cancer cells; which lead to bone breakdown and calcium release (Kaplan, 2006a).<br>• Excessive use of vitamins and minerals and conditions unrelated to cancer, such as dehydration, renal impairment, primary hyperparathyroidism, thyrotoxicosis, thiazide diuretics, and hormone therapy. | **Clinical**<br>Fatigue, weakness, confusion, decreased level of responsiveness, hyporeflexia, nausea, vomiting, constipation, ileus, polyuria (excessive urination), polydipsia (excessive thirst), dehydration, and dysrhythmias<br><br>**Diagnostic**<br>Serum calcium level exceeding 11 mg/dL (2.74 mmol/L) | **Medical**<br>See Chapter 14.<br><br>**Nursing**<br>• Identify patients at risk for hypercalcemia and assess for signs and symptoms of hypercalcemia<br>• Educate patient and family; prevention and early detection can prevent fatality<br>• Teach at-risk patients to recognize and report signs and symptoms of hypercalcemia<br>• Encourage patients to consume 2–4 L of fluid daily unless contraindicated by existing renal or cardiac disease<br>• Explain the use of dietary and pharmacologic interventions such as stool softeners and laxatives for constipation<br>• Advise patients to maintain nutritional intake without restricting normal calcium intake<br>• Discuss antiemetic therapy if nausea and vomiting occur<br>• Promote mobility by emphasizing its importance in preventing demineralization and breakdown of bones<br>• Institute safety precautions for patients with impaired mental and mobility status |
| **Pericardial Effusion and Cardiac Tamponade**<br>Pericardial effusion is an accumulation of fluid in the pericardial space. Cardiac tamponade occurs when the accumulation compresses the heart and thereby impedes expansion of the ventricles and cardiac filling during diastole. As ventricular volume and cardiac output fall, the heart pump fails, and circulatory collapse develops.<br>With gradual onset, fluid accumulates gradually, and the outer layer of the pericardial space stretches to compensate for rising pressure. Large amounts of fluid accumulate before symptoms of heart failure occur. With rapid onset, pressures rise too quickly for the pericardial space to compensate. | **Clinical**<br>• Neck vein distention during inspiration (Kussmaul's sign)<br>• Pulsus paradoxus (systolic blood pressure decrease exceeding 10 mm Hg during inspiration; pulse gets stronger on expiration)<br>• Distant heart sounds, rubs and gallops, cardiac dullness<br>• Compensatory tachycardia (heart beats faster to compensate for decreased cardiac output)<br>• Increased venous and vascular pressures<br><br>**Diagnostic**<br>• Electrocardiography (ECG) helps diagnose pericardial effusion<br>• In small effusion, chest x-rays show small amounts of fluid in the pericardium; in large effusions, x-ray films disclose "water-bottle" heart (obliteration of vessel contour and cardiac chambers)<br>• CT scans help diagnose pleural effusions and evaluate effect of treatment<br>• Narrow pulse pressure<br>• Shortness of breath and tachypnea | **Medical**<br>• Patients with small effusions who are not symptomatic do not require treatment. These patients are monitored for signs and symptoms of increasing fluid accumulation (Higdon & Higdon, 2006)<br>• Pericardiocentesis (the aspiration or withdrawal of pericardial fluid by a large-bore needle inserted into the pericardial space); in malignant effusions, pericardiocentesis provides only temporary relief; fluid may reaccumulate (Story, 2006); windows or openings in the pericardium can be created surgically as a palliative measure to drain fluid into the pleural space; catheters may also be placed in the pericardial space and sclerosing agents (such as bleomycin or thiotepa) injected to prevent fluid from reaccumulating (Story, 2006)<br>• Radiation therapy or antineoplastic agents, depending on how sensitive the primary tumor is to these treatments and the degree of symptoms that exist; in mild effusions, prednisone and diuretic medications may be prescribed and the patient's status carefully monitored |

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**Table 16-10 ONCOLOGIC EMERGENCIES: MANIFESTATIONS AND MANAGEMENT (Continued)**

| Emergency | Clinical Manifestations and Diagnostic Findings | Management |
|---|---|---|
| Cancerous tumors, particularly from adjacent thoracic tumors (lung, esophagus, breast cancers), and cancer treatment are the most common causes of cardiac tamponade. Radiation therapy of 4000 cGy or more to the mediastinal area has also been implicated in pericardial fibrosis, pericarditis, and resultant cardiac tamponade. Untreated pericardial effusion and cardiac tamponade lead to circulatory collapse and cardiac arrest (Story, 2006). | • Weakness, chest pain, orthopnea, anxiety, diaphoresis, lethargy, and altered consciousness from decreased cerebral perfusion | **Nursing**<br>• Monitor vital signs and oxygen saturation frequently<br>• Assess for pulsus paradoxus<br>• Monitor ECG tracings<br>• Assess heart and lung sounds, neck vein filling, level of consciousness, respiratory status, and skin color and temperature<br>• Monitor and record intake and output<br>• Review laboratory findings (eg, arterial blood gas and electrolyte levels)<br>• Elevate the head of the patient's bed to ease breathing<br>• Minimize patient's physical activity to reduce oxygen requirements; administer supplemental oxygen as prescribed<br>• Provide frequent oral hygiene<br>• Reposition and encourage the patient to cough and take deep breaths every 2 hours<br>• As needed, maintain patent intravenous access, reorient the patient, and provide supportive measures and appropriate patient instruction |
| **Disseminated Intravascular Coagulation (DIC; also called consumption coagulopathy)**<br>Complex disorder of coagulation or fibrinolysis (destruction of clots), which results in thrombosis or bleeding. DIC is most commonly associated with hematologic cancers (leukemia and lymphoma); cancer of prostate, gastrointestinal (GI) tract, and lungs; chemotherapy (methotrexate, prednisone, L-asparaginase, vincristine, 5-fluorouracil, cyclophosphamide; targeted agents bevacizumab, thalidomide, interferon; hormonal agents (tamoxifen, Megace); and other processes such as trauma, sepsis, hepatic failure, and anaphylaxis (Enzone, 2006; Viable, 2005).<br>Blood clots form when normal coagulation mechanisms are triggered. Once activated, the clotting cascade continues to consume clotting factors and platelets faster than the body can replace them. Clots are deposited in the microvasculature, placing the patient at great risk for impaired circulation, tissue hypoxia, and necrosis. In addition, fibrinolysis occurs, breaking down clots and increasing the circulating levels of anticoagulant substances, thereby placing the patient at risk for hemorrhage (Enzone, 2006). | **Clinical**<br>*Chronic DIC:* Few or no observable symptoms or easy bruising, prolonged bleeding from venipuncture and injection sites, bleeding of the gums, and slow GI bleeding<br>*Acute DIC:* Life-threatening hemorrhage and infarction; clinical symptoms of this syndrome are varied and depend on the organ system involved in thrombus and infarction or bleeding episodes<br><br>**Diagnostic**<br>• Prolonged prothrombin time (PT or protime)<br>• Prolonged partial thromboplastin time (PTT)<br>• Prolonged thrombin time (TT)<br>• Decreased fibrinogen level<br>• Decreased platelet level<br>• Decrease in clotting factors<br>• Decreased hemoglobin<br>• Decreased hematocrit<br>• Elevated fibrin split products<br>• Positive protamine sulfate precipitation test (thrombin activation test)<br>• Elevated D-dimer<br>• Prolonged international normalized ratio (INR)<br>• Decreased plasminogen levels | **Medical**<br>• Chemotherapy, biologic response modifier therapy, radiation therapy, or surgery is used to treat the underlying cancer<br>• Antibiotic therapy is used for sepsis<br>• Anticoagulants, such as heparin or antithrombin III, decrease the stimulation of the coagulation pathways<br>• Drotrecogin alfa is used with caution in patients with DIC related to sepsis (Ezzone, 2006)<br>• Transfusion of fresh-frozen plasma or cryoprecipitates (which contain clotting factors and fibrinogen), packed red blood cells, and platelets may be used as replacement therapy to prevent or control bleeding<br>• Although controversial, antifibrinolytic agents such as aminocaproic acid (Amicar), which is associated with increased thrombus formation, may be used<br><br>**Nursing**<br>• Monitor vital signs<br>• Measure and document intake and output<br>• Assess skin color and temperature; lung, heart, and bowel sounds; level of consciousness, headache, visual disturbances, chest pain, decreased urine output, and abdominal tenderness<br>• Inspect all body orifices, tube insertion sites, incisions, and bodily excretions for bleeding<br>• Review laboratory test results<br>• Minimize physical activity to decrease injury risks and oxygen requirements<br>• Prevent bleeding; apply pressure to all venipuncture sites, and avoid nonessential invasive procedures; provide electric rather than straight-edged razors; avoid tape on the skin and advise gentle but adequate oral hygiene<br>• Assist the patient to turn, cough, and take deep breaths on regular schedule<br>• Reorient the patient, if needed; maintain a safe environment; and provide appropriate patient education and supportive measures |

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**Table 16-10 ONCOLOGIC EMERGENCIES: MANIFESTATIONS AND MANAGEMENT (Continued)**

| Emergency | Clinical Manifestations and Diagnostic Findings | Management |
|---|---|---|
| **Syndrome of Inappropriate Secretion of Antidiuretic Hormone (SIADH)**<br>The continuous, uncontrolled release of antidiuretic hormone (ADH), produced by tumor cells or by the abnormal stimulation of the hypothalamic–pituitary network, leads to increased extracellular fluid volume, water intoxication, hyponatremia, and increased excretion of urinary sodium. As fluid volume increases, stretch receptors in the right atrium respond by releasing a second hormone, atrial natriuretic factor (ANF). The release of ANF causes increased renal excretion of sodium, which worsens hyponatremia.<br>The most common cause of SIADH is cancer, especially small cell cancers of the lung. A variety of nonmalignant diseases, trauma and medications are associated with SIADH. Antineoplastics including vincristine, vinblastine, cisplatin, and cyclophosphamide, as well as morphine stimulate ADH secretion, which promotes conservation and reabsorption of water by the kidneys. As more fluid is absorbed, the circulatory volume increases, ANF is released, and sodium is actively excreted by the kidneys in compensation (Clancey, 2006) | **Clinical**<br>*Serum sodium levels lower than 125 mEq/L* (125 mmol/L): symptoms of hyponatremia including personality changes, irritability, nausea, anorexia, vomiting, weight gain, fatigue, muscular pain (myalgia), headache, lethargy, and confusion<br>*Serum sodium levels lower than 115 mEq/L* (11 mmol/L): seizure, abnormal reflexes and gait, papilledema, coma, and death; edema is rare<br><br>**Diagnostic**<br>• Decreased serum sodium level<br>• Increased urine osmolality<br>• Increased urinary sodium level<br>• Decreased blood urea nitrogen (BUN), creatinine, and serum albumin levels secondary to dilution<br>• Abnormal water load test results | **Medical**<br>• Treat underlying disease process or eliminate contributing medications<br>• Fluid intake range limited to 500–1000 mL/day to increase the serum sodium level and decrease fluid overload. If water restriction alone is not effective in correcting or controlling serum sodium levels, demeclocycline is often prescribed to interfere with the antidiuretic action of ADH and ANF; if neurologic symptoms are severe, parenteral sodium replacement and diuretic therapy are indicated; electrolyte levels are monitored carefully to detect secondary magnesium, potassium, and calcium imbalances; after the symptoms of SIADH are controlled, the underlying cancer is treated; if water excess continues despite treatment, pharmacologic intervention (urea and furosemide) may be indicated (Clancey, 2006)<br><br>**Nursing**<br>• Recognize individuals at risk<br>• Maintain intake and output measurements as often as hourly for severe hyponatremia (Clancey, 2006)<br>• Assess level of consciousness, lung and heart sounds, vital signs, daily weight, and urine specific gravity; also assess for nausea, vomiting, anorexia, edema, fatigue, and lethargy<br>• Monitor laboratory test results, including serum electrolyte levels, osmolality, and BUN, creatinine, and urinary sodium levels<br>• Minimize the patient's activity; provide appropriate oral hygiene; maintain environmental safety; and restrict fluid intake if necessary<br>• Reorient the patient and provide instruction and encouragement as needed |
| **Tumor Lysis Syndrome**<br>Potentially fatal complication associated with radiation, biotherapy, or chemotherapy-induced cell destruction of large or rapidly growing cancers such as leukemia, lymphoma, and small cell lung cancer (Higdon & Higdon, 2006). The release of intracellular contents from the tumor cells leads to electrolyte imbalances—hyperkalemia, hypocalcemia, hyperphosphatemia, and hyperuricemia—because the kidneys can no longer excrete large volumes of the released intracellular metabolites. | **Clinical**<br>Clinical manifestations depend on the extent of metabolic abnormalities<br>• *Neurologic:* Fatigue, weakness, memory loss, altered mental status, muscle cramps, tetany, paresthesias (numbness and tingling), seizures<br>• *Cardiac:* Elevated blood pressure, shortened QT complexes, widened QRS waves, altered T waves, dysrhythmias, cardiac arrest<br>• *GI:* Anorexia, nausea, vomiting, abdominal cramps, diarrhea, increased bowel sounds<br>• *Renal:* Flank pain, oliguria, anuria, renal failure, acidic urine pH<br>Other: Gout, malaise, pruritis<br><br>**Diagnostic**<br>Electrolyte imbalances identified by serum electrolyte measurement and urinalysis; EKG necessary to monitor cardiac abnormalities (Gobel, 2006) | **Medical**<br>• To prevent renal failure and restore electrolyte balance, aggressive fluid hydration is initiated 24–48 hours before and after the initiation of cytotoxic therapy to increase urine volume and eliminate uric acid and electrolytes; urine is alkalinized by adding sodium bicarbonate to intravenous fluid to maintain a urine pH of 7 to 7.5; this prevents renal failure secondary to uric acid precipitation in the kidneys (Gobel, 2006)<br>• Diuresis with a loop diuretic or osmotic diuretic if urine output is not sufficient (Gobel, 2006)<br>• Allopurinol therapy to inhibit the conversion of nucleic acids to uric acid or rasburicase to oxidizes uric acid to allantoin that has higher solubility than uric acid (Gobel, 2006)<br>• Administration of a cation-exchange resin, such as sodium polystyrene sulfonate (Kayexalate) to treat hyperkalemia by binding and eliminating potassium through the bowel<br>• Administration of intravenous sodium bicarbonate, hypertonic dextrose, and regular insulin temporarily shifts potassium into cells and lowers serum potassium levels<br>• Administration of phosphate-binding gels, such as aluminum hydroxide, to treat hyperphosphatemia by promoting phosphate excretion in the feces<br>• Hemodialysis when patients are unresponsive to the standard approaches for managing uric acid and electrolyte abnormalities |

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**Table 16-10 ONCOLOGIC EMERGENCIES: MANIFESTATIONS AND MANAGEMENT (Continued)**

| Emergency | Clinical Manifestations and Diagnostic Findings | Management |
|---|---|---|
| | | **Nursing**<br>• Identify at-risk patients, including those in whom tumor lysis syndrome may develop up to 1 week after therapy has been completed<br>• Institute essential preventive measures (eg, fluid hydration, allopurinol)<br>• Assess patient for signs and symptoms of electrolyte imbalances<br>• Assess urine pH to confirm alkalization<br>• Monitor serum electrolyte and uric acid levels for evidence of fluid volume overload secondary to aggressive hydration<br>• Instruct patients to report symptoms indicating electrolyte disturbances |

Because of the high costs associated with maintaining freestanding hospices, care is often delivered through coordination of services provided by hospitals, home care programs, and the community. The view that palliative care services are necessary only in extreme circumstances prevents appropriate and timely consultation with palliative care specialists (MacDonald, 2005; Pavlish & Ceronsky, 2007). Patients should be referred to palliative care and hospice services in a timely fashion so that complex patient needs can be addressed. Although physicians, social workers, clergy, dietitians, pharmacists, physical therapists, and volunteers are involved in patient care, nurses often coordinate hospice services.

Hospice programs strive to facilitate clear communication among family members and health care providers. Most patients and families are informed of the prognosis and are encouraged to participate in decisions regarding pursuing or terminating cancer treatment. Through collaboration with other support disciplines, the nurse helps the patient and family cope with changes in role identity, family structure, grief, and loss. Hospice nurses are actively involved in bereavement counseling. See Chapter 17 for detailed discussion of end-of-life care.

## Cancer Survivorship

The National Cancer Institute (2007) estimates that over 10 million individuals are alive today who have been previously diagnosed with cancer. Largely as a result of increased screening programs for breast, cervical, and prostate cancers and advances in treatment, the numbers of cancer survivors has tripled over the past 37 years. Cancer survivorship refers to a distinct phase of cancer care that follows primary treatment for cancer and lasts until cancer recurrence or end of life (Hewitt, Greenfield & Stovall, 2006). Although individuals vary and there are many types of cancers and treatments, the acute, long-term, and late effects of cancer and its treatment may have multiple physical and psychosocial consequences.

Approaches to survivorship care are often based on expert opinion and experiences rather than evidence-based interventions. Knowledge regarding survivorship concerns continues to evolve. The Institute of Medicine identified four components of survivorship care (Hewitt, et al., 2006), listed in Table 16-11. Multiple professional and advocacy organizations across the country have recommended that a survivorship care plan be provided to all cancer patients and their primary care physician at the completion of treatment. The survivorship care plan includes a summary of cancer diagnosis and treatment, recommendations for follow-up and care, including approaches to treat symptoms, rehabilitative needs, monitoring for late effects, and surveillance and screening for new and recurrent cancer. Referrals for specific services such as lymphedema therapy, support groups, and genetic counseling are also provided. Nurses assist in the development of the survivorship care plan and provide education and care for cancer survivors. Nurses, other health care providers, public health professionals, and patient advocates design and conduct research in order to identify needs of cancer survivors and evidence-based approaches to care.

**Table 16-11 COMPONENTS OF SURVIVORSHIP CARE**

| Component | Examples of Care |
|---|---|
| Prevention and detection of new and recurrent cancer. | • Mammography (per ACS guidelines)<br>• Papanicolaou (Pap) smears (per ACS guidelines)<br>• Smoking cessation programs<br>• Nutrition counseling |
| Surveillance for cancer spread, recurrence or second cancers | • Colonoscopy post–colon cancer<br>• Mammography post–breast cancer<br>• Liver function tests post–colon cancer<br>• Prostate specific antigen post–prostate cancer |
| Intervention for consequences of cancer and its treatments | • Lymphedema therapy<br>• Pain management<br>• Enterostomal therapy<br>• Fertility care |
| Coordination between specialists and primary care providers to meet health needs | • Care for comorbidities (eg, diabetes)<br>• Influenza vaccination<br>• Bone densitometry |

ACS, American Cancer Society.

From Hewitt, M., Greenfield, S. & Stovall, E. (Eds.). (2006). *From cancer patient to cancer survivor*. Washington, DC: Institute of Medicine and National Research Council. The National Academies Press. Components of survivorship care provided by the Institute of Medicine report on cancer survivorship.

## CRITICAL THINKING EXERCISES

EBP **1** Your patient has just completed treatment planning for receiving external beam radiation for an aggressive nasopharyngeal cancer. The patient has expressed concerns about what side effects of this treatment can be anticipated. What would your response be to him? What evidence-based nursing interventions would you implement to minimize side effects? Are there any preventive measures to protect the patient's oral mucosa? What nutritional needs would this patient experience and what approaches should be used to address them? What is the evidence for the interventions you identified? How strong is that evidence, and what criteria did you use to assess the strength of that evidence?

**2** A 58-year-old patient with bone metastasis from an unknown primary cancer has been receiving an opioid through a continuous subcutaneous infusion of analgesia with an infusion pump to relieve his severe pain. His wife tells you that both she and her husband fear that he will become addicted to the opioid; his adult children report that his pain remains severe and unrelieved. As a home care nurse, what assessments would be of highest priority to you during your initial visit to this patient? What nursing interventions would be indicated for the patient and his wife?

**3** A 33-year-old man has presented to the cancer center for treatment of colorectal cancer. In reviewing his family history, you note that his father and grandfather (who are both deceased) had metastatic colon cancer and his father's sister had endometrial cancer at age 45. You also note that he has two younger sisters. What information is important in this family history and why? What type of referral would be appropriate for this man and his family? How would you best advise this man and his family regarding cancer risks and screening practices?

**4** Your 28-year-old patient with acute leukemia, hospitalized for high-dose chemotherapy, has developed tumor lysis syndrome and acute renal failure. Describe the underlying pathology that can lead to the signs and symptoms of tumor lysis syndrome. What patient monitoring will be essential during this patient's care? Describe the medical and nursing management strategies that will be used for this patient.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

### Professional Organizations

American Pain Society (APS), www.ampainsoc.org
American Society of Clinical Oncology (ASCO), www.asco.org
Coalition of Cancer Cooperative Groups, www.cancertrialshelp.org/
Hospice and Palliative Care Nurses Association (HPNA), www.hpna.org
Lance Armstrong Foundation, www.livestrong.org/
National Center for Complementary and Alternative Medicine (NCCAM), www.nccam.nih.gov
National Comprehensive Cancer Network, www.nccn.org
Oncology Nursing Society (ONS), www.ons.org

### Patient/Family Support and Education

American Brain Tumor Association, www.abta.org
American Cancer Society (ACS), www.cancer.org
Cancer Care, Inc., www.cancercare.org
National Cancer Institute (NCI), www.cancer.gov
National Center for Complementary and Alternative Medicine, http://nccam.nih.gov
National Coalition for Cancer Survivorship, www.canceradvocacy.org
National Hospice and Palliative Care Organization, www.nhpco.org
Oncolink, Abramson Cancer Center of the University of Pennsylvania, www.oncolink.upenn.edu
Quackwatch, an Internet site serving as an independent watchdog to identify dubious sources of CAM and unproven therapies circulating on the Internet and in print, www.quackwatch.org
The Wellness Community, www.wellness-community.org



# chapter 17 End-of-Life Care

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Discuss the historical, legal, and sociocultural perspectives of palliative and end-of-life care in the United States.
2. Define palliative care.
3. Compare and contrast the settings where palliative care and end-of-life care are provided.
4. Describe the principles and components of hospice care.
5. Identify barriers to improving care at the end of life.
6. Reflect on personal experience with and attitudes toward death and dying.
7. Apply skills for communicating with terminally ill patients and their families.
8. Provide culturally and spiritually sensitive care to terminally ill patients and their families.
9. Implement nursing measures to manage physiologic responses to terminal illness.
10. Support actively dying patients and their families.
11. Identify components of uncomplicated grief and mourning and implement nursing measures to support patients and families.

## GLOSSARY

**assisted suicide:** use of pharmacologic agents to hasten the death of a terminally ill patient; illegal in most states

**autonomy:** self-determination; in the health care context, the right of the individual to make choices about the use and discontinuation of medical treatment

**bereavement:** period during which mourning for a loss takes place

**euthanasia:** Greek for "good death"; has evolved to mean the intentional killing by act or omission of a dependent human being for his or her alleged benefit

**grief:** the personal feelings that accompany an anticipated or actual loss

**hospice:** a coordinated program of interdisciplinary care and services provided primarily in the home to terminally ill patients and their families

**interdisciplinary collaboration:** communication and cooperation among members of diverse health care disciplines jointly to plan, implement, and evaluate care

**Medicare Hospice Benefit:** a Medicare entitlement that provides for comprehensive, interdisciplinary palliative care and services for eligible beneficiaries who have a terminal illness and a life expectancy of less than 6 months

**mourning:** individual, family, group, and cultural expressions of grief and associated behaviors

**palliative care:** comprehensive care for patients whose disease is not responsive to cure; care also extends to patients' families

**palliative sedation:** use of pharmacologic agents, at the request of the terminally ill patient, to induce sedation when symptoms have not responded to other management measures; the purpose is not to hasten the patient's death but to relieve intractable symptoms

**prognosis:** the expected course of an illness and the chance for recovery

**spirituality:** personal belief systems that focus on a search for meaning and purpose in life, intangible elements that impart meaning and vitality to life, and a connectedness to a higher or transcendent dimension

**terminal illness:** progressive, irreversible illness that despite cure-focused medical treatment will result in the patient's death

## Nursing and End-of-Life Care

Nurses can have a significant and lasting effect on the way in which patients live until they die, the manner in which the death occurs, and the enduring memories of that death for the families. Nursing has a long history of holistic, person-centered and family-centered care. Indeed, the definition of nursing highlights nursing's commitment to the diagnosis and treatment of *human responses to illness* (American Nurses Association [ANA], 2003). There may be no setting or circumstance in which nursing care—that is, attention to human responses—is more important than in caring for dying patients.

Knowledge about end-of-life principles of care and patients' and families' unique responses to illness are essential to supporting their unique values and goals. There is an opportunity to bring research, education, and practice together to change the culture of dying, bringing much-needed improvement to care that is relevant across practice settings, age groups, cultural backgrounds, and illnesses. The National Institute for Nursing Research (NINR) has taken the lead in coordinating research related to end-of-life care within the National Institutes of Health (NIH) and included end-of-life care in its strategic plan (see References and Selected Readings). In its 2004 State-of-the-Science conference aimed at improvement of end-of-life care, the NIH concluded that patient and family needs at end of life are neither appreciated nor well understood (NIH, 2005).

### Death and Dying in America

The focus on care of the dying has been motivated by the aging of the population, the prevalence of and publicity surrounding life-threatening illnesses (eg, cancer and AIDS), and the increasing likelihood of a prolonged period of chronic illness prior to death. Although there are more opportunities than ever before to allow peaceful death, the knowledge and technologies available to health care providers have made the process of dying anything but peaceful. Patients and clinicians may view death as what happens when medicine fails. This attitude has placed the issue of death and improvement of the dying process outside the focus of modern medicine and health care. Numerous initiatives aimed at improving end-of-life care have been launched in recent years, spurred by a widespread call for substantive change in the way Americans deal with death.

The National Consensus Project for Quality Palliative Care (NCP, 2009) identified the following eight key domains underlying a more comprehensive and humane approach to care of the dying. These include:

- *Structure and processes of care*. The timely plan of care is based on a comprehensive interdisciplinary assessment of the patient and family.
- *Physical aspects of care*. Pain, other symptoms, and side effects are managed based on the best available evidence, with attention to disease-specific pain and symptoms, which is skillfully and systematically applied.
- *Psychological and psychiatric aspects of care*. Psychological status is assessed and managed based on the best available evidence, which is skillfully and systematically applied. When necessary, psychiatric issues are addressed and treated.
- *Social aspects of care*. Comprehensive interdisciplinary assessment identifies the social needs of patients and their families, and a plan of care is developed to respond to these needs as effectively as possible.
- *Spiritual, religious, and existential aspects of care*. Spiritual and existential dimensions are assessed and responded to based on the best available evidence, which is skillfully and systematically applied.
- *Cultural aspects of care*. The palliative care program assesses and attempts to meet the needs of the patient, family, and community in a culturally sensitive manner.
- *Care of the imminently dying patient*. Signs and symptoms of impending death are recognized and communicated in developmentally appropriate language for children and patients with cognitive disabilities with respect to family preferences. Care appropriate for this phase of illness is provided to the patient and family.
- *Ethical and legal aspects of care*. The patient's goals, preferences, and choices are respected within the limits of applicable state and federal law, within current accepted standards of medical care, and form the basis for the plan of care.

Major organizations, such as the National Hospice and Palliative Care Organization, National Quality Forum, and others have used the NCP clinical guidelines to structure quality palliative and end-of-life programs.

### Technology and End-of-Life Care

In the 20th century, chronic, degenerative diseases replaced communicable diseases as the major causes of death. In the earlier part the 20th century, most deaths occurred at home. Most families had direct experience with death, providing care to family members at the end of life and then mourning their losses. As the place of death shifted from home to hospitals, families became increasingly distanced from the death experience.

The application of technology to prolong life has raised several ethical issues. The major question is: Because we *can* prolong life through increasingly sophisticated technology, does it necessarily follow that we *must* do so? In the later half of the 20th century, a "technologic imperative" practice pattern among health care professionals emerged, along with an expectation among patients and families that every available means to extend life must be tried. By the early 1970s, when hospice care was just beginning in this country, technology had become an expected companion of the critically and terminally ill. The implications of technologic intervention at the end of life are profound and affect how clinicians care for the dying, how family and friends participate in care, how patients and families understand and choose among end-of-life care options, how families prepare for **terminal illness** and death, and how they heal after the death of a loved one.

### Sociocultural Context

Although each person experiences terminal illness uniquely, terminal illness is also shaped by the broader social and cultural contexts in which it occurs. The approach in the United States to serious illness has been described as "death-denying"; that is, the health care system has been built on management of acute illness and the use of technology to

cure (when possible) and to extend life. As a result, life-threatening illness, life-sustaining treatment decisions, dying, and death occur in a social environment in which illness is largely considered an enemy. Many common expressions reflect this dominant sociocultural view. For example, people talk about the "war" against cancer, "fighting" illness, and when patients choose not to pursue the most aggressive course of medical treatment to fight their diseases, many health care providers perceive this as "giving up." A care/cure dichotomy has emerged in which health care providers may view cure as the ultimate good and care as second best, a good only when cure is no longer possible. In such a model, alleviating suffering is not as valued as curing disease. Patients who cannot be cured feel distanced from the health care team, and when curative treatments have failed, they feel that they too have failed. Patients and families may fear that any shift from curative goals to comfort-focused care will result in no care or lower-quality care, and that the clinicians on whom they have come to rely will abandon them if they withdraw from a focus on cure.

This is exemplified by the statement in late-stage illness that "nothing more can be done." This all-too-frequently used statement communicates the belief of many clinicians that there is nothing of value to offer patients beyond cure; however, in a care-focused perspective, there is always more that can be done. This expanded notion of healing implies that healing can take place throughout life. There are many opportunities for physical, spiritual, emotional, and social healing, even as body systems begin to fail at the end of life.

### Clinicians' Attitudes Toward Death

Clinicians' attitudes toward the terminally ill and dying remain the greatest barrier to improving care at the end of life. Kübler-Ross illuminated the concerns of the seriously ill and dying in her seminal work, *On Death and Dying*, in 1969. At that time, it was common for patients to be kept uninformed about life-threatening diagnoses, particularly cancer, and for physicians and nurses to avoid open discussion of death and dying with their patients. Her work revealed that, given open discussion, adequate time, and some help in working through the process, patients could reach a stage of acceptance in which they were neither angry nor depressed about their fate.

Clinicians' reluctance to discuss disease and death openly with patients stems from their own anxieties about death as well as misconceptions about what and how much patients want to know about their illnesses. In an early study of care of the dying in hospital settings, sociologists Glaser and Strauss (1965) discovered that health care professionals in hospital settings avoided direct communication about dying in hopes that the patient would discover it on his or her own. They identified four "awareness contexts":

1. *Closed awareness:* The patient is unaware of his or her terminal state, whereas others are aware. Closed awareness may be characterized as a conspiracy between the family and health care professionals to guard the "secret," fearing that the patient may not be able to cope with full disclosure about his or her status, and the patient's acceptance of others' accounts of his or her "future biography" as long as the others give him or her no reason to be suspicious.
2. *Suspected awareness:* The patient suspects what others know and attempts to find out details about his or her condition. Suspected awareness may be triggered by inconsistencies in the family's and the clinician's communication and behavior, discrepancies between clinicians' accounts of the seriousness of the patient's illness, or a decline in the patient's condition or other environmental cues.
3. *Mutual pretense awareness:* The patient, the family, and the health care professionals are aware that the patient is dying but all pretend otherwise.
4. *Open awareness:* The patient, the family, and the health care professionals are aware that the patient is dying and openly acknowledge that reality.

Glaser and Strauss (1965) also identified a pattern of clinician behavior in which those clinicians who feared or were uncomfortable discussing death developed and substituted "personal mythologies" for appraisals of what level of disclosure patients actually wanted. For example, clinicians avoided direct communication with patients about the seriousness of their illness based on their beliefs that (1) patients already knew the truth or would ask if they wanted to know, or (2) patients would subsequently lose all hope, give up, or be psychologically harmed by disclosure.

Although Glaser and Strauss's findings were published decades ago, their observations remain valid today. A growing number of health care providers are becoming comfortable with assessing patients' and families' information needs and disclosing honest information about the seriousness of illness, but many still avoid the topic of death in hope that the patient will ask or find out on his or her own. Despite progress on many health care fronts, many who work with dying patients have identified the persistence of a conspiracy of silence about dying.

### Patient and Family Denial

Patient and family denial about the seriousness of terminal illness also has been cited as a barrier to discussion about end-of-life treatment options. However, denial is a useful coping mechanism that enables the patient to gain temporary emotional distance from a situation that is too painful to contemplate fully (Buckman, 2005). Patients in denial may be using that strategy to preserve important interpersonal relationships, to protect others from the emotional effects of their illness, or to protect themselves because of fears of abandonment (Zimmerman & Wennberg, 2006). Denial may become a barrier to care if patients or families refuse to acknowledge a diagnosis or refuse to hear about treatment options. Nurses must accept patients regardless of the degree to which they are in denial about their illness and work with other health care providers to present the same message.

Patient and family awareness of **prognosis** is a key factor in acceptance of and planning for death. Even patients and families who have received clear and honest information may not fully accept the situation. For patients who have been informed about terminal illness, their understanding of treatment goals and prognosis is dynamic and may sometimes require reinforcement. Furthermore, patients' and their caregivers' understanding of treatment goals and prognosis can differ dramatically. In a study of patients with terminal cancer, researchers found that only 33% of patients and their caregivers understood that treatment goals were

not cure-focused and that there was discrepancy between patients' and caregivers' understanding in 39% of cases. Such misunderstandings can complicate both delivery of effective care and informed consent for care (Burns, Broom, Smith, et al., 2007). Patients with noncancer diagnoses, such as heart failure, chronic obstructive pulmonary disease (COPD), renal failure, dementia, or neurodegenerative diseases such as amyotrophic lateral sclerosis (ALS), frequently do not receive adequate information and support to fully understand their prognosis, yet they often desire clear and honest information. For example, they may have troublesome symptoms and reduced quality of life paralleling or exceeding that of those patients with cancer. Patients may want but are unlikely to receive clear information about disease progression, advanced care planning, and prognosis (Stapleton & Curtis, 2007). Similarly, in a qualitative study of preferences for prognosis communication among patients with end-stage heart failure, researchers found a strong preference for physician disclosure about treatment possibilities and probable outcomes (ie, a balance of honest disclosure with hope) (Caldwell, Arthur & Demers, 2007). Clearly, further research is needed to examine the complex interactions between patients' misconceptions about advanced illness, their underlying psychological states, and clinicians' persistent lack of explanations of treatment expectations and prognosis.

The questions of how to communicate truthfully with patients and encourage patient **autonomy** in a way that acknowledges where they are on the continuum of acceptance remains a challenge. Despite the continued reluctance of health care providers to engage in open discussion about end-of-life issues, studies have confirmed that patients want information about their illness and end-of-life choices and that they are not harmed by open discussion about death. Timing of sensitive discussion takes experience, but speaking the truth can be a relief to patients and families, enhancing their autonomy by making way for truly informed consent as the basis for decision making.

#### Assisted Suicide

The assisted suicide debate has aimed a spotlight on the adequacy and quality of end-of-life care in the United States. **Assisted suicide** refers to providing another person the means to end his or her own life. Physician-assisted suicide involves the prescription by a physician of a lethal dose of medication for the purpose of ending someone's life (not to be confused with the ethically and legally supported practice of withholding or withdrawing medical treatment in accordance with the wishes of the terminally ill person).

Although assisted suicide is expressly prohibited under statutory or common law in the overwhelming majority of states, calls for legalized assisted suicide have highlighted inadequacies in the care of the dying. Public support for physician-assisted suicide has resulted in a number of state ballot initiatives. In 1994, Oregon voters approved the Oregon Death With Dignity Act, the first and—until 2008—only such legislative initiative to pass. This law provides for access to physician-assisted suicide by terminally ill patients under very controlled circumstances. After numerous challenges the law was enacted in 1997. The number of Oregonians who have self-administered physician-prescribed lethal medication has remained small, totaling 341 persons who have died under the terms of the law since it was passed in 1997 (Oregon Department of Human Services, 2008).

In November 2008, voters approved the Washington Death with Dignity Act. Modeled after the Oregon Death With Dignity law, the act contains the same safeguards and will be administered through the State Department of Health (Compassion and Choices, 2008). Twenty-five other states have considered and rejected assisted suicide initiatives. It is likely the issue will be pursued in the courts and throughout ballot measures in other states.

Proponents of physician-assisted suicide argue that terminally ill people should have a legally sanctioned right to make independent decisions about the value of their lives and the timing and circumstances of their deaths, and its opponents argue for greater access to symptom management and psychosocial support for people approaching the end of life.

The ANA Position Statement on Assisted Suicide acknowledges the complexity of the assisted suicide debate but clearly states that nursing participation in assisted suicide is a violation of the Code for Nurses. The ANA Position Statement further stresses the important role of the nurse in supporting effective symptom management, contributing to the creation of environments for care that honor the patient's and family's wishes, as well as identifying their concerns and fears (ANA, 1994). The Hospice and Palliative Nurses Association (HPNA) opposes the legalization of assisted suicide (HPNA, 2006). The Oncology Nursing Society (ONS, 2007) takes a somewhat more neutral stance, stating that nurses follow the ethical mandates of the profession while seeking to understand the meaning behind the patient's request for hastening death. Similarly, the American Academy of Hospice and Palliative Medicine (AAHPM, 2007) has also recommended that clinicians carefully assess the fear and suffering that have led patients to request assisted suicide and to address these without hastening death (Chart 17-1).

## Settings for End-of-Life Care

### Palliative Care

**Palliative care** is an approach to care for the seriously ill that has long been a part of cancer care. More recently, it has been expanded to address the comprehensive symptom management, psychosocial care, and spiritual support needed to enhance the quality of life for patients with noncancer diagnoses. Although hospice care is considered by many to be the gold standard for palliative care, the term **hospice** is generally associated with palliative care that is delivered at home or in special facilities to patients who are approaching the end of life. Both palliative care and hospice care have been recognized as important bridges between cure-oriented treatment and the needs of the terminally ill patients and their families for comprehensive care in the final years, months, or weeks of life. Advocates for improved care for the dying have stated that acceptance, management, and understanding of death should become fully integrated concepts in mainstream health care.

CHART 17-1 *Ethics and Related Issues*

**"What If a Patient Asks You to Help Him End His Life?"**

**Situation**

You are a hospice nurse visiting a 72-year-old man with prostate cancer and metastasis to the bone. He reports severe pain that is increasing and unrelieved by any of the pharmacologic and nonpharmacologic interventions that have been tried. He lives with his wife but has no other family members nearby or close friends. He has told his only surviving son, who lives across the country, that he wants to obtain assistance to help him die when the pain becomes unbearable. He asks if you can help him with this request.

**Dilemma**

The patient's autonomy conflicts with the nurse's obligation to respect and protect human life, to promote comfort and relieve suffering, and to "do no harm."

**Discussion**

1. What should your follow-up consist of?
2. Should you discuss the patient's request with his wife before you end the visit that day? Discuss the moral basis for your decision.
3. Should you discuss the patient's request with the patient's primary care physician? What is the basis for your decision?
4. What is the position of the American Nurses Association (ANA) on assisted suicide, and how does the ANA position relate to your understanding of your moral obligation?
5. What is your responsibility to the patient and his wife?
6. What ethical and legal issues are involved in taking action or not taking action in this situation?

Palliative care, which is conceptually broader than hospice care, is both an approach to care and a structured system for care delivery that aims to "prevent and relieve suffering and to support the best possible quality of life for patients and their families, regardless of the stage of the disease or the need for other therapies" (NCP, 2009, p. 6). Palliative care emphasizes management of psychological, social, and spiritual problems in addition to control of pain and other physical symptoms. As the definition suggests, palliative care does not begin when cure-focused treatment ends but is most beneficial when it is provided along with disease-remitting treatments (World Health Organization, 2008). The goal of palliative care is to improve the patient's and family's quality of life, and many aspects of this type of comprehensive, comfort-focused approach to care are applicable earlier in the process of life-threatening disease and in conjunction with cure-focused treatment.

In palliative care, **interdisciplinary collaboration** is necessary to bring about the desired outcomes for patients and their families. Interdisciplinary collaboration, which is different from multidisciplinary practice, is based on communication and cooperation among the various disciplines, each member of the team contributing to a single integrated care plan that addresses the needs of the patient and family. Multidisciplinary care refers to participation of clinicians with varied backgrounds and skill sets but without coordination and integration.

### Palliative Care at the End of Life

The broadening of the concept of palliative care actually *followed* the development of hospice services in the United States. All hospice care is palliative care; not all palliative care is hospice care. The difference is that hospice care is a type of palliative care delivered at the end of life. Hospice care focuses on quality of life, but by necessity, it usually includes realistic emotional, social, spiritual, and financial preparation for death. After hospice care was recognized as a distinct program of services under Medicare in the early 1980s (see Funding Hospice Costs), organizations providing hospice care were able to receive Medicare reimbursement if they could demonstrate that the hospice program met the Medicare "conditions of participation," or regulations, for hospice providers.

Many chronic diseases do not have a predictable "end stage" that fits hospice eligibility criteria, and many patients die after a long, slow, and often painful decline, without the benefit of the coordinated palliative care that is unique to hospice programs. The palliative approach to care could benefit many more patients if it were available across care settings and earlier in the disease process. Palliative care programs are now being developed in other settings for patients who are either not eligible for hospice or who are "not ready" to enroll in a formal hospice program. As yet there is no dedicated reimbursement to providers for palliative care services when they are delivered outside the hospice setting, making the sustainability of such programs challenging.

### Palliative Care in the Hospital Setting

Since the advent of diagnosis-related groups (DRGs) as the basis for prospective payment for hospital services in the 1980s, hospitals have had a financial incentive to transfer patients with terminal illnesses who are no longer in need of acute care to other settings, such as long-term care facilities and home, to receive care. Despite the economic and human costs associated with death in the hospital setting, as many as 50% of all deaths occur in acute care settings (MedPAC, 2006). The landmark Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments documented troubling deficiencies in the care of the dying in hospital settings (SUPPORT Principal Investigators, 1995). Other studies have demonstrated that the health care system continues to be challenged when meeting seriously ill patients' needs for pain and symptom management and their families' needs for information and support. However, numerous guidelines have been issued in recent years in an effort to improve care for seriously ill and dying patients across settings. For example, in its 2000 to 2001 standards, the Joint Commission recognized pain as the "fifth vital sign" to ensure that pain is assessed routinely (Phillips, 2000), and in 2006 the National Quality Forum (NQF) issued a consensus report on preferred practices for palliative and hospice care quality. The latter report builds on the NCP's eight domains of quality palliative and hospice care to develop 38 preferred practices to serve as a foundation for quality monitoring and reporting in health care organizations.

It is clear that many patients will continue to opt for hospital care or will by default find themselves in hospital settings at the end of life. Increasingly, hospitals are conducting system-wide assessments of end-of-life care practices and outcomes and are developing innovative models for delivering high-quality, person-centered care to patients approaching the end of life. Hospitals cite considerable financial barriers to providing high-quality palliative care in acute care settings (Connor, 2007–2008). Public policy changes have been called for that would reimburse hospitals for care delivered via designated hospital-wide palliative care beds, clustered palliative care units, or palliative care consultation services in acute care settings. Resources are available for developing hospital–hospice partnerships to provide high-quality palliative care for hospitalized patients and for addressing the palliative care needs of other specialized populations, such as patients receiving such care in intensive care units (ICUs) and pediatric patients (Center to Advance Palliative Care, 2008).

### *Palliative Care in Long-Term Care Facilities*

The total number of nursing home residents declined between 1985 and 2000 (Federal Interagency Forum on Aging-Related Statistics, 2006). However, experts estimate that 69% of people who now reach 65 years of age will need some form of long-term care in their lifetimes, whether in the community or in a residential care facility (American Association of Homes and Services for the Aging, 2007). As a result, the likely place of death for a growing number of Americans after age 65 will be a long-term care facility. A recent systematic review of available data revealed that nursing homes were the place of death for 25% to 40% of Americans (Gruneir, Mor, Weitzen, et al., 2007). These authors further noted that the trend toward care of dying patients in long-term care facilities will continue as the population ages and as managed care payers pressure health care providers to minimize costs.

Yet residents of long-term care facilities typically have poor access to high-quality palliative care. Regulations that govern how care in these facilities is organized and reimbursed tend to emphasize restorative measures and serve as a disincentive to palliative care. Since 1986, home hospice programs have been permitted to enroll long-term care facility residents in hospice programs and to provide interdisciplinary services to residents who qualify for hospice care. Of the more than 800,000 Medicare beneficiaries who received hospice services in 2005, 28% resided in long-term care facilities (Department of Health and Human Services [DHHS], 2007). These people were older, more likely to have noncancer diagnoses such as dementia, and to have spent more time in hospice care at a higher cost to Medicare (DHHS, 2007). In 1997, the Office of the Inspector General (OIG), an oversight arm of the federal government, questioned whether such services are an unnecessary duplication of services already provided by long-term care facility staff. In 2008, the OIG reported on the appropriateness of payments for hospice care in nursing homes. Meanwhile, long-term care facilities are under increasing public pressure to improve care of the dying and are beginning to develop palliative care units or services, to contract with home hospice programs to provide hospice care in the facilities, and to educate staff, residents, and their families about pain and symptom management and end-of-life care.

## Hospice Care

Hospice is a coordinated program of interdisciplinary services provided by professional caregivers and trained volunteers to patients with serious, progressive illnesses that are not responsive to cure. Hospice in the United States is not a place but a concept of care in which the end of life is viewed as a developmental stage. The root of the word hospice is *hospes*, meaning "host." According to Cicely Saunders, who founded the world-renowned St. Christopher's Hospice in London, the principles underlying hospice are as follows:

- Death must be accepted.
- The patient's total care is best managed by an interdisciplinary team whose members communicate regularly with one another.
- Pain and other symptoms of terminal illness must be managed.
- The patient and family should be viewed as a single unit of care.
- Home care of the dying is necessary.
- Bereavement care must be provided to family members.
- Research and education should be ongoing.

### *Hospice Care in the United States*

The hospice movement in the United States is based on the belief that meaningful living is achievable during terminal illness and that it is best supported in the home, free from technologic interventions to prolong physiologic dying. The concept of hospice care as an alternative to depersonalized death in institutions began in the early 1970s as a grassroots, volunteer-based, and spiritually centered movement. After the first hospice in the United States was founded in 1974 in Connecticut, the concept quickly spread, and the number of hospice programs in the United States increased dramatically. By 2007, there were 4,700 hospice programs in operation, serving an estimated 1.4 million patients (NHPCO, 2008).

Despite more than 30 years of existence in the United States, hospice remains an option for end-of-life care that has not been fully integrated into mainstream health care. Physicians are reluctant to refer patients to hospice, and patients are reluctant to accept this form of care. Reasons include the difficulties in making a terminal prognosis (especially for those patients with noncancer diagnoses), the strong association of hospice with death, advances in "curative" treatment options in late-stage illness, and financial pressures on health care providers that may cause them to retain rather than refer hospice-eligible patients. As a result, many patients and families do not fully benefit from the comprehensive, interdisciplinary support offered by hospice programs; the median length of stay in a hospice program is just under 20 days (NHPCO, 2008).

The goal of hospice is to enable the patient to remain at home, surrounded by the people and objects that have been important to him or her throughout life. The patient and family make up the unit of care. Hospice care does not seek

to hasten death or encourage the prolongation of life through artificial means. Hospice care hinges on the competent patient's full or "open" awareness of dying; it embraces realism about death and helps patients and families understand the dying process so that they can live each moment as fully as possible. Approximately 20% of hospice programs have developed inpatient facilities or residences (NHPCO, 2008) where terminally ill patients without family support and those who desire inpatient care may receive hospice services.

### Funding Hospice Care

Since 1983, the **Medicare Hospice Benefit** has covered costs of hospice care for Medicare beneficiaries. State Medical Assistance (Medicaid) also provides coverage for hospice care, as do most commercial insurers. To receive Medicare payment for hospice services, programs are required to comply with rules known as "conditions of participation," which are enforced by the Centers for Medicare and Medicaid Services. In many aspects, Medicare standards have come to largely define hospice philosophy and services.

Eligibility criteria for hospice vary depending on the hospice program, but generally patients must have a progressive, irreversible illness and limited life expectancy and must opt for palliative care rather than cure-focused treatment. Chart 17-2 presents the eligibility criteria for hospice coverage under the Medicare Hospice Benefit. According to Medicare, the patient who wishes to use his or her Medicare Hospice Benefit must be certified by a physician as terminally ill, with a life expectancy of 6 months or less if the disease follows its natural course. Thus, hospice has come to be defined as care provided to terminally ill persons and their families in the last 6 months of the patient's life. Because of additional Medicare rules concerning completion of cure-focused medical treatment before the Medicare Hospice Benefit may be accessed, many patients delay enrollment in hospice programs until very close to the end of life.

Federal rules for hospices require that patients' eligibility be reviewed periodically. Patients who live longer than 6 months under hospice care are not discharged if their physician and the hospice medical director continue to certify that the patient is terminally ill with a life expectancy of 6 months or less (assuming that the disease continues its expected course). Once a patient meets eligibility criteria and elects to use the benefit, the Medicare-certified hospice program assumes responsibility for providing and paying for the care and treatment related to the terminal illness for which hospice care was elected. The Medicare-certified hospice is paid a predetermined dollar amount for each day of hospice care that each patient receives. Four levels of hospice care are covered under Medicare and Medicaid hospice benefits:

- *Routine home care:* All services provided are included in the daily rate to the hospice.
- *Inpatient respite care:* A 5-day inpatient stay, provided on an occasional basis to relieve the family caregivers.
- *Continuous care:* Continuous nursing care provided in the home for management of a medical crisis. Care reverts to the routine home care level after the crisis is resolved. (For example, seizure activity develops and a nurse is placed in the home continuously to monitor the patient and administer medications. After 72 hours, the seizure activity is under control, the family has been instructed how to care for the patient, and the continuous nursing care is discontinued.)
- *General inpatient care:* Inpatient stay for symptom management that cannot be provided in the home. This is not subject to the guidelines for a standard hospital inpatient stay.

Most hospice care is provided at the "routine home care" level and includes the services described in Chart 17-3. According to federal guidelines, hospices may provide no more than 20% of the aggregate annual patient days at the inpatient level. Patients may "revoke" their hospice benefits at any time, resuming traditional coverage under Medicare or Medicaid for the terminal illness. Those who revoke their benefits may also reelect to use them at a later time.

#### Chart 17-2 • *Eligibility Criteria for Hospice Care*

**General**

- Serious, progressive illness
- Limited life expectancy
- Informed choice of palliative care over cure-focused treatment

**Hospice-Specific**

- Presence of a family member or other caregiver continuously in the home when the patient is no longer able to safely care for him/herself (some hospices have created special services within their programs for patients who live alone, but this varies widely)

**Medicare and Medicaid Hospice Benefits**

- Medicare Part A; Medical Assistance eligibility
- Waiver of traditional Medicare/Medicaid benefits for the terminal illness
- Life expectancy of 6 months or less
- Physician certification of terminal illness
- Care must be provided by a Medicare-certified hospice program

#### Chart 17-3 • *Home Hospice Services Covered Under the Medicare/Medicaid Hospice Benefit Routine Home Care Level*

- Nursing care provided by or under the supervision of a registered nurse, available 24 hours a day
- Medical social services
- Physician's services
- Counseling services, including dietary counseling
- Home health aide/homemaker
- Physical/occupational/speech therapists
- Volunteers
- Bereavement follow-up (for up to 13 months after the death of the patient)
- Medical supplies for the palliation of the terminal illness
- Medical equipment for the palliation of the terminal illness
- Medications for the palliation of the terminal illness

Hospice programs are reaching out to patients with very advanced illness and seeking ways to provide them with hospice services while they are completing courses of treatment that many programs previously defined as "life-prolonging," such as disease-modifying therapies for dementia, enteral or parenteral nutritional support, and certain types of chemotherapy. The hospice industry has begun to refer to more flexible policies concerning disease-modifying medical treatment at the time of admission as "open access." The National Hospice and Palliative Care Organization acknowledges the concept of open access, stating that palliative care is "treatment that enhances comfort and improves the quality of an individual's life during the last phase of life. No specific therapy is excluded from consideration" (NHPCO, 2006).

Hospice use has increased steadily since the inception of the Medicare Hospice Benefit. Between 2000 and 2004, hospice use among Medicare beneficiaries increased by 50%, and within that period, the proportion of hospice enrollees with cancer diagnoses fell to 43% of the total. The most common primary hospice diagnoses among Medicare patients are neurodegenerative diseases (such as dementia and Parkinson's disease) followed by cardiovascular diseases (MedPAC, 2006).

Although hospice utilization continues to increase, many patients who could benefit from hospice care do not receive it. Only slightly more than one third of Americans who died in 2007 had received hospice care (NHPCO, 2008). Most terminally ill patients who are not enrolled in hospice die in hospitals and long-term care facilities.

## Nursing Care of Terminally Ill Patients

Many patients suffer unnecessarily when they do not receive adequate attention for the symptoms accompanying serious illness. Careful evaluation of the patient should include not only the physical problems but also the psychosocial and spiritual dimensions of the patient's and family's experience of serious illness. This approach contributes to a more comprehensive understanding of how the patient's and family's life has been affected by illness and leads to nursing care that addresses their needs in every dimension.

### Psychosocial Issues

Nurses are responsible for educating patients about their illness and for supporting them as they adapt to life with the illness. Nurses can assist patients and families with life review, values clarification, treatment decision making, and end-of-life closure. The only way to do this effectively is to try to appreciate and understand the illness from the patient's perspective.

Nurses should be both culturally aware and sensitive in their approaches to communication with patients and families about death. Attitudes toward open disclosure about terminal illness vary widely among different cultures, and direct communication with patients about such matters may be viewed as harmful (Barclay, Blackwell & Tulsky, 2007). To provide effective patient-centered and family-centered care at the end of life, nurses must be willing to set aside their own assumptions and attitudes so that they can discover what type and amount of disclosure is most meaningful to each patient and family within their unique belief systems (Table 17-1).

The social and legal evolution of advance directive documents represents some progress in people's willingness to both contemplate and communicate their wishes concerning the end of life (Chart 17-4). Now legally sanctioned in every state and federally sanctioned through the Patient Self-Determination Act of 1991, advance directives are written documents that allow competent people to document their preferences regarding the use or nonuse of medical treatment at the end of life, specify their preferred setting for care, and communicate other valuable insights into their values and beliefs. The addition of a proxy directive (the appointment and authorization of another person to make medical decisions on behalf of the person who created the advance directive when he or she can no longer speak for himself or herself) is an important addition to the "living will" or medical directive that specifies the signer's preferences. These documents are widely available from health care providers, community organizations, bookstores, and the Internet. However, their underuse reflects society's continued discomfort with openly confronting the subject of death. Furthermore, the existence of a properly executed advance directive does not reduce the complexity of end-of-life decisions.

The Patient Self-Determination Act requires that health care entities receiving Medicare or Medicaid reimbursement must ask if patients have advance directives, provide information about advance directives, and incorporate advance directives into the medical record. However, advance directives should not be considered a substitute for ongoing

#### Chart 17-4 • *Methods of Stating End-of-Life Preferences*

**Advance directives**—written documents that allow the individual of sound mind to document preferences regarding end-of-life care that should be followed when the signer is terminally ill and unable to verbally communicate his/her wishes. The documents are generally completed in advance of serious illness, but may be completed after a diagnosis of serious illness if the signer is still of sound mind. The most common types are the durable power of attorney for health care and the living will.

**Durable power of attorney for health care**—a legal document through which the signer appoints and authorizes another individual to make medical decisions on his/her behalf when he/she is no longer able to speak for him/herself. This is also known as a health care power of attorney or a proxy directive.

**Living will**—a type of advance directive in which the individual documents treatment preferences. It provides instructions for care in the event that the signer is terminally ill and not able to communicate his/her wishes directly and often is accompanied by a durable power of attorney for health care. This is also known as a medical directive or treatment directive.

Information about the advance care planning and state-specific advance directive documents and instructions are available at www.caringinfo.org

**Table 17-1 OVERVIEW OF RELIGIOUS AND CULTURAL BELIEFS AND VIEWS ON DEATH AND DYING**

| Religion | General Religious/Cultural Beliefs | Views About Death/Preparing for Death |
|---|---|---|
| Hinduism | • Each caste has a different view of death.<br>• This life is a transition between the previous life and the next.<br>• Bodies are cremated. During the first 10 days after death, relatives must create a new ethereal body.<br>• Good *karma* leads to good rebirth or release, and bad *karma* leads to bad rebirth. | • Many elderly people withdraw into their homes, where they prepare for death through prayer and meditation.<br>• A "good death" is timely, in the right place (on the ground at home), conscious and prepared, with the mind on God. All affairs should be in order.<br>• A "bad death" is untimely, violent, and unprepared. The worst death is suicide. |
| Judaism | • Human beings are mortal, and their bodies belong to God.<br>• Although the physician has the authority to determine the appropriate course of treatment, ultimately the patient has the right to choose, as long as the medical regimen follows Jewish law.<br>• Disclosure is important. Most patients want to know the truth.<br>• Jews are obligated to visit the sick. | • Traditional criteria for death are cessation of breathing and heartbeat. Conservative rabbis have accepted brain death as fulfilling these criteria.<br>• Advance directives for health care are permissible.<br>• Views on the use of artificial nutrition and hydration vary, depending on the particular sect/movement.<br>• Most rabbis maintain that Jews may enroll in hospice. |
| Buddhism | • There is no central authority in the Buddhist religion.<br>• Taboo and religious purity play little, if any, role, and religious law imposes no special requirements for medical treatment.<br>• Treatment by someone of the same gender is preferable.<br>• Cremation is the most common way of disposing of the dead.<br>• Some Buddhists may be unwilling to take pain-relieving medications or strong sedatives. It is believed that an unclouded mind can lead to a better rebirth.<br>• Buddhists believe that after death there is either rebirth or nirvana—the latter being enlightenment that frees the soul from the cycle of death and rebirth. | • Teachings emphasize the inevitability of death; therefore, Buddhists tend to be psychologically prepared to accept impending death with calmness and dignity.<br>• Death occurs when a body is bereft of vitality, heat, and sentiency. Brain death is disputed as meeting the requirements for death.<br>• It is often appropriate to decide that the patient is beyond medical help and to allow events to take their course. In these cases, it is justifiable to refuse or withdraw treatment in light of the overall prognosis.<br>• Buddhism supports the use of hospice. |
| Islam | • Muslims believe in one God.<br>• God revealed the message of God to Muhammad, the prophet, in the Qur'an (Koran). The Qur'an states that Muslims should maintain a balanced diet and exercise.<br>• Muslim patients may wish to engage in ritual prayer, practiced five times during the day.<br>• Fasting during the month of Ramadan is a pillar of Islam.<br>• Completion of the pilgrimage (*hajj*) to Mecca (money and health permitting), at least once, is also a pillar of Islam. | • Everyone will face death, and the way a person dies is of great individual importance.<br>• Death cannot happen except by God's permission. However, it is recognized that diseases and trauma cause death.<br>• There is a belief that health care providers must do everything possible to prevent a premature death.<br>• Pain is a cleansing instrument of God. Pain can also be viewed as having an educational purpose (pain can compensate for sin).<br>• The killing of a terminally ill person is an act of disobedience against God. However, pain relief or withholding or withdrawing of life support when there is no doubt that the person's disease is causing untreatable suffering is permissible as long as there is formal agreement among all parties concerned. |
| Traditional Christianity | • Christians believe in one God.<br>• The belief in eternal salvation sets Christianity apart.<br>• Beliefs vary. Some Christians hope to attain eternal salvation, and some view the religion more as a culture.<br>• Even within a family, religious views can differ. Some family members may not follow the religion at all. | • Intentionally bringing about death by either omission or commission is prohibited.<br>• The appropriateness of analgesia and sedation to avoid terminal suffering and despair is acceptable, if it does not, by clouding consciousness, take away the final opportunity for repentance.<br>• There is no obligation to postpone death; the attempt to save life at all costs is forbidden. However, there could be a duty to use high-technology medicine to gain a last opportunity for repentance.<br>• Impending death offers a final chance to become reconciled with those whom one has harmed and to ask God's forgiveness.<br>• Liturgical (ceremonial) Christians generally regard last rites as integral to the relationship with God. Repentance can include confessing formally and receiving Communion and final anointing. This often involves particular ministers.<br>• Christians who follow the religion at a cultural level are likely to have secular approaches to end-of-life decisions.<br>• Advance directives allow patients to appoint decision makers and to provide instructions that ensure that their wishes are followed. |

Information compiled from Firth, S. (2005). End of life: A Hindu view. *Lancet, 366*(9486), 682–686. Dorff, E. N. (2005). End of life: Jewish perspectives. *Lancet, 366*(9488), 862–865. Keown, D. (2005). End of life: the Buddhist view. *Lancet, 366*(9489), 952–955. Sachedina, A. (2005). End of life: The Islamic view. *Lancet, 366*(9487), 774–779. Engelhardt, H. T. & Smith Iltis, A. (2005). End of life: The traditional Christian view. *Lancet, 366*(9490), 1045–1049.

communication among the health care provider, patient, and family as the end of life approaches (Tulsky, 2005).

## Communication

As previously discussed, remarkable strides have been made in the ability to prolong life, but attention to care for the dying lags behind. On one level, this should come as no surprise. Each of us will eventually face death, and most would agree that one's own demise is a subject he or she would prefer not to contemplate. Confronting death in our patients uncovers our own deeply rooted fears.

To develop a level of comfort and expertise in communicating with seriously and terminally ill patients and their families, nurses must first consider their own experiences with and values concerning illness and death. Reflection, reading, and talking with family members, friends, and colleagues can help nurses examine beliefs about death and dying. Talking with people from different cultural and religious backgrounds can help nurses view personally held beliefs through a different lens and can increase their sensitivity to death-related beliefs and practices in other cultures. Discussion with nursing and nonnursing colleagues can also be useful; it may reveal the values shared by many health care professionals and may also identify diversity in the values of patients in their care. Values clarification and personal death awareness exercises can provide a starting point for self-discovery and discussion.

### Skills for Communicating With the Seriously Ill

Nurses need to develop skill and comfort in assessing patients' and families' responses to serious illness and planning interventions that support their values and choices throughout the continuum of care. Throughout the course of a serious illness, patients and their families encounter complicated treatment decisions and bad news about disease progression. They may have to make difficult decisions at the time of diagnosis, when disease-focused treatment fails, when the effectiveness of a particular intervention is being discussed, and when decisions about hospice care are presented. These critical points on the treatment continuum demand patience, empathy, and honesty from nurses. Discussing sensitive issues such as serious illness, hopes for survival, and fears associated with death is never easy. However, the art of therapeutic communication can be learned and, like other skills, must be practiced to gain expertise. Like other skills, communication should be practiced in a "safe" setting, such as a classroom or clinical skills laboratory with other students or clinicians.

Communication with each patient and family should be tailored to their particular level of understanding and values concerning disclosure. Before disclosing any health information about a patient to family members, nurses should follow their agency's policy for obtaining patient consent in accordance with Health Insurance Portability and Accountability Act (HIPAA) rules.

### Nursing Interventions When Patients and Families Receive Bad News

Communicating about a life-threatening diagnosis or about disease progression is best accomplished by the interdisciplinary team in any setting: a physician, nurse, social worker, and chaplain should be present whenever possible to provide information, facilitate discussion, and address concerns. Most important, the presence of the team conveys caring and respect for the patient and family. If the patient wishes to have family present for the discussion, arrangements should be made to have the discussion at a time that is best for everyone. Creating the right setting is particularly important. A quiet area with a minimum of disturbances should be used. All clinicians present should turn off pagers, cell phones, and other communication devices for the duration of the meeting and should allow sufficient time for the patient and family to absorb and respond to the news. Finally, the space in which the meeting takes place should be conducive to seating all participants at eye level. It is difficult enough for the patient and family to be the recipients of bad news without having an array of clinicians standing uncomfortably over them at the foot of the patient's bed.

After the initial discussion of a life-threatening illness or progression of a disease, the patient and family will probably have many questions and may need to be reminded of factual information. Coping with news about a serious diagnosis or poor prognosis is an ongoing process. The nurse should be sensitive to these ongoing needs and may need to repeat previously provided information or simply be present while the patient and family react emotionally. The most important intervention the nurse can provide is listening empathetically. Seriously ill patients and their families need time and support to cope with the changes brought about by serious illness and the prospect of impending death. The nurse who is able to listen without judging and without trying to solve the patient's and family's problems provides an invaluable intervention. Keys to effective listening include the following:

- Resist the impulse to fill the "empty space" in communication with talk.
- Allow the patient and family sufficient time to reflect and respond after asking a question.
- Prompt gently: "Do you need more time to think about this?"
- Avoid distractions (noise, interruptions).
- Avoid the impulse to give advice.
- Avoid canned responses: "I know just how you feel."
- Ask questions.
- Assess understanding—your own and the patient's—by restating, summarizing, and reviewing.

### Responding With Sensitivity to Difficult Questions

Patients often direct questions or concerns to nurses before they have been able to fully discuss the details of their diagnosis and prognosis with their physicians or the entire health care team. Using open-ended questions allows the nurse to elicit the patient's and family's concerns, explore misconceptions and needs for information, and form the basis for collaboration with physicians and other team members.

For example, a seriously ill patient may ask the nurse, "Am I dying?" The nurse should avoid making unhelpful responses that dismiss the patient's real concerns or defer the issue to another care provider. Nursing assessment and intervention are always possible, even when a need for further discussion with a physician is clearly indicated. Whenever possible,

discussions in response to a patient's concerns should occur when the patient expresses a need, although that may be the least convenient time for the nurse. Creating an uninterrupted space of just 5 minutes can do much to identify the source of the concern, allay anxieties, and plan for follow-up.

In response to the question, "Am I dying?," the nurse could establish eye contact and follow with a statement acknowledging the patient's fears ("This must be very difficult for you") and an open-ended statement or question ("Tell me more about what is on your mind"). The nurse then needs to listen intently, ask additional questions for clarification, and provide reassurance only when it is realistic. In this example, the nurse might quickly ascertain that the patient's question emanates from a need for specific information—about diagnosis and prognosis from the physician, about the physiology of the dying process from the nurse, or perhaps about financial implications for the family from the social worker. The chaplain may also be called to talk with the patient about existential concerns.

As a member of the interdisciplinary team caring for the patient at the end of life, the nurse plays an important role in facilitating the team's understanding of the patient's values and preferences, family dynamics concerning decision making, and the patient's and family's response to treatment and changing health status. Many dilemmas in patient care at the end of life are related to poor communication between team members and the patient and family, as well as to failure of team members to communicate with one another effectively. Regardless of the care setting, the nurse can ensure a proactive approach to the psychosocial care of the patient and family. Periodic, structured assessments provide an opportunity for all parties to consider their priorities and plan for an uncertain future. The nurse can help the patient and family clarify their values and preferences concerning end-of-life care by using a structured approach. Sufficient time must be devoted to each step, so that the patient and family have time to process new information, formulate questions, and consider their options. The nurse may need to plan several meetings to accomplish the steps described in Chart 17-5.

### Chart 17-5 • *Breaking Bad News: The S-P-I-K-E-S Strategy*

**Setting (S)**

- Arrange for a private setting.
- Involve significant others: Identify who will be the spokesperson (if applicable).
- Sit down.
- Communicate that you are listening, using silence and repetition.
- Remain available for the duration of the meeting.

**Perception (P)**

- Identify what the patient and family understand.
- Use the same vocabulary that they do.

**Invitation (I)**

- Obtain permission for the depth and breadth of information to be shared.

**Knowledge (K)**

- Provide a warning that bad news is going to be shared.
- Avoid technical language.
- Give the information in small chunks.
- Tailor the rate at which information is provided.

**Empathy (E)**

- Listen for and identify the emotion (or mix of emotions).
- Identify the source or cause of the emotion.
- Show the patient that you have made the connection between emotion and cause.

**Strategy and Summary (S)**

- Check for understanding.
- Summarize the discussion.
- Reiterate the plan.

Adapted with permission from Buckman, R. A. (2005). Breaking bad news: The S-P-I-K-E-S strategy. *Community Oncology, 2*(2), 138–142.

## Providing Culturally Sensitive Care at the End of Life

Although death, grief, and mourning are universally accepted aspects of living, the values, expectations, and practices during serious illness, as death approaches and after death are culturally bound and expressed. Health care providers may share very similar values concerning end-of-life care and may find that they are inadequately prepared to assess for and implement care plans that support culturally diverse perspectives. Historical mistrust of the health care system and unequal access to even basic medical care may underlie the beliefs and attitudes among ethnically diverse populations (see Table 17-1). In addition, lack of education or knowledge about end-of-life care treatment options and language barriers influence decisions among many socioeconomically disadvantaged groups.

The nurse's role is to assess the values, preferences, and practices of every patient, regardless of ethnicity, socioeconomic status, or background. The nurse can share knowledge about a patient's and family's cultural beliefs and practices with the health care team and facilitate the adaptation of the care plan to accommodate these practices. For example, a nurse may find that a male patient prefers to have his eldest son make all of his care decisions. Institutional practices and laws governing informed consent are also rooted in the Western notion of autonomous decision making and informed consent. If a patient wishes to defer decisions to his son, the nurse can work with the team to negotiate informed consent, respecting the patient's right not to participate in decision making and honoring his family's cultural practice.

The nurse should assess and document the patient's and family's specific beliefs, preferences, and practices regarding end-of-life care, preparation for death, and after-death rituals. Chart 17-6 identifies topics that the nurse should cover and questions the nurse may use to elicit the information.

The nurse must use judgment and discretion about the timing and setting for eliciting this information. Some patients may wish to have a family member speak for them or may be unable to provide information because of advanced illness. The nurse should give the patient and family a context for the discussion, such as, "It is very important to us to provide care that addresses your needs and the needs of your

CHART 17-6

### Assessing End-of-Life Care Beliefs, Preferences, and Practices

***Disclosure/truth telling:*** "Tell me how you/your family talk about very sensitive or serious matters."
- Content: "Are there any topics that you or your family are uncomfortable discussing?"
- Person responsible for disclosure: "Is there one person in the family who assumes responsibility for obtaining and sharing information?"
- Disclosure practices regarding children: "What kind of information may be shared with children in your family, and who is responsible for communicating with the children?"
- Sharing of information within the family or community group: "What kind/how much information should be shared with your immediate family? Your extended family? Others in the community (for example, members of a religious community)?"

***Decision-making style:*** "How are decisions made in your family? Who would you like to be involved in decisions about your treatment or care?"
- Individual
- Family-centered
- Family elder or patriarch/matriarch
- Deference to authority (such as the physician)

***Symptom management:*** "How would you like us to help you to manage the physical effects of your illness?"
- Acceptability of medications used for symptom relief
- Beliefs regarding expression of pain and other symptoms
- Degree of symptom management desired

***Life-sustaining treatment expectations:*** "Have you thought about what type of medical treatment you or your loved one would want as the end of life is nearing? Do you have an advance directive (living will and/or durable power of attorney)?"
- Nutrition/hydration at the end of life
- Cardiopulmonary resuscitation
- Ventilator
- Dialysis
- Antibiotics
- Medications to treat infection

***Desired location of dying:*** "Do you have a preference about being at home or in some other location when you die?"
- Desired role for family members in providing care: "Who do you want to be involved in caring for you at the end of life?"
- Gender-specific prohibitions: "Are you uncomfortable having either males or females provide your care or your loved one's personal care?"

***Spiritual/religious practices and rituals:*** "Is there anything that we should know about your spiritual or religious beliefs about death? Are there any practices that you would like us to observe as death is nearing?"

***Care of the body after the death:*** "Is there anything that we should know about how a body/your body should be treated after death?"

***Expression of grief:*** "What types of losses have you and your family experienced? How do you and your family express grief?"

***Funeral and burial practices:*** "Are there any rituals or practices associated with funerals or burial that are especially important to you?"

***Mourning practices:*** "How have you and your family carried on after a loss in the past? Are their particular behaviors or practices that are expected or required?"?

family. We want to honor and support your wishes, and want you to feel free to tell us how we are doing, and what we could do to better meet your needs. I'd like to ask you some questions; what you tell me will help me to understand and support what is most important to you at this time. You don't need to answer anything that makes you uncomfortable. Is it all right to ask some questions?" The assessment of end-of-life beliefs, preferences, and practices should be carried out in short segments over a period of time (for example, across multiple days of an inpatient hospital stay or in conjunction with multiple patient visits to an outpatient setting). The discomfort of novice nurses with asking questions and discussing this type of sensitive content can be reduced by prior practice in a classroom or clinical skills laboratory, observation of interviews conducted by experienced nurses, and partnering with experienced nurses during the first few assessments.

## Goal Setting in Palliative Care at the End of Life

As treatment goals begin to shift in the direction of comfort care over aggressive disease-focused treatment, symptom relief and patient/family–defined quality of life assume greater prominence in treatment decision making. Throughout the course of the illness, and especially as the patient's functional status and symptoms indicate approaching death, the clinician should help the patient and family weigh the benefits of continued diagnostic testing and disease-focused medical treatment against the costs of those activities. The patient and family may be extremely reluctant to forgo monitoring that has become routine throughout the illness (eg, blood testing, x-rays) but that may contribute little to a primary focus on comfort. Likewise, health care providers may have difficulty discontinuing such diagnostic testing or medical treatment.

Specifically, the nurse should collaborate with other members of the interdisciplinary team to share assessment findings and develop a coordinated plan of care (Fig. 17-1). In addition, the nurse should help the patient and family clarify their goals, expected outcomes, and values as they consider treatment options (Chart 17-7). The nurse should work with colleagues in other disciplines to ensure that the patient and family are referred for continuing psychosocial support, symptom management, and assistance with other care-related challenges (eg, arrangements for home care or hospice support, referrals for financial assistance).

## Spiritual Care

Attention to the spiritual component of the illness experienced by the patient and family is not new within the context of nursing care, yet many nurses lack the comfort or skills to assess and intervene in this dimension. **Spirituality**

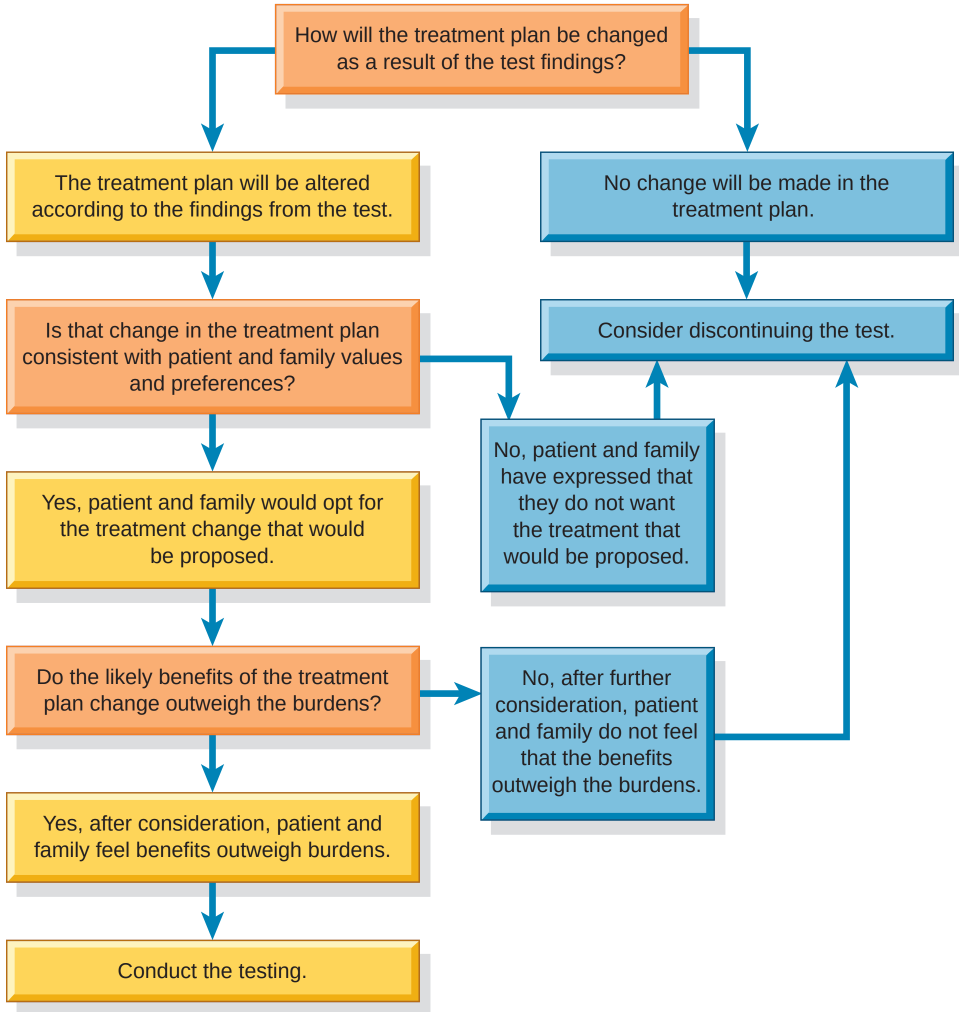



**Figure 17-1** An algorithm for decision making about diagnostic testing at the end of life.

CHART 17-7

### *Assessing the Patient and Family Perspective: Goal Setting in Palliative Care*

Patient and family

- **Awareness of diagnosis, illness stage, and prognosis:** "Tell me your understanding of your illness right now."
- **Values:** "Tell me what is most important to you as you are thinking about the treatment options available to you/your loved one."
- **Preferences:** "You've said that being comfortable and pain-free is most important to you right now. Where would you like to receive care (home, hospital, long-term care facility, doctor's office), and how can I help?"
- **Expected/desired outcomes:** "What are your hopes and expectations for this (diagnostic test [eg, CT scan] or treatment)?"
- **Benefits and burdens:** "Is there a point at which you would say that the testing or treatment is outweighed by the burdens it is causing you (eg, getting from home to the hospital, pain, nausea, fatigue, interference with other important activities)?"

contains features of religiosity, but the two concepts are not interchangeable (Puchalski, Lunsford, Marris, et al., 2006). Spirituality refers to "one's relationship with the transcendent questions that confront one as a human being and how one relates to those questions" (Sulmasy, 2006, p. 1386). For most people, contemplating one's own death raises many issues, such as the meaning of existence, the purpose of suffering, and the existence of an afterlife. A survey on end-of-life issues conducted by the American Association of Retired Persons (AARP, 2005) revealed the following:

- Total physical dependency was worse than death (87%).
- Dying painfully (49%), dying from a long-term illness (36%), dying in an institution (30%), and dying alone (21%) made many people "very afraid."
- Being free from pain (74%), being at peace spiritually (69%), and knowing how to say goodbye were "very important" (67%).

The spiritual assessment is a key component of comprehensive nursing assessment for terminally ill patients and their families. Although the nursing assessment should include religious affiliation, spiritual assessment is conceptually much

broader than religion and therefore is relevant regardless of a patient's expression of religious preference or affiliation. In addition to assessment of the role of religious faith and practices, important religious rituals, and connection to a religious community (see Table 17-1), the nurse should further explore:

- The harmony or discord between the patient's and the family's beliefs
- Other sources of meaning, hope, and comfort
- The presence or absence of a sense of peace of mind and purpose in life
- Spiritual or religious beliefs about illness, medical treatment, and care of the sick

Puchalski (2007–2008) created a four-step spiritual assessment process using the acronym FICA, which involves asking the following questions:

- *F*aith and belief: Do you consider yourself to be a spiritual or religious person? What is your *faith* or belief? What gives your life meaning?
- *I*mportance and *I*nfluence: What *importance* does faith have in your life? Have your beliefs influenced the way you take care of yourself and your illness? What role do your beliefs play in regaining your health?
- *C*ommunity: Are you a part of a spiritual or religious *community*? Is this of support to you and how? Is there a group of people you really love or who are important to you?
- *A*ddress in care: How would you like me to *address* these issues in your health care?

## Hope

Clinicians and researchers have observed that although specific hopes may change over time, hope generally persists in some form across every stage of illness. In terminal illness, hope represents the patient's imagined future, forming the basis of a positive, accepting attitude and providing the patient's life with meaning, direction, and optimism. When hope is viewed in this way, it is not limited to cure of the disease; instead, it focuses on what is achievable in the time remaining. Many patients find hope in working on important relationships and creating legacies. Terminally ill patients can be extremely resilient, reconceptualizing hope repeatedly as they approach the end of life.

Numerous nurse researchers have studied the concept of hope, and they have related its presence to spirituality, quality of life, and transcendence. Hope is a multidimensional construct that provides comfort as a person endures life threats and personal challenges. Buckley and Herth (2004) identified the following categories of hope-fostering and hope-hindering activities among terminally ill hospice patients with various diagnoses:

- *Hope-fostering categories:* love of family and friends, spirituality/faith, setting goals and maintaining independence, positive relationships with clinicians, humor, personal characteristics, and uplifting memories
- *Hope-hindering categories:* abandonment and isolation, uncontrollable pain/discomfort, and devaluation of personhood

Nurses can support hope for the patient and family by using effective listening and communication skills, thus encouraging realistic hope that is specific to their needs for information, expectations for the future, and values and preferences concerning the end of life. It is important for the nurse to engage in self-reflection and to identify his or her own biases and fears concerning illness, life, and death. As the nurse becomes more skilled in working with seriously ill patients, he or she can become less determined to "fix" and more willing to listen; more comfortable with silence, grief, anger, and sadness; and more fully present with patients and their families.

Nursing interventions for enabling and supporting hope include the following:

- Listening attentively
- Encouraging sharing of feelings
- Providing accurate information
- Encouraging and supporting the patient's control over his or her circumstances, choices, and environment whenever possible
- Assisting patients to explore ways for finding meaning in their lives
- Encouraging realistic goals
- Facilitating effective communication within families
- Making referrals for psychosocial and spiritual counseling
- Assisting with the development of supports in the home or community when none exist

## Managing Physiologic Responses to Terminal Illness

Patients approaching the end of life experience many of the same symptoms, regardless of their underlying disease processes. Symptoms in terminal illness may be caused by the disease, either directly (eg, dyspnea due to chronic obstructive lung disease) or indirectly (eg, nausea and vomiting related to pressure in the gastric area), by the treatment for the disease, or by a coexisting disorder that is unrelated to the disease. Symptoms should be carefully and systematically assessed and managed. Questions that guide the assessment of symptoms are listed in Chart 17-8. Also, see the Nursing Research Profile presented in Chart 17-9.

CHART 17-8

### *Assessing Symptoms Associated With Terminal Illness*

- How is this symptom affecting the patient's life?
- What is the meaning of the symptom to the patient? To the family?
- How does the symptom affect physical functioning, mobility, comfort, sleep, nutritional status, elimination, activity level, and relationships with others?
- What makes the symptom better?
- What makes it worse?
- Is it worse at any particular time of the day?
- What are the patient's expectations and goals for managing the symptom? The family's?
- How is the patient coping with the symptom?
- What is the economic effect of the symptom and its management?

Adapted from Jacox, A., Carr, D. B. & Payne, R. (1994). *Management of cancer pain.* Rockville, MD: AHCPR.

CHART 17-9

## NURSING RESEARCH PROFILE

## *Symptoms in Hospice Patients With End-Stage Heart Disease*

McMillan, S. C., Dunbar, S. B. & Zhang, W. (2007). The prevalence of symptoms in hospice patients with end-stage heart disease. *Journal of Hospice and Palliative Nursing, 9*(3), 124–131.

### Purpose

Heart disease is the leading cause of death in the United States. After cancer, it is the second most frequent diagnosis in hospice patients; however, little is known about how to guide patient care as patients with heart disease approach the end of life. The purpose of this study was to evaluate the type and frequency of symptoms in patients with end-stage heart failure newly enrolled in hospices. Such research is needed so that effective interventions for this group of patients can be developed.

### Design

In this study, researchers conducted a retrospective review of medical records of patients with end-stage heart failure as the primary diagnosis who were admitted to a large, not-for-profit hospice program in 2004. They collected data from 51 eligible patients, using a medical record audit form to guide data collection. The form addressed demographic data, physical symptoms, and psychosocial assessment data. Psychosocial data included 10 depressive symptoms. Researchers also assessed satisfaction with social support in a subset of patients and caregivers.

### Findings

The average length of stay (LOS) in the hospice was 127.5 days, with a range of 1 to 195 days and a median of 31 days. The average patient age was 80.3 years and 57.1 years for caregivers. The majority of the subjects were Caucasian, and the number of men and women was about equal. Caregivers were more likely to be women.

Patients reported 1 to 28 symptoms, with an average of 11.9 symptoms. The most prevalent symptom was fatigue or weakness (82.4%) followed by shortness of breath (76.5%). (Shortness of breath was noted at rest in 52.9% of medical records.) Swelling or edema was subjectively reported in 56.9% of patients. Slightly more than 41% reported weight loss with decreased appetite reported by 49%. Nearly 40% reported difficulty concentrating and many reported chest pain (37.3%) and chest pressure (25.5%). "Worst pain in the past 24 hours" averaged 6.9 on a scale of 0 to 10, which was nearly in the severe range.

### Nursing Implications

The LOS in the hospice program for patients with end-stage heart failure exceeded national norms for hospice patients (all diagnoses combined). This may reflect difficulty predicting life expectancy in patients with noncancer diagnoses.

In the patients, fatigue or weakness and shortness of breath were very common. These subjective symptoms need to be assessed by the health care team; patients can rate their intensity and associated distress on a scale of 0 to 10. Health care team members need to accept as valid patients' reports about these symptoms and to identify interventions to address them. The findings of this study can be used to develop and test specific interventions that can be tested in future research.

The patient's goals should guide symptom management. Medical interventions may be aimed at treating the underlying causes of the symptoms or reducing the impact of symptoms. For example, a medical intervention such as thoracentesis (an invasive procedure in which fluid is drained from the pleural space) may be performed to temporarily relieve dyspnea in a patient with pleural effusion secondary to lung cancer. Pharmacologic and nonpharmacologic methods of symptom management may be used in combination with medical interventions to modify the physiologic causes of symptoms. In addition, pharmacologic management with low-dose oral morphine is very effective in relieving dyspnea (Lorenz, Lynn, Dy, et al., 2008), and guided relaxation may reduce the anxiety associated with the sensation of breathlessness. As is true with pain, the principles of pharmacologic symptom management are use of the smallest dose of the medication to achieve the desired effect, avoidance of polypharmacy, anticipation and management of adverse effects, and creation of a therapeutic regimen that is acceptable to the patient based on his or her goals for maximizing quality of life.

The patient's goals take precedence over the clinicians' goals to relieve all symptoms at all costs. Although clinicians may believe that symptoms must be completely relieved whenever possible, the patient might choose instead to decrease symptoms to a tolerable level rather than to relieve them completely if the side effects of medications are unacceptable to him or her. This often allows the patient to have greater independence, mobility, and alertness and to devote attention to issues he or she considers of higher priority and greater importance.

*Anticipating* and planning interventions for symptoms is a cornerstone of end-of-life care. Both patients and family members cope more effectively with new symptoms and exacerbations of existing symptoms when they know what to expect and how to manage them. Hospice programs typically provide "emergency kits" containing ready-to-administer doses of a variety of medications that are useful to treat symptoms in advanced illness. For example, a kit might contain small doses of oral morphine liquid for pain or shortness of breath, a benzodiazepine for restlessness, and an acetaminophen suppository for fever. Family members can be instructed to administer a prescribed dose from the emergency kit, often avoiding prolonged suffering for the patient as well as rehospitalization for symptom management.

### *Pain*

In the final stages of illnesses such as cancer, acquired immunodeficiency syndrome (AIDS), heart disease, COPD, and renal disease, pain and other symptoms are common (Solano, Gomes & Higginson, 2006). Pain results from both the diseases and the modalities used to treat them. A recent analysis of the research literature revealed that despite abundant literature and World Health Organization guidelines for pain management, prevalence of pain is as high as 50% in patients with cancer of any type (van den Beuken-van Everdingen, de Rijke, Kessels, et al., 2007) as well as in terminally ill patients with common noncancer diagnoses (Solano, et al., 2006). Chapter 13 presents the importance of pain assessment, assessment principles for pain that include identifying the effect of the pain on the patient's life, and the importance of believing the patient's report of the pain and its effect. Although the means to relieve pain have existed for many years, the continued, pervasive undertreatment of pain has been well documented. Poorly managed pain affects the psychological, emotional, social, and financial well-being of patients. Despite studies demonstrating the negative effects of inadequate pain management, practice has been slow to change (Gordon, Dahl, Miaskowski, et al., 2005).

Patients who are receiving an established regimen of analgesics should continue to receive those medications as they approach the end of life. Inability to communicate pain should not be equated with the absence of pain. Although most pain can be managed effectively using the oral route, as the end of life nears, patients may be less able to swallow oral medications due to somnolence or nausea. Patients who have been receiving opioids should continue to receive equianalgesic doses via rectal or sublingual routes. Concentrated morphine solution can be very effectively delivered by the sublingual route, because the small liquid volume is well tolerated even if swallowing is not possible. As long as the patient continues to receive opioids, a regimen to combat constipation must be implemented. If the patient cannot swallow laxatives or stool softeners, rectal suppositories or enemas may be necessary.

The nurse should teach the family about continuation of comfort measures as the patient approaches the end of life, how to administer analgesics via alternative routes, and how to assess for pain when the patient cannot verbally report pain intensity. Because the analgesics administered orally or rectally are short-acting and typically scheduled as frequently as every 3 to 4 hours around the clock, there is always a strong possibility that a patient approaching the end of life will die in close proximity to the time of analgesic administration. If the patient is at home, family members administering analgesics should be prepared for this possibility. They need reassurance that they did not "cause" the death of the patient by administering a dose of analgesic medication.

### *Dyspnea*

Dyspnea is an uncomfortable awareness of breathing that is common in patients approaching the end of life (Weissman, 2005). A highly subjective symptom, dyspnea often is not associated with visible signs of distress, such as tachypnea, diaphoresis, or cyanosis. Patients with primary lung tumors, lung metastases, pleural effusion, or restrictive lung disease may experience significant dyspnea. Although the underlying cause of the dyspnea can be identified and treated in some cases, the burdens of additional diagnostic evaluation and treatment aimed at the physiologic problem may outweigh the benefits. The treatment of dyspnea varies depending on the patient's general physical condition and imminence of death. For example, a blood transfusion may provide temporary symptom relief for a patient with anemia earlier in the disease process; however, as the patient approaches the end of life, the benefits are typically short-lived or absent.

#### Nursing Assessment and Intervention

As with assessment and management of pain, reports of dyspnea by patients must be believed. As is true for physical pain, the meaning of dyspnea to an individual patient may increase his or her suffering. For example, the patient may interpret increasing dyspnea as a sign that death is approaching. For some patients, sensations of breathlessness may invoke frightening images of drowning or suffocation, and the resulting cycle of fear and anxiety may increase the sensation of breathlessness. Therefore, the nurse should conduct a careful assessment of the psychosocial and spiritual components of the dyspnea. Physical assessment parameters include symptom intensity, distress, and interference with activities; auscultation of lung sounds; assessment of fluid balance, including measurement of dependent edema (circumference of lower extremities) and abdominal girth; temperature; skin color; sputum quantity and character; and cough.

To determine the intensity of dyspnea and its interference with daily activities, the patient can be asked to report the severity of the dyspnea using a scale of 0 to 10, where 0 is no dyspnea and 10 is the worst imaginable dyspnea. The patient's baseline rating before treatment and subsequent measurements taken during exacerbation of the symptom, periodically during treatment, and whenever the treatment plan changes provide ongoing objective evidence for the efficacy of the treatment plan. In addition, physical assessment findings may assist in locating the source of the dyspnea and selecting nursing interventions to relieve the symptom. The components of the assessment change as the patient's condition changes. For example, when the patient who has been on daily weights can no longer get out of bed, the goal of comfort may outweigh the benefit of continued weights. Like other symptoms at the end of life, dyspnea can be managed effectively in the absence of assessment and diagnostic data (eg, arterial blood gases) that are standard when a patient's illness or symptom is reversible.

Nursing management of dyspnea at the end of life is directed toward administering medical treatment for the underlying pathology, monitoring the patient's response to treatment, helping the patient and family manage anxiety (which exacerbates dyspnea), altering the perception of the symptom, and conserving energy (Chart 17-10). Pharmacologic intervention is aimed at modifying lung physiology and improving performance as well as altering the perception of the symptom. Bronchodilators and corticosteroids are used to treat underlying obstructive pathology, thereby improving overall lung function. Low doses of opioids are very effective in relieving dyspnea, although the mechanism of relief is not

### Chart 17-10 • *Palliative Nursing Interventions for Dyspnea*

**Decrease Anxiety**

- Administer prescribed anxiolytic medications as indicated for anxiety or panic associated with dyspnea.
- Assist with relaxation techniques, guided imagery.
- Provide patient with a means to call for assistance (call bell/light within reach in a hospital or long-term care facility; handheld bell or other device for home).

**Treat Underlying Pathology**

- Administer prescribed bronchodilators and corticosteroids (obstructive pathology).
- Administer blood products, erythropoietin as prescribed (typically not beneficial in advanced disease).
- Administer prescribed diuretics and monitor fluid balance.

**Alter Perception of Breathlessness**

- Administer prescribed oxygen therapy via nasal cannula, if tolerated; masks may not be well tolerated.
- Administer prescribed low-dose opioids via oral route (morphine sulfate is used most commonly).
- Provide air movement in the patient's environment with a portable fan.

**Reduce Respiratory Demand**

- Teach patient and family to implement energy conservation measures.
- Place needed equipment, supplies, and nourishment within reach.
- For home or hospice care, offer bedside commode, electric bed (with head that elevates).

entirely clear. Although dyspnea in terminal illness is typically not associated with diminished blood oxygen saturation, low-flow oxygen often provides psychological comfort to both patients and families, particularly in the home setting.

As previously mentioned, dyspnea may be exacerbated by anxiety, and anxiety may trigger episodes of dyspnea, setting off a respiratory crisis in which the patient and family may panic. For patients receiving care at home, patient and family instruction should include anticipation and management of crisis situations and a clearly communicated emergency plan. The patient and family should be instructed about medication administration, condition changes that should be reported to the physician and nurse, and strategies for coping with diminished reserves and increasing symptomatology as the disease progresses. The patient and family need reassurance that the symptom can be effectively managed at home without the need for activation of the emergency medical services or hospitalization and that a nurse will be available at all times via telephone or to make a visit.

## *Nutrition and Hydration at the End of Life*

### Anorexia

Anorexia and cachexia are common in the seriously ill. The profound changes in the patient's appearance and a lack of interest in the socially important rituals of mealtime are particularly disturbing to families. The approach to the problem varies depending on the patient's stage of illness, level of disability associated with the illness, and desires. The anorexia–cachexia syndrome is characterized by disturbances in carbohydrate, protein, and fat metabolism; endocrine dysfunction; and anemia. The syndrome results in severe asthenia (loss of energy).

Although causes of anorexia may be controlled for a period of time, progressive anorexia is an expected and natural part of the dying process. Anorexia may be related to or exacerbated by situational variables (eg, the ability to have meals with the family versus eating alone in the "sick room"), progression of the disease, treatment for the disease, or psychological distress. The patient and family should be instructed in strategies to manage the variables associated with anorexia (Table 17-2).

***Use of Pharmacologic Agents to Stimulate Appetite.*** A number of pharmacologic agents are commonly used to stimulate appetite in patients with anorexia. These include dexamethasone (Decadron), megestrol acetate (Megace), and dronabinol (Marinol). Although these agents may result in temporary weight gain, their use is not associated with an increase in lean body mass in terminally ill patients. Therapy should be tapered or discontinued after 4 to 8 weeks if there is no response (Wrede-Seaman, 2008).

Dexamethasone initially increases appetite and may provide short-term weight gain in some patients. It should be considered for those patients whose life expectancy is less than 6 weeks because the beneficial effects may be limited to the first few weeks of therapy and side effects increase over time (Del Fabbro, Dalal & Bruera, 2006). Therapy may need to be discontinued in patients with a longer life expectancy; after 3 to 4 weeks, corticosteroids interfere with the synthesis of muscle protein.

Megestrol acetate produces temporary weight gain of primarily fatty tissue, with little effect on protein balance. Because of the time required to see any effect from this agent, therapy should not be initiated if life expectancy is less than 30 days. With long-term use, megestrol acetate may have fewer side effects than dexamethasone (Del Fabbro, et al., 2006).

Dronabinol is a psychoactive compound found in cannabis that may be helpful in reducing nausea and vomiting, appetite loss, pain, and anxiety, thereby improving food and fluid intake in some patients. However, in most patients, it is not as effective as other agents for appetite stimulation. Although dronabinol may have beneficial effects on appetite in patients with advanced cancer, it has not been shown to be more effective than megestrol. In addition, it possesses undesirable central nervous system side effects (Del Fabbro, et al., 2006).

### Cachexia

Cachexia refers to severe muscle wasting and weight loss associated with illness. Although anorexia may exacerbate cachexia, it is not the primary cause. Cachexia is associated with anabolic and catabolic changes in metabolism that relate to activity of neurohormones and proinflammatory cytokines, resulting in profound protein loss. These processes appear to be similar at the end stages of both cancer and

**Table 17-2 MEASURES FOR MANAGING ANOREXIA**

| Nursing Interventions | Patient and Family Teaching Tips |
|---|---|
| Initiate measures to ensure adequate dietary intake without adding stress to the patient at mealtimes. | Reduce the focus on "balanced" meals; offer the same food as often as the patient desires it. |
| Assess the impact of medications (eg, chemotherapy, antiretrovirals) or other therapies (radiation therapy, dialysis) that are being used to treat the underlying illness. | Increase the nutritional value of meals. For example, add dry milk powder to milk, and use this fortified milk to prepare cream soups, milkshakes, and gravies. |
| Administer and monitor effects of prescribed treatment for nausea, vomiting, and delayed gastric emptying. | |
| Encourage patient to eat when effects of medications have subsided. | Allow and encourage the patient to eat when hungry, regardless of usual meal times. |
| Assess and modify environment to eliminate unpleasant odors and other factors that cause nausea, vomiting, and anorexia. | Eliminate or reduce noxious cooking odors, pet odors, or other odors that may precipitate nausea, vomiting, or anorexia. |
| Remove items that may reduce appetite (soiled tissues, bedpans, emesis basins, clutter). | Keep patient's environment clean, uncluttered, and comfortable. |
| Assess and manage anxiety and depression to the extent possible. | Make mealtime a shared experience away from the "sick" room whenever possible.<br>Reduce stress at mealtimes.<br>Avoid confrontations about the amount of food consumed.<br>Reduce or eliminate routine weighing of the patient. |
| Position to enhance gastric emptying. | Encourage patient to eat in a sitting position; elevate the head of the patient's bed.<br>Plan meals (food selection and portion size) that the patient desires.<br>Provide small frequent meals if they are easier for patient to eat. |
| Assess for constipation and/or intestinal obstruction. | Ensure that patient and family understand that prevention of constipation is essential, even when the patient's intake is minimal. |
| Prevent and manage constipation on an ongoing basis, even when the patient's intake is minimal. | Encourage adequate fluid intake, dietary fiber, and use of bowel program to prevent constipation. |
| Provide frequent mouth care, particularly following nourishment. | Assist the patient to rinse after every meal. Avoid mouthwashes that contain alcohol or glycerine, which dry mucous membranes. |
| Ensure that dentures fit properly. | Weight loss may cause dentures to loosen and cause irritation. Remove them to inspect the gums and to provide oral care. |
| Administer and monitor effects of topical and systemic treatment for oropharyngeal pain. | The patient's comfort may be enhanced if medications for pain relief given on an as-needed basis for breakthrough pain are administered before mealtimes. |

some noncancer illnesses, such as heart disease (Siddiqui, Pandya, Harvey, et al., 2006; von Haehling, Doehner & Anker, 2007). However, the pathophysiology of cachexia in terminal illness is not well understood. In terminal illness, the severity of tissue wasting is greater than would be expected from reduced food intake alone, and typically increasing appetite or food intake does not reverse cachexia.

Anorexia and cachexia differ from starvation (simple food deprivation) in several important ways. Appetite is lost early in the process, the body becomes catabolic in a dysfunctional way, and supplementation by gastric feeding (tube feeding) or parenteral nutrition in advanced disease does not replenish lean body mass that has been lost. At one time it was believed that cancer patients with rapidly growing tumors developed cachexia because the tumor created an excessive nutritional demand and diverted nutrients from the rest of the body. Research links cytokines produced by the body in response to a tumor to a complex inflammatory-immune response present in patients whose tumors have metastasized, leading to anorexia, weight loss, and altered metabolism. An increase in cytokines occurs not only in cancer but also in AIDS and many other chronic diseases (Del Fabbro, et al., 2006).

### Artificial Nutrition and Hydration

Along with breathing, eating and drinking are essential to survival throughout life. Near the end of life, the body's nutritional needs change, and the desire for food and fluid may diminish. People may no longer be able to use, eliminate, or store nutrients and fluids adequately. Eating and sharing meals are important social activities in families and communities, and food preparation and enjoyment are linked to happy memories, strong emotions, and hopes for survival. For patients with serious illness, food preparation and mealtimes often become battlegrounds in which well-meaning family members argue, plead, and cajole to encourage ill people to eat. It is not unusual for seriously ill patients to lose their appetites entirely, to develop strong aversions to foods they have enjoyed in the past, or to crave a particular food to the exclusion of all other foods.

Although nutritional supplementation may be an important part of the treatment plan in early or chronic illness, unintended weight loss and dehydration are expected characteristics of progressive illness. As illness progresses, patients, families, and clinicians may believe that, without artificial nutrition and hydration, terminally ill patients will "starve," causing profound suffering and hastened death. However, starvation should not be viewed as the failure to insert tubes for nutritional supplementation or hydration of terminally ill patients with irreversible progression of disease. Studies have demonstrated that terminally ill patients with cancer who were hydrated did not have improved biochemical parameters and exhibited lower serum albumin levels, leading to fluid retention (Morita, Hyodo, Yoshimi, et al., 2006). The use of artificial nutrition and hydration (tube and intravenous [IV]

fluids and feeding) carry considerable risks and do not contribute to comfort at end of life (Casarett, Kapo & Kaplan, 2005). Similarly, survival is not increased when terminally ill patients with advanced dementia receive enteral feeding (Chernoff, 2006), and no data support an association between tube feeding and improved quality of life in these patients (Kapo, Morrison & Liao, 2007). Furthermore, in patients who are close to death, symptoms associated with dehydration such as dry mouth, confusion, and diminished alertness are common and typically do not respond to artificial nutrition. Dry mouth can generally be managed through nursing measures such as mouth care and environmental changes with medications to diminish confusion.

As the patient approaches the end of life, the family and health care providers should offer the patient what he or she prefers and can most easily tolerate. The nurse should instruct the family how to separate feeding from caring, demonstrating love, sharing, and caring by being with the loved one in other ways. Preoccupation with appetite, feeding, and weight loss diverts energy and time that the patient and family could use in other meaningful activities. In addition to those give in Table 17-2, the following are tips to promote nutrition for terminally ill patients:

- Offer small portions of favorite foods.
- Cool foods may be better tolerated than hot foods.
- Offer cheese, eggs, peanut butter, mild fish, chicken, or turkey. Meat (especially beef) may taste bitter and unpleasant.
- Add milk shakes, Instant Breakfast drinks, or other liquid supplements.
- Place nutritious foods at the bedside (fruit juices, milk shakes in insulated drink containers with straws).
- Schedule meals when family members can be present to provide company and stimulation.
- Offer ice chips made from frozen fruit juices.
- Allow the patient to refuse foods and fluids.

### Delirium

Many patients remain alert, arousable, and able to communicate until very close to death. Others sleep for long intervals and awaken only intermittently, with eventual somnolence until death. Delirium refers to concurrent disturbances in level of consciousness, psychomotor behavior, memory, thinking, attention, and sleep–wake cycle (Breibart & Alici, 2008). In some patients, a period of agitated delirium precedes death, sometimes causing families to be hopeful that suddenly active patients may be getting better. Confusion may be related to underlying, treatable conditions such as medication side effects or interactions, pain or discomfort, hypoxia or dyspnea, or a full bladder or impacted stool. In patients with cancer, confusion may be secondary to brain metastases. Delirium may also be related to metabolic changes, infection, and organ failure.

Patients with delirium may become hypoactive or hyperactive, restless, irritable, and fearful. Sleep deprivation and hallucinations may occur. If treatment of the underlying factors contributing to these symptoms brings no relief, a combination of pharmacologic intervention with neuroleptics or benzodiazepines may be effective in decreasing distressing symptoms. Haloperidol (Haldol) may reduce hallucinations and agitation. Benzodiazepines (eg, lorazepam [Ativan]) can reduce anxiety but do not clear the sensorium and may contribute to worsening cognitive impairment if used alone.

Nursing interventions are aimed at identifying the underlying causes of delirium; acknowledging the family's distress over its occurrence; reassuring family members about what is normal; teaching family members how to interact with and ensure safety for the patient with delirium; and monitoring the effects of medications used to treat severe agitation, paranoia, and fear. Confusion may mask the patient's unmet spiritual needs and fears about dying. Spiritual intervention, music therapy, gentle massage, and therapeutic touch may provide some relief. Reduction of environmental stimuli, avoidance of harsh lighting or very dim lighting (which may produce disturbing shadows), presence of familiar faces, and gentle reorientation and reassurance are also helpful.

### Depression

Clinical depression should neither be accepted as an inevitable consequence of dying nor confused with sadness and anticipatory grieving, which are normal reactions to the losses associated with impending death. Emotional and spiritual support and control of disturbing physical symptoms are appropriate interventions for situational depression associated with terminal illness. Researchers have linked the psychological effects of cancer pain to suicidal thought and, less frequently, to carrying out a planned suicide (Maytal & Stern, 2006). Patients and their families must be given space and time to experience sadness and to grieve, but patients should not have to endure untreated depression at the end of their lives. An effective combined approach to clinical depression includes relief of physical symptoms, attention to emotional and spiritual distress, and pharmacologic intervention with psychostimulants, selective serotonin reuptake inhibitors, and tricyclic antidepressants (Lorenz, et al., 2008).

## Palliative Sedation at the End of Life

Effective control of symptoms can be achieved under most conditions, but some patients may experience distressing, intractable symptoms. Although **palliative sedation** remains controversial, it is offered in some settings to patients who are close to death or who have symptoms that do not respond to conventional pharmacologic and nonpharmacologic approaches, resulting in unrelieved suffering. Palliative sedation is distinguished from **euthanasia** and physician-assisted suicide in that the intent of palliative sedation is to relieve symptoms, not to hasten death. Palliative sedation is most commonly used when the patient exhibits intractable pain, dyspnea, seizures, or delirium, and it is generally considered appropriate in only the most difficult situations. Before implementing palliative sedation, the health care team should assess for the presence of underlying and treatable causes of suffering, such as depression or spiritual distress. Finally, the patient and family should be fully informed about the use of this treatment and alternatives.

Palliative sedation is accomplished through infusion of a benzodiazepine or barbiturate in doses adequate to induce sleep and eliminate signs of discomfort (De Graeff & Dean, 2007). Nurses act as collaborating members of the

interdisciplinary health care team, providing emotional support to patients and families, facilitating clarification of values and preferences, and providing comfort-focused physical care. Once sedation has been induced, the nurse should continue to comfort the patient, monitor the physiologic effects of the sedation, support the family during the final hours or days of their loved one's life, and ensure communication within the health care team and between the team and family.

## Nursing Care of Patients Who Are Close to Death

Providing care to patients who are close to death and being present at the time of death can be one of the most rewarding experiences a nurse can have. Patients and their families are understandably fearful of the unknown, and the approach of death may prompt new concerns or cause previous fears or issues to resurface. Family members who have always had difficulty communicating or who are part of families in which there are old resentments and hurts may experience heightened difficulty as their loved one nears death. However, the time at the end of life can also afford opportunities to resolve old hurts and learn new ways of being a family. Regardless of the setting, skilled practitioners can make dying patients comfortable, make space for their loved ones to remain present if they wish, and can give family members the opportunity to experience growth and healing. Likewise, patients and family members may be less apprehensive near the time of death if they know what to expect and how to respond.

### Expected Physiologic Changes

As death approaches and organ systems begin to fail, observable, expected changes in the body take place. Nursing care measures aimed at patient comfort, such as pain medications (administered rectally or sublingually), turning, mouth care, eye care, positioning to facilitate draining of secretions, and measures to protect the skin from urine or feces (if the patient is incontinent), should be continued. The nurse should consult with the physician about discontinuing measures that no longer contribute to patient comfort, such as drawing blood, administering tube feedings, suctioning (in most cases), and invasive monitoring. The nurse should prepare the family for the normal, expected changes that accompany the period immediately preceding death. Although the exact time of death cannot be predicted, it is often possible to identify when the patient is very close to death. Hospice programs frequently provide written information for families so they know what to expect and what to do as death nears (Chart 17-11).

If family members have been prepared for the time of death, they are less likely to panic and are better able to be with their loved ones in a meaningful way. Noisy, gurgling breathing or moaning is generally most distressing to family members. In most cases, the sounds of breathing at the end of life are related to oropharyngeal relaxation and diminished awareness. Family members may have difficulty believing that the patient is not in pain or that the patient's breathing could not be improved by suctioning secretions. Patient positioning and family reassurance are the most helpful responses to these symptoms.

When death is imminent, patients may become increasingly somnolent and unable to clear sputum or oral secretions, which may lead to further impairment of breathing from pooled or dried and crusted secretions. The sound (terminal bubbling) and appearance of the secretions are often more distressing to family members than is the presence of the secretions to the patient. Family distress over the changes in the patient's condition may be eased by supportive nursing care. Continuation of comfort-focused interventions and reassurance that the patient is not in any distress can do much to ease family concerns. Gentle mouth care with a moistened swab or very soft toothbrush helps maintain the integrity of the patient's mucous membranes. In addition, gentle oral suctioning, positioning to enhance drainage of secretions, and sublingual or transdermal administration of anticholinergic drugs (Table 17-3) reduce the production of secretions and provide comfort to the patient and support to the family. Deeper suctioning may cause significant discomfort to the dying patient and is rarely of any benefit because secretions reaccumulate rapidly.

### The Death Vigil

Although each death is unique, it is often possible for experienced clinicians to assess that the patient is "actively" or imminently dying and to prepare the family in the final days or hours leading to death. As death nears, the patient may withdraw, sleep for longer intervals, or become somnolent. Death is generally preceded by a period of gradual diminishment of bodily functions, increased intervals between respirations, a weakened and irregular pulse, diminished blood pressure, and skin color changes or mottling may occur. Family members should be encouraged to be with the patient, to speak and reassure the patient of their presence, to stroke or touch the patient, or to lie alongside the patient (even in the hospital or long-term care facility) if the family members are comfortable with this degree of closeness and can do so without causing discomfort to the patient.

The family may have gone to great lengths to ensure that their loved one will not die alone. However, despite the best intentions and efforts of the family and clinicians, the patient may die at a time when no one is present. In any setting, it is unrealistic for family members to be at the patient's bedside 24 hours a day. Experienced hospice clinicians have observed and reported that some patients appear to "wait" until family members are away from the bedside to die, perhaps to spare their loved ones the pain of being present at the time of death. Nurses can reassure family members throughout the death vigil by being present intermittently or continuously, modeling behaviors (such as touching and speaking to the patient), providing encouragement in relation to family care giving, providing reassurance about normal physiologic changes, and encouraging family rest breaks. If a patient dies while family members are away from the bedside, they may express feelings of guilt and profound grief and may need emotional support.

### After-Death Care

For patients who have received adequate management of symptoms and for families who have received adequate preparation and support, the actual time of death is

## Chart 17-11 • *Educating the Family: Signs of Approaching Death*

**The person shows less interest in eating and drinking.** For many patients, refusal of food is an indication that they are ready to die. Fluid intake may be limited to that which will keep their mouths from feeling too dry.

- What you can do: Offer, but do not force, fluids and medication. Sometimes pain or other symptoms that have required medication in the past may no longer be present. For most patients, pain medications are still needed, and they can be provided by concentrated oral solutions placed under the tongue or by rectal suppository.

**Urinary output may decrease in amount and frequency.**

- What you can do: No response is needed unless the patient expresses a desire to urinate and cannot. Call the hospice nurse for advice if you are not sure.

**As the body weakens, the patient will sleep more and begin to detach from the environment.** He or she may refuse your attempts to provide comfort.

- What you can do: Allow your loved one to sleep. You may wish to sit with him or her, play soft music, or hold hands. Your loved one's withdrawal is normal and is not a rejection of your love.

**Mental confusion may become apparent** because less oxygen is available to supply the brain. The patient may report strange dreams or visions.

- What you can do: As he or she awakens from sleep, remind him or her of the day and time, where he or she is, and who is present. This is best done in a casual, conversational way.

**Vision and hearing may become somewhat impaired, and speech may be difficult to understand.**

- What you can do: Speak clearly but no more loudly than necessary. Keep the room as light as the patient wishes, even at night. Carry on all conversations as if they can be heard, because hearing may be the last of the senses to cease functioning.
- Many patients are able to talk until minutes before death and are reassured by the exchange of a few words with a loved one.

**Secretions may collect in the back of the throat and rattle or gurgle as the patient breathes though the mouth.** He or she may try to cough, and his or her mouth may become dry and encrusted with secretions.

- What you can do: If the patient is trying to cough up secretions and is experiencing choking or vomiting, call the hospice nurse for assistance.
- Secretions may drain from the mouth if you place the patient on his or her side and provide support with pillows.
- Cleansing the mouth with moistened mouth swabs will help to relieve the dryness that occurs with mouth breathing.
- Offer water in small amounts to keep the mouth moist. A straw with one finger placed over the end can be used to transfer sips of water to the patient's mouth.

**Breathing may become irregular with periods of no breathing (apnea).** The patient may be working very hard to breathe and may make a moaning sound with each breath. As the time of death nears, the breathing remains irregular and may become more shallow and mechanical.

- What you can do: Raising the head of the bed may help the patient to breathe more easily. The moaning sound does not mean that the patient is in pain or other distress; it is the sound of air passing over very relaxed vocal cords.

**As the oxygen supply to the brain decreases, the patient may become restless.** It is not unusual to pull at the bed linens, to have visual hallucinations, or even to try to get out of bed at this point.

- What you can do: Reassure the patient in a calm voice that you are there. Prevent him or her from falling by trying to get out of bed. Soft music or a back rub may be soothing.

**The patient may feel hot one moment and cold the next as the body loses its ability to control temperature.** As circulation slows, the arms and legs may become cool and bluish. The underside of the body may darken. It may be difficult to feel a pulse at the wrist.

- What you can do: Provide and remove blankets as needed. Avoid using electric blankets, which may cause burns because the patient cannot tell you if he or she is too warm.
- Sponge the patient's head with a cool cloth if this provides comfort.

**Loss of bladder and bowel control may occur around the time of death.**

- What you can do: Protect the mattress with waterproof padding and change the padding as needed to keep the patient comfortable.

**As people approach death, many times they report seeing gardens, libraries, or family or friends who have died.** They may ask you to pack their bags and find tickets or a passport. Sometimes they may become insistent and attempt to do these chores themselves. They may try getting out of bed (even if they have been confined to bed for a long time) so that they can "leave."

- What you can do: Reassure the patient that it is all right; he or she can "go" without getting out of bed. Stay close, share stories, and be present.

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## Table 17-3 PHARMACOLOGIC MANAGEMENT OF EXCESS ORAL/RESPIRATORY SECRETIONS WHEN DEATH IS IMMINENT

| Medication | Dose |
|---|---|
| Atropine sulfate drops 1% | 1 or 2 drops 1% oral/sublingual q4–6h prn or around the clock (ATC) up to 12 drops/d |
| Atropine injection | 0.4–0.6 mg intravenous/subcutaneous/intramuscular q4–6h prn or ATC (if oral therapy is ineffective) |
| Glycopyrrolate (Robinul) | 1–2 mg oral/rectal/sublingual TID prn or ATC (maximum dose 6 mg/d) |
| Hyoscyamine (Levsin) | 0.125–0.25 mg oral/sublingual q4–6h prn or ATC (maximum dose 1.5 mg/d) |
| Scopolamine (Transderm Scop) | 1–3 patches q3d (maximum dose 3 patches every 72 h)* |

Note: There is no evidence that one agent is more effective than another; therefore, selection should be based on the agent's side-effect profile, onset of action, duration of action, and route of administration. Adverse effects include central nervous system changes (eg, irritability, disorientation, hallucination, delirium), cardiac changes (eg, tachycardia or bradycardia, dysrhythmias), blurred vision, urinary retention, constipation, dry mouth, flushing, and confusion.

*The patch may take up to 12 hours before an effect is observed; it may be of little benefit if initiated in a patient who is imminently dying.

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commonly peaceful and occurs without struggle. Nurses may or may not be present at the time of a patient's death. In many states, nurses are authorized to make the pronouncement of death and sign the death certificate when death is expected. The determination of death is made through a physical examination that includes auscultation for the absence of breathing and heart sounds. Home care or hospice programs in which nurses make the time-of-death visit and pronouncement of death have polices and procedures to guide the nurse's actions during this visit. Immediately on cessation of vital functions, the body begins to change. It becomes dusky or bluish, waxen-appearing, and cool; blood darkens and pools in dependent areas of the body (eg, the back and sacrum if the body is in a supine position); and urine and stool may be evacuated.

Immediately after death, family members should be allowed and encouraged to spend time with the deceased. Normal responses of family members at the time of death vary widely and range from quiet expressions of grief to overt expressions that include wailing and prostration. The family's desire for privacy during their time with the deceased should be honored. Family members may wish to independently manage or assist with care of the body after death. In the home, after-death care of the body frequently includes culturally specific rituals such as bathing the body. Home care agencies and hospices vary in the policies surrounding removal of tubes. In the absence of specific guidance from the organization, the nurse should shut off infusions of any kind (IV or tube feeding) and leave IV access devices, feeding tubes, catheters, and wound dressings in place. When an expected death occurs in the home setting, the family generally will have received assistance with funeral arrangements in advance of the death. The funeral director often transports the body directly to the funeral home. In the hospital or long-term care facility, nurses follow the facility's procedure for preparation of the body and transportation to the facility's morgue. However, the needs of families to remain with the deceased, to wait until other family members arrive before the body is moved, and to perform after-death rituals should be honored.

## Grief, Mourning, and Bereavement

A wide range of feelings and behaviors are normal, adaptive, and healthy reactions to the loss of a loved one. **Grief** refers to the personal feelings that accompany an anticipated or actual loss. **Mourning** refers to individual, family, group, and cultural expressions of grief and associated behaviors. **Bereavement** refers to the period of time during which mourning takes place. Both grief reactions and mourning behaviors change over time as people learn to live with the loss. Although the pain of the loss may be tempered by the passage of time, loss is an ongoing developmental process, and time does not heal the bereaved individual completely. That is, the bereaved do not get over a loss entirely, nor do they return to who they were before the loss. Rather, they develop a new sense of who they are and where they fit in a world that has changed dramatically and permanently.

### *Anticipatory Grief and Mourning*

Denial, sadness, anger, fear, and anxiety are normal grief reactions in people with life-threatening illness and those close to them. Kübler-Ross (1969) described five common emotional reactions to dying that are applicable to the experience of any loss (Table 17-4). Not every patient or family member

**Table 17-4 KÜBLER-ROSS'S FIVE STAGES OF DYING**

| Stage | Nursing Implications |
|---|---|
| **Denial:** "This cannot be true." Feelings of isolation. May search for another health care professional who will give a more favorable opinion. May seek unproven therapies. | Denial can be an adaptive response, providing a buffer after bad news. It allows time to mobilize defenses but can be maladaptive when it prevents the patient or family from seeking help or when denial behaviors cause more pain or distress than the illness or interfere with everyday functions. Nurses should assess the patient's and family's coping style, information needs, and understanding of the illness and treatment to establish a basis for empathetic listening, education, and emotional support. Rather than confronting the patient with information he or she is not ready to hear, the nurse can encourage him or her to share fears and concerns. Open-ended questions or statements such as "Tell me more about how you are coping with this new information about your illness" can provide a springboard for expression of concerns. |
| **Anger:** "Why me?" Feelings of rage, resentment or envy directed at God, health care professionals, family, others. | Anger can be very isolating, and loved ones or clinicians may withdraw. Nurses should allow the patient and family to express anger, treating them with understanding, respect, and knowledge that the root of the anger is grief over impending loss. |
| **Bargaining:** "I just want to see my grandchild's birth, then I'll be ready. . . ." Patient and/or family plead for more time to reach an important goal. Promises are sometimes made with God. | Terminally ill patients are sometimes able to outlive prognoses and achieve some future goal. Nurses should be patient, allow expression of feelings, and support realistic and positive hope. |
| **Depression:** "I just don't know how my kids are going to get along after I'm gone." Sadness, grief, mourning for impending losses. | Normal and adaptive response. Clinical depression should be assessed and treated when present. Nurses should encourage the patient and family to fully express their sadness. Insincere reassurance or encouragement of unrealistic hopes should be avoided. |
| **Acceptance:** "I've lived a good life, and I have no regrets." Patient and/or family are neither angry nor depressed. | The patient may withdraw as his or her circle of interest diminishes. The family may feel rejected by the patient. Nurses need to support the family's expression of emotions and encourage them to continue to be present for the patient. |

experiences every stage; many patients never reach a stage of acceptance, and patients and families fluctuate on a sometimes daily basis in their emotional responses. Furthermore, although impending loss stresses the patient, people who are close to him or her, and the functioning of the family unit, awareness of dying also provides a unique opportunity for family members to reminisce, resolve relationships, plan for the future, and say goodbye.

Individual and family coping with the anticipation of death is complicated by the varied and conflicting trajectories that grief and mourning may assume in families. For example, the patient may be experiencing sadness while contemplating role changes that have been brought about by the illness and the patient's spouse or partner may be expressing or suppressing feelings of anger about the current changes in role and impending loss of the relationship. Others in the family may be engaged in denial (eg, "Dad will get better; he just needs to eat more"), fear ("Who will take care of us?" or "Will I get sick too?"), or profound sadness and withdrawal. Although each of these behaviors is normal, tension may arise when one or more family members perceive that others are less caring, too emotional, or too detached.

The nurse should assess the characteristics of the family system and intervene in a manner that supports and enhances the cohesion of the family unit. Parameters for assessing the family facing life-threatening illness are identified in Chart 17-12. The nurse can suggest that family members talk about their feelings and understand them in the broader context of anticipatory grief and mourning. Acknowledging and expressing feelings, continuing to interact with the patient in meaningful ways, and planning for the time of death and bereavement are adaptive family behaviors. Professional support provided by grief counselors, whether in the community, at a local hospital, in the long-term care facility, or associated with a hospice program, can help both the patient and the family sort out and acknowledge feelings and make the end of life as meaningful as possible.

CHART 17-12

### Assessing for Anticipatory Mourning in the Family Facing Life-Threatening Illness

**Family Constellation**

- Identify the members who constitute the patient's family. Who is important to the patient?
- Identify roles and relationships among the family members.
  - Who is the primary caregiver?
  - By what authority is this person the primary caregiver?

**Cohesion and Boundaries**

- How autonomous/interdependent are family members?
  - Degree of involvement with each other as individuals and as a family
  - Degree of bonding between family members
  - Degree of "teamwork" in the family
  - Degree of reliance on individual family members for specific tasks/roles
- How do family members differ in
  - Personality?
  - Worldview?
  - Priorities?
- What are the implicit and explicit expectations or "rules" for behavior within the family?

**Flexibility and Adaptability**

- What is the family's ability to integrate new information?
- How does the family manage change?
- How able are the family members to assume new roles and responsibilities?

**Communication**

- What is the style of communication in the family, in terms of
  - Openness?
  - Directness?
  - Clarity?
- What are the constraints on communication?
- What topics are avoided?

### Grief and Mourning After Death

When a loved one dies, the family members enter a new phase of grief and mourning as they begin to accept the loss, feel the pain of permanent separation, and prepare to live a life without the deceased. Even if the loved one died after a long illness, preparatory grief experienced during the terminal illness does not preclude the grief and mourning that follow the death. With a death after a long or difficult illness, family members may experience conflicting feelings of relief that the loved one's suffering has ended, compounded by guilt and grief related to unresolved issues or the circumstances of death. Grief work may be especially difficult if a patient's death was painful, prolonged, accompanied by unwanted interventions, or unattended. Families who had no preparation or support during the period of imminence and death may have a more difficult time finding a place for the painful memories.

Although some family members may experience prolonged or complicated mourning, most grief reactions fall within a "normal" range. The feelings are often profound, but bereaved people eventually reconcile the loss and find a way to reengage with their lives. Grief and mourning are affected by several factors, including individual characteristics, coping skills, and experiences with illness and death; the nature of the relationship to the deceased; factors surrounding the illness and the death; family dynamics; social support; and cultural expectations and norms. Uncomplicated grief and mourning are characterized by emotional feelings of sadness, anger, guilt, and numbness; physical sensations such as hollowness in the stomach and tightness in the chest, weakness, and lack of energy; cognitions that include preoccupation with the loss and a sense of the deceased as still present; and behaviors such as crying, visiting places that are reminders of the deceased, social withdrawal, and restless overactivity (Zhang, El-Jawahri & Prigerson, 2006).

After-death rituals, including preparation of the body, funeral practices, and burial rituals, are socially and culturally significant ways in which family members begin to accept

the reality and finality of death. Preplanning of funerals is becoming increasingly common, and hospice professionals in particular help the family make plans for death, often involving the patient, who may wish to play an active role. Preplanning of the funeral relieves the family of the burden of making decisions in the intensely emotional period after a death.

In general, the period of mourning is an adaptive response to loss during which mourners come to accept the loss as real and permanent, acknowledge and experience the painful emotions that accompany the loss, experience life without the deceased, overcome impediments to adjustment, and find a new way of living in a world without the loved one. Particularly immediately after the death, mourners begin to recognize the reality and permanence of the loss by talking about the deceased and telling and retelling the story of the illness and death. Societal norms in the United States are frequently at odds with the normal grieving processes of people; time excused from work obligations is typically measured in days, and mourners are often expected to get over the loss quickly and get on with life.

In reality, the work of grief and mourning takes time, and avoiding grief work after the death often leads to long-term adjustment difficulties. According to Rando (2000), mourning for a loss involves the "undoing" of psychosocial ties that bind mourners to the deceased, personal adaptation to the loss, and learning to live in the world without the deceased. Six key processes of mourning allow people to accommodate to the loss in a healthy way:

1. Recognition of the loss
2. Reaction to the separation, and experiencing and expressing the pain of the loss
3. Recollection and reexperiencing the deceased, the relationship, and the associated feelings
4. Relinquishing old attachments to the deceased
5. Readjustment to adapt to the new world without forgetting the old
6. Reinvestment (Rando, 2000)

Although many people complete the work of mourning with the informal support of families and friends, many find that talking with others who have had a similar experience, such as in formal support groups, normalizes the feelings and experiences and provides a framework for learning new skills to cope with the loss and create a new life. Hospitals, hospices, religious organizations, and other community organizations often sponsor bereavement support groups. Groups for parents who have lost a child, children who have lost a parent, widows, widowers, and gay men and lesbians who have lost a life partner are some examples of specialized support groups available in many communities. Nursing interventions for those experiencing grief and mourning are identified in Chart 17-13.

### Complicated Grief and Mourning

Complicated grief and mourning are characterized by prolonged feelings of sadness and feelings of general worthlessness or hopelessness that persist long after the death, prolonged symptoms that interfere with activities of daily living (anorexia, insomnia, fatigue, panic), or self-destructive behaviors such as alcohol or substance abuse and suicidal ideation or attempts. Complicated grief and mourning require professional assessment and can be treated with psychological interventions, and in some cases, with medications.

**Chart 17-13 • *Nursing Interventions for Grief and Mourning***

**Support the Expression of Feelings**

- Encourage the telling of the story using open-ended statements or questions (eg, "Tell me about your husband").
- Assist the mourner to find an outlet for his or her feelings: talking, attending a support group, keeping a journal, finding a safe outlet for angry feelings (writing letters that will not be mailed, physical activity).
- Assess emotional affect and reinforce the normalcy of feelings.
- Assess for guilt and regrets.
  - Are you especially troubled by a certain memory or thought?
  - How do you manage those memories?

**Assess for the Presence of Social Support**

- Do you have someone to whom you can talk about your husband?
- May I help you to find someone you can talk to?

**Assess Coping Skills**

- How are you managing day to day?
- Have you experienced other losses? How did you manage those?
- Are there things you are having trouble doing?
- Do you have/need help with specific tasks?

**Assess for Signs of Complicated Grief and Mourning and Offer Professional Referral**

## Coping With Death and Dying: Professional Caregiver Issues

Whether practicing in a trauma center, ICU or other acute care setting, home care, hospice, long-term care, or the many locations where patients and their families receive ambulatory services, the nurse is closely involved with complex and emotionally laden issues surrounding loss of life. To be most effective and satisfied with the care he or she provides, the nurse should attend to his or her own emotional responses to the losses witnessed every day. Well before the nurse exhibits symptoms of stress or burnout, he or she should acknowledge the difficulty of coping with others' pain on a daily basis and put healthy practices in place that guard against emotional exhaustion. In hospice settings, where death, grief, and loss are expected outcomes of patient care, interdisciplinary colleagues rely on one another for support, using meeting time to express frustration, sadness, anger, and other emotions; to learn coping skills from one another; and to speak about how they were affected by the lives of those patients who have died since the last meeting. In many settings, staff members organize or attend memorial services to support families and other caregivers,

who find comfort in joining one another to remember and celebrate the lives of patients. Finally, healthy personal habits, including diet, exercise, stress reduction activities (eg, dance, yoga, tai chi, meditation), and sleep, help guard against the detrimental effects of stress.

## CRITICAL THINKING EXERCISES

EBP **1** You are making follow-up telephone calls to the primary caregivers (family members) for all the patients who have died in the past 3 months in the hospital unit where you are a primary nurse. What questions could you ask to screen for complicated grief and bereavement? What activities or strategies would you consider to help families deal with their loss (before and after the death)? What is the evidence base for your selection of those activities and strategies? What resources are available in the community? What bereavement services are indicated for the staff? What would you suggest to a staff member who continues to have problems in coping with death of her patients?

**2** You are caring for a 68-year-old man with end-stage heart failure in a hospital-based palliative care unit. You observe that he has peripheral edema and cachexia. He reports dyspnea at rest, profound fatigue, and activity intolerance. He tells you that he would like to return home, but his wife becomes very anxious when he has pain or shortness of breath, causing him to become anxious as well. What additional assessments would you conduct? What strategies would you implement to (1) relieve the patient's symptoms and discomfort, (2) prepare his wife to manage his care at home, and (3) initiate conversations to prepare both of them for his inevitable death?

EBP **3** A 33-year-old married mother of two young children has been referred for hospice care. She has advanced breast cancer with metastases to the bone, liver, and lung. During your initial visit to the patient's home, you assess that she is experiencing severe pain in her ribs and pelvis (she reports a score of 8 on a 0 to 10 pain intensity scale). In addition, she reports that she has no appetite. Her physician has prescribed morphine for her pain, but you assess that she has used very few doses of the morphine. Her husband tells you privately that he has discouraged her use of the medicine because it has made her very sleepy and nauseated in the past, and he believes this is the reason for her poor appetite. The interdisciplinary team is meeting to discuss the patient's treatment plan. What additional assessment data are needed to determine the wishes and expectations of the patient as well as the husband? What factors might be contributing to her anorexia? What interventions, both pharmacologic and nonpharmacologic, would you consider? What is the evidence base for each selection?

**4** You have been assigned to make a home visit to an 87-year-old widow who has end-stage COPD. She lives in an assisted living facility. The staff has made a referral for inpatient palliative care because the patient can no longer perform her activities of daily living (ADLs) in her apartment without assistance. She has no family living nearby; her son lives about 1 hour away and he visits her once a month. During your assessment visit, she tearfully states, "I don't know why I am still here. I want God to take me before I become a complete burden." Discuss how you would carry out additional assessment and the recommendations that you might make based on findings from your assessment. Give examples of questions you would ask to further assess the patient. What types of palliative care services may be helpful for this case. Why?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Academy of Hospice and Palliative Medicine, www.aahpm.org

Americans for Better Care of the Dying (ABCD), www.abcd-caring.org

Association for Death Education and Counseling (ADEC), www.adec.org

American Hospice Foundation, www.americanhospice.org

Caring Connections, a program of the National Hospice and Palliative Care Organization, www.caringinfo.org

Center to Advance Palliative Care, www.capc.org

Children's Hospice International, www.chionline.org

Compassion and Choices, www.compassionandchoices.org

Department of Pain Medicine and Palliative Care Phillips Ambulatory Care Center, www.stoppain.org

EDELE: A resource for data on death and dying, www.edeledata.org

End-of-Life Nursing Education Consortium, www.aacn.nche.edu/ELNEC

EPERC: End of Life/Palliative Education Resource Center, www.eperc.mcw.edu

Family Caregiver Alliance, www.caregiver.org

Growthhouse, Inc., provides information and referral services for agencies working with death and dying issues, www.growthhouse.org

HMS Center for Palliative Care (Harvard Medical School), Dana Farber Cancer Institute, www.hms.harvard.edu/cdi/pallcare

Hospice and Palliative Nurses Association (HPNA), www.hpna.org

Hospice Association of America, National Association for Home Care, www.nahc.org/haa

Hospice Education Institute, www.hospiceworld.org

Hospice Foundation of America, www.hospicefoundation.org

Hospice Net, provides information and support to patients and families facing life-threatening illnesses, www.hospicenet.org

National Consensus Project for Quality Palliative Care (national guidelines), www.nationalconsensusproject.org

National Hospice and Palliative Care Organization, National Hospice Foundation, www.nhpco.org

National Palliative Care Research Center, Brookdale Department of Geriatrics and Adult Development, www.npcrc.org

National Prison Hospice Association, www.npha.org

Palliative Care Nursing, www.palliativecarenursing.net

Population-based Palliative Care Research Network, www.uchsc.edu/popcrn

Promoting Excellence in End-of-Life Care, www.promotingexcellence.org

Supportive Care of the Dying: A Coalition for Compassionate Care; Providence Health and Services, www.careofdying.org

unit 4

# Perioperative Concepts and Nursing Management

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient Recovering From Abdominal Surgery



**Mr. Dickson**, a 60-year-old smoker, was admitted to the surgical unit 5 hours ago after colon resection for cancer. He is groggy but easily arousable. He can move all extremities with equal strength, but feels better lying still. In the last 4 hours, 125 mL of greenish material has drained from his nasogastric tube, which is connected to low intermittent suction. His abdomen is mildly distended; bowel sounds are absent. The large abdominal dressing has a reconstitutable bulb drain with 30 mL of serosanguineous drainage; the dressing's minimal visible drainage has not increased in several hours. A peripheral IV of D5W 12NS with 20 mEq of KCl is infusing at 125 mL/h. Mr. Dickson has voided 600 mL of clear urine. Vital signs are: Temp 97°F; HR 82, B/P 112/70; Resp 12 and shallow. Lung auscultation reveals scattered crackles throughout and a weak cough. After a 50-mg morphine injection, Mr. Dickson rates his pain at 3 (down from 7). He is reluctant to use his incentive spirometer for fear of more pain.

Visit the Point to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **RISK FOR IMPAIRED GAS EXCHANGE**—At risk for excess or deficit in oxygenation and/or carbon dioxide elimination at the alveolar-capillary membrane | **RESPIRATORY MONITORING**—Collection and analysis of patient data to ensure airway patency and adequate gas exchange | **ANXIETY CONTROL**— Personal actions to eliminate or reduce feelings of apprehension and tension from an unidentifiable source |
| **RISK FOR INEFFECTIVE AIRWAY CLEARANCE**— At risk for inability to clear secretions or obstructions from the respiratory tract to maintain a clear airway | **COUGH ENHANCEMENT**—Promotion of deep inhalation by the patient with subsequent generation of high intrathoracic pressures and compression of underlying lung parenchyma for the forceful expulsion of air | **RESPIRATORY STATUS: GAS EXCHANGE**— The alveolar exchange of $O_2$ and $CO_2$ to maintain arterial blood gas concentrations |
| **ACUTE PAIN**— Unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage | **PAIN MANAGEMENT**— Alleviation of pain or reduction in pain to a level of comfort that is acceptable to the patient | **PAIN LEVEL**— Severity of observed or reported pain |
| **IMPAIRED PHYSICAL MOBILITY**—Limitation in independent, purposeful physical movement of the body or of one or more extremities | **TEACHING: PRESCRIBED ACTIVITY/EXERCISE**— Preparing a patient to achieve and/or maintain a prescribed level of activity | **MOBILITY**— Ability to move purposefully in own environment independently with or without assistive device |


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chapter 18

# Preoperative Nursing Management

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Define the three phases of perioperative patient care.

**2** Describe a comprehensive preoperative assessment to identify surgical risk factors.

**3** Identify health factors that affect patients preoperatively.

**4** Identify legal and ethical considerations related to obtaining informed consent for surgery.

**5** Describe preoperative nursing measures that decrease the risk for infection and other postoperative complications.

**6** Describe the immediate preoperative preparation of the patient.

**7** Develop a preoperative teaching plan designed to promote the patient's recovery from anesthesia and surgery, thus preventing postoperative complications.

## GLOSSARY

**ambulatory surgery:** includes outpatient, same-day, or short-stay surgery that does not require an overnight hospital stay

**informed consent:** the patient's autonomous decision about whether to undergo a surgical procedure, based on the nature of the condition, the treatment options, and the risks and benefits involved

**intraoperative phase:** period of time that begins with transfer of the patient to the operating room table and continues until the patient is admitted to the postanesthesia care unit

**perioperative phase:** period of time that constitutes the surgical experience; includes the preoperative, intraoperative, and postoperative phases of nursing care

**postoperative phase:** period of time that begins with the admission of the patient to the postanesthesia care unit and ends after follow-up evaluation in the clinical setting or home

**preadmission testing:** diagnostic testing performed before admission to the hospital

**preoperative phase:** period of time from when the decision for surgical intervention is made to when the patient is transferred to the operating room table

Surgery, whether elective or emergent, is a stressful, complex event. In the past decades, the patient scheduled for elective surgery was admitted to the hospital at least 1 day before surgery for evaluation and preparation. Today, as a result of advances in technology, surgical techniques and instrumentation, and anesthesia, many surgical procedures take place in outpatient or ambulatory settings in which the patient returns home after recovering from the anesthesia in the postanesthesia care unit (PACU). Often, surgical patients who require hospital stays are trauma patients, acutely ill patients, patients undergoing major surgery, patients who require emergency surgery, and patients with concurrent medical disorders. As a result, the acuity and complexity of surgical patients and procedures have increased in the inpatient setting. Although each setting (ambulatory, outpatient, or inpatient) offers its own unique advantages for the delivery of patient care, all patients require a comprehensive preoperative nursing assessment and nursing interventions to prepare for surgery.

## Perioperative Nursing

The field of perioperative and perianesthesia nursing includes a wide variety of nursing functions. The **perioperative period** consists of three phases that begin and end at a particular point in the sequence of events in the surgical experience. The **preoperative phase** begins when the decision to proceed with surgical intervention is made and ends with the transfer of the patient onto the operating room (OR) table. The **intraoperative phase** begins when the patient is transferred onto the OR table and ends with admission to the PACU. Nursing duties involve acting as scrub nurse, circulating nurse, or registered nurse first assistant (RNFA) (see Chapter 19 for a description of these roles). The **postoperative phase** begins with the admission of the patient to the PACU and ends with a follow-up evaluation in the clinical setting or home (see Chapter 20).

Each perioperative phase includes a wide range of activities the nurse performs using the nursing process and based on the standards of practice of the American Society of PeriAnesthesia Nurses (2007). Chart 18-1 presents nursing activities characteristic of the three perioperative phases of care. Each phase of the surgical experience is reviewed in more detail in this chapter and in the other chapters in this unit.

A conceptual model of patient care, published by the Association of PeriOperative Registered Nurses, formerly known as the Association of Operating Room Nurses (still abbreviated AORN), helps delineate the relationships between various components of nursing practice and patient outcomes. The Perioperative Nursing Data Set (PNDS) categorizes the practice of perioperative nursing practice into four domains: safety, physiologic responses, behavioral responses, and health care systems. The first three domains reflect phenomena of concern to perioperative nurses and are composed of nursing diagnoses, interventions, and outcomes. The fourth domain, the health care system, consists of structural data elements and focuses on clinical processes and outcomes. The model is used to depict the relationship of nursing process components to the achievement of optimal patient outcomes (Phillips, 2007).

## Advances in Technology and Anesthesia

Advances in technology have led to more complex procedures, more complicated microsurgical and laser technology, more sophisticated bypass equipment, increased use of laparoscopic and minimally invasive surgery, and more sensitive monitoring devices. Surgery today can involve the transplantation of multiple human organs, the implantation of mechanical devices, the reattachment of body parts, and the use of robots and minimally invasive procedures in the OR.

Advances in anesthesia have kept pace with these surgical technologies. More sophisticated monitoring and new pharmacologic agents, such as short-acting anesthetics and more effective antiemetics, have improved postoperative pain management, reduced postoperative nausea and vomiting, and shortened procedure and recovery times.

## Surgical Classifications

Surgery may be performed for various reasons. A surgical procedure may be diagnostic (eg, biopsy, exploratory laparotomy), curative (eg, excision of a tumor or an inflamed appendix), or reparative (eg, multiple wound repair). It may be reconstructive or cosmetic (eg, mammoplasty or a facelift) or palliative (eg, to relieve pain or correct a problem—for instance, a gastrostomy tube may be inserted to compensate for the inability to swallow food). Surgery may also be classified according to the degree of urgency involved: emergent, urgent, required, elective, and optional (Table 18-1).

## Preadmission Testing

Concurrent with the increase in ambulatory surgeries have been changes in the delivery of and payment for health care. The pressure to reduce hospital stays and contain costs has resulted in diagnostic **preadmission testing** (PAT) and preoperative preparation prior to admission. Many facilities have a presurgical services department to facilitate PAT and to initiate the nursing assessment process, which focuses on admission data such as patient demographics, health history, and other information pertinent to the surgical procedure (ie, appropriate consent forms, diagnostic and laboratory tests) (Rothrock, 2007). The increasing use of ambulatory, same-day, or short-stay surgery means that patients leave the hospital sooner, which increases the need for teaching, discharge planning, preparation for self-care, and referral for home care and rehabilitation services.

## Special Considerations During the Perioperative Period

### Gerontologic Considerations

The hazards of surgery for the elderly are proportional to the number and severity of coexisting health problems and the nature and duration of the operative procedure. The

## Chart 18-1 • *Examples of Nursing Activities in the Perioperative Phases of Care*

### Preoperative Phase

**Preadmission Testing (PAT)**

1. Initiates initial preoperative assessment
2. Initiates teaching appropriate to patient's needs
3. Involves family in interview
4. Verifies completion of preoperative diagnostic testing.
5. Verifies understanding of surgeon-specific preoperative orders (eg, bowel preparation, preoperative shower)
6. Discusses and reviews advanced directive document
7. Begins discharge planning by assessing patient's need for postoperative transportation and care

**Admission to Surgical Center**

1. Completes preoperative assessment
2. Assesses for risks for postoperative complications
3. Reports unexpected findings or any deviations from normal
4. Verifies that operative consent has been signed
5. Coordinates patient teaching and plan of care with nursing staff and other health team members
6. Reinforces previous teaching
7. Explains phases in perioperative period and expectations
8. Answers patient's and family's questions

**In the Holding Area**

1. Assesses patient's status, baseline pain, and nutritional status
2. Reviews chart
3. Identifies patient
4. Verifies surgical site and marks site per institutional policy
5. Establishes intravenous line
6. Administers medications if prescribed
7. Takes measures to ensure patient's comfort
8. Provides psychological support
9. Communicates patient's emotional status to other appropriate members of the health care team

### Intraoperative Phase

**Maintenance of Safety**

1. Maintains aseptic, controlled environment
2. Effectively manages human resources, equipment, and supplies for individualized patient care
3. Transfers patient to operating room bed or table
4. Positions patient based on functional alignment and exposure of surgical site
5. Applies grounding device to patient
6. Ensures that the sponge, needle, and instrument counts are correct
7. Completes intraoperative documentation

**Physiologic Monitoring**

1. Calculates effects on patient of excessive fluid loss or gain
2. Distinguishes normal from abnormal cardiopulmonary data
3. Reports changes in patient's vital signs
4. Institutes measures to promote normothermia

**Psychological Support (Before Induction and When Patient Is Conscious)**

1. Provides emotional support to patient
2. Stands near or touches patient during procedures and induction
3. Continues to assess patient's emotional status

### Postoperative Phase

**Transfer of Patient to Postanesthesia Care Unit**

1. Communicates intraoperative information
   a. Identifies patient by name
   b. States type of surgery performed
   c. Identifies type and amounts of anesthetic and analgesic agents used
   d. Reports patient's vital signs and response to surgical procedure and anesthesia
   e. Describes intraoperative factors (eg, insertion of drains or catheters, administration of blood, medications during surgery, or occurrence of unexpected events)
   f. Describes physical limitations
   g. Reports patient's preoperative level of consciousness
   h. Communicates necessary equipment needs
   i. Communicates presence of family or significant others

**Postoperative Assessment Recovery Area**

1. Determines patient's immediate response to surgical intervention
2. Monitors patient's vital signs and physiologic status
3. Assesses patient's pain level and administers appropriate pain relief measures
4. Maintains patient's safety (airway, circulation, prevention of injury)
5. Administers medications, fluid, and blood component therapy, if prescribed
6. Provides oral fluids if prescribed for ambulatory surgery patient
7. Assesses patient's readiness for transfer to in-hospital unit or for discharge home based on institutional policy (eg, Alderete score, see Chapter 20)

**Surgical Nursing Unit**

1. Continues close monitoring of patient's physical and psychological response to surgical intervention
2. Assesses patient's pain level and administers appropriate pain relief measures
3. Provides teaching to patient during immediate recovery period
4. Assists patient in recovery and preparation for discharge home
5. Determines patient's psychological status
6. Assists with discharge planning

**Home or Clinic**

1. Provides follow-up care during office or clinic visit or by telephone contact
2. Reinforces previous teaching and answers patient's and family's questions about surgery and follow-up care
3. Assesses patient's response to surgery and anesthesia and their effects on body image and function
4. Determines family's perception of surgery and its outcome

underlying principle that guides the preoperative assessment, surgical care, and postoperative care is that elderly patients have less physiologic reserve (the ability of an organ to return to normal after a disturbance in its equilibrium) than younger patients. Respiratory and cardiac complications are the leading causes of postoperative morbidity and mortality in older adults (Stanley, Blair & Beare, 2005). Cardiac reserves are lower, renal and hepatic functions are depressed, and gastrointestinal activity is likely to be reduced. Dehydration, constipation, and malnutrition may

**Table 18-1 CATEGORIES OF SURGERY BASED ON URGENCY**

| Classification | Indications for Surgery | Examples |
|---|---|---|
| I. Emergent—Patient requires immediate attention; disorder may be life-threatening | Without delay | Severe bleeding<br>Bladder or intestinal obstruction<br>Fractured skull<br>Gunshot or stab wounds<br>Extensive burns |
| II. Urgent—Patient requires prompt attention | Within 24–30 hours | Acute gallbladder infection<br>Kidney or ureteral stones |
| III. Required—Patient needs to have surgery | Plan within a few weeks or months | Prostatic hyperplasia without bladder obstruction<br>Thyroid disorders<br>Cataracts |
| IV. Elective—Patient should have surgery | Failure to have surgery not catastrophic | Repair of scars<br>Simple hernia<br>Vaginal repair |
| V. Optional—Decision rests with patient | Personal preference | Cosmetic surgery |

occur. Sensory limitations, such as impaired vision or hearing and reduced tactile sensitivity, are often the reasons for falls (Meiner & Lueckenolte, 2006). Therefore, the nurse must be alert to maintaining a safe environment. Arthritis is common in older people and may affect mobility, making it difficult for the patient to turn from one side to the other or ambulate without discomfort. Protective measures include adequate padding for tender areas, moving the patient slowly, protecting bony prominences from prolonged pressure, and providing gentle massage to promote circulation.

As the body ages, its ability to perspire decreases. Because decreased perspiration leads to dry, itchy skin that becomes fragile and is easily abraded, precautions are taken when moving an elderly person. Decreased subcutaneous fat makes older people more susceptible to temperature changes. A lightweight cotton blanket is an appropriate cover when an elderly patient is moved to and from the OR.

Because the elderly patient may have greater risks during the perioperative period, the following factors are critical: (1) skillful preoperative assessment and treatment (Kazmierski, Kowman, Banach, et al., 2006), (2) skillful anesthesia and surgery, and (3) meticulous and competent postoperative and postanesthesia management. In addition, the nurse should incorporate pain management information and pain communication skills when teaching the elderly patient how to obtain greater postoperative pain relief (see Providing Patient Teaching).

## Patients Who Are Obese

Like age, obesity increases the risk and severity of complications associated with surgery. During surgery, fatty tissues are especially susceptible to infection. In addition, obesity increases technical and mechanical problems related to surgery. Therefore, dehiscence (wound separation) and wound infections are more common. Moreover, the obese patient may be more difficult to care for because of the excessive weight. It has been estimated that for each 30 pounds of excess weight, about 25 additional miles of blood vessels are needed, and this places increased demands on the heart. The patient tends to have shallow respirations when supine, which increases the risk of hypoventilation and postoperative pulmonary complications. Short thick necks, large tongues, and redundant pharyngeal tissue, along with an increased demand for oxygen and decreased reserves, can make intubation difficult (Marley, Hoyle & Ries, 2005). The anesthesiologist or anesthetist also assesses for obstructive sleep apnea that is often diagnosed and treated with continuous positive airway pressure (CPAP) preoperatively. The use of CPAP should continue throughout the perioperative period, especially when sleep is likely, for example, in the recovery room or at night (McGlinch, Que, Nelson, et al., 2006). As the incidence of obesity continues to grow, nurses will be called on to be part of multidisciplinary teams that will develop and implement clinical plans for patients who are obese.

## Patients With Disabilities

Special considerations for patients with mental or physical disabilities include the need for appropriate assistive devices, modifications in preoperative teaching, and additional assistance with and attention to positioning or transferring. Assistive devices include hearing aids, eyeglasses, braces, prostheses, and other devices. People who are hearing-impaired may need a sign interpreter or some alternative communication system perioperatively. If the patient relies on signing or speech (lip) reading and his or her eyeglasses or contact lenses are removed or the health care staff wears surgical masks, an alternative method of communication will be needed. These needs must be identified in the preoperative evaluation and clearly communicated to personnel. Specific strategies for accommodating the patient's needs must be identified in advance. Ensuring the security of assistive devices is important, because these devices are expensive and are likely to be lost.

Most patients are directed to move from the stretcher to the OR table and back again. In addition to being unable to see or hear instructions, the patient with a disability may be unable to move without special devices or a great deal of assistance. The patient with a disability that affects body position (eg, cerebral palsy, postpolio syndrome, and other neuromuscular disorders) may need special positioning during surgery to prevent pain and injury. Moreover, these patients may be unable to sense whether their extremities are positioned incorrectly.

Patients with respiratory problems related to a disability (eg, multiple sclerosis, muscular dystrophy) may experience difficulties unless the problems are made known to the anesthesiologist or anesthetist and adjustments are made. These

factors need to be clearly identified in the preoperative period and communicated to the appropriate personnel.

### Patients Undergoing Ambulatory Surgery

**Ambulatory surgery** includes outpatient, same-day, or short-stay surgery that does not require an overnight hospital stay but may entail an admission to an inpatient hospital setting for less than 24 hours. During the brief time the patient and family spend in the ambulatory setting, the nurse must quickly and comprehensively assess and anticipate the patient's needs and at the same time begin planning for discharge and follow-up home care.

The nurse needs to be sure that the patient and family understand that the patient will first go to the preoperative holding area before going to the OR for the surgical procedure and then will spend some time in the PACU before being discharged home with the family later that day. Other preoperative teaching content should also be verified and reinforced as needed (see later discussion). The nurse should ensure that any plans for follow-up home care are in place if needed.

### Patients Undergoing Emergency Surgery

Emergency surgeries are unplanned and occur with little time for preparation for the patient or the perioperative team. See Chapter 19 for the duties of the members of the perioperative team. The unpredictable nature of trauma and emergency surgery poses unique challenges to the nurse throughout the perioperative period. It is important for the nurse to communicate with the patient and team members as calmly and effectively as possible in these situations.

Factors that affect patients preparing to undergo surgery also apply to patients undergoing emergency surgery, but usually in a very condensed time frame. The only opportunity for preoperative assessment may take place at the same time as resuscitation in the emergency department. For the unconscious patient, informed consent and essential information, such as pertinent past medical history and allergies, need to be obtained from a family member, if one is available. A quick visual survey of the patient is essential to identify all sites of injury if the emergency surgery is due to trauma (see Chapter 71 for more information). The patient, who may have undergone a traumatic experience, may need extra support and explanation of the surgery.

## Informed Consent

**Informed consent** is the patient's autonomous decision about whether to undergo a surgical procedure. Voluntary and written informed consent from the patient is necessary before nonemergent surgery can be performed in order to protect the patient from unsanctioned surgery and protect the surgeon from claims of an unauthorized operation. Consent is a legal mandate, but it also helps the patient to prepare psychologically, because it helps to ensure that the patient understands the surgery to be performed (Rothrock, 2007).

While the nurse may ask the patient to sign the consent form and witness the signature, it is the surgeon's responsibility to provide a clear and simple explanation of what the surgery will entail prior to the patient giving consent. The surgeon must also inform the patient of the benefits, alternatives, possible risks, complications, disfigurement, disability, and removal of body parts as well as what to expect in the early and late postoperative periods. The nurse clarifies the information provided and if the patient requests additional information, the nurse notifies the physician. The nurse ascertains that the consent form has been signed before administering psychoactive premedication, because consent is not valid if it is obtained while the patient is under the influence of medications that can affect judgment and decision-making capacity.

*NURSING ALERT*

**The signed consent form is placed in a prominent place on the patient's chart and accompanies the patient to the OR.**

Many ethical principles are integral to informed consent (see Chapter 3). Informed consent is necessary in the following circumstances:

- Invasive procedures, such as a surgical incision, a biopsy, a cystoscopy, or paracentesis
- Procedures requiring sedation and/or anesthesia (see Chapter 19 for a discussion of anesthesia)
- A nonsurgical procedure, such as an arteriography, that carries more than a slight risk to the patient
- Procedures involving radiation

The patient personally signs the consent if of legal age and mentally capable. Permission is otherwise obtained from a surrogate, who most often is a responsible family member (preferably next of kin) or legal guardian. See Chart 18-2 for criteria for valid informed consent. State regulations and agency policy must be followed. In an emergency, it may be necessary for the surgeon to operate as a lifesaving measure without the patient's informed consent. However, every effort must be made to contact the patient's family. In such a situation, contact can be made by telephone, fax, or other electronic means.

If the patient has doubts and has not had the opportunity to investigate alternative treatments, a second opinion may be requested. No patient should be urged or coerced to give informed consent. Refusing to undergo a surgical procedure is a person's legal right and privilege. However, such information must be documented and relayed to the surgeon so that other arrangements can be made. For example, additional explanations may be provided to the patient and family, or the surgery may be rescheduled. Consents for specific procedures such as sterilization, therapeutic abortion, disposal of severed body parts, organ donation, and blood product administration provide additional protection for the patient (Rothrock, 2007).

The consent process can be improved by providing audiovisual materials to supplement discussion, by ensuring that the wording of the consent form is understandable, and by using other strategies and resources as needed to help the patient understand its content (see Chart 18-2) (Sallady, 2005).

## Preoperative Assessment

The goal in the preoperative period is for the patient to be as healthy as possible. Every attempt is made to address risk factors that otherwise lead to postoperative complications

## Chart 18-2 • *Valid Informed Consent*

**Voluntary Consent**

Valid consent must be freely given, without coercion. Patient must be at least 18 years of age (unless an emancipated minor), consent must be obtained by a physician, and patient's signature must be witnessed by a professional staff member.

**Incompetent Patient**

Legal definition: individual who is *not* autonomous and cannot give or withhold consent (eg, individuals who are cognitively impaired, mentally ill, or neurologically incapacitated).

**Informed Subject**

Informed consent should be in writing. It should contain the following:

- Explanation of procedure and its risks
- Description of benefits and alternatives
- An offer to answer questions about procedure
- Instructions that the patient may withdraw consent
- A statement informing the patient if the protocol differs from customary procedure

**Patient Able to Comprehend**

If the patient is non–English speaking, it is necessary to provide consent (written and verbal) in a language that is understandable to the client. A trained medical interpreter may be consulted. Alternative formats of communication (eg, Braille, large print, sign interpreter) may be needed if the patient has a disability that affects vision or hearing. Questions must be answered to facilitate comprehension if material is confusing.

## CHART 18-3 *Risk Factors for Surgical Complications*

- Hypovolemia
- Dehydration or electrolyte imbalance
- Nutritional deficits
- Extremes of age (very young, very old)
- Extremes of weight (emaciation, obesity)
- Infection and sepsis
- Toxic conditions
- Immunologic abnormalities
- Pulmonary disease
  - Obstructive disease
  - Restrictive disorder
  - Respiratory infection
- Renal or urinary tract disease
  - Decreased renal function
  - Urinary tract infection
  - Obstruction
- Pregnancy
  - Diminished maternal physiologic reserve
- Cardiovascular disease
  - Coronary artery disease or previous myocardial infarction
  - Cardiac failure
  - Dysrhythmias
  - Hypertension
  - Prosthetic heart valve
  - Thromboembolism
  - Hemorrhagic disorders
  - Cerebrovascular disease
- Endocrine dysfunction
  - Diabetes mellitus
  - Adrenal disorders
  - Thyroid malfunction
- Hepatic disease
  - Cirrhosis
  - Hepatitis
- Preexisting mental or physical disability

and hinder recovery (Chart 18-3). Before any surgical treatment is initiated, a health history is obtained, a physical examination is performed during which vital signs are noted, and a database is established for future comparisons. During the physical examination, many factors that have the potential to affect the patient undergoing surgery are considered. Genetic considerations are also taken into account during assessment to prevent complications with anesthesia (Chart 18-4).

Health care providers should be alert for signs of abuse, which can occur at all ages and to men and women from all socioeconomic, ethnic, and cultural groups (Weber & Kelley, 2007). Findings need to be reported accordingly (see Chapter 5 for further discussion of signs of abuse). Blood tests, x-rays, and other diagnostic tests are prescribed when indicated by information obtained from the history and physical examination.

## Nutritional and Fluid Status

Optimal nutrition is an essential factor in promoting healing and resisting infection and other surgical complications. Assessment of a patient's nutritional status identifies factors that can affect the patient's surgical course, such as obesity weight loss, malnutrition, deficiencies in specific nutrients, metabolic abnormalities, and the effects of medications on nutrition. Nutritional needs may be determined by measurement of body mass index and waist circumference (U.S. Department of Health and Human Services, 2007). See Chapter 5 for further discussion of nutritional assessment.

Any nutritional deficiency, such as malnutrition, should be corrected before surgery to provide adequate protein for tissue repair. The nutrients needed for wound healing are summarized in Table 18-2.

Dehydration, hypovolemia, and electrolyte imbalances can lead to significant problems in patients with comorbid medical conditions or in patients who are elderly. The severity of fluid and electrolyte imbalances is often difficult to determine. Mild volume deficits may be treated during surgery; however, additional time may be needed to correct pronounced fluid and electrolyte deficits to promote the best possible preoperative condition.

## Dentition

The condition of the mouth is an important health factor to assess. Dental caries, dentures, and partial plates are particularly significant to the anesthesiologist or anesthetist, because decayed teeth or dental prostheses may become dislodged during intubation and occlude the airway. This is

CHART 18-4

**GENETICS IN NURSING PRACTICE**
*Perioperative Nursing*

Nurses who are caring for patients undergoing surgery need to take various genetic considerations into account when assessing patients throughout the perioperative experience. For example, surgical outcomes may be altered by genetic conditions that may cause complications with anesthesia, including the following:

- Malignant hyperthermia
- Central core disease (CCD)
- Duchenne muscular dystrophy
- Hyperkalemic periodic paralysis
- King-Denborough syndrome

**Nursing Assessments**

**Preoperative Family History Assessment**

- Obtain a thorough assessment of personal and family history, inquiring about prior problems with surgery or anesthesia with specific attention to complications such as fever, rigidity, dark urine, and unexpected reactions.
- Inquire about any history of musculoskeletal complaints, history of heat intolerance, fevers of unknown origin, or unusual drug reaction.
- Assess for family history of any sudden or unexplained death, especially during participation in athletic events.

**Patient Assessment**

- Assess for subclinical muscle weakness.
- Assess for other physical features suggestive of an underlying genetic condition, such as contractures, kyphoscoliosis, and pterygium with progressive weakness.

**Management Issues Specific to Genetics**

- Inquire whether DNA mutation or other genetic testing has been performed on an affected family member.
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of diagnostic/genetic testing.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed malignant hyperthermia.
- Participate in management and coordination of care of patients with genetic conditions and individuals predisposed to develop or pass on a genetic condition.

**Genetics Resources for Nurses and Their Patients on the Web**

**Genetic Alliance—**a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Clinics—**a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling and testing information, www.geneclinics.org

**International Council of Nurses (ICN)—**ICN's statement re: genetics and nursing, www.icn.ch/matters_genetics.htm

**National Organization of Rare Disorders—**a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man—**a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/entrez/query.fcgi?db-OMIM

especially important for elderly patients, as well as those from underserved communities or who are uninsured or do not have regular dental care.

## Drug or Alcohol Use

People who abuse drugs or alcohol frequently deny or attempt to hide it. In such situations, the nurse who is obtaining the patient's health history needs to ask frank questions with patience, care, and a nonjudgmental attitude. See Chapter 5 for an assessment of alcohol and drug use.

Because acutely intoxicated people are susceptible to injury, surgery is postponed if possible. If emergency surgery is required, local, spinal, or regional block anesthesia is used for minor surgery. Otherwise, to prevent vomiting and potential aspiration, a nasogastric tube is inserted before general anesthesia is administered.

The person with a history of chronic alcoholism often suffers from malnutrition and other systemic problems that increase surgical risk. Alcohol withdrawal syndrome (ie, delirium tremens) may be anticipated between 48 and 72 hours after alcohol withdrawal and is associated with a significant mortality rate when it occurs postoperatively. This increase in mortality rate can be contributed to cardiac dysrhythmias, cardiomyopathy, and bleeding tendencies seen in long-term alcohol abuse (Lussier-Cushing, Repper-DeLisi, Mitchell, et al., 2007).

## Respiratory Status

The goal for surgical patients is optimal respiratory function. The patient is taught breathing exercises and the use of an incentive spirometer if indicated. Because ventilation is potentially compromised during all phases of surgical treatment, surgery is usually postponed if the patient has a respiratory infection. Patients with underlying respiratory disease (eg, asthma, chronic obstructive pulmonary disease) are assessed carefully for current threats to their pulmonary status. Patients also need to be assessed for comorbid conditions such as human immunodeficiency virus (HIV) infection and Parkinson's disease, which may affect respiratory function (West, 2008).

Patients who smoke are urged to stop 4 to 8 weeks before surgery to significantly reduce pulmonary and wound healing complications. Preoperative smoking cessation interventions can be effective in changing smoking behavior and reducing the incidence of postoperative complications (Moller & Villebro, 2007).

## Cardiovascular Status

The goal in preparing any patient for surgery is to ensure a well-functioning cardiovascular system to meet the oxygen, fluid, and nutritional needs of the perioperative period. If the patient has uncontrolled hypertension, surgery may be postponed until the blood pressure is under control. At

**Table 18-2 NUTRIENTS IMPORTANT FOR WOUND HEALING**

| Nutrient | Rationale for Increased Need | Possible Deficiency Outcome |
|---|---|---|
| Protein | To allow collagen deposition and wound healing to occur | Collagen deposition leading to impaired/delayed wound healing<br>Decreased skin and wound strength<br>Increased wound infection rates |
| Arginine (amino acid) | To provide necessary substrate for collagen synthesis and nitric oxide (crucial for wound healing) at wound site<br>To increase wound strength and collagen deposition<br>To stimulate T-cell response<br>Associated with a variety of essential reactions of intermediary metabolism | Impaired wound healing |
| Carbohydrates and fats | Primary source of energy in the body and consequently in the wound healing process<br>To meet the demand for increased essential fatty acids needed for cellular function after an injury<br>To spare protein<br>To restore normal weight | Signs and symptoms of protein deficiency due to use of protein to meet energy requirements<br>Extensive weight loss |
| Water | To replace fluid lost through vomiting, hemorrhage, exudates, fever, drainage, diuresis<br>To maintain homeostasis | Signs, symptoms, and complications of dehydration, such as poor skin turgor, dry mucous membranes, oliguria, anuria, weight loss, increased pulse rate, decreased central venous pressure |
| Vitamin C | Important for capillary formation, tissue synthesis, and wound healing through collagen formation<br>Needed for antibody formation | Impaired/delayed wound healing related to impaired collagen formation and increased capillary fragility and permeability<br>Increased risk for infection related to decreased antibodies |
| Vitamin B complex | Indirect role in wound healing through their influence on host resistance | Decreased enzymes available for energy metabolism |
| Vitamin A | Increases inflammatory response in wounds, reduces anti-inflammatory effects of corticosteroids on wound healing | Impaired/delayed wound healing related to decreased collagen synthesis; impaired immune function<br>Increased risk for infection |
| Vitamin K | Important for normal blood clotting<br>Impaired intestinal synthesis associated with the use of antibiotics | Prolonged prothrombin time<br>Hematomas contributing to impaired healing and predisposition to wound infections |
| Magnesium | Essential cofactor for many enzymes that are involved in the process of protein synthesis and wound repair | Impaired/delayed wound healing (impaired collagen production) |
| Copper | Required cofactor in the development of connective tissue | Impaired wound healing |
| Zinc | Involved in DNA synthesis, protein synthesis, cellular proliferation needed for wound healing<br>Essential to immune function | Impaired immune response |

Information from Dudek, S. G. (2006). *Nutrition essentials for nursing practice* (5th ed.). Philadelphia: Lippincott Williams & Wilkins; and Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

times, surgical treatment can be modified to meet the cardiac tolerance of the patient. For example, in a patient with obstruction of the descending colon and coronary artery disease, a temporary simple colostomy may be performed rather than a more extensive colon resection that would require a prolonged period of anesthesia.

## Hepatic and Renal Function

The presurgical goal is optimal function of the liver and urinary systems so that medications, anesthetic agents, body wastes, and toxins are adequately metabolized and removed from the body.

The liver is important in the biotransformation of anesthetic compounds. Therefore, any disorder of the liver has an effect on how anesthetic agents are metabolized. Because acute liver disease is associated with high surgical mortality, preoperative improvement in liver function is a goal. Careful assessment may include various liver function tests (see Chapter 39).

The kidneys are involved in excreting anesthetic medications and their metabolites; therefore, surgery is contraindicated if a patient has acute nephritis, acute renal insufficiency with oliguria or anuria, or other acute renal problems (see Chapter 44). Exceptions include surgeries performed as lifesaving measures or those necessary to improve urinary function (ie, obstructive uropathy).

## Endocrine Function

The patient with diabetes who is undergoing surgery is at risk for hypoglycemia and hyperglycemia. Hypoglycemia may develop during anesthesia or postoperatively from inadequate carbohydrates or excessive administration of insulin. Hyperglycemia, which can increase the risk for surgical wound infection, may result from the stress of surgery, which can trigger increased levels of catecholamine. Other risks are acidosis and glucosuria. Although the surgical risk in the patient with controlled diabetes is no

greater than in the patient without diabetes, strict glycemic control (80 to 110 mg/dL) leads to better outcomes (Plank, Blaha, Cordingley, et al., 2006). Frequent monitoring of blood glucose levels is important before, during, and after surgery (see Chapter 41 for a discussion of the patient with diabetes).

Patients who have received corticosteroids are at risk for adrenal insufficiency. Therefore, the use of corticosteroids for any purpose during the preceding year must be reported to the anesthesiologist or anesthetist and surgeon. The patient is monitored for signs of adrenal insufficiency.

Patients with uncontrolled thyroid disorders are at risk for thyrotoxicosis (with hyperthyroid disorders) or respiratory failure (with hypothyroid disorders). Therefore, the patient is assessed for a history of these disorders.

## Immune Function

An important function of the preoperative assessment is to determine the presence of allergies. It is especially important to identify and document any sensitivity to medications and past adverse reactions to these agents. The patient is asked to identify any substances that precipitated previous allergic reactions, including medications, blood transfusions, contrast agents, latex, and food products, and to describe the signs and symptoms produced by these substances. A sample latex allergy screening questionnaire is shown in Figure 18-1.

Immunosuppression is common with corticosteroid therapy, renal transplantation, radiation therapy, chemotherapy, and disorders affecting the immune system, such as acquired immunodeficiency syndrome (AIDS) and leukemia. The mildest symptoms or slightest temperature elevation must be investigated. Because patients who are immunosuppressed are highly susceptible to infection, great care is taken to ensure strict asepsis.

## Previous Medication Use

A medication history is obtained because of the possible effects of medications on the patient's perioperative course, including the possibility of drug interactions. Any medication the patient is using or has used in the past is documented, including over-the-counter (OTC) preparations, herbal agents, and the frequency with which they are used. Many medications have an effect on physiologic functions; interactions of such medications with anesthetic agents can cause serious problems, such as arterial hypotension and circulatory collapse. Medications that cause particular concern are listed in Table 18-3.

The anesthesiologist or anesthetist evaluates the potential effects of prior medication therapy, considering the length of time the patient has used the medication, the physical condition of the patient, and the nature of the proposed surgery (D'Arcy, 2007).

Many patients take self-prescribed or OTC medications. Aspirin is a common OTC medication that inhibits platelet aggregation; therefore, it is prudent to stop aspirin at least 7 to 10 days before surgery if possible, especially for surgeries in which excess bleeding would cause significant complications, such as brain or spinal cord surgeries (Rothrock, 2007). Any use of aspirin or other OTC medications is noted in the patient's chart and conveyed to the anesthesiologist or anesthetist and surgeon.

### Latex Allergy Assessment

| Ask the patient the following questions. Check "Yes" or "No" in the box. | YES | NO |
|---|---|---|
| 1. Has a doctor ever told you that you are allergic to latex? | | |
| 2. Do you have on-the-job exposure to latex? | | |
| 3. Were you born with problems involving your spinal cord? | | |
| 4. Have you ever had allergies, asthma, hay fever, eczema, or problems with rashes? | | |
| 5. Have you ever had respiratory distress, rapid heart rate, or swelling? | | |
| 6. Have you ever had swelling, itching, hives, or other symptoms after contact with a balloon? | | |
| 7. Have you ever had swelling, itching, hives, or other symptoms after a dental examination or procedure? | | |
| 8. Have you ever had swelling, itching, hives, or other symptoms following a vaginal or rectal examination or after contact with a diaphragm or condom? | | |
| 9. Have you ever had swelling, itching, hives, or other symptoms during or within 1 hour after wearing rubber gloves? | | |
| 10. Have you ever had a rash on your hands that lasted longer than 1 week? | | |
| 11. Have you ever had swelling, itching, hives, runny nose, eye irritation, wheezing, or asthma after contact with any latex or rubber product? | | |
| 12. Have you ever had swelling, itching, hives, or other symptoms after being examined by someone wearing rubber or latex gloves? | | |
| 13. Are you allergic to bananas, avocados, kiwi, or chestnuts? | | |
| 14. Have you ever had an unexplained anaphylactic episode? | | |

**Preop RN Signature:** ____________________

**Patient Name:** ____________________

**Procedure:** ____________________

**Scheduled Date / Time:** ____________________

**Surgeon:** ____________________

**Figure 18-1** Example of a latex allergy assessment form. Courtesy of Inova Fairfax Hospital, Falls Church, VA.

*NURSING ALERT*

**Because of possible adverse interactions, the nurse must assess and document the patient's use of prescription medications, OTC medications (especially aspirin), herbal agents, and the frequency with which medications are used. The nurse must clearly communicate this information to the anesthesiologist or anesthetist.**

The use of herbal medications is widespread among patients; approximately 40% of Americans report taking some

**Table 18-3 EXAMPLES OF MEDICATIONS WITH THE POTENTIAL TO AFFECT THE SURGICAL EXPERIENCE**

| Agent | Effect of Interaction With Anesthetics |
|---|---|
| **Corticosteroids**<br>Prednisone (Deltasone) | Cardiovascular collapse can occur if discontinued suddenly. Therefore, a bolus of corticosteroid may be administered intravenously immediately before and after surgery. |
| **Diuretics**<br>Hydrochlorothiazide (HydroDIURIL) | During anesthesia, may cause excessive respiratory depression resulting from an associated electrolyte imbalance |
| **Phenothiazines**<br>Chlorpromazine (Thorazine) | May increase the hypotensive action of anesthetics |
| **Tranquilizers**<br>Diazepam (Valium) | May cause anxiety, tension, and even seizures if withdrawn suddenly |
| **Insulin** | Interaction between anesthetics and insulin must be considered when a patient with diabetes is undergoing surgery. Intravenous insulin may need to be administered to keep the blood glucose within the normal range. |
| **Antibiotics**<br>Erythromycin (Ery-Tab) | When combined with a curariform muscle relaxant, nerve transmission is interrupted and apnea from respiratory paralysis may result. |
| **Anticoagulants**<br>Warfarin (Coumadin) | Can increase the risk of bleeding during the intraoperative and postoperative periods; should be discontinued in anticipation of elective surgery. The surgeon will determine how long before the elective surgery the patient should stop taking an anticoagulant, depending on the type of planned procedure and the medical condition of the patient. |
| **Antiseizure Medications** | Intravenous administration of medication may be needed to keep the patient seizure-free in the intraoperative and postoperative periods. |
| **Thyroid Hormone**<br>Levothyroxine sodium (Levothroid) | Intravenous administration may be needed during the postoperative period to maintain thyroid levels. |
| Opioids | Long-term use of opioids for chronic pain (6 mo or greater) in the preoperative period may alter the patient's response to analgesic agents. |

Adapted from D'Arcy, Y. (2007). Managing pain in a patient who is drug dependent. *Nursing, 37*(3), 36–41.

form of these substances (Messina, 2006). The most commonly used herbal medications are echinacea, ephedra, garlic (*Allium sativum*), ginkgo biloba, ginseng, kava kava (*Piper methysticum*), St. John's wort (*Hypericum perforatum*), licorice extract (*Glycyrrhizinc acid*), and valerian (*Valeriana officinalis*). Many patients fail to report using herbal medicines to their health care providers; therefore, the nurse must ask surgical patients specifically about the use of these agents. Any use of herbal medications is noted in the patient's chart and conveyed to the anesthesiologist or anesthetist and surgeon because of the potential effects on coagulation and potentially lethal interactions with other medications. Currently, it is recommended that the use of herbal products be discontinued 2 to 3 weeks before surgery (Rothrock, 2007).

## Psychosocial Factors

Most patients have some type of emotional reaction before any surgical procedure, be it obvious or hidden, normal or abnormal. Fears may be related to fear of the unknown or of death, anesthesia, pain, complications, or cancer. Preoperative anxiety may be an anticipatory response to an experience viewed by the patient as a threat to his or her customary role in life, permanent incapacity, body integrity, increased responsibilities or burden on family members, or life itself. Less obvious concerns may occur because of previous experiences with the health care system and people the patient has known with the same condition. Psychological distress directly influences body functioning. Therefore, it is imperative to identify any anxiety the patient is experiencing (Kain, Caldwell-Andrews, Mayes, et al., 2007).

People express fear in different ways. For example, some patients may repeatedly ask many questions, even though answers were given previously. Others may withdraw, deliberately avoiding communication, perhaps by reading, watching television, or talking about trivialities. Consequently, the nurse must be empathetic, listen well, and provide information that helps alleviate concerns.

An important outcome of the psychosocial assessment is the determination of the extent and role of the patient's support network. The value and reliability of available support systems are assessed. Other information, such as usual level of functioning and typical daily activities, may assist in the patient's care and recovery. Assessing the patient's readiness to learn and determining the best approach to maximize comprehension provides the basis for preoperative patient education. This is of particular importance in patients who are developmentally delayed and those who are cognitively impaired, where the approach to patient education and consent will include the legal guardian.

## Spiritual and Cultural Beliefs

Spiritual beliefs play an important role in how people cope with fear and anxiety. Regardless of the patient's religious affiliation, spiritual beliefs can be as therapeutic as medication.

Every attempt must be made to help the patient obtain the spiritual support that he or she requests. Therefore, the nurse must respect and support the beliefs of each patient. Some nurses may avoid the subject of a clergy visit lest the suggestion alarm the patient. Asking whether the patient's spiritual advisor knows about the impending surgery is a caring, nonthreatening approach.

Showing respect for a patient's cultural values and beliefs facilitates rapport and trust. Some areas of assessment include identifying the ethnic group to which the patient relates and the customs and beliefs the patient holds about illness and health care providers. For example, patients from some cultural groups are unaccustomed to expressing feelings openly. Nurses need to consider this pattern of communication when assessing pain. As a sign of respect, people from some cultural groups may not make direct eye contact with others (Andrews & Boyle, 2008). The nurse should know that this lack of eye contact is not avoidance or a lack of interest.

Perhaps the most valuable skill at the nurse's disposal is listening carefully to the patient, especially when obtaining the history. Invaluable information and insights may be gained through effective communication and interviewing skills. An unhurried, understanding, and caring nurse promotes confidence on the part of the patient.

## General Preoperative Nursing Interventions

There are a wide range of interventions used to prepare the patient physically and psychologically and to maintain safety.

### Providing Patient Teaching

Nurses have long recognized the value of preoperative instruction (Rothrock, 2007). Each patient is taught as an individual, with consideration for any unique concerns or learning needs. Multiple teaching strategies should be used (eg, verbal, written, return demonstration), depending on the patient's needs and abilities.

Preoperative teaching is initiated as soon as possible, beginning in the physician's office, in the clinic, or at the time of PAT when diagnostic tests are performed. During PAT, the nurse or health care provider makes resources available related to patient teaching such as written instructions (designed to be copied and given to patients), audiovisual resources, and telephone numbers to ensure that teaching continues until the patient arrives for the surgical intervention. When possible, instruction is spaced over a period of time to allow the patient to assimilate information and ask questions as they arise.

Frequently, teaching sessions are combined with various preparation procedures to allow for an easy and timely flow of information. The nurse should guide the patient through the experience and allow ample time for questions. Teaching should go beyond descriptions of the procedure and should include explanations of the sensations the patient will experience. For example, telling the patient only that preoperative medication will cause relaxation before the operation is not as effective as also noting that the medication may result in lightheadedness and drowsiness. Knowing what to expect will help the patient anticipate these reactions and thus attain a higher degree of relaxation than might otherwise be expected. For some patients, overly detailed descriptions may increase anxiety; therefore, the nurse should be sensitive to this and provide less detail based on the individual patient's needs.

#### Deep Breathing, Coughing, and Incentive Spirometry

One goal of preoperative nursing care is to teach the patient how to promote optimal lung expansion and resulting blood oxygenation after anesthesia. The patient assumes a sitting position to enhance lung expansion. The nurse then demonstrates how to take a deep, slow breath and how to exhale slowly. After practicing deep breathing several times, the patient is instructed to breathe deeply, exhale through the mouth, take a short breath, and cough from deep in the lungs (Chart 18-5). The nurse or respiratory therapist also demonstrates how to use an incentive spirometer, a device that provides measurement and feedback related to breathing effectiveness (see Chapter 25). In addition to enhancing respiration, these exercises may help the patient relax. Research indicates that some patients benefit from intensive inspiratory muscle training in the preoperative period (Hulzebos, Helders, Favie, et al., 2006).

If a thoracic or abdominal incision is anticipated, the nurse demonstrates how to splint the incision to minimize pressure and control pain. The patient should put the palms of both hands together, interlacing the fingers snugly. Placing the hands across the incisional site acts as an effective splint when coughing. In addition, the patient is informed that medications are available to relieve pain and should be taken regularly for pain relief so that effective deep-breathing and coughing exercises can be performed. The goal in promoting coughing is to mobilize secretions so that they can be removed. Deep breathing before coughing stimulates the cough reflex. If the patient does not cough effectively, atelectasis (collapse of the alveoli), pneumonia, or other lung complications may occur.

#### Mobility and Active Body Movement

The goals of promoting mobility postoperatively are to improve circulation, prevent venous stasis, and promote optimal respiratory function. The patient should be taught that early and frequent ambulation immediately postoperative as tolerated will help to prevent complications.

The nurse explains the rationale for frequent position changes after surgery and then shows the patient how to turn from side to side and how to assume the lateral position without causing pain or disrupting intravenous (IV) lines, drainage tubes, or other equipment. Any special position the patient needs to maintain after surgery (eg, adduction or elevation of an extremity) is discussed, as is the importance of maintaining as much mobility as possible despite restrictions. Reviewing the process before surgery is helpful, because the patient may be too uncomfortable or drowsy after surgery to absorb new information.

Exercise of the extremities includes extension and flexion of the knee and hip joints (similar to bicycle riding while lying on the side) unless contraindicated by type of surgical procedure (eg, hip replacement). The foot is rotated as though tracing the largest possible circle with the great toe

CHART 18-5

PATIENT EDUCATION

## *Preoperative Instructions to Prevent Postoperative Complications*

**Diaphragmatic Breathing**

Diaphragmatic breathing refers to a flattening of the dome of the diaphragm during inspiration, with resultant enlargement of the upper abdomen as air rushes in. During expiration, the abdominal muscles contract.

1. Practice in the same position you would assume in bed after surgery: a semi-Fowler's position, propped in bed with the back and shoulders well supported with pillows.
2. With your hands resting lightly on the front of the lower ribs, and fingertips against lower chest to feel the movement.



Diaphragmatic breathing

3. Breathe out gently and fully as the ribs sink down and inward toward midline.
4. Then take a deep breath through your nose and mouth, letting the abdomen rise as the lungs fill with air.
5. Hold this breath for a count of five.
6. Exhale and let out *all* the air through your nose and mouth.
7. Repeat this exercise 15 times with a short rest after each group of five.
8. Practice this twice a day preoperatively.

**Coughing**

1. Lean forward slightly from a sitting position in bed, interlace your fingers together, and place your hands across the incisional site to act as a splintlike support when coughing.

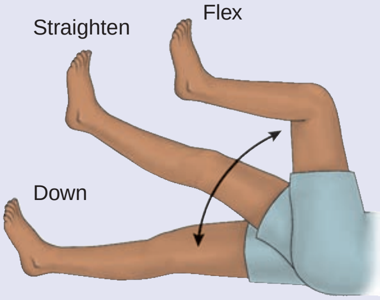


Splinting of chest when coughing

2. Breathe with the diaphragm as described under "Diaphragmatic Breathing."
3. With your mouth slightly open, breathe in fully.
4. "Hack" out sharply for three short breaths.
5. Then, keeping your mouth open, take in a quick deep breath and immediately give a strong cough once or twice. This helps clear secretions from your chest. It may cause some discomfort but will not harm your incision.

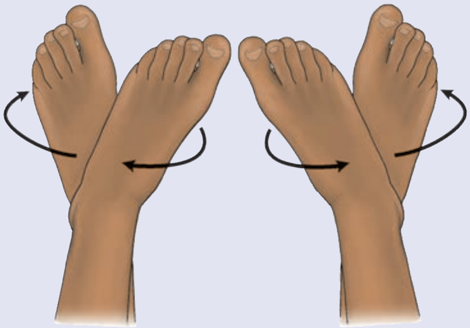
**Leg Exercises**

1. Lie in a semi-Fowler's position and perform the following simple exercises to improve circulation.
2. Bend your knee and raise your foot—hold it a few seconds, then extend the leg and lower it to the bed.




Leg exercises

3. Do this five times with one leg, then repeat with the other leg.
4. Then trace circles with the feet by bending them down, in toward each other, up, and then out.
5. Repeat these movements five times.



Foot exercises

**Turning to the Side**

1. Turn on your side with the uppermost leg flexed most and supported on a pillow.
2. Grasp the side rail as an aid to maneuver to the side.
3. Practice diaphragmatic breathing and coughing while on your side.

**Getting Out of Bed**

1. Turn on your side.
2. Push yourself up with one hand as you swing your legs out of bed.

(see Chart 18-5). The elbow and shoulder are also put through their range of motion. At first, the patient is assisted and reminded to perform these exercises. Later, the patient is encouraged to do them independently. Muscle tone is maintained so that ambulation will be easier. The nurse should remember to use proper body mechanics and to instruct the patient to do the same. Whenever the patient is positioned, his or her body needs to be properly aligned.

### Pain Management

A pain assessment should include differentiation between acute and chronic pain. A pain intensity scale should be introduced and explained to the patient to promote more effective postoperative pain management. Chapter 13 contains several examples of pain scales. Preoperative patient teaching also needs to include the difference between acute and chronic pain, so that the patient is prepared to differentiate acute postoperative pain from a chronic condition such as back pain. Preoperative pain assessment and teaching for the elderly patient may require additional attention (Chart 18-6).

Postoperatively, medications are administered to relieve pain and maintain comfort without suppressing respiratory function. The patient is instructed to take the medication as frequently as prescribed during the initial postoperative period for pain relief. Anticipated methods of administration of analgesic agents for inpatients include patient-controlled analgesia (PCA), epidural catheter bolus or infusion, or patient-controlled epidural analgesia (PCEA). A patient who is expected to go home will likely receive oral analgesic agents. These methods are discussed with the patient before surgery, and the patient's interest and willingness to use them are assessed.

### Cognitive Coping Strategies

Cognitive strategies may be useful for relieving tension, overcoming anxiety, decreasing fear, and achieving relaxation. Examples of such strategies include the following:

- Imagery: The patient concentrates on a pleasant experience or restful scene.
- Distraction: The patient thinks of an enjoyable story or recites a favorite poem or song.
- Optimistic self-recitation: The patient recites optimistic thoughts ("I know all will go well").
- Music therapy: The patient listens to soothing music (an easy-to-administer, inexpensive, noninvasive intervention).

### Instruction for Patients Undergoing Ambulatory Surgery

Preoperative education for the same-day or ambulatory surgical patient comprises all previously discussed patient teaching as well as collaborative planning with the patient and family for discharge and follow-up home care. The major difference in outpatient preoperative education is the teaching environment.

Preoperative teaching content may be presented in a group class, on a videotape, at PAT, or by telephone in conjunction with the preoperative interview. In addition to answering questions and describing what to expect, the nurse tells the patient when and where to report, what to bring (insurance card, list of medications and allergies), what to leave at home (jewelry, watch, medications, contact lenses), and what to wear (loose-fitting, comfortable clothes; flat shoes). The nurse in the surgeon's office may initiate teaching before the perioperative telephone contact.

During the final preoperative telephone call, teaching is completed or reinforced as needed, and last-minute instructions are given. The patient is reminded not to eat or drink as directed.

## Providing Psychosocial Interventions

### Reducing Anxiety and Decreasing Fear

During the preoperative assessment of psychological factors and spiritual and cultural beliefs, the nurse assists the patient to identify coping strategies that he or she has previously used to decrease fear. Discussions with the patient to help determine the source of fears can help with expression of concerns. The patient benefits from knowing when family and friends will be able to visit after surgery and that a spiritual advisor will be available if desired. The general preoperative teaching and cognitive strategies addressed earlier in this section help decrease preoperative anxiety in many patients. Knowing ahead of time about the possible need for a ventilator, drainage tubes, or other types of equipment helps decrease anxiety related to the postoperative period. Chart 18-7 addresses patient teaching as a means of reducing emotional distress.

### Respecting Cultural, Spiritual, and Religious Beliefs

Psychosocial interventions include identifying and showing respect for cultural, spiritual, and religious beliefs. In some cultures, for example, people are stoic in regard to pain,

**CHART 18-6** *Preoperative Pain Assessment and Teaching for the Elderly*

The older person undergoing surgery may have a combination of chronic illnesses and health issues in addition to the specific one for which surgery is indicated. The elderly frequently do not report symptoms, perhaps because they fear a serious illness may be diagnosed or because they accept such symptoms as part of the aging process. Subtle clues alert the nurse to underlying problems. Some older patients believe that pain is inevitable with aging and is meant to be endured; therefore, nurses must teach the patient about the benefits of controlling pain (Linton & Lach, 2007). Older patients also report higher levels of preoperative anxiety; therefore, the nurse should be prepared to spend additional time, increase the amount of therapeutic touch utilized, and encourage family members to be present to decrease anxiety (Stanley, et al., 2005).

CHART 18-7 NURSING RESEARCH PROFILE
## *Nursing Intervention Following Day Surgery for Breast Cancer*

Allard, N. C. (2007). Day surgery for breast cancer: Effects of a psychoeducational telephone intervention on functional status and emotional distress. *Oncology Nursing Forum, 34*(1), 133–141.

**Purpose**

Breast cancer causes significant physical and emotional distress in the approximately 400 women in Canada diagnosed each week. The purpose of this study was to determine if a nursing intervention based on a self-regulation theory know as Attentional Focus and Sympton Management Intervention (AFSMI) was effective in enhancing functional status and relieving emotional distress in women who underwent day surgery for breast cancer as part of their initial treatment.

**Design**

A convenience sample of 117 women with primary breast cancer who were scheduled for day surgery were randomized into two groups. The control group ($n = 56$) received usual care, while the experimental group ($n = 61$) received AFSMI during two phone sessions. Functional status was measured with the Sickness Impact Profile (SIP) and emotional distress was measured using the short form of the Profile of Mood States (POMS). The SIP and POMS were measured preoperatively and at 3 to 4 days and 10 to 11 days after surgery.

**Findings**

The mean age of the total sample was 54 years; 37% had a secondary level of education, and 46% were married. More women in the group who received the AFSMI had a greater number of chronic health conditions (37%) compared to the control group (22%) ($X^2 = 4.55$; $p = 0.03$). Significant differences were found between the two groups on home management, total mood disturbance, confusion, and tension scores. The group that received AFSMI had more effective home management, as measured by a subscale of the SIP, compared to the usual care group ($F[1,98] = 4.9$; $p = 0.03$). Those who received AFSMI also had lower scores on the POMS compared to the usual care group ($F[1,93] = 3.98$; $p = 0.05$).

**Nursing Implications**

During preoperative assessment and teaching, nurses should be aware that AFSMI was effective in reducing emotional distress and enhancing physical functioning in this study. More research is needed, but this may be a low-cost and effective nursing strategy to consider implementing, especially with women who exhibit high levels of stress in the preoperative period before day surgery for breast cancer.

whereas in others they are more expressive. These responses should be recognized as normal for those patients and families and should be respected by perioperative personnel (Andrews & Boyle, 2008). If patients decline blood transfusions for religious reasons (Jehovah's Witnesses), this information needs to be clearly identified in the preoperative period, documented, and communicated to the appropriate personnel.

## Maintaining Patient Safety

Protecting patients from injury is one of the major roles of the perioperative nurse. Adherence to AORN recommended practices, The Joint Commission patient safety goals (Chart 18-8), and national patient safety goals are crucial (Rothrock, 2007). These apply to hospitals as well as to ambulatory surgery centers and office-based surgery facilities (The Joint Commission, 2008).

## Managing Nutrition and Fluids

The major purpose of withholding food and fluid before surgery is to prevent aspiration. Until recently, fluid and food were restricted preoperatively overnight and often longer. However, the American Society of Anesthesiologists reviewed this practice and has made new recommendations for people undergoing elective surgery who are otherwise healthy. Specific recommendations depend on the age of the patient and the type of food eaten. For example, adults may be advised to fast for 8 hours after eating fatty food and 4 hours after ingesting milk products. Many patients are currently allowed clear liquids up to 2 hours before an elective procedure (Spry, 2005).

## Preparing the Bowel

Enemas are not commonly prescribed preoperatively unless the patient is undergoing abdominal or pelvic surgery. In this case, a cleansing enema or laxative may be prescribed

### Chart 18-8 • *2009 National Patient Safety Goals*

- Improve the accuracy of patient identification
- Improve effectiveness of communication among caregivers
- Improve safety of using medications
- Reduce the risk of health care–associated infections
- Accurately and completely reconcile medications across continuum of care
- Reduce the risk of patient harm resulting from falls
- Reduce the risk of influenza and pneumococcal disease in institutionalized older adults
- Reduce the risk of surgical fires
- Implement applicable National Patient Safety Goals and associated requirements by components and practitioner sites
- Encourage patients' active involvement in their own care as a patient safety strategy
- Prevent health care–associated pressure ulcers (decubitus ulcers)
- Identify safety risks inherent in the organization's patient population
- Improve recognition and response to changes in a patient's condition

From The Joint Commission. (2008). *2009 National patient safety goals.* Available at: www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/09_npsg_facts.htm

the evening before surgery and may be repeated the morning of surgery. The goals of this preparation are to allow satisfactory visualization of the surgical site and to prevent trauma to the intestine or contamination of the peritoneum by fecal material. Unless the condition of the patient presents some contraindication, the toilet or bedside commode, rather than the bedpan, is used for evacuating the enema if the patient is hospitalized during this time. In addition, antibiotics may be prescribed to reduce intestinal flora.

### Preparing the Skin

The goal of preoperative skin preparation is to decrease bacteria without injuring the skin. If the surgery is not performed as an emergency, the patient may be instructed to use a soap containing a detergent-germicide to cleanse the skin area for several days before surgery to reduce the number of skin organisms; this preparation may be carried out at home.

Generally, hair is not removed preoperatively unless the hair at or around the incision site is likely to interfere with the operation. If hair must be removed, electric clippers are used for safe hair removal immediately before the operation. To ensure the correct site, the surgical site is typically marked by the patient and the surgeon in the preoperative waiting area.

## Immediate Preoperative Nursing Interventions

Immediately prior to the procedure the patient changes into a hospital gown that is left untied and open in the back. The patient with long hair may braid it, remove hairpins, and cover the head completely with a disposable paper cap. The mouth is inspected, and dentures or plates are removed. If left in the mouth, these items could easily fall to the back of the throat during induction of anesthesia and cause respiratory obstruction.

Jewelry is not worn to the OR; wedding rings and jewelry or body piercings should be removed to prevent injury. If a patient objects to removing a ring, some institutions allow the ring to be securely fastened to the finger with tape. All articles of value, including assistive devices, dentures, glasses, and prosthetic devices, are given to family members or are labeled clearly with the patient's name and stored in a safe and secure place according to the institution's policy.

All patients (except those with urologic disorders) should void immediately before going to the OR. This is particularly important in promoting continence during low abdominal surgery and to make abdominal organs more accessible. Urinary catheterization is performed in the OR as necessary.

### Administering Preanesthetic Medication

The use of preanesthetic medication is minimal with ambulatory or outpatient surgery. If prescribed, it is usually administered in the preoperative holding area. If a preanesthetic medication is administered, the patient is kept in bed with the side rails raised, because the medication can cause lightheadedness or drowsiness. During this time, the nurse observes the patient for any untoward reaction to the medications. The immediate surroundings are kept quiet to promote relaxation.

Often, surgery is delayed or OR schedules are changed, and it becomes impossible to request that a medication be given at a specific time. In these situations, the preoperative medication is prescribed "on call to OR." The nurse can have the medication ready to administer as soon as a call is received from the OR staff. It usually takes 15 to 20 minutes to prepare the patient for the OR. If the nurse gives the medication before attending to the other details of preoperative preparation, the patient will have at least partial benefit from the preoperative medication and will have a smoother anesthetic and operative course.

### Maintaining the Preoperative Record

Preoperative checklists contain critical elements that must be checked and verified preoperatively (Rothrock, 2007). The nurse completes the preoperative checklist (Fig. 18-2). The completed chart (with the preoperative checklist and verification form) accompanies the patient to the OR with the surgical consent form attached, along with all laboratory reports and nurses' records. Any unusual last-minute observations that may have a bearing on anesthesia or surgery are noted prominently at the front of the chart.

### Transporting the Patient to the Presurgical Area

The patient is transferred to the holding area or presurgical suite in a bed or on a stretcher about 30 to 60 minutes before the anesthetic is to be given. The stretcher should be as comfortable as possible, with a sufficient number of blankets to prevent chilling in an air-conditioned room. A small head pillow is usually provided.

The patient is taken to the preoperative holding area, greeted by name, and positioned comfortably on the stretcher or bed. The surrounding area should be kept quiet if the preoperative medication is to have maximal effect. Unpleasant sounds or conversation should be avoided, because they may be misinterpreted by a sedated patient.

Patient safety in the preoperative area is a priority. Use of a standard process or procedure to verify patient identification, the surgical procedure, and the surgical site is imperative to maximize patient safety (World Health Organization, 2008). This allows for prompt intervention if any discrepancies are identified.

### Attending to Family Needs

Most hospitals and ambulatory surgery centers have a waiting room where family members and significant others can wait while the patient is undergoing surgery. This room may be equipped with comfortable chairs, televisions, telephones, and light refreshments. Volunteers may remain with the family, offer them coffee, and keep them informed of the patient's progress. After surgery, the surgeon may meet the family in the waiting room and discuss the outcome.

**Preoperative Checklist**

1. Patient's name: ______________ Date: ________ Height: ______ Weight: ______
   Identification band present: ______________
2. Informed consent signed: __________ Special permits signed: ______________
3. Surgical site: ______________ (Ex: Sterilization)
4. History & physical examination report present: __________ Date: ______________
5. Laboratory records present: ______________
   CBC: ________ Hgb: ________ Urinalysis: ________ Hct: ________

6.

| Item | Present | Removed |
|---|---|---|
| a. Natural teeth | ________ | ________ |
| Dentures; upper, lower, partial | ________ | ________ |
| Bridge, fixed; crown | ________ | ________ |
| b. Contact lenses | ________ | ________ |
| c. Other prostheses—type: ______ | ________ | ________ |
| d. Jewelry: | | |
| Wedding band (taped/tied) | ________ | ________ |
| Rings | ________ | ________ |
| Earrings: pierced, clip-on | ________ | ________ |
| Neck chains | ________ | ________ |
| Any other body piercings | ________ | ________ |
| e. Make-up | ________ | ________ |
| Nail polish | ________ | ________ |
| 7. Clothing | | |
| a. Clean patient gown | ________ | ________ |
| b. Cap | ________ | ________ |
| c. Sanitary pad, etc. | ________ | ________ |

8. Family instructed where to wait? ______________
9. Valuables secured? ______________
10. Blood available? ________ Ordered? ______ Where? ______________
11. Preanesthetic medication given: ______________
    Type: __________ Time: ________
12. Voided: ________ Amount: ________ Time: ________ Catheter: ________
    Mouth care given: ______________
13. Vital signs: Temperature: ______ Pulse: ______ Resp: ______ Blood Pressure: ______
14. Special problems/precautions: (Allergies, deafness, etc.): ______________
15. Area of skin preparation: ______________
16. ______________ Date: ________ Time: ________
    Signature: Nurse releasing patient

**Figure 18-2** Example of a preoperative checklist.

The family and significant others should never judge the seriousness of an operation by the length of time the patient is in the OR. A patient may be in the OR much longer than the actual operating time for several reasons:

- Patients are routinely transported well in advance of the actual operating time.
- The anesthesiologist or anesthetist often makes additional preparations that may take 30 to 60 minutes.
- The surgeon may take longer than expected with the preceding case, which delays the start of the next surgical procedure.

After surgery, the patient is taken to the PACU to ensure safe emergence from anesthesia. Family members and significant others waiting to see the patient after surgery should be informed that the patient may have certain equipment or devices (eg, IV lines, indwelling urinary catheter, nasogastric tube, oxygen lines, monitoring equipment, blood transfusion lines) in place when he or she returns from surgery. When the patient returns to the room, the nurse provides explanations regarding the frequent postoperative observations that will be made. However, it is the responsibility of the surgeon, not the nurse, to relay the surgical findings and the prognosis, even when the findings are favorable.

## Expected Patient Outcomes

Expected patient outcomes in the preoperative phase of care are summarized in Chart 18-9.

## Chart 18-9 • *Expected Patient Outcomes in the Preoperative Phase of Care*

**Relief of anxiety,** evidenced when the patient
- Discusses with the anesthesiologist, anesthetist, or nurse anesthetist concerns related to types of anesthesia and induction
- Verbalizes an understanding of the preanesthetic medication and general anesthesia
- Discusses last-minute concerns with the nurse or physician
- Discusses financial concerns with the social worker, when appropriate
- Requests visit with spiritual advisor when appropriate
- Appears relaxed when visited by health care team members

**Decreased fear,** evidenced when the patient
- Discusses fears with health care professionals or a spiritual advisor, or both
- Verbalizes an understanding of any expected bodily changes, including expected duration of bodily changes

**Understanding of the surgical intervention,** evidenced when the patient
- Participates in preoperative preparation
- Demonstrates and describes exercises he or she is expected to perform postoperatively
- Reviews information about postoperative care
- Accepts preanesthetic medication, if prescribed
- Remains in bed once premedicated
- Relaxes during transportation to the OR or unit
- States rationale for use of side rails
- Discusses postoperative expectations

**No evidence of preoperative complications**

## CRITICAL THINKING EXERCISES

**1** During your preoperative assessment of your patient, a 42-year-old female who is alert and oriented reports that she is having her right breast removed for cancer. The OR schedule indicates that she is having a left mastectomy (breast removal). What preoperative assessments are indicated? What nursing interventions are warranted? What should your initial action be?

**2** A morbidly obese 55-year-old patient with diabetes and a history of high blood pressure who takes insulin, antihypertensive medication, aspirin, and several herbal supplements daily is scheduled for major abdominal surgery. What preoperative assessments would be appropriate? What instructions would you anticipate for the patient regarding medications and their rationale? What additional preoperative teaching should be undertaken with this patient?

EBP **3** A patient is admitted to the same-day surgery unit with a known allergy to latex. What resources would you use to identify evidence-based practices during the perioperative period? Identify the evidence for and the criteria used to evaluate the strength of the evidence for the practices identified for this patient.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:
- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Academy of Ambulatory Care Nursing, www.aaacn.org
American Society of Metabolic and Bariatric Surgery, www.asbs.org
American Society of PeriAnesthesia Nurses, www.aspan.org
Association of Perioperative Registered Nurses, www.aorn.org
Centers for Medicare and Medicaid Services, www.cms.hhs.gov
The Joint Commission, www.jointcommission.org



chapter 19

# Intraoperative Nursing Management

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the interdisciplinary approach to the care of the patient during surgery.
2. Describe the principles of surgical asepsis.
3. Describe the roles of the surgical team members during the intraoperative phase of care.
4. Identify adverse effects of surgery and anesthesia.
5. Identify the surgical risk factors related to age-specific populations and nursing interventions to reduce those risks.
6. Compare types of anesthesia with regard to uses, advantages, disadvantages, and nursing responsibilities.
7. Use the nursing process to optimize patient outcomes during the intraoperative period.
8. Describe the role of the nurse in ensuring patient safety during the intraoperative period.

## GLOSSARY

**anesthesia:** a state of narcosis, analgesia, relaxation, and loss of reflexes

**anesthesiologist:** physician trained to deliver anesthesia and to monitor the patient's condition during surgery

**anesthetic agent:** the substance, such as a chemical or gas, used to induce anesthesia

**anesthetist:** health care professional, such as a nurse anesthetist, who is trained to deliver anesthesia and to monitor the patient's condition during surgery

**circulating nurse (or circulator):** registered nurse who coordinates and documents patient care in the operating room

**epidural anesthesia:** state of narcosis, analgesia, relaxation, and loss of reflexes achieved by injecting an anesthetic agent into the epidural space of the spinal cord

**general anesthesia:** state of narcosis, analgesia, relaxation, and loss of reflexes produced by pharmacologic agents

**local anesthesia:** injection of a solution containing the anesthetic agent into the tissues at the planned incision site

## GLOSSARY *(Continued)*

**malignant hyperthermia:** a rare life-threatening condition triggered by exposure to most anesthetic agents inducing a drastic and uncontrolled increase in skeletal muscle oxidative metabolism that can overwhelm the body's capacity to supply oxygen, remove carbon dioxide, and regulate body temperature, eventually leading to circulatory collapse and death if untreated. Malignant hyperthermia is often inherited as an autosomal dominant disorder

**moderate sedation:** previously referred to as conscious sedation, involves use of sedation to depress the level of consciousness without altering the patient's ability to maintain a patent airway and to respond to physical stimuli and verbal commands

**monitored anesthesia care:** moderate sedation administered by an anesthesiologist or anesthetist

**regional anesthesia:** an anesthetic agent is injected around nerves so that the area supplied by these nerves is anesthetized

**restricted zone:** area in the operating room where scrub attire and surgical masks are required; includes operating room and sterile core areas

**scrub role:** registered nurse, licensed practical nurse, or surgical technologist who scrubs and dons sterile surgical attire, prepares instruments and supplies, and hands instruments to the surgeon during the procedure

**semirestricted zone:** area in the operating room where scrub attire is required; may include areas where surgical instruments are processed

**spinal anesthesia:** achieved when a local anesthetic agent is introduced into the subarachnoid space of the spinal cord

**surgical asepsis:** absence of microorganisms in the surgical environment to reduce the risk for infection

**unrestricted zone:** area in the operating room that interfaces with other departments; includes patient reception area and holding area

The intraoperative experience has undergone many changes and advances that make it safer and less disturbing to patients. Even with these advances, anesthesia and surgery still place the patient at risk for several complications or adverse events. Consciousness or full awareness, mobility, protective biologic functions, and personal control are totally or partially relinquished by the patient when entering the operating room (OR). Staff from the departments of anesthesia, nursing, and surgery work collaboratively to implement professional standards of care, to control iatrogenic and individual risks, to prevent complications, and to promote high-quality patient outcomes.

## The Surgical Team

The surgical team consists of the patient, the anesthesiologist or anesthetist, the surgeon, nurses, and the surgical technologists (or assistants). The anesthesiologist or anesthetist (often a nurse anesthetist) administers the **anesthetic agent** and monitors the patient's physical status throughout the surgery. The surgeon, nurses, and assistants scrub and perform the surgery. The person in the scrub role, either a nurse or a surgical technologist, provides sterile instruments and supplies to the surgeon during the procedure. The circulating nurse coordinates the care of the patient in the OR. Care provided by the circulating nurse includes assisting with patient positioning, preparing the patient's skin for surgery, managing surgical specimens, anticipating the needs of the surgical team, and documenting intraoperative events. Collaboration of the surgical team using evidence-based practice tailored to the specific case results in optimum patient care and improved outcomes.

### The Patient

As the patient enters the OR, he or she may feel either relaxed and prepared or fearful and highly stressed. These feelings depend to a large extent on the amount and timing of preoperative sedation and the individual patient. Fears about loss of control, the unknown, pain, death, changes in body structure or function, and disruption of lifestyle all contribute to anxiety. These fears can increase the amount of anesthetic medication needed, the level of postoperative pain, and overall recovery time. See Chapter 7 for more information on stress.

The patient is also subject to several risks. Infection, failure of the surgery to relieve symptoms or correct a deformity, temporary or permanent complications related to the procedure or the anesthetic agent, and death are uncommon but potential outcomes of the surgical experience (Chart 19-1). In addition to fears and risks, the patient undergoing sedation and anesthesia temporarily loses both cognitive function and biologic self-protective mechanisms. Loss of pain sense, reflexes, and ability to communicate subjects the intraoperative patient to possible injury.

#### Gerontologic Considerations

Elderly patients face higher risks from anesthesia and surgery compared to younger adult patients (Rothrock, 2007). There is a progressive loss of skeletal muscle mass in conjunction with an increase in adipose tissue. About one-third of surgical patients are 65 years of age or older. These numbers will increase with prolongation of the lifespan (Barash, Cullen & Stoelting, 2006; Bready, Noorily & Dillman, 2007). Even in the healthiest older adult perioperative management is considerably more complex because of comorbidities, more advanced disease, and increased susceptibility to nosocomial illnesses. Age alone confers enough surgical risk that it is a clinical predictor of cardiovascular complications (Duthie, Katz & Malone, 2007).

Biologic variations of particular importance include age-related cardiovascular and pulmonary changes. The aging heart and blood vessels have decreased ability to respond to stress. Reduced cardiac output and limited cardiac reserve make the elderly patient vulnerable to changes in circulating volume and blood oxygen levels. Excessive or rapid administration of intravenous (IV) solutions can cause pulmonary edema. A sudden or prolonged decline in blood pressure may lead to cerebral ischemia, thrombosis, embolism, infarction, and anoxia. Reduced gas exchange can result in cerebral hypoxia.

Lower doses of anesthetic agents are required in elderly patients due to decreased tissue elasticity (lung and cardiovascular systems) and reduced lean tissue mass. Elderly patients often experience an increase in the duration of clinical effects of medications. With decreased plasma proteins, more of the anesthetic agent remains free or unbound, and the result is more potent action (Barash, et al., 2006).

**Chart 19-1 • *Potential Adverse Effects of Surgery and Anesthesia***

Anesthesia and surgery disrupt all major body systems. Although most patients can compensate for surgical trauma and the effects of anesthesia, all patients are at risk during the operative procedure. These risks include the following:

- Allergic reactions
- Cardiac dysrhythmia from electrolyte imbalance or adverse effect of anesthetic agents
- Myocardial depression, bradycardia, and circulatory collapse
- Central nervous system agitation, seizures, and respiratory arrest
- Oversedation or undersedation
- Agitation or disorientation, especially in elderly patients
- Hypoxemia or hypercarbia from hypoventilation and inadequate respiratory support during anesthesia
- Laryngeal trauma, oral trauma, and broken teeth from difficult intubation
- Hypothermia from cool operating room temperatures, exposure of body cavities, and impaired thermoregulation secondary to anesthetic agents
- Hypotension from blood loss or adverse effect of anesthesia
- Infection
- Thrombosis from compression of blood vessels or stasis
- Malignant hyperthermia secondary to adverse effect of anesthesia
- Nerve damage and skin breakdown from prolonged or inappropriate positioning
- Electrical shock or burns
- Laser burns
- Drug toxicity, faulty equipment, and human error

In addition, body tissues of the older adult are made up predominantly of water, and those tissues with a rich blood supply, such as skeletal muscle, liver, and kidneys, shrink as the body ages. Reduced liver size decreases the rate at which the liver can inactivate many anesthetic agents, and decreased kidney function slows the elimination of waste products and anesthetic agents. Other factors that affect the elderly surgical patient in the intraoperative period include the following:

- Impaired ability to increase metabolic rate and impaired thermoregulatory mechanisms increase susceptibility to hypothermia.
- Bone loss (25% in women, 12% in men) necessitates careful manipulation and positioning during surgery.
- Reduced ability to adjust rapidly to emotional and physical stress influences surgical outcomes and requires meticulous observation of vital functions.

All of these factors lead to a higher likelihood of perioperative mortality and morbidity in elderly patients (Barash, et al., 2006). Further discussion of age-related physiologic changes can be found in Chapter 12.

### *Nursing Care*

Throughout surgery, nursing responsibilities include providing for the safety and well-being of the patient, coordinating the OR personnel, and performing scrub and circulating activities. Because the patient's emotional state remains a concern, the care initiated by preoperative nurses is continued by the intraoperative nursing staff that provides the patient with information and reassurance. The nurse supports coping strategies and reinforces the patient's ability to influence outcomes by encouraging active participation in the plan of care incorporating cultural, ethnic, and religious considerations as appropriate.

As patient advocates, intraoperative nurses monitor factors that can cause injury, such as patient position, equipment malfunction, and environmental hazards, and they protect the patient's dignity and interests while the patient is anesthetized. Additional responsibilities include maintaining surgical standards of care and identifying and minimizing risks and complications.

### *Cultural Diversity*

Cultural, ethnic, and religious diversity are important considerations for all health care professionals. Nurses in the perioperative area should be aware of medications that may be prohibited by certain groups (ie, Muslims and those of the Jewish faith cannot use porcine-based products [heparin (porcine or bovine)], Buddhists may choose not to use bovine products). In certain cultures, the head is a sacred area and staff should allow patients to apply their own surgical cap in this case. When English is the second language of the patient having surgery under local anesthesia, personnel can be provided who speak the patient's native language (DeFazio-Quinn, 2006; Miller, 2009).

## The Circulating Nurse

The **circulating nurse,** a qualified registered nurse (Phillips, 2007), works in collaboration with surgeons, anesthesia providers, and other health care providers to plan the best course of action for each patient (Rothrock, 2007). In this leadership role the circulating nurse manages the OR and protects the patient's safety and health by monitoring the activities of the surgical team, checking the OR conditions, and continually assessing the patient for signs of injury and implementing appropriate interventions. Main responsibilities include verifying consent; coordinating the team; and ensuring cleanliness, proper temperature, humidity, lighting, safe function of equipment, and the availability of supplies and materials. The circulating nurse monitors aseptic practices to avoid breaks in technique while coordinating the movement of related personnel (medical, x-ray, and laboratory), as well as implementing fire safety precautions. The circulating nurse also monitors the patient and documents specific activities throughout the operation to ensure the patient's safety and well-being.

In addition, the circulating nurse is responsible for ensuring that the second verification of the surgical procedure and site takes place and is documented (Fig. 19-1). In some institutions, this is referred to as a "time out" that takes place among the surgical team prior to induction of anesthesia. Every member of the surgical team verifies the patient's name, procedure, and surgical site using objective documentation and data before beginning the surgery (World Health Organization, 2008). Proper patient identification is one of the 2009 National Patient Safety Goals (see Chart 18-8 in Chapter 18). Research suggests use of a surgical safety checklist reduces morbidity and mortality (Haynes, Weiser, Berry, et al., 2009).

***NURSING ALERT***

**It is imperative that the correct patient identity, surgical procedure, and surgical site be verified prior to surgery.**

## The Scrub Role

The registered nurse, licensed practical nurse, or surgical technologist (or assistant) performs the activities of the **scrub role,** including performing a surgical hand scrub; setting up the sterile tables; preparing sutures, ligatures, and special equipment (eg, laparoscope); and assisting the surgeon and the surgical assistants during the procedure by anticipating the instruments and supplies that will be required, such as sponges, drains, and other equipment. As the surgical incision is closed, the scrub person and the circulator count all needles, sponges, and instruments to be sure they are accounted for and not retained as a foreign body in the patient (AORN, 2007; Rothrock, 2007). Standards call for all sponges to be visible on x-ray and for sponge counts to take place at the beginning of surgery and twice at the end. Tissue specimens obtained during surgery are labeled by the person in the scrub role and sent to the laboratory by the circulator.

## The Surgeon

The surgeon performs the surgical procedure, heads the surgical team, and is a licensed physician (MD), osteopath (DO), oral surgeon (DDS or DMD), or podiatrist (DPM) who is specially trained and qualified. Qualifications and training must adhere to the Joint Commission standards, hospital standards, and local and state admitting practices and procedures (Phillips, 2007).

World Health Organization

**SURGICAL SAFETY CHECKLIST (FIRST EDITION)**

Before induction of anaesthesia ▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

| SIGN IN | TIME OUT | SIGN OUT |
|---|---|---|
| ☐ PATIENT HAS CONFIRMED<br>• IDENTITY<br>• SITE<br>• PROCEDURE<br>• CONSENT<br><br>☐ SITE MARKED/NOT APPLICABLE<br><br>☐ ANAESTHESIA SAFETY CHECK COMPLETED<br><br>☐ PULSE OXIMETER ON PATIENT AND FUNCTIONING<br><br>DOES PATIENT HAVE A:<br><br>KNOWN ALLERGY?<br>☐ NO<br>☐ YES<br><br>DIFFICULT AIRWAY/ASPIRATION RISK?<br>☐ NO<br>☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE<br><br>RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?<br>☐ NO<br>☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED | ☐ CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE<br><br>☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM<br>• PATIENT<br>• SITE<br>• PROCEDURE<br><br>ANTICIPATED CRITICAL EVENTS<br><br>☐ SURGEON REVIEWS: WHAT ARE THE CRITICAL OR UNEXPECTED STEPS, OPERATIVE DURATION, ANTICIPATED BLOOD LOSS?<br><br>☐ ANAESTHESIA TEAM REVIEWS: ARE THERE ANY PATIENT-SPECIFIC CONCERNS?<br><br>☐ NURSING TEAM REVIEWS: HAS STERILITY (INCLUDING INDICATOR RESULTS) BEEN CONFIRMED? ARE THERE EQUIPMENT ISSUES OR ANY CONCERNS?<br><br>HAS ANTIBIOTIC PROPHYLAXIS BEEN GIVEN WITHIN THE LAST 60 MINUTES?<br>☐ YES<br>☐ NOT APPLICABLE<br><br>IS ESSENTIAL IMAGING DISPLAYED?<br>☐ YES<br>☐ NOT APPLICABLE | NURSE VERBALLY CONFIRMS WITH THE TEAM:<br><br>☐ THE NAME OF THE PROCEDURE RECORDED<br><br>☐ THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT (OR NOT APPLICABLE)<br><br>☐ HOW THE SPECIMEN IS LABELLED (INCLUDING PATIENT NAME)<br><br>☐ WHETHER THERE ARE ANY EQUIPMENT PROBLEMS TO BE ADDRESSED<br><br>☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE REVIEW THE KEY CONCERNS FOR RECOVERY AND MANAGEMENT OF THIS PATIENT |

THIS CHECKLIST IS NOT INTENDED TO BE COMPREHENSIVE. ADDITIONS AND MODIFICATIONS TO FIT LOCAL PRACTICE ARE ENCOURAGED.

**Figure 19-1** Surgical safety checklist. Used with permission from World Health Organization. (2008). New checklist to help make surgery safer. *WHO Bulletin, 86*(7), 496–576.

## The Registered Nurse First Assistant

The registered nurse first assistant (RNFA) is another member of the OR team. Although the scope of practice of the RNFA depends on each state's nurse practice act, the RNFA practices under the direct supervision of the surgeon. RNFA responsibilities may include handling tissue, providing exposure at the operative field, suturing, and maintaining hemostasis (Rothrock, 2007). The role requires a thorough understanding of anatomy and physiology, tissue handling, and the principles of surgical asepsis. The RNFA must be aware of the objectives of the surgery, must have the knowledge and ability to anticipate needs and to work as a skilled member of a team, and must be able to handle any emergency situation in the OR.

## The Anesthesiologist and Anesthetist

An **anesthesiologist** is a physician specifically trained in the art and science of anesthesiology. An **anesthetist** is also a qualified and specifically trained health care professional who administers anesthetic medications. Most anesthetists are nurses who have graduated from an accredited nurse anesthesia program and have passed examinations sponsored by the American Association of Nurse Anesthetists to become a certified registered nurse anesthetist (CRNA). The anesthesiologist or anesthetist assesses the patient before surgery, selects the anesthesia, administers it, intubates the patient if necessary, manages any technical problems related to the administration of the anesthetic agent, and supervises the patient's condition throughout the surgical procedure. Before the patient enters the OR, often at preadmission testing, the anesthesiologist or anesthetist visits the patient to perform an assessment, supply information, and answer questions. The type of anesthetic agent to be administered, previous reactions to anesthetic medications, and known anatomic abnormalities that would make airway management difficult are among the topics discussed.

The anesthesiologist or anesthetist uses the American Society of Anesthesiologists (ASA) Physical Status Classification System to determine the patient's status. A patient who is classified as P2, P3, or P4 has a systemic disease that may or may not be related to the cause of surgery. If a patient with a classification of P1, P2, P3, P4, or P5 requires emergency surgery, an E is added to the physical status designation (eg, P1E, P2E). P6 refers to a patient who is brain dead and is undergoing surgery as an organ donor. The abbreviations ASA1 through ASA6 are often used interchangeably with P1 to P6 to designate physical status (Phillips, 2007).

When the patient arrives in the OR, the anesthesiologist or anesthetist reassesses the patient's physical condition immediately prior to initiating anesthesia. The anesthetic agent is administered, and the patient's airway is maintained through either an intranasal intubation, oral intubation, or a laryngeal mask airway. During surgery, the anesthesiologist or anesthetist monitors the patient's blood pressure, pulse, and respirations as well as the electrocardiogram (ECG), blood oxygen saturation level, tidal volume, blood gas levels, blood pH, alveolar gas concentrations, and body temperature. Monitoring by electroencephalography is sometimes required. Levels of anesthetic medications in the body can also be determined; a mass spectrometer can provide instant readouts of critical concentration levels on display terminals. This information is used to assess the patient's ability to breathe unassisted or the need for mechanical assistance if ventilation is poor and the patient is not breathing well independently.

## The Surgical Environment

The surgical environment is known for its stark appearance and cool temperature. The surgical suite is behind double doors, and access is limited to authorized personnel. External precautions include adherence to principles of surgical asepsis; strict control of the OR environment is required, including traffic pattern restrictions. Policies governing this environment address such issues as the health of the staff; the cleanliness of the rooms; the sterility of equipment and surfaces; processes for scrubbing, gowning, and gloving; and OR attire.

To provide the best possible conditions for surgery, the OR is situated in a location that is central to all supporting services (eg, pathology, x-ray, and laboratory). The OR has special air filtration devices to screen out contaminating particles, dust, and pollutants.

The National Patient Safety Goals all pertain to the perioperative areas (see Chart 18-8 in Chapter 18), but the one with the most direct relevance to the OR is the reduction of the risk of surgical fires. The risk of fire in the OR is ever present due to three factors: a source of fuel, an oxygen source, and a mechanism to ignite a fire (AORN, 2007). All surgical services personnel must familiarize themselves with the department fire emergency response plan and be competent in the use and safeguards of all combustible materials and equipment in the surgical environment (Rothrock, 2007). Surgical drapes provide an opportunity for oxygen to concentrate; a stray spark could more easily ignite a fire. This occurs most commonly in ambulatory surgery settings (Joint Commission, 2005). To further improve safety, electrical hazards, emergency exit clearances, and storage of equipment and anesthetic gases are monitored periodically by official agencies, such as the state department of health and the Joint Commission.

To help decrease microbes, the surgical area is divided into three zones: the **unrestricted zone,** where street clothes are allowed; the **semirestricted zone,** where attire consists of scrub clothes and caps; and the **restricted zone,** where scrub clothes, shoe covers, caps, and masks are worn. The surgeons and other surgical team members wear additional sterile clothing and protective devices during surgery.

The Association of PeriOperative Registered Nurses (AORN), recommends specific practices for personnel wearing surgical attire to promote a high level of cleanliness in a particular practice setting (AORN, 2007). OR attire includes close-fitting cotton dresses, pantsuits, jumpsuits, and gowns. Knitted cuffs on sleeves and pant legs prevent organisms shed from the perineum, legs, and arms from being released into the immediate surroundings. Shirts and waist drawstrings should be tucked inside the pants to prevent accidental contact with sterile areas and to contain skin shedding. Wet or soiled garments should be changed.

Masks are worn at all times in the restricted zone of the OR. High-filtration masks decrease the risk of postoperative wound infection by containing and filtering microorganisms from the oropharynx and nasopharynx. Masks should fit tightly; should cover the nose and mouth completely; and should not interfere with breathing, speech, or vision. Masks must be adjusted to prevent venting from the sides. Disposable masks have a filtration efficiency exceeding 95%. Masks are changed between patients and should not be worn outside the surgical department. The mask must be either on or off; it must not be allowed to hang around the neck.

Headgear should completely cover the hair (head and neckline, including beard) so that hair, bobby pins, clips, and particles of dandruff or dust do not fall on the sterile field.

Shoes should be comfortable and supportive. Shoe covers are worn when it is anticipated that spills or splashes will occur. If worn, the covers should be changed whenever they become wet, torn, or soiled (Phillips, 2007; Rothrock, 2007).

Barriers such as scrub attire and masks do not entirely protect the patient from microorganisms. Upper respiratory tract infections, sore throats, and skin infections in staff and patients are sources of pathogens and must be reported.

Because artificial fingernails harbor microorganisms and can cause nosocomial infections, a ban on artificial nails by OR personnel is supported by the Centers for Disease Control and Prevention (CDC), AORN, and the Association of Professionals in Infection Control. Research provides support for policies prohibiting artificial nails for health care workers (Gordin, Schultz, Huber, et al., 2007). Short, natural fingernails are encouraged.

### Principles of Surgical Asepsis

**Surgical asepsis** prevents the contamination of surgical wounds. The patient's natural skin flora or a previously existing infection may cause postoperative wound infection. Rigorous adherence to the principles of surgical asepsis by OR personnel is basic to preventing surgical site infections.

All surgical supplies, instruments, needles, sutures, dressings, gloves, covers, and solutions that may come in contact with the surgical wound or exposed tissues must be sterilized before use (Rothrock, 2007). Traditionally, the surgeon, surgical assistants, and nurses prepared themselves by scrubbing their hands and arms with antiseptic soap and water, but this practice is being challenged by research investigating the optimal length of time to scrub and the best preparation to use.

In some institutions, an alcohol-based product or scrubless soap is used to prepare for surgery (Rothrock, 2007).

Surgical team members wear long-sleeved, sterile gowns and gloves. Head and hair are covered with a cap, and a mask is worn over the nose and mouth to minimize the possibility that bacteria from the upper respiratory tract will enter the wound. During surgery, only personnel who have scrubbed, gloved, and gowned touch sterilized objects. Nonscrubbed personnel refrain from touching or contaminating anything sterile.

An area of the patient's skin larger than that requiring exposure during the surgery is meticulously cleansed, and an antiseptic solution is applied (Phillips, 2007). If hair needs to be removed, this is done immediately before the procedure with clippers (not shaved) to minimize the risk of infection (Celik & Kara, 2007). The remainder of the patient's body is covered with sterile drapes.

### Environmental Controls

In addition to the protocols described previously, surgical asepsis requires meticulous cleaning and maintenance of the OR environment. Floors and horizontal surfaces are cleaned between cases with detergent, soap and water or a detergent germicide. Sterilized equipment is inspected regularly to ensure optimal operation and performance.

All equipment that comes into direct contact with the patient must be sterile. Sterilized linens, drapes, and solutions are used. Instruments are cleaned and sterilized in a unit near the OR. Individually wrapped sterile items are used when additional individual items are needed.

Airborne bacteria are a concern. To decrease the amount of bacteria in the air, standard OR ventilation provides 15 air exchanges per hour, at least three of which are fresh air (Phillips, 2007). A room temperature of 20°C to 24°C (68°F to 73°F), humidity between 30% and 60%, and positive pressure relative to adjacent areas are maintained. Staff members shed skin scales, resulting in about 1000 bacteria-carrying particles (or colony-forming units [CFUs]) per cubic foot per minute. With the standard air exchanges, air counts of bacteria are reduced to 50 to 150 CFUs per cubic foot per minute. Systems with high-efficiency particulate air (HEPA) filters are needed to remove particles larger than 0.3 μm (Rothrock, 2007). Unnecessary personnel and physical movement may be restricted to minimize bacteria in the air and achieve an OR infection rate no greater than 3% to 5% in clean, infection-prone surgery.

Some ORs have laminar airflow units. These units provide 400 to 500 air exchanges per hour (Phillips, 2007). When used appropriately, laminar airflow units result in fewer than 10 CFUs per cubic foot per minute during surgery. The goal for a laminar airflow–equipped OR is an infection rate of less than 1%. An OR equipped with a laminar airflow unit is frequently used for total joint replacement or organ transplant surgery.

Even using all precautions, wound contamination may inadvertently occur resulting in a nosocomial infection and a prolonged hospitalization. Constant surveillance and conscientious technique in carrying out aseptic practices are necessary to reduce the risk of contamination and infection.

### Basic Guidelines for Maintaining Surgical Asepsis

All practitioners involved in the intraoperative phase have a responsibility to provide and maintain a safe environment. Adherence to aseptic practice is part of this responsibility. The basic principles of aseptic technique follow:

- All materials in contact with the surgical wound or used within the sterile field must be sterile. Sterile surfaces or articles may touch other sterile surfaces or articles and remain sterile; contact with unsterile objects at any point renders a sterile area contaminated.
- Gowns of the surgical team are considered sterile in front from the chest to the level of the sterile field. The sleeves are also considered sterile from 2 inches above the elbow to the stockinette cuff.
- Sterile drapes are used to create a sterile field (Fig. 19-2). Only the top surface of a draped table is considered sterile. During draping of a table or patient, the sterile drape is held well above the surface to be covered and is positioned from front to back.
- Items are dispensed to a sterile field by methods that preserve the sterility of the items and the integrity of the sterile field. After a sterile package is opened, the edges are considered unsterile. Sterile supplies, including solutions, are delivered to a sterile field or handed to a scrubbed person in such a way that the sterility of the object or fluid remains intact.
- The movements of the surgical team are from sterile to sterile areas and from unsterile to unsterile areas. Scrubbed people and sterile items contact only sterile areas; circulating nurses and unsterile items contact only unsterile areas.
- Movement around a sterile field must not cause contamination of the field. Sterile areas must be kept in view during movement around the area. At least a 1-foot distance from the sterile field must be maintained to prevent inadvertent contamination.
- Whenever a sterile barrier is breached, the area must be considered contaminated. A tear or puncture of the drape permitting access to an unsterile surface underneath renders the area unsterile. Such a drape must be replaced.



**Figure 19-2** Proper draping exposes only the surgical site, which decreases the risk for infection.

- Every sterile field is constantly monitored and maintained. Items of doubtful sterility are considered unsterile. Sterile fields are prepared as close as possible to the time of use.
- The routine administration of hyperoxia (high levels of oxygen) is *not* recommended to reduce surgical site infections.

## Health Hazards Associated With the Surgical Environment

Faulty equipment, improper use of equipment, exposure to toxic substances, as well as infectious waste, cuts, needlestick injuries, and lasers are some of the associated hazards in the surgical environment (Kiffmeyer & Hadstein, 2007; Phillips, 2007). Internal monitoring of the OR includes the analysis of surface swipe samples and air samples for infectious and toxic agents. In addition, policies and procedures for minimizing exposure to body fluids and reducing the dangers associated with lasers and radiation have been established.

Regardless of the size or location of an incision, unintentional retention of an object (eg, sponge, instrument) can occur. A retained object can cause wound infection or disruption, an abscess can form, and fistulas may develop between organs (Phillips, 2007).

### Laser Risks

The AORN has recommended practices for laser safety (Phillips, 2007). When lasers are in use, warning signs must be clearly posted to alert personnel. Safety precautions are implemented to reduce the possibility of exposing the eyes and skin to laser beams, to prevent inhalation of the laser plume (smoke and particulate matter), and to protect the patient and personnel from fire and electrical hazards. Several types of lasers are available for clinical use; perioperative personnel should be familiar with the unique features, specific operation, and safety measures for each type of laser used in the practice setting and wear appropriate laser goggles for the type of laser beam in use.

Smoke evacuators are used in some procedures to remove the laser plume from the operative field. In recent years, this technology has been used to protect the surgical team from the potential hazards associated with the generalized smoke plume generated by standard electrocautery units.

### Exposure to Blood and Body Fluids

OR attire has changed dramatically since the advent of acquired immunodeficiency syndrome (AIDS). Double-gloving is routine in trauma and other types of surgery where sharp bone fragments are present. In addition to the routine scrub suit and double gloves, some surgical personnel wear rubber boots, a waterproof apron, and sleeve protectors. Goggles, or a wrap-around face shield, are worn to protect against splashing when the surgical wound is irrigated or when bone drilling is performed. In hospitals where numerous total joint procedures are performed, a complete bubble mask may be used. This mask provides full-barrier protection from bone fragments and splashes. Ventilation is accomplished through an accompanying hood with a separate air filtration system.

# The Surgical Experience

During the surgical procedure, the patient will need sedation, anesthesia, or some combination of these.

## Types of Anesthesia and Sedation

Research estimates anesthesia-related death rates in the United States to be less than 1 per 10,000 surgeries (Barash, et al., 2006). For the patient, the anesthesia experience consists of having an IV line inserted, if it was not inserted earlier; receiving a sedating agent prior to induction with an anesthetic agent; losing consciousness; being intubated, if indicated; and then receiving a combination of anesthetic agents. Typically the experience is a smooth one, and the patient has no recall of the events. The main types of anesthesia are general anesthesia, regional anesthesia, moderate sedation, monitored anesthesia care, and local anesthesia.

### General Anesthesia

**Anesthesia** is a state of narcosis (severe central nervous system depression produced by pharmacologic agents), analgesia, relaxation, and reflex loss. Patients under **general anesthesia** are not arousable, not even to painful stimuli. They lose the ability to maintain ventilatory function and require assistance in maintaining a patent airway. Cardiovascular function may be impaired as well.

The Joint Commission has issued an alert regarding the phenomenon of patients being partially awake while under general anesthesia (referred to as anesthesia awareness). Patients at greatest risk of anesthesia awareness are cardiac, obstetric, and major trauma patients. The entire surgical team must be aware of this phenomenon and help prevent or manage it (Joint Commission, 2008).

General anesthesia consists of four stages, each associated with specific clinical manifestations (Rothrock, 2007):

- *Stage I: beginning anesthesia.* As the patient breathes in the anesthetic mixture, warmth, dizziness, and a feeling of detachment may be experienced. The patient may have a ringing, roaring, or buzzing in the ears and, although still conscious, may sense an inability to move the extremities easily. During this stage, noises are exaggerated; even low voices or minor sounds seem loud and unreal. For this reason, unnecessary noises and motions are avoided when anesthesia begins.
- *Stage II: excitement.* The excitement stage, characterized variously by struggling, shouting, talking, singing, laughing, or crying, is often avoided if the anesthetic agent is administered smoothly and quickly. The pupils dilate, but they contract if exposed to light; the pulse rate is rapid, and respirations may be irregular. Because of the possibility of uncontrolled movements of the patient during this stage, the anesthesiologist or anesthetist must always be assisted by someone ready to help restrain the patient. Manipulation increases circulation to the operative site and thereby increases the potential for bleeding.
- *Stage III: surgical anesthesia.* Surgical anesthesia is reached by continued administration of the anesthetic vapor or gas. The patient is unconscious and lies quietly on the table. The pupils are small but contract when

exposed to light. Respirations are regular, the pulse rate and volume are normal, and the skin is pink or slightly flushed. With proper administration of the anesthetic agent, this stage may be maintained for hours in one of several planes, ranging from light (1) to deep (4), depending on the depth of anesthesia needed.

- *Stage IV: medullary depression*. This stage is reached if too much anesthesia has been administered. Respirations become shallow, the pulse is weak and thready, and the pupils become widely dilated and no longer contract when exposed to light. Cyanosis develops and, without prompt intervention, death rapidly follows. If this stage develops, the anesthetic agent is discontinued immediately and respiratory and circulatory support is initiated to prevent death. Stimulants, although rarely used, may be administered; narcotic antagonists can be used if the overdosage is due to opioids.

When opioid agents (narcotics) and neuromuscular blockers (relaxants) are administered, several of the stages are absent. During smooth administration of an anesthetic agent, there is no sharp division between stages I, II, and III, and there is no stage IV. The patient passes gradually from one stage to another, and it is through close observation of the signs exhibited by the patient that an anesthesiologist or anesthetist controls the situation. The responses of the pupils, the blood pressure, and the respiratory and cardiac rates are among the most reliable guides to the patient's condition.

Anesthetic agents used in general anesthesia are inhaled or administered by IV. Anesthetic medications produce anesthesia because they are delivered to the brain at a high partial pressure that enables them to cross the blood–brain barrier. Relatively large amounts of anesthetic medication must be administered during induction and the early maintenance phases because the anesthetic agent is recirculated and deposited in body tissues. As these sites become saturated, smaller amounts of the anesthetic agent are required to maintain anesthesia because equilibrium or near equilibrium has been achieved between brain, blood, and other tissues. When possible, the anesthesia induction (initiation) begins with IV anesthesia and is then maintained at the desired stage by inhalation methods, achieving a smooth transition and eliminating the obvious stages of anesthesia.

Any condition that diminishes peripheral blood flow, such as vasoconstriction or shock, may reduce the amount of anesthetic medication required. Conversely, when peripheral blood flow is unusually high, as in a muscularly active or apprehensive patient, induction is slower, and greater quantities of anesthetic agents are required because the brain receives a smaller quantity of anesthetic agent.

### Inhalation

Inhaled anesthetic agents include volatile liquid agents and gases. Volatile liquid anesthetic agents produce anesthesia when their vapors are inhaled. Some commonly used inhalation agents are included in Table 19-1. All are administered

**Table 19-1 INHALATION ANESTHETIC AGENTS**

| Agent | Administration | Advantages | Disadvantages | Implications/Considerations |
|---|---|---|---|---|
| **Volatile Liquids** | | | | |
| Halothane (Fluothane) | Inhalation; special vaporizer | Not explosive or flammable<br>Induction rapid and smooth<br>Useful in almost every type of surgery<br>Low incidence of postoperative nausea and vomiting | Requires skillful administration to prevent overdosage<br>May cause liver damage<br>May produce hypotension<br>Requires special vaporizer for administration | In addition to observation of pulse and respiration postoperatively, blood pressure must be monitored frequently. |
| Enflurane (Ethrane) | Inhalation | Rapid induction and recovery<br>Potent analgesic agent<br>Not explosive or flammable | Respiratory depression may develop rapidly, along with ECG abnormalities.<br>Not compatible with epinephrine | Observe for possible respiratory depression. Administration with epinephrine may cause ventricular fibrillation. |
| Isoflurane (Forane) | Inhalation | Rapid induction and recovery<br>Muscle relaxants are markedly potentiated. | A profound respiratory depressant | Monitor respirations closely and support when necessary. |
| Sevoflurane* (Ultrane) | Inhalation | Rapid induction and excretion; minimal side effects | Coughing and laryngospasm; trigger for malignant hyperthermia | Monitor for malignant hyperthermia. |
| Desflurane (Suprane) | Inhalation | Rapid induction and emergence; rare organ toxicity | Respiratory irritation; trigger for malignant hyperthermia | Monitor for malignant hyperthermia and dysrhythmias. |
| **Gases** | | | | |
| Nitrous oxide ($N_2O$) | Inhalation (semi-closed method) | Induction and recovery rapid<br>Nonflammable<br>Useful with oxygen for short procedures<br>Useful with other agents for all types of surgery | Poor relaxant<br>Weak anesthetic<br>May produce hypoxia | Most useful in conjunction with other agents with longer action.<br>Monitor for chest pain, hypertension, and stroke. |
| Oxygen ($O_2$) | Inhalation | Can increase $O_2$ available to tissues | High concentrations are hazardous. | Increased fire risk when used with lasers |

*Currently most popular choice.

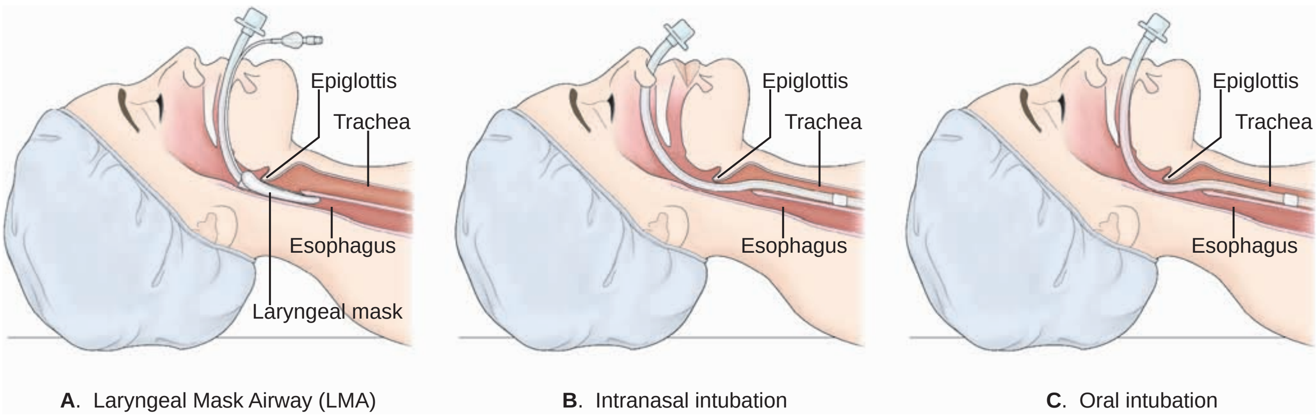



**Figure 19-3** Anesthetic delivery methods. **A,** laryngeal mask airway (LMA). **B,** Nasal endotracheal catheter (in position with cuff inflated). **C,** Oral endotracheal intubation (tube is in position with cuff inflated).

in combination with oxygen and usually nitrous oxide as well.

Gas anesthetic agents are administered by inhalation and are always combined with oxygen. Nitrous oxide is the most commonly used gas anesthetic agent. When inhaled, the anesthetic agents enter the blood through the pulmonary capillaries and act on cerebral centers to produce loss of consciousness and sensation. When anesthetic administration is discontinued, the vapor or gas is eliminated through the lungs.

The vapor from inhalation anesthetic agents can be administered to the patient by several methods. The inhalation anesthetic agent may be administered through a laryngeal mask airway (Fig. 19-3A), a flexible tube with an inflatable silicone ring and cuff that can be inserted into the larynx. The endotracheal technique for administering anesthetic medications consists of introducing a soft rubber or plastic endotracheal tube into the trachea, usually by means of a laryngoscope. The endotracheal tube may be inserted through either the nose (see Fig. 19-3B) or mouth (see Fig. 19-3C). When in place, the tube seals off the lungs from the esophagus so that, if the patient vomits, stomach contents do not enter the lungs.

#### Intravenous Administration

General anesthesia can also be produced by the IV administration of various substances, such as barbiturates, benzodiazepines, nonbarbiturate hypnotics, dissociative agents, and opioid agents. Table 19-2 lists commonly used IV anesthetic and analgesic agents, including IV medications used as muscle relaxants in the intraoperative period. These medications may be administered to induce or maintain anesthesia. Although they are often used in combination with inhalation anesthetic agents, they may be used alone. They may also be used to produce moderate sedation, as discussed later in this chapter.

An advantage of IV anesthesia is that the onset of anesthesia is pleasant; there is none of the buzzing, roaring, or dizziness known to follow administration of an inhalation anesthetic agent. The duration of action is brief, and the patient awakens with little nausea or vomiting.

The IV anesthetic agents are nonexplosive, require little equipment, and are easy to administer. The low incidence of postoperative nausea and vomiting makes the method useful in eye surgery, because in this setting vomiting would increase intraocular pressure and endanger vision in the operated eye. IV anesthesia is useful for short procedures but is used less often for the longer procedures of abdominal surgery. It is not indicated for children who have small veins or for those who require intubation because of their susceptibility to respiratory obstruction.

IV neuromuscular blockers (muscle relaxants) block the transmission of nerve impulses at the neuromuscular junction of skeletal muscles. Muscle relaxants are used to relax muscles in abdominal and thoracic surgery, relax eye muscles in certain types of eye surgery, facilitate endotracheal intubation, treat laryngospasm, and assist in mechanical ventilation.

### Regional Anesthesia

In **regional anesthesia,** an anesthetic agent is injected around nerves so that the region supplied by these nerves is anesthetized. The effect depends on the type of nerve involved. Motor fibers are the largest fibers and have the thickest myelin sheath. Sympathetic fibers are the smallest and have a minimal covering. Sensory fibers are intermediate. A local anesthetic agent blocks motor nerves least readily and sympathetic nerves most readily. An anesthetic agent cannot be regarded as having worn off until all three systems (motor, sensory, and autonomic) are no longer affected.

The patient receiving regional anesthesia is awake and aware of his or her surroundings unless medications are given to produce mild sedation or to relieve anxiety. The health care team must avoid careless conversation, unnecessary noise, and unpleasant odors; these may be noticed by the patient in the OR and may contribute to a negative response to the surgical experience. A quiet environment is therapeutic. The diagnosis must not be stated aloud if the patient is not to know it at this time.

#### Epidural Anesthesia

**Epidural anesthesia** is achieved by injecting a local anesthetic agent into the epidural space that surrounds the dura mater of the spinal cord (Fig. 19-4). The administered medication diffuses across the layers of the spinal cord to provide anesthesia and pain relief (Schwartz, 2006). In contrast,

**Table 19-2 COMMONLY USED INTRAVENOUS MEDICATIONS**

| Medication | Common Usage | Advantages | Disadvantages | Comments |
|---|---|---|---|---|
| **Opioid Analgesic Agents** | | | | |
| Alfentanil (Alfenta) | Surgical analgesia in ambulatory patients | Ultra-short (5–10 min) acting analgesic agent; duration of action 0.5 h; bolus or infusion | | Potency: 750 μg; half-life 1.6 h |
| Fentanyl (Sublimaze) | Surgical analgesia: epidural infusion for postoperative analgesia; add to SAB | Good cardiovascular stability; duration of action 0.5 h | May cause muscle or chest wall rigidity | Most commonly used opioid; potency: 100 μg = 10 mg morphine sulfate; elimination half-life 3.6 h |
| Morphine sulfate (MS) | Preoperative pain; premedication; postoperative pain | Inexpensive; duration of action 4–5 h; euphoria; good cardiovascular stability | Nausea and vomiting; histamine release; postural ↓ BP and ↓ SVR | Epidural and intrathecal administration for postoperative pain; elimination half-life 3 h |
| Remifentanil (Ultiva) | IV infusion for surgical analgesia; small boluses for brief, intense pain | Easily titratable; very short duration; good cardiovascular stability Ultiva is rapidly metabolized by hydrolysis of the propanoic acid–methyl ester linkage by nonspecific blood and tissue esterases. | New; expensive; requires mixing; may cause muscle rigidity | Potency: 25 μg = 10 mg morphine sulfate; 20–30 times potency of alfentanil; elimination half-life 3–10 min |
| Sufentanil (Sufenta) | Surgical analgesia | Duration of action 0.5 h; prolonged analgesia exceptionally potent (5–10 times more than fentanyl); provides good stability in cardiovascular surgery | Prolonged respiratory depression | Potency: 15 μg = 10 mg morphine sulfate; elimination half-life 2.7 h |
| **Depolarizing Muscle Relaxants** | | | | |
| Succinylcholine | Relax skeletal muscles for surgery and orthopedic manipulations; short procedures; intubation | Short duration; rapid onset | No known effect on consciousness, pain threshold, or cerebration; fasciculations, postoperative myalgias, dysrhythmias; raises serum $K^+$ in tissue trauma, muscular disease, paralysis, burns; histamine release is slight; requires refrigeration | Prolonged muscle relaxation with serum cholinesterase deficiency and some antibiotics; may trigger malignant hyperthermia |
| **Nondepolarizing Muscle Relaxants—Intermediate Onset and Duration** | | | | |
| Atracurium besylate (Tracrium) | Intubation; maintenance of skeletal muscle relaxation | No significant cardiovascular or cumulative effects; good with renal failure | Requires refrigeration; slight histamine release; pregnancy risk category C; do not mix with lactated Ringer's solution or alkaline solutions such as barbiturates | Rapid IV bolus; use cautiously with geriatric and debilitated patients |
| Cisatracurium besylate (Nimbex) | Intubation; maintenance of skeletal muscle relaxation | Similar to atracurium | No histamine release | Similar to atracurium |
| Mivacurium (Mivacron) | Intubation; maintenance of skeletal muscle relaxation | Short acting; rapid metabolism by plasma cholinesterase; used as bolus or infusion | Expensive in longer cases | Competes with acetylcholine for receptor sites at the motor end plate, blocking neuromuscular transmission; new; rarely need to reverse; prolonged effect with plasma cholinesterase deficiency |
| Rocuronium (Zemuron) | Intubation; maintenance of relaxation | Rapid onset (dose dependent); elimination via kidney and liver | No known effect on consciousness, pain threshold, or cerebration; vagolytic; may ↑ HR | Duration similar to atracurium and vecuronium |

*Continued on following page*

**Table 19-2 COMMONLY USED INTRAVENOUS MEDICATIONS (Continued)**

| Medication | Common Usage | Advantages | Disadvantages | Comments |
|---|---|---|---|---|
| Vecuronium (Norcuron) | Intubation; maintenance of relaxation | No significant cardiovascular or cumulative effects; no histamine release | Requires mixing | Mostly eliminated in bile, some in urine |
| **Nondepolarizing Muscle Relaxants—Longer Onset and Duration** | | | | |
| *d*-Tubocurarine | Adjunct to anesthesia; maintenance of relaxation | | No known effect on consciousness, pain threshold, or cerebration; might cause histamine release and transient ganglionic blockade | Mostly used for pretreatment with succinylcholine |
| Metocurine (Metubine) | Maintenance of relaxation | Good cardiovascular stability | Slight histamine release | Most commonly used opioid; potency: 100 μg = 10 mg morphine sulfate; elimination half-life 3.6 h |
| Pancuronium (Pavulon) | Maintenance of relaxation | | May cause ↑ HR and ↑ BP | Used intrathecally and epidurally for postoperative pain; elimination half-life 3 h |
| **Intravenous Anesthetic Agents** | | | | |
| Diazepam (Valium, Dizac) | Amnesia; hypnotic; relieves anxiety; preoperative | Good sedation | Long acting | Residual effects for 20–90 h; increased effect with alcohol |
| Etomidate (Amidate) | Induction of general anesthesia; indicated to supplement low-potency anesthetic agents | Short-acting hypnotic; good cardiovascular stability; fast, smooth induction and recovery | May cause brief period of apnea; pain with injection and myotonic movements | |
| Ketamine (Ketalar) | Induction; occasional maintenance (IV or IM) | Short acting; profound analgesia; patient maintains airway; good in small children and burn patients | Large doses may cause hallucinations and respiratory depression; chest wall rigidity; laryngeal spasm | Need darkened, quiet room for recovery; often used in trauma cases |
| Midazolam (Versed) | Hypnotic; anxiolytic; sedation; often used as adjunct to induction | Excellent amnesia; water soluble (no pain with IV injection); short acting | Slower induction than thiopental | Often used for amnesia with insertion of invasive monitors or regional anesthesia; depresses all levels of CNS, including limbic and reticular formation, probably through increased action of GABA, which is major inhibitory neurotransmitter in brain |
| Propofol (Diprivan) | Induction and maintenance; sedation with regional anesthesia or MAC | Rapid onset; awakening in 4–8 min; produces sedation/hypnosis rapidly (within 40 sec) and smoothly with minimal excitation; decreases intraocular pressure and systemic vascular resistance; rarely is associated with malignant hyperthermia and histamine release | May cause pain when injected; suppresses cardiac output and respiratory drive | Short elimination half-life (34–64 min) |
| Sodium methohexital (Brevital) | Induction; methohexital slows the activity of brain and nervous system | Ultra-short-acting barbiturate | May cause hiccups | Can be given rectally |
| Thiopental sodium (Pentothal) | Induction; stops seizures | | May cause laryngospasm; can be given rectally | Large doses may cause apnea and cardiovascular depression |

BP, blood pressure; CNS, central nervous system; GABA, gamma-aminobutyric acid; HR, heart rate; IM, intramuscular; IV, intravenous; MAC, monitored anesthesia care; SAB, subarachnoid block; SVR, stroke volume ratio.

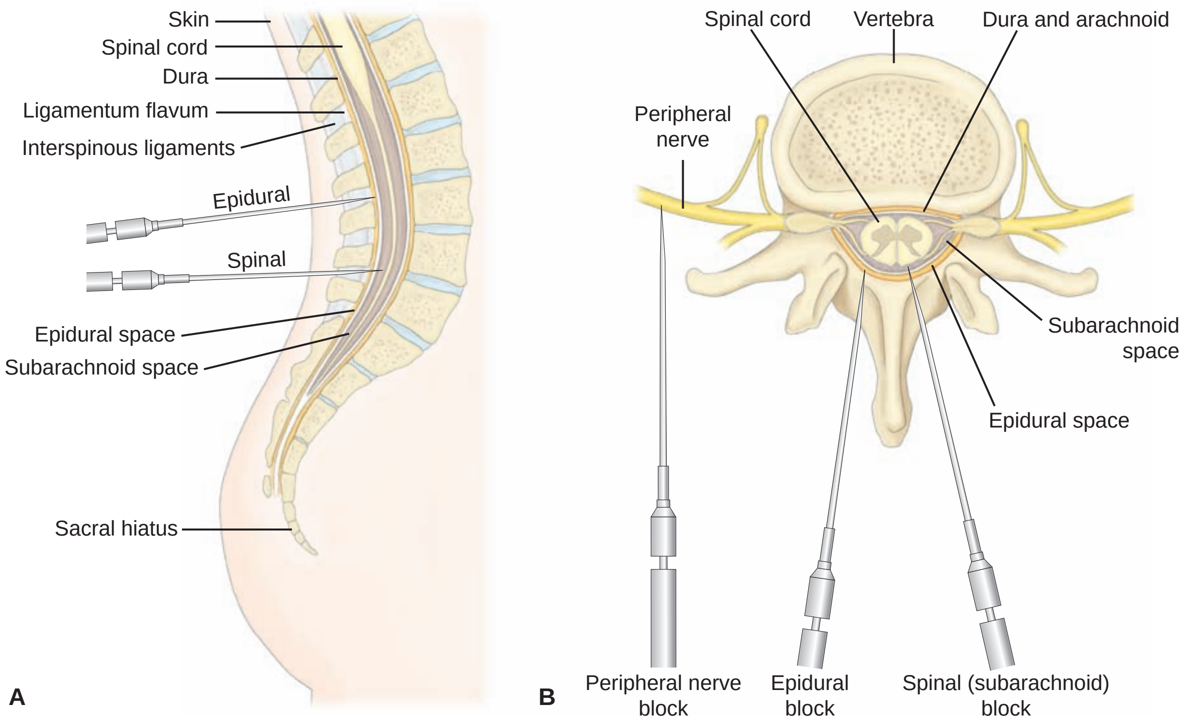



**Figure 19-4** **A,** Injection sites for spinal and epidural anesthesia. **B,** Cross-section of injection sites for peripheral nerve, epidural, and spinal blocks.

spinal anesthesia involves injection through the dura mater into the subarachnoid space surrounding the spinal cord. Epidural anesthesia blocks sensory, motor, and autonomic functions; it differs from spinal anesthesia by the site of the injection and the amount of anesthetic agent used. Epidural doses are much higher because the epidural anesthetic agent does not make direct contact with the spinal cord or nerve roots.

An advantage of epidural anesthesia is the absence of headache that can result from spinal anesthesia. A disadvantage is the greater technical challenge of introducing the anesthetic agent into the epidural rather than the subarachnoid space. If inadvertent puncture of the dura occurs during epidural anesthesia and the anesthetic agent travels toward the head, high spinal anesthesia can result; this can produce severe hypotension and respiratory depression and arrest. Treatment of these complications includes airway support, IV fluids, and use of vasopressors.

### Spinal Anesthesia

**Spinal anesthesia** is an extensive conduction nerve block that is produced when a local anesthetic agent is introduced into the subarachnoid space at the lumbar level, usually between L4 and L5 (see Fig. 19-4). It produces anesthesia of the lower extremities, perineum, and lower abdomen. For the lumbar puncture procedure, the patient usually lies on the side in a knee–chest position. Sterile technique is used as a spinal puncture is made and the medication is injected through the needle. As soon as the injection has been made, the patient is positioned on his or her back. If a relatively high level of block is sought, the head and shoulders are lowered.

The spread of the anesthetic agent and the level of anesthesia depend on the amount of fluid injected, the speed with which it is injected, the positioning of the patient after the injection, and the specific gravity of the agent. If the specific gravity is greater than that of cerebrospinal fluid (CSF), the agent moves to the dependent position of the subarachnoid space. If the specific gravity is less than that of CSF, the anesthetic agent moves away from the dependent position. The anesthesiologist or anesthetist controls the administration of the agent. Table 19-3 presents types of regional anesthesia agents.

A few minutes after induction of a spinal anesthetic agent, anesthesia and paralysis affect the toes and perineum and then gradually the legs and abdomen. If the anesthetic agent reaches the upper thoracic and cervical spinal cord in high concentrations, a temporary partial or complete respiratory paralysis results. Paralysis of the respiratory muscles is managed by mechanical ventilation until the effects of the anesthetic agent on the cranial and thoracic nerves have worn off.

Nausea, vomiting, and pain may occur during surgery when spinal anesthesia is used. As a rule, these reactions result from manipulation of various structures, particularly those within the abdominal cavity. Adequate hydration and the IV administration of appropriate medications may prevent such reactions (Fetzer, 2008).

Headache may be an after-effect of spinal anesthesia. Several factors are related to the incidence of headache: the size of the spinal needle used, the leakage of fluid from the subarachnoid space through the puncture site, and the patient's hydration status. Measures that increase cerebrospinal pressure are helpful in relieving headache. These

**Table 19-3 SELECTED REGIONAL AND LOCAL ANESTHETIC AGENTS**

| Agent | Administration | Advantages | Disadvantages | Implications/Considerations |
|---|---|---|---|---|
| Lidocaine (Xylocaine) | Epidural, spinal, peripheral intravenous anesthesia, and local infiltration | Rapid<br>Longer duration of action (compared with procaine)<br>Free from local irritative effect | Occasional idiosyncrasy | Useful topically for cystoscopy<br>Observe for untoward reactions—drowsiness, depressed respiration, seizures |
| Bupivacaine (Marcaine, Sensoricaine) | Epidural, spinal, peripheral intravenous anesthesia, and local infiltration | Duration is 2–3 times longer than lidocaine | Use cautiously in patients with known drug allergies or sensitivities. | A period of analgesia persists after return of sensation; therefore, need for strong analgesics agents is reduced.<br>Greater potency and longer action than lidocaine |
| Tetracaine (Pontocaine) | Topical, infiltration, and nerve block | Long acting, produces good relaxation | Occasional allergic reaction | More than 10 times as potent as procaine (Novocaine) |
| Procaine (Novocaine) | Local infiltration | | Occasional allergic reaction | Commonly used in oral or dental surgery |

include maintaining a quiet environment, keeping the patient lying flat, and keeping the patient well hydrated.

In continuous spinal anesthesia, the tip of a plastic catheter remains in the subarachnoid space during the surgical procedure so that more anesthetic medication may be injected as needed. This technique allows greater control of the dosage, but there is greater potential for postanesthetic headache because of the large-gauge needle used.

#### Local Conduction Blocks

Examples of common local conduction blocks are:

- Brachial plexus block, which produces anesthesia of the arm
- Paravertebral anesthesia, which produces anesthesia of the nerves supplying the chest, abdominal wall, and extremities
- Transsacral (caudal) block, which produces anesthesia of the perineum and, occasionally, the lower abdomen

### *Moderate Sedation*

**Moderate sedation,** previously referred to as conscious sedation, is a form of anesthesia that involves the IV administration of sedatives or analgesic medications to reduce patient anxiety and control pain during diagnostic or therapeutic procedures. It is being used increasingly for specific short-term surgical procedures in hospitals and ambulatory care centers (Rothrock, 2007). The goal is to depress a patient's level of consciousness to a moderate level to enable surgical, diagnostic, or therapeutic procedures to be performed while ensuring the patient's comfort during and cooperation with the procedures. With moderate sedation, the patient is able to maintain a patent airway, retain protective airway reflexes, and respond to verbal and physical stimuli.

Moderate sedation can be administered by an anesthesiologist, anesthetist, or other specially trained and credentialed physician or nurse. The patient receiving moderate sedation is never left alone and is closely monitored by a physician or nurse who is knowledgeable and skilled in detecting dysrhythmias, administering oxygen, and performing resuscitation. The continual assessment of the patient's vital signs, level of consciousness, and cardiac and respiratory function is an essential component of moderate sedation. Pulse oximetry, ECG monitor, and frequent measurement of vital signs are used to monitor the patient. The regulations for use and administration of moderate sedation differ from state to state, and its administration is addressed by standards issued by the Joint Commission and by institutional policies and nursing specialty organizations, including the Association of PeriAnesthesia Nurses.

### *Monitored Anesthesia Care*

**Monitored anesthesia care** (MAC), also referred to as monitored sedation, is moderate sedation administered by an anesthesiologist or anesthetist who must be prepared and qualified to convert to general anesthesia if necessary. The skills of an anesthesiologist or anesthetist may be necessary to manage the effects of a level of deeper sedation to return the patient to the appropriate level of sedation (Barash, et al., 2006). MAC may be used for healthy patients undergoing relatively minor surgical procedures and for some critically ill patients who may be unable to tolerate anesthesia without extensive invasive monitoring and pharmacologic support (Rothrock, 2007).

### *Local Anesthesia*

**Local anesthesia** is the injection of a solution containing the anesthetic agent into the tissues at the planned incision site. Often it is combined with a local regional block by injecting around the nerves immediately supplying the area. Advantages of local anesthesia are as follows:

- It is simple, economical, and nonexplosive.
- Equipment needed is minimal.
- Postoperative recovery is brief.
- Undesirable effects of general anesthesia are avoided.
- It is ideal for short and minor surgical procedures.

Local anesthesia is often administered in combination with epinephrine. Epinephrine constricts blood vessels, which prevents rapid absorption of the anesthetic agent and thus prolongs its local action. Rapid absorption of the anesthetic agent into the bloodstream, which could cause

seizures, is also prevented. Agents that can be used as local anesthetic agents are listed in Table 19-3; some of the same agents used in regional anesthesia are used as local anesthetic agents.

Local anesthesia is the preferred method in any surgical procedure in which it can be used. However, contraindications include high preoperative levels of anxiety, because surgery with local anesthesia may increase anxiety. A patient who requests general anesthesia rarely does well under local anesthesia. For some surgical procedures, local anesthesia is impractical because of the number of injections and the amount of anesthetic medication that would be required (eg, breast reconstruction).

The skin is prepared as for any surgical procedure, and a small-gauge needle is used to inject a modest amount of the anesthetic medication into the skin layers. This produces blanching or a wheal. Additional anesthetic medication is then injected into the skin until an area the length of the proposed incision is anesthetized. A larger, longer needle then is used to infiltrate deeper tissues with the anesthetic agent. The action of the agent is almost immediate, so surgery may begin as soon as the injection is complete. Anesthesia lasts 45 minutes to 3 hours, depending on the anesthetic agent and the simultaneous use of epinephrine.

## *Potential Intraoperative Complications*

The surgical patient is subject to several risks. Potential intraoperative complications include nausea and vomiting, anaphylaxis, hypoxia, hypothermia, and malignant hyperthermia. The national Surgical Care Improvement Project (SCIP) set a national goal of a 25% reduction in surgical complications by 2010. Targeted areas include surgical site infections, as well as cardiac, respiratory, and venous thromboembolic complications (SCIP, 2005).

### NAUSEA AND VOMITING

Nausea and vomiting, or regurgitation, may affect patients during the intraoperative period. If gagging occurs, the patient is turned to the side, the head of the table is lowered, and a basin is provided to collect the vomitus. Suction is used to remove saliva and vomited gastric contents. The advent of new anesthetic agents has reduced the incidence; however, there is no single way to prevent nausea and vomiting. An interdisciplinary approach involving the surgeon, anesthesiologist or anesthetist, and nurse is best (Fetzer, 2008).

In some cases, the anesthesiologist or anesthetist administers antiemetics preoperatively or intraoperatively to counteract possible aspiration. If the patient aspirates vomitus, an asthmalike attack with severe bronchial spasms and wheezing is triggered. Pneumonitis and pulmonary edema can subsequently develop, leading to extreme hypoxia. Increasing medical attention is being paid to silent regurgitation of gastric contents (not related to preoperative fasting times), which occurs more frequently than previously realized. The volume and acidity of the aspirate determine the extent of damage to the lungs. Patients may be given citric acid and sodium citrate (Bicitra), a clear, nonparticulate antacid to increase gastric fluid pH or a histamine-2 ($H_2$) receptor antagonist such as cimetidine (Tagamet), ranitidine (Zantac), or famotidine (Pepcid) to decrease gastric acid production (Rothrock, 2007).

### ANAPHYLAXIS

Any time the patient comes into contact with a foreign substance, there is the potential for an anaphylactic reaction. Because medications are the most common cause of anaphylaxis, intraoperative nurses must be aware of the type and method of anesthesia used as well as the specific agents. An anaphylactic reaction can occur in response to many medications, latex, or other substances. The reaction may be immediate or delayed. Anaphylaxis is a life-threatening acute allergic reaction.

Fibrin sealants are used in a variety of surgical procedures, and cyanoacrylate tissue adhesives are used to close wounds without the use of sutures. These sealants have been implicated in allergic reactions and anaphylaxis (Phillips, 2007). Although these reactions are rare, the nurse must be alert to the possibility and observe the patient for changes in vital signs and symptoms of anaphylaxis when these products are used. See Chapters 15 and 53 for more details about the signs, symptoms, and treatment of anaphylaxis and anaphylactic shock.

### HYPOXIA AND OTHER RESPIRATORY COMPLICATIONS

Inadequate ventilation, occlusion of the airway, inadvertent intubation of the esophagus, and hypoxia are significant potential complications associated with general anesthesia. Many factors can contribute to inadequate ventilation. Respiratory depression caused by anesthetic agents, aspiration of respiratory tract secretions or vomitus, and the patient's position on the operating table can compromise the exchange of gases. Anatomic variation can make the trachea difficult to visualize and result in insertion of the artificial airway into the esophagus rather than into the trachea. In addition to these dangers, asphyxia caused by foreign bodies in the mouth, spasm of the vocal cords, relaxation of the tongue, or aspiration of vomitus, saliva, or blood can occur. Brain damage from hypoxia occurs within minutes; therefore, vigilant monitoring of the patient's oxygenation status is a primary function of the anesthesiologist or anesthetist and the circulating nurse. Peripheral perfusion is checked frequently, and pulse oximetry values are monitored continuously.

### HYPOTHERMIA

During anesthesia, the patient's temperature may fall. Glucose metabolism is reduced, and, as a result, metabolic acidosis may develop. This condition is called hypothermia and is indicated by a core body temperature that is lower than normal (36.6°C [98.0°F] or less). Inadvertent hypothermia may occur as a result of a low temperature in the OR, infusion of cold fluids, inhalation of cold gases, open body wounds or cavities, decreased muscle activity, advanced age, or the pharmaceutical agents used (eg, vasodilators, phenothiazines, general anesthetic medications). Hypothermia can depress neuronal activity and decrease

cellular oxygen requirements below the minimum levels normally required for continued cell viability. As a result, it is used to protect function during some surgical procedures (eg, carotid endarterectomy, cardiopulmonary bypass) (Barash, et al., 2006).

Unintentional hypothermia needs to be avoided. If it occurs, it must be minimized or reversed. If hypothermia is intentional, the goal is safe return to normal body temperature. Environmental temperature in the OR can temporarily be set at 25°C to 26.6°C (78°F to 80°F). IV and irrigating fluids are warmed to 37°C (98.6°F). Wet gowns and drapes are removed promptly and replaced with dry materials, because wet materials promote heat loss. Whatever methods are used to rewarm the patient, warming must be accomplished gradually, not rapidly. Conscientious monitoring of core temperature, urinary output, ECG, blood pressure, arterial blood gas levels, and serum electrolyte levels is required.

## MALIGNANT HYPERTHERMIA

**Malignant hyperthermia** (MH) is a rare inherited muscle disorder that is chemically induced by anesthetic agents (Rothrock, 2007). MH can be triggered by myopathies, emotional stress, heatstroke, neuroleptic malignant syndrome, strenuous exercise exertion, and trauma. It occurs in 1 in 50,000 to 100,000 adults. Mortality from MH was reported to be as high as 70%, but with prompt recognition and rapid treatment, it has fallen to less than 10% (Hommertzheim & Steinke, 2006). Susceptible people include those with strong and bulky muscles, a history of muscle cramps or muscle weakness and unexplained temperature elevation, and an unexplained death of a family member during surgery that was accompanied by a febrile response (Litman & Rosenberg, 2005).

### Pathophysiology

During anesthesia, potent agents such as inhalation anesthetic agents (halothane, enflurane) and muscle relaxants (succinylcholine) may trigger the symptoms of malignant hyperthermia (Rothrock, 2007). Stress and some medications, such as sympathomimetics (epinephrine), theophylline, aminophylline, anticholinergics (atropine), and cardiac glycosides (digitalis), can induce or intensify such a reaction.

The pathophysiology of MH is related to a hypermetabolic condition that involves altered mechanisms of calcium function in skeletal muscle cells. This disruption of calcium causes clinical symptoms of hypermetabolism, which in turn increases muscle contraction (rigidity) and causes hyperthermia and subsequent damage to the central nervous system.

### Clinical Manifestations

The initial symptoms of malignant hyperthermia are related to cardiovascular and musculoskeletal activity. Tachycardia (heart rate greater than 150 bpm) is often the earliest sign. Sympathetic nervous stimulation also leads to ventricular dysrhythmia, hypotension, decreased cardiac output, oliguria, and, later, cardiac arrest. With the abnormal transport of calcium, rigidity or tetanuslike movements occur, often in the jaw. Generalized muscle rigidity is one of the earliest signs. The rise in temperature is actually a late sign that develops rapidly; body temperature can increase 1°C to 2°C (2°F to 4°F) every 5 minutes and core body temperature can exceed 42°C (107°F) (Hommertzheim & Steinke, 2006; Rothrock, 2007).

### Medical Management

Recognizing symptoms early and discontinuing anesthesia promptly are imperative. Goals of treatment are to decrease metabolism, reverse metabolic and respiratory acidosis, correct dysrhythmias, decrease body temperature, provide oxygen and nutrition to tissues, and correct electrolyte imbalance. The Malignant Hyperthermia Association of the United States (MHAUS) publishes a treatment protocol that should be posted in the OR and be readily available on a malignant hyperthermia cart.

Anesthesia and surgery should be postponed. However, if end-tidal $CO_2$ monitoring and dantrolene sodium (Dantrium) are available and the anesthesiologist is experienced in managing MH, the surgery may continue using a different anesthetic agent (Barash, et al., 2006). Although malignant hyperthermia usually manifests about 10 to 20 minutes after induction of anesthesia, it can also occur during the first 24 hours after surgery.

### Nursing Management

Although malignant hyperthermia is uncommon, the nurse must identify patients at risk, recognize the signs and symptoms, have the appropriate medication and equipment available, and be knowledgeable about the protocol to follow. This preparation may be lifesaving for the patient.

## NURSING PROCESS

### The Patient During Surgery

Intraoperative nurses focus on nursing diagnoses, interventions, and outcomes that surgical patients and their families experience. Additional priorities include collaborative problems and expected goals.

#### Assessment

Nursing assessment of the intraoperative patient involves obtaining data from the patient and the patient's medical record to identify factors that can affect care. These serve as guidelines for an individualized plan of patient care. The intraoperative nurse uses the focused preoperative nursing assessment documented on the patient record. This includes assessment of physiologic status (eg, health–illness level, level of consciousness), psychosocial status (eg, anxiety level, verbal communication problems, coping mechanisms), physical status (eg, surgical site, skin condition, and effectiveness of preparation; mobility of joints), and ethical concerns (Chart 19-2).

#### Diagnosis

*Nursing Diagnoses*

Based on the assessment data, some major nursing diagnoses may include the following:

- Anxiety related to surgical or environmental concerns
- Risk of latex allergy response due to possible exposure to latex in OR environment

CHART 19-2 **Ethics and Related Issues**

**To Resuscitate or Not?**

**Situation**

Your ambulatory care center has developed a policy, authorized through the medical staff, that allows for patients to have a do-not-resuscitate order (DNR) in place during a surgical procedure. This policy follows the American Society of Anesthesiologists guidelines for DNR in the OR. You are preparing a patient for surgery, and the anesthesiologist who will be administering the anesthetic agent writes an order for the DNR to be rescinded during surgery. The physician is refusing to talk to the patient concerning the DNR.

**Problem**

The patient believes his wishes will be followed with regard to resuscitation in the event of a cardiac arrest and the physician does not believe he can administer anesthesia if the DNR is in place.

**Discussion**

- What are the rights of the patient with regard to advance directives?
- What can you do to advocate for the patient?
- Should you contact the ethics committee of the hospital?
- How do you contact the ethics committee?

- Risk for perioperative positioning injury related to positioning in the OR
- Risk for injury related to anesthesia and surgical procedure
- Disturbed sensory perception (global) related to general anesthesia or sedation

*Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include the following:

- Nausea and vomiting
- Anaphylaxis
- Hypoxia
- Unintentional hypothermia
- Malignant hyperthermia
- Infection

## Planning and Goals

The major goals for care of the patient during surgery include reduced anxiety, absence of latex exposure, absence of positioning injuries, freedom from injury, maintenance of the patient's dignity, and absence of complications.

## Nursing Interventions

*Reducing Anxiety*

The OR environment can seem cold, stark, and frightening to the patient, who may be feeling isolated and apprehensive. Introducing yourself, addressing the patient by name warmly and frequently, verifying details, providing explanations, and encouraging and answering questions provide a sense of professionalism and friendliness that can help the patient feel safe and secure. When discussing what the patient can expect in surgery, the nurse uses basic communication skills, such as touch and eye contact, to reduce anxiety. Attention to physical comfort (warm blankets, padding, and position changes) helps the patient feel more comfortable. Telling the patient who else will be present in the OR, how long the procedure is expected to take, and other details helps the patient prepare for the experience and gain a sense of control.

*Reducing Latex Exposure*

Patients with latex allergies require early identification and communication to all personnel about the presence of the allergy. The AORN (2007) has recommended standards of care for patients with latex allergy. In most ORs, there are few latex items currently in use, but because there still remain some instances of latex use, maintenance of latex allergy precautions throughout the perioperative period must be observed. For safety, manufacturers and hospital materials managers need to take responsibility for identifying the latex content in items used by patients and health care personnel. (See Chapters 18 and 53 for assessment for latex allergy.)

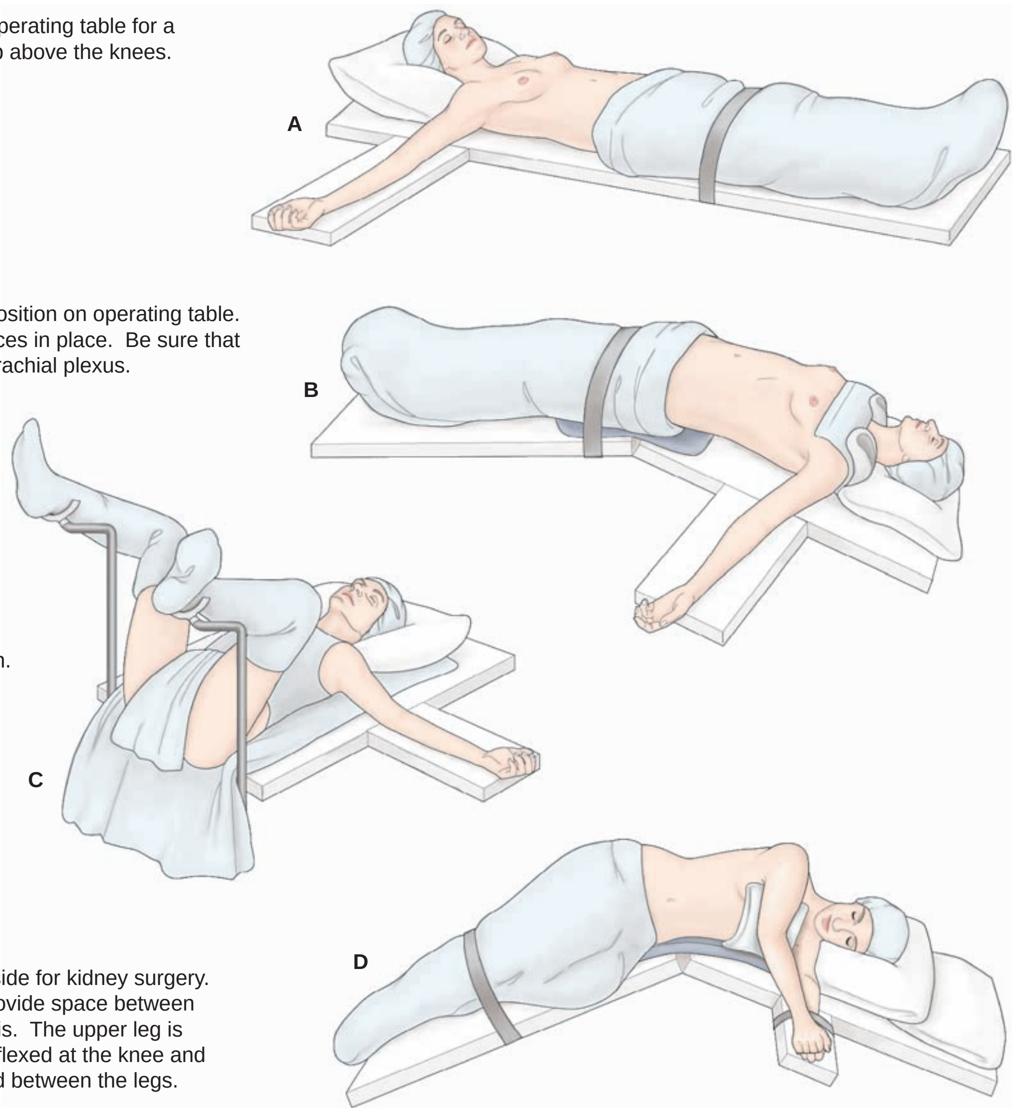
**NURSING ALERT**

**It is the responsibility of all nurses, and particularly perianesthesia and perioperative nurses, to be aware of latex allergies, necessary precautions, and products that are latex-free. Hospital staff is also at risk for development of a latex allergy secondary to repeated exposure to latex products.**

*Preventing Intraoperative Positioning Injury*

The patient's position on the operating table depends on the surgical procedure to be performed as well as on the patient's physical condition (Fig. 19-5). The potential for transient discomfort or permanent injury is present, because many positions are awkward. Hyperextending joints, compressing arteries, or pressing on nerves and bony prominences usually results in discomfort simply because the position must be sustained for a long period of time (Rothrock, 2007). Factors to consider include the following:

- The patient should be in as comfortable a position as possible, whether conscious or unconscious.
- The operative field must be adequately exposed.
- An awkward position, undue pressure on a body part, or use of stirrups or traction should not obstruct the vascular supply.
- Respiration should not be impeded by pressure of arms on the chest or by a gown that constricts the neck or chest.
- Nerves must be protected from undue pressure. Improper positioning of the arms, hands, legs, or feet can cause serious injury or paralysis. Shoulder braces must be well padded to prevent irreparable nerve injury, especially when the Trendelenburg position is necessary.
- Precautions for patient safety must be observed, particularly with thin, elderly, or obese patients and those with a physical deformity.
- The patient may need light restraint before induction in case of excitement.




**A**. Patient in position on the operating table for a laparotomy. Note the strap above the knees.

**B**. Patient in Trendelenburg position on operating table. Note padded shoulder braces in place. Be sure that brace does not press on brachial plexus.

**C**. Patient in lithotomy position. Note that the hips extend over the edge of the table.

**D**. Patient lies on unaffected side for kidney surgery. Table is spread apart to provide space between the lower ribs and the pelvis. The upper leg is extended; the lower leg is flexed at the knee and hip joints; a pillow is placed between the legs.

**Figure 19-5** Positions on the operating table. Captions call attention to safety and comfort features. All surgical patients wear caps to cover the hair completely.

The usual position for surgery, called the dorsal recumbent position, is flat on the back. Both arms are positioned at the side of the table, one with the hand placed palm down; the other is carefully positioned on an armboard to facilitate IV infusion of fluids, blood, or medications. This position is used for most abdominal surgeries except for surgery of the gallbladder or pelvis (see Fig. 19-5A).

The Trendelenburg position usually is used for surgery on the lower abdomen and pelvis to obtain good exposure by displacing the intestines into the upper abdomen. In this position, the head and body are lowered. The patient is held in position by padded shoulder braces (see Fig. 19-5B).

The lithotomy position is used for nearly all perineal, rectal, and vaginal surgical procedures (see Fig. 19-5C). The patient is positioned on the back with the legs and thighs flexed. The position is maintained by placing the feet in stirrups.

The Sims or lateral position is used for renal surgery. The patient is placed on the nonoperative side with an air pillow 12.5 to 15 cm (5 to 6 inches) thick under the loin, or on a table with a kidney or back lift (see Fig. 19-5D).

### *Protecting the Patient From Injury*

A variety of activities are used to address the diverse patient safety issues that arise in the OR. The nurse protects the patient from injury by providing a safe environment. Verifying information, checking the chart for completeness, and maintaining surgical asepsis and an optimal environment are critical nursing responsibilities. Verification that all required documentation is completed is an important function of the intraoperative nurse. A surgical checklist is used prior to induction of anesthesia, before the skin incision is made, and before the patient leaves the OR (see Fig. 19-1). It is important to review the patient's record for the following:

- Correct informed surgical consent, with patient's signature
- Completed records for health history and physical examination

- Results of diagnostic studies
- Allergies (including latex)

In addition to checking that all necessary patient data are complete, the perioperative nurse obtains the necessary equipment specific to the procedure. The need for nonroutine medications, blood components, instruments, and other equipment and supplies is assessed, and the readiness of the room, completeness of physical setup, and completeness of instrument, suture, and dressing setups are determined. Any aspects of the OR environment that may negatively affect the patient are identified. These include physical features, such as room temperature and humidity; electrical hazards; potential contaminants (dust, blood, and discharge on floor or surfaces; uncovered hair; nonsterile attire of personnel; jewelry worn by personnel; chipped or artificial fingernails); and unnecessary traffic. The circulating nurse also sets up and maintains suction equipment in working order, sets up invasive monitoring equipment, assists with insertion of vascular access and monitoring devices (arterial, Swan-Ganz, central venous pressure, IV lines), and initiates appropriate physical comfort measures for the patient.

Preventing physical injury includes using safety straps and side rails and not leaving the sedated patient unattended. Transferring the patient from the stretcher to the OR table requires safe transferring practices. Other safety measures include properly positioning a grounding pad under the patient to prevent electrical burns and shock, removing excess antiseptic solution from the patient's skin, and promptly and completely draping exposed areas after the sterile field has been created to decrease the risk for hypothermia.

Nursing measures to prevent injury from excessive blood loss include blood conservation using equipment such as a cell-saver (a device for recirculating the patient's own blood cells) and administration of blood products (Phillips, 2007). Few patients undergoing an elective procedure require blood transfusion, but those undergoing high-risk procedures (such as orthopedic or cardiac surgeries) may require an intraoperative transfusion. The circulating nurse anticipates this need, checks that blood has been cross-matched and held in reserve, and is prepared to administer blood.

#### *Serving as Patient Advocate*

The patient undergoing general anesthesia or moderate sedation experiences temporary sensory or perceptual alteration or loss, and has an increased need for protection and advocacy. Patient advocacy in the OR entails maintaining the patient's physical and emotional comfort, privacy, rights, and dignity. Patients, whether conscious or unconscious, should not be subjected to excess noise, inappropriate conversation, or, most of all, derogatory comments. Banter in the OR should not include comments about the patient's physical appearance, job, personal history, and so forth. Cases have been reported in which seemingly deeply anesthetized patients recalled the entire surgical experience, including disparaging personal remarks made by OR personnel. As an advocate, the nurse never engages in such conversation and discourages others from doing so. Other advocacy activities include minimizing the clinical, dehumanizing aspects of being a surgical patient by making sure the patient is treated as a person, respecting cultural and spiritual values, providing physical privacy, and maintaining confidentiality.

#### *Monitoring and Managing Potential Complications*

It is the responsibility of the surgeon and the anesthesiologist or anesthetist to monitor and manage complications. However, intraoperative nurses also play an important role. Being alert to and reporting changes in vital signs, cardiac dysrhythmias, symptoms of nausea and vomiting, anaphylaxis, hypoxia, hypothermia, and malignant hyperthermia and assisting with their management are important nursing functions. Each of these complications was discussed earlier. Maintaining asepsis and preventing infection are responsibilities of all members of the surgical team (Phillips, 2007; Rothrock, 2007). Evidence-based interventions to decrease surgical site infections include appropriate skin preparation and antibiotic administration. Using clippers to remove hair from the surgical site as needed instead of shaving the site is recommended (Celik & Kara, 2007; SCIP, 2005).

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Exhibits low level of anxiety while awake during the intraoperative phase of care
2. Has no symptoms of latex allergy
3. Remains free of perioperative positioning injury
4. Experiences no unexpected threats to safety
5. Has dignity preserved throughout OR experience
6. Is free of complications (eg, nausea and vomiting, anaphylaxis, hypoxia, hypothermia, malignant hyperthermia, or deep vein thrombosis) or experiences successful management of adverse effects of surgery and anesthesia should they occur

## CRITICAL THINKING EXERCISES

**1** An 80-year-old patient with Parkinson's disease and decreased hearing is scheduled for surgery. Identify factors that have the potential to affect this elderly surgical patient in the intraoperative period. Develop a plan of care for safe intraoperative care of this patient.

**2** EBP A patient has an identified latex allergy and is undergoing surgery. What resources would you use to identify the current guidelines for avoiding latex exposure for the patient? What is the evidence base for current latex allergy practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

**3** A patient has an unintentional temperature of 36°C (96°F) halfway through surgery. Describe the actions you would take and what parameters you would monitor. How would your actions differ if the patient is at the very end of the surgical procedure?

**4** EBP A patient is scheduled for spinal surgery. Develop an evidence-based plan of care that will reduce the risk of infection. What is the evidence base for infection control practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Latex Allergy Association, www.latexallergyresources.org

American Society of Anesthesiologists, www.asahq.org

American Society of PeriAnesthesia Nurses, www.aspan.org

Association of PeriOperative Registered Nurses, Inc., www.aorn.org

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, www.cdc.gov/injury

The Joint Commission, www.jointcommission.org

Malignant Hyperthermia Association of the United States (MHAUS), www.mhaus.org

National SCIP Partnership, Oklahoma Foundation for Medical Quality, www.medqic.org/scip



# chapter 20

# Postoperative Nursing Management

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the responsibilities of the postanesthesia care unit nurse in the prevention of immediate postoperative complications.
2. Compare postoperative care of the ambulatory surgery patient with that of the hospitalized surgery patient.
3. Identify common postoperative problems and their management.
4. Describe the gerontologic considerations related to postoperative management.
5. Describe variables that affect wound healing.
6. Demonstrate postoperative dressing techniques.
7. Identify assessment parameters appropriate for the early detection of postoperative complications.

## GLOSSARY

**dehiscence:** partial or complete separation of wound edges

**evisceration:** protrusion of organs through the surgical incision

**first-intention healing:** method of healing in which wound edges are surgically approximated and integumentary continuity is restored without granulation

**Phase I PACU:** area designated for care of surgical patients immediately after surgery and for patients whose condition warrants close monitoring

**Phase II PACU:** area designated for care of surgical patients who have been transferred from a phase I PACU because their condition no longer requires the close monitoring provided in a phase I PACU

**Phase III PACU:** setting in which the patient is cared for in the immediate postoperative period and then prepared for discharge from the facility

**postanesthesia care unit (PACU):** area where postoperative patients are monitored as they recover from anesthesia; formerly referred to as the recovery room or postanesthesia recovery room

**second-intention healing:** method of healing in which wound edges are not surgically approximated and integumentary continuity is restored by the process known as granulation

**third-intention healing:** method of healing in which surgical approximation of wound edges is delayed and integumentary continuity is restored by apposing areas of granulation

The postoperative period extends from the time the patient leaves the operating room (OR) until the last follow-up visit with the surgeon. This may be as short as a day or two or as long as several months. During the postoperative period, nursing care focuses on reestablishing the patient's physiologic equilibrium, alleviating pain, preventing complications, and teaching the patient self-care. Careful assessment and immediate intervention assist the patient in returning to optimal function quickly, safely, and as comfortably as possible. Ongoing care in the community through home care, clinic visits, office visits, or telephone follow-up facilitates an uncomplicated recovery.

## Care of the Patient in the Postanesthesia Care Unit

The **postanesthesia care unit (PACU),** also called the recovery room or postanesthesia recovery room, is located adjacent to the operating rooms suite. Patients still under anesthesia or recovering from anesthesia are placed in this unit for easy access to experienced, highly skilled nurses, anesthesiologists or anesthetists, surgeons, advanced hemodynamic and pulmonary monitoring and support, special equipment, and medications.

### Phases of Postanesthesia Care

In some hospitals and ambulatory surgical centers, postanesthesia care is divided into three phases (Phillips, 2007). In the **phase I PACU,** used during the immediate recovery phase, intensive nursing care is provided. In the **phase II PACU,** the patient is prepared for self-care or care in the hospital or an extended care setting. In **phase III PACU,** the patient is prepared for discharge. Recliners rather than stretchers or beds are standard in many phase III units, which may also be referred to as step-down, sit-up, or progressive care units. Patients may remain in a PACU unit for as long as 4 to 6 hours, depending on the type of surgery and any preexisting conditions. In facilities without separate phase I, II, and III units, the patient remains in the PACU and may be discharged home directly from this unit.

### Admitting the Patient to the PACU

Transferring the postoperative patient from the OR to the PACU is the responsibility of the anesthesiologist or anesthetist. During transport from the OR to the PACU, the anesthesia provider remains at the head of the stretcher (to maintain the airway), and a surgical team member remains at the opposite end. Transporting the patient involves special consideration of the incision site, potential vascular changes, and exposure. The surgical incision is considered every time the postoperative patient is moved; many wounds are closed under considerable tension, and every effort is made to prevent further strain on the incision. The patient is positioned so that he or she is not lying on and obstructing drains or drainage tubes. Orthostatic hypotension may occur when a patient is moved too quickly from one position to another (eg, from a lithotomy position to a horizontal position or from a lateral to a supine position), so the patient must be moved slowly and carefully. As soon as the patient is placed on the stretcher or bed, the soiled gown is removed and replaced with a dry gown. The patient is covered with lightweight blankets and warmed. Three side rails may be raised to prevent falls.

**Chart 20-1 • *Anesthesia Provider-to-Nurse Report and Nurse-to-Nurse Report: Information to Convey***

Patient name, gender, age
Surgical procedure
Anesthetic options (agents and reversal agents used)
Estimated blood loss/fluid loss
Fluid/blood replacement
Vital signs—significant problems
Complications encountered (anesthetic or surgical)
Preoperative medical diagnosis (eg, diabetes, hypertension, allergies)
Considerations for immediate postoperative period (pain management, reversals, ventilator settings)
Language barrier
Location of patient's family

Ideally, the anesthesia provider should not leave the patient until the nurse is satisfied with the patient's airway and immediate condition.

The nurse who admits the patient to the PACU reviews essential information with the anesthesiologist or anesthetist (Chart 20-1) and the circulating nurse. Monitoring equipment is attached and oxygen applied, and an immediate physiologic assessment is conducted.

### Nursing Management in the PACU

The nursing management objectives for the patient in the PACU are to provide care until the patient has recovered from the effects of anesthesia (eg, until resumption of motor and sensory functions), is oriented, has stable vital signs, and shows no evidence of hemorrhage or other complications.

#### Assessing the Patient

Frequent, skilled assessments of the patient's airway, respiratory function, cardiovascular function, skin color, level of consciousness, and ability to respond to commands are the cornerstones of nursing care in the PACU. The nurse performs and documents a baseline assessment, then checks the surgical site for drainage or hemorrhage and makes sure that all drainage tubes and monitoring lines are connected and functioning. The nurse checks any intravenous (IV) fluids or medications currently infusing and verifies dosage and rate.

After the initial assessment, vital signs are monitored and the patient's general physical status is assessed and documented at least every 15 minutes (Barash, Cullen & Stoelting, 2006). The nurse must be aware of any pertinent information from the patient's history that may be significant (eg, patient is deaf or hard of hearing, has a history of seizures, has diabetes, or is allergic to certain medications or to latex). Administration of the patient's

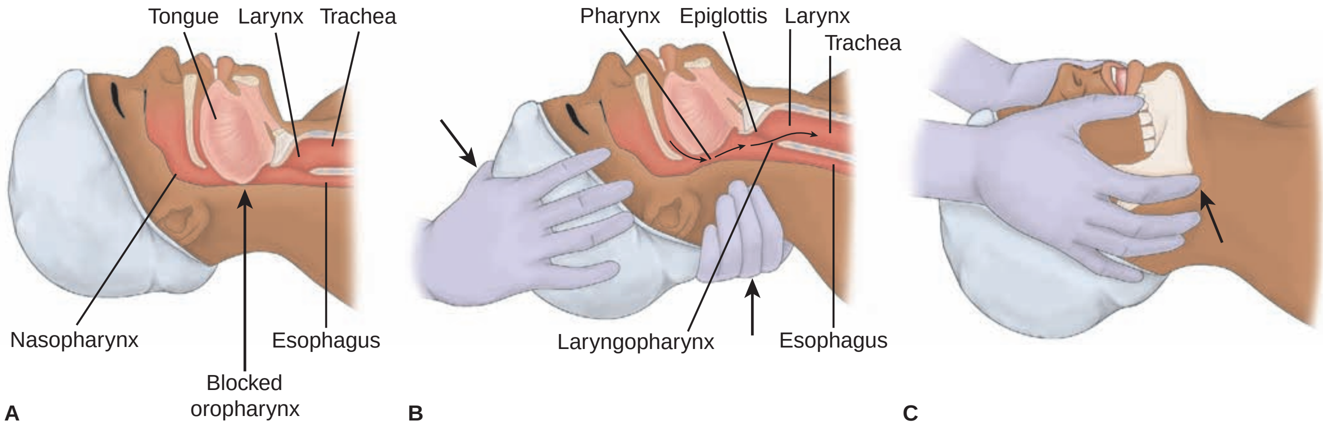



**Figure 20-1** **A,** A hypopharyngeal obstruction occurs when neck flexion permits the chin to drop toward the chest; obstruction almost always occurs when the head is in the midposition. **B,** Tilting the head back to stretch the anterior neck structure lifts the base of the tongue off the posterior pharyngeal wall. The direction of the *arrows* indicates the pressure of the hands. **C,** Opening the mouth is necessary to correct a valvelike obstruction of the nasal passage during expiration, which occurs in about 30% of unconscious patients. Open the patient's mouth (separate lips and teeth) and move the lower jaw forward so that the lower teeth are in front of the upper teeth. To regain backward tilt of the neck, lift with both hands at the ascending rami of the mandible.

postoperative analgesic requirements is a top priority (Barash, et al., 2006).

*NURSING ALERT*

**A systolic blood pressure of less than 90 mm Hg is usually considered immediately reportable. However, the patient's preoperative or baseline blood pressure is used to make informed postoperative comparisons. A previously stable blood pressure that shows a downward trend of 5 mm Hg at each 15-minute reading should also be reported.**

### *Maintaining a Patent Airway*

The primary objective in the immediate postoperative period is to maintain ventilation and thus prevent hypoxemia (reduced oxygen in the blood) and hypercapnia (excess carbon dioxide in the blood). Both can occur if the airway is obstructed and ventilation is reduced (hypoventilation). Besides checking the physician's orders for and administering supplemental oxygen, the nurse assesses respiratory rate and depth, ease of respirations, oxygen saturation, and breath sounds.

Patients who have experienced prolonged anesthesia usually are unconscious, with all muscles relaxed. This relaxation extends to the muscles of the pharynx. When the patient lies on his or her back, the lower jaw and the tongue fall backward and the air passages become obstructed (Fig. 20-1A). This is called hypopharyngeal obstruction. Signs of occlusion include choking; noisy and irregular respirations; decreased oxygen saturation scores; and within minutes, a blue, dusky color (cyanosis) of the skin. Because movement of the thorax and the diaphragm does not necessarily indicate that the patient is breathing, the nurse needs to place the palm of the hand at the patient's nose and mouth to feel the exhaled breath.

*NURSING ALERT*

**The treatment of hypopharyngeal obstruction involves tilting the head back and pushing forward on the angle of the lower jaw, as if to push the lower teeth in front of the upper teeth (see Fig. 20-1B, C). This maneuver pulls the tongue forward and opens the air passages.**

The anesthesiologist or anesthetist may leave a hard rubber or plastic airway in the patient's mouth to maintain a patent airway (Fig. 20-2). Such a device should not be

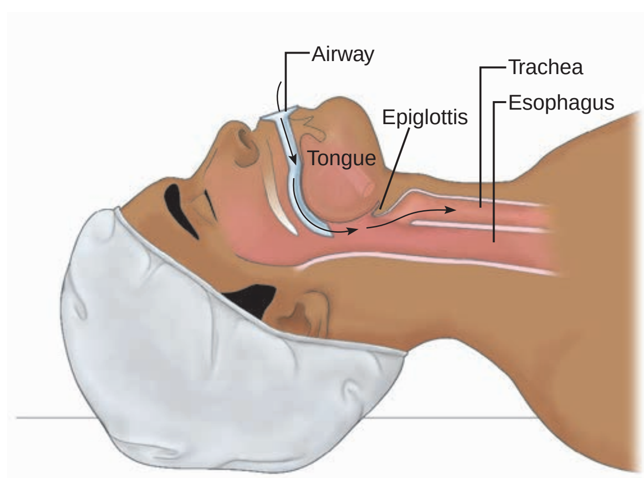



**Figure 20-2** Use of an airway to maintain a patent airway after anesthesia. The airway passes over the base of the tongue and permits air to pass into the pharynx in the region of the epiglottis. Patients often leave the operating room with an airway in place. The airway should remain in place until the patient recovers sufficiently to breathe normally. As the patient regains consciousness, the airway usually causes irritation and should be removed.

removed until signs such as gagging indicate that reflex action is returning. Alternatively, the patient may enter the PACU with an endotracheal tube still in place and may require continued mechanical ventilation. The nurse assists in initiating the use of the ventilator and in the weaning and extubation processes. Some patients, particularly those who have had extensive or lengthy surgical procedures, may be transferred from the OR directly to the intensive care unit (ICU) or from the PACU to the ICU while still intubated and receiving mechanical ventilation. In most facilities the patient is awakened and extubated in the OR (except in cases of trauma or a critically ill patient) and arrives in the PACU breathing without support.

If the teeth are clenched, the mouth may be opened manually but cautiously with a padded tongue depressor. The head of the bed is elevated 15 to 30 degrees unless contraindicated, and the patient is closely monitored to maintain the airway as well as to minimize the risk of aspiration. If vomiting occurs, the patient is turned to the side to prevent aspiration and the vomitus is collected in the emesis basin. Mucus or vomitus obstructing the pharynx or the trachea is suctioned with a pharyngeal suction tip or a nasal catheter introduced into the nasopharynx or oropharynx to a distance of 15 to 20 cm (6 to 8 inches). Caution is necessary in suctioning the throat of a patient who has had a tonsillectomy or other oral or laryngeal surgery because of risk of bleeding and discomfort.

### *Maintaining Cardiovascular Stability*

To monitor cardiovascular stability, the nurse assesses the patient's mental status; vital signs; cardiac rhythm; skin temperature, color, and moisture; and urine output. Central venous pressure, pulmonary artery pressure, and arterial lines are monitored if in place. The nurse also assesses the patency of all IV lines. The primary cardiovascular complications seen in the PACU include hypotension and shock, hemorrhage, hypertension, and dysrhythmias.

#### Hypotension and Shock

Hypotension can result from blood loss, hypoventilation, position changes, pooling of blood in the extremities, or side effects of medications and anesthetics. The most common cause is loss of circulating volume through blood and plasma loss. If the amount of blood loss exceeds 500 mL (especially if the loss is rapid), replacement is usually indicated.

Shock, one of the most serious postoperative complications, can result from hypovolemia and decreased intravascular volume. The types of shock are classified as hypovolemic, cardiogenic, neurogenic, anaphylactic, and septic shock. The classic signs of hypovolemic shock (the most common type of shock) are pallor; cool, moist skin; rapid breathing; cyanosis of the lips, gums, and tongue; rapid, weak, thready pulse; narrowing pulse pressure; low blood pressure; and concentrated urine. See Chapter 15 for a detailed discussion of shock.

Hypovolemic shock can be avoided largely by the timely administration of IV fluids, blood, blood products, and medications that elevate blood pressure. The primary intervention for hypovolemic shock is volume replacement, with an infusion of lactated Ringer's solution, 0.9% sodium chloride solution, colloids, or blood component therapy (see Table 15-2 in Chapter 15). Oxygen is administered by nasal cannula, face mask, or mechanical ventilation. If fluid administration fails to reverse hypovolemic shock, then various cardiac, vasodilator, and corticosteroid medications may be prescribed to improve cardiac function and reduce peripheral vascular resistance.

The PACU bed provides easy access to the patient, is easily movable, can readily be positioned to facilitate use of measures to counteract shock, and has features that facilitate care, such as IV poles, side rails, and wheel brakes. The patient is placed flat with the legs elevated. Respiratory rate, pulse rate, blood pressure, blood oxygen concentration, urinary output, level of consciousness, central venous pressure, pulmonary artery pressure, pulmonary capillary wedge pressure, and cardiac output are monitored to provide information on the patient's respiratory and cardiovascular status. Vital signs are monitored continuously until the patient's condition has stabilized.

Other factors can contribute to hemodynamic instability, such as body temperature and pain. The PACU nurse implements measures to manage these factors. The nurse keeps the patient warm (while avoiding overheating to prevent cutaneous vessels from dilating and depriving vital organs of blood), avoids exposure, and maintains normothermia (to prevent vasodilation). Pain control measures are implemented, as discussed later in this chapter.

#### Hemorrhage

Hemorrhage is an uncommon yet serious complication of surgery that can result in hypovolemic shock and death. It can present insidiously or emergently at any time in the immediate postoperative period or up to several days after surgery (Table 20-1). The patient presents with hypotension; rapid, thready pulse; disorientation; restlessness; oliguria; and cold, pale skin. The early phase of shock will

**Table 20-1 CLASSIFICATIONS OF HEMORRHAGE**

| Classification | Defining Characteristic |
|---|---|
| **Time Frame** | |
| Primary | Hemorrhage occurs at the time of surgery. |
| Intermediary | Hemorrhage occurs during the first few hours after surgery when the rise of blood pressure to its normal level dislodges insecure clots from untied vessels. |
| Secondary | Hemorrhage may occur some time after surgery if a suture slips because a blood vessel was not securely tied, became infected, or was eroded by a drainage tube. |
| **Type of Vessel** | |
| Capillary | Hemorrhage is characterized by a slow, general ooze. |
| Venous | Darkly colored blood bubbles out quickly. |
| Arterial | Blood is bright red and appears in spurts with each heartbeat. |
| **Visibility** | |
| Evident | Hemorrhage is on the surface and can be seen. |
| Concealed | Hemorrhage is in a body cavity and cannot be seen. |

manifest in feelings of apprehension, decreased cardiac output, and vascular resistance. Breathing becomes labored and "air hunger" will be exhibited; the patient will feel cold (hypothermia) and may experience tinnitus. If shock symptoms are left untreated, the patient will continually grow weaker but can remain conscious until near death (Barash, et al., 2006; Rothrock, 2007).

Transfusing blood or blood products and determining the cause of hemorrhage are the initial therapeutic measures. The surgical site and incision should always be inspected for bleeding. If bleeding is evident, a sterile gauze pad and a pressure dressing are applied, and the site of the bleeding is elevated to heart level if possible. The patient is placed in the shock position (flat on back; legs elevated at a 20-degree angle; knees kept straight). If hemorrhage is suspected but cannot be visualized, the patient may be taken back to the OR for emergency exploration of the surgical site.

If hemorrhage is suspected, the nurse should be aware of any special considerations related to blood loss replacement. Certain patients may decline blood transfusions for religious or cultural reasons and may identify this request on their advance directives or living will.

#### Hypertension and Dysrhythmias

Hypertension is common in the immediate postoperative period secondary to sympathetic nervous system stimulation from pain, hypoxia, or bladder distention. Dysrhythmias are associated with electrolyte imbalance, altered respiratory function, pain, hypothermia, stress, and anesthetic agents. Both hypertension and dysrhythmias are managed by treating the underlying causes.

### *Relieving Pain and Anxiety*

The PACU nurse monitors the patient's physiologic status, manages pain, and provides psychological support in an effort to relieve the patient's fears and concerns. The nurse checks the medical record for special needs and concerns of the patient. Opioid analgesics are administered mostly by IV in the PACU (Rothrock, 2007). IV opioids provide immediate pain relief and are short-acting, thus minimizing the potential for drug interactions or prolonged respiratory depression while anesthetics are still active in the patient's system. When the patient's condition permits, a close member of the family may visit in the PACU to decrease the family's anxiety and make the patient feel more secure.

### *Controlling Nausea and Vomiting*

Nausea and vomiting are common issues in the PACU (Chart 20-2). The nurse should intervene at the patient's first report of nausea to control the problem rather than wait for it to progress to vomiting.

**NURSING ALERT**

**At the slightest indication of nausea, the patient is turned completely to one side to promote mouth drainage and prevent aspiration of vomitus, which can cause asphyxiation and death.**

Many medications are available to control postoperative nausea and vomiting (PONV) without oversedating the patient; they are commonly administered during surgery as

**CHART 20-2** NURSING RESEARCH PROFILE

## *Preventing Postoperative Nausea and Vomiting*

Forrester, C. M, Matern, C. E., Kelly, J., et al. (2007). Meclizine in combination with ondansetron for prevention of postoperative nausea and vomiting in high-risk patients. *AANA Journal, 75*(1), 27–33.

**Purpose**

Postoperative nausea and vomiting (PONV) are prevalent in surgical patients, especially those with known risks related to general anesthesia, female, nonsmoker, and history of motion sickness and PONV. This study investigated whether meclizine (Antivert), a medication commonly administered for motion sickness, given in the preoperative period to high-risk patients, would decrease PONV.

**Design**

This was a randomized, controlled trial in which 77 patients were studied, all of whom had four of five known risk factors for PONV. Patients who consented were randomly assigned to either the experimental group that received 50 mg of meclizine administered by mouth 15 to 30 minutes prior to surgery or usual care with no meclizine. All patients received a prophylactic dose of ondansetron 4 mg IV 15 to 30 minutes administered before the end of the surgical procedure. Severity of PONV was measured on a 0 (no nausea) to 10 (worst nausea) verbal numeric rating scale (VNRS) prior to surgery, in the postanesthesia care unit (PACU) 15 minutes before any antiemetic administration for nausea and every 15 minutes thereafter and on admission to the same day surgery unit.

**Findings**

There were no significant differences between the two groups in demographics, surgical or anesthesia time, analgesia requirements or overall nausea in the PACU. Patients who received meclizine ($n = 39$) and became nauseated had lower VNRS scores in the PACU at 15 ($p = .013$) and 45 ($p = .006$) minutes compared to the placebo group ($n = 38$).

**Nursing Implications**

Further study is needed, but in this small study, 50 mg of meclizine administered by mouth 15 to 30 minutes prior to surgery helped decrease the severity and incidence of PONV. Nurses working in the perioperative areas should be aware that meclizine is an inexpensive medication with a long duration of action and few side effects that may be helpful in the management of PONV.

**Table 20-2 EXAMPLES OF MEDICATIONS USED TO CONTROL NAUSEA AND VOMITING**

| Drug Classes | Name | Major Indications |
|---|---|---|
| GI stimulant | Metoclopramide (Reglan) | Relief of symptoms of acute and recurrent gastroparesis (ie, feelings of fullness after only a few bites of food, bloating, excessive belching nausea) |
| Phenothiazine Antiemetic | Prochlorperazine (Compazine) | Control of severe nausea and vomiting |
| Phenothiazine Antiemetic Antimotion sickness | Promethazine (Phenergan) | Prevention and control of nausea and vomiting associated with anesthesia and surgery |
| Antimotion sickness | Dimenhydrinate (Dramamine) | Prevention and treatment of nausea, vomiting, or vertigo of motion sickness |
| Antiemetic | Hydroxyzine (Vistaril, Atarax) | Control of nausea and vomiting and as adjunct to analgesia preoperatively and postoperatively to allow decreased opioid dosage |
| Antiemetic Antimotion sickness | Scopolamine (Transderm-Scop) | Prevention and control of nausea and vomiting associated with motion sickness and recovery from surgery |
| Antiemetic | Ondansetron (Zofran) | Prevention of postoperative nausea and vomiting |

well as in the PACU. Table 20-2 contains examples of medications commonly prescribed to control PONV (Fetzer, 2008; Karch, 2008). Ondansetron (Zofran) is an effective antiemetic with few side effects and is frequently the drug of choice.

The risk of PONV ranges from 30% in the general surgical population but increases to 80% with certain risk factors. These risks include general anesthesia, female gender, nonsmoker, history of PONV, and history of motion sickness (Forrester, Matern, Kelly, et al., 2007). Surgical risks are increased with PONV due to an increase in intra-abdominal pressure, elevated central venous pressure, the potential for aspiration, increased heart rate and systemic blood pressure, which increase the risk of myocardial ischemia and dysrhythmias. Postoperative pain is increased as well (Barash, et al., 2006). Ongoing research is investigating the most efficacious combination of medications for patients with different risk profiles (Board & Board, 2006; Bridges, Nettle, Dugirrala, et al., 2006; Forrester, et al., 2007).

### Gerontologic Considerations

The elderly patient, like all patients, is transferred from the OR table to the bed or stretcher slowly and gently. The effects of this action on blood pressure and ventilation are monitored. Special attention is given to keeping the patient warm because elderly patients are more susceptible to hypothermia. The patient's position is changed frequently to stimulate respirations and to promote circulation and comfort.

Immediate postoperative care for the elderly patient is the same as for any surgical patient, but additional support is given if cardiovascular, pulmonary, or renal function is impaired. With careful monitoring, it is possible to detect cardiopulmonary deficits before signs and symptoms are apparent. Changes associated with the aging process, the prevalence of chronic diseases, alteration in fluid and nutrition status, and the increased use of medications result in postoperative requirements and slower recovery from anesthesia due to the prolonged time to eliminate sedatives and anesthetic agents. The elderly patient requires understanding of specific needs such as hypothermia, need for protection of fragile skin, padding and repositioning, depleted energy levels, cardiac and pulmonary issues, postoperative pain, and the sensitivity and metabolic issues related to medication. Having less physiologic reserve, elderly patients require more frequent monitoring. Postoperative confusion and delirium affect as many as 51% of older patients. Acute confusion may be caused by pain, analgesic agents, hypotension, fever, hypoglycemia, fluid loss, fecal impaction, urinary retention, or anemia (Cofer, 2005; Litwack, 2006). Providing adequate hydration; reorienting to the environment; and reassessing the doses of sedatives, anesthetics, and analgesics may reduce the risk for confusion. Hypoxia can present as confusion and restlessness, as can blood loss and electrolyte imbalances. Exclusion of all other causes of confusion must precede the assumption that confusion is related to age, circumstances, and medications.

### Determining Readiness for Discharge From the PACU

A patient remains in the PACU until fully recovered from the anesthetic agent. Indicators of recovery include stable blood pressure, adequate respiratory function, and adequate oxygen saturation level compared with baseline.

Many hospitals use a scoring system (eg, Aldrete score) to determine the patient's general condition and readiness for transfer from the PACU. Throughout the recovery period, the patient's physical signs are observed and evaluated by means of a scoring system based on a set of objective criteria. This evaluation guide allows an objective assessment of the patient's condition in the PACU (Fig. 20-3). The patient is assessed at regular intervals, and a total score is calculated and recorded on the assessment record. The Aldrete score is usually 8 to 10 before discharge from the PACU. Patients with a score of less than 7 must remain in the PACU until their condition improves or they are transferred to an intensive care area, depending on their preoperative baseline score (Rothrock, 2007).

The patient is discharged from the phase I PACU by the anesthesiologist or anesthetist to the critical care unit, the medical-surgical unit, the phase II PACU, or home with a responsible family member. In some hospitals and ambulatory care centers, patients are discharged to a phase III PACU, where they are prepared for discharge.

**Post Anesthesia Care Unit**
**MODIFIED ALDRETE SCORE**

Patient: ______________________ Final score: ______________________

Room: ______________________ Surgeon: ______________________

Date: ______________________ PACU nurse: ______________________

| Area of Assessment | Point Score | Upon Admission | After | | | |
|---|---|---|---|---|---|---|
| | | | 15 min | 30 min | 45 min | 60 min |
| **Activity** | | | | | | |
| (Able to move spontaneously or on command) | | | | | | |
| • Ability to move all extremities | 2 | | | | | |
| • Ability to move 2 extremities | 1 | | | | | |
| • Unable to control any extremity | 0 | | | | | |
| **Respiration** | | | | | | |
| • Ability to breathe deeply and cough | 2 | | | | | |
| • Limited respiratory effort (dyspnea or splinting) | 1 | | | | | |
| • No spontaneous effort | 0 | | | | | |
| **Circulation** | | | | | | |
| • BP ± 20% of preanesthetic level | 2 | | | | | |
| • BP ± 20% –49% of preanesthetic level | 1 | | | | | |
| • BP ± 50% of preanesthetic level | 0 | | | | | |
| **Consciousness** | | | | | | |
| • Fully awake | 2 | | | | | |
| • Arousable on calling | 1 | | | | | |
| • Not responding | 0 | | | | | |
| **$O_2$ Saturation** | | | | | | |
| • Able to maintain $O_2$ sat >92% on room air | 2 | | | | | |
| • Needs $O_2$ inhalation to maintain $O_2$ sat >90% | 1 | | | | | |
| • $O_2$ sat <90% even with $O_2$ supplement | 0 | | | | | |
| Totals: | | | | | | |

Required for discharge from Post Anesthesia Care Unit: 7–8 points

______________________ ______________________

Time of release Signature of nurse

**Figure 20-3** Postanesthesia care unit record; modified Aldrete score ($O_2$ sat = oxygen saturation; BP = blood pressure). Modified from Aldrete, A. & Wright, A. (1992). Revised Aldrete score for discharge. *Anesthesiology News, 18*(1), 17.

## Preparing the Postoperative Patient for Direct Discharge

Ambulatory surgical centers frequently only have a step-down PACU similar to a phase II PACU. This type of patient is basically healthy and will be discharged directly to home. Prior to discharge the patient will require verbal and written instructions and information about follow-up care.

### *Promoting Home and Community-Based Care*

To ensure patient safety and recovery, expert patient teaching and discharge planning are necessary when a patient

CHART 20-3 HOME CARE CHECKLIST
*Discharge After Surgery*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Name the procedure that was performed and identify any permanent changes in anatomic structure or function. | ✔ | ✔ |
| • Describe ongoing postoperative therapeutic regimen, including medications, diet, activities to perform (eg, walking and breathing exercises) and to avoid (eg, driving a car; contact sports), adjuvant therapies, dressing changes and wound care, and any other treatments. | ✔ | ✔ |
| • Describe signs and symptoms of complications. | ✔ | ✔ |
| • State time and date of follow-up appointments. | ✔ | ✔ |
| • Identify interventions and strategies to use in adapting to any permanent changes in structure or function. | ✔ | ✔ |
| • Relate how to reach health care provider with questions or complications. | ✔ | ✔ |
| • State understanding of community resources and referrals (if any). | ✔ | ✔ |
| • Describe pertinent health promotion activities (eg, weight reduction, smoking cessation, stress management). | ✔ | ✔ |

undergoes same-day or ambulatory surgery. Because anesthetics cloud memory for concurrent events, verbal and written instructions should be given to both the patient and the adult who will be accompanying the patient home. Alternative formats (eg, large print, Braille) of instructions or use of a sign language interpreter may be required to ensure patient and family understanding. A translator may be required if the patient and family members do not understand English.

#### Teaching Patients Self-Care

The patient and caregiver (eg, family member or friend) are informed about expected outcomes and immediate postoperative changes anticipated. Chart 20-3 identifies important teaching points; before discharging the patient, the nurse provides written instructions covering each of those points. Prescriptions are given to the patient. The nurse's or surgeon's telephone number is provided, and the patient and caregiver are encouraged to call with questions and to schedule follow-up appointments.

Although recovery time varies depending on the type and extent of surgery and the patient's overall condition, instructions usually advise limited activity for 24 to 48 hours. During this time, the patient should not drive a vehicle, drink alcoholic beverages, or perform tasks that require energy or skill. Fluids may be consumed as desired and smaller-than-normal amounts may be eaten at mealtime. Patients are cautioned not to make important decisions at this time because the medications, anesthesia, and surgery may affect their decision-making ability.

#### Continuing Care

Although most patients who undergo ambulatory surgery recover quickly and without complications, some patients require referral for home care. These may be elderly or frail patients, those who live alone, and patients with other health care problems or disabilities that might interfere with self-care or resumption of usual activities. The home care nurse assesses the patient's physical status (eg, respiratory and cardiovascular status, adequacy of pain management, the surgical incision, surgical complications) and the patient's and family's ability to adhere to the recommendations given at the time of discharge. Previous teaching is reinforced as needed. The home care nurse may change surgical dressings, monitor the patency of a drainage system, or administer medications. The patient and family are reminded about the importance of keeping follow-up appointments with the surgeon. Follow-up phone calls from the nurse or surgeon are also used to assess the patient's progress and to answer any questions.

## Care of the Hospitalized Postoperative Patient

The majority of surgeries are now performed in ambulatory care centers, and surgical patients who require hospital stays include trauma patients, acutely ill patients, patients undergoing major surgery, patients who require emergency surgery, and patients with a concurrent medical disorder. Seriously ill patients and those who have undergone major cardiovascular, pulmonary, or neurologic surgery may be admitted to specialized ICUs for close monitoring and advanced interventions and support. The care required by these patients in the immediate postoperative period is discussed in specific chapters of this book. Patients admitted to the clinical unit for postoperative care have multiple needs and stay for a short period of time. Postoperative care for those surgical patients returning to the general medical-surgical unit is discussed later in this chapter.

### Receiving the Patient in the Clinical Unit

The patient's room is readied by assembling the necessary equipment and supplies: IV pole, drainage receptacle holder, suction equipment, oxygen, emesis basin, tissues, disposable pads, blankets, and postoperative documentation forms. When the call comes to the unit about the patient's transfer from the PACU, the need for any additional items

**CHART 20-4** *Guidelines for Immediate Postoperative Nursing Interventions*

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess breathing and administer supplemental oxygen, if prescribed. | 1. Assessment provides a baseline and helps identify signs and symptoms of respiratory distress early. |
| 2. Monitor vital signs and note skin warmth, moisture, and color. | 2. A careful baseline assessment helps identify signs and symptoms of shock early. |
| 3. Assess the surgical site and wound drainage systems. Connect all drainage tubes to gravity or suction as indicated and monitor closed drainage systems. | 3. Assessment provides a baseline and helps identify signs and symptoms of hemorrhage early. |
| 4. Assess level of consciousness, orientation, and ability to move extremities. | 4. These parameters provide a baseline and help identify signs and symptoms of neurologic complications. |
| 5. Assess pain level, pain characteristics (location, quality) and timing, type, and route of administration of last dose of analgesic. | 5. Assessment provides a baseline of current pain level and for assessment of effectiveness of pain management strategies. |
| 6. Administer analgesics as prescribed and assess their effectiveness in relieving pain. | 6. Administration of analgesics helps decrease pain. |
| 7. Place the call light, emesis basin, ice chips (if allowed), and bedpan or urinal within reach. | 7. Attending to these needs provides for comfort and safety. |
| 8. Position the patient to enhance comfort, safety, and lung expansion. | 8. This promotes safety and reduces risk of postoperative complications. |
| 9. Assess IV sites for patency and infusions for correct rate and solution. | 9. Assessing IV sites and infusions helps detect phlebitis and prevents errors in rate and solution type. |
| 10. Assess urine output in closed drainage system or the patient's urge to void and bladder distention. | 10. Assessment provides a baseline and helps identify signs of urinary retention. |
| 11. Reinforce the need to begin deep breathing and leg exercises. | 11. These activities help to prevent complications. |
| 12. Provide information to the patient and family. | 12. Patient teaching helps to decrease the patient's and family's anxiety. |

is communicated. The PACU nurse reports relevant data about the patient to the receiving nurse (see Chart 20-1).

Usually the surgeon speaks to the family after surgery and relates the general condition of the patient. The receiving nurse reviews the postoperative orders, admits the patient to the unit, performs an initial assessment, and attends to the patient's immediate needs (Chart 20-4).

## Nursing Management After Surgery

During the first 24 hours after surgery, nursing care of the hospitalized patient on the general medical-surgical unit involves continuing to help the patient recover from the effects of anesthesia, frequently assessing the patient's physiologic status, monitoring for complications, managing pain, and implementing measures designed to achieve the long-range goals of independence with self-care, successful management of the therapeutic regimen, discharge to home, and full recovery. In the initial hours after admission to the clinical unit, adequate ventilation, hemodynamic stability, incisional pain, surgical site integrity, nausea and vomiting, neurologic status, and spontaneous voiding are primary concerns. The pulse rate, blood pressure, and respiration rate are recorded at least every 15 minutes for the first hour and every 30 minutes for the next 2 hours. Thereafter, they are measured less frequently if they remain stable. The temperature is monitored every 4 hours for the first 24 hours.

Patients usually begin to return to their usual state of health several hours after surgery or after awaking the next morning. Although pain may still be intense, many patients feel more alert, less nauseous, and less anxious. They have begun their breathing and leg exercises as appropriate for the type of surgery, and many will have dangled their legs over the edge of the bed, stood, and ambulated a few feet or been assisted out of bed to the chair at least once. Many will have tolerated a light meal and had IV fluids discontinued. The focus of care shifts from intense physiologic management and symptomatic relief of the adverse effects of anesthesia to regaining independence with self-care and preparing for discharge.

## NURSING PROCESS

### The Hospitalized Patient Recovering From Surgery

Nursing care of the hospitalized patient recovering from surgery takes place in a compressed time frame, with much of the healing and recovery occurring after the patient is discharged to home or to a rehabilitation center.

#### Assessment

Assessment of the hospitalized postoperative patient includes monitoring vital signs and completing a review of systems upon the patient's arrival to the clinical unit (see Chart 20-4) and at regular intervals thereafter.

Respiratory status is important because pulmonary complications are among the most frequent and serious problems encountered by the surgical patient. The nurse

monitors for airway patency and any signs of laryngeal edema. The quality of respirations, including depth, rate, and sound, are assessed regularly. Chest auscultation verifies that breath sounds are normal (or abnormal) bilaterally, and the findings are documented as a baseline for later comparisons. Often, because of the effects of analgesic and anesthetic medications, respirations are slow. Shallow and rapid respirations may be caused by pain, constricting dressings, gastric dilation, abdominal distention, or obesity. Noisy breathing may be due to obstruction by secretions or the tongue. Another possible complication is flash pulmonary edema that occurs when protein and fluid accumulate in the alveoli unrelated to elevated pulmonary artery occlusive pressure. Signs and symptoms include agitation; tachypnea; tachycardia; decreased pulse oximetry readings; frothy, pink sputum; and crackles on auscultation.

The nurse assesses the patient's pain level using a verbal or visual analogue scale and assesses the characteristics of the pain. The patient's appearance, pulse, respirations, blood pressure, skin color (adequate or cyanotic), and skin temperature (cold and clammy, warm and moist, or warm and dry) are clues to cardiovascular function. When the patient arrives in the clinical unit, the surgical site is assessed for bleeding, type and integrity of dressings, and drains.

The nurse also assesses the patient's mental status and level of consciousness, speech, and orientation and compares them with the preoperative baseline. Although a change in mental status or postoperative restlessness may be related to anxiety, pain, or medications, it may also be a symptom of oxygen deficit or hemorrhage. These serious causes must be investigated and excluded before other causes are pursued.

General discomfort that results from laying in one position on the operating table, the handling of tissues by the surgical team, the body's reaction to anesthesia, and anxiety are also common causes of restlessness. These discomforts may be relieved by administering the prescribed analgesics, changing the patient's position frequently, and assessing and alleviating the cause of anxiety. If tight, drainage-soaked bandages are causing discomfort, reinforcing or changing the dressing completely as prescribed by the physician may make the patient more comfortable. The bladder is assessed for distention because urinary retention can also cause restlessness.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include the following:

- Risk for ineffective airway clearance related to depressed respiratory function, pain, and bed rest
- Acute pain related to surgical incision
- Decreased cardiac output related to shock or hemorrhage
- Risk for activity intolerance related to generalized weakness secondary to surgery
- Impaired skin integrity related to surgical incision and drains
- Ineffective thermoregulation related to surgical environment and anesthetic agents
- Risk for imbalanced nutrition, less than body requirements related to decreased intake and increased need for nutrients secondary to surgery
- Risk for constipation related to effects of medications, surgery, dietary change, and immobility
- Risk for urinary retention related to anesthetic agents
- Risk for injury related to surgical procedure/positioning or anesthetic agents
- Anxiety related to surgical procedure
- Risk for ineffective management of therapeutic regimen related to wound care, dietary restrictions, activity recommendations, medications, follow-up care, or signs and symptoms of complications

### *Collaborative Problems or Potential Complications*

Based on the assessment data, potential complications may include the following:

- Pulmonary infection/hypoxia
- Deep vein thrombosis (DVT)
- Hematoma or hemorrhage
- Infection
- Pulmonary embolism
- Wound dehiscence or evisceration

## Planning and Goals

The major goals for the patient include optimal respiratory function, relief of pain, optimal cardiovascular function, increased activity tolerance, unimpaired wound healing, maintenance of body temperature, and maintenance of nutritional balance. Further goals include resumption of usual pattern of bowel and bladder elimination, identification of any perioperative positioning injury, acquisition of sufficient knowledge to manage self-care after discharge, and absence of complications.

## Nursing Interventions

### *Preventing Respiratory Complications*

Respiratory depressive effects of opioid medications, decreased lung expansion secondary to pain, and decreased mobility combine to put the patient at risk for common respiratory complications, particularly atelectasis (alveolar collapse; incomplete expansion of the lung), pneumonia, and hypoxemia (Rothrock, 2007). Atelectasis remains a risk for the patient who is not moving well or ambulating or who is not performing deep-breathing and coughing exercises or using an incentive spirometer. Signs and symptoms include decreased breath sounds over the affected area, crackles, and cough. Pneumonia is characterized by chills and fever, tachycardia, and tachypnea. Cough may or may not be present and may or may not be productive. Hypostatic pulmonary congestion, caused by a weakened cardiovascular system that permits stagnation of secretions at lung bases, may develop; this condition occurs most frequently in elderly patients who are not mobilized effectively. The symptoms are often vague, with perhaps a slight elevation of temperature, pulse, and respiratory rate, as well as a cough. Physical examination reveals dullness and crackles at the base of the lungs. If the condition progresses, the outcome may be fatal.

The types of hypoxemia that can affect postoperative patients are subacute and episodic. Subacute hypoxemia is a constant low level of oxygen saturation when breathing appears normal. Episodic hypoxemia develops suddenly, and the patient may be at risk for cerebral dysfunction, myocardial ischemia, and cardiac arrest. Risk for hypoxemia is increased in patients who have undergone major surgery (particularly abdominal), are obese, or have preexisting pulmonary problems. Hypoxemia is detected by pulse oximetry that measures blood oxygen saturation. Factors that may affect the accuracy of pulse oximetry readings include cold extremities, tremors, atrial fibrillation, acrylic nails, and black or blue nail polish (these colors interfere with the functioning of the pulse oximeter; other colors do not).

Preventive measures and timely recognition of signs and symptoms help avert pulmonary complications. Crackles indicate static pulmonary secretions that need to be mobilized by coughing and deep-breathing exercises. When a mucus plug obstructs one of the bronchi entirely, the pulmonary tissue beyond the plug collapses, resulting in atelectasis.

To clear secretions and prevent pneumonia, the nurse encourages the patient to turn frequently, take deep breaths, cough, and use the incentive spirometer at least every 2 hours. These pulmonary exercises should begin as soon as the patient arrives on the clinical unit and continue until the patient is discharged. Even if he or she is not fully awake from anesthesia, the patient can be asked to take several deep breaths. This helps expel residual anesthetic agents, mobilize secretions, and prevent atelectasis. Careful splinting of abdominal or thoracic incision sites helps the patient overcome the fear that the exertion of coughing might open the incision. Analgesic agents are administered to permit more effective coughing, and oxygen is administered as prescribed to prevent or relieve hypoxia. To encourage lung expansion, the patient is encouraged to yawn or take sustained maximal inspirations to create a negative intrathoracic pressure of −40 mm Hg and expand lung volume to total capacity. Chest physical therapy may be prescribed if indicated. See Chapter 25.

Coughing is contraindicated in patients who have head injuries or who have undergone intracranial surgery (because of the risk for increasing intracranial pressure), as well as in patients who have undergone eye surgery (because of the risk for increasing intraocular pressure) or plastic surgery (because of the risk for increasing tension on delicate tissues).

Early ambulation increases metabolism and pulmonary aeration and, in general, improves all body functions. The patient is encouraged to be out of bed as soon as possible (ie, on the day of surgery, or no later than the first postoperative day). This practice is especially valuable in preventing pulmonary complications in older patients.

### *Relieving Pain*

Most patients experience some pain after a surgical procedure. Complete absence of pain in the area of the surgical incision may not occur for a few weeks, depending on the site and nature of the surgery, but the intensity of postoperative pain gradually subsides on subsequent days. About one third of patients report severe pain, one third moderate pain, and one third little or no pain. This does not mean that the patients in the last group have no pain; rather, they appear to activate psychodynamic mechanisms that impair the registering of pain ("gate closing" theory and nociceptive transmission). See Chapter 13 for a more detailed discussion of pain.

Many factors (motivational, affective, cognitive, emotional, and cultural) influence the pain experience. The degree and severity of postoperative pain and the patient's tolerance for pain depend on the incision site, the nature of the surgical procedure, the extent of surgical trauma, the type of anesthesia, and route of administration. The preoperative preparation received by the patient (including information about what to expect, reassurance, psychological support, and teaching specific communication techniques related to pain) is a significant factor in decreasing anxiety, apprehension, the amount of postoperative pain, and PONV (Barash, et al., 2006).

Intense pain stimulates the stress response, which adversely affects the cardiac and immune systems. When pain impulses are transmitted, both muscle tension and local vasoconstriction increase, further stimulating pain receptors. This increases myocardial demand and oxygen consumption. The hypothalamic stress response also results in an increase in blood viscosity and platelet aggregation, increasing the risk of thrombosis and pulmonary embolism.

Often the physician has prescribed different medications or dosages to cover various levels of pain. The nurse discusses these options with the patient to determine the best medication. The nurse assesses the effectiveness of the medication periodically, beginning 30 minutes after administration, or sooner if the medication is being delivered by patient-controlled analgesia (PCA).

**OPIOID ANALGESICS.** Opioid analgesics are commonly prescribed for pain and immediate postoperative restlessness. A preventive approach, rather than an "as needed" (PRN) approach, is more effective in relieving pain. With a preventive approach, the medication is administered at prescribed intervals rather than when the pain becomes severe or unbearable. Many patients (and some health care providers) are overly concerned about the risk of drug addiction in the postoperative patient. However, this risk is negligible with the use of opioid medications for short-term pain control (D'Arcy, 2007).

**PATIENT-CONTROLLED ANALGESIA.** The nurse's goal is pain prevention rather than sporadic pain control. Patients recover more quickly when adequate pain relief measures are used, and PCA permits patients to administer their own pain medication when needed. Most patients are candidates for PCA. The two requirements for PCA are an understanding of the need to self-dose and the physical ability to self-dose. The amount of medication delivered by the IV or epidural route and the time span during which the opioid medication is released are controlled by the PCA device. PCA promotes patient participation in care, eliminates delayed administration of analgesics, maintains a therapeutic drug level, and enables the patient to move, turn, cough,

and take deep breaths with less pain, thus reducing postoperative pulmonary complications (Rothrock, 2007).

**EPIDURAL INFUSIONS AND INTRAPLEURAL ANESTHESIA.** Patients undergoing many types of procedures and surgeries benefit from the use of epidural infusion of opioids (Schwartz, 2006). Epidural infusions are used with caution in chest procedures because the analgesic may ascend along the spinal cord and affect respiration. Intrapleural anesthesia involves the administration of local anesthetic by a catheter between the parietal and visceral pleura. It provides sensory anesthesia without affecting motor function to the intercostal muscles. This anesthesia allows more effective coughing and deep breathing in conditions such as cholecystectomy, renal surgery, and rib fractures in which pain in the thoracic region would interfere with these exercises.

A local opioid or a combination anesthetic (opioid plus local anesthetic agent) is used in the epidural infusion.

**OTHER PAIN RELIEF MEASURES.** For pain that is difficult to control, a subcutaneous pain management system may be used. This is a silicone catheter that is inserted at the site of the affected area. The catheter is attached to a pump that delivers a continuous amount of local anesthetic at a specific amount determined and prescribed by the physician (Fig. 20-4).

Nonpharmacologic pain relief measures, such as guided imagery, music, and application of heat or cold (if prescribed) have been successful in decreasing pain (Rothrock, 2007). Changing the patient's position, using distraction, applying cool washcloths to the face, and providing back massage may be useful in relieving general discomfort temporarily, promoting relaxation, and rendering medication more effective when it is administered.

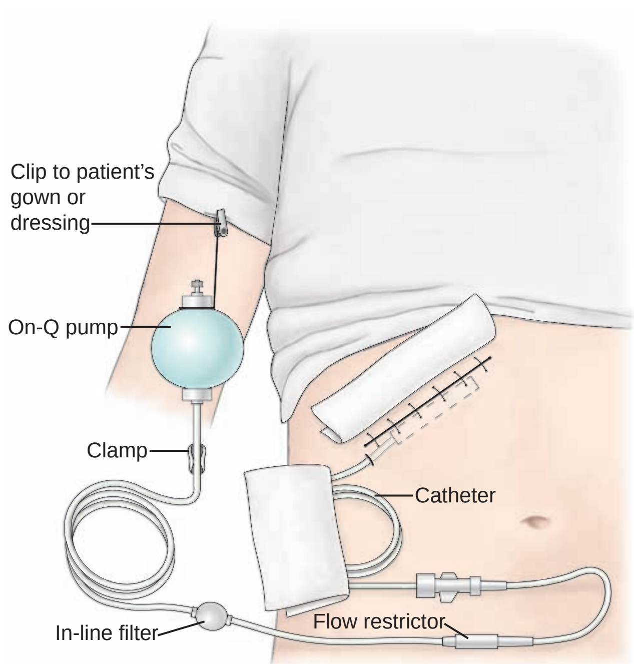



**Figure 20-4** Subcutaneous pain management system consists of a pump, filter, and catheter that delivers a specific amount of prescribed local anesthetic at the rate determined by the physician. Redrawn from I-Flow Corporation, Lake Forest, CA.

### *Promoting Cardiac Output*

If signs and symptoms of shock or hemorrhage occur, treatment and nursing care are implemented as described in the discussion of care in the PACU.

Although most patients do not hemorrhage or go into shock, changes in circulating volume, the stress of surgery, and the effects of medications and preoperative preparations all affect cardiovascular function. IV fluid replacement may be prescribed for up to 24 hours after surgery or until the patient is stable and tolerating oral fluids. Close monitoring is indicated to detect and correct conditions such as fluid volume deficit, altered tissue perfusion, and decreased cardiac output, all of which can increase the patient's discomfort, place him or her at risk of complications, and prolong the hospital stay. Some patients are at risk of fluid volume excess secondary to existing cardiovascular or renal disease, advanced age, and other factors (Litwack, 2006). Consequently, fluid replacement must be carefully managed, and intake and output records must be accurate.

Nursing management includes assessing the patency of the IV lines and ensuring that the correct fluids are administered at the prescribed rate. Intake and output, including emesis and output from wound drainage systems, are recorded separately and totaled to determine fluid balance. If the patient has an indwelling urinary catheter, hourly outputs are monitored and rates of less than 30 mL/h are reported; if the patient is voiding, an output of less than 240 mL per 8-hour shift is reported. Electrolyte levels and hemoglobin and hematocrit levels are monitored. Decreased hemoglobin and hematocrit levels can indicate blood loss or dilution of circulating volume by IV fluids. If dilution is contributing to the decreased levels, the hemoglobin and hematocrit will rise as the stress response abates and fluids are mobilized and excreted.

Venous stasis from dehydration, immobility, and pressure on leg veins during surgery put the patient at risk for DVT. Leg exercises and frequent position changes are initiated early in the postoperative period to stimulate circulation. Patients should avoid positions that compromise venous return, such as raising the bed's knee gatch, placing a pillow under the knees, sitting for long periods, and dangling the legs with pressure at the back of the knees. Venous return is promoted by anti-embolism stockings and early ambulation.

### *Encouraging Activity*

Early ambulation has a significant effect on recovery and the prevention of complications (eg, atelectasis, hypostatic pneumonia, gastrointestinal [GI] discomfort, circulatory problems) (Rothrock, 2007). Postoperative activity orders are checked before the patient is assisted to get out of bed, in many instances, on the evening following surgery. Sitting up at the edge of the bed for a few minutes may be all that the patient who has undergone a major surgical procedure can tolerate at first.

Ambulation reduces postoperative abdominal distention by increasing GI tract and abdominal wall tone and stimulating peristalsis. Early ambulation prevents stasis of blood, and thromboembolic events occur less frequently. Pain is often

decreased when early ambulation is possible, and the hospital stay is shorter and less costly.

Despite the advantages of early ambulation, patients may be reluctant to get out of bed on the evening of surgery. Reminding them of the importance of early mobility in preventing complications may help patients overcome their fears. When a patient gets out of bed for the first time, orthostatic hypotension, also called postural hypotension, is a concern. Orthostatic hypotension is an abnormal drop in blood pressure that occurs as the patient changes from a supine to a standing position. It is common after surgery because of changes in circulating blood volume and bed rest. Signs and symptoms include a decrease of 20 mm Hg in systolic blood pressure or 10 mm Hg in diastolic blood pressure, weakness, dizziness, and fainting. Older adults are at increased risk for orthostatic hypotension secondary to age-related changes in vascular tone. To detect orthostatic hypotension, the nurse assesses the patient's blood pressure first in the supine position, after the patient sits up, again after the patient stands, and 2 to 3 minutes later. Gradual position change gives the circulatory system time to adjust. If the patient becomes dizzy, he or she is returned to the supine position, and ambulation is delayed for several hours.

To assist the postoperative patient in getting out of bed for the first time after surgery, the nurse:

1. Helps the patient move gradually from the lying position to the sitting position by raising the head of the bed and encourages the patient to splint the incision when applicable.
2. Positions the patient completely upright (sitting) and turned so that both legs are hanging over the edge of the bed.
3. Helps the patient stand beside the bed.

After becoming accustomed to the upright position, the patient may start to walk. The nurse should be at the patient's side to give physical support and encouragement. Care must be taken not to tire the patient; the extent of the first few periods of ambulation varies with the type of surgical procedure and the patient's physical condition and age.

Whether or not the patient can ambulate early in the postoperative period, bed exercises are encouraged to improve circulation. Bed exercises consist of the following:

- Arm exercises (full range of motion, with specific attention to abduction and external rotation of the shoulder)
- Hand and finger exercises
- Foot exercises to prevent DVT, foot drop, and toe deformities and to aid in maintaining good circulation
- Leg flexion and leg-lifting exercises to prepare the patient for ambulation
- Abdominal and gluteal contraction exercises

Hampered by pain, dressings, IV lines, or drains, many patients cannot engage in activity without assistance. Helping the patient increase his or her activity level on the first postoperative day is important to prevent complications related to prolonged inactivity. One way to increase the patient's activity is to have the patient perform as much routine hygiene care as possible. Setting up the patient to bathe with a bedside wash basin or, if possible, assisting the patient to the bathroom to sit in a chair at the sink not only gets the patient moving but helps restore a sense of self-control and prepares the patient for discharge.

For a safe discharge to home, patients need to be able to ambulate a functional distance (eg, length of the house or apartment), get in and out of bed unassisted, and be independent with toileting. Patients can be asked to perform as much as they can and then to call for assistance. The patient and the nurse can collaborate on a schedule for progressive activity that includes ambulating in the room and hallway and sitting out of bed in a chair. Assessing the patient's vital signs before, during, and after a scheduled activity helps the nurse and patient determine the rate of progression. By providing physical support, the nurse maintains the patient's safety; by communicating a positive attitude about the patient's ability to perform the activity, the nurse promotes the patient's confidence. The nurse encourages the patient to continue to perform bed exercises, wear pneumatic compression or prescribed anti-embolism stockings when in bed, and rest as needed. If the patient has had orthopedic surgery of the lower extremities or will require a mobility aid (ie, walker, crutches) at home, a physical therapist may be involved the first time the patient gets out of bed to teach him or her to ambulate safely or to use the mobility aid correctly.

### *Caring for Wounds*

**WOUND HEALING.** Wounds heal by different mechanisms, depending on the condition of the wound. Surgical wound healing occurs in three phases: **first-intention, second-intention,** and **third-intention wound healing** (Chart 20-5) (Rothrock, 2007). With shorter hospital stays, much of the healing takes place at home, and both the hospital and home care nurse should be informed about the principles of wound healing (Hahler, 2006; Hunter, Thompson, Langemo, et al., 2007).

Ongoing assessment of the surgical site involves inspection for approximation of wound edges, integrity of sutures or staples, redness, discoloration, warmth, swelling, unusual tenderness, or drainage. The area around the wound should also be inspected for a reaction to tape or trauma from tight bandages. As a wound heals, many factors, such as adequate nutrition, cleanliness, rest, and position, determine how quickly healing occurs. These factors are influenced by nursing interventions. Specific nursing assessments and interventions that address these factors and help promote wound healing are presented in Table 20-3.

**CARING FOR SURGICAL DRAINS.** Nursing interventions to promote wound healing also include management of surgical drains. Drains are tubes that exit the peri-incisional area, either into a portable wound suction device (closed) or into the dressings (open). The principle involved is to allow the escape of fluids that could otherwise serve as a culture medium for bacteria. In portable wound suction, the use of gentle, constant suction enhances drainage of these fluids and collapses the skin flaps against the underlying tissue, thus removing "dead space." Types of wound drains include the Penrose, Hemovac, and Jackson-Pratt drains (Fig. 20-5). Output (drainage) from wound systems

## Chart 20-5 • *Wound Healing Mechanisms*

### First-Intention Healing

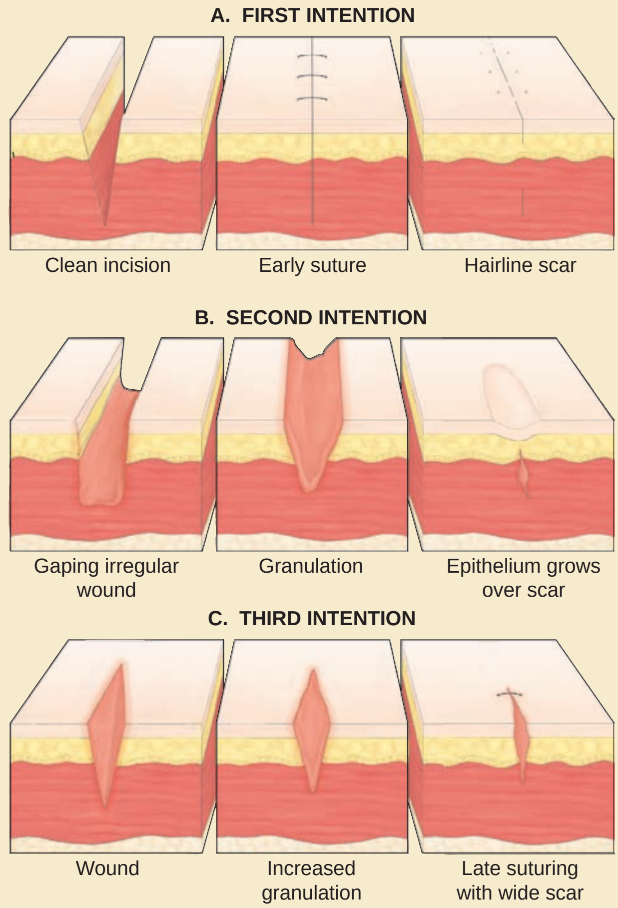
Wounds made aseptically with a minimum of tissue destruction that are properly closed heal with little tissue reaction by first intention (primary union). When wounds heal by first-intention healing, granulation tissue is not visible and scar formation is minimal. Postoperatively, many of these wounds are covered with a dry sterile dressing. If a cyanoacrylate tissue adhesive (Liquiband) was used to close the incision without sutures, a dressing is contraindicated.

### Second-Intention Healing

Second-intention healing (granulation) occurs in infected wounds (abscess) or in wounds in which the edges have not been approximated. When an abscess is incised, it collapses partly, but the dead and dying cells forming its walls are still being released into the cavity. For this reason, a drainage tube or gauze packing is inserted into the abscess pocket to allow drainage to escape easily. Gradually, the necrotic material disintegrates and escapes, and the abscess cavity fills with a red, soft, sensitive tissue that bleeds easily. This tissue is composed of minute, thin-walled capillaries and buds that later form connective tissue. These buds, called granulations, enlarge until they fill the area left by the destroyed tissue. The cells surrounding the capillaries change their round shape to become long, thin, and intertwined to form a scar (cicatrix). Healing is complete when skin cells (epithelium) grow over these granulations. This method of repair is called healing by granulation, and it takes place whenever pus is formed or when loss of tissue has occurred for any reason. When the postoperative wound is to be allowed to heal by secondary intention, it is usually packed with saline-moistened sterile dressings and covered with a dry sterile dressing.

### Third-Intention Healing

Third-intention healing (secondary suture) is used for deep wounds that either have not been sutured early or break down and are resutured later, thus bringing together two apposing granulation surfaces. This results in a deeper and wider scar. These wounds are also packed postoperatively with moist gauze and covered with a dry sterile dressing.




is recorded. The amount of bloody drainage on the surgical dressing is assessed frequently. Spots of drainage on the dressings are outlined with a pen, and the date and time of the outline are recorded on the dressing so that increased drainage can be easily seen. A certain amount of bloody drainage in a wound drainage system or on the dressing is expected, but excessive amounts should be reported to the surgeon. Increasing amounts of fresh blood on the dressing should be reported immediately. Some wounds are irrigated heavily before closure in the OR, and open drains exiting the wound may be embedded in the dressings. These wounds may drain large amounts of blood-tinged fluid that saturate the dressing. The dressing can be reinforced with sterile gauze bandages; the time at which they were reinforced should be documented. If drainage continues, the surgeon should be notified so that the dressing can be changed. Multiple similar drains are numbered or otherwise labeled (eg, left lower quadrant, left upper quadrant) so that output measurements can be reliably and consistently recorded.

**CHANGING THE DRESSING.** Although the first postoperative dressing is usually changed by a member of the surgical team, subsequent dressing changes in the immediate postoperative period are usually performed by the nurse. A dressing is applied to a wound for one or more of the following reasons: (1) to provide a proper environment for wound healing; (2) to absorb drainage; (3) to splint or immobilize the wound; (4) to protect the wound and new epithelial tissue from mechanical injury; (5) to protect the wound from bacterial contamination and from soiling by feces, vomitus, and urine; (6) to promote hemostasis, as in a pressure dressing; and (7) to provide mental and physical comfort for the patient.

The patient is told that the dressing is to be changed and that changing the dressing is a simple procedure associated

**Table 20-3 FACTORS AFFECTING WOUND HEALING**

| Factors | Rationale | Nursing Interventions |
|---|---|---|
| Age of patient | The older the patient, the less resilient the tissues. | Handle all tissues gently. |
| Handling of tissues | Rough handling causes injury and delayed healing. | Handle tissues carefully and evenly. |
| Hemorrhage | Accumulation of blood creates dead spaces as well as dead cells that must be removed. The area becomes a growth medium for organisms. | Monitor vital signs. Observe incision site for evidence of bleeding and infection. |
| Hypovolemia | Insufficient blood volume leads to vasoconstriction and reduced oxygen and nutrients available for wound healing. | Monitor for volume deficit (circulatory impairment). Correct by fluid replacement as prescribed. |
| Local factors | | |
| Edema | Reduces blood supply by exerting increased interstitial pressure on vessels. | Elevate part; apply cool compresses. |
| Inadequate dressing technique | | |
| Too small | Permits bacterial invasion and contamination. | Follow guidelines for proper dressing technique. |
| Too tight | Reduces blood supply carrying nutrients and oxygen. | |
| Nutritional deficits | Protein–calorie depletion may occur. Insulin secretion may be inhibited, causing blood glucose to rise. | Correct deficits; this may require parenteral nutritional therapy. Monitor blood glucose levels. Administer vitamin supplements as prescribed. |
| Foreign bodies | Foreign bodies retard healing. | Keep wounds free of dressing threads and talcum powder from gloves. |
| Oxygen deficit (tissue oxygenation insufficient) | Insufficient oxygen may be due to inadequate lung and cardiovascular function as well as localized vasoconstriction. | Encourage deep breathing, turning, controlled coughing. |
| Drainage accumulation | Accumulated secretions hamper healing process. | Monitor closed drainage systems for proper functioning. Institute measures to remove accumulated secretions. |
| Medications | | |
| Corticosteroids | May mask presence of infection by impairing normal inflammatory response. | Be aware of action and effect of medications patient is receiving. |
| Anticoagulants | May cause hemorrhage. | |
| Broad-spectrum and specific antibiotics | Effective if administered immediately before surgery for specific pathology or bacterial contamination. If administered after wound is closed, ineffective because of intravascular coagulation. | |
| Patient overactivity | Prevents approximation of wound edges. Resting favors healing. | Use measures to keep wound edges approximated: taping, bandaging, splints. Encourage rest. |
| Systemic disorders<br>Hemorrhagic shock<br>Acidosis<br>Hypoxia<br>Renal failure<br>Hepatic disease<br>Sepsis | These depress cell functions that directly affect wound healing. | Be familiar with the nature of the specific disorder. Administer prescribed treatment. Cultures may be indicated to determine appropriate antibiotic. |
| Immunosuppressed state | Patient is more vulnerable to bacterial and viral invasion; defense mechanisms are impaired. | Provide maximum protection to prevent infection. Restrict visitors with colds; institute mandatory hand hygiene by all staff. |
| Wound stressors<br>Vomiting<br>Valsalva maneuver<br>Heavy coughing<br>Straining | Produce tension on wounds, particularly of the torso. | Encourage frequent turning and ambulation and administer antiemetic medications as prescribed. Assist patient in splinting incision. |

with little discomfort. The dressing change is performed at a suitable time (eg, not at mealtimes or when visitors are present). Privacy is provided, and the patient is not unduly exposed. The nurse should avoid referring to the incision as a scar because the term may have negative connotations for the patient. Assurance is given that the incision will shrink as it heals and that the redness will fade.

The nurse performs hand hygiene before and after the dressing change and wears disposable gloves (sterile or clean as needed) for the dressing change itself. Most dressing changes following surgery are sterile. In accordance with standard precautions, dressings are never touched by ungloved hands because of the danger of transmitting pathogenic organisms. The tape or adhesive portion of the dressing is removed by pulling it parallel with the skin surface and in the direction of hair growth, rather than at right angles. Alcohol wipes or nonirritating solvents aid in removing adhesive painlessly and quickly. The soiled dressing is removed and deposited in a container designated for disposal of biomedical waste.

Gloves are changed and a new dressing applied. If the patient is sensitive to adhesive tape, the dressing may be held in place with hypoallergenic tape. Many tapes are porous to prevent skin maceration. Some wounds become edematous after having been dressed, causing considerable tension on the tape. If the tape is not flexible, the stretching bandage

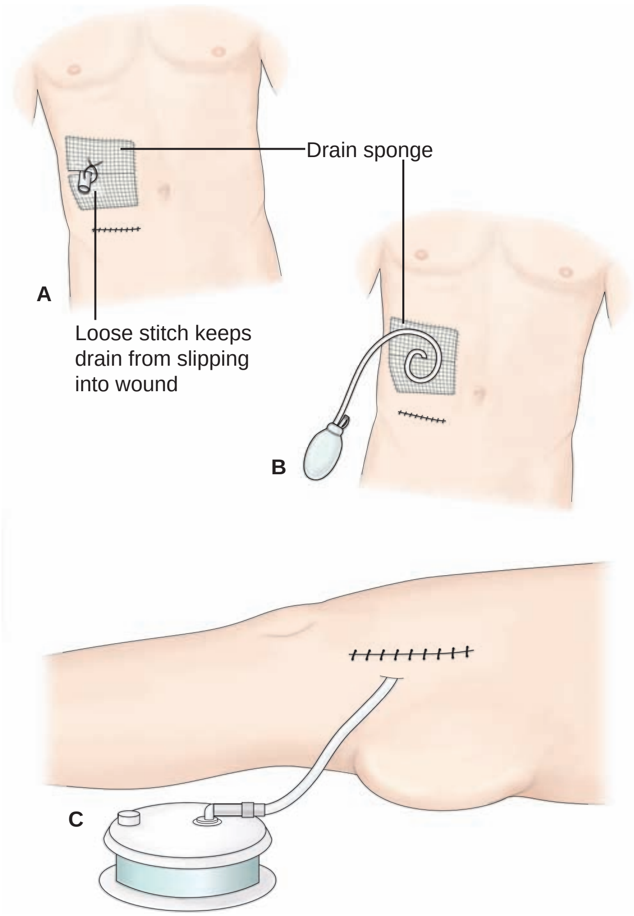



**Figure 20-5** Types of surgical drains: **A,** Penrose, **B,** Jackson-Pratt, **C,** Hemovac.

will also cause a shear injury to the skin. This can result in denuded areas or large blisters and should be avoided. An elastic adhesive bandage (Elastoplast, Microfoam-3M) may be used to hold dressings in place over mobile areas, such as the neck or the extremities, or where pressure is required.

While changing the dressing, the nurse has an opportunity to teach the patient how to care for the incision and change the dressings at home. The nurse observes for indicators of the patient's readiness to learn, such as looking at the incision, expressing interest, or assisting in the dressing change. Information on self-care activities and possible signs of infection is summarized in Chart 20-6.

### *Maintaining Normal Body Temperature*

The patient is still at risk for malignant hyperthermia and hypothermia in the postoperative period. Efforts are made to identify malignant hyperthermia and to treat it early and promptly (Rothrock, 2007). (See the discussion of malignant hyperthermia in Chapter 19.)

Patients who have received anesthesia are susceptible to chills and drafts. Hypothermia management, begun in the intraoperative period, extends into the postoperative period to prevent significant nitrogen loss and catabolism. Low body temperature is reported to the physician. The room is maintained at a comfortable temperature, and blankets are provided to prevent chilling. Treatment includes oxygen administration, adequate hydration, and proper nutrition. The patient is also monitored for cardiac dysrhythmias. The risk of hypothermia is greater in the elderly and in patients who were in the cool OR environment for a prolonged period.

### *Managing Gastrointestinal Function and Resuming Nutrition*

Discomfort of the GI tract (nausea, vomiting, and hiccups) and resumption of oral intake are issues for both the patient and the nurse. See the earlier discussion of nausea and vomiting in the PACU.

If risk of vomiting is high due to the nature of surgery, a nasogastric tube is inserted preoperatively and remains in place throughout the surgery and the immediate postoperative period. A nasogastric tube also may be inserted before surgery if postoperative distention is anticipated. In addition, a nasogastric tube may be inserted if a patient who has food in the stomach requires emergency surgery.

Hiccups, produced by intermittent spasms of the diaphragm secondary to irritation of the phrenic nerve, can occur after surgery. The irritation may be direct, such as from stimulation of the nerve by a distended stomach, subdiaphragmatic abscess, or abdominal distention; indirect, such as from toxemia or uremia that stimulates the nerve; or reflexive, such as irritation from a drainage tube or obstruction of the intestines. Usually these occurrences are mild, transitory attacks that cease spontaneously. If hiccups persist, they may produce considerable distress and serious effects such as vomiting, exhaustion, and wound dehiscence. The physician may prescribe phenothiazine medications (eg chlorpromazine [Thorazine]) for intractable hiccups (Zonderman & Doyle, 2006).

Once nausea and vomiting have subsided and the patient is fully awake and alert, the sooner he or she can tolerate a usual diet, and the more quickly normal GI function will resume. Taking food by mouth stimulates digestive juices and promotes gastric function and intestinal peristalsis. The return to normal dietary intake should proceed at a pace set by the patient. The nature of the surgery and the type of anesthesia directly affect the rate at which normal gastric activity resumes. Liquids are typically the first substances desired and tolerated by the patient after surgery. Water, juice, and tea may be given in increasing amounts. Cool fluids are tolerated more easily than those that are ice cold or hot. Soft foods (gelatin, custard, milk, and creamed soups) are added gradually after clear fluids have been tolerated. As soon as the patient tolerates soft foods well, solid food may be given.

Assessment and management of GI function are important after surgery because the GI tract is subject to uncomfortable or potentially life-threatening complications. Any postoperative patient may suffer from distention. Postoperative distention of the abdomen results from the accumulation of gas in the intestinal tract. Manipulation of the abdominal organs during surgery may produce a loss of normal peristalsis for 24 to 48 hours, depending on the type and extent of surgery. Even though nothing is given by mouth, swallowed air and GI tract secretions enter the stomach and intestines; if not propelled by peristalsis, they collect in the

**CHART 20-6** PATIENT EDUCATION
**Wound Care Instructions**

**Until Sutures Are Removed**

1. Keep the wound dry and clean.
   - If there is no dressing, ask your nurse or physician if you can bathe or shower.
   - If a dressing or splint is in place, do not remove it unless it is wet or soiled.
   - If wet or soiled, change dressing yourself if you have been taught to do so; otherwise, call your nurse or physician for guidance.
   - If you have been taught, instruction might be as follows:
     - Cleanse area *gently* with sterile normal saline once or twice daily.
     - Cover with a sterile Telfa pad or gauze square large enough to cover wound.
     - Apply hypoallergenic tape (Dermacel or paper). Adhesive is not recommended because it is difficult to remove without possible injury to the incisional site.
2. Immediately report any of these signs of infection:
   - Redness, marked swelling exceeding ½ inch (2.5 cm) from incision site; tenderness; or increased warmth around wound
   - Red streaks in skin near wound
   - Pus or discharge, foul odor
   - Chills or temperature higher than 37.7°C (100°F)
3. If soreness or pain causes discomfort, apply a dry cool pack (containing ice or cold water) or take prescribed acetaminophen tablets (2) every 4–6 hours. Avoid using aspirin without direction or instruction because bleeding can occur with its use.
4. Swelling after surgery is common. To help reduce swelling, elevate the affected part to the level of the heart.
   - Hand or arm
     - Sleep—elevate arm on pillow at side
     - Sitting—place arm on pillow on adjacent table
     - Standing—rest affected hand on opposite shoulder; support elbow with unaffected hand
   - Leg or foot
     - Sitting—place a pillow on a facing chair; provide support underneath the knee
     - Lying—place a pillow under affected leg

**After Sutures Are Removed**

Although the wound appears to be healed when sutures are removed, it is still tender and will continue to heal and strengthen for several weeks.

1. Follow recommendations of physician or nurse regarding extent of activity.
2. Keep suture line clean; do not rub vigorously; pat dry. Wound edges may look red and may be slightly raised. This is normal.
3. If the site continues to be red, thick, and painful to pressure after 8 weeks, consult the health care provider. (This may be due to excessive collagen formation and should be checked.)

intestines, producing distention and causing the patient to complain of fullness or pain in the abdomen. Most often, the gas collects in the colon. Abdominal distention is further increased by immobility, anesthetic agents, and the use of opioid medications.

After major abdominal surgery, distention may be avoided by having the patient turn frequently, exercise, and ambulate as early as possible. This also alleviates distention produced by swallowing air, which is common in anxious patients. A nasogastric tube inserted before surgery may remain in place until full peristaltic activity (indicated by the passage of flatus) has resumed. The nurse detects bowel sounds by listening to the abdomen with a stethoscope. Bowel sounds are documented so that diet progression can occur.

Paralytic ileus and intestinal obstruction are potential postoperative complications that occur more frequently in patients undergoing intestinal or abdominal surgery. Refer to Chapter 38 for discussion of treatment.

### *Promoting Bowel Function*

Constipation is common after surgery and can be minor or a serious complication. Decreased mobility, decreased oral intake, and opioid analgesics contribute to difficulty having a bowel movement. In addition, irritation and trauma to the bowel during surgery may inhibit intestinal movement for several days. The combined effect of early ambulation, improved dietary intake, and a stool softener (if prescribed) promotes bowel elimination. Until the patient reports return of bowel function, the nurse should assess the abdomen for distention and the presence and frequency of bowel sounds. If the abdomen is not distended and bowel sounds are present, and if the patient does not have a bowel movement by the second or third postoperative day, the physician should be notified so that a laxative can be administered.

### *Managing Voiding*

Urinary retention after surgery can occur for various reasons. Anesthetics, anticholinergic agents, and opioids interfere with the perception of bladder fullness and the urge to void and inhibit the ability to initiate voiding and completely empty the bladder. Abdominal, pelvic, and hip surgery may increase the likelihood of retention secondary to pain. In addition, some patients find it difficult to use the bedpan or urinal in the recumbent position.

Bladder distention and the urge to void should be assessed at the time of the patient's arrival on the unit and frequently thereafter. The patient is expected to void within 8 hours after surgery (this includes time spent in the PACU). If the patient has an urge to void and cannot, or if the bladder is distended and no urge is felt or the patient cannot void, catheterization is not delayed solely on the basis of the 8-hour time frame. All methods to encourage the patient to void should be tried (eg, letting water run, applying heat to the perineum). The bedpan should be warm; a cold bedpan

causes discomfort and automatic tightening of muscles (including the urethral sphincter). If the patient cannot void on a bedpan, it may be possible to use a commode rather than resorting to catheterization. Male patients are often permitted to sit up or stand beside the bed to use the urinal, but safeguards should be taken to prevent the patient from falling or fainting due to loss of coordination from medications or orthostatic hypotension. If the patient cannot void in the specified time frame, the patient is catheterized and the catheter is removed after the bladder has emptied. Straight intermittent catheterization is preferred over indwelling catheterization because the risk of infection is increased with an indwelling catheter.

Even if the patient voids, the bladder may not necessarily be empty. The nurse notes the amount of urine voided and palpates the suprapubic area for distention or tenderness. A portable ultrasound device may also be used to assess residual volume. Intermittent catheterization may be prescribed every 4 to 6 hours until the patient can void spontaneously and the postvoid residual is less than 100 mL.

#### *Maintaining a Safe Environment*

During the immediate postoperative period, the patient recovering from anesthesia should have three side rails up, and the bed should be in the low position. The nurse assesses the patient's level of consciousness and orientation and determines whether the patient can resume wearing his or her eyeglasses or hearing aid, because impaired vision, inability to hear postoperative instructions, or inability to communicate verbally places the patient at risk for injury. All objects the patient may need should be within reach, especially the call light. Any immediate postoperative orders concerning special positioning, equipment, or interventions should be implemented as soon as possible. The patient is instructed to ask for assistance with any activity. Although restraints are occasionally necessary for the disoriented patient, they should be avoided if at all possible. Agency policy on the use of restraints must be consulted and followed.

Any surgical procedure has the potential for injury due to disrupted neurovascular integrity resulting from prolonged awkward positioning in the OR, manipulation of tissues, inadvertent severing of nerves or blood vessels, or tight bandages. Any orthopedic surgery or surgery involving the extremities carries a risk of peripheral nerve damage. Vascular surgeries, such as replacement of sections of diseased peripheral arteries or inserting an arteriovenous graft, put the patient at risk for thrombus formation at the surgical site and subsequent ischemia of tissues distal to the thrombus. Assessment includes having the patient move the hand or foot distal to the surgical site through a full range of motion, assessing all surfaces for intact sensation, and assessing peripheral pulses (Rothrock, 2007).

#### *Providing Emotional Support to the Patient and Family*

Although patients and families are undoubtedly relieved that surgery is over, anxiety levels may remain high in the immediate postoperative period. Many factors contribute to this anxiety: pain, being in an unfamiliar environment, inability to control one's circumstances or care for oneself, fear of the long-term effects of surgery, fear of complications, fatigue, spiritual distress, altered role responsibilities, ineffective coping, and altered body image are all potential reactions to the surgical experience. The nurse helps the patient and family work through their anxieties by providing reassurance and information and by spending time listening to and addressing their concerns. The nurse describes hospital routines and what to expect in the time until discharge and explains the purpose of nursing assessments and interventions. Informing patients when they will be able to drink fluids or eat, when they will be getting out of bed, and when tubes and drains will be removed helps them gain a sense of control and participation in recovery and engages them in the plan of care. Acknowledging family members' concerns and accepting and encouraging their participation in the patient's care assists them in feeling that they are helping their loved one. The nurse can modify the environment to enhance rest and relaxation by providing privacy, reducing noise, adjusting lighting, providing enough seating for family members, and encouraging a supportive atmosphere.

#### *Managing Potential Complications*

The postoperative patient is at risk for complications as outlined below and listed in Table 20-4.

**DEEP VEIN THROMBOSIS.** Serious potential complications of surgery include DVT and pulmonary embolism (PE) (Rothrock, 2007).

Prophylactic treatment is common for patients at risk for DVT and PE. Low-molecular-weight or low-dose heparin and low-dose warfarin (Coumadin) are other anticoagulants that may be used. External pneumatic compression and anti-embolism stockings can be used alone or in combination

**Table 20-4 POTENTIAL POSTOPERATIVE COMPLICATIONS**

| Body System/Type | Complications |
|---|---|
| Respiratory | Atelectasis, pneumonia, PE aspiration |
| Cardiovascular | Shock, thrombophlebitis |
| Neurologic | Delirium, stroke |
| Skin/wound | Breakdown, infection, dehiscence, evisceration, delayed healing, hemorrhage, hematoma |
| Gastrointestinal | Constipation, paralytic ileus, bowel obstruction |
| Urinary | Acute urine retention, urinary tract infection |
| Functional | Weakness, fatigue, functional decline |
| Thromboembolic | DVT, PE |

**Table 20-5 WOUND CLASSIFICATION AND ASSOCIATED SURGICAL SITE INFECTION RISK**

| Surgical Category | Determinants of Category | Expected Risk of Postsurgical Infection (%) |
|---|---|---|
| Clean | Nontraumatic site<br>Uninfected site<br>No inflammation<br>No break in aseptic technique<br>No entry into respiratory, alimentary, genitourinary, or oropharyngeal tracts | 1–3 |
| Clean-contaminated | Entry into respiratory, alimentary, genitourinary or oropharyngeal tracts without unusual contamination<br>Appendectomy<br>Minor break in aseptic technique<br>Mechanical drainage | 3–7 |
| Contaminated | Open, newly experienced traumatic wounds<br>Gross spillage from gastrointestinal tract<br>Major break in aseptic technique<br>Entry into genitourinary or biliary tract when urine or bile is infected | 7–16 |
| Dirty | Traumatic wound with delayed repair, devitalized tissue, foreign bodies, or fecal contamination<br>Acute inflammation and purulent drainage encountered during procedure | 16–29 |

with low-dose heparin. The stress response that is initiated by surgery inhibits the fibrinolytic system, resulting in blood hypercoagulability. Dehydration, low cardiac output, blood pooling in the extremities, and bed rest add to the risk of thrombosis formation. Although all postoperative patients are at some risk, factors such as a history of thrombosis, malignancy, trauma, obesity, indwelling venous catheters, and hormone (eg, estrogen) use increase the risk. The first symptom of DVT may be a pain or cramp in the calf. Initial pain and tenderness may be followed by a painful swelling of the entire leg, often accompanied by fever, chills, and diaphoresis (Cawley, 2008).

The benefits of early ambulation and leg exercises in preventing DVT cannot be overemphasized, and these activities are recommended for all patients, regardless of their risk. It is important to avoid the use of blanket rolls, pillow rolls, or any form of elevation that can constrict vessels under the knees. Even prolonged "dangling" (having the patient sit on the edge of the bed with legs hanging over the side) can be dangerous and is not recommended in susceptible patients because pressure under the knees can impede circulation. Adequate hydration is also encouraged; the patient can be offered juices and water throughout the day to avoid dehydration. Refer to Chapter 31 for a complete discussion of DVT and to Chapter 23 for discussion of PE.

**HEMATOMA.** At times, concealed bleeding occurs beneath the skin at the surgical site. This hemorrhage usually stops spontaneously but results in clot (hematoma) formation within the wound. If the clot is small, it will be absorbed and need not be treated. If the clot is large, the wound usually bulges somewhat, and healing will be delayed unless the clot is removed. After several sutures are removed by the physician, the clot is evacuated and the wound is packed lightly with gauze. Healing occurs usually by granulation, or a secondary closure may be performed.

**INFECTION (WOUND SEPSIS).** The creation of a surgical wound disrupts the integrity of the skin, bypassing the body's primary defense and protection against infection. Exposure of deep body tissues to pathogens in the environment places the patient at risk for infection of the surgical site, and a potentially life-threatening complication such as infection increases hospital length of stay, costs of care, and risk of further complications. It is estimated that 14% to 16% of all health care–associated infections are surgical-site infections and 77% of surgical patients who die do so due to sepsis associated with infections (Phillips, 2007).

Multiple factors, including the type of wound, place the patient at risk of infection. Surgical wounds are classified according to the degree of contamination. Table 20-5 defines the terms used to describe surgical wounds and gives the expected rate of wound infection per category. Patient-related factors include age, nutritional status, diabetes, smoking, obesity, remote infections, endogenous mucosal microorganisms, altered immune response, length of preoperative stay, and severity of illness (Phillips, 2007). Factors related to the surgical procedure include the method of preoperative skin preparation, surgical attire of the team, method of sterile draping, duration of surgery, antimicrobial prophylaxis, aseptic technique, factors related to surgical technique, drains or foreign material, OR ventilation, length of procedure, and exogenous micro-organisms. Other risk factors for wound sepsis include wound contamination, foreign body, faulty suturing technique, devitalized tissue, hematoma, debilitation, dehydration, malnutrition, anemia, obesity, shock, duration of surgical procedure, and associated disorders (eg, diabetes mellitus) (Baugh, Zuelaer, Meador, et al., 2007; Litwack, 2006). Efforts to prevent wound infection are directed at reducing risks. Preoperative and intraoperative risks and interventions are discussed in Chapters 18 and 19. Postoperative care of the wound centers on assessing the wound, preventing contamination and infection before wound edges have sealed, and enhancing healing.

Wound infection may not be evident until at least postoperative day 5. Most patients are discharged before that time, and more than half of wound infections are diagnosed after discharge, highlighting the importance of patient education regarding wound care. Signs and symptoms of wound infection include increased pulse rate and

temperature; an elevated white blood cell count; wound swelling, warmth, tenderness, or discharge; and incisional pain. Local signs may be absent if the infection is deep. *Staphylococcus aureus* accounts for many postoperative wound infections. Other infections may result from *Escherichia coli*, *Proteus vulgaris*, *Aerobacter aerogenes*, *Pseudomonas aeruginosa*, and other organisms. Although they are rare, beta-hemolytic streptococcal or clostridial infections can be rapid and deadly and need strict infection control practices to prevent the spread of infection to others. Intensive medical and nursing care is essential if the patient is to survive.

When a wound infection is diagnosed in a surgical incision, the surgeon may remove one or more sutures or staples and, using aseptic precautions, separate the wound edges with a pair of blunt scissors or a hemostat. Once the incision is opened, a drain is inserted. If the infection is deep, an incision and drainage procedure may be necessary. Antimicrobial therapy and a wound care regimen are also initiated.

**WOUND DEHISCENCE AND EVISCERATION.** Wound **dehiscence** (disruption of surgical incision or wound) and **evisceration** (protrusion of wound contents) are serious surgical complications (Fig. 20-6). Dehiscence and evisceration are especially serious when they involve abdominal incisions or wounds. These complications result from sutures giving way, from infection, or, more frequently, from marked distention or strenuous cough. They may also occur because of increasing age, anemia, poor nutritional status, obesity, malignancy, jaundice, diabetes, use of steroids, and gender in patients undergoing abdominal surgery (Hahler, 2006; Hunter, et al., 2007).

When the wound edges separate slowly, the intestines may protrude gradually or not at all, and the earliest sign may be a gush of bloody (serosanguineous) peritoneal fluid from the wound. When a wound ruptures suddenly, coils of intestine may push out of the abdomen. The patient may report that "something gave way." The evisceration causes pain and may be associated with vomiting.

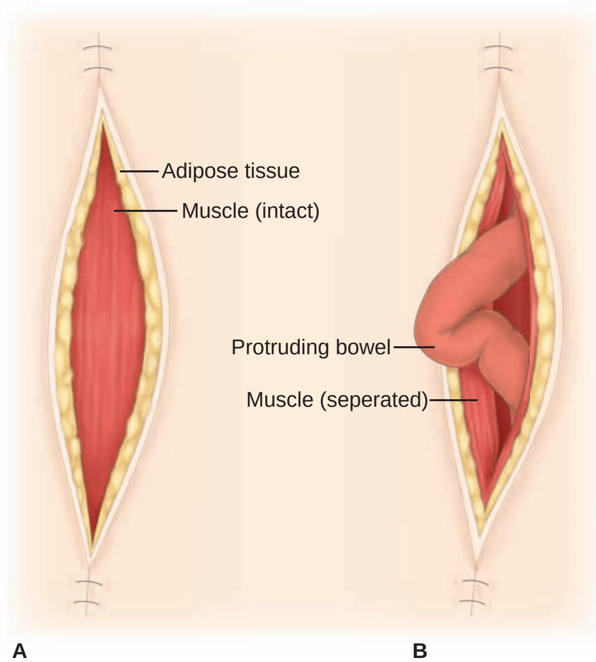



**Figure 20-6** **A,** Wound dehiscence. **B,** Wound evisceration.

### NURSING ALERT

**If disruption of a wound occurs, the patient is placed in the low Fowler's position and instructed to lie quietly. These actions minimize protrusion of body tissues. The protruding coils of intestine are covered with sterile dressings moistened with sterile saline solution, and the surgeon is notified at once.**

An abdominal binder can provide support and guard against dehiscence and often is used along with the primary dressing, especially in patients with weak or pendulous abdominal walls or when rupture of a wound has occurred (Hahler, 2006).

**GERONTOLOGIC CONSIDERATIONS.** Elderly patients recover more slowly, have longer hospital stays, and are at greater risk for development of postoperative complications. Delirium, pneumonia, decline in functional ability, exacerbation of comorbid conditions, pressure ulcers, decreased oral intake, GI disturbance, and falls are all threats to recovery in the older adult (Litwack, 2006; Mentes, 2006). Expert nursing care can help the older adult avoid these complications or minimize their effects (Phillips, 2007).

Postoperative delirium, characterized by confusion, perceptual and cognitive deficits, altered attention levels, disturbed sleep patterns, and impaired psychomotor skills, is a significant problem for older adults (Cofer, 2005). Causes of delirium are multifactorial (Chart 20-7). Skilled and frequent assessment of mental status and of all physiologic factors influencing mental status helps the nurse plan for care because delirium may be the initial or only indicator of infection, fluid and electrolyte imbalance, or deterioration of respiratory or hemodynamic status in the elderly patient. Factors that determine whether a patient is at risk for delirium include age, history of alcohol abuse, preoperative cognitive function, physical function, serum chemistries, and type of surgery.

Recognizing postoperative delirium and identifying and treating its underlying cause are the goals of care. Postoperative delirium is sometimes mistaken for preexisting dementia or is attributed to age. In addition to monitoring and managing identifiable causes, the nurse implements supportive interventions. Keeping the patient in a well-lit room and close to the nurses' station can reduce sensory deprivation. At the same time, distracting and unfamiliar noises should be minimized. Because pain can contribute to postoperative delirium, adequate pain control without oversedation is essential (Phillips, 2007).

The patient is reoriented as often as necessary, and staff should introduce themselves each time they come in contact with the patient. Engaging the patient in conversation

**Chart 20-7 • *Causes of Postoperative Delirium***

- Acid–base disturbances
- Age greater than 80 years
- Fluid and electrolyte imbalance
- Dehydration
- History of dementia-like symptoms
- Hypoxia
- Hypercarbia
- Infection (urinary tract, wound, respiratory)
- Medications (anticholinergics, benzodiazepines, central nervous system depressants)
- Unrelieved pain
- Blood loss
- Decreased cardiac output
- Cerebral hypoxia
- Heart failure
- Acute myocardial infarction
- Hypothermia or hyperthermia
- Unfamiliar surroundings and sensory deprivation
- Emergent surgery
- Alcohol withdrawal
- Urinary retention
- Fecal impaction
- Polypharmacy
- Presence of multiple diseases
- Sensory impairments
- High stress or anxiety levels

and care activities and placing a clock and calendar nearby may improve cognitive function. Physical activity should not be neglected while the patient is confused because physical deterioration can worsen delirium and place the patient at increased risk for other complications. Restraints should be avoided because they can worsen confusion. If possible, a family member or staff member is asked to stay with the patient instead. Haloperidol (Haldol) or lorazepam (Ativan) may be administered during episodes of acute confusion, but these medications should be discontinued as soon as possible to avoid side effects.

Other problems confronting the elderly postoperative patient, such as pneumonia, altered bowel function, DVT, weakness, and functional decline, often can be prevented by early and progressive ambulation. Prolonged sitting positions are avoided at they promote venous stasis in the lower extremities. Assistance with ambulation may be required to keep the patient from bumping into objects and falling. A physical therapy referral may be indicated to promote safe, regular exercise for the older adult.

Urinary incontinence can be prevented by providing easy access to the call bell and the commode and by prompting voiding. Early ambulation and familiarity with the room help the patient to become self-sufficient sooner.

Optimal nutritional status is important for wound healing, return of normal bowel function, and fluid and electrolyte balance. The nurse and patient can consult with the dietitian to plan appealing, high-protein meals that provide sufficient fiber, calories, and vitamins. Nutritional supplements, such as Ensure or Sustacal, may be recommended. Multivitamins, iron, and vitamin C supplements may be prescribed to aid in tissue healing, formation of new red blood cells, and overall nutritional status.

In addition to monitoring and managing physiologic recovery of the older adult, the nurse identifies and addresses psychosocial needs. The older adult may require much encouragement and support to resume activities, and the pace may be slow. Sensory deficits may require frequent repetition of instructions, and decreased physiologic reserve may necessitate frequent rest periods. The older adult may require extensive discharge planning to coordinate both professional and family care providers, and the nurse, social worker, or nurse case manager may institute the plan for continuing care.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients have always required detailed discharge instructions to become proficient in special self-care needs after surgery; however, shorter hospital stays have increased the amount of information needed while reducing the amount of time in which to provide it. Although needs are specific to individual patients and the procedures they have undergone, general patient education needs for postoperative care have been identified (see Chart 20-3).

**CONTINUING CARE.** Community-based services are frequently necessary after surgery. Older patients, patients who live alone, patients without family support, and patients with preexisting chronic illness or disabilities are often in greatest need. Planning for discharge involves arranging for necessary services early in the acute care hospitalization for wound care, drain management, catheter care, infusion therapy, and physical or occupational therapy. The home care nurse coordinates these activities and services.

During home care visits, the nurse assesses the patient for postoperative complications by assessment of the surgical incision, respiratory and cardiovascular status, adequacy of pain management, fluid and nutritional status, and the patient's progress in returning to preoperative status. The nurse evaluates the patient's and family's ability to manage dressing changes and drainage systems and other devices and to administer prescribed medications. The nurse may change dressings or catheters if needed. The nurse identifies any additional services that are needed and assists the patient and family to arrange for them. Previous teaching is reinforced, and the patient is reminded to keep follow-up appointments. The patient and family are instructed about signs and symptoms to be reported to the surgeon. In addition, the nurse provides information about how to obtain needed supplies and suggests resources or support groups.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Maintains optimal respiratory function
   a. Performs deep-breathing exercises

   b. Displays clear breath sounds
   c. Uses incentive spirometer as prescribed
   d. Splints incisional site when coughing to reduce pain
2. Indicates that pain is decreased in intensity
3. Increases activity as prescribed
   a. Alternates periods of rest and activity
   b. Progressively increases ambulation
   c. Resumes normal activities within prescribed time frame
   d. Performs activities related to self-care
4. Wound heals without complication
5. Maintains body temperature within normal limits
6. Resumes oral intake
   a. Reports absence of nausea and vomiting
   b. Eats at least 75% of usual diet
   c. Is free of abdominal distress and gas pains
   d. Exhibits normal bowel sounds
7. Reports resumption of usual bowel elimination pattern
8. Resumes usual voiding pattern
9. Is free of injury
10. Exhibits decreased anxiety
11. Acquires knowledge and skills necessary to manage therapeutic regimen
12. Experiences no complications

## CRITICAL THINKING EXERCISES

**1** EBP A frail 86-year-old woman is admitted to PACU following a hemi-arthroplasty of her right hip. She has a history of osteoporosis. She is complaining of pain and difficulty taking a deep breath. How would you prioritize her needs, and what complications would you anticipate? Develop an evidence-based plan of care for her, addressing priorities from admission to the unit until discharge. What resources would you use to identify the current safe practice guidelines? Identify the criteria used to evaluate the strength of the evidence for these practices.

**2** A 36-year-old woman who is obese and has had abdominal surgery is admitted to the phase II PACU. Identify what information is essential to obtain during report from the OR, describe the Aldrete scoring system, and explain how you will know when the patient is ready to be discharged from the PACU.

**3** EBP A 45-year-old patient who is a smoker is admitted to the postoperative nursing unit after abdominal surgery and is complaining of severe pain. Develop an evidence-based plan of care for this patient, addressing pain relief from admission to the unit until discharge to home. What resources would you use to identify the current pain relief practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research articles.*
***Double asterisk indicates classic reference.*


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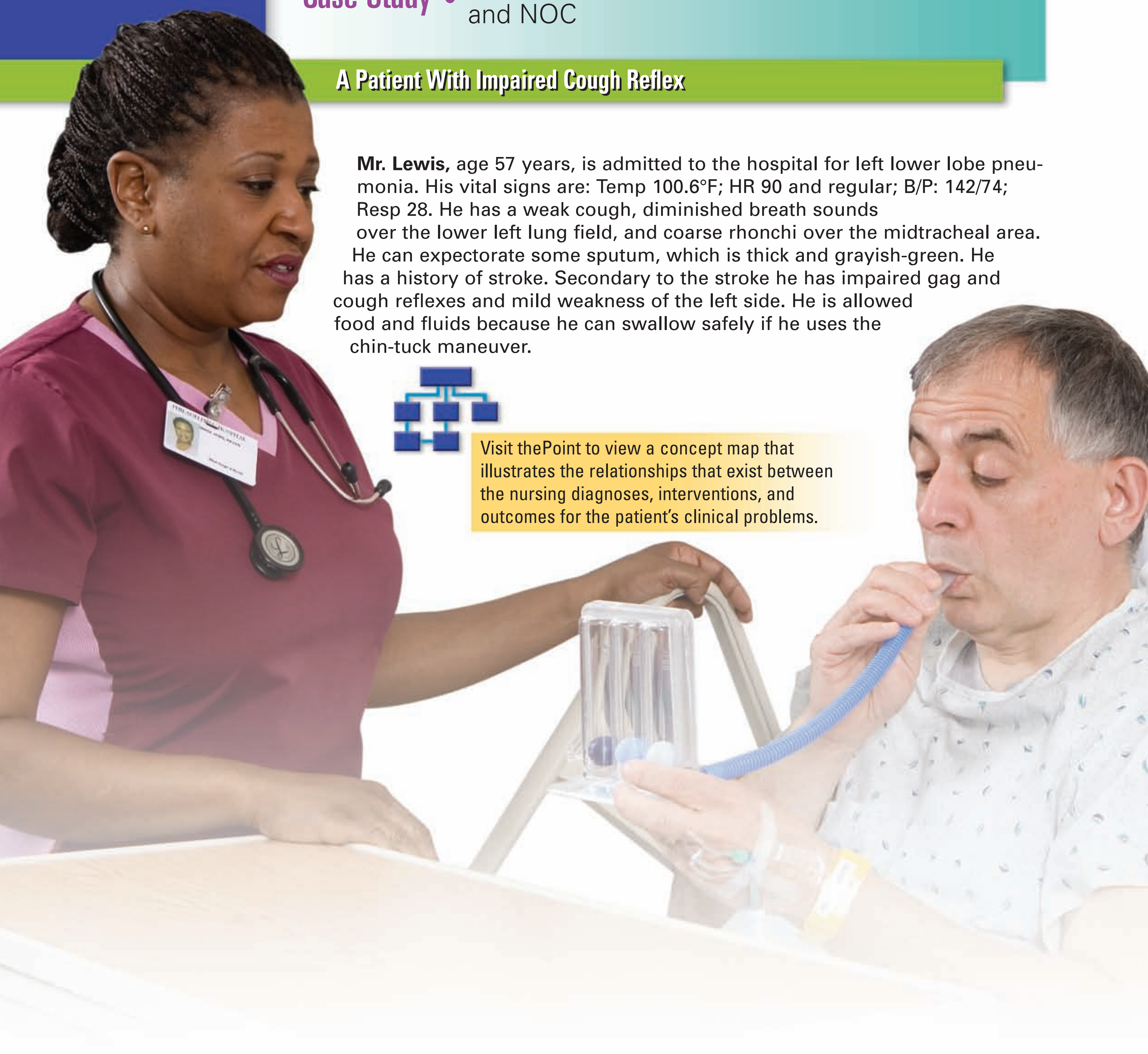
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unit 5

# Gas Exchange and Respiratory Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Impaired Cough Reflex



**Mr. Lewis,** age 57 years, is admitted to the hospital for left lower lobe pneumonia. His vital signs are: Temp 100.6°F; HR 90 and regular; B/P: 142/74; Resp 28. He has a weak cough, diminished breath sounds over the lower left lung field, and coarse rhonchi over the midtracheal area. He can expectorate some sputum, which is thick and grayish-green. He has a history of stroke. Secondary to the stroke he has impaired gag and cough reflexes and mild weakness of the left side. He is allowed food and fluids because he can swallow safely if he uses the chin-tuck maneuver.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **INEFFECTIVE AIRWAY CLEARANCE—** Inability to clear secretions or obstructions from the respiratory tract to maintain a clear airway | **RESPIRATORY MONITORING—** Collection and analysis of patient data to ensure airway patency and adequate gas exchange | **RESPIRATORY STATUS: AIRWAY PATENCY—** Extent to which the tracheobronchial passages remain open |
| **IMPAIRED GAS EXCHANGE—** Excess or deficit in oxygenation and/or carbon dioxide elimination at the alveolar-capillary membrane | **AIRWAY MANAGEMENT—** Facilitation of patency of air passages | **RESPIRATORY STATUS: GAS EXCHANGE—** The alveolar exchange of $O_2$ and $CO_2$ to maintain arterial blood gas concentrations |
| **INEFFECTIVE BREATHING PATTERN—** Inspiration and/or expiration that does not provide adequate ventilation | **COUGH ENHANCEMENT—** Promotion of deep inhalation by the patient with subsequent generation of high intrathoracic pressures and compression of underlying lung parenchyma for the forceful expulsion of air | **RESPIRATORY STATUS: VENTILATION—** Movement of air in and out of the lungs |
| **RISK FOR ASPIRATION—** At risk for entry of gastrointestinal secretions, oropharyngeal secretions, solids, or fluids into tracheobronchial passages | **AIRWAY SUCTIONING—** Removal of airway secretions by inserting a suction catheter into the patient's oral airway and/or trachea<br>**ASPIRATION PRECAUTIONS—** Prevention or minimization of risk factors in the patient at risk for aspiration | |


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chapter 21

# Assessment of Respiratory Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the structures and functions of the upper and lower respiratory tracts.
2. Describe ventilation, perfusion, diffusion, shunting, and the relationship of pulmonary circulation to these processes.
3. Discriminate between normal and abnormal breath sounds.
4. Use assessment parameters appropriate for determining the characteristics and severity of the major symptoms of respiratory dysfunction.
5. Identify the nursing implications of procedures used for diagnostic evaluation of respiratory function.

## GLOSSARY

**apnea:** temporary cessation of breathing
**bronchophony:** abnormal increase in clarity of transmitted voice sounds
**bronchoscopy:** direct examination of larynx, trachea, and bronchi using an endoscope
**cilia:** short hairs that provide a constant whipping motion that serves to propel mucus and foreign substances away from the lung toward the larynx
**compliance:** measure of the force required to expand or inflate the lungs
**crackles:** soft, high-pitched, discontinuous popping sounds during inspiration caused by delayed reopening of the airways
**diffusion:** exchange of gas molecules from areas of high concentration to areas of low concentration
**dyspnea:** labored breathing or shortness of breath
**egophony:** abnormal change in tone of voice that is heard when auscultating lungs
**fremitus:** vibrations of speech felt as tremors of chest wall during palpation
**hemoptysis:** expectoration of blood from the respiratory tract
**hypoxemia:** decrease in arterial oxygen tension in the blood
**hypoxia:** decrease in oxygen supply to the tissues and cells
**obstructive sleep apnea:** temporary absence of breathing during sleep secondary to transient upper airway obstruction
**orthopnea:** inability to breathe easily except in an upright position
**oxygen saturation:** percentage of hemoglobin that is bound to oxygen
**physiologic dead space:** portion of the tracheobronchial tree that does not participate in gas exchange
**pulmonary perfusion:** blood flow through the pulmonary vasculature
**respiration:** gas exchange between atmospheric air and the blood and between the blood and cells of the body
**rhonchi:** low-pitched wheezing or snoring sound associated with partial airway obstruction, heard on chest auscultation
**stridor:** harsh high-pitched sound heard on inspiration, usually without need of stethoscope, secondary to upper airway obstruction
**tachypnea:** abnormally rapid respirations
**tidal volume:** volume of air inspired and expired with each breath during normal breathing
**ventilation:** movement of air in and out of airways
**wheezes:** continuous musical sounds associated with airway narrowing or partial obstruction

Disorders of the respiratory system are common and are encountered by nurses in every setting from the community to the intensive care unit. Expert assessment skills must be developed and used to provide the best care for patients with acute and chronic respiratory problems. In order to differentiate between normal and abnormal assessment findings, an understanding of respiratory function and the significance of abnormal diagnostic test results is essential.

# Anatomic and Physiologic Overview

The respiratory system is composed of the upper and lower respiratory tracts. Together, the two tracts are responsible for **ventilation** (movement of air in and out of the airways). The upper respiratory tract, known as the upper airway, warms and filters inspired air so that the lower respiratory tract (the lungs) can accomplish gas exchange. Gas exchange involves delivering oxygen to the tissues through the bloodstream and expelling waste gases, such as carbon dioxide, during expiration. The respiratory system works in concert with the cardiovascular system; the respiratory system is responsible for ventilation and diffusion, and the cardiovascular system is responsible for perfusion (Farquhar & Fantasia, 2005).

## Anatomy of the Respiratory System

### *Upper Respiratory Tract*

Upper airway structures consist of the nose, sinuses and nasal passages, pharynx, tonsils and adenoids, larynx, and trachea.

#### Nose

The nose serves as a passageway for air to pass to and from the lungs. It filters impurities and humidifies and warms the air as it is inhaled. The nose is composed of an external and an internal portion. The external portion protrudes from the face and is supported by the nasal bones and cartilage. The anterior nares (nostrils) are the external openings of the nasal cavities.

The internal portion of the nose is a hollow cavity separated into the right and left nasal cavities by a narrow vertical divider, the septum. Each nasal cavity is divided into three passageways by the projection of the turbinates from the lateral walls. The turbinate bones are also called conchae (the name suggested by their shell-like appearance). Because of their curves, these bones increase the mucous membrane surface of the nasal passages and slightly obstruct the air flowing through them (Fig. 21-1).

Air entering the nostrils is deflected upward to the roof of the nose, and it follows a circuitous route before it reaches the nasopharynx. It comes into contact with a large surface of moist, warm, highly vascular, ciliated mucous membrane (called nasal mucosa) that traps practically all the dust and organisms in the inhaled air. The air is moistened, warmed to body temperature, and brought into contact with sensitive nerves. Some of these nerves detect odors; others provoke sneezing to expel irritating dust. Mucus, secreted continuously by goblet cells, covers the surface of the nasal mucosa and is moved back to the nasopharynx by the action of the **cilia** (fine hairs).

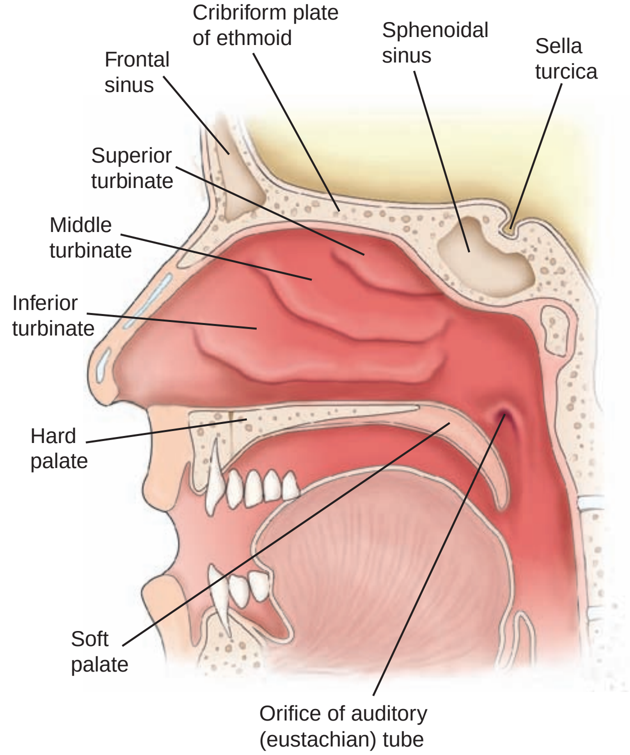



**Figure 21-1** Cross-section of nasal cavity.

#### Paranasal Sinuses

The paranasal sinuses include four pairs of bony cavities that are lined with nasal mucosa and ciliated pseudostratified columnar epithelium. These air spaces are connected by a series of ducts that drain into the nasal cavity. The sinuses are named by their location: frontal, ethmoidal, sphenoidal, and maxillary (Fig. 21-2). A prominent function of the sinuses is to serve as a resonating chamber in speech. The sinuses are a common site of infection.

#### Pharynx, Tonsils, and Adenoids

The pharynx, or throat, is a tubelike structure that connects the nasal and oral cavities to the larynx. It is divided into three regions: nasal, oral, and laryngeal. The nasopharynx is located posterior to the nose and above the soft palate. The oropharynx houses the faucial, or palatine, tonsils. The laryngopharynx extends from the hyoid bone to the cricoid cartilage. The epiglottis forms the entrance to the larynx.

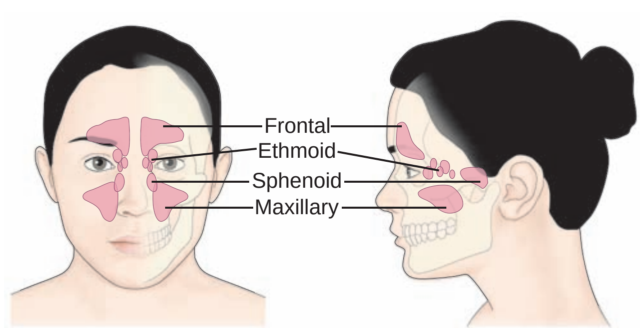



**Figure 21-2** The paranasal sinuses.

The adenoids, or pharyngeal tonsils, are located in the roof of the nasopharynx. The tonsils, the adenoids, and other lymphoid tissue encircle the throat. These structures are important links in the chain of lymph nodes guarding the body from invasion by organisms entering the nose and the throat. The pharynx functions as a passageway for the respiratory and digestive tracts.

### Larynx

The larynx, or voice organ, is a cartilaginous epithelium-lined structure that connects the pharynx and the trachea. The major function of the larynx is vocalization. It also protects the lower airway from foreign substances and facilitates coughing. It is frequently referred to as the voice box and consists of the following:

- Epiglottis: a valve flap of cartilage that covers the opening to the larynx during swallowing
- Glottis: the opening between the vocal cords in the larynx
- Thyroid cartilage: the largest of the cartilage structures; part of it forms the Adam's apple
- Cricoid cartilage: the only complete cartilaginous ring in the larynx (located below the thyroid cartilage)
- Arytenoid cartilages: used in vocal cord movement with the thyroid cartilage
- Vocal cords: ligaments controlled by muscular movements that produce sounds; located in the lumen of the larynx

### Trachea

The trachea, or windpipe, is composed of smooth muscle with C-shaped rings of cartilage at regular intervals. The cartilaginous rings are incomplete on the posterior surface and give firmness to the wall of the trachea, preventing it from collapsing. The trachea serves as the passage between the larynx and the bronchi.

## Lower Respiratory Tract

The lower respiratory tract consists of the lungs, which contain the bronchial and alveolar structures needed for gas exchange.

### Lungs

The lungs are paired elastic structures enclosed in the thoracic cage, which is an airtight chamber with distensible walls (Fig. 21-3). Ventilation requires movement of the walls of the thoracic cage and of its floor, the diaphragm. The effect of these movements is alternately to increase and decrease the capacity of the chest. When the capacity of the chest is increased, air enters through the trachea (inspiration) because of the lowered pressure within and inflates the lungs. When the chest wall and diaphragm return to their previous positions (expiration), the lungs recoil and force the air out through the bronchi and trachea. Inspiration occurs during the first third of the respiratory cycle, expiration during the later two thirds. The inspiratory phase of respiration normally requires energy; the expiratory phase is normally passive, requiring very little energy.

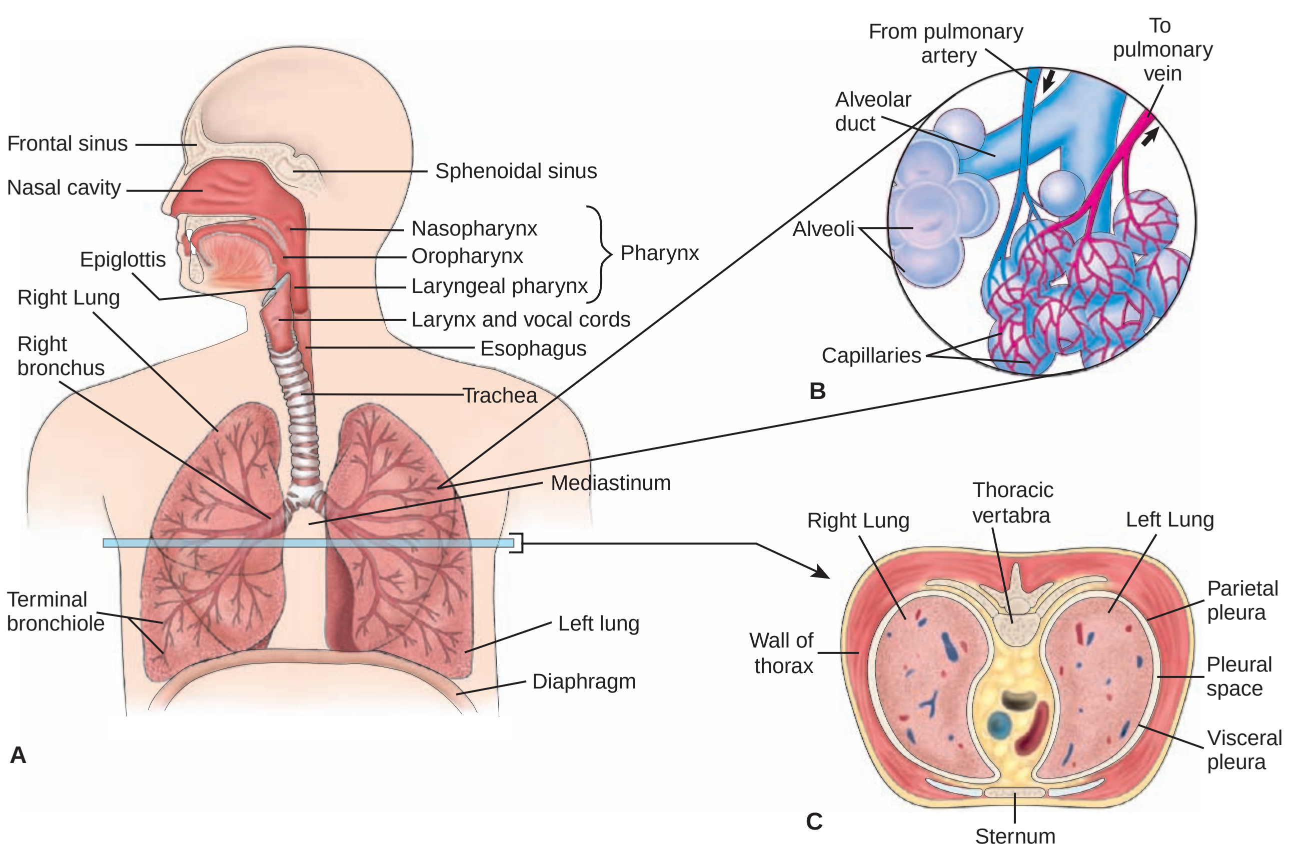



**Figure 21-3** The respiratory system; **A,** upper respiratory structures and the structures of the thorax; **B,** alveoli, **C,** and a horizontal cross-section of the lungs.

In respiratory diseases, such as chronic obstructive pulmonary disease (COPD), expiration requires energy.

***Pleura.*** The lungs and wall of the thorax are lined with a serous membrane called the pleura. The visceral pleura covers the lungs; the parietal pleura lines the thorax. The visceral and parietal pleura and the small amount of pleural fluid between these two membranes serve to lubricate the thorax and lungs and permit smooth motion of the lungs within the thoracic cavity with each breath.

***Mediastinum.*** The mediastinum is in the middle of the thorax, between the pleural sacs that contain the two lungs. It extends from the sternum to the vertebral column and contains all the thoracic tissue outside the lungs (heart, thymus, certain large blood vessels [ie, aorta, vena cava], and esophagus).

***Lobes.*** Each lung is divided into lobes. The right lung has upper, middle, and lower lobes, whereas the left lung consists of upper and lower lobes (Fig. 21-4). Each lobe is further subdivided into two to five segments separated by fissures, which are extensions of the pleura.

***Bronchi and Bronchioles.*** There are several divisions of the bronchi within each lobe of the lung. First are the lobar bronchi (three in the right lung and two in the left lung). Lobar bronchi divide into segmental bronchi (10 on the right and 8 on the left), which are the structures identified when choosing the most effective postural drainage position for a given patient. Segmental bronchi then divide into subsegmental bronchi. These bronchi are surrounded by connective tissue that contains arteries, lymphatics, and nerves.

The subsegmental bronchi then branch into bronchioles, which have no cartilage in their walls. Their patency depends entirely on the elastic recoil of the surrounding smooth muscle and on the alveolar pressure. The bronchioles contain submucosal glands, which produce mucus that covers the inside lining of the airways. The bronchi and bronchioles are also lined with cells that have surfaces covered with cilia. These cilia create a constant whipping motion that propels mucus and foreign substances away from the lungs toward the larynx.

The bronchioles then branch into terminal bronchioles, which do not have mucus glands or cilia. Terminal bronchioles then become respiratory bronchioles, which are considered to be the transitional passageways between the conducting airways and the gas exchange airways. Up to this point, the conducting airways contain about 150 mL of air in the tracheobronchial tree that does not participate in gas exchange; this is known as **physiologic dead space.** The respiratory bronchioles then lead into alveolar ducts and alveolar sacs and then alveoli. Oxygen and carbon dioxide exchange takes place in the alveoli.

***Alveoli.*** The lung is made up of about 300 million alveoli, which are arranged in clusters of 15 to 20. These alveoli are so numerous that if their surfaces were united to form one sheet, it would cover 70 square meters—the size of a tennis court.

There are three types of alveolar cells. Type I alveolar cells are epithelial cells that form the alveolar walls. Type II alveolar cells are metabolically active. These cells secrete surfactant, a phospholipid that lines the inner surface and prevents alveolar collapse. Type III alveolar cell macrophages are large phagocytic cells that ingest foreign matter (eg, mucus, bacteria) and act as an important defense mechanism.

## Function of the Respiratory System

The cells of the body derive the energy they need from the oxidation of carbohydrates, fats, and proteins. As with any type of combustion, this process requires oxygen. Certain vital tissues, such as those of the brain and the heart, cannot

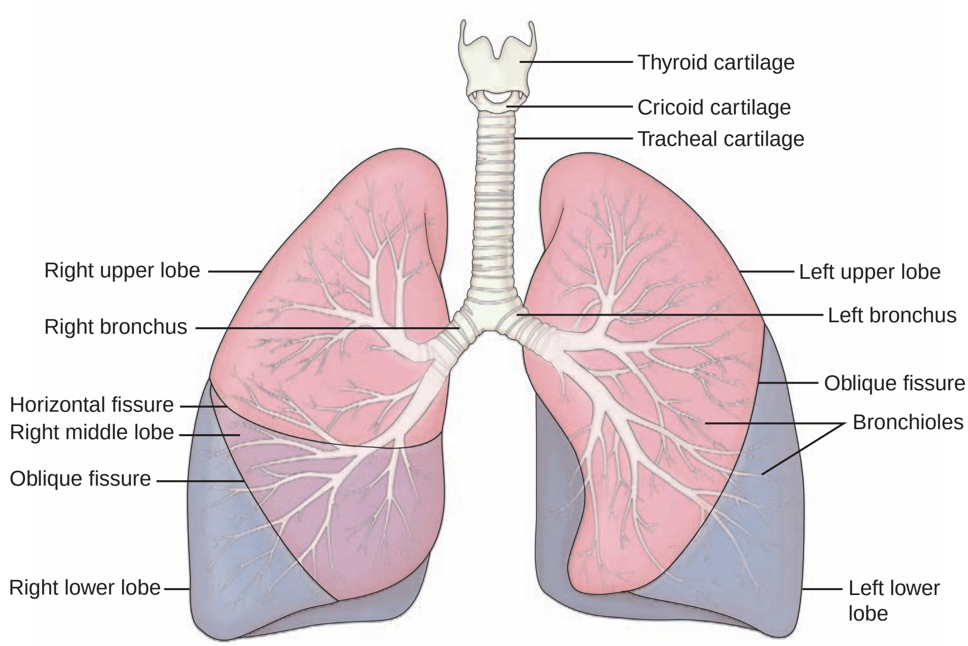



**Figure 21-4** Anterior view of the lungs. The lungs consist of five lobes. The right lung has three lobes (upper, middle, lower); the left has two (upper and lower). The lobes are further subdivided by fissures. The bronchial tree, another lung structure, inflates with air to fill the lobes.

survive for long without a continuous supply of oxygen. However, as a result of oxidation in the body tissues, carbon dioxide is produced and must be removed from the cells to prevent the buildup of acid waste products. The respiratory system performs this function by facilitating life-sustaining processes such as oxygen transport, respiration and ventilation, and gas exchange.

### Oxygen Transport

Oxygen is supplied to, and carbon dioxide is removed from, cells by way of the circulating blood. Cells are in close contact with capillaries, the thin walls of which permit easy passage or exchange of oxygen and carbon dioxide. Oxygen diffuses from the capillary through the capillary wall to the interstitial fluid. At this point, it diffuses through the membrane of tissue cells, where it is used by mitochondria for cellular respiration. The movement of carbon dioxide occurs by diffusion in the opposite direction—from cell to blood.

### Respiration

After these tissue capillary exchanges, blood enters the systemic veins (where it is called venous blood) and travels to the pulmonary circulation. The oxygen concentration in blood within the capillaries of the lungs is lower than in the lungs' air sacs (alveoli). Because of this concentration gradient, oxygen diffuses from the alveoli to the blood. Carbon dioxide, which has a higher concentration in the blood than in the alveoli, diffuses from the blood into the alveoli. Movement of air in and out of the airways (ventilation) continually replenishes the oxygen and removes the carbon dioxide from the airways and lungs. This whole process of gas exchange between the atmospheric air and the blood and between the blood and cells of the body is called **respiration**.

### Ventilation

During inspiration, air flows from the environment into the trachea, bronchi, bronchioles, and alveoli. During expiration, alveolar gas travels the same route in reverse.

Physical factors that govern air flow in and out of the lungs are collectively referred to as the mechanics of ventilation and include air pressure variances, resistance to air flow, and lung compliance.

#### Air Pressure Variances

Air flows from a region of higher pressure to a region of lower pressure. During inspiration, movement of the diaphragm and other muscles of respiration enlarges the thoracic cavity and thereby lowers the pressure inside the thorax to a level below that of atmospheric pressure. As a result, air is drawn through the trachea and bronchi into the alveoli. During expiration, the diaphragm relaxes and the lungs recoil, resulting in a decrease in the size of the thoracic cavity. The alveolar pressure then exceeds atmospheric pressure, and air flows from the lungs into the atmosphere.

#### Airway Resistance

Resistance is determined chiefly by the radius or size of the airway through which the air is flowing. Any process that changes the bronchial diameter or width affects airway resistance and alters the rate of air flow for a given pressure gradient during respiration (Chart 21-1). With increased resistance, greater-than-normal respiratory effort is required to achieve normal levels of ventilation.

**Chart 21-1 • *Causes of Increased Airway Resistance***

Common phenomena that may alter bronchial diameter, which affects airway resistance, include the following:
- Contraction of bronchial smooth muscle—as in asthma
- Thickening of bronchial mucosa—as in chronic bronchitis
- Obstruction of the airway—by mucus, a tumor, or a foreign body
- Loss of lung elasticity—as in emphysema, which is characterized by connective tissue encircling the airways, thereby keeping them open during both inspiration and expiration

#### Compliance

**Compliance,** or distensibility, is the elasticity and expandability of the lungs and thoracic structures. Compliance allows the lung volume to increase when the difference in pressure between the atmosphere and thoracic cavity (pressure gradient) causes air to flow in. Factors that determine lung compliance are the surface tension of the alveoli (normally low with the presence of surfactant) and the connective tissue (ie, collagen and elastin) of the lungs.

Compliance is determined by examining the volume–pressure relationship in the lungs and the thorax. Compliance is normal (1.0 L/cm $H_2O$) if the lungs and thorax easily stretch and distend when pressure is applied. High or increased compliance occurs if the lungs have lost their elasticity and the thorax is overdistended (eg, in emphysema). Low or decreased compliance occurs if the lungs and thorax are "stiff." Conditions associated with decreased compliance include morbid obesity, pneumothorax, hemothorax, pleural effusion, pulmonary edema, atelectasis, pulmonary fibrosis, and acute respiratory distress syndrome (ARDS), which are discussed in later chapters in this unit. Measurement of compliance is one method used to assess the progression and improvement in patients with ARDS. Lungs with decreased compliance require greater-than-normal energy expenditure by the patient to achieve normal levels of ventilation. Compliance is usually measured under static conditions.

#### Lung Volumes and Capacities

Lung function, which reflects the mechanics of ventilation, is viewed in terms of lung volumes and lung capacities. Lung volumes are categorized as tidal volume, inspiratory reserve volume, expiratory reserve volume, and residual volume. Lung capacity is evaluated in terms of vital capacity, inspiratory capacity, functional residual capacity, and total lung capacity. These terms are described in Table 21-1.

### Pulmonary Diffusion and Perfusion

**Diffusion** is the process by which oxygen and carbon dioxide are exchanged at the air–blood interface. The alveolar–capillary membrane is ideal for diffusion because of its

**Table 21-1 LUNG VOLUMES AND LUNG CAPACITIES**

| Term | Symbol | Description | Normal Value* | Significance |
|---|---|---|---|---|
| **Lung Volumes** | | | | |
| Tidal volume | VT or TV | The volume of air inhaled and exhaled with each breath | 500 mL or 5–10 mL/kg | The tidal volume may not vary, even with severe disease. |
| Inspiratory reserve volume | IRV | The maximum volume of air that can be inhaled after a normal inhalation | 3000 mL | |
| Expiratory reserve volume | ERV | The maximum volume of air that can be exhaled forcibly after a normal exhalation | 1100 mL | Expiratory reserve volume is decreased with restrictive conditions, such as obesity, ascites, pregnancy. |
| Residual volume | RV | The volume of air remaining in the lungs after a maximum exhalation | 1200 mL | Residual volume may be increased with obstructive disease. |
| **Lung Capacities** | | | | |
| Vital capacity | VC | The maximum volume of air exhaled from the point of maximum inspiration VC = TV + IRV + ERV | 4600 mL | A decrease in vital capacity may be found in neuromuscular disease, generalized fatigue, atelectasis, pulmonary edema, COPD, and obesity. |
| Inspiratory capacity | IC | The maximum volume of air inhaled after normal expiration IC = TV + IRV | 3500 mL | A decrease in inspiratory capacity may indicate restrictive disease. May also be decreased in obesity. |
| Functional residual capacity | FRC | The volume of air remaining in the lungs after a normal expiration FRV = ERV + RV | 2300 mL | Functional residual capacity may be increased with COPD and decreased in ARDS and obesity. |
| Total lung capacity | TLC | The volume of air in the lungs after a maximum inspiration TLC = TV + IRV + ERV + RV | 5800 mL | Total lung capacity may be decreased with restrictive disease (atelectasis, pneumonia) and increased in COPD. |

* Values for healthy men; women are 20–25% less.
ARDS, acute respiratory distress syndrome; COPD, chronic obstructed pulmonary disease.

thinness and large surface area. In the normal healthy adult, oxygen and carbon dioxide travel across the alveolar–capillary membrane without difficulty as a result of differences in gas concentrations in the alveoli and capillaries.

**Pulmonary perfusion** is the actual blood flow through the pulmonary circulation. The blood is pumped into the lungs by the right ventricle through the pulmonary artery. The pulmonary artery divides into the right and left branches to supply both lungs. These two branches divide further to supply all parts of each lung. Normally about 2% of the blood pumped by the right ventricle does not perfuse the alveolar capillaries. This shunted blood drains into the left side of the heart without participating in alveolar gas exchange.

The pulmonary circulation is considered a low-pressure system because the systolic blood pressure in the pulmonary artery is 20 to 30 mm Hg and the diastolic pressure is 5 to 15 mm Hg. Because of these low pressures, the pulmonary vasculature normally can vary its capacity to accommodate the blood flow it receives. However, when a person is in an upright position, the pulmonary artery pressure is not great enough to supply blood to the apex of the lung against the force of gravity. Thus, when a person is upright, the lung may be considered to be divided into three sections: an upper part with poor blood supply, a lower part with maximal blood supply, and a section between the two with an intermediate supply of blood. When a person who is laying down turns to one side, more blood passes to the dependent lung.

Perfusion is also influenced by alveolar pressure. The pulmonary capillaries are sandwiched between adjacent alveoli. If the alveolar pressure is sufficiently high, the capillaries are squeezed. Depending on the pressure, some capillaries completely collapse, whereas others narrow.

Pulmonary artery pressure, gravity, and alveolar pressure determine the patterns of perfusion. In lung disease, these factors vary, and the perfusion of the lung may become very abnormal.

### Ventilation and Perfusion Balance and Imbalance

Adequate gas exchange depends on an adequate ventilation–perfusion ($\dot{V}/\dot{Q}$) ratio. In different areas of the lung, the ($\dot{V}/\dot{Q}$) ratio varies. Alterations in perfusion may occur with a change in the pulmonary artery pressure, alveolar pressure, or gravity. Airway blockages, local changes in compliance, and gravity may alter ventilation.

($\dot{V}/\dot{Q}$) imbalance occurs as a result of inadequate ventilation, inadequate perfusion, or both. There are four possible ($\dot{V}/\dot{Q}$) states in the lung: normal ($\dot{V}/\dot{Q}$) ratio, low ($\dot{V}/\dot{Q}$) ratio (shunt), high ($\dot{V}/\dot{Q}$) ratio (dead space), and absence of ventilation and perfusion (silent unit) (Chart 21-2). ($\dot{V}/\dot{Q}$) imbalance causes shunting of blood, resulting in **hypoxia** (low level of cellular oxygen). Shunting appears to be the main cause of hypoxia after thoracic or abdominal surgery

## Chart 21-2 • *Ventilation-Perfusion Ratios*

**Normal Ratio (A)**

In the healthy lung, a given amount of blood passes an alveolus and is matched with an equal amount of gas **(A).** The ratio is 1:1 (ventilation matches perfusion).

**Low Ventilation–Perfusion Ratio: Shunts (B)**

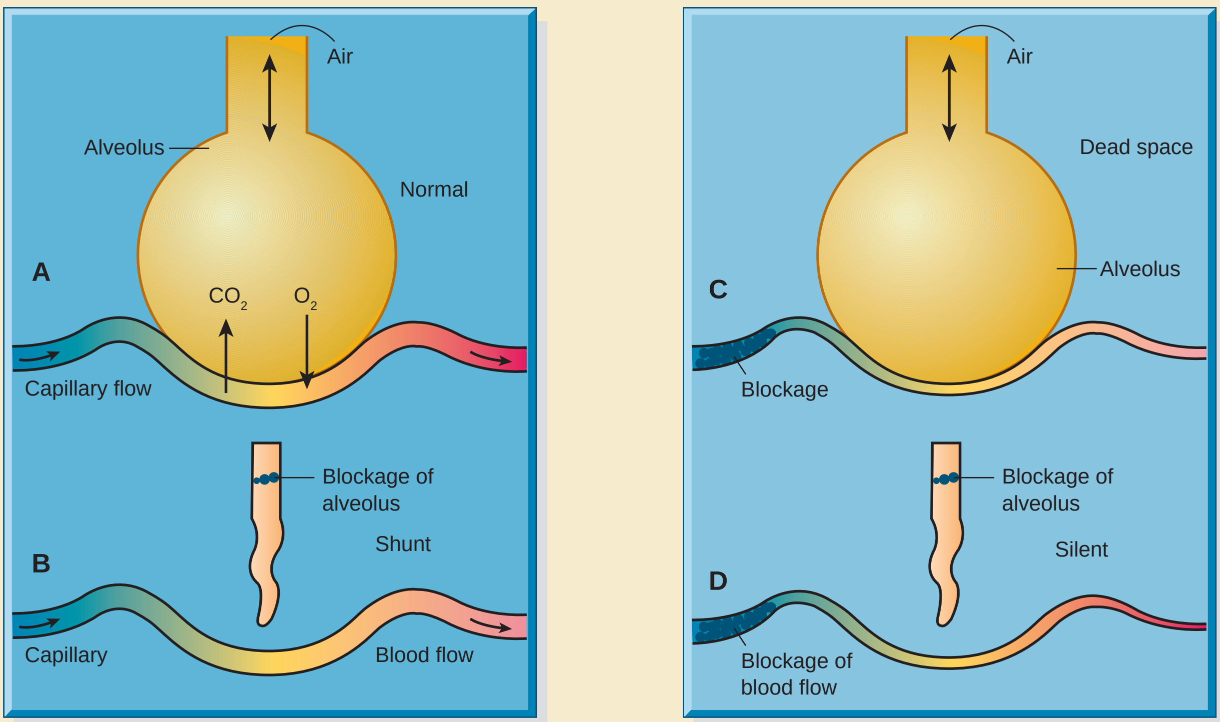
Low ventilation–perfusion states may be called shunt-producing disorders. When perfusion exceeds ventilation, a shunt exists **(B).** Blood bypasses the alveoli without gas exchange occurring. This is seen with obstruction of the distal airways, such as with pneumonia, atelectasis, tumor, or a mucus plug.

**High Ventilation–Perfusion Ratio: Dead Space (C)**

When ventilation exceeds perfusion, dead space results **(C).** The alveoli do not have an adequate blood supply for gas exchange to occur. This is characteristic of a variety of disorders, including pulmonary emboli, pulmonary infarction, and cardiogenic shock.

**Silent Unit (D)**

In the absence of both ventilation and perfusion or with limited ventilation and perfusion, a condition known as a silent unit occurs **(D).** This is seen with pneumothorax and severe acute respiratory distress syndrome.




and most types of respiratory failure. Severe hypoxia results when the amount of shunting exceeds 20%. Supplemental oxygen may eliminate hypoxia, depending on the type of ($\dot{V}/\dot{Q}$) imbalance.

## *Gas Exchange*

### Partial Pressure of Gases

The air we breathe is a gaseous mixture consisting mainly of nitrogen (78.6%) and oxygen (20.8%), with traces of carbon dioxide (0.04%), water vapor (0.05%), helium, and argon. The atmospheric pressure at sea level is about 760 mm Hg. Partial pressure is the pressure exerted by each type of gas in a mixture of gases. The partial pressure of a gas is proportional to the concentration of that gas in the mixture. The total pressure exerted by the gaseous mixture, whether in the atmosphere or in the lungs, is equal to the sum of the partial pressures.

Based on these facts, the partial pressures of nitrogen and oxygen can be calculated. The partial pressure of nitrogen in the atmosphere at sea level is 78.6% of 760, or 597 mm Hg; that of oxygen is 20.8% of 760, or 158 mm Hg. Chart 21-3 identifies and defines terms and abbreviations related to partial pressure of gases.

Once the air enters the trachea, it becomes fully saturated with water vapor, which displaces some of the other gases. Water vapor exerts a pressure of 47 mm Hg when it fully saturates a mixture of gases at the body temperature of 37°C (98.6°F). Nitrogen and oxygen are responsible for almost all of the remaining 713 mm Hg pressure. Once this mixture enters the alveoli, it is further diluted by carbon dioxide. In the alveoli, the water vapor continues to exert a pressure of 47 mm Hg. The remaining 713 mm Hg pressure is now exerted as follows: nitrogen, 569 mm Hg (74.9%); oxygen, 104 mm Hg (13.6%); and carbon dioxide, 40 mm Hg (5.3%).

## Chart 21-3 • *Partial Pressure Abbreviations*

P = pressure
$PO_2$ = partial pressure of oxygen
$PCO_2$ = partial pressure of carbon dioxide
$PAO_2$ = partial pressure of alveolar oxygen
$PACO_2$ = partial pressure of alveolar carbon dioxide
$PaO_2$ = partial pressure of arterial oxygen
$PaCO_2$ = partial pressure of arterial carbon dioxide
$P\bar{v}O_2$ = partial pressure of venous oxygen
$P\bar{v}CO_2$ = partial pressure of venous carbon dioxide
$P_{50}$ = partial pressure of oxygen when the hemoglobin is 50% saturated

When a gas is exposed to a liquid, the gas dissolves in the liquid until an equilibrium is reached. The dissolved gas also exerts a partial pressure. At equilibrium, the partial pressure of the gas in the liquid is the same as the partial pressure of the gas in the gaseous mixture. Oxygenation of venous blood in the lung illustrates this point. In the lung, venous blood and alveolar oxygen are separated by a very thin alveolar membrane. Oxygen diffuses across this membrane to dissolve in the blood until the partial pressure of oxygen in the blood is the same as that in the alveoli (104 mm Hg). However, because carbon dioxide is a by-product of oxidation in the cells, venous blood contains carbon dioxide at a higher partial pressure than that in the alveolar gas. In the lung, carbon dioxide diffuses out of venous blood into the alveolar gas. At equilibrium, the partial pressure of carbon dioxide in the blood and in alveolar gas is the same (40 mm Hg). The changes in partial pressure are shown in Figure 21-5.

### Effects of Pressure on Oxygen Transport

Oxygen and carbon dioxide are transported simultaneously either dissolved in blood or combined with hemoglobin in red blood cells. Each 100 mL of normal arterial blood carries 0.3 mL of oxygen physically dissolved in the plasma and 20 mL of oxygen in combination with hemoglobin. Large amounts of oxygen can be transported in the blood because oxygen combines easily with hemoglobin to form oxyhemoglobin:

$$O_2 + Hgb \leftrightarrow HgbO_2$$

The volume of oxygen physically dissolved in the plasma is measured by the partial pressure of oxygen in the arteries ($PaO_2$). The higher the $PaO_2$, the greater the amount of oxygen dissolved. For example, at a $PaO_2$ of 10 mm Hg, 0.03 mL of oxygen is dissolved in 100 mL of plasma. At $PaO_2$ of 20 mm Hg, twice this amount is dissolved in plasma, and at $PaO_2$ of 100 mm Hg, 10 times this amount is dissolved. Therefore, the amount of dissolved oxygen is directly proportional to the partial pressure, regardless of how high the oxygen pressure becomes.

The amount of oxygen that combines with hemoglobin depends on both the amount of hemoglobin in the blood and on $PaO_2$, but only up to a $PaO_2$ of about 150 mm Hg. This is measured as $O_2$ saturation ($SaO_2$), the percentage of the $O_2$ that could be carried if all the hemoglobin held the maximum possible amount of $O_2$. When the $PaO_2$ is 150 mm Hg, hemoglobin is 100% saturated and does not combine with any additional oxygen. When hemoglobin is 100% saturated, 1 g of hemoglobin combines with 1.34 mL of oxygen. Therefore, in a person with 14 g/dL of hemoglobin, each 100 mL of blood contains about 19 mL of oxygen associated with hemoglobin. If the $PaO_2$ is less than 150 mm Hg, the percentage of hemoglobin saturated with oxygen decreases. For example, at a $PaO_2$ of 100 mm Hg (normal value), saturation is 97%; at a $PaO_2$ of 40 mm Hg, saturation is 70%.

### Oxyhemoglobin Dissociation Curve

The oxyhemoglobin dissociation curve (Chart 21-4) shows the relationship between the partial pressure of oxygen ($PaO_2$) and the percentage of saturation of oxygen ($SaO_2$). The percentage of saturation can be affected by carbon dioxide, hydrogen ion concentration, temperature, and 2,3-diphosphoglycerate. An increase in these factors shifts the curve to the right, so that less oxygen is picked up in the lungs, but more oxygen is released to the tissues, if $PaO_2$ is unchanged. A decrease in these factors causes the curve to shift to the left, making the bond between oxygen and hemoglobin stronger. If the $PaO_2$ is still unchanged, more oxygen is picked up in the lungs, but less oxygen is given up to the tissues. The unusual shape of the oxyhemoglobin dissociation curve is a distinct advantage to the patient for two reasons:

1. If the $PaO_2$ decreases from 100 to 80 mm Hg as a result of lung disease or heart disease, the hemoglobin of the arterial blood remains almost maximally saturated (94%), and the tissues do not suffer from hypoxia.
2. When the arterial blood passes into tissue capillaries and is exposed to the tissue tension of oxygen (about 40 mm Hg), hemoglobin gives up large quantities of oxygen for use by the tissues.

With a normal value for $PaO_2$ (80 to 100 mm Hg) and $SaO_2$ (95% to 98%), there is a 15% margin of excess oxygen

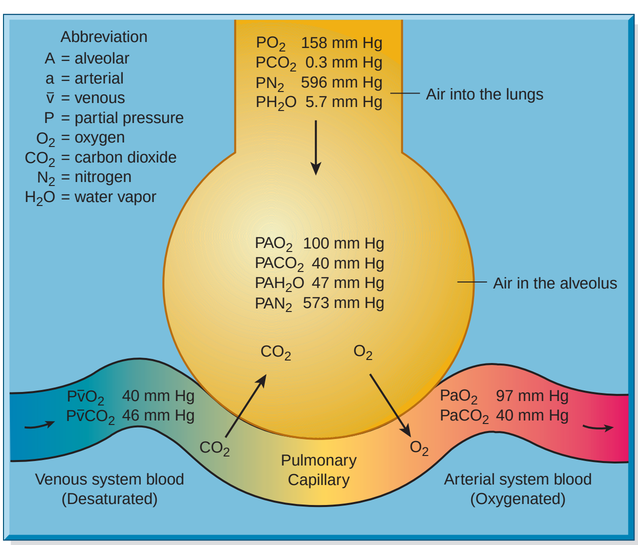


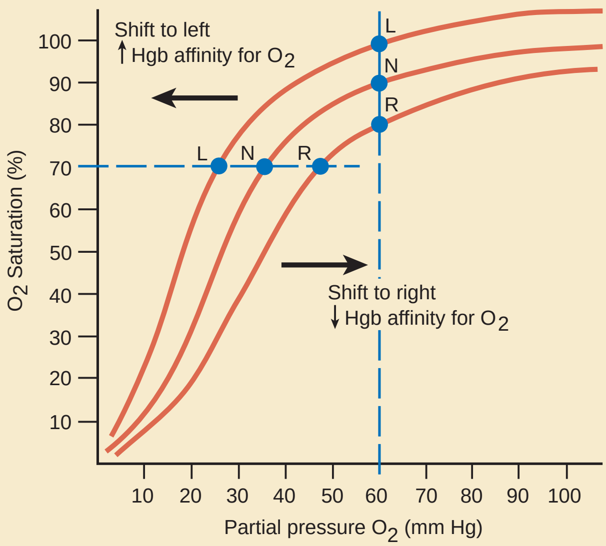

**Figure 21-5** Changes occur in the partial pressure of gases during respiration. These values vary as a result of the exchange of oxygen and carbon dioxide and the changes that occur in their partial pressures as venous blood flows through the lungs.

## Chart 21-4 • *Oxyhemoglobin Dissociation Curve*

The oxyhemoglobin dissociation curve is marked to show three oxygen levels:

1. Normal levels—$PaO_2$ above 70 mm Hg
2. Relatively safe levels—$PaO_2$ 45 to 70 mm Hg
3. Dangerous levels—$PaO_2$ below 40 mm Hg

The normal (middle) curve (N) shows that 75% saturation occurs at a $PaO_2$ of 40 mm Hg. If the curve shifts to the right (R), the same saturation (75%) occurs at the higher $PaO_2$ of 57 mm Hg. If the curve shifts to the left (L), 75% saturation occurs at a $PaO_2$ of 25 mm Hg.




available to the tissues. With a normal hemoglobin level of 15 mg/dL and a $PaO_2$ level of 40 mm Hg ($SaO_2$ 75%), there is adequate oxygen available for the tissues but no reserve for physiologic stresses that increase tissue oxygen demand. If a serious incident occurs (eg, bronchospasm, aspiration, hypotension, or cardiac dysrhythmias) that reduces the intake of oxygen from the lungs, tissue hypoxia results.

An important consideration in the transport of oxygen is cardiac output, which determines the amount of oxygen delivered to the body and affects lung and tissue perfusion. If the cardiac output is normal (5 L/min), the amount of oxygen delivered to the body per minute is normal. Under normal conditions, only 250 mL of oxygen is used per minute, which is approximately 25% of available oxygen. The rest of the oxygen returns to the right side of the heart, and the $PaO_2$ of venous blood drops from 80 to 100 mm Hg to about 40 mm Hg. If cardiac output falls, however, the amount of oxygen delivered to the tissues also falls and may be inadequate to meet the body's needs.

### Carbon Dioxide Transport

At the same time that oxygen diffuses from the blood into the tissues, carbon dioxide diffuses from tissue cells to blood and is transported to the lungs for excretion. The amount of carbon dioxide in transit is one of the major determinants of the acid–base balance of the body. Normally, only 6% of the venous carbon dioxide is removed in the lungs, and enough remains in the arterial blood to exert a pressure of 40 mm Hg. Most of the carbon dioxide (90%) is carried by red blood cells; the small portion (5%) that remains dissolved in the plasma (partial pressure of carbon dioxide [$PCO_2$]) is the critical factor that determines carbon dioxide movement in or out of the blood.

Although the many processes involved in respiratory gas transport seem to occur in intermittent stages, the changes are rapid, simultaneous, and continuous.

### Neurologic Control of Ventilation

Resting respiration is the result of cyclic excitation of the respiratory muscles by the phrenic nerve. The rhythm of breathing is controlled by respiratory centers in the brain. The inspiratory and expiratory centers in the medulla oblongata and pons control the rate and depth of ventilation to meet the body's metabolic demands.

The apneustic center in the lower pons stimulates the inspiratory medullary center to promote deep, prolonged inspirations. The pneumotaxic center in the upper pons is thought to control the pattern of respirations.

Several groups of receptor sites assist in the brain's control of respiratory function. The central chemoreceptors, located in the medulla, respond to chemical changes in the cerebrospinal fluid, which result from chemical changes in the blood. These receptors respond to an increase or decrease in the pH and convey a message to the lungs to change the depth and then the rate of ventilation to correct the imbalance. The peripheral chemoreceptors are located in the aortic arch and the carotid arteries and respond first to changes in $PaO_2$, then to partial pressure of carbon dioxide ($PaCO_2$) and pH. The Hering-Breuer reflex is activated by stretch receptors in the alveoli. When the lungs are distended, inspiration is inhibited; as a result, the lungs do not become overdistended. In addition, proprioceptors in the muscles and joints respond to body movements, such as exercise, causing an increase in ventilation. Thus, range-of-motion exercises in an immobile patient stimulate breathing. Baroreceptors, also located in the aortic and carotid bodies, respond to an increase or decrease in arterial blood pressure and cause reflex hypoventilation or hyperventilation.

## Gerontologic Considerations

A gradual decline in respiratory function begins in early to middle adulthood and affects the structure and function of the respiratory system. The vital capacity of the lungs and strength of the respiratory muscles peak between 20 and 25 years of age and decrease thereafter. With aging (40 years and older), changes occur in the alveoli that reduce the surface area available for the exchange of oxygen and carbon dioxide. At approximately 50 years of age, the alveoli begin to lose elasticity. A decrease in vital capacity occurs with loss of chest wall mobility, which restricts the tidal flow of air. The amount of respiratory dead space increases with age. These changes result in a decreased diffusion capacity for oxygen with increasing age, producing lower oxygen levels in the arterial circulation. Elderly people have a decreased ability to rapidly move air in and out of the lungs.

Gerontologic changes in the respiratory system are summarized in Table 21-2. Despite these changes, in the absence of chronic pulmonary disease, elderly people are able

**Table 21-2 AGE-RELATED CHANGES IN THE RESPIRATORY SYSTEM**

| | Structural Changes | Functional Changes | History and Physical Findings |
|---|---|---|---|
| Defense mechanisms (respiratory and nonrespiratory) | ↓ Number of cilia and ↓ mucus<br>↓ Cough and gag reflex<br>Loss of surface area of the capillary membrane<br>Lack of a uniform or consistent ventilation and/or blood flow | ↓ Protection against foreign particles<br>↓ Protection against aspiration<br>↓ Antibody response to antigens<br>↓ Response to hypoxia and hypercapnia (chemoreceptors) | ↓ Cough reflex and mucus<br>↑ Infection rate<br>History of respiratory infections, COPD, pneumonia.<br>Risk factors: smoking, environmental exposure, TB exposure |
| Lung | ↓ Size of airway<br>↑ Diameter of alveolar ducts<br>↑ Collagen of alveolar walls<br>↑ Thickness of alveolar membranes<br>↓ Elasticity of alveolar sacs | ↑ Airway resistance<br>↑ Pulmonary compliance<br>↓ Expiratory flow rate<br>↓ Oxygen diffusion capacity<br>↑ Dead space<br>Premature closure of airways<br>↑ Air trapping<br>↓ Expiratory flow rates<br>Ventilation–perfusion mismatch<br>↓ Exercise capacity<br>↑ Anteroposterior (AP) diameter | Unchanged total lung capacity (TLC)<br>↑ Residual volume (RV)<br>↓ Inspiratory reserve volume (IRV)<br>↓ Expiratory reserve volume (ERV)<br>↓ Forced vital capacity (FVC) and vital capacity (VC)<br>↑ Functional residual capacity (FRC)<br>↓ $PaO_2$<br>↑ $CO_2$ |
| Chest wall and muscles | Calcification of intercostal cartilages<br>Arthritis of costovertebral joints<br>↓ Continuity of diaphragm<br>Osteoporotic changes<br>↓ Muscle mass<br>Muscle atrophy | ↑ Rigidity and stiffness of thoracic cage<br>↓ Respiratory muscle strength<br>↑ Work of breathing<br>↓ Capacity for exercise<br>↓ Peripheral chemosensitivity<br>↑ Risk for inspiratory muscle fatigue | Kyphosis, barrel chest<br>Skeletal changes<br>↑ AP diameter<br>Shortness of breath<br>↑ Abdominal and diaphragmatic breathing<br>↓ Maximum expiratory flow rates |

to carry out activities of daily living, but they may have decreased tolerance for, and require additional rest after, prolonged or vigorous activity.

# Assessment

## Health History

The health history focuses on the physical and functional problems and the effects of these problems on the patient, including the ability to carry out activities of daily living. Several common symptoms related to the respiratory system are discussed in detail below. If the patient is experiencing severe dyspnea, the nurse may need to modify or abbreviate the questions asked and the timing of the health history to avoid increasing the patient's breathlessness and anxiety.

In addition to identifying the chief reason why the patient is seeking health care, the nurse tries to determine when the health problem or symptom started, how long it lasted, if it was relieved at any time, and how relief was obtained. The nurse obtains information about precipitating factors, duration, severity, and associated factors or symptoms.

### *Common Symptoms*

The major signs and symptoms of respiratory disease are dyspnea, cough, sputum production, chest pain, wheezing, and hemoptysis. The nurse also assesses the impact of signs and symptoms on the patient's ability to perform activities of daily living and to participate in usual work and family activities.

#### Dyspnea

**Dyspnea** (subjective feeling of difficult or labored breathing, breathlessness, shortness of breath) is a symptom common to many pulmonary and cardiac disorders, particularly when there is decreased lung compliance or increased airway resistance. The right ventricle of the heart is affected ultimately by lung disease because it must pump blood through the lungs against greater resistance. Dyspnea may also be associated with neurologic or neuromuscular disorders (eg, myasthenia gravis, Guillain-Barré syndrome, muscular dystrophy, postpolio syndrome) that affect respiratory function. Dyspnea can also occur after physical exercise in people without disease (Davis & Holliday, 2005; Porth & Matfin, 2009). It is also common at the end of life in patients with a variety of disorders.

In general, acute diseases of the lungs produce a more severe grade of dyspnea than do chronic diseases. Sudden dyspnea in a healthy person may indicate pneumothorax (air in the pleural cavity), acute respiratory obstruction, allergic reaction, or myocardial infarction. In immobilized patients, sudden dyspnea may denote pulmonary embolism. Dyspnea and **tachypnea** accompanied by progressive hypoxemia in a person who has recently experienced lung trauma, shock, cardiopulmonary bypass, or multiple blood transfusions may signal acute respiratory distress syndrome (ARDS). **Orthopnea** (inability to breathe easily except in an upright position) may be found in patients with heart disease and occasionally in patients with COPD; dyspnea with an expiratory wheeze occurs with COPD. Noisy breathing may result from a narrowing of the airway or localized obstruction of a major bronchus by a tumor or foreign body. The high-pitched

sound heard (usually on inspiration) when someone is breathing through a partially blocked upper airway is called **stridor**. The presence of both inspiratory and expiratory wheezing usually signifies asthma if the patient does not have heart failure. Because dyspnea can occur with other disorders (eg, cardiac disease, anaphylactic reactions, severe anemia), these disorders also need to be considered when obtaining the patient's health history (Davis & Holliday, 2005).

The circumstance that produces the dyspnea must be determined. Therefore, it is important to ask the patient the following questions:

- How much exertion triggers shortness of breath? Does it occur at rest? With exercise? Running? Climbing stairs?
- Is there an associated cough?
- Is the shortness of breath related to other symptoms?
- Was the onset of shortness of breath sudden or gradual?
- At what time of day or night does the shortness of breath occur?
- Is the shortness of breath worse when laying flat?
- Is the shortness of breath worse while walking? If so, when walking how far? How fast?
- How severe is the shortness of breath? On a scale of 1 to 10, if 1 is breathing without any effort and 10 is breathing that is as difficult as it could possibly be, how hard is it to breathe?

It is especially important to assess the patient's rating of the intensity of breathlessness, the effort required to breathe, and the severity of the breathlessness or dyspnea. Patients use a variety of terms and phrases to describe breathlessness, and the nurse needs to clarify what terms are most familiar to the patient and what these terms mean. Visual analogue or other scales can be used to assess changes in the severity of dyspnea over time (Dorman, Byrne & Edwards, 2007; Porth & Matfin, 2009).

### Cough

Cough is a reflex that protects the lungs from the accumulation of secretions or the inhalation of foreign bodies. Its presence or absence can be a diagnostic clue because some disorders cause coughing and others suppress it. The cough reflex may be impaired by weakness or paralysis of the respiratory muscles, prolonged inactivity, the presence of a nasogastric tube, or depressed function of the medullary centers in the brain (eg, anesthesia, brain disorders) (Irwin, Baumann, Bolser, et al., 2006; Porth & Matfin, 2009).

Cough results from irritation of the mucous membranes anywhere in the respiratory tract. The stimulus that produces a cough may arise from an infectious process or from an airborne irritant, such as smoke, smog, dust, or a gas. A persistent and frequent cough can be exhausting and cause pain. Cough may indicate serious pulmonary disease or a variety of other problems as well, including cardiac disease, medication reactions (eg, amiodarone [Cordarone], angiotensin-converting enzyme [ACE] inhibitors), smoking, and gastroesophageal reflux disease (Irwin, et al., 2006).

To help determine the cause of the cough, the nurse describes the cough: dry, hacking, brassy, wheezing, loose, or severe. A dry, irritative cough is characteristic of an upper respiratory tract infection of viral origin, or it may be a side effect of ACE inhibitor therapy. An irritative, high-pitched cough can be caused by laryngotracheitis. A brassy cough is the result of a tracheal lesion, while a severe or changing cough may indicate bronchogenic carcinoma. Pleuritic chest pain that accompanies coughing may indicate pleural or chest wall (musculoskeletal) involvement.

The nurse inquires about the onset and time of coughing. Coughing at night may indicate the onset of left-sided heart failure or bronchial asthma. A cough in the morning with sputum production may indicate bronchitis. A cough that worsens when the patient is supine suggests postnasal drip (rhinosinusitis). Coughing after food intake may indicate aspiration of material into the tracheobronchial tree. A cough of recent onset is usually from an acute infection.

A persistent cough may affect a patient's quality of life and may produce embarrassment, exhaustion, inability to sleep, and pain. Therefore, the nurse should explore the effect of a chronic cough on the patient and the patient's view about the significance of the cough and its effect on his or her life.

Violent coughing causes bronchial spasm, obstruction, and further irritation of the bronchi and may result in syncope (fainting). A severe, repeated, or uncontrolled cough that is nonproductive is exhausting and potentially harmful.

### Sputum Production

A patient who coughs long enough almost invariably produces sputum. Sputum production is the reaction of the lungs to any constantly recurring irritant. It also may be associated with a nasal discharge. The nature of the sputum is often indicative of its cause. A profuse amount of purulent sputum (thick and yellow, green, or rust-colored) or a change in color of the sputum is a common sign of a bacterial infection. Thin, mucoid sputum frequently results from viral bronchitis. A gradual increase of sputum over time may occur with chronic bronchitis or bronchiectasis. Pink-tinged mucoid sputum suggests a lung tumor. Profuse, frothy, pink material, often welling up into the throat, may indicate pulmonary edema. Foul-smelling sputum and bad breath point to the presence of a lung abscess, bronchiectasis, or an infection caused by fusospirochetal or other anaerobic organisms.

### Chest Pain

Chest pain or discomfort may be associated with pulmonary or cardiac disease. Chest pain associated with pulmonary conditions may be sharp, stabbing, and intermittent, or it may be dull, aching, and persistent. The pain usually is felt on the side where the pathologic process is located, but it may be referred elsewhere—for example, to the neck, back, or abdomen.

Chest pain may occur with pneumonia, pulmonary embolism with lung infarction, pleurisy, or as a late symptom of bronchogenic carcinoma. In carcinoma, the pain may be dull and persistent because the cancer has invaded the chest wall, mediastinum, or spine.

Lung disease does not always cause thoracic pain because the lungs and the visceral pleura lack sensory nerves and are insensitive to pain stimuli. However, the parietal pleura has a rich supply of sensory nerves that are stimulated by inflammation and stretching of the membrane. Pleuritic pain from irritation of the parietal pleura is sharp and seems to "catch" on inspiration; patients often describe it as being

"like the stabbing of a knife." Patients are more comfortable when they lay on the affected side because this splints the chest wall, limits expansion and contraction of the lung, and reduces the friction between the injured or diseased pleurae on that side. Pain associated with cough may be reduced manually by splinting the rib cage.

The nurse assesses the quality, intensity, and radiation of pain and identifies and explores precipitating factors and their relationship to the patient's position. In addition, it is important to assess the relationship of pain to the inspiratory and expiratory phases of respiration.

#### Wheezing

Wheezing is a high-pitched, musical sound heard mainly on expiration (asthma) or inspiration (bronchitis). It is often the major finding in a patient with bronchoconstriction or airway narrowing. **Rhonchi** are low pitched continuous sounds heard over the lungs in partial airway obstruction. Depending on their location and severity, these sounds may be heard with or without a stethoscope.

#### Hemoptysis

**Hemoptysis** (expectoration of blood from the respiratory tract) is a symptom of both pulmonary and cardiac disorders. The onset of hemoptysis is usually sudden, and it may be intermittent or continuous. Signs, which vary from blood-stained sputum to a large, sudden hemorrhage, always merit investigation. The most common causes are:

- Pulmonary infection
- Carcinoma of the lung
- Abnormalities of the heart or blood vessels
- Pulmonary artery or vein abnormalities
- Pulmonary embolus and infarction

Diagnostic evaluation to determine the cause includes chest x-ray, chest angiography, and bronchoscopy. A careful history and physical examination are necessary to identify the underlying disorder, irrespective of whether the bleeding involved a small amount of blood in the sputum or a massive hemorrhage. The amount of blood produced is not always proportional to the seriousness of the cause.

First, it is important to determine the source of the bleeding—the gums, nasopharynx, lungs, or stomach. The nurse may be the only witness to the episode. When documenting the bleeding episode, the nurse considers the following points:

- Bloody sputum from the nose or the nasopharynx is usually preceded by considerable sniffing, with blood possibly appearing in the nose.
- Blood from the lung is usually bright red, frothy, and mixed with sputum. Initial symptoms include a tickling sensation in the throat, a salty taste, a burning or bubbling sensation in the chest, and perhaps chest pain, in which case the patient tends to splint the bleeding side. The term hemoptysis is reserved for the coughing up of blood arising from a pulmonary hemorrhage. This blood has an alkaline pH (greater than 7.0).
- If the hemorrhage is in the stomach, the blood is vomited (hematemesis) rather than coughed up. Blood that has been in contact with gastric juice is sometimes so dark that it is referred to as "coffee ground emesis." This blood has an acid pH (less than 7.0).

### *Past Health, Family, and Social History*

After exploring the current problem, the nurse obtains a brief history of events and conditions that could affect current health status. Specific questions are asked about childhood illnesses, immunizations, chronic medical conditions, injuries, hospitalizations, surgeries, allergies, and current medications (including over-the-counter medications and herbal remedies). Since many lung disorders are related to or exacerbated by tobacco smoke, smoking history (including exposure to second-hand smoke) is also obtained. Smoking history is usually expressed in pack-years, which is number of packs of cigarettes smoked per day times the number of years the patient smoked. It is important to find out if (and when) the patient quit smoking or is still smoking. The nurse assesses for risk factors and genetic factors that may contribute to the patient's lung condition (Charts 21-5 and 21-6).

In addition, psychosocial factors that may affect the patient are explored (Chart 21-7). These factors include anxiety, role changes, family relationships, financial problems, employment status, and the strategies the patient uses to cope with them. Many respiratory diseases are chronic and progressively debilitating and disabling. It is important that the patient with a respiratory disorder understand the condition and be familiar with necessary self-care interventions. The nurse evaluates these factors over time and provides education as needed.

## Physical Assessment of the Respiratory System

### *General Appearance*

The patient's general appearance may give clues to respiratory status. In particular, the nurse inspects for clubbing of the fingers and notes skin color.

#### Clubbing of the Fingers

Clubbing of the fingers is a sign of lung disease that is found in patients with chronic hypoxic conditions, chronic lung infections, or malignancies of the lung (Bickley, 2007). This finding may be manifested initially as sponginess of the nail bed and loss of the nail bed angle (Fig. 21-6).

#### Cyanosis

Cyanosis, a bluish coloring of the skin, is a very late indicator of hypoxia. The presence or absence of cyanosis is determined by the amount of unoxygenated hemoglobin in the blood. Cyanosis appears when there is at least 5 g/dL of unoxygenated hemoglobin. A patient with a hemoglobin

CHART 21-5 ***Risk Factors for Respiratory Disease***

- Smoking (the single most important contributor to lung disease)
- Exposure to secondhand smoke
- Personal or family history of lung disease
- Genetic makeup
- Exposure to allergens and environmental pollutants
- Exposure to certain recreational and occupational hazards

CHART 21-6

GENETICS IN NURSING PRACTICE

### Genetic Influences

Various conditions that affect gas exchange and respiratory function are influenced by genetics factors, including:

- Asthma
- Chronic obstructive pulmonary disease
- Cystic fibrosis
- Alpha-1 antitrypsin deficiency

**Nursing Assessments**

**Family History Assessment**

- Assess family history for other family members with histories of respiratory impairment.
- Assess family history for individuals with early-onset chronic pulmonary disease, family history of hepatic disease in infants (clinical symptoms of alpha-1 antitrypsin deficiency).
- Inquire about family history of genetic cystic fibrosis.

**Patient Assessment**

- Assess for symptoms such as changes in respiratory status associated with asthma (eg, wheezing, hyperresponsiveness, mucosal edema, and mucus production).
- Assess for multisystem effects characteristic of cystic fibrosis (eg, productive cough, wheezing, obstructive airways disease, gastrointestinal problems including pancreatic insufficiency, clubbing of the fingers).

**Management Issues Specific to Genetics**

- Inquire whether DNA mutation or other genetic testing has been performed on affected family members.
- Refer for further genetics counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetics testing and gene-based interventions.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed genetic-related respiratory disorders.
- Participate in management and coordination of care of patients with genetic conditions, individuals predisposed to develop or pass on a genetic condition.

**Genetic Resources**

**American Lung Association**—www.lungusa.org
**Cystic Fibrosis Foundation**—www.cff.org
**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org
**Gene Clinics**—a listing of common genetic disorders with clinical summaries, genetics counseling and testing information, www.geneclinics.org
**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org
**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM

level of 15 g/dL does not demonstrate cyanosis until 5 g/dL of that hemoglobin becomes unoxygenated, reducing the effective circulating hemoglobin to two thirds of the normal level.

A patient with anemia rarely manifests cyanosis, and a patient with polycythemia may appear cyanotic even if adequately oxygenated. Therefore, cyanosis is *not* a reliable sign of hypoxia.

Assessment of cyanosis is affected by room lighting, the patient's skin color, and the distance of the blood vessels from the surface of the skin. In the presence of a pulmonary condition, central cyanosis is assessed by observing the color of the tongue and lips. This indicates a decrease in oxygen tension in the blood. Peripheral cyanosis results from decreased blood flow to the body's periphery (fingers, toes, or earlobes), as in vasoconstriction from exposure to cold, and does not necessarily indicate a central systemic problem.

### Upper Respiratory Structures

For a routine examination of the upper airway, only a simple light source, such as a penlight, is necessary. A more thorough examination requires the use of a nasal speculum.

CHART 21-7

### Assessing for Psychosocial Factors Related to Pulmonary Disease and Respiratory Function

- What strategies does the patient use to cope with the signs and symptoms and challenges associated with pulmonary disease?
- What effect has the pulmonary disease had on the patient's quality of life, goals, role within the family, and occupation?
- What changes has the pulmonary disease had on the patient's family and relationships with family members?
- Does the patient exhibit depression, anxiety, anger, hostility, dependency, withdrawal, isolation, avoidance, noncompliance, acceptance, or denial?
- What support systems does the patient use to cope with the illness?
- Are resources (relatives, friends, or community groups) available? Do the patient and family use them effectively?

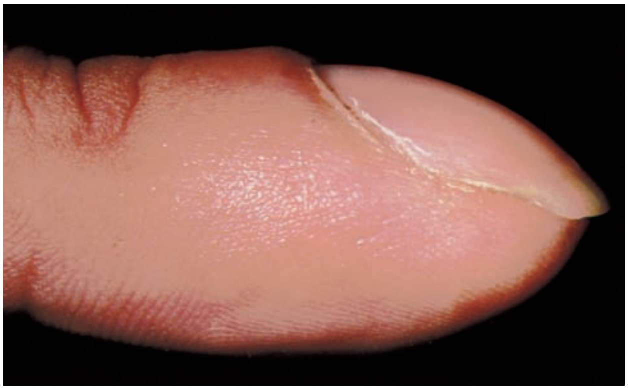


**Figure 21-6** Clubbed finger. In clubbing, the distal phalanx of each finger is rounded and bulbous. The nail plate is more convex, and the angle between the plate and the proximal nail fold increases to 180 degrees or more. The proximal nail fold, when palpated, feels spongy or floating. Among the many causes are chronic hypoxia and lung cancer.

### Nose and Sinuses

The nurse inspects the external nose for lesions, asymmetry, or inflammation and then asks the patient to tilt the head backward. Gently pushing the tip of the nose upward, the nurse examines the internal structures of the nose, inspecting the mucosa for color, swelling, exudate, or bleeding. The nasal mucosa is normally redder than the oral mucosa. It may appear swollen and hyperemic if the patient has a common cold, but in allergic rhinitis, the mucosa appears pale and swollen.

Next, the nurse inspects the septum for deviation, perforation, or bleeding. Most people have a slight degree of septal deviation, but actual displacement of the cartilage into either the right or left side of the nose may produce nasal obstruction. Such deviation usually causes no symptoms.

While the head is still tilted back, the nurse inspects the inferior and middle turbinates. In chronic rhinitis, nasal polyps may develop between the inferior and middle turbinates; they are distinguished by their gray appearance. Unlike the turbinates, they are gelatinous and freely movable.

Next, the nurse may palpate the frontal and maxillary sinuses for tenderness (Fig. 21-7). Using the thumbs, the nurse applies gentle pressure in an upward fashion at the supraorbital ridges (frontal sinuses) and in the cheek area adjacent to the nose (maxillary sinuses). Tenderness in either area suggests inflammation. The frontal and maxillary sinuses can be inspected by transillumination (passing a strong light through a bony area, such as the sinuses, to inspect the cavity; Fig. 21-8). If the light fails to penetrate, the cavity likely contains fluid or pus.

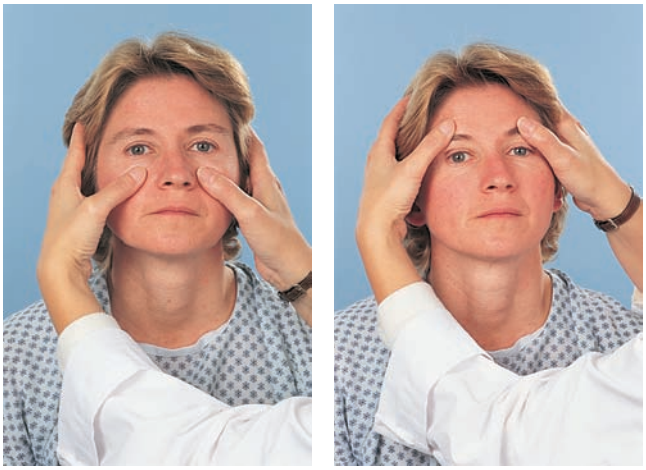


**Figure 21-7** Technique for palpating the frontal sinuses at left and the maxillary sinuses at right.



**Figure 21-8** At left, the nurse positions the light source for transillumination of the frontal sinus. At right, the nurse shields the patient's brow and shines the light. In normal conditions (a darkened room), the light should shine through the tissues and appear as a reddish glow (above the nurse's hand) over the sinus.

### Mouth and Pharynx

After the nasal inspection, the nurse assesses the mouth and pharynx, instructing the patient to open the mouth wide and take a deep breath. Usually this flattens the posterior tongue and briefly allows a full view of the anterior and posterior pillars, tonsils, uvula, and posterior pharynx (see Chapter 35, Fig. 35-2). The nurse inspects these structures for color, symmetry, and evidence of exudate, ulceration, or enlargement. If a tongue blade is needed to depress the tongue to visualize the pharynx, it is pressed firmly beyond the midpoint of the tongue to avoid a gagging response.

### Trachea

Next, the position and mobility of the trachea are noted by direct palpation. This is performed by placing the thumb and index finger of one hand on either side of the trachea just above the sternal notch. The trachea is highly sensitive, and palpating too firmly may trigger a coughing or gagging response. The trachea is normally in the midline as it enters the thoracic inlet behind the sternum, but it may be deviated by masses in the neck or mediastinum. Pleural or pulmonary disorders, such as a pneumothorax, may also displace the trachea.

## *Lower Respiratory Structures and Breathing*

Assessment of the lower respiratory structures includes inspection, palpation, percussion, and auscultation of the thorax.

### Thoracic Inspection

Inspection of the thorax provides information about the musculoskeletal structure, the patient's nutritional status, and the respiratory system. The nurse observes the skin over the thorax for color and turgor and for evidence of loss of subcutaneous tissue. It is important to note asymmetry, if present. In recording or reporting the findings, anatomic landmarks are used as points of reference (Chart 21-8).

***Chest Configuration.*** Normally, the ratio of the anteroposterior diameter to the lateral diameter is 1:2. However, there are four main deformities of the chest associated with respiratory disease that alter this relationship: barrel chest, funnel chest (pectus excavatum), pigeon chest (pectus carinatum), and kyphoscoliosis.

*BARREL CHEST.* Barrel chest occurs as a result of overinflation of the lungs. There is an increase in the anteroposterior diameter of the thorax. In a patient with emphysema, the ribs are more widely spaced and the intercostal spaces tend to bulge on expiration. The appearance of the patient with advanced emphysema is thus quite characteristic and often allows the observer to detect its presence easily, even from a distance.

*FUNNEL CHEST (PECTUS EXCAVATUM).* Funnel chest occurs when there is a depression in the lower portion of the sternum. This may compress the heart and great vessels, resulting in murmurs. Funnel chest may occur with rickets or Marfan's syndrome.

*PIGEON CHEST (PECTUS CARINATUM).* A pigeon chest occurs as a result of displacement of the sternum. There is an increase in the anteroposterior diameter. This may occur with rickets, Marfan's syndrome, or severe kyphoscoliosis.

*KYPHOSCOLIOSIS.* Kyphoscoliosis is characterized by elevation of the scapula and a corresponding S-shaped spine. This deformity limits lung expansion within the thorax. It may occur with osteoporosis and other skeletal disorders that affect the thorax.

***Breathing Patterns and Respiratory Rates.*** Observing the rate and depth of respiration is a simple but important aspect of assessment. The normal adult who is resting comfortably takes 12 to 18 breaths per minute. Except for occasional sighs, respirations are regular in depth and rhythm. This normal pattern is described as eupnea. The rate and depth of various patterns of respiration are presented in Table 21-3.

Certain patterns of respiration are characteristic of specific disease states. Respiratory rhythms and their deviation from normal are important observations that the nurse reports and documents. Temporary pauses of breathing, or **apnea**, may be noted. When apneas occur repeatedly during sleep, secondary to transient upper airway blockage, the condition is called **obstructive sleep apnea.** In thin people, it is quite normal to note a slight retraction of the intercostal spaces during quiet breathing. Bulging of the intercostal spaces during expiration implies obstruction of expiratory airflow, as in emphysema. Marked retraction on inspiration, particularly if asymmetric, implies blockage of a branch of the respiratory tree. Asymmetric bulging of the intercostal spaces, on one side or the other, is created by an increase in pressure within the hemithorax. This may be a result of air trapped under pressure within the pleural cavity, where it is not normally present (pneumothorax), or the pressure of fluid within the pleural space (pleural effusion).

### Thoracic Palpation

The nurse palpates the thorax for tenderness, masses, lesions, respiratory excursion, and vocal fremitus. If the patient has reported an area of pain or if lesions are apparent, the nurse performs direct palpation with the fingertips (for skin lesions and subcutaneous masses) or with the ball of the hand (for deeper masses or generalized flank or rib discomfort).

***Respiratory Excursion.*** Respiratory excursion is an estimation of thoracic expansion and may disclose significant information about thoracic movement during breathing. The nurse assesses the patient for range and symmetry of excursion. For anterior assessment, the nurse places the thumbs along the costal margin of the chest wall and instructs the patient to inhale deeply. The nurse observes movement of the thumbs during inspiration and expiration. This movement is normally symmetric (Bickley, 2007).

Posterior assessment is performed by placing the thumbs adjacent to the spinal column at the level of the tenth rib (Fig. 21-9). The hands lightly grasp the lateral rib cage. Sliding the thumbs medially about 2.5 cm (1 inch) raises a small skin fold between the thumbs. The patient is instructed to take a full inspiration and to exhale fully. The nurse observes for normal flattening of the skin fold and feels the symmetric movement of the thorax.

Decreased chest excursion may be caused by chronic fibrotic disease. Asymmetric excursion may be due to splinting secondary to pleurisy, fractured ribs, trauma, or unilateral bronchial obstruction (Bickley, 2007).

***Tactile Fremitus.*** Sound generated by the larynx travels distally along the bronchial tree to set the chest wall in resonant motion. This is especially true of consonant sounds. The detection of the resulting vibration on the chest wall by touch is called tactile **fremitus**.

Normal fremitus is widely varied. It is influenced by the thickness of the chest wall, especially if that thickness is muscular. However, the increase in subcutaneous tissue associated with obesity may also affect fremitus. Lower-pitched sounds travel better through the normal lung and produce greater vibration of the chest wall. Therefore, fremitus is more pronounced in men than in women because of the deeper male voice. Normally, fremitus is most pronounced where the large bronchi are closest to the chest wall and least palpable over the distant lung fields. Therefore, it is most palpable in the upper thorax, anteriorly and posteriorly.

The patient is asked to repeat "ninety-nine" or "one, two, three," or "eee, eee, eee" as the nurse's hands move down the patient's thorax. The vibrations are detected with the palmar surfaces of the fingers and hands, or the ulnar aspect of the extended hands, on the thorax. The hand or hands are moved in sequence down the thorax. Corresponding areas of the thorax are compared (Fig. 21-10). Bony areas are not tested.

Air does not conduct sound well, but a solid substance such as tissue does, provided that it has elasticity and is not compressed. Therefore, an increase in solid tissue per unit volume of lung enhances fremitus, and an increase in air per unit volume of lung impedes sound. Patients with emphysema, which results in the rupture of alveoli and trapping of air, exhibit almost no tactile fremitus. A patient with consolidation of a

## Chart 21-8 • *Locating Thoracic Landmarks*

With respect to the thorax, location is defined both horizontally and vertically. With respect to the lungs, location is defined by lobe.

### Horizontal Reference Points

Horizontally, thoracic locations are identified according to their proximity to the rib or the intercostal space under the examiner's fingers. On the anterior surface, identification of a specific rib is facilitated by first locating the angle of Louis. This is where the manubrium joins the body of the sternum in the midline. The second rib joins the sternum at this prominent landmark.

Other ribs may be identified by counting down from the second rib. The intercostal spaces are referred to in terms of the rib immediately above the intercostal space; for example, the fifth intercostal space is directly below the fifth rib.

Locating ribs on the posterior surface of the thorax is more difficult. The first step is to identify the spinous process. This is accomplished by finding the seventh cervical vertebra (*vertebra prominens*), which is the most prominent spinous process. When the neck is slightly flexed, the seventh cervical spinous process stands out. Other vertebrae are then identified by counting downward.

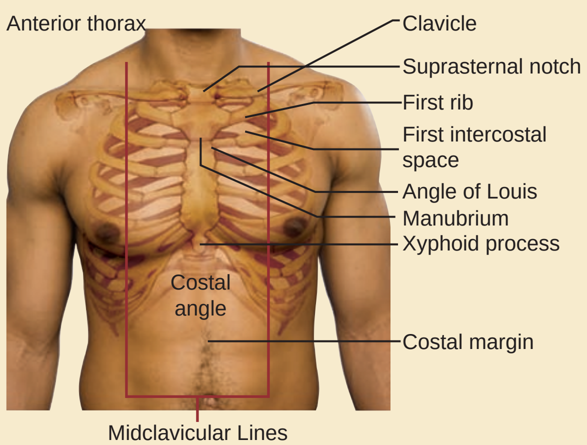
### Vertical Reference Points

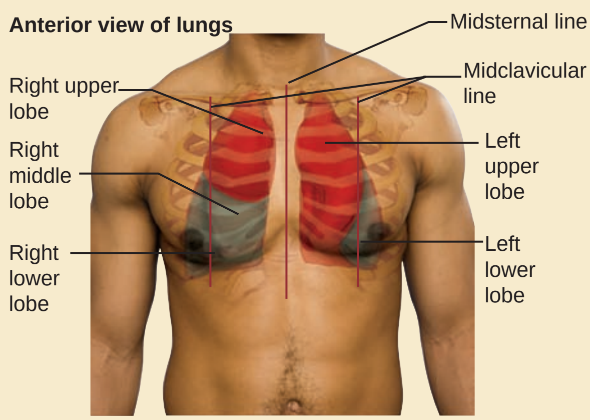
Several imaginary lines are used as vertical referents or landmarks to identify the location of thoracic findings. The *midsternal line* passes through the center of the sternum.The *midclavicular line* is an imaginary line that descends from the middle of the clavicle. The *point of maximal impulse* of the heart normally lies along this line on the left thorax.

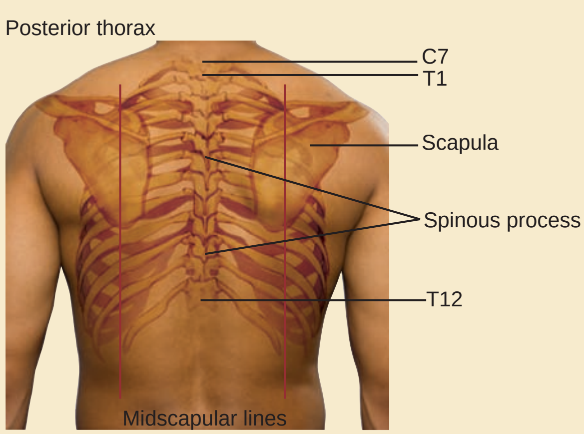
When the arm is abducted from the body at 90 degrees, imaginary vertical lines may be drawn from the anterior axillary fold, from the middle of the axilla, and from the posterior axillary fold. These lines are called, respectively, the *anterior axillary line,* the *midaxillary line,* and the *posterior axillary line*. A line drawn vertically through the superior and inferior poles of the scapula is called the *scapular line*, and a line drawn down the center of the vertebral column is called the *vertebral line*. Using these landmarks, for example, the examiner communicates findings by referring to an area of dullness extending from the vertebral to the scapular line between the seventh and tenth ribs on the right.

### Lobes of the Lungs

The lobes of the lung may be mapped on the surface of the chest wall in the following manner. The line between the upper and lower lobes on the left begins at the fourth thoracic spinous process posteriorly, proceeds around to cross the fifth rib in the midaxillary line, and meets the sixth rib at the sternum. This line on the right divides the right middle lobe from the right lower lobe. The line dividing the right upper lobe from the middle lobe is an incomplete one that begins at the fifth rib in the midaxillary line, where it intersects the line between the upper and lower lobes and traverses horizontally to the sternum. Thus, the upper lobes are dominant on the anterior surface of the thorax and the lower lobes are dominant on the posterior surface. There is no presentation of the right middle lobe on the posterior surface of the chest.



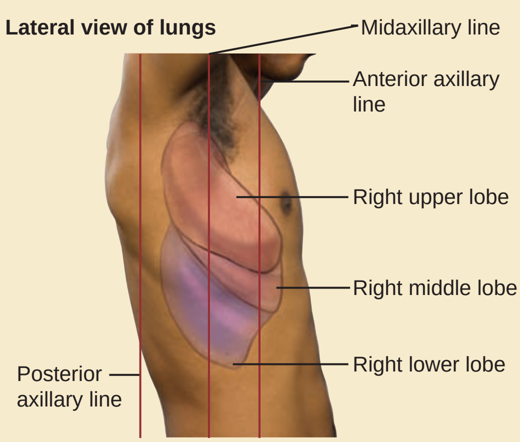
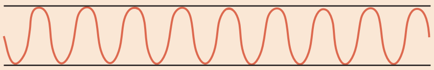
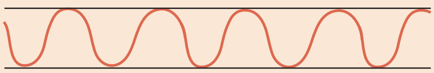
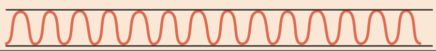
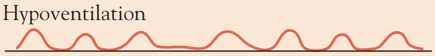
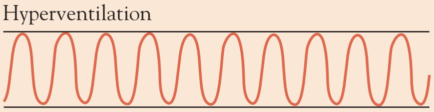
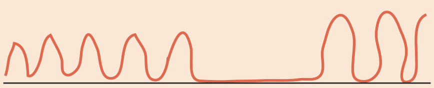
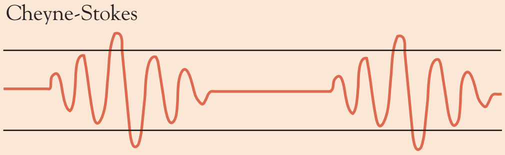
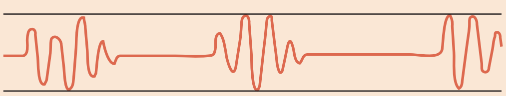



**Table 21-3 RATES AND DEPTHS OF RESPIRATION**

| Type | Description |
|---|---|
| Eupnea  | Normal, breathing at 12–18 breaths/min |
| Bradypnea  | Slower than normal rate (<10 breaths/min), with normal depth and regular rhythm<br>Associated with increased intracranial pressure, brain injury, and drug overdose |
| Tachypnea  | Rapid, shallow breathing >24 breaths/min<br>Associated with pneumonia, pulmonary edema, metabolic acidosis, septicemia, severe pain, or rib fracture |
| Hypoventilation  | Shallow, irregular breathing |
| Hyperpnea | Increase depth of respirations |
| Hyperventilation  | Increased rate and depth of breathing that results in decreased $PaCO_2$ level<br>Inspiration and expiration are nearly equal in duration<br>Called Kussmaul's respiration if associated with diabetic ketoacidosis or renal origin |
| Apnea  | Period of cessation of breathing; time duration varies; apnea may occur briefly during other breathing disorders, such as with sleep apnea; life-threatening if sustained |
| Cheyne-Stokes  | Regular cycle where the rate and depth of breathing increase, then decrease until apnea (usually about 20 seconds) occurs<br>Duration of apnea may vary and progressively lengthen; therefore, it is timed and reported<br>Associated with heart failure and damage to the respiratory center (drug-induced, tumor, trauma) |
| Biot's respiration  | Periods of normal breathing (3–4 breaths) followed by a varying period of apnea (usually 10–60 seconds)<br>Also called cluster breathing<br>Associated with some nervous system disorders |

lobe of the lung from pneumonia has increased tactile fremitus over that lobe. Air in the pleural space does not conduct sound (Bickley, 2007).

### Thoracic Percussion

Percussion sets the chest wall and underlying structures in motion, producing audible and tactile vibrations. The nurse uses percussion to determine whether underlying tissues are filled with air, fluid, or solid material. Percussion also is used to estimate the size and location of certain structures within the thorax (eg, diaphragm, heart, liver).

Percussion usually begins with the posterior thorax. Ideally, the patient is in a sitting position with the head flexed forward and the arms crossed on the lap. This position separates the scapulae widely and exposes more lung area for assessment. The nurse percusses across each shoulder top, locating the 5-cm width of resonance overlying the lung apices (Fig. 21-11). Then the nurse proceeds down the posterior thorax, percussing symmetric areas at intervals of 5 to 6 cm (2 to 2.5 inches). The middle finger is positioned parallel to the ribs in the intercostal space; the finger is placed firmly against the chest wall before it is struck with the middle finger of the opposite hand. Bony structures (scapulae or ribs) are not percussed.

Percussion over the anterior chest is performed with the patient in an upright position with shoulders arched backward and arms at the side. The nurse begins in the supraclavicular area and proceeds downward, from one intercostal space to the next. In the female patient, it may be necessary to displace the breasts for an adequate examination. Dullness noted to the left of the sternum between the third and fifth intercostal spaces is a normal finding, because that is the location of the heart. Similarly, there is a normal span of liver dullness in the right thorax, from the fifth intercostal space to the right costal margin at the midclavicular line (Bickley, 2007).

The anterior and lateral thorax is examined with the patient in a supine position. If the patient cannot sit up, percussion of the posterior thorax is performed with the patient positioned on the side.

Dullness over the lung occurs when air-filled lung tissue is replaced by fluid or solid tissue. Table 21-4 reviews percussion sounds and their characteristics.

***Diaphragmatic Excursion.*** The normal resonance of the lung stops at the diaphragm. The position of the diaphragm is different during inspiration and expiration.

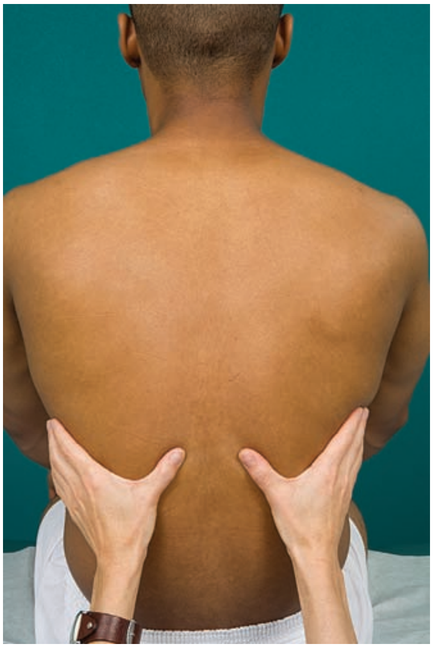


**Figure 21-9** Method for assessing posterior respiratory excursion. Place both hands posteriorly at the level of T9 or T10. Slide hands medially to pinch a small amount of skin between your thumbs. Observe for symmetry as the patient exhales fully following a deep inspiration.

To assess the position and motion of the diaphragm, the nurse instructs the patient to take a deep breath and hold it while the maximal descent of the diaphragm is percussed. The point at which the percussion note at the midscapular line changes from resonance to dullness is marked with a pen. The patient is then instructed to exhale fully and hold it while the nurse again percusses downward to the dullness of the diaphragm. This point is also marked. The distance between the two markings indicates the range of motion of the diaphragm.

Maximal excursion of the diaphragm may be as much as 8 to 10 cm (3 to 4 inches) in healthy, tall young men, but for most people it is usually 5 to 7 cm (2 to 2.75 inches). Normally, the diaphragm is about 2 cm (0.75 inches) higher on the right because of the position of the heart and the liver above and below the left and right segments of the diaphragm, respectively. Decreased diaphragmatic excursion may occur with pleural effusion and emphysema. An increase in intra-abdominal pressure, as in pregnancy, obesity, or ascites, may account for a diaphragm that is positioned high in the thorax (Bickley, 2007).

### Thoracic Auscultation

Assessment concludes with auscultation of the anterior, posterior, and lateral thorax. Auscultation is useful in assessing the flow of air through the bronchial tree and in evaluating the presence of fluid or solid obstruction in the lung. The nurse auscultates for normal breath sounds, adventitious sounds, and voice sounds.

The nurse places the diaphragm of the stethoscope firmly against the chest wall as the patient breathes slowly and deeply through the mouth. Corresponding areas of the chest are auscultated in a systematic fashion from the apices to the bases and along midaxillary lines. The sequence of auscultation and the positioning of the patient are similar to those used for percussion. It often is necessary to listen to two full inspirations and expirations at each anatomic location for valid interpretation of the sound heard. Repeated deep breaths may result in symptoms of hyperventilation (eg, lightheadedness); this is avoided by having the patient rest and breathe normally periodically during the examination.

***Breath Sounds.*** Normal breath sounds are distinguished by their location over a specific area of the lung and

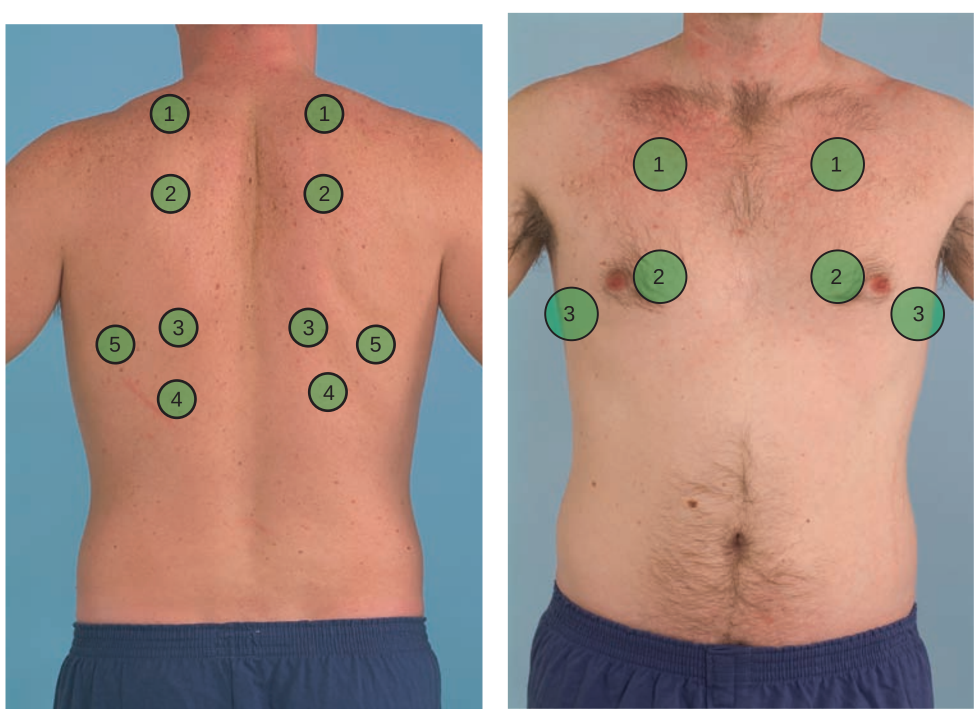



**Figure 21-10** Palpation sequence for tactile fremitus: posterior thorax (*left*) and anterior thorax (*right*).

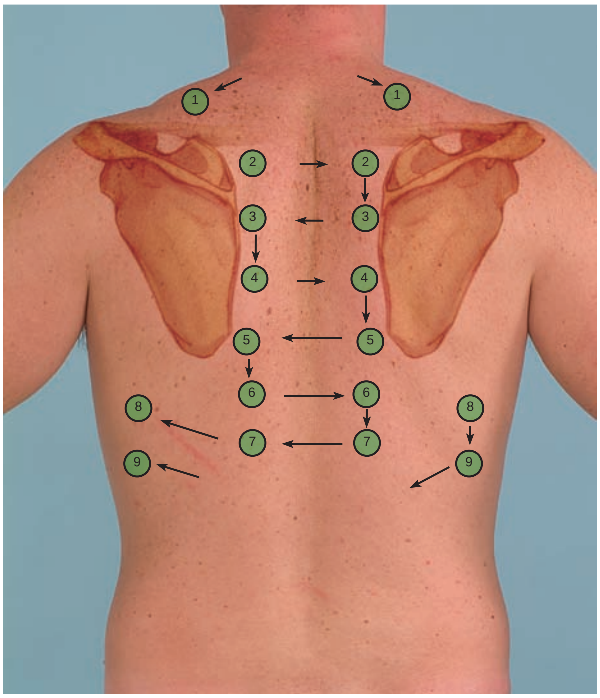



**Figure 21-11** Percussion of the posterior thorax. With the patient in a sitting position, symmetric areas of the lungs are percussed at 5-cm intervals. This progression starts at the apex of each lung and concludes with percussion of each lateral chest wall.

are identified as vesicular, bronchovesicular, and bronchial (tubular) breath sounds (Table 21-5).

The location, quality, and intensity of breath sounds are determined during auscultation. When airflow is decreased by bronchial obstruction (atelectasis) or when fluid (pleural effusion) or tissue (obesity) separates the air passages from the stethoscope, breath sounds are diminished or absent. For example, the breath sounds of the patient with emphysema are faint or often completely inaudible. When they are heard, the expiratory phase is prolonged. In the obese or morbidly obese patient, breath sounds may be inaudible. Bronchial and bronchovesicular sounds that are audible anywhere except over the main bronchus in the lungs signify pathology, usually indicating consolidation in the lung (eg, pneumonia, heart failure). This finding requires further evaluation.

***Adventitious Sounds.*** An abnormal condition that affects the bronchial tree and alveoli may produce adventitious (additional) sounds. Adventitious sounds are divided into two categories: discrete, noncontinuous sounds (**crackles**) and continuous musical sounds (**wheezes**) (Table 21-6). The duration of the sound is the important distinction to make in identifying the sound as noncontinuous or continuous.

***Voice Sounds.*** The sound heard through the stethoscope as the patient speaks is known as vocal resonance. The vibrations produced in the larynx are transmitted to the chest wall as they pass through the bronchi and alveolar tissue. During the process, the sounds are diminished in intensity and altered so that syllables are not distinguishable. Voice sounds are usually assessed by having the patient repeat "ninety-nine" or "eee" while the nurse listens with the stethoscope in corresponding areas of the chest from the apices to the bases.

**Bronchophony** describes vocal resonance that is more intense and clearer than normal. **Egophony** describes voice sounds that are distorted. It is best appreciated by having the patient repeat the letter E. The distortion produced by consolidation transforms the sound into a clearly heard A rather than E. Bronchophony and egophony are indicative of consolidation, such as occurs in pneumonia, or pleural effusion. When an abnormality is detected, it should be evident using more than one assessment method. A change in tactile fremitus is more subtle and can be missed, but bronchophony can be noted loudly and clearly.

Whispered pectoriloquy, distinctly hearing words that seem to come from the spot being auscultated, is a very subtle finding, which is heard in the presence of rather dense consolidation of the lungs. This transmission of high-frequency components of whispered sound is not noted in normal physiology. The significance is the same as that of bronchophony (Bickley, 2007).

### Interpreting Findings

The physical findings for the most common respiratory diseases are summarized in Table 21-7.

## Assessment of Respiratory Function in the Acutely or Critically Ill Patient

Assessment of respiratory status is essential for the well-being of the patient who is acutely or critically ill. Often, such a patient is intubated and receiving mechanical ventilation. This requires that the nurse have expertise in physical assessment, be skilled in monitoring techniques, and be

**Table 21-4 CHARACTERISTICS OF PERCUSSION SOUNDS**

| Sound | Relative Intensity | Relative Pitch | Relative Duration | Location Example | Examples |
|---|---|---|---|---|---|
| Flatness | Soft | High | Short | Thigh | Large pleural effusion |
| Dullness | Medium | Medium | Medium | Liver | Lobar pneumonia |
| Resonance | Loud | Low | Long | Normal lung | Simple chronic bronchitis |
| Hyperresonance | Very loud | Lower | Longer | None normally | Emphysema, pneumothorax |
| Tympany | Loud | High* | —* | Gastric air bubble or puffed-out cheek | Large pneumothorax |

*Distinguished mainly by its musical timbre.

**Table 21-5 BREATH SOUNDS**

| | Duration of Sounds | Intensity of Expiratory Sound | Pitch of Expiratory Sound | Locations Where Heard Normally |
|---|---|---|---|---|
| Vesicular*  | Inspiratory sounds last longer than expiratory ones | Soft | Relatively low | Entire lung field except over the upper sternum and between the scapulae |
| Bronchovesicular  | Inspiratory and expiratory sounds are about equal | Intermediate | Intermediate | Often in the 1st and 2nd interspaces anteriorly and between the scapulae (over the main bronchus) |
| Bronchial  | Expiratory sounds last longer than inspiratory ones | Loud | Relatively high | Over the manubrium, if heard at all |
| Tracheal  | Inspiratory and expiratory sounds are about equal | Very loud | Relatively high | Over the trachea in the neck |

*The thickness of the bars indicates intensity of breath sounds; the steeper their incline, the higher the pitch of the sounds.

knowledgeable about possible ventilator-induced lung injury. The nurse reviews the patient's health history, including the history of disorders affecting lung function, signs and symptoms, and exposure to medications and other agents that can affect respiratory status. The nurse also observes the patient's respiratory status to analyze and interpret a variety of clinical findings and laboratory test results. After checking the ventilator settings to make sure that they are set as prescribed and that alarms are always in the "on" position, the nurse must assess for patient–ventilator synchrony and for agitation, restlessness, and other signs of respiratory distress (nasal flaring, excessive use of intercostals and accessory muscles, uncoordinated movement of the chest and abdomen, and a report by the patient of shortness of breath). The nurse must note changes in the patient's vital signs and evidence of hemodynamic instability

**Table 21-6 ABNORMAL (ADVENTITIOUS) BREATH SOUNDS**

| Breath Sound | Description | Etiology |
|---|---|---|
| **Crackles** | | |
| Crackles in general | Soft, high-pitched, discontinuous popping sounds that occur during inspiration (while usually heard on inspiration, they may also be heard on expiration); may or may not be cleared by coughing | Secondary to fluid in the airways or alveoli or to delayed opening of collapsed alveoli<br>Associated with heart failure and pulmonary fibrosis |
| Coarse crackles | Discontinuous popping sounds heard in early inspiration; harsh, moist sound originating in the large bronchi | Associated with obstructive pulmonary disease |
| Fine crackles | Discontinuous popping sounds heard in late inspiration; sounds like hair rubbing together; originates in the alveoli | Associated with interstitial pneumonia, restrictive pulmonary disease (eg, fibrosis); fine crackles in early inspiration are associated with bronchitis or pneumonia |
| **Wheezes** | | |
| Wheezes in general | Usually heard on expiration, but may be heard on inspiration depending on the cause | Associated with bronchial wall oscillation and changes in airway diameter<br>Associated with chronic bronchitis or bronchiectasis |
| Sonorous wheezes (rhonchi) | Deep, low-pitched rumbling sounds heard primarily during expiration; caused by air moving through narrowed tracheobronchial passages | Associated with secretions or tumor |
| Sibilant wheezes | Continuous, musical, high-pitched, whistlelike sounds heard during inspiration and expiration caused by air passing through narrowed or partially obstructed airways; may clear with coughing | Associated with bronchospasm, asthma, and buildup of secretions |
| **Friction Rubs** | | |
| Pleural friction rub | Harsh, crackling sound, like two pieces of leather being rubbed together (sound imitated by rubbing thumb and finger together near the ear)<br>Heard during inspiration alone or during both inspiration and expiration.<br>May subside when patient holds breath; coughing will not clear sound<br>Best heard over the lower lateral anterior surface of the thorax<br>Sound can be enhanced by applying pressure to the chest wall with the diaphragm of the stethoscope | Secondary to inflammation and loss of lubricating pleural fluid |

**Table 21-7 ASSESSMENT FINDINGS IN COMMON RESPIRATORY DISORDERS**

| Disorder | Tactile Fremitus | Percussion | Auscultation |
|---|---|---|---|
| Consolidation (eg, pneumonia) | Increased | Dull | Bronchial breath sounds, crackles, bronchophony, egophony, whispered pectoriloquy |
| Bronchitis | Normal | Resonant | Normal to decreased breath sounds, wheezes |
| Emphysema | Decreased | Hyperresonant | Decreased intensity of breath sounds, usually with prolonged expiration |
| Asthma (severe attack) | Normal to decreased | Resonant to hyperresonant | Wheezes |
| Pulmonary edema | Normal | Resonant | Crackles at lung bases, possibly wheezes |
| Pleural effusion | Absent | Dull to flat | Decreased to absent breath sounds, bronchial breath sounds and bronchophony, egophony, and whispered pectoriloquy above the effusion over the area of compressed lung |
| Pneumothorax | Decreased | Hyperresonant | Absent breath sounds |
| Atelectasis | Absent | Flat | Decreased to absent breath sounds |

and report them to the physician, because they may indicate that the mechanical ventilation is ineffective or that the patient's status has deteriorated. It is necessary to assess the position of the patient to be certain that the head of the bed is elevated to prevent aspiration, especially if the patient is receiving enteral feedings. In addition, the patient's mental status should be assessed and compared to previous status. Lethargy and somnolence may be signs of increasing carbon dioxide levels and should not be considered insignificant, even if the patient is receiving sedation or analgesic agents.

Chest auscultation, percussion, and palpation are essential parts of the evaluation of the critically ill patient with or without mechanical ventilation. Assessment of the anterior and posterior lung fields is part of the nurse's routine evaluation. If the patient is recumbent, it is essential to turn the patient to assess all lung fields. Dependent areas must be assessed for normal breath sounds and adventitious sounds. Failure to examine the dependent areas of the lungs can result in missing the findings associated with disorders such as atelectasis or pleural effusion. Percussion is performed to assess for pleural effusion; if pleural effusion is present, the affected lung fields are dull to percussion and breath sounds are absent. A pleural friction rub may also be present.

Tests of the patient's respiratory status are easily performed at the bedside by measuring the respiratory rate (see earlier discussion), tidal volume, minute ventilation, vital capacity, inspiratory force, and compliance. These tests are particularly important for patients who are at risk for pulmonary complications, including those who have undergone chest or abdominal surgery, have had prolonged anesthesia, have preexisting pulmonary disease, and those who are elderly or obese. These tests are also used routinely for mechanically ventilated patients.

The patient whose chest expansion is limited by external restrictions such as obesity or abdominal distention and who cannot breathe deeply because of postoperative pain or sedation will inhale and exhale a low volume of air (referred to as low tidal volumes). Prolonged hypoventilation at low tidal volumes can produce alveolar collapse (atelectasis). The amount of air remaining in the lungs after a normal expiration (functional residual capacity, FRC) decreases, the ability of the lungs to expand (compliance) is reduced, and the patient must breathe faster to maintain the same degree of tissue oxygenation. These events can be exaggerated in patients who have preexisting pulmonary diseases, in elderly patients whose airways are less compliant because the small airways may collapse during expiration, or in patients who are obese, who have relatively low tidal volumes even when healthy. More details of the assessment of the patient with lung disease, including arterial blood gas (ABG) analysis, are described in subsequent chapters in this unit and in Chapter 14.

*NURSING ALERT*

**The nurse should not rely only on visual inspection of the rate and depth of a patient's respiratory excursions to determine the adequacy of ventilation. Respiratory excursions may appear normal or exaggerated due to an increased work of breathing, but the patient may actually be moving only enough air to ventilate the dead space. If there is any question regarding adequacy of ventilation, auscultation or pulse oximetry (or both) should be used for additional assessment of respiratory status.**

### *Tidal Volume*

The volume of each breath is referred to as the **tidal volume** (see Table 21-1 to review lung capacities and volumes). A spirometer is an instrument that can be used at the bedside to measure volumes. If the patient is breathing through an endotracheal tube or tracheostomy, the spirometer is directly attached to it and the exhaled volume is obtained from the reading on the gauge. In other patients, the spirometer is attached to a face mask or a mouthpiece positioned so that it is airtight, and the exhaled volume is measured.

The tidal volume may vary from breath to breath. To ensure that the measurement is reliable, it is important to measure the volumes of several breaths and to note the range of tidal volumes, together with the average tidal volume.

### *Minute Ventilation*

Respiratory rates and tidal volume alone are unreliable indicators of adequate ventilation, because both can vary widely from breath to breath. However, together the tidal volume and respiratory rate are important because the

**CHART 21-9 Risk Factors for Hypoventilation**

- Limited neurologic impulses transmitted from the brain to the respiratory muscles, as in spinal cord trauma, cerebrovascular accidents, tumors, myasthenia gravis, Guillain-Barré syndrome, polio, and drug overdose
- Depressed respiratory centers in the medulla, as with anesthesia, sedation, and drug overdose
- Limited thoracic movement (kyphoscoliosis), limited lung movement (pleural effusion, pneumothorax), or reduced functional lung tissue (chronic pulmonary diseases, severe pulmonary edema)

minute ventilation, which is useful in detecting respiratory failure, can be determined from them. Minute ventilation is the volume of air expired per minute. It is equal to the product of the tidal volume in liters multiplied by the respiratory rate or frequency. In practice, the minute ventilation is not calculated but is measured directly using a spirometer. In a patient receiving mechanical ventilation, minute volume is often monitored by the ventilator and can be viewed on the monitoring screen.

Minute ventilation may be decreased by a variety of conditions that result in hypoventilation. When the minute ventilation falls, alveolar ventilation in the lungs also decreases, and the $PaCO_2$ increases. Risk factors for hypoventilation are listed in Chart 21-9.

#### Vital Capacity

Vital capacity is measured by having the patient take in a maximal breath and exhale fully through a spirometer. The normal value depends on the patient's age, gender, body build, and weight.

**NURSING ALERT**

**Most patients can generate a vital capacity twice the volume they normally breathe in and out (tidal volume). If the vital capacity is less than 10 mL/kg, the patient will be unable to sustain spontaneous ventilation and will require respiratory assistance.**

When the vital capacity is exhaled at a maximal flow rate, the forced vital capacity (FVC) is measured. Most patients can exhale at least 80% of their vital capacity in 1 second (forced expiratory volume in 1 second, or $FEV_1$) and almost all of it in 3 seconds ($FEV_3$). A reduction in $FEV_1$ suggests abnormal pulmonary air flow. If the patient's $FEV_1$ and forced vital capacity are proportionately reduced, maximal lung expansion is restricted in some way. If the reduction in $FEV_1$ greatly exceeds the reduction in forced vital capacity ($FEV_1$/FVC less than 85%), the patient may have some degree of airway obstruction.

#### Inspiratory Force

Inspiratory force evaluates the effort the patient is making during inspiration. It does not require patient cooperation and therefore is a useful measurement in the unconscious patient. The equipment needed for this measurement includes a manometer that measures negative pressure and adapters that are connected to an anesthesia mask or a cuffed endotracheal tube. The manometer is attached and the airway is completely occluded for 10 to 20 seconds while the inspiratory efforts of the patient are registered on the manometer. The normal inspiratory pressure is about 100 cm $H_2O$. If the negative pressure registered after 15 seconds of occluding the airway is less than about 25 cm $H_2O$, mechanical ventilation is usually required because the patient lacks sufficient muscle strength for deep breathing or effective coughing.

## Diagnostic Evaluation

A wide range of diagnostic studies may be performed in patients with respiratory conditions.

### Pulmonary Function Tests

Pulmonary function tests (PFTs) are routinely used in patients with chronic respiratory disorders. They are performed to assess respiratory function and to determine the extent of dysfunction. Such tests include measurements of lung volumes, ventilatory function, and the mechanics of breathing, diffusion, and gas exchange.

PFTs are useful in monitoring the course of a patient with an established respiratory disease and assessing the response to therapy. They are useful as screening tests in potentially hazardous industries, such as coal mining and those that involve exposure to asbestos and other noxious fumes, dusts, or gases. Prior to surgery, they are used to screen patients who are scheduled for thoracic and upper abdominal surgical procedures, patients who are obese, and symptomatic patients with a history suggesting high risk. In addition, PFTs may be used for evaluation of respiratory symptoms and disability for insurance or legal purposes (Porth & Matfin, 2009) and to diagnose occupational respiratory disease.

PFTs generally are performed by a technician using a spirometer that has a volume-collecting device attached to a recorder that demonstrates volume and time simultaneously. A number of tests are carried out because no single measurement provides a complete picture of pulmonary function. The most frequently used PFTs are described in Table 21-8. Technology is available that allows for more complex assessment of pulmonary function. Methods include exercise tidal flow–volume loops, negative expiratory pressure, nitric oxide, forced oscillation, and diffusing capacity for helium or carbon monoxide. These assessment methods allow for detailed evaluation of expiratory flow limitations and airway inflammation.

PFT results are interpreted on the basis of the degree of deviation from normal, taking into consideration the patient's height, weight, age, and gender. Because there is a wide range of normal values, PFTs may not detect early localized changes. The patient with respiratory symptoms (dyspnea, wheezing, cough, sputum production) usually undergoes a complete diagnostic evaluation, even if the results of PFTs are "normal." Trends of results provide information about disease progression as well as the patient's response to therapy.

**Table 21-8 PULMONARY FUNCTION TESTS**

| Term Used | Symbol | Description | Remarks |
|---|---|---|---|
| Forced vital capacity | FVC | Vital capacity performed with a maximally forced expiratory effort | Forced vital capacity is often reduced in COPD because of air trapping. |
| Forced expiratory volume (qualified by subscript indicating the time interval in seconds) | $FEV_t$ (usually $FEV_1$) | Volume of air exhaled in the specified time during the performance of forced vital capacity; $FEV_1$ is volume exhaled in 1 second | A valuable clue to the severity of the expiratory airway obstruction |
| Ratio of timed forced expiratory volume to forced vital capacity | $FEV_t$/FVC%, usually $FEV_1$/FVC% | $FEV_t$ expressed as a percentage of the forced vital capacity | Another way of expressing the presence or absence of airway obstruction |
| Forced expiratory flow | $FEF_{200-1200}$ | Mean forced expiratory flow between 200 and 1200 mL of the FVC | An indicator of large airway obstruction |
| Forced midexpiratory flow | $FEF_{25-75\%}$ | Mean forced expiratory flow during the middle half of the FVC | Slowed in small airway obstruction |
| Forced end expiratory flow | $FEF_{75-85\%}$ | Mean forced expiratory flow during the terminal portion of the FVC | Slowed in obstruction of smallest airways |
| Maximal voluntary ventilation | MVV | Volume of air expired in a specified period (12 seconds) during repetitive maximal effort | An important factor in exercise tolerance |

COPD, chronic obstructive pulmonary disease.

Patients with respiratory disorders may be taught how to measure their peak flow rate (which reflects maximal expiratory flow) at home using a spirometer. This allows them to monitor the progress of therapy, to alter medications and other interventions as needed based on caregiver guidelines, and to notify the health care provider if there is inadequate response to their own interventions. Home care teaching instructions are described in Chapter 24, which discusses asthma.

## Arterial Blood Gas Studies

Measurements of blood pH and of arterial oxygen and carbon dioxide tensions are obtained when managing patients with respiratory problems and adjusting oxygen therapy as needed. The arterial oxygen tension (partial pressure or $PaO_2$) indicates the degree of oxygenation of the blood, and the arterial carbon dioxide tension (partial pressure or $PaCO_2$) indicates the adequacy of alveolar ventilation. ABG studies aid in assessing the ability of the lungs to provide adequate oxygen and remove carbon dioxide and the ability of the kidneys to reabsorb or excrete bicarbonate ions to maintain normal body pH. Serial ABG analysis also is a sensitive indicator of whether the lung has been damaged after chest trauma. ABG levels are obtained through an arterial puncture at the radial, brachial, or femoral artery or through an indwelling arterial catheter. ABG levels are discussed in detail in Chapter 14.

Patients whose ABG levels are monitored repeatedly with blood obtained from arterial punctures should receive an explanation of the purpose of the procedure. Because of the nerves in arterial walls, patients often experience pain with repeated ABG level checks but are often unaware of the purpose of the puncture and the fact that the ABG results could make a major difference in their treatment (Crawford, 2004).

## Pulse Oximetry

Pulse oximetry is a noninvasive method of continuously monitoring the **oxygen saturation** of hemoglobin ($SaO_2$). When oxygen saturation is measured with pulse oximetry, it is referred to as $SpO_2$ (Clark, Giuliano & Chen, 2006). Although pulse oximetry does not replace ABG measurement, it is an effective tool to monitor for subtle or sudden changes in oxygen saturation. It is used in all settings where oxygen saturation monitoring is needed, such as the home, clinics, ambulatory surgical settings, and hospitals.

A probe or sensor is attached to the fingertip (Fig. 21-12), forehead, earlobe, or bridge of the nose. The sensor detects changes in oxygen saturation levels by monitoring light signals generated by the oximeter and reflected by blood pulsing through the tissue at the probe. Normal $SpO_2$ values are 95% to 100%. Values less than 85% indicate that the tissues are not receiving enough oxygen, and further evaluation is needed. $SpO_2$ values obtained by pulse oximetry are unreliable in cardiac arrest, shock, and other states of low perfusion (eg, sepsis, peripheral vascular disease, hypothermia) and when vasoconstrictor medications have been used. Additional causes of inaccurate pulse oximetry results include anemia, abnormal hemoglobin, high carbon monoxide level, use of dyes (eg, methylene blue), or if the patient has dark skin or is wearing nail polish. Bright light, particularly sunlight, fluorescent and xenon lights, and patient movement (including shivering) also affect accuracy. Furthermore, pulse oximetry values are not reliable detectors of hypoventilation if the patient is receiving supplemental oxygen (Clark, et al., 2006).

## Cultures

Throat cultures (see Chapter 22) may be performed to identify organisms responsible for pharyngitis. Throat culture may also assist in identifying organisms responsible for infection of the lower respiratory tract. Nasal swabs may be performed for the same purpose.

## Sputum Studies

Sputum is obtained for analysis to identify pathogenic organisms and to determine whether malignant cells are present. A sputum specimen also may be obtained to assess for hypersensitivity states (in which there is an increase in eosinophils). Periodic sputum examinations may be necessary for patients receiving antibiotics, corticosteroids, and immunosuppressive medications for prolonged periods




A

B

**Figure 21-12** Measuring blood oxygenation with pulse oximetry reduces the need for invasive procedures, such as drawing blood for analysis of oxygen levels. **A,** Self-contained digital fingertip pulse oximeter, which incorporates the sensor and the display into one unit. **B,** Table top model with sensor attached. Memory permits tracking heart rate and oxygen saturation over time.

because these agents are associated with opportunistic infections.

Expectoration is the usual method for collecting a sputum specimen. The patient is instructed to clear the nose and throat and rinse the mouth to decrease contamination of the sputum. After taking a few deep breaths, the patient coughs (rather than spits), using the diaphragm, and expectorates into a sterile container.

If the sputum cannot be raised spontaneously, the patient often can be induced to cough deeply by breathing an irritating aerosol of supersaturated saline, propylene glycol, or some other agent delivered with an ultrasonic nebulizer. Other methods of collecting sputum specimens include endotracheal aspiration, bronchoscopic removal, bronchial brushing, transtracheal aspiration, and gastric aspiration (the last is usually done for tuberculosis organisms; see Chapter 23). Generally, the deepest specimens (those from the base of the lungs) are obtained in the early morning after they have accumulated overnight.

The specimen is delivered to the laboratory within 2 hours by the patient or nurse. Allowing the specimen to stand for several hours in a warm room results in the overgrowth of contaminant organisms and may make it difficult to identify the pathogenic organisms (especially *Mycobacterium tuberculosis*). The home care nurse may assist patients who need help obtaining the sample or who cannot deliver the specimen to the laboratory in a timely fashion.

## Imaging Studies

Imaging studies, including x-rays, computed tomography (CT), magnetic resonance imaging (MRI), contrast studies, and radioisotope diagnostic scans may be part of any diagnostic workup, ranging from a determination of the extent of infection in sinusitis to tumor growth in cancer.

### *Chest X-Ray*

Normal pulmonary tissue is radiolucent; therefore, densities produced by fluid, tumors, foreign bodies, and other pathologic conditions can be detected by x-ray examination. A chest x-ray may reveal an extensive pathologic process in the lungs in the absence of symptoms. The routine chest x-ray consists of two views: the posteroanterior projection and the lateral projection. Chest x-rays are usually taken after full inspiration (a deep breath) because the lungs are best visualized when they are well aerated. Also, the diaphragm is at its lowest level and the largest expanse of lung is visible. If taken on expiration, x-ray films may accentuate an otherwise unnoticed pneumothorax or obstruction of a major artery.

### *Computed Tomography*

CT is an imaging method in which the lungs are scanned in successive layers by a narrow-beam x-ray. The images produced provide a cross-sectional view of the chest. Whereas a chest x-ray shows major contrasts between body densities such as bone, soft tissue, and air, CT can distinguish fine tissue density. CT may be used to define pulmonary nodules and small tumors adjacent to pleural surfaces that are not visible on routine chest x-rays and to demonstrate mediastinal abnormalities and hilar adenopathy, which are difficult to visualize with other techniques. Contrast agents are useful when evaluating the mediastinum and its contents.

### *Magnetic Resonance Imaging*

MRI is similar to CT except that magnetic fields and radiofrequency signals are used instead of a narrow-beam x-ray. MRI yields a much more detailed diagnostic image than CT because it visualizes soft tissues. MRI is used to characterize pulmonary nodules, to help stage bronchogenic carcinoma (assessment of chest wall invasion), and to evaluate inflammatory activity in interstitial lung disease, acute

pulmonary embolism, and chronic thrombolytic pulmonary hypertension.

### Fluoroscopic Studies

Fluoroscopy is used to assist with invasive procedures, such as a chest needle biopsy or transbronchial biopsy, that are performed to identify lesions. It also may be used to study the movement of the chest wall, mediastinum, heart, and diaphragm; to detect diaphragm paralysis; and to locate lung masses.

### Pulmonary Angiography

Pulmonary angiography is most commonly used to investigate thromboembolic disease of the lungs, such as pulmonary emboli, and congenital abnormalities of the pulmonary vascular tree. It involves the rapid injection of a radiopaque agent into the vasculature of the lungs for radiographic study of the pulmonary vessels. It can be performed by injecting the radiopaque agent into a vein in one or both arms (simultaneously) or into the femoral vein, with a needle or catheter. The agent also can be injected into a catheter that has been inserted in the main pulmonary artery or its branches or into the great veins proximal to the pulmonary artery.

### Radioisotope Diagnostic Procedures (Lung Scans)

Several types of lung scans—($\dot{V}/\dot{Q}$) scan, gallium scan, and positron emission tomography (PET)—are used to assess normal lung functioning, pulmonary vascular supply, and gas exchange.

A ($\dot{V}/\dot{Q}$) lung scan is performed by injecting a radioactive agent into a peripheral vein and then obtaining a scan of the chest to detect radiation. The isotope particles pass through the right side of the heart and are distributed into the lungs in proportion to the regional blood flow, making it possible to trace and measure blood perfusion through the lung. This procedure is used clinically to measure the integrity of the pulmonary vessels relative to blood flow and to evaluate blood flow abnormalities, as seen in pulmonary emboli. The imaging time is 20 to 40 minutes, during which the patient lies under the camera with a mask fitted over the nose and mouth. This is followed by the ventilation component of the scan. The patient takes a deep breath of a mixture of oxygen and radioactive gas, which diffuses throughout the lungs. A scan is performed to detect ventilation abnormalities in patients who have regional differences in ventilation. It may be helpful in the diagnosis of bronchitis, asthma, inflammatory fibrosis, pneumonia, emphysema, and lung cancer. Ventilation without perfusion is seen with pulmonary emboli.

A gallium scan is a radioisotope lung scan used to detect inflammatory conditions, abscesses, adhesions, and the presence, location, and size of tumors. It is used to stage bronchogenic cancer and document tumor regression after chemotherapy or radiation. Gallium is injected intravenously, and scans are taken at intervals (eg, 6, 24, and 48 hours) to evaluate gallium uptake by the pulmonary tissues.

PET is a radioisotope study with advanced diagnostic capabilities that is used to evaluate lung nodules for malignancy. PET can detect and display metabolic changes in tissue, distinguish normal tissue from diseased tissue (such as in cancer), differentiate viable from dead or dying tissue, show regional blood flow, and determine the distribution and fate of medications in the body. PET is more accurate in detecting malignancies than CT and has equivalent accuracy in detecting malignant nodules when compared with invasive procedures such as thoracoscopy.

## Endoscopic Procedures

Endoscopic procedures include bronchoscopy, thoracoscopy, and thoracentesis.

### Bronchoscopy

**Bronchoscopy** is the direct inspection and examination of the larynx, trachea, and bronchi through either a flexible fiberoptic bronchoscope or a rigid bronchoscope (Fig. 21-13). The fiberoptic scope is used more frequently in current practice.

#### Procedure

The purposes of diagnostic bronchoscopy are: (1) to examine tissues or collect secretions, (2) to determine the location and extent of the pathologic process and to obtain a tissue sample for diagnosis (by biting or cutting forceps, curettage, or brush biopsy), (3) to determine whether a tumor can be resected surgically, and (4) to diagnose bleeding sites (source of hemoptysis).

Therapeutic bronchoscopy is used to (1) remove foreign bodies from the tracheobronchial tree, (2) remove secretions obstructing the tracheobronchial tree when the patient cannot clear them, (3) treat postoperative atelectasis, and (4) destroy and excise lesions. It has also been used to insert stents to relieve airway obstruction that is caused by tumors or miscellaneous benign conditions or that occurs as a complication of lung transplantation.

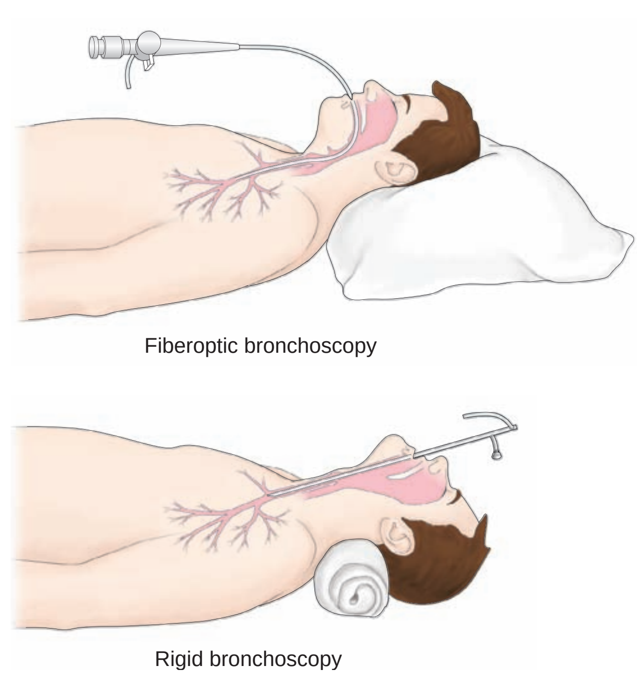



**Figure 21-13** Endoscopic bronchoscopy permits visualization of bronchial structures. The bronchoscope is advanced into bronchial structures orally. Bronchoscopy permits the clinician not only to diagnose but also to treat various lung problems.

The fiberoptic bronchoscope is a thin, flexible bronchoscope that can be directed into the segmental bronchi. Because of its small size, its flexibility, and its excellent optical system, it allows increased visualization of the peripheral airways and is ideal for diagnosing pulmonary lesions. Fiberoptic bronchoscopy allows biopsy of previously inaccessible tumors and can be performed at the bedside. It also can be performed through endotracheal or tracheostomy tubes of patients on ventilators. Cytologic examinations can be performed without surgical intervention.

The rigid bronchoscope is a hollow metal tube with a light at its end. It is used mainly for removing foreign substances, investigating the source of massive hemoptysis, or performing endobronchial surgical procedures. Rigid bronchoscopy is performed in the operating room, not at the bedside.

Possible complications of bronchoscopy include a reaction to the local anesthetic, infection, aspiration, bronchospasm, **hypoxemia** (low blood oxygen level), pneumothorax, bleeding, and perforation.

#### Nursing Interventions

Before the procedure, a signed consent form is obtained from the patient. Food and fluids are withheld for 6 hours before the test to reduce the risk of aspiration when the cough reflex is blocked by anesthesia. The nurse explains the procedure to the patient to reduce fear and decrease anxiety and administers preoperative medications (usually atropine and a sedative or opioid) as prescribed to inhibit vagal stimulation (thereby guarding against bradycardia, dysrhythmias, and hypotension), suppress the cough reflex, sedate the patient, and relieve anxiety.

*NURSING ALERT*

**Sedation given to patients with respiratory insufficiency may precipitate respiratory arrest.**

The patient must remove dentures and other oral prostheses. The examination is usually performed under local anesthesia or moderate sedation, but general anesthesia may be used for rigid bronchoscopy. A topical anesthetic such as lidocaine (Xylocaine) may be sprayed on the pharynx or dropped on the epiglottis and vocal cords and into the trachea to suppress the cough reflex and minimize discomfort. Sedatives or opioids are administered intravenously as prescribed to provide moderate sedation.

After the procedure, it is important that the patient takes nothing by mouth until the cough reflex returns, because the preoperative sedation and local anesthesia impair the protective laryngeal reflex and swallowing for several hours. Once the patient demonstrates a cough reflex, the nurse may offer ice chips and eventually fluids. In the elderly patient, the nurse assesses for confusion and lethargy, which may be due to the large doses of lidocaine administered during the procedure. The nurse also monitors the patient's respiratory status and observes for hypoxia, hypotension, tachycardia, dysrhythmias, hemoptysis, and dyspnea. Any abnormality is reported promptly. The patient is not discharged from the recovery area until adequate cough reflex and respiratory status are present. The nurse instructs the patient and family caregivers to report any shortness of breath or bleeding immediately.

### Thoracoscopy

Thoracoscopy is a diagnostic procedure in which the pleural cavity is examined with an endoscope (Fig. 21-14).

#### Procedure

Small incisions are made into the pleural cavity in an intercostal space; the location of the incision depends on the clinical and diagnostic findings. After any fluid present in the pleural cavity is aspirated, the fiberoptic mediastinoscope is inserted into the pleural cavity, and its surface is inspected through the instrument. After the procedure, a chest tube may be inserted, and the pleural cavity is drained by negative-pressure water-seal drainage.

Thoracoscopy is primarily indicated in the diagnostic evaluation of pleural effusions, pleural disease, and tumor staging. Biopsies of the lesions can be performed under visualization for diagnosis.

Thoracoscopic procedures have expanded with the availability of video monitoring, which permits improved visualization of the lung. Video-assisted thoracoscopy (VATS) may be used in the diagnosis and treatment of empyema, pleural effusion, and other respiratory disorders

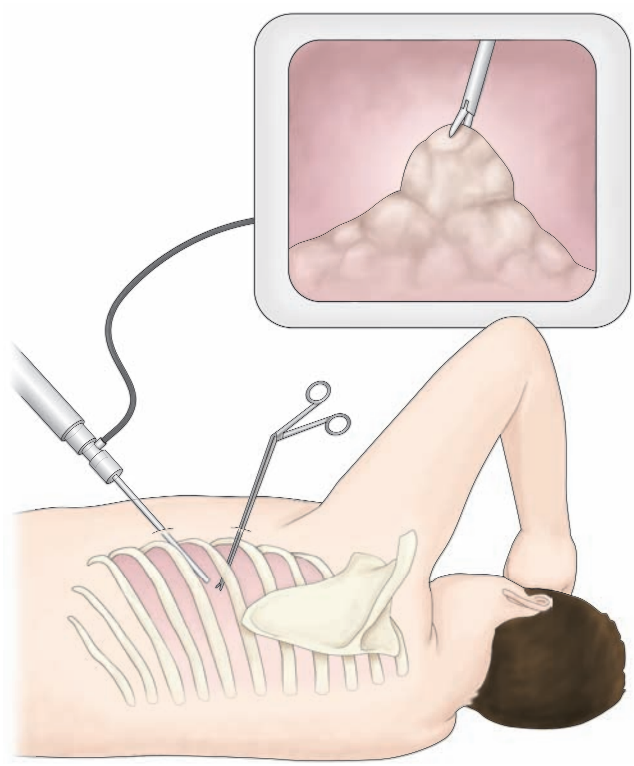


**Figure 21-14** Endoscopic thoracoscopy. Like bronchoscopy, thoracoscopy uses fiberoptic instruments and video cameras for visualizing thoracic structures. Unlike bronchoscopy, thoracoscopy usually requires the surgeon to make a small incision before inserting the endoscope. A combined diagnostic–treatment procedure, thoracoscopy includes excising tissue for biopsy.

(Luh, Chou, Wang, et al., 2005). Such procedures also have been used with the carbon dioxide laser in the removal of pulmonary blebs and bullae and in the treatment of spontaneous pneumothorax. Lasers have also been used in the excision of peripheral pulmonary nodules. Although the laser does not replace the need for thoracotomy in the treatment of some lung cancers, its use continues to expand, because it is less invasive than open surgical procedures and hospitalization and recovery are shorter.

#### Nursing Interventions

Follow-up care in the health care facility and at home involves monitoring the patient for shortness of breath (which might indicate a pneumothorax) and minor activity restrictions, which vary depending on the intensity of the procedure. If a chest tube was inserted during the procedure, monitoring of the chest drainage system and chest tube insertion site is essential (see Chapter 25).

### *Thoracentesis*

A thin layer of pleural fluid normally remains in the pleural space. An accumulation of pleural fluid may occur with some disorders. Thoracentesis (aspiration of fluid or air from the pleural space) is performed for diagnostic or therapeutic reasons (Chart 21-10). Purposes of the procedure include removal of fluid and air from the pleural cavity, aspiration of pleural fluid for analysis, pleural biopsy, and instillation of medication into the pleural space. When performed for biopsy, studies of pleural fluid include Gram stain culture and sensitivity, acid-fast staining and culture, differential cell count, cytology, pH, specific gravity, total protein, and lactic dehydrogenase. When thoracentesis is performed under ultrasound guidance, it has a lower rate of complications than when it is performed without ultrasound guidance.

## Biopsy

Biopsy, the excision of a small amount of tissue, may be performed to permit examination of cells from the pharynx, larynx, and nasal passages. Local, topical, moderate sedation, or general anesthesia may be administered, depending on the site and the procedure.

### *Pleural Biopsy*

Pleural biopsy is accomplished by needle biopsy of the pleura or by pleuroscopy, a visual exploration through a fiberoptic bronchoscope inserted into the pleural space. Pleural biopsy is performed when there is pleural exudate of undetermined origin or when there is a need to culture or stain the tissue to identify tuberculosis or fungi.

### *Lung Biopsy Procedures*

If the chest x-ray findings are inconclusive or show pulmonary density (indicating an infiltrate or lesion), biopsy may be performed to obtain lung tissue for examination to identify the nature of the lesion. Several nonsurgical lung biopsy techniques are used because they yield accurate information with low morbidity: transcatheter bronchial brushing, transbronchial lung biopsy, and percutaneous (through-the-skin) needle biopsy.

#### Procedure

In transcatheter bronchial brushing, a fiberoptic bronchoscope is introduced into the bronchus under fluoroscopy. A small brush attached to the end of a flexible wire is inserted through the bronchoscope. Under direct visualization, the area under suspicion is brushed back and forth, causing cells to slough off and adhere to the brush. The catheter port of the bronchoscope may be used to irrigate the lung tissue with saline solution to secure material for additional studies. The brush is removed from the bronchoscope and a slide is made for examination under the microscope. The brush may be cut off and sent to the pathology laboratory for analysis.

This procedure is useful for cytologic evaluations of lung lesions and for the identification of pathogenic organisms (eg, *Nocardia, Aspergillus, Pneumocystis jiroveci*). It is especially useful in the immunologically compromised patient.

Another method of bronchial brushing involves the introduction of the catheter through the cricothyroid membrane by needle puncture. After this procedure, the patient is instructed to hold a finger or thumb over the puncture site while coughing to prevent air from leaking into the surrounding tissues.

In transbronchial lung biopsy, biting or cutting forceps are introduced by a fiberoptic bronchoscope. A biopsy is indicated when a lung lesion is suspected and the results of routine sputum samples and bronchoscopic washings are negative.

In percutaneous needle biopsy, a cutting needle or a spinal-type needle is used to obtain a tissue specimen for histologic study. Analgesia may be administered before the procedure. The skin over the biopsy site is cleansed and anesthetized, and a small incision is made. The biopsy needle is inserted through the incision into the pleura with the patient holding his or her breath in midexpiration. Using fluoroscopic monitoring, the surgeon guides the needle into the periphery of the lesion and obtains a tissue sample from the mass. Possible complications include pneumothorax, pulmonary hemorrhage, and empyema.

#### Nursing Interventions

After the procedure, recovery and home care are similar to those for bronchoscopy and thoracoscopy. Nursing care involves monitoring the patient for shortness of breath, bleeding, and infection. In preparation for discharge, the patient and family are instructed to report pain, shortness of breath, visible bleeding, redness of the biopsy site, or purulent drainage (pus) to the health care provider immediately. Patients who have undergone biopsy are often anxious because of the need for the biopsy and the potential findings; the nurse must consider this in providing postbiopsy care and teaching.

### *Lymph Node Biopsy*

The scalene lymph nodes are enmeshed in the deep cervical pad of fat overlying the scalenus anterior muscle. They drain the lungs and mediastinum and may show histologic changes from intrathoracic disease. If these nodes are palpable on physical examination, a scalene node biopsy may

CHART 21-10

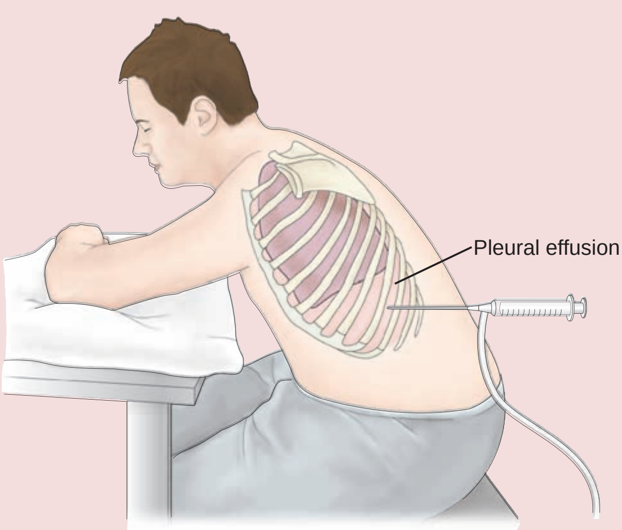
## Guidelines for Assisting the Patient Undergoing Thoracentesis

### Equipment

- Thoracentesis tray
- Sterile gloves
- Germicide solution
- Local anesthetic
- Sterile collection bottles

### Implementation

| Action | Rationale |
| --- | --- |
| 1. Ascertain in advance that a chest x-ray has been ordered and completed and the consent form for thoracentesis has been signed. | 1. Posteroanterior and lateral chest x-ray films are used to localize fluid and air in the pleural cavity and to aid in determining the puncture site. When fluid is loculated (isolated in a pocket of pleural fluid), ultrasound scans are performed to help select the best site for needle aspiration. |
| 2. Assess the patient for allergy to the local anesthetic to be used. | 2. If the patient is allergic to the initially prescribed anesthetic, assessment findings provide an opportunity to use a safer anesthetic. |
| 3. Administer sedation if prescribed. | 3. Sedation enables the patient to cooperate with the procedure and promotes relaxation. |
| 4. Inform the patient about the nature of the procedure and<br>a. The importance of remaining immobile<br>b. Pressure sensations to be experienced<br>c. That minimal discomfort is anticipated after the procedure. | 4. An explanation helps to orient the patient to the procedure, assists the patient to mobilize resources, and provides an opportunity to ask questions and verbalize anxiety. |
| 5. Position the patient comfortably with adequate supports. If possible, place the patient upright or in one of the following positions:<br>a. Sitting on the edge of the bed with the feet supported and arms on a padded over-the-bed table<br>b. Straddling a chair with arms and head resting on the back of the chair<br>c. Lying on the unaffected side with the head of the bed elevated 30 to 45 degrees if unable to assume a sitting position. | 5. The upright position facilitates the removal of fluid that usually localizes at the base of the thorax. A position of comfort helps the patient to relax. |




Continued on following page

**CHART 21-10** ***Guidelines for Assisting the Patient Undergoing Thoracentesis*** (*Continued*)

| Action | Rationale |
|---|---|
| 6. Support and reassure the patient during the procedure.<br>a. Prepare the patient for the cold sensation of skin germicide solution and for a pressure sensation from infiltration of local anesthetic agent.<br>b. Encourage the patient to refrain from coughing. | 6. Sudden and unexpected movement, such as coughing, by the patient can traumatize the visceral pleura and lung. |
| 7. Expose the entire chest. The site for aspiration is visualized by chest x-ray and percussion. If fluid is in the pleural cavity, the thoracentesis site is determined by the chest x-ray, ultrasound scanning, and physical findings, with attention to the site of maximal dullness on percussion. | 7. If air is in the pleural cavity, the thoracentesis site is usually in the second or third intercostal space in the midclavicular line because air rises in the thorax. |
| 8. The procedure is performed under aseptic conditions. After the skin is cleansed, the physician uses a small-caliber needle to inject a local anesthetic slowly into the intercostal space. | 8. An intradermal wheal is raised slowly; rapid injection causes pain. The parietal pleura is very sensitive and should be well infiltrated with anesthetic before the physician passes the thoracentesis needle through it. |
| 9. The physician advances the thoracentesis needle with the syringe attached. When the pleural space is reached, suction may be applied with the syringe. | 9. Use of thoracentesis needle allows proper insertion. |
| a. A 20-mL syringe with a three-way stopcock is attached to the needle (one end of the adapter is attached to the needle and the other to the tubing leading to a receptacle that receives the fluid being aspirated). | a. When a large quantity of fluid is withdrawn, a three-way stopcock serves to keep air from entering the pleural cavity. |
| b. If a considerable quantity of fluid is removed, the needle is held in place on the chest wall with a small hemostat. | b. The hemostat steadies the needle on the chest wall. Sudden pleuritic chest pain or shoulder pain may indicate that the needle point is irritating the visceral or the diaphragmatic pleura. |
| 10. After the needle is withdrawn, pressure is applied over the puncture site and a small, airtight, sterile dressing is fixed in place. | 10. Pressure helps to stop bleeding, and the airtight dressing protects the site and prevents air from entering the pleural cavity. |
| 11. Advise the patient that he or she will be on bed rest and a chest x-ray will be obtained after thoracentesis. | 11. A chest x-ray verifies that there is no pneumothorax. |
| 12. Record the total amount of fluid withdrawn from the procedure and document the nature of the fluid, its color, and its viscosity. If indicated, prepare samples of fluid for laboratory evaluation. A specimen container with formalin may be needed for a pleural biopsy. | 12. The fluid may be clear, serous, bloody, purulent, etc. |
| 13. Monitor the patient at intervals for increasing respiratory rate; asymmetry in respiratory movement; faintness; vertigo; tightness in chest; uncontrollable cough; blood-tinged, frothy mucus; a rapid pulse; and signs of hypoxemia. | 13. Pneumothorax, tension pneumothorax, subcutaneous emphysema, and pyogenic infection are complications of a thoracentesis. Pulmonary edema or cardiac distress can occur after a sudden shift in mediastinal contents when large amounts of fluid are aspirated. |

be performed. A biopsy of these nodes may be performed to detect spread of pulmonary disease to the lymph nodes and to establish a diagnosis or prognosis in such diseases as Hodgkin lymphoma, sarcoidosis, fungal disease, tuberculosis, and carcinoma.

### Procedure

Mediastinoscopy is the endoscopic examination of the mediastinum for exploration and biopsy of mediastinal lymph nodes that drain the lungs; this examination does not require a thoracotomy. Biopsy is usually performed through a suprasternal incision. Mediastinoscopy is carried out to detect mediastinal involvement of pulmonary malignancy and to obtain tissue for diagnostic studies of other conditions (eg, sarcoidosis).

An anterior mediastinotomy is thought to provide better exposure and diagnostic possibilities than a mediastinoscopy. An incision is made in the area of the second or third costal cartilage. The mediastinum is explored, and biopsies are performed on any lymph nodes found. Chest tube drainage is required after the procedure. Mediastinotomy is particularly valuable to determine whether a pulmonary lesion is resectable.

### Nursing Interventions

Postprocedure care focuses on providing adequate oxygenation, monitoring for bleeding, and providing pain relief. The patient may be discharged a few hours after the chest drainage system is removed. The nurse should instruct the patient and family about monitoring for changes in respiratory status, taking into consideration the impact of anxiety about the potential findings of the biopsy on their ability to remember those instructions.

## CRITICAL THINKING EXERCISES

**1** A 48-year-old woman with a long history of smoking (40 pack-years) is scheduled for surgery under general anesthesia to remove a lump from her breast. In preparation for surgery, she is scheduled for PFTs, which she refuses to have because she says her breathing is fine and has nothing to do with her breasts. How would you respond to her statement? What impact does her 40 pack-year history of cigarette smoking have on your preoperative, intraoperative, and postoperative assessment?

**2** You are obtaining a health history from a 62-year-old patient who is seeking health care because of a persistent cough and extreme fatigue. She mentions that she cannot keep up with her grandchildren and even gets out of breath when reading to them or talking to them on the phone. What specific information about signs and symptoms would you obtain during the health history? How would you modify your physical examination based on your observations? What initial laboratory tests would you anticipate will be ordered for this patient?

**3** An 88-year-old man has been recently relocated because his family does not want him to live by himself. He has never been seen at this pulmonary clinic and is here to get acquainted with his new health care providers. He says his lungs are "no good" because he has smoked since he was 18 years old and was exposed to asbestos during the 15 years he worked in shipyards. He brought a folder from his previous health care provider with results of tests that were done during a hospitalization for pneumonia 2 years earlier: PFTs, ABGs, sputum cultures, chest x-ray, and CT scan of the chest. What questions will you ask him about his health history? What tests do you anticipate being repeated at this time and why?

EBP **4** A 70-year-old patient who has cancer of the lung has undergone a thoracentesis with removal of 750 mL of pleural fluid to relieve his shortness of breath. Soon after the procedure is completed, the patient reports that his shortness of breath has increased rather than decreased. Based on your knowledge of risks associated with thoracentesis, what assessment data would you obtain from this patient and report to the physician? What additional nursing measures are warranted for the patient at this time? What is the evidence on which your nursing interventions are based? How would you determine the strength of that evidence? How would you respond if the patient had been discharged an hour after the thoracentesis and provided this information to you by telephone from home?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisks indicates nursing research.*


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## RESOURCES

American Association for Respiratory Care, www.aarc.org

American Lung Association, www.lungusa.org

National Heart, Lung, and Blood Institute/National Institutes of Health, www.nhlbi.nih.gov/index.htm

National Lung Health Education Program, www.nlhep.org (has easy-to-read teaching resources for patients)



chapter 22

# Management of Patients With Upper Respiratory Tract Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe nursing management of patients with upper airway disorders.
2. Compare and contrast the upper respiratory tract infections with regard to cause, incidence, clinical manifestations, management, and the significance of preventive health care.
3. Use the nursing process as a framework for care of patients with upper airway infection.
4. Describe nursing management of the patient with epistaxis.
5. Use the nursing process as a framework for care of patients undergoing laryngectomy.

## GLOSSARY

**alaryngeal communication:** alternative modes of speaking that do not involve the normal larynx; used by patients whose larynx has been surgically removed

**aphonia:** impaired ability to use one's voice due to disease or injury to the larynx

**apnea:** cessation of breathing

**carcinogen:** agent that can cause cancer; carcinogens can be chemicals, viruses, hormones, ionizing radiation, or solid materials

**dysphagia:** difficulties in swallowing

**epistaxis:** hemorrhage from the nose due to rupture of tiny, distended vessels in the mucous membrane of any area of the nose

**herpes simplex:** cold sore (cutaneous viral infection with painful vesicles and erosions on the tongue, palate, gingiva, buccal membranes, or lips)

**laryngectomy:** surgical removal of all or part of the larynx and surrounding structures

**laryngitis:** inflammation of the larynx; may be caused by voice abuse, exposure to irritants, or infectious organisms

**medicamentosa:** rebound nasal congestion commonly associated with overuse of over-the-counter nasal decongestants

**nuchal rigidity:** stiffness of the neck or inability to bend the neck

**pharyngitis:** inflammation of the throat; usually viral or bacterial in origin

**rhinitis:** inflammation of the mucous membranes of the nose; may be infectious, allergic, or inflammatory in origin

**rhinorrhea:** drainage of a large amount of fluid from the nose

**rhinosinusitis:** inflammation of the nares and paranasal sinuses, including frontal, ethmoid, maxillary, and sphenoid sinuses; replaces the term "sinusitis"

**tonsillitis:** inflammation of the tonsils, usually due to an acute infection

**xerostomia:** dryness of the mouth from a variety of causes

Upper respiratory tract disorders are those that involve the nose, paranasal sinuses, pharynx, larynx, trachea, or bronchi. Many of these conditions are relatively minor, and their effects are limited to mild and temporary discomfort and inconvenience for the patient. However, others are acute, severe, and life-threatening and may require permanent alterations in breathing and speaking. Therefore, the nurse must have expert assessment skills, an understanding of the wide variety of disorders that may affect the upper airway, and an awareness of the impact of these alterations on patients. Because many of these disorders are treated outside the hospital or at home by patients themselves, patient teaching is an important aspect of nursing care. When caring for patients with acute, life-threatening disorders, the nurse needs highly developed assessment and clinical management skills, along with a focus on rehabilitation needs.

## UPPER AIRWAY INFECTIONS

Upper airway infections are the most common cause of illness and affect most people on occasion. Some infections are acute, with symptoms that last several days; others are chronic, with symptoms that last a long time or recur. Patients with these conditions seldom require hospitalization. However, nurses working in community settings or long-term care facilities may encounter patients who have these infections. Therefore, it is important for the nurse to recognize the signs and symptoms and to provide appropriate care.

Infections of the upper airway are also known as upper respiratory tract infections (URIs); the common cold is the most frequently occurring example. URIs occur when micro-organisms such as viruses and bacteria are inhaled. There are many causative organisms, and people are susceptible throughout life. URIs are the most common reason for seeking health care and for absences from school and work.

URIs affect the nasal cavity; ethmoidal air cells; and frontal, maxillary, and sphenoid sinuses; as well as the pharynx, larynx, and trachea. About 90% of upper respiratory disorders stem from a viral infection of the upper respiratory passages and subsequent mucous membrane inflammation. On average, adults typically develop two to four URIs per year because of the wide variety of respiratory viruses that circulate in the community. Although patients are rarely hospitalized for treatment of URIs, the nurse can influence patient outcomes in community settings and in long-term facilities through patient teaching. Special considerations with regard to URIs in the elderly are summarized in Chart 22-1.

### CHART 22-1 *Upper Respiratory Tract Disorders in the Elderly*

- Upper respiratory infections in the elderly may have more serious consequences if patients have concurrent medical problems that compromise their respiratory or immune status.
- Influenza causes exacerbations of chronic obstructive pulmonary disease (COPD) and reduced pulmonary function.
- Antihistamines to treat upper respiratory disorders must be used cautiously in the elderly because of their side effects and potential interactions with other medications.
- Rhinosinusitis in the elderly is often preceded by nasal packing for treatment of epistaxis.
- As the population ages, it is likely that the number of patients with chronic rhinosinusitis (CRS) and the need for endoscopic sinus surgery will increase. Older patients with CRS present with symptoms similar to those of younger adults and experience a similar degree of improvement and quality of life after endoscopic sinus surgery (Reh, Mace, Robinson, et al., 2007).
- Laryngitis in the elderly is common and most frequently occurs secondary to gastroesophageal reflux disease (GERD). The elderly are more likely to have impaired esophageal peristalsis and a weaker esophageal sphincter. Treatment measures include sleeping with the head of the bed elevated and the use of medications such as $H_2$-receptor blockers (eg, famotidine [Pepcid], ranitidine [Zantac]) or proton pump inhibitors (omeprazole [Prilosec]).

## Rhinitis

**Rhinitis** is a group of disorders characterized by inflammation and irritation of the mucous membranes of the nose. These conditions can have a significant impact on quality of life and contribute to sinus, ear, and sleep problems and learning disorders. Rhinitis often coexists with other respiratory disorders, such as asthma (Nihlén, Greiff, Montnémery, et al., 2006). It affects more than 50 million people in the United States annually.

Rhinitis may be acute or chronic, nonallergic or allergic. Allergic rhinitis is further classified as seasonal or perennial rhinitis and is commonly associated with exposure to airborne particles such as dust, dander, or plant pollens in people who are allergic to these substances. Seasonal rhinitis occurs during pollen seasons, and perennial rhinitis occurs throughout the year. Allergic disorders, including allergic rhinitis, are described in detail in Chapter 53.

### Pathophysiology

Rhinitis may be caused by a variety of factors, including changes in temperature or humidity; odors; infection; age; systemic disease; use of over-the-counter (OTC) and prescribed nasal decongestants; and the presence of a foreign body. Allergic rhinitis may occur with exposure to allergens such as foods (eg, peanuts, walnuts, brazil nuts, wheat, shellfish, soy, cow's milk, and eggs), medications (eg, penicillin, sulfa medications, aspirin, and others with the potential to produce an allergic reaction), and particles in the indoor and outdoor environment (Chart 22-2). The most common cause of nonallergic rhinitis is the common cold. Drug-induced rhinitis may occur with antihypertensive agents, such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers; "statins," such as atorvastatin (Lipitor) and simvastatin (Zocor); antidepressants; aspirin; and some antianxiety medications. Other causes of rhinitis are identified in Table 22-1. Figure 22-1 shows the pathologic processes involved in rhinitis and rhinosinusitis.

### Clinical Manifestations

The signs and symptoms of rhinitis include **rhinorrhea** (excessive nasal drainage, runny nose); nasal congestion; nasal discharge (purulent with bacterial rhinitis); sneezing; and

## Chart 22-2 • *Examples of Common Indoor and Outdoor Allergens*

**Common Indoor Allergens**

- Dust mite feces
- Dog dander
- Cat dander
- Cockroach droppings
- Molds

**Common Outdoor Allergens**

- Trees (eg, oak, elm, western red cedar, ash, birch, sycamore, maple, walnut, cypress)
- Weeds (eg, ragweed, tumbleweed, sagebrush, pigweed, cockleweed, Russian thistle)
- Grasses (eg, timothy, orchard, sweet vernal, bermuda, sour dock, redtop, bluegrass)
- Molds (*Alternaria, Cladosporium, Aspergillus*)

pruritus of the nose, roof of the mouth, throat, eyes, and ears. Headache may occur, particularly if rhinosinusitis is also present. Nonallergic rhinitis can occur throughout the year.

## Medical Management

The management of rhinitis depends on the cause, which may be identified through the history and physical examination. The nurse asks the patient about recent symptoms as well as possible exposure to allergens in the home, environment, or workplace. If viral rhinitis is the cause, medications may be prescribed to relieve the symptoms. In allergic rhinitis, allergy tests may be performed to identify possible allergens. Depending on the severity of the allergy, desensitizing immunizations and corticosteroids may be required (see Chapter 53 for more details). If symptoms suggest a bacterial infection, an antimicrobial agent is used (see later discussion of rhinosinusitis). Patients with nasal septal deformities or nasal polyps may be referred to an ear, nose, and throat specialist.

**Table 22-1 CAUSES OF RHINOSINUSITIS**

| Category | Causes |
|---|---|
| Vasomotor | Idiopathic<br>Abuse of nasal decongestants (rhinitis medicamentosa)<br>Psychological stimulation (anger, sexual arousal)<br>Irritants (smoke, air pollution, exhaust fumes, cocaine) |
| Mechanical | Tumor<br>Deviated septum<br>Crusting<br>Hypertrophied turbinates<br>Foreign body<br>Cerebrospinal fluid leak |
| Chronic inflammatory | Polyps (in cystic fibrosis)<br>Sarcoidosis<br>Wegener's granulomatosis<br>Midline granuloma |
| Infectious | Acute viral infection<br>Acute or chronic rhinosinusitis<br>Rare nasal infections (syphilis, tuberculosis) |
| Hormonal | Pregnancy<br>Use of oral contraceptives<br>Hypothyroidism |

Adapted from Carr, M. M. Differential diagnosis of rhinitis. Available at: http://icarus.med.utoronto.ca/carr/manual/ddxrhinitis.html

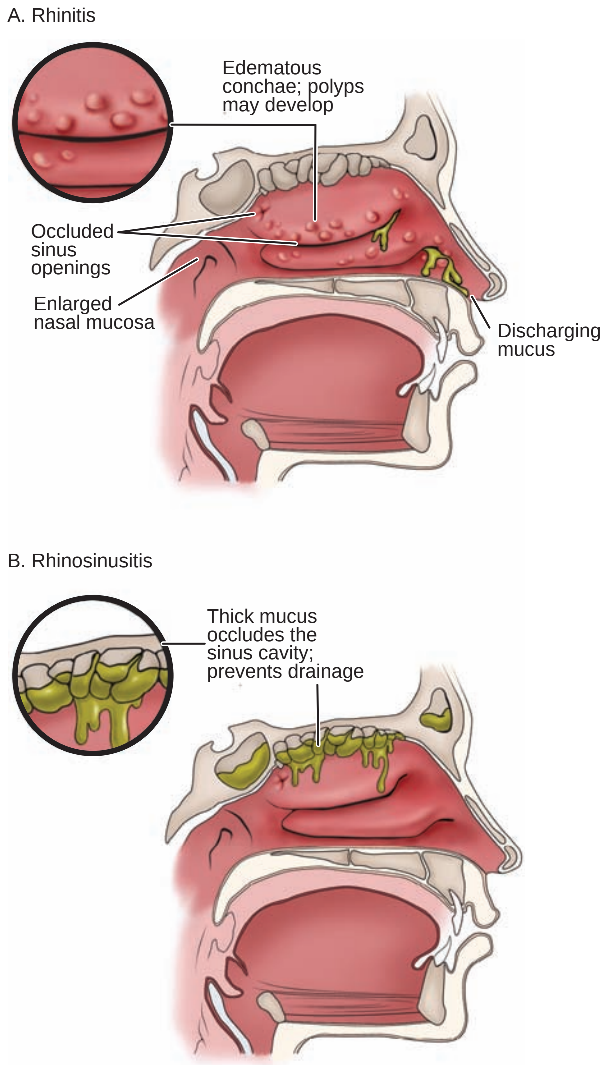



**Figure 22-1** Pathophysiologic processes in rhinitis and rhinosinusitis. Although pathophysiologic processes are similar in rhinitis and rhinosinusitis, they affect different structures. **A,** In rhinitis, the mucous membranes lining the nasal passages become inflamed, congested, and edematous. The swollen nasal conchae block the sinus openings, and mucus is discharged from the nostrils. **B,** Rhinosinusitis is also marked by inflammation and congestion, with thickened mucous secretions filling the sinus cavities and occluding the openings.

### *Pharmacologic Therapy*

Medication therapy for allergic and nonallergic rhinitis focuses on symptom relief. Antihistamines and corticosteroid nasal sprays may be useful. Antihistamines remain the most common treatment and are administered for sneezing, pruritus, and rhinorrhea. Examples of commonly prescribed antihistamines are discussed in more detail in Chapter 53. Brompheniramine/pseudoephedrine (Dimetapp) is an

example of combination antihistamine/decongestant medications. Cromolyn (NasalCrom), a mast cell stabilizer that inhibits the release of histamine and other chemicals, is also used in the treatment of rhinitis. Oral decongestant agents may be used for nasal obstruction. Use of saline nasal spray can act as a mild decongestant and can liquefy mucus to prevent crusting. Two inhalations of intranasal ipratropium (Atrovent) can be administered in each nostril two to three times per day for symptomatic relief of rhinorrhea. In addition, intranasal corticosteroids may be used for severe congestion, and ophthalmic agents (cromolyn ophthalmic solution 4%) may be used to relieve irritation, itching, and redness of the eyes. Newer allergy treatments include leukotriene modifiers (eg, montelukast [Singulair], zafirlukast [Accolate], zileuton [Zyflo]), immunoglobulin E modifiers (Xolair), and immunomodulatory medications, which are all part of the revised asthma treatment guidelines and are discussed further in Chapter 24. The choice of medications depends on the symptoms, adverse reactions, adherence factors, risk of drug interactions, and cost to the patient.

## Nursing Management

### *Teaching Patients Self-Care*

The nurse instructs the patient with allergic rhinitis to avoid or reduce exposure to allergens and irritants, such as dusts, molds, animals, fumes, odors, powders, sprays, and tobacco smoke. Patient education is essential when assisting the patient in the use of all medications. To prevent possible drug interactions, the patient is cautioned to read drug labels before taking any OTC medication.

The nurse instructs the patient about the importance of controlling the environment at home and at work. Saline nasal sprays or aerosols may be helpful in soothing mucous membranes, softening crusted secretions, and removing irritants. The nurse instructs the patient in correct administration of nasal medications. To achieve maximal relief, the patient is instructed to blow the nose before applying any medication into the nasal cavity. In addition, the patient is taught to keep the head upright; spray quickly and firmly into each nostril away from the nasal septum; and wait at least 1 minute before administering the second spray. The container should be cleaned after each use and should never be shared with other people to avoid cross-contamination.

In the case of infectious rhinitis, the nurse reviews hand hygiene technique with the patient as a measure to prevent transmission of organisms. This is especially important for those in contact with vulnerable populations such as the very young, the elderly, or people who are immunosuppressed (eg, patients with human immunodeficiency virus [HIV] infection, those taking immunosuppressive medications). In the elderly and other high-risk populations, the nurse reviews the value of receiving an influenza vaccination each year to achieve immunity before the beginning of the flu season.

# *Viral Rhinitis (Common Cold)*

Viral rhinitis is the most frequent viral infection in the general population. The term common cold often is used when referring to a URI that is self-limited and caused by a virus. The term cold refers to an infectious, acute inflammation of the mucous membranes of the nasal cavity characterized by nasal congestion, rhinorrhea, sneezing, sore throat, and general malaise. More broadly, the term refers to an acute URI, whereas terms such as rhinitis, pharyngitis, and laryngitis distinguish the sites of the symptoms. The term is also used when the causative virus is influenza (the flu). Colds are highly contagious because virus is shed for about 2 days before the symptoms appear and during the first part of the symptomatic phase.

In the United States, colds are more frequent during the late fall and winter seasons. The incidence of viral rhinitis follows a specific pattern during the year, depending on the causative agent. Although viral rhinitis can occur at any time, three periods account for the epidemics in the United States: in September, just after the opening of school; in late January; and toward the end of April.

Seasonal changes in relative humidity may affect the prevalence of colds. The most common cold-causing viruses survive better when humidity is low, in the colder months of the year.

Colds are believed to be caused by as many as 200 different viruses (National Institute of Allergy and Infectious Disease, 2007). Rhinoviruses are the most likely causative organisms. Other viruses implicated in the common cold include coronavirus, adenovirus, respiratory syncytial virus, influenza virus, and parainfluenza virus. Each virus may have multiple strains; as a result, people are susceptible to colds throughout life (Tierney, McPhee & Papadakis, 2007). Development of a vaccine against the multiple strains of virus is almost impossible. Immunity after recovery is variable and depends on many factors, including a person's natural host resistance and the specific virus that caused the cold. Despite popular belief, cold temperatures and exposure to cold rainy weather do not increase the incidence or severity of the common cold.

## Clinical Manifestations

Signs and symptoms of viral rhinitis are low-grade fever, nasal congestion, rhinorrhea and nasal discharge, halitosis, sneezing, tearing watery eyes, "scratchy" or sore throat, general malaise, chills, and often headache and muscle aches. As the illness progresses, cough usually appears. In some people, the virus exacerbates **herpes simplex,** commonly called a cold sore (Chart 22-3).

The symptoms of viral rhinitis may last from 1 to 2 weeks. If severe systemic respiratory symptoms occur, it is no longer considered viral rhinitis but one of the other acute URIs. Allergic conditions can affect the nose, mimicking the symptoms of a cold.

## Medical Management

Management consists of symptomatic therapy that includes an adequate fluid intake, rest, prevention of chilling, and use of expectorants as needed. Warm salt-water gargles soothe the sore throat, and nonsteroidal anti-inflammatory drugs (NSAIDs), such as aspirin or ibuprofen, relieve aches and pains. Antihistamines are used to relieve sneezing, rhinorrhea, and nasal congestion.

## Chart 22-3 • *Colds and Cold Sores (Herpes Simplex Virus HSV-1)*

Herpes labialis is an infection that is caused by the herpes simplex virus. It is characterized by an eruption of small, painful blisters on the skin of the lips, mouth, gums, tongue, or the skin around the mouth. The blisters are commonly referred to as "cold sores" or "fever blisters." Once the person is infected with this virus, it can lie latent in the cells for a period of time. The incubation period is about 2 to 12 days. It is activated by overexposure to sunlight or wind, colds, influenza and similar infections, heavy alcohol use, and physical or emotional stress.

Herpes labialis is extremely common and is caused by the herpes simplex virus type 1. HSV-1 is also an important cause of genital herpes, which is increasing in college students and selected populations in the United States (Xu, Sternberg, Kottiri, et al., 2006). (In contrast, HSV-2 typically causes painful vesicular and ulcerative lesions in the genital and anal areas.) Most Americans are infected with the type 1 virus by the age of 20 years, because HSV-1 is typically transmitted during childhood through nonsexual contact. Herpes labialis is extremely contagious and can be spread through contaminated razors, towels, and dishes. Oral/genital contact can spread oral herpes to the genitals (and vice versa). People with active herpetic lesions should avoid oral sex. It is extremely important for patients to understand that the virus can be transmitted by asymptomatic people.

Early symptoms of herpes labialis include burning, itching, and increased sensitivity or tingling sensation. These symptoms may occur several days before the appearance of lesions. The lesions appear as macules or papules, progressing to small blisters (vesicles) filled with clear, yellowish fluid. They are raised, red, and painful and can break and ooze. The lesions typically extend through the epidermis and penetrate into the underlying dermis, consistent with a partial-thickness wound (Patel, Romanelli, Roberts, et al., 2007). Eventually yellow crusts slough to reveal pink, healing skin. Typically, the virus is no longer detectable in the lesion or wound 5 days after the vesicle has developed.

Medications used in the management of herpes labialis include acyclovir (Zovirax) and valacyclovir (Valtrex), which help to minimize the symptoms and the duration or length of flare-up. Other medications used for analgesia include acetaminophen with codeine and other milder forms of opioids. Topical anesthetics such as xylocaine can help in the control of discomfort. Occlusive dressings have been shown to speed the healing process. Not only do such dressings prevent desiccation and scab formation, they also maintain an aqueous wound environment rich in growth factors and matrix materials; however, occlusive dressings are not practical for lip and mucosa lesions (Patel, et al., 2007). In this case, alternatives include occlusive ointments such as Herpecin-L or docosanol (Abreva).



Guaifenesin (Mucinex), an expectorant, is available without a prescription and is used to promote removal of secretions. Several antiviral medications are available by prescription, including amantadine (Symmetrel) and rimantadine (Flumadine). These medications can reduce the severity of symptoms and may reduce the duration of the common cold. Antimicrobial agents (antibiotics) should not be used, because they do not affect the virus or reduce the incidence of bacterial complications. In addition, their inappropriate use has been implicated in development of organisms resistant to therapy.

Topical nasal decongestants (eg, phenylephrine nasal [Neo-Synephrine], oxymetazoline nasal [Afrin]) should be used with caution. Topical therapy delivers medication directly to the nasal mucosa, and its overuse can produce rhinitis **medicamentosa,** or rebound rhinitis. Most patients treat the common cold with OTC medications that produce moderate clinical benefits, such as relief of symptoms.

In addition, herbal medicines (eg, echinacea, zinc lozenges, zinc nasal spray) are frequently used to treat the common cold; however, evidence regarding their effectiveness in shortening the symptomatic phase is questionable (Linde, Barrett, Wolkart, et al., 2006; Wu, Zhang, Qiu, et al., 2007). The inhalation of steam or heated, humidified air has been a mainstay of home remedies for common cold sufferers, but the value of this therapy has not been demonstrated.

## Nursing Management

### *Teaching Patients Self-Care*

Most viruses can be transmitted in several ways: direct contact with infected secretions; inhalation of large particles from others' coughing or sneezing; or inhalation of small particles (aerosol) that may be suspended in the air for up to an hour. Handwashing (or use of alcohol-based antibacterial cleaning agents) remains the most effective measure to prevent transmission of organisms. The nurse teaches the patient how to break the chain of infection with appropriate handwashing or hand hygiene and the use of tissues to avoid the spread of the virus with coughing and sneezing. The nurse teaches methods to treat symptoms of the common cold and provides both verbal and written information to assist the patient in the prevention and management of URIs.

# *Rhinosinusitis*

**Rhinosinusitis,** formerly called sinusitis, is an inflammation of the paranasal sinuses and nasal cavity. The clinical practice guideline for adult sinusitis released by the American Academy of Otolaryngology-Head and Neck Surgery Foundation (Rosenfeld, Andes, Bhattacharyya, et al., 2007) recommends use of the term rhinosinusitis since sinusitis is almost always accompanied by inflammation of the nasal mucosa. Rhinosinusitis affects one in seven Americans. About 31 million people in the United States are diagnosed with this condition each year, resulting in direct annual health care costs of $5.8 billion in ambulatory and emergency services alone (Rosenfeld, et al., 2007).

Uncomplicated rhinosinusitis is rhinosinus without extension of inflammation outside of the paranasal sinuses and

nasal cavity. Rhinosinusitis is classified by duration of symptom as acute (less than 4 weeks), subacute (4 to 12 weeks), and chronic (more than 12 weeks). Rhinosinusitis can be a bacterial or viral infection.

## ACUTE RHINOSINUSITIS

Acute rhinosinusitis is classified as acute bacterial rhinosinusitis (ABRS) or viral rhinosinusitis (AVRS). Recurrent acute rhinosinusitis is characterized by four or more acute episodes of ABRS per year (Rosenfeld, et al., 2007) and is discussed with chronic rhinosinusitis.

### Pathophysiology

Acute rhinosinusitis usually follows a viral URI or cold, such as an unresolved viral or bacterial infection, or an exacerbation of allergic rhinitis. Normally, the sinus openings into the nasal passages are clear and infections resolve promptly. However, if their drainage is obstructed by a deviated septum or by hypertrophied turbinates, spurs, or nasal polyps or tumors, sinus infection may persist as a smoldering (persistent) secondary infection or progress to an acute suppurative process (causing purulent discharge).

Nasal congestion, caused by inflammation, edema, and transudation of fluid secondary to URI, leads to obstruction of the sinus cavities (see Fig. 22-1). This provides an excellent medium for bacterial growth. Other conditions that can block the normal flow of sinus secretions include abnormal structures of the nose, enlarged adenoids, diving and swimming, tooth infection, trauma to the nose, tumors, and the pressure of foreign objects. Some people are more prone to rhinosinusitis because exposure to environmental hazards such as paint, sawdust, and chemicals may result in chronic inflammation of the nasal passages.

Bacterial organisms account for more than 60% of the cases of acute sinusitis. Typical pathogens include *Streptococcus pneumoniae*, *Haemophilus influenzae*, and less commonly *Staphylococcus aureus* and *Moraxella catarrhalis* (Tierney, et al., 2007). Biofilms, which consist of organized, heterogenous communities of bacteria, have been found to be 10 to 1000 times more resistant to antibiotic treatment and more likely to contribute to host resistance when compared with other bacteria. They serve as bacterial reservoirs that can cause systemic illness when released into the circulation. Although antibiotics kill bacteria in the biofilm margin, cells deep in the biofilm are not affected, allowing for regrowth once antibiotic therapy has been discontinued. Pathogens in the upper respiratory tract that form biofilms include those species listed above as well as *Pseudomonas aeruginosa* (Post, Hiller, Nistico, et al., 2007).

Other organisms that are occasionally isolated include *Chlamydia pneumoniae*, *Streptococcus pyogenes*, viruses, and fungi (*Aspergillus fumigatus*). Fungal infections occur most often in immunosuppressed patients.

### Clinical Manifestations

Symptoms of ABRS include purulent nasal drainage (anterior, posterior, or both) accompanied by nasal obstruction or a combination of facial pain, pressure, or a sense of fullness (referred to collectively as facial pain–pressure–fullness), or both (Rosenfeld, et al., 2007). The facial pain–pressure–fullness may involve the anterior face or the periorbital region. The patient may also report cloudy or colored nasal discharge congestion, blockage, or stuffiness as well as a localized or diffuse headache. The occurrence of symptoms for 10 days or more days after the initial onset of upper respiratory symptoms indicates ABRS. A red streak visible in the lateral recess of the oropharynx suggests ABRS, but its presence requires further study (Thomas & Aizin, 2006).

The symptoms of AVRS are similar to those of ABRS with the exception of the duration of symptoms. Symptoms of AVRS occur for less than 10 days after the onset of upper respiratory symptoms and do not worsen (Rosenfeld, et al., 2007).

### Assessment and Diagnostic Findings

A careful history and physical examination are performed. The head and neck, particularly the nose, ears, teeth, sinuses, pharynx, and chest, are examined. There may be tenderness to palpation over the infected sinus area. The sinuses are percussed using the index finger, tapping lightly to determine whether the patient experiences pain. Although less frequently performed, transillumination of the affected area may reveal a decrease in the transmission of light with rhinosinusitis (see Chapter 21). Diagnostic imaging (x-ray, computed tomography [CT], magnetic resonance imaging (MRI)) is not recommended and generally not needed for the diagnosis of acute rhinosinusitis if the patient meets clinical diagnostic criteria (Rosenfeld, et al., 2007). When a complication or alternative diagnosis is suspected, CT scans may be indicated because these scans are sensitive to inflammatory changes and bone destruction and identify anatomical variations that can guide sinus surgery if indicated.

To confirm the diagnosis of maxillary and frontal rhinosinusitis and identify the pathogen, sinus aspirates may be obtained. Flexible endoscopic culture techniques and swabbing of the sinuses have been used for this purpose.

### Complications

If untreated, acute rhinosinusitis may lead to severe complications. Local complications include osteomyelitis and mucocele (cyst of the paranasal sinuses). Osteomyelitis requires prolonged antibiotic therapy and at times removal of necrotic bone. Intracranial complications, although rare, include cavernous sinus thrombosis, meningitis, brain abscess, ischemic brain infarction, and severe orbital cellulitis (Tierney, et al., 2007). Mucoceles may require surgical treatment to establish intranasal drainage or complete excision with ablation of the sinus cavity. Brain abscesses occur by direct spread and can be life-threatening. Frontal epidural abscesses are usually quiescent but can be detected by CT scan.

### Medical Management

Treatment of acute rhinosinusitis depends on the cause; oral therapies can include antibiotics for bacterial cases and oral corticosteroids for acute inflammation. The goals of treatment of acute rhinosinusitis are to shrink the nasal mucosa, relieve pain, and treat infection. Because of inappropriate use of antibiotics for nonbacterial illness, including viral rhinosinusitis, and the resulting resistance that has occurred, caution must be used if oral antibiotics are prescribed. Saline lavage is an alternative to oral antibiotics and has been effective in relieving symptoms, reducing inflammation,

**Table 22-2 NASAL CORTICOSTEROIDS AND COMMON SIDE EFFECTS**

| Nasal Corticosteroids | Side Effects | Contraindications (for all nasal corticosteroids) |
|---|---|---|
| Beclomethasone (Beconase) | Nasal irritation, headache, nausea, lightheadedness, epistaxis, rhinorrhea, watering eyes, sneezing, dry nose and throat | Avoid in patients with recurrent epistaxis, glaucoma, and cataracts. Patients who have been exposed to measles/varicella or who have adrenal insufficiency should avoid these medications. |
| Budesonide (Rhinocort) | Epistaxis, pharyngitis, cough, nasal irritation, bronchospasm | |
| Mometasone (Nasonex) | Headache, viral infection, pharyngitis, epistaxis, cough, dysmenorrhea, musculoskeletal pain, arthralgia | |
| Triamcinolone (Nasacort AQ) | Pharyngitis, epistaxis, cough, headache | |

clearing the passages of stagnant mucus, and reducing the likelihood of development of opportunistic infections (Sharp, Denman, Puumala, et al., 2007).

Observation without the use of antibiotics is an option for some patients with uncomplicated ABRS (mild pain, temperature of less than 38.3°C [101°F]). In this case, follow-up is essential. When ABRS is confirmed, antibiotic therapy is prescribed. Amoxicillin (Amoxil) is the antibiotic of choice. For patients who are allergic to penicillin, trimethoprim-sulfamethoxazole (Bactrim, Septra) (Rosenfeld, et al., 2007), macrolides (clarithromycin [Biaxin], azithromycin [Zithromax]), and quinolones (ciprofloxacin [Cipro], levofloxacin [Levaquin]) can be used. Other antibiotics used to treat ABRS include cephalosporins such as cephalexin (Keflex), cefuroxime (Ceftin), cefaclor (Ceclor), and cefixime (Suprax). Most patients improve spontaneously, and antibiotics should be reserved for patients with prolonged symptoms (Sharp, et al., 2007). However, deep-seated bacterial rhinosinusitis can be a serious infection that requires antibiotic treatment for 2 to 3 weeks.

Treatment of acute rhinosinusitis typically involves nasal saline lavage and decongestants (guaifenesin/pseudoephedrine [Entex PSE]). Decongestants or nasal saline sprays can increase patency of the ostiomeatal unit and improve drainage of the sinuses. Topical decongestants should not be used for longer than 3 or 4 days. Oral decongestants must be used cautiously in patients with hypertension. OTC antihistamines, such as diphenhydramine (Benadryl) and cetirizine (Zyrtec), and prescription antihistamines such as fexofenadine (Allegra) are used if an allergic component is suspected.

Intranasal corticosteroids have been shown to produce complete or marked improvement in acute symptoms of rhinosinusitis; however, they are not recommended as routine treatment (Rosenfeld, et al., 2007). Examples of intranasal corticosteroids, side effects, and precautions are presented in Table 22-2.

If the patient continues to have symptoms after 7 to 10 days, the sinuses may need to be irrigated.

## Nursing Management

### *Teaching Patients Self-Care*

Patient teaching is an important aspect of nursing care for the patient with acute rhinosinusitis. The nurse instructs the patient about symptoms of complications that require immediate follow-up. Referral to a physician is indicated if periorbital edema and severe pain on palpation occur. The nurse instructs the patient about methods to promote drainage of the sinuses, including humidification of the air in the home and use of warm compresses to relieve pressure. The patient is advised to avoid swimming, diving, and air travel during the acute infection. Patients using tobacco are instructed to immediately stop smoking or using any form of tobacco. Most patients use nasal sprays incorrectly, which can lead to several side effects that include nasal irritation, nasal burning, bad taste, and drainage in the throat or even epistaxis. Therefore, if an intranasal corticosteroid is prescribed, it is important to teach the patient the correct use of prescribed nasal sprays through demonstration, explanation, and return demonstration to evaluate the patient's understanding of the correct method of administration. The nurse also teaches the patient about the side effects of prescribed and OTC nasal sprays and about rebound congestion, medicamentosa. Once the decongestant is discontinued, the nasal passages close and congestion results. Appropriate medications to use for pain relief include acetaminophen (Tylenol) and NSAIDs such as ibuprofen (Advil), naproxen sodium (Aleve), and aspirin for adults older than 20 years of age.

The nurse tells patients with recurrent sinusitis to begin decongestants at the first sign of rhinosinusitis. This promotes drainage and decreases the risk of bacterial infection. Patients should also check with their health care provider or pharmacist before using OTC medications because many cold medications can worsen symptoms or other heath problems, specifically hypertension.

The nurse stresses the importance of following the recommended antibiotic regimen because a consistent blood level of the medication is critical to treat the infection. The nurse teaches the patient the early signs of a sinus infection and recommends preventive measures such as following healthy practices and avoiding contact with people with URIs.

The nurse explains to the patient that fever, severe headache, and **nuchal rigidity** (stiffness of the neck or inability to bend the neck) are signs of potential complications. Patients with chronic symptoms of rhinosinusitis who do not have marked improvement in 4 weeks with continuous medical treatment may be candidates for aspiration of the sinus or for sinus surgery.

**NURSING ALERT**

**Patients with nasotracheal and nasogastric tubes in place are at risk for development of sinus infections. Thus, accurate assessment of patients with these tubes is critical. Removal of the nasotracheal or nasogastric tube as soon as the patient's condition permits allows the sinuses to drain, possibly avoiding septic complications.**

## CHRONIC RHINOSINUSITIS AND RECURRENT ACUTE RHINOSINUSITIS

Chronic rhinosinusitis (CRS) affects 14% to 16% of the U.S. population. It occurs more often in women than men. CRS accounts for almost 20 million office visits annually, and people with CRS have five times more prescriptions filled than people without CRS. It is diagnosed when the patient has experienced 12 weeks or longer of two or more of the following symptoms: mucopurulent drainage, nasal obstruction, facial pain–pressure–fullness, or decreased sense of smell. In about 29% to 36% of patients, CRS is accompanied by nasal polyps. Recurrent acute rhinosinusitis is diagnosed when four or more episodes of ABRS occur per year with no signs or symptoms of rhinosinusitis between the episodes. The use of antibiotics in people with recurrent acute rhinosinusitis is even higher than in CRS. Both CRS and recurrent acute rhinosinusitis affect quality of life as well as physical and social function (Rosenfeld, et al., 2007).

### Pathophysiology

Mechanical obstruction in the ostia of the frontal, maxillary, and anterior ethmoid sinuses (known collectively as the ostiomeatal complex) is the usual cause of CRS and recurrent acute rhinosinusitis. Obstruction prevents adequate drainage of the nasal passages, resulting in accumulation of secretions and an ideal medium for bacterial growth. Persistent blockage in an adult may occur because of infection, allergy, or structural abnormalities. Other associated conditions and factors may include cystic fibrosis, ciliary dyskinesia, neoplastic disorders, gastroesophageal reflux disease, tobacco use, and environmental pollution (Rosenfeld, et al., 2007).

Both aerobic and anaerobic bacteria have been implicated in chronic rhinosinusitis and recurrent rhinosinusitis. Common aerobic bacteria include alpha-hemolytic streptococci, microaerophilic streptococci, and *S. aureus*. Common anaerobic bacteria include gram-negative bacilli, *Peptostreptococcus*, and *Fusobacterium*.

In addition, immunodeficiency should be considered in patients with CRS or acute recurrent rhinosinusitis. Acute fulminant/invasive sinusitis is a life-threatening illness and is commonly attributed to *Aspergillus* in immunocompromised patients. Chronic fungal sinusitis also poses a risk. Chronic invasive fungal sinusitis occurs in immunocompromised patients along with fungus ball/mycetoma and allergic fungal sinusitis, the more common forms of chronic fungal sinusitis, which are considered noninvasive conditions in immunocompromised patients. The fungus ball is usually a brown or greenish-black material with the consistency of peanut butter or cottage cheese. Symptoms include nasal stuffiness, nasal discharge, and facial pain (Taxy, 2006).

### Clinical Manifestations

Clinical manifestations of CRS include impaired mucociliary clearance and ventilation, cough (because the thick discharge constantly drips backward into the nasopharynx), chronic hoarseness, chronic headaches in the periorbital area, and facial pain. As a result of chronic nasal congestion, the patient is usually required to breathe through the mouth. Snoring, sore throat, and, in some situations, adenoidal hypertrophy may also occur. Periorbital edema and facial pain are common. These symptoms are generally most pronounced on awakening in the morning. Fatigue and nasal congestion are also common. Many patients experience a decrease in smell and taste and a sense of fullness in the ears.

### Assessment and Diagnostic Findings

The health assessment focuses on onset and duration of symptoms. It addresses the quantity and quality of nasal discharge and cough, the presence of pain, factors that relieve or aggravate the pain, and allergies. It is essential to obtain any history of comorbid conditions, including asthma, and history of tobacco use. A history of fever, fatigue, previous episodes and treatments, and previous response to therapies is also obtained.

In the physical assessment, the external nose is evaluated for any evidence of anatomical abnormality. A crooked-appearing external nose may imply septal deviation internally. The nasal mucous membranes are assessed for erythema, pallor, atrophy, edema, crusting, discharge, polyps, erosions, and septal perforations or deviations. Appropriate lighting improves visualization of the nasal cavity and should be used in every examination. Pain on examination of the teeth and with tapping with a tongue blade suggests tooth infection.

Assessment of the posterior oropharynx may reveal purulent or mucoid discharge, which is indicative of an infection caused by CRS. The patients' eyes are examined for conjunctival erythema, tearing, photophobia, and edema of the lids. Additional assessment techniques include transillumination of the sinuses and palpation of the sinuses. The frontal and maxillary sinuses are palpated, and the patient is asked whether this produces tenderness. The pharynx is inspected for erythema and discharge and palpated for cervical node adenopathy (Rosenfeld, et al., 2007).

Imaging studies such as x-ray, sinoscopy, ultrasound, CT, and MRI may be used in the diagnosis of chronic rhinosinusitis. X-ray is an inexpensive and readily available tool to assess disorders of the paranasal sinuses. CT of the paranasal sinuses can identify mucosal abnormalities, sinus ostial obstruction, anatomical variants, sinonasal polyposis, and neoplastic disease. In addition, nasal endoscopy allows for visualization of the posterior nasal cavity, nasopharynx, and sinus drainage pathways and can identify posterior septal deviation and polyps. Osseous destruction, extrasinus extension of the disease process, and local invasion suggest malignancy (Rosenfeld, et al., 2007).

### Complications

Complications of chronic rhinosinusitis, although uncommon, include severe orbital cellulitis, subperiosteal abscess, cavernous sinus thrombosis, meningitis, encephalitis, and ischemic infarction. Chronic rhinosinusitis can lead to

intracranial infection either by direct spread through bone or via venous channels, resulting in epidural abscess, subdural empyema, meningitis, and brain abscess. Clinical sequelae can include personality changes with frontal lobe abscesses, headache, symptoms of elevated intracranial pressure to include alterations of consciousness, visual changes, focal neurologic deficits, seizures, and, ultimately, coma and death.

Frontal rhinosinusitis can lead to osteomyelitis of the frontal bones. Patients typically present with headache, fever, and a characteristic doughy edema over the involved bone. Ethmoid rhinosinusitis may result in orbital cellulitis, which usually begins with edema of the eyelids and rapidly progresses to ptosis (droopy eyelid), proptosis (bulging eye), chemosis (edema of the bulbar conjunctiva), and diminished extraocular movements. Patients are usually febrile and acutely ill and require immediate attention because pressure on the optic nerve can lead to loss of vision and spread of infection can lead to intracranial infection. Cavernous sinus thrombophlebitis can be a result of extension of infection along venous channels from the orbit, ethmoid, frontal sinuses, or nose. Symptoms may include altered consciousness, lid edema, and proptosis, as well as third, fourth, and sixth cranial nerve palsies.

## Medical Management

Medical management of chronic rhinosinusitis and recurrent acute rhinosinusitis is similar to that of acute rhinosinusitis. Early identification of risk factors guides the selection of treatment and leads to early intervention and ultimately better patient outcomes. General measures include adequate hydration, steam inhalation 20 to 30 minutes three times per day whenever possible, saline irrigation (Harvey, Hannan, Badia, et al., 2007), and saline nose drops. Patients are instructed to sleep with the head of the bed elevated and to avoid exposure to cigarette smoke and fumes. Patients are cautioned to avoid caffeine and alcohol, which can cause dehydration.

Prescribed medications may be necessary. Antibiotics include amoxicillin, trimethoprim-sulfamethoxazole, doxycycline (Vibramycin), amoxicillin–clavulanic acid (Augmentin), cefpodoxime (Vantin), cefuroxime axetil, telithromycin (Ketek), azithromycin, clarithromycin, and levofloxacin. The course of antibiotic treatment for chronic rhinosinusitis and recurrent acute bacterial rhinosinusitis may be as long as 3 to 4 weeks to effectively eradicate the offending organism. Medications commonly used for relief of symptoms include loratadine (Claritin), fexofenadine, cetirizine, chlorpheniramine (Chlor-Trimeton), and diphenhydramine. For patients with concomitant asthma, leukotriene inhibitors such as montelukast, and zafirlukast may be used. Commonly used nasal steroids include mometasone furoate (Nasonex) and fluticasone propionate (Flonase). If allergies are a possible cause of chronic rhinosinusitis, oral antihistamines or nasal corticosteroids may also be prescribed. The use of intranasal inhalations has been associated with a significant improvement of symptoms of chronic rhinosinusitis and a reduction in nasal bacteria (Harvey, et al., 2007).

### Surgical Management

If standard medical therapy fails and symptoms persist, surgery, usually endoscopic, may be indicated to correct structural deformities that obstruct the ostia (openings) of the sinuses. Minimally invasive surgical procedures are used, reducing postoperative discomfort and producing significant improvement in the patient's quality of life. Some of the specific procedures performed include excising and cauterizing nasal polyps, correcting a deviated septum, incising and draining the sinuses, aerating the sinuses, and removing tumors. Antimicrobial agents are administered before and after surgery. Computer-assisted or computer-guided surgery is used to increase the precision of the surgical procedure and to minimize complications (Stelter, Andratschke, Leunig, et al., 2006). Some patients with severe chronic rhinosinusitis obtain relief only by moving to a dry climate.

If rhinosinusitis is caused by a fungal infection, surgery is required to excise the fungus ball and necrotic tissue and drain the sinuses. Patients require aggressive surgical débridement and drainage as well as systemic antifungal medications. Although chronic invasive fungal rhinosinusitis tends to respond well to conservative medical management, surgical intervention may be required in acute invasive fungal rhinosinusitis.

## Nursing Management

Because the patient usually performs care measures for sinusitis at home, nursing management consists mainly of patient teaching.

### Teaching Patients Self-Care

Many people with sinus infections tend to blow their nose frequently and with force to clear their nasal passages. However, doing so often increases the symptoms. Therefore, the patient is instructed to blow the nose gently and to use tissue to remove the nasal drainage. Increasing fluid intake, applying local heat (hot wet packs), and elevating the head of the bed promote drainage of the sinuses. The nurse also instructs the patient about the importance of following the prescribed medication regimen. Instructions on the early signs of a sinus infection are provided, and preventive measures are reviewed. The nurse instructs the patient about signs and symptoms that require follow-up and provides these instructions verbally and in writing. Instructions in alternate formats (eg, large font, patient's language) may be needed to increase the patient's understanding and adherence to the treatment plan. The nurse encourages the patient to follow-up with his or her primary health care provider if symptoms persist.

*NURSING ALERT*

**URIs, specifically chronic rhinosinusitis and recurrent acute rhinosinusitis, may be linked to primary or secondary immune deficiency or treatment with immunosuppressive therapy (ie, for cancer or organ transplantation). Typical symptoms may be blunted or absent due to immunosuppression. Immunocompromised patients are at increased risk for acute or chronic fungal infections; these infections can progress rapidly and become life-threatening. Thus, assessment, early reporting of symptoms to the physician, and immediate initiation of treatment are essential.**

# Pharyngitis

## ACUTE PHARYNGITIS

Acute **pharyngitis** is a sudden painful inflammation of the pharynx, the back portion of the throat that includes the posterior third of the tongue, soft palate, and tonsils. It is commonly referred to as a sore throat. In the United States, it is estimated that approximately 11 million people experience pharyngitis each year. Because of environmental exposure to viral agents and poorly ventilated rooms, the incidence of viral pharyngitis peaks during winter and early spring in regions that have warm summers and cold winters. Viral pharyngitis spreads easily in the droplets of coughs and sneezes and unclean hands that have been exposed to the contaminated fluids.

### Pathophysiology

Viral infection causes most cases of acute pharyngitis. Responsible viruses include the adenovirus, influenza virus, Epstein-Barr virus, and herpes simplex virus. Bacterial infection accounts for the remainder of cases. Ten percent of adults with pharyngitis have group A beta-hemolytic streptococcus (GABHS), which is commonly referred to as group A streptococcus (GAS) or streptococcal pharyngitis. Streptococcal pharyngitis warrants use of antibiotic treatment. When GAS causes acute pharyngitis, the condition is known as strep throat. The body responds by triggering an inflammatory response in the pharynx. This results in pain, fever, vasodilation, edema, and tissue damage, manifested by redness and swelling in the tonsillar pillars, uvula, and soft palate. A creamy exudate may be present in the tonsillar pillars (Fig. 22-2). Other bacterial organisms implicated in acute pharyngitis include *Mycoplasma pneumoniae*, *Neisseria gonorrhoeae*, and *H. influenzae* type B (Braun, Wagner, Huttner, et al., 2006). *M. pneumoniae* is one of the most common known bacterial pathogens of the respiratory tract and is encountered frequently in people with upper respiratory symptoms.

Uncomplicated viral infections usually subside promptly, within 3 to 10 days after the onset. However, pharyngitis caused by more virulent bacteria, such as GAS, is a more severe illness. If left untreated, the complications can be severe and life-threatening. Complications include sinusitis, otitis media, peritonsillar abscess, mastoiditis, and cervical adenitis. In rare cases, the infection may lead to bacteremia, pneumonia, meningitis, rheumatic fever, and nephritis.

### Clinical Manifestations

The signs and symptoms of acute pharyngitis include a fiery-red pharyngeal membrane and tonsils, lymphoid follicles that are swollen and flecked with white-purple exudate, enlarged and tender cervical lymph nodes, and no cough. Fever (higher than 38.3°C [101°F]), malaise, and sore throat also may be present. Occasionally, patients with GAS pharyngitis exhibit vomiting, anorexia, and a scarlatina-form rash with urticaria known as scarlet fever.

People who have streptococcal pharyngitis suddenly develop a painful sore throat 1 to 5 days after being exposed to the streptococcus bacteria. They usually report malaise, fever (with or without chills), headache, myalgia, painful cervical adenopathy, and nausea. The tonsils appear swollen and erythematous, and they may or may not have an exudate. The roof of the mouth is often erythematous and may demonstrate petechiae. Bad breath is common.

### Assessment and Diagnostic Findings

Accurate diagnosis of pharyngitis is essential to determine the cause (viral or bacterial) and to initiate treatment early. Once a definitive diagnosis of GAS is made, administration of appropriate antibiotics hastens symptom resolution and reduces the transmission of the illness. The most dependable method of testing relies on swab specimens obtained from posterior pharynx and tonsils as recommended by the Infectious Diseases Society of America (Fox, Marcon & Bonsu, 2006). Both the tonsillar pillars and the posterior pharyngeal wall should be touched by the swabs; the tongue should not be included. In most communities, preliminary culture reports are available in 24 hours.

Newer and more rapid diagnostic tests (eg, the rapid streptococcal antigen test [RSAT] are available. However, the accuracy of rapid antigen tests for detecting GAS in throat specimens varies widely, depending on the person performing the test. When RSAT is performed correctly and used together with professional clinical evaluation, it is considered a valid test for the diagnosis of GAS (Humair, Revaz, Bovier, et al., 2006).

RSAT is also available for self-testing; however, back-up culture of negative rapid antigen tests should be performed in all settings to reliably diagnose GAS pharyngitis. Therefore, self-testing is not recommended (Fox, Cohen, Marcon, et al., 2006).

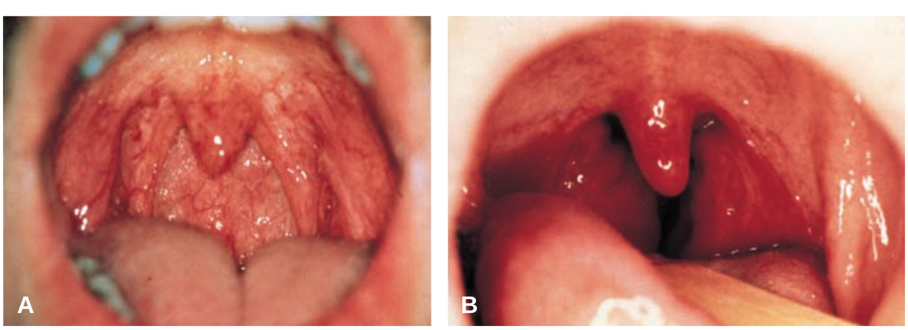



**Figure 22-2** Pharyngitis—inflammation without exudate. **A,** Redness and vascularity of the pillars and uvula are mild to moderate. **B,** Redness is diffuse and intense. Each patient would probably complain of a sore throat. From Bickley, L. S. (2007). *Bates' guide to physical examination and history taking* (9th ed.). Philadelphia: Lippincott Williams & Wilkins.

## Medical Management

Viral pharyngitis is treated with supportive measures because antibiotics have no effect on the causal organism. Bacterial pharyngitis is treated with a variety of antimicrobial agents.

### Pharmacologic Therapy

If the cause of pharyngitis is bacterial, penicillin is usually the treatment of choice. Penicillin V potassium given for 5 days is the regimen of choice. Traditionally, penicillin was administered as a single injection; however, oral forms are used more often and are as effective and less painful than injections. Penicillin injections are recommended only if there is a concern that the patient will not comply with therapy (Tierney, et al., 2007).

For patients who are allergic to penicillin or have organisms that are resistant to erythromycin (one fifth of GAS and most *S. aureus* organisms are resistant to penicillin and erythromycin), cephalosporins, and macrolides (clarithromycin and azithromycin) may be used. Once-daily azithromycin may be given for only 3 days due to its long half-life (Tierney, et al., 2007). A 5- or 10-day course of cephalosporin may be prescribed. Five-day administration of cefpodoxime and cefuroxime has also been successful in producing bacteriologic cures.

Severe sore throats can also be relieved by analgesic medications, as prescribed. For example, aspirin or acetaminophen can be taken at 4- to 6-hour intervals; if required, acetaminophen with codeine can be taken three or four times daily. Some patients find salt-water gargling to be soothing. In severe cases, gargles with benzocaine may relieve symptoms.

### Nutritional Therapy

A liquid or soft diet is provided during the acute stage of the disease, depending on the patient's appetite and the degree of discomfort that occurs with swallowing. Cool beverages, warm liquids, and flavored frozen desserts such as Popsicles are often soothing. Occasionally, the throat is so sore that liquids cannot be taken in adequate amounts by mouth. In severe situations, intravenous (IV) fluids may be needed. Otherwise, the patient is encouraged to drink as much fluid as possible (at least 2 to 3 L per day).

## Nursing Management

Nursing care for patients with viral pharyngitis focuses on symptomatic management. For patients who demonstrate signs of strep throat and have a history of rheumatic fever, who appear toxic, who have clinical scarlet fever, or who have symptoms suggesting peritonsillar abscess, nursing care focuses on prompt initiation and correct administration of prescribed antibiotic therapy. The nurse instructs the patient about signs and symptoms that warrant prompt contact with the physician. These include dyspnea, drooling, inability to swallow, and inability to fully open the mouth.

The nurse instructs the patient to stay in bed during the febrile stage of illness and to rest frequently once up and about. Used tissues should be disposed of properly to prevent the spread of infection. The nurse (or the patient or family member, if the patient is not hospitalized) should examine the skin once or twice daily for possible rash, because acute pharyngitis may precede some other communicable diseases (eg, rubella).

Depending on the severity of the pharyngitis and the degree of pain, warm saline gargles or throat irrigations are used. The benefits of this treatment depend on the degree of heat that is applied. The nurse teaches the patient about these procedures and about the recommended temperature of the solution: high enough to be effective and as warm as the patient can tolerate, usually 40.6°C to 43.3°C (105°F to 110°F). Irrigating the throat may reduce spasm in the pharyngeal muscles and relieve soreness of the throat.

An ice collar also can relieve severe sore throats. Mouth care may promote the patient's comfort and prevent the development of fissures (cracking) of the lips and oral inflammation when bacterial infection is present. The nurse instructs the patient to resume activity gradually and to delay returning to work or school until after 24 hours of antibiotic therapy. A full course of antibiotic therapy is indicated in patients with strep infection because of the potential complications such as nephritis and rheumatic fever, which may have their onset 2 or 3 weeks after the pharyngitis has subsided. The nurse instructs the patient and family about the importance of taking the full course of therapy and informs them about the symptoms to watch for that may indicate complications.

In addition, the nurse instructs the patient about preventive measures that include not sharing eating utensils, glasses, napkins, food, or towels; cleaning telephones after use; using a tissue to cough or sneeze; disposing of used tissues appropriately; and avoiding exposure to tobacco and secondhand smoke. The nurse also teaches the patient with pharyngitis, especially streptococcal pharyngitis, to replace his or her toothbrush with a new one.

# CHRONIC PHARYNGITIS

Chronic pharyngitis is a persistent inflammation of the pharynx. It is common in adults who work in dusty surroundings, use their voice to excess, suffer from chronic cough, or habitually use alcohol and tobacco.

There are three types of chronic pharyngitis:

- Hypertrophic: characterized by general thickening and congestion of the pharyngeal mucous membrane
- Atrophic: probably a late stage of the first type (the membrane is thin, whitish, glistening, and at times wrinkled)
- Chronic granular ("clergyman's sore throat"), characterized by numerous swollen lymph follicles on the pharyngeal wall

## Clinical Manifestations

Patients with chronic pharyngitis complain of a constant sense of irritation or fullness in the throat, mucus that collects in the throat and can be expelled by coughing, and difficulty swallowing. This is often associated with intermittent postnasal drip that causes minor irritation and inflammation of the pharynx. A sore throat that is worse with swallowing in the absence of pharyngitis suggests the possibility of thyroiditis, and patients with this symptom are referred for evaluation for possible thyroiditis.

## Medical Management

Treatment of chronic pharyngitis is based on relieving symptoms, avoiding exposure to irritants, and correcting any upper respiratory, pulmonary, gastrointestinal, or cardiac condition that might be responsible for a chronic cough.

Nasal congestion may be relieved by short-term use of nasal sprays or medications containing ephedrine sulfate (Kondon's Nasal) or phenylephrine hydrochloride (Neo-Synephrine). For a patient with a history of allergy, one of the antihistamine decongestant medications, such as Pseudoephedrine (Sudafed) or brompheniramine/pseudoephedrine, is prescribed orally every 4 to 6 hours. Aspirin (for patients older than 20 years of age) or acetaminophen is recommended for its anti-inflammatory and analgesic properties.

For adults with chronic pharyngitis, tonsillectomy is an effective option, if consideration is given to morbidity and complications relating to the surgery. For further information, see the section Tonsillitis and Adenoiditis, below.

## Nursing Management

### *Teaching Patients Self-Care*

To prevent the infection from spreading, the nurse instructs the patient to avoid contact with others until the fever subsides. The nurse recommends avoidance of alcohol, tobacco, secondhand smoke, and exposure to cold or to environmental or occupational pollutants. The patient may minimize exposure to pollutants by wearing a disposable facemask. The nurse encourages the patient to drink plenty of fluids. Gargling with warm saline solution may relieve throat discomfort. Lozenges keep the throat moistened.

# *Tonsillitis and Adenoiditis*

The tonsils are composed of lymphatic tissue and are situated on each side of the oropharynx. The faucial or palatine tonsils and lingual tonsils are located behind the pillars of fauces and tongue, respectively. They frequently serve as the site of acute infection (**tonsillitis**). Acute tonsillitis can be confused with pharyngitis. Chronic tonsillitis is less common and may be mistaken for other disorders such as allergy, asthma, and sinusitis.

The adenoids or pharyngeal tonsils consist of lymphatic tissue near the center of the posterior wall of the nasopharynx. Infection of the adenoids frequently accompanies acute tonsillitis. Frequently occurring bacterial pathogens include GABHS, the most common organism. The most common viral pathogen is Epstein-Barr virus, present in 90% of affected adults. Cytomegalovirus may also cause tonsillitis and adenoiditis. Often thought of as a childhood disorder, tonsillitis can occur in adults.

## Clinical Manifestations

The symptoms of tonsillitis include sore throat, fever, snoring, and difficulty swallowing. Enlarged adenoids may cause mouth-breathing, earache, draining ears, frequent head colds, bronchitis, foul-smelling breath, voice impairment, and noisy respiration. Unusually enlarged adenoids fill the space behind the posterior nares, making it difficult for the air to travel from the nose to the throat and resulting in nasal obstruction. Infection can extend to the middle ears by way of the auditory (eustachian) tubes and may result in acute otitis media, which can lead to spontaneous rupture of the tympanic membranes (eardrums) and further extension of the infection into the mastoid cells, causing acute mastoiditis. The infection also may reside in the middle ear as a chronic, low-grade, smoldering process that eventually may cause permanent deafness.

## Assessment and Diagnostic Findings

The diagnosis of acute tonsillitis is primarily clinical, with attention given to whether the illness is viral or bacterial in nature. As in acute pharyngitis, RSAT is quick and convenient; however, it is less sensitive than the throat swab culture.

A thorough physical examination is performed, and a careful history is obtained to rule out related or systemic conditions. The tonsillar site is cultured to determine the presence of bacterial infection. When cytomegalovirus infection is present, the differential diagnosis should include HIV, hepatitis A, and rubella (McKerrow, 2007). In adenoiditis, if recurrent episodes of suppurative otitis media result in hearing loss, comprehensive audiometric assessment is warranted (see Chapter 59).

## Medical Management

Tonsillitis is treated through the use of supportive measures that include increased fluid intake, analgesics, salt-water gargles, and rest. Bacterial infections are treated with penicillin (first-line therapy) or cephalosporins. Viral tonsillitis is not effectively treated with antibiotic therapy.

Tonsillectomy and adenoidectomy continue to be commonly performed surgical procedures, with evolving surgical techniques aimed at reducing complications and improving postoperative recovery. Patients who experience no adverse events for 6 hours have a low overall risk of later bleeding and other complications (Tierney, et al., 2007). Adults who have undergone a tonsillectomy to treat recurrent streptococcal infections experience a decease in the number of episodes of streptococcal or other throat infections or days with throat pain (Alho, Koivunen, Penna, et al., 2007).

Tonsillectomy or adenoidectomy is indicated if the patient has had repeated episodes of tonsillitis despite antibiotic therapy; hypertrophy of the tonsils and adenoids that could cause obstruction and obstructive sleep apnea; repeated attacks of purulent otitis media; suspected hearing loss due to serous otitis media that has occurred in association with enlarged tonsils and adenoids; and in some other conditions, such as an exacerbation of asthma or rheumatic fever. Indications for adenoidectomy include chronic nasal airway obstruction, chronic rhinorrhea, obstruction of the eustachian tube with related ear infections, and abnormal speech. Surgery is also indicated if the patient has developed a peritonsillar abscess that occludes the pharynx, making swallowing difficult and endangering the patency of the airway (particularly during sleep). The presence of persistent tonsillar asymmetry should prompt an excisional biopsy to rule out lymphoma (Tierney, et al., 2007). Antibiotic therapy may be initiated for patients undergoing tonsillectomy or adenoidectomy. Therapy may include oral penicillin, and

cephalosporin (eg, cefdinir [Omnicef]), or moxifloxacin (Avelox).

## Nursing Management

### Providing Postoperative Care

Continuous nursing observation is required in the immediate postoperative and recovery periods because of the significant risk of hemorrhage. In the immediate postoperative period, the most comfortable position is prone, with the patient's head turned to the side to allow drainage from the mouth and pharynx. The nurse must not remove the oral airway until the patient's gag and swallowing reflexes have returned. The nurse applies an ice collar to the neck, and a basin and tissues are provided for the expectoration of blood and mucus.

Symptoms of postoperative complications include fever, throat pain, ear pain, and bleeding. Pain can be effectively controlled with analgesic medications. Postoperative bleeding, which occurs in only 2% to 4% of tonsillectomy cases, may be classified as primary (occurring within the first 24 hours), or secondary (occurring between 24 hours and 8 days). The blood may be bright red if the patient expectorates it before swallowing it. If the patient swallows the blood, it becomes brown because of the action of the acidic gastric juice. If the patient vomits large amounts of dark blood or bright-red blood at frequent intervals, or if the pulse rate and temperature rise and the patient is restless, the nurse notifies the surgeon immediately. The nurse should have the following items ready for examination of the surgical site for bleeding: a light, a mirror, gauze, curved hemostats, and a waste basin.

Occasionally, suture or ligation of a bleeding vessel is required. In such cases, the patient is taken to the operating room and given general anesthesia. After ligation, continuous nursing observation and postoperative care are required, as in the initial postoperative period. If there is no bleeding, water and ice chips may be given to the patient as soon as desired. The patient is instructed to refrain from too much talking and coughing because these activities can produce throat pain.

Postoperative antibiotics are often prescribed to prevent complications. The possible benefits of antibiotic use should be weighed against the risks.

### Teaching Patients Self-Care

Tonsillectomy and adenoidectomy are usually performed as outpatient surgery and the patient is sent home from the recovery room once awake, oriented, and able to drink liquids and void. The patient and family must understand the signs and symptoms of hemorrhage. As previously stated, bleeding may occur up to 8 days after surgery. The nurse instructs the patient about use of liquid acetaminophen with or without codeine for pain control and explains that the pain will subside during the first 3 to 5 days. The nurse informs the patient about the need to take the full course of any prescribed antibiotic.

Alkaline mouthwashes and warm saline solutions are useful in coping with the thick mucus and halitosis that may be present after surgery. The nurse should explain to the patient that a sore throat, stiff neck, minor ear pain, and vomiting may occur in the first 24 hours. The patient should eat an adequate diet with soft foods, which are more easily swallowed than hard foods. The patient should avoid spicy, hot, acidic, or rough foods. Milk and milk products (ice cream and yogurt) may be restricted because they make removal of mucus more difficult for some patients. The nurse instructs the patient about the need to maintain good hydration. It is important to tell the patient to avoid vigorous tooth brushing or gargling because these activities can cause bleeding. The nurse encourages the use of a cool-mist vaporizer or humidifier in the home postoperatively. The patient should avoid smoking and heavy lifting or exertion for 10 days.

# Peritonsillar Abscess

Peritonsillar abscess (also called quinsy) is the most common major suppurative complication of sore throat. This collection of purulent exudate between the tonsillar capsule and the surrounding tissues, including the soft palate, may develop after an acute tonsillar infection that progresses to a local cellulitis and abscess. However, many patients do not experience symptoms or report a respiratory tract infection prior to diagnosis (Dunn, Lane, Everitt, et al., 2007). The most common causative organism is GABHS (Kaminski, 2007). In more severe cases, the infection can spread over the palate and to the neck and chest. Edema can cause airway obstruction, which can be life-threatening and is a medical emergency. Peritonsillar abscess can be life-threatening with mediastinitis, intracranial abscess, and empyemas resulting from spread of infection. Early detection and aggressive management are essential (Collin & Beasley, 2006). Although peritonsillar abscess is most common between 20 and 40 years, it can occur at any age. In older adults, it can progress to mediastinitis (Kinzer, Maier & Ridder, 2007).

## Clinical Manifestations

The person with a peritonsillar abscess appears acutely ill. The patient often has a severe sore throat, fever, trismus (inability to open the mouth), and drooling. Inflammation of the medial pterygoid muscle that lies lateral to the tonsil results in spasm, severe pain, and difficulty in opening the mouth fully. The pain may be so intense that the patient has difficulty swallowing saliva. The patient's breath often smells rancid. Other symptoms include a raspy voice, odynophagia (a severe sensation of burning, squeezing pain while swallowing), **dysphagia** (difficulty swallowing), and otalgia (pain in the ear). Odynophagia is caused by the inflammation of the superior constrictor muscle of the pharynx that forms the lateral wall of the tonsil. This causes pain on lateral movement of the head. The patient may also have tender and enlarged cervical lymph nodes. Examination of the oropharynx reveals erythema of the anterior pillar and soft palate as well as a purulent tonsil on the side of the peritonsillar abscess. The tonsil is pushed inferomedially and the uvula is shifted contralaterally. The patient may also have erythema of the skin of the chest.

If the clinical presentation reveals bilateral swollen tonsils with a midline uvula, bilateral peritonsillar abscess should be a consideration.

## Assessment and Diagnostic Findings

Emergency department physicians are often required to make the diagnosis of peritonsillar abscess and to decide whether aspiration, an invasive procedure, should be carried out based on the patient's clinical picture. Intraoral ultrasound and transcutaneous cervical ultrasound are used in the diagnosis of peritonsillar cellulitis and abscesses.

## Medical Management

Antimicrobial agents and corticosteroid therapy are used for treatment of peritonsillar abscess. Antibiotics (usually penicillin) are extremely effective in controlling the infection and, if they are prescribed early in the course of the disease, the abscess may resolve without needing to be incised. However, if the abscess does not resolve, treatment choices include needle aspiration, incision and drainage under local or general anesthesia, and drainage of the abscess with simultaneous tonsillectomy. Following needle aspiration (discussed below) intramuscular administration of clindamycin (Cleocin) can be used in the outpatient setting, thus reducing both antibiotic and hospital costs. Use of topical anesthetic agents and throat irrigations may be prescribed to promote comfort along with administration of prescribed analgesic agents.

Patients with signs of toxicity or complications require hospitalization for IV antibiotics, imaging studies, observation, and proper airway management. Rarely, the patient with a peritonsillar abscess presents with acute airway obstruction and requires immediate airway management. Procedures may include intubation, cricothyroidotomy, or tracheotomy.

### Surgical Management

Needle aspiration may be preferred over a more extensive procedure due to its high efficacy, low cost, and patient tolerance. The mucous membrane over the swelling is first sprayed with a topical anesthetic and then injected with a local anesthetic. Single or repeated needle aspirations are performed to decompress the abscess. Alternatively, the abscess may be incised and drained. These procedures are performed best with the patient in the sitting position to make it easier to expectorate the pus and blood that accumulate in the pharynx. The patient experiences almost immediate relief. Incision and drainage is also an effective option but is more painful than needle aspiration. On occasion, patients may require a second aspiration for successful treatment of peritonsillar abscess. If 3 mL or more of purulent material is aspirated, the patient will likely need to be seen the next day for further aspiration (Viljoen & Loock, 2007).

Tonsillectomy is considered for patients who are poor candidates for needle aspiration or incision and drainage. The risk of hemorrhage following tonsillectomy to treat peritonsillar abscess is higher than that of elective tonsillectomy and may be due to the patient's previous use of aspirin for pain relief.

## Nursing Management

If the patient requires intubation, cricothyroidotomy, or tracheotomy to treat airway obstruction, the nurse assists with the procedure and provides support to the patient before, during, and after the procedure. The nurse also assists with the needle aspiration when indicated.

The nurse encourages the patient to use prescribed topical anesthetic agents and assists with throat irrigations or the frequent use of mouthwashes or gargles, using saline or alkaline solutions at a temperature of 40.6°C to 43.3°C (105°F to 110°F). Gentle gargling after the procedure with a cool normal saline gargle may relieve discomfort. The patient must be upright and clearly expectorate forward. The nurse instructs the patient to gargle *gently* at intervals of 1 or 2 hours for 24 to 36 hours. Liquids that are cool or at room temperature are usually well tolerated. Adequate fluids must be provided to treat dehydration and prevent its recurrence.

The nurse also observes the patient for complications and instructs the patient about signs and symptoms of complications that require prompt attention by the physician. At discharge, the nurse provides verbal and written instructions regarding foods to avoid, when to return to work, and the need to refrain from or cease smoking; it is also important to reinforce the need for continuation of good oral hygiene.

# Laryngitis

**Laryngitis,** an inflammation of the larynx, often occurs as a result of voice abuse or exposure to dust, chemicals, smoke, and other pollutants or as part of a URI. It also may be caused by isolated infection involving only the vocal cords. Laryngitis is also associated with gastroesophageal reflux (referred to as reflux laryngitis).

Laryngitis is very often caused by the pathogens that cause the common cold and pharyngitis; the most common cause is a virus, and laryngitis is often associated with allergic rhinitis or pharyngitis. Bacterial invasion may be secondary. The onset of infection may be associated with exposure to sudden temperature changes, dietary deficiencies, malnutrition, or an immunosuppressed state. Viral laryngitis is common in the winter and is easily transmitted to others.

## Clinical Manifestations

Signs of acute laryngitis include hoarseness or **aphonia** (complete loss of voice) and severe cough. Chronic laryngitis is marked by persistent hoarseness. Other signs of acute laryngitis include sudden onset made worse by cold dry wind. The throat feels worse in the morning and improves when the patient is indoors in a warmer climate. At times, the patient presents with a dry cough and a dry, sore throat that worsens in the evening hours. If allergies are present, the uvula will be visibly edematous. Many patients also complain of a "tickle" in the throat that is made worse by cold air or cold liquids.

## Medical Management

Management of acute laryngitis includes resting the voice, avoiding irritants (including smoking), resting, and inhaling cool steam or an aerosol. If the laryngitis is part of a more extensive respiratory infection caused by a bacterial organism or if it is severe, appropriate antibacterial therapy is instituted. The majority of patients recover with conservative treatment; however, laryngitis tends to be more severe in elderly patients and may be complicated by pneumonia.

For chronic laryngitis, the treatment includes resting the voice, eliminating any primary respiratory tract infection, eliminating smoking, and avoiding secondhand smoke. Topical corticosteroids, such as beclomethasone dipropionate (Vanceril), may be given by inhalation. These preparations have few systemic or long-lasting effects and may reduce local inflammatory reactions. Treatment for reflux laryngitis typically involves use of proton pump inhibitors such as omeprazole (Prilosec OTC) given once daily.

## Nursing Management

The nurse instructs the patient to rest the voice and to maintain a well-humidified environment. If laryngeal secretions are present during acute episodes, expectorant agents are suggested, along with a daily fluid intake of 2 to 3 L to thin secretions. The nurse instructs the patient about the importance of taking prescribed medications, including proton pump inhibitors, and using continuous positive airway therapy at bedtime, if prescribed for obstructive sleep apnea. In cases involving infection, the nurse informs the patient that the symptoms of laryngitis often extend a week to 10 days after completion of antibiotic therapy. The nurse instructs the patient about signs and symptoms that require contacting the health care provider. These signs and symptoms include loss of voice with sore throat that makes swallowing saliva difficult, hemoptysis, and noisy respirations. It is important to report continued hoarseness after voice rest or laryngitis that persists for longer than 5 days because of the possibility of malignancy.

## NURSING PROCESS

### The Patient With Upper Airway Infection

#### Assessment

A health history may reveal signs and symptoms of headache, sore throat, pain around the eyes and on either side of the nose, difficulty in swallowing, cough, hoarseness, fever, stuffiness, and generalized discomfort and fatigue. Determining when the symptoms began, what precipitated them, what if anything relieves them, and what aggravates them is part of the assessment. The nurse should also determine any history of allergy or the existence of a concomitant illness. Inspection may reveal swelling, lesions, or asymmetry of the nose as well as bleeding or discharge. The nurse inspects the nasal mucosa for abnormal findings such as increased redness, swelling, exudate, and nasal polyps, which may develop in chronic rhinitis. The mucosa of the nasal turbinates may also be swollen (boggy) and pale, bluish-gray. The nurse palpates the frontal and maxillary sinuses for tenderness, which suggests inflammation, and then inspects the throat by having the patient open the mouth wide and take a deep breath. Redness, asymmetry, or evidence of drainage, ulceration, or enlargement of the tonsils and pharynx are abnormal. Palpation of the neck lymph nodes for enlargement and tenderness is necessary.

#### Diagnosis

***Nursing Diagnoses***

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective airway clearance related to excessive mucus production secondary to retained secretions and inflammation
- Acute pain related to upper airway irritation secondary to an infection
- Impaired verbal communication related to physiologic changes and upper airway irritation secondary to infection or swelling
- Deficient fluid volume related to decreased fluid intake and increased fluid loss secondary to diaphoresis associated with a fever
- Deficient knowledge regarding prevention of URIs, treatment regimen, surgical procedure, or postoperative care

***Collaborative Problems/Potential Complications***

Based on assessment data, potential complications include:

- Sepsis
- Meningitis or brain abscess
- Peritonsillar abscess, otitis media, or sinusitis

#### Planning and Goals

The major goals for the patient may include maintenance of a patent airway, relief of pain, maintenance of effective means of communication, normal hydration, knowledge of how to prevent upper airway infections, and absence of complications.

#### Nursing Interventions

***Maintaining a Patent Airway***

An accumulation of secretions can block the airway in patients with an upper airway infection. As a result, changes in the respiratory pattern occur, and the work of breathing increases to compensate for the blockage. The nurse can implement several measures to loosen thick secretions or to keep the secretions moist so that they can be easily expectorated. Increasing fluid intake helps thin the mucus. Use of room vaporizers or steam inhalation also loosens secretions and reduces inflammation of the mucous membranes. To enhance drainage from the sinuses, the nurse instructs the patient about positioning; this depends on the location of the infection or inflammation. For example, drainage for sinusitis or rhinitis is achieved in the upright position. In some conditions, topical or systemic medications, when prescribed, help relieve nasal or throat congestion.

***Promoting Comfort***

URIs usually produce localized discomfort. In sinusitis, pain may occur in the area of the sinuses, or a general headache may be produced. In pharyngitis, laryngitis, or tonsillitis, a sore throat occurs. The nurse encourages the patient to take analgesics, such as acetaminophen with codeine, as prescribed, to relieve this discomfort. A pain intensity rating scale (see Chapter 13) may be used to assess effectiveness of pain relief measures. Other helpful measures include topical

anesthetic agents for symptomatic relief of herpes simplex blisters (see Chart 22-3) and sore throats, hot packs to relieve the congestion of sinusitis and promote drainage, and warm-water gargles or irrigations to relieve the pain of a sore throat. The nurse encourages rest to relieve the generalized discomfort and fever that accompany many upper airway conditions (especially rhinitis, pharyngitis, and laryngitis). The nurse instructs the patient in general hygiene techniques to prevent the spread of infection. For postoperative care after tonsillectomy and adenoidectomy, an ice collar may reduce swelling and decrease bleeding.

***Promoting Communication***

Upper airway infections may result in hoarseness or loss of speech. The nurse instructs the patient to refrain from speaking as much as possible and, if possible, to communicate in writing instead. Additional strain on the vocal cords may delay full return of the voice. The nurse encourages the patient and family to use alternative forms of communication, such as a memo pad or a bell to signal for assistance.

***Encouraging Fluid Intake***

Upper airway infections lead to fluid loss. Sore throat, malaise, and fever may interfere with a patient's willingness to eat and drink. The nurse provides a list of easily ingested foods to increase caloric intake during the acute phase of illness. These include soups, pudding, yogurt, cottage cheese, high protein drinks, and Popsicles. The nurse encourages the patient to drink 2 to 3 L of fluid per day during the acute stage of airway infection, unless contraindicated, to thin the secretions and promote drainage. Liquids (hot or cold) may be soothing, depending on the disorder.

***Promoting Home and Community-Based Care***

TEACHING PATIENTS SELF-CARE. Prevention of most upper airway infections is difficult because of the many potential causes. But because most URIs are transmitted by hand-to-hand contact, the nurse teaches the patient and family techniques to minimize the spread of infection to others, including frequent handwashing. The nurse advises the patient to avoid exposure to people who are at risk for serious illness if respiratory infection is transmitted (elderly adults, immunosuppressed people, and those with chronic health problems).

The nurse teaches patients and their families strategies to relieve symptoms of URIs. It is important to reinforce the need to complete the treatment regimen, particularly when antibiotics are prescribed.

CONTINUING CARE. Referral for home care is rare. However, it may be indicated for people whose health status was compromised before the onset of the respiratory infection and for those who cannot manage self-care without assistance. In such circumstances, the home care nurse assesses the patient's respiratory status and progress in recovery. The nurse may advise elderly patients and those at increased risk from a respiratory infection to consider annual influenza and pneumococcal vaccination as recommended by the physician. A follow-up appointment with the primary care provider may be indicated for patients with compromised health status to ensure that the respiratory infection has resolved.

***Monitoring and Managing Potential Complications***

Although major complications of URIs are rare, the nurse must be aware of them and assess the patient for them. Because most patients with URIs are managed at home, patients and their families must be instructed to monitor for signs and symptoms and to seek immediate medical care if the patient's condition does not improve or if the patient's physical status appears to be worsening.

Sepsis or meningitis may occur in patients with compromised immune status or in those with an overwhelming bacterial infection. The patient with a URI and family members are instructed to seek medical care if the patient's condition fails to improve within several days after the onset of symptoms, if unusual symptoms develop, or if the patient's condition deteriorates. They are instructed about signs and symptoms that require further attention: persistent or high fever, increasing shortness of breath, confusion, and increasing weakness and malaise. The patient with sepsis requires expert care to treat the infection, stabilize vital signs, and prevent or treat septicemia and shock. Deterioration of the patient's condition necessitates intensive care measures (eg, hemodynamic monitoring and administration of vasoactive medications, IV fluids, nutritional support, corticosteroids) to monitor the patient's status and to support the patient's vital signs. High doses of antibiotics may be administered to treat the causative organism. The nurse's role is to monitor the patient's vital signs, hemodynamic status, and laboratory values, administer needed treatment, alleviate the patient's physical discomfort, and provide explanations, teaching, and emotional support to the patient and family.

Peritonsillar abscess may develop after an acute infection of the tonsils. The patient requires treatment to drain the abscess and receives antibiotics for infection and topical anesthetic agents and throat irrigations to relieve pain and sore throat. Follow-up is necessary to ensure that the abscess resolves; tonsillectomy may be required. The nurse assists the patient in administering throat irrigations and instructs the patient and family about the importance of adhering to the prescribed treatment regimen and recommended follow-up appointments.

In some severe situations, peritonsillar abscess may progress to meningitis or brain abscess. The nurse assesses for changes in mental status ranging from subtle personality changes through drowsiness to coma, nuchal rigidity, and focal neurologic signs that signal increasing cerebral edema around the abscess. Seizures, typically grand mal, occur in this setting. Intensive care measures are necessary. High doses of antibiotics may be used to treat the causative organism. The nurse's role is similar to caring for the patient with sepsis in an intensive care setting. The nurse monitors the patient's neurologic status and reports changes immediately to the physician.

Otitis media and rhinosinusitis may develop with URI. The patient and family are instructed about the signs and symptoms of otitis media and rhinosinusitis and about the importance of follow-up with the primary health care practitioner to ensure adequate evaluation and treatment of these conditions.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Maintains a patent airway by managing secretions
   a. Reports decreased congestion
   b. Assumes best position to facilitate drainage of secretions
   c. Uses self-care measures appropriately and consistently to manage secretions during the acute phase of illness
2. Reports relief of pain and discomfort using pain intensity scale
   a. Uses comfort measures: analgesics, hot packs, gargles, rest
   b. Demonstrates adequate oral hygiene
3. Demonstrates ability to communicate needs, wants, level of comfort
4. Maintains adequate fluid and nutrition intake
5. Utilizes strategies to prevent upper airway infections and allergic reactions
   a. Demonstrates hand hygiene technique
   b. Identifies the value of the influenza vaccine
6. Demonstrates an adequate level of knowledge and performs self-care adequately
7. Becomes free of signs and symptoms of infection
   a. Exhibits normal vital signs (temperature, pulse, respiratory rate)
   b. Absence of purulent drainage
   c. Free of pain in ears, sinuses, and throat
   d. Absence of signs of inflammation
8. Absence of complications
   a. No signs of sepsis: fever, hypotension, deterioration of cognitive status
   b. Vital signs and hemodynamic status normal
   c. No evidence of neurologic involvement
   d. No signs of development of peritonsillar abscess
   e. Resolution of URI without development of otitis media or sinusitis
   f. No signs and symptoms of brain abscess

# OBSTRUCTION AND TRAUMA OF THE UPPER RESPIRATORY AIRWAY

## *Obstruction During Sleep*

Obstructive sleep apnea (OSA) is a disorder characterized by recurrent episodes of upper airway obstruction and a reduction in ventilation. It is defined as cessation of breathing (**apnea**) during sleep usually caused by repetitive upper airway obstruction. As many as 18 million Americans suffer from sleep apnea (Pagel, 2007). OSA interferes with people's ability to obtain adequate rest, thus affecting memory, learning, and decision making.

Risk factors for OAS include obesity, male gender, postmenopausal status, and advanced age. The major risk factor is obesity; a larger neck circumference and increased amounts of peripharyngeal fat narrow and compress the upper airway. OSA affects 4% of males and 2% of females. Women are not often referred for evaluation of OSA, possibly because they are less likely to report classic symptoms (Patil, Schneider, Schwartz, et al., 2007). Other associated factors include alterations in the upper airway, such as structural changes (eg, tonsillar hypertrophy, abnormal posterior positioning of one or both jaws, and variations in craniofacial structures) that contribute to the collapsibility of the upper airway.

### Pathophysiology

The pharynx is a collapsible tube that can be compressed by the soft tissues and structures surrounding it. The tone of the muscles of the upper airway is reduced during sleep. Mechanical factors such as reduced diameter of the upper airway or dynamic changes in the upper airway during sleep may result in obstruction. These sleep-related changes may predispose to upper airway collapse when small amounts of negative pressure are generated during inspiration.

Repetitive apneic events result in hypoxia (decreased oxygen saturation) and hypercapnia (increased concentration of carbon dioxide), which triggers a sympathetic response. As a consequence, patients with OSA have a high prevalence of hypertension and an increased risk of myocardial infarction and stroke. In patients with preexisting cardiovascular disease, the nocturnal hypoxemia may predispose to dysrhythmias. Patients who have a diagnosis of heart failure and who have untreated OSA are at increased risk of death (Wang, Parker, Newton, et al., 2007). OSA in the absence of identifiable cardiovascular disease can increase insulin resistance and other metabolic changes that can increase the risk of vascular disease (McArdle, Hillman, Beilin, et al., 2007). OSA is more prevalent in people with coronary artery disease, congestive heart failure, metabolic syndrome, and type 2 diabetes (Patil, et al., 2007).

### Clinical Manifestations

OSA is characterized by frequent and loud snoring with breathing cessation for 10 seconds or longer, for at least five episodes per hour, followed by awakening abruptly with a loud snort as the blood oxygen level drops. Patients with sleep apnea may have anywhere from five apneic episodes per hour to several hundred per night.

Classic signs and symptoms of obstructive sleep apnea include snoring, snorting, gasping, choking, and witnessed apneic episodes commonly reported by the bed partner. Common signs and symptoms of OSA are presented in Chart 22-4. Symptoms typically progress with increases in weight, aging, and during the transition to menopause (Patil, et al., 2007). Patients are typically unaware of nocturnal upper airway obstruction during sleep. They frequently complain of insomnia including difficulty in going to sleep, nighttime awakenings, and early morning awakenings with an inability to go back to sleep, as well as chronic fatigue and hypersomnolence (daytime sleepiness). When obtaining the health history, the nurse asks the patient about sleeping during normal activities such as eating or talking. Patients with this symptom are considered to have pathologic hypersomnolence (Patil, et al., 2007).

**CHART 22-4** *Assessing for Obstructive Sleep Apnea (OSA)*

Be alert for the following signs and symptoms:
- Excessive daytime sleepiness
- Frequent nocturnal awakening
- Insomnia
- Loud snoring
- Morning headaches
- Intellectual deterioration
- Personality changes, irritability
- Impotence
- Systemic hypertension
- Dysrhythmias
- Pulmonary hypertension, cor pulmonale
- Polycythemia
- Enuresis

## Assessment and Diagnostic Evaluation

The diagnosis of sleep apnea is based on clinical features plus a polysomnographic finding (sleep study), which is the definitive test for OSA. The test is an overnight study that measures multiple physiologic signals to include those related to sleep (electroencephalogram [EEG], electro-oculogram, segmental electrocardiogram [ECG]), respiration (airflow, thoracoabdominal effort, and oximetry), and cardiac dysrhythmia (electrocardiogram) (Patil, et al., 2007).

## Medical Management

Patients usually seek medical treatment because their sleeping partners express concern or because they experience excessive sleepiness at inappropriate times or settings (eg, while driving a car). A variety of treatments are used. Weight loss and avoidance of alcohol and hypnotic medications are the first steps (Tierney, et al., 2007). In more severe cases involving hypoxemia and severe hypercapnia, the treatment includes continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) therapy with supplemental oxygen via nasal cannula. (The use of CPAP is discussed in more detail in Chapter 25.) CPAP is used to prevent airway collapse, whereas BiPAP makes breathing easier and results in a lower average airway pressure (Basner, 2007). Although these treatments are effective in management of OSA, compliance with treatment continues to be a major concern (Lin, Prasad, Pan, et al., 2007).

Surgical procedures also may be performed to correct OSA. Simple tonsillectomy may be effective for patients with larger tonsils and low body mass index (Nakata, Noda, Yanagi, et al., 2006). Uvulopalatopharyngoplasty is the resection of pharyngeal soft tissue and removal of approximately 15 mm of the free edge of the soft palate and uvula. Effective in about 50% of patients, it is more effective in eliminating snoring than apnea. Nasal septoplasty may be performed for gross anatomic nasal septal deformities. Tracheostomy relieves upper airway obstruction but has numerous adverse effects, including speech difficulties and increased risk of infections. These procedures, as well as other maxillofacial surgeries, are reserved for patients with life-threatening dysrhythmias or severe disability who have not responded to conventional therapy (Tierney, et al., 2007).

### Pharmacologic Therapy

Although medications are not generally recommended for OSA, modafinil (Provigil) has been shown to reduce daytime sleepiness (Valentino & Foldvary-Schaefer, 2007). Protriptyline (Triptil) given at bedtime may increase the respiratory drive and improve upper airway muscle tone. Medroxyprogesterone acetate (Provera) and acetazolamide (Diamox) have been used for sleep apnea associated with chronic alveolar hypoventilation, but their benefits have not been well established. The patient must understand that these medications are not a substitute for CPAP or BiPAP. Administration of low-flow nasal oxygen at night can help relieve hypoxemia in some patients but has little effect on the frequency or severity of apnea. Further studies on the effectiveness of pharmacologic therapy are needed.

## Nursing Management

The patient with OSA may not recognize the potential consequences of the disorder. Therefore, the nurse explains the disorder in terms that are understandable to the patient and relates symptoms (daytime sleepiness) to the underlying disorder. The nurse also instructs the patient and family about treatments, including the correct and safe use of CPAP, BiPAP, and oxygen therapy, if prescribed. The nurse teaches the patient about the risk of untreated OSA and the benefits of treatment approaches.

# Epistaxis (Nosebleed)

**Epistaxis,** a hemorrhage from the nose, is caused by the rupture of tiny, distended vessels in the mucous membrane of any area of the nose. Rarely does epistaxis originate in the densely vascular tissue over the turbinates. Most commonly, the site is the anterior septum, where three major blood vessels enter the nasal cavity: (1) the anterior ethmoidal artery on the forward part of the roof (Kiesselbach's plexus), (2) the sphenopalatine artery in the posterosuperior region, and (3) the internal maxillary branches (the plexus of veins located at the back of the lateral wall under the inferior turbinate).

Several risk factors are associated with epistaxis (Chart 22-5).

**CHART 22-5** *Risk Factors for Epistaxis*

- Local infections (vestibulitis, rhinitis, sinusitis)
- Systemic infections (scarlet fever, malaria)
- Drying of nasal mucous membranes
- Nasal inhalation of illicit drugs (eg, cocaine)
- Trauma (digital trauma as in picking the nose; blunt trauma; fracture; forceful nose blowing)
- Arteriosclerosis
- Hypertension
- Tumor (sinus or nasopharynx)
- Thrombocytopenia
- Use of aspirin
- Liver disease
- Redu-Osler-Weber syndrome (hereditary hemorrhagic telangiectasia)

## Medical Management

Management of epistaxis depends on its cause and the location of the bleeding site. A nasal speculum, penlight, or headlight may be used to identify the site of bleeding in the nasal cavity. Most nosebleeds originate from the anterior portion of the nose. Initial treatment may include applying direct pressure. The patient sits upright with the head tilted forward to prevent swallowing and aspiration of blood and is directed to pinch the soft outer portion of the nose against the midline septum for 5 or 10 minutes continuously. Application of nasal decongestants (phenylephrine, one or two sprays) to act as vasoconstrictors may be necessary. If these measures are unsuccessful in stopping the bleeding, the nose must be examined using good illumination and suction to determine the site of bleeding. Topical cocaine (4%) may be applied using an applicator or spray. It serves as both an anesthetic and a vasoconstrictor. If cocaine is not available, oxymetazoline (topical decongestant) and tetracaine (Pontocaine; topical anesthetic) can be substituted with equal results. Visible bleeding sites may be cauterized with silver nitrate or electrocautery (high-frequency electrical current). A supplemental patch of Surgicel or Gelfoam may be used (Tierney, et al., 2007).

Alternatively, a cotton tampon may be used to try to stop the bleeding. Suction may be used to remove excess blood and clots from the field of inspection. The search for the bleeding site should shift from the anteroinferior quadrant to the anterosuperior, then to the posterosuperior, and finally to the posteroinferior area. The field is kept clear by using suction and by shifting the cotton tampon.

If the origin of the bleeding cannot be identified, the nose may be packed with gauze impregnated with petrolatum jelly or antibiotic ointment; a topical anesthetic spray and decongestant agent may be used before the gauze packing is inserted, or a balloon-inflated catheter may be used (Fig. 22-3). Alternatively, a compressed nasal sponge may be used. Once the sponge becomes saturated with blood or is moistened with a small amount of saline, it will expand and produce tamponade to halt the bleeding. The packing may remain in place for 48 hours or up to 5 or 6 days if necessary to control bleeding. Antibiotics may be prescribed because of the risk of iatrogenic sinusitis and toxic shock syndrome.

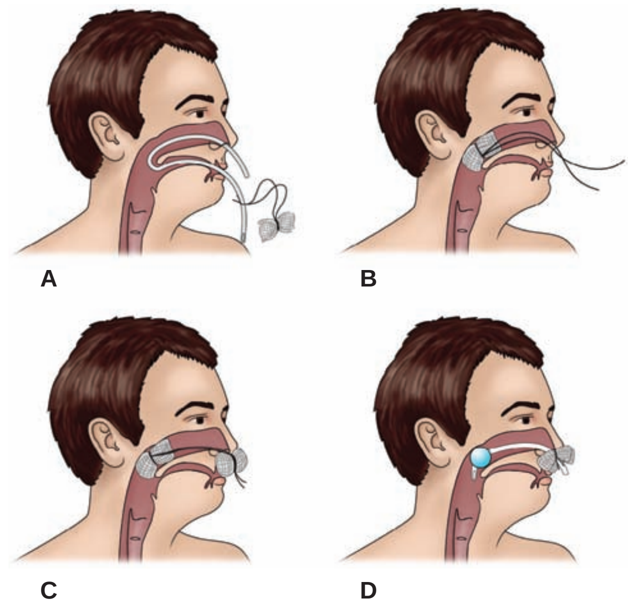



**Figure 22-3** Packing to control bleeding from the posterior nose. **A,** Catheter is inserted and packing is attached. **B,** Packing is drawn into position as the catheter is removed. **C,** Strip is tied over a bolster to hold the packing in place with an anterior pack installed "accordion pleat" style. **D,** Alternative method, using a balloon catheter instead of gauze packing.

## Nursing Management

The nurse monitors the patient's vital signs, assists in the control of bleeding, and provides tissues and an emesis basin to allow the patient to expectorate any excess blood. It is common for patients to be anxious in response to a nosebleed. Blood loss on clothing and handkerchiefs can be frightening, and the nasal examination and treatment are uncomfortable. Assuring the patient in a calm, efficient manner that bleeding can be controlled can help reduce anxiety. The nurse continuously assesses the patient's airway and breathing as well as vital signs. On rare occasions, a patient with significant hemorrhage requires IV infusions of crystalloid solutions (normal saline) as well as cardiac and pulse oximetry monitoring.

### Teaching Patients Self-Care

Once the bleeding is controlled, the nurse instructs the patient to avoid vigorous exercise for several days and to avoid hot or spicy foods and tobacco because this may cause vasodilation and increase the risk of rebleeding. Discharge teaching includes reviewing ways to prevent epistaxis: avoiding forceful nose blowing, straining, high altitudes, and nasal trauma (including nose picking). Adequate humidification may prevent drying of the nasal passages. The nurse explains how to apply direct pressure to the nose with the thumb and the index finger for 15 minutes in the case of a recurrent nosebleed. If recurrent bleeding cannot be stopped, the patient is instructed to seek additional medical attention.

# Nasal Obstruction

The passage of air through the nostrils is frequently obstructed by a deviation of the nasal septum, hypertrophy of the turbinate bones, or the pressure of nasal polyps. Chronic nasal congestion forces the patient to breath through the mouth, thus producing dryness of the oral mucosa and associated problems including persistent dry, cracked lips. Patients with chronic nasal congestion often suffer from sleep deprivation due to difficulty maintaining an adequate airway while lying flat and during sleep.

Persistent nasal obstruction also may lead to chronic infection of the nose and result in frequent episodes of nasopharyngitis. Frequently, the infection extends to the nasal sinuses. When rhinosinusitis develops and the drainage from these cavities is obstructed by deformity or swelling within the nose, pain is experienced in the region of the affected sinus.

## Medical Management

The treatment of nasal obstruction requires the removal of the obstruction, followed by measures to treat whatever chronic infection exists. In many patients, an underlying

allergy also requires treatment. Measures to reduce or alleviate nasal obstruction include nonsurgical as well as surgical techniques. Commonly used medications include nasal corticosteroids (see Table 22-2) as well as oral leukotriene inhibitors, such as montelukast. Treatment with nasal corticosteroids for 1 to 3 months is usually successful for treatment of small polyps and may even reduce the need for surgical intervention. A short course of oral corticosteroids (6-day course of prednisone) may be beneficial in the treatment of nasal obstruction due to polyps (Tierney, et al., 2007). Additional medications may include antibiotics for the treatment of underlying infection or antihistamines for management of allergies. Hypertrophied turbinates may be treated by applying an astringent agent to shrink them.

A more aggressive approach in treating nasal obstruction caused by turbinate hypertrophy involves surgical reduction of the hypertrophy. Surgical procedures used to treat obstructive nasal conditions are collectively known as functional rhinoplasty. Technical advances with newer techniques provide a number of options for reconstruction and reshaping of the nose (Swartout & Toriumi, 2007).

### Nursing Management

Most of the surgical procedures are performed on an outpatient basis. The nurse explains the procedure after the physician provides the initial description. Postoperatively, the nurse elevates the head of the bed to promote drainage and to alleviate discomfort from edema. Frequent oral hygiene is encouraged to overcome dryness caused by breathing through the mouth. Before discharge from the outpatient or same-day surgical unit, the patient is instructed to avoid blowing the nose with force during the postoperative recovery period. The patient is also instructed about the signs and symptoms of bleeding and infection and when to contact the physician. The patient is provided with written postoperative instructions, including emergency phone numbers.

## Fractures of the Nose

The location of the nose makes it susceptible to injury. Nasal fracture is the most common facial fracture and the most common fracture in the body. Fractures of the nose usually result from a direct assault. Nasal fractures may affect the ascending process of the maxilla and the septum. The torn mucous membrane results in a nosebleed. Complications include hematoma, infection, abscess, and avascular or septic necrosis. However, as a rule, serious consequences usually do not occur.

### Clinical Manifestations

The signs and symptoms of a nasal fracture are pain, bleeding from the nose externally and internally into the pharynx, swelling of the soft tissues adjacent to the nose, periorbital ecchymosis, nasal obstruction, and deformity. The patient's nose may have an asymmetric appearance that may not be obvious until the edema subsides.

### Assessment and Diagnostic Findings

The nose is examined internally to rule out the possibility that the injury may be complicated by a fracture of the nasal septum and a submucosal septal hematoma. Intranasal examination is performed in all cases to rule out septal hematoma (Tierney, et al., 2007). Because of the swelling and bleeding that occur with a nasal fracture, an accurate diagnosis can be made only after the swelling subsides.

Clear fluid draining from either nostril suggests a fracture of the cribriform plate with leakage of cerebrospinal fluid. Because cerebrospinal fluid contains glucose, it can readily be differentiated from nasal mucus by means of a dipstick (Dextrostix). Usually, careful inspection or palpation discloses any deviations of the bone or disruptions of the nasal cartilages. An x-ray may reveal displacement of the fractured bones and may help rule out extension of the fracture into the skull.

### Medical Management

A nasal fracture very often produces bleeding from the nasal passage. As a rule, bleeding is controlled with the use of packing. Cold compresses are used to prevent or reduce edema. For the patient who has sustained enough trauma to break the nose or any facial bone, the emergency medical team must consider the possibility of a cervical spine fracture. Therefore, it is essential to ensure a patent airway and to rule out a cervical spine fracture. Uncomplicated nasal fractures may be treated initially with antibiotics, analgesic agents, and a decongestant nasal spray.

Treatment of nasal fractures is aimed at restoring nasal function and returning the appearance of the nose to baseline. The patient is referred to a specialist to evaluate the need to realign the bones. Although improved outcomes are obtained when reduction of the fracture is performed during the first 3 hours after the injury, this is often not possible because of the edema. If immediate reduction of the fracture is not possible, it is performed within 3 to 7 days. Timing is important when treating nasal fractures because further delay in treatment may result in significant bone healing, which ultimately may require surgical intervention that includes rhinoplasty to reshape the external appearance of the nose. A septorhinoplasty is performed when the nasal septum needs to be repaired. In patients who develop a septal hematoma, the physician drains the hematoma through a small incision. A septal hematoma that is not drained can lead to permanent deformity of the nose.

### Nursing Management

Immediately after the fracture, the nurse applies ice and encourages the patient to keep the head elevated. The nurse instructs the patient to apply ice packs to the nose for 20 minutes four times a day to decrease swelling. The patient who experiences bleeding from the nose (epistaxis) is usually frightened and anxious and needs reassurance. The packing inserted to stop the bleeding may be uncomfortable and unpleasant, and obstruction of the nasal passages by the packing forces the patient to breathe through the mouth. This in turn causes the oral mucous membranes to become dry. Mouth rinses help to moisten the mucous membranes and to reduce the odor and taste of dried blood in the

oropharynx and nasopharynx. Use of analgesic agents such as acetaminophen or NSAIDs such as ibuprofen or naproxen is encouraged. When removing the cotton pledgets, the nurse carefully inspects the mucosa for lacerations or a septal hematoma. The nurse instructs the patient to avoid sports activities for 6 weeks.

## Laryngeal Obstruction

Obstruction of the larynx because of edema is a serious, often fatal, condition. The larynx is a stiff box that will not stretch. It contains a narrow space between the vocal cords (glottis), through which air must pass. Swelling of the laryngeal mucous membranes may close off the opening tightly, leading to life-threatening hypoxia or suffocation. Edema of the glottis occurs rarely in patients with acute laryngitis, occasionally in patients with urticaria, and more frequently in patients with severe inflammation of the throat, as in scarlet fever. It is an occasional but usually preventable cause of death in severe anaphylaxis (angioedema).

Hereditary angioedema (HAE) is also characterized by episodes of life-threatening laryngeal edema. Laryngeal edema in people with HAE can occur at any age, although young adults are at greatest risk. Risk factors for laryngeal obstruction are given in Table 22-3.

Foreign bodies frequently are aspirated into the pharynx, the larynx, or the trachea and cause a twofold problem. First, they obstruct the air passages and cause difficulty in breathing, which may lead to asphyxia; later, they may be drawn farther down, entering the bronchi or a bronchial branch and causing symptoms of irritation, such as a croupy cough, expectoration of blood or mucus, or labored breathing. The physical signs and x-ray findings confirm the diagnosis.

### Clinical Manifestations

The patient's clinical presentation and x-ray findings confirm the diagnosis of laryngeal obstruction. The patient may demonstrate lowered oxygen saturation; however, normal oxygen saturation should not be interpreted as a sign that the obstruction is not significant. Use of accessory muscles to maximize airflow may occur and is often manifested by retractions in the neck or abdomen during inspirations. Patients who demonstrate these symptoms are at an immediate risk of collapse, and respiratory support (ie, mechanical ventilation or positive-pressure ventilation) is considered.

### Assessment and Diagnostic Findings

A thorough history can be very useful in diagnosing and treating the patient with a laryngeal obstruction. However, emergency measures to secure the patient's airway should not be delayed to obtain a history or perform tests. If possible, the nurse obtains a history from the patient or family about heavy alcohol or tobacco consumption, current medications, history of airway problems, recent infections, pain or fever, dental pain or poor dentition, and any previous surgeries, radiation therapy, or trauma.

Rarely, patients with nasogastric tubes in place develop a postcricoid ulceration (referred to as "nasogastric tube syndrome"). This ulceration affects the posterior cricoarytenoid muscles, causing vocal cord abduction paralysis and ultimately upper airway obstruction (Marcus, Caine, Hamdan, et al., 2006).

### Medical Management

Medical management is based on the initial evaluation of the patient and the need to ensure a patent airway. If the airway is obstructed by a foreign body and signs of asphyxia are apparent, immediate treatment is necessary. Frequently, if the foreign body has lodged in the pharynx and can be visualized, the finger can dislodge it. If the obstruction is in the larynx or the trachea, the clinician or other rescuer tries the subdiaphragmatic abdominal thrust maneuver (Chart 22-6). If all efforts are unsuccessful, an immediate tracheotomy is necessary (see Chapter 25 for further discussion). If the obstruction is caused by edema resulting from an allergic reaction, treatment may include immediate administration of subcutaneous epinephrine and a corticosteroid (see Chapter 53). Ice may be applied to the neck in an effort to reduce edema. Continuous pulse oximetry is essential in the patient who has experienced acute upper airway obstruction.

## Cancer of the Larynx

Cancer of the larynx accounts for approximately half of all head and neck cancers. The American Cancer Society (ACS, 2007b) estimates that about 11,300 new cases and

**Table 22-3 RISK FACTORS FOR LARYNGEAL OBSTRUCTION**

| Precipitating Event | Mechanism of Obstruction |
|---|---|
| History of allergies; exposure to medications, latex, foods (peanuts, tree nuts [eg, walnuts, pecans]), bee stings | Anaphylaxis |
| Foreign body | Inhalation/ingestion of meat or other food items, coin, chewing gum, balloon fragments, drug packets (ingested to avoid criminal arrest) |
| Heavy alcohol consumption; heavy tobacco use | Obstruction from tumor |
| Family history of airway problems | Suggests angioedema (type I hypersensitivity reaction) |
| Use of angiotensin-converting enzyme (ACE) inhibitor | Increased risk of angioedema of the mucous membranes |
| Recent throat pain or recent fever | Infectious process |
| History of surgery or previous tracheostomy | Possible subglottic stenosis |
| History of nasogastric tube placement | Nasogastric tube syndrome |

## Chart 22-6 • *Performing the Abdominal Thrust Maneuver*

To assist a patient or other person who is choking on a foreign object, the nurse performs the abdominal thrust maneuver (sometimes called the Heimlich maneuver) according to guidelines set forth by the American Heart Association. (*Note:* Hands crossed at the neck is the universal sign for choking.)

1. Stand behind the person who is choking.
2. Place both arms around the person's waist.
3. Make a fist with one hand with the thumb outside the fist.
4. Place thumb side of fist against the person's abdomen above the navel and below the xiphoid process.
5. Grasp fist with other hand.
6. Quickly and forcefully exert pressure against the person's diaphragm, pressing upward with quick, firm thrusts.
7. Apply thrusts 6 to 10 times until the obstruction is cleared.
8. The pressure from the thrusts should lift the diaphragm, force air into the lungs, and create an artificial cough powerful enough to expel the aspirated object.



3,660 deaths occur annually, with an overall survival rate of 65%. Cancer of the larynx is most common in people between the ages of 60 and 70 years (Schiech, 2007), and it occurs four to five times more frequently in men than in women.

**Carcinogens** that have been associated with laryngeal cancer include tobacco (smoke, smokeless) and alcohol and their combined effects (Chart 22-7). Use of chewing tobacco from other countries has increased the risk of laryngeal cancer because of its stronger potency, and the risk of laryngeal cancer may be greater than that associated with cigarette smoking (Sapkota, Gajalakshmi, Jetly, et al., 2007). Occupational exposure to coal dust, steel dust, iron compounds and fumes, formaldehyde, and dust from hard alloys (eg., still or iron compounds) is associated with hypopharyngeal or laryngeal cancer (Shangina, Brennan, Szeszenia-Dabrowska, et al., 2006). Dietary patterns of Western cultures are associated with an increased risk of supraglottic cancer of the larynx. Other risk factors include straining the voice, chronic laryngitis, nutritional deficiencies (riboflavin), and family predisposition.

### CHART 22-7 *Risk Factors for Laryngeal Cancer*

**Carcinogens**

- Tobacco (smoke, smokeless)
- Combined effects of alcohol and tobacco
- Asbestos
- Secondhand smoke
- Paint fumes
- Wood dust
- Cement dust
- Chemicals
- Tar products
- Mustard gas
- Leather and metals

**Other Factors**

- Straining the voice
- Chronic laryngitis
- Nutritional deficiencies (riboflavin)
- History of alcohol abuse
- Familial predisposition
- Age (higher incidence after 60 years of age)
- Gender (more common in men)
- Race (more prevalent in African Americans)
- Weakened immune system

Almost all malignant tumors of the larynx arise from the surface epithelium and are classified as squamous cell carcinoma. Approximately 55% of patients with laryngeal cancer present with involved lymph nodes at the time of diagnosis, with bilateral lesions present in 16% of patients (De Vita, Hellman & Rosenberg, 2005). The lifetime survival rate for patients who have small laryngeal cancers without evidence of spread to the lymph nodes is about 75% to 95%. Recurrence occurs usually within the first 2 to 3 years after diagnosis. The presence of disease after 5 years is often secondary to a new primary malignancy. The incidence of distant metastasis with squamous cell carcinoma of the head and neck (including larynx cancer) is relatively low.

## Clinical Manifestations

Hoarseness of more than 2 weeks' duration occurs in the patient with cancer in the glottic area because the tumor impedes the action of the vocal cords during speech. The voice may sound harsh, raspy, and lower in pitch. Affected voice sounds are not early signs of subglottic or supraglottic cancer. The patient may complain of a persistent cough or sore throat and pain and burning in the throat, especially when consuming hot liquids or citrus juices. A lump may be felt in the neck. Later symptoms include dysphagia, dyspnea (difficulty breathing), unilateral nasal obstruction or discharge, persistent hoarseness, persistent ulceration, and foul breath. Cervical lymph adenopathy, unintentional weight loss, a general debilitated state, and pain radiating to the ear may occur with metastasis.

## Assessment and Diagnostic Findings

An initial assessment includes a complete history and physical examination of the head and neck. This includes identification of risk factors, family history, and any underlying medical conditions. An indirect laryngoscopy, using a flexible endoscope, is initially performed in the otolaryngologist's office to visually evaluate the pharynx, larynx, and possible tumor. Mobility of the vocal cords is assessed; if normal movement is limited, the growth may affect muscle, other tissue, and even the airway. The neck and the thyroid gland are palpated for enlarged lymph nodes and enlarged thyroid gland.

Diagnostic procedures that may be used include endoscopy, including virtual endoscopy, optical imaging, and CT. If a tumor of the larynx is suspected on an initial examination, a direct laryngoscopic examination is performed under local or general anesthesia to evaluate all areas of the larynx. In some cases, intraoperative examination obtained by direct microscopic visualization and palpation of the vocal folds may yield a more accurate diagnosis. Samples of the suspicious tissue are obtained for analysis.

The classification, including stage of the tumor (ie, size and histology of the tumor, presence and extent of cervical lymph node involvement) and location of the tumor serve as a basis for treatment. CT and MRI are used to assess regional adenopathy and soft tissues and to stage and determine the extent of a tumor. MRI is also helpful in posttreatment follow-up to detect a recurrence. Positron emission tomography (PET) scanning may also be used to detect recurrence of a laryngeal tumor after treatment.

## Medical Management

The goals of treatment of laryngeal cancer include cure, preservation of safe, effective swallowing, preservation of useful voice, and avoidance of permanent tracheostoma (Tierney, et al., 2007). Treatment options include surgery, radiation therapy, and chemotherapy. The prognosis depends on the tumor stage, the patient's gender and age, and pathologic features of the tumor, including the grade and depth of infiltration. The treatment plan also depends on whether the cancer is an initial diagnosis or a recurrence. In addition, before treatment begins, a complete dental examination is performed to rule out any oral disease. Any dental problems are resolved, if possible, before surgery and radiotherapy.

For patients with early stage tumors and lesions without lymph node involvement, radiation therapy or surgery may be effective. Surgical procedures may include transoral endoscopic laser resection, classic open vertical hemilaryngectomy for glottic tumors, or classic horizontal supraglottic laryngectomy. Five-year survival rates exceed 80% to 90% with excellent patient-reported satisfaction. In supraglottic tumors, selective neck dissection or irradiation is necessary because of the high risk of neck node involvement (Tierney, et al., 2007). Chemotherapy followed by radiation therapy allows conservation of the larynx without any effect on survival. Concurrent chemoradiotherapy provides high rates of laryngeal preservation (Lefebvre, 2006). Patients with complete response to chemotherapy have a higher probability of cure after hyperfractionation (radiation treatments given in smaller doses but more often than standard radiation therapy). Some tumors may be treated with hyperfractionated radiation therapy; however, this form of radiation therapy may have more severe short-term side effects (varying degrees of mucositis or inflammation of the mucous membranes) but fewer long-term side effects (Majem, Mesia, Mañós, et al., 2006).

For patients with more advanced disease, cisplatin-based chemotherapy plus radiation protocols have been used effectively. 5-Fluorouracil (5-FU) is also commonly used in the treatment of laryngeal squamous cell cancer. Patients and their physicians must carefully consider the various side effects and complications associated with the different treatment modalities (Tierney, et al., 2007).

The presence of lymph node involvement in the neck can affect the outcome. Supraglottic tumors metastasize early and bilaterally even when there appears to be no lymph node involvement at the time of diagnosis. When the neck is involved, the treatment includes surgery or chemoradiation or both (Tierney, et al., 2007).

### *Surgical Management*

The overall goals for the patient undergoing surgical treatment include minimizing the effects of surgery on speech, swallowing, and breathing while maximizing the cure of the cancer. Several different curative procedures are available that can offer voice-sparing results while achieving a positive cure rate for the patient who has an early laryngeal carcinoma. Surgical options include (1) vocal cord stripping, (2) cordectomy, (3) laser surgery, (4) partial laryngectomy, or (5) total laryngectomy.

#### Vocal Cord Stripping

Stripping of the cord is used to treat dysplasia, hyperkeratosis, and leukoplakia and is often curative for these lesions. The procedure involves removal of the mucosa of the edge of the vocal cord, using an operating microscope. Early vocal cord lesions are initially treated with radiation therapy.

#### Cordectomy

Cordectomy, which is an excision of the vocal cord, is usually performed via transoral laser. This procedure is used for lesions limited to the middle third of the vocal cord. The resulting voice quality is related to the extent of tissue removed.

#### Laser Surgery

Laser microsurgery is well known to have several advantages for treatment of early glottic cancers. Treatment and recovery are shorter, with fewer side effects, and treatment may be less costly than for other forms of therapy (De Vita, et al., 2005). Microelectrodes are useful for surgical resection of smaller laryngeal carcinomas. The carbon dioxide ($CO_2$) laser can be used for the treatment of many laryngeal tumors, with the exception of large vascular tumors. When compared with the results of other treatments for early laryngeal cancer, laser microsurgery is considered to be the method of choice based on patient outcomes (Ambrosch, 2007).

#### Partial Laryngectomy

A partial laryngectomy (laryngofissure–thyrotomy) is often used for smaller cancers of the larynx. It is recommended in

the early stages of cancer in the glottic area when only one vocal cord is involved. The surgery is associated with a very high cure rate. It may also be performed for recurrence when high-dose radiation has failed. A portion of the larynx is removed, along with one vocal cord and the tumor; all other structures remain. The airway remains intact, and the patient is expected to have no difficulty swallowing. The voice quality may change, or the patient may sound hoarse.

### Total Laryngectomy

Complete removal of the larynx (total **laryngectomy**) can provide the desired cure in most advanced laryngeal cancers, when the tumor extends beyond the vocal cords, or for cancer that recurs or persists after radiation therapy. In a total laryngectomy, the laryngeal structures are removed, including the hyoid bone, epiglottis, cricoid cartilage, and two or three rings of the trachea. The tongue, pharyngeal walls, and trachea are preserved. A total laryngectomy results in permanent loss of the voice and a change in the airway, requiring a permanent tracheostomy (Fig. 22-4). Occasionally, patients continue to have a laryngectomy tube in the stoma. Laryngectomy tubes are similar in appearance to tracheostomy tubes; however, a laryngectomy tube can be distinguished from a tracheostomy tube because the patient is unable to speak or breathe when the laryngectomy tube is occluded. Patients who have a total laryngectomy require alternatives to normal speech; these may include a prosthetic device, such as the Blom-Singer valve, to speak without aspirating.

Surgery is more difficult when the lesion involves the midline structures or both vocal cords. With or without neck dissection, a total laryngectomy requires a permanent tracheal stoma because the larynx that provides the protective sphincter is no longer present. The tracheal stoma prevents the aspiration of food and fluid into the lower respiratory tract. The patient has no voice but has normal swallowing. A total laryngectomy changes the manner in which airflow is used for breathing and speaking, as depicted in Figure 22-4. The patient has significant loss of the natural voice and the need to breathe through an opening (stoma) created in the lower neck. Complications that may occur include a salivary leak, wound infection from the development of a pharyngocutaneous fistula, stomal stenosis, and dysphagia secondary to esophageal stricture. Despite these changes and potential complications, many patients who have undergone a total laryngectomy maintain a good quality of life overall (Woodard, Oplatek & Petruzzelli, 2007). In some cases, the patient may be a candidate for a near-total laryngectomy. In this situation, the patient would be a candidate for chemotherapy and radiotherapy regimens postoperatively. Voice preservation can be achieved in most cases.

Advances in surgical techniques for treating laryngeal cancer may minimize the cosmetic and functional deficits previously seen with total laryngectomy. Some microlaryngeal surgery can be performed endoscopically.

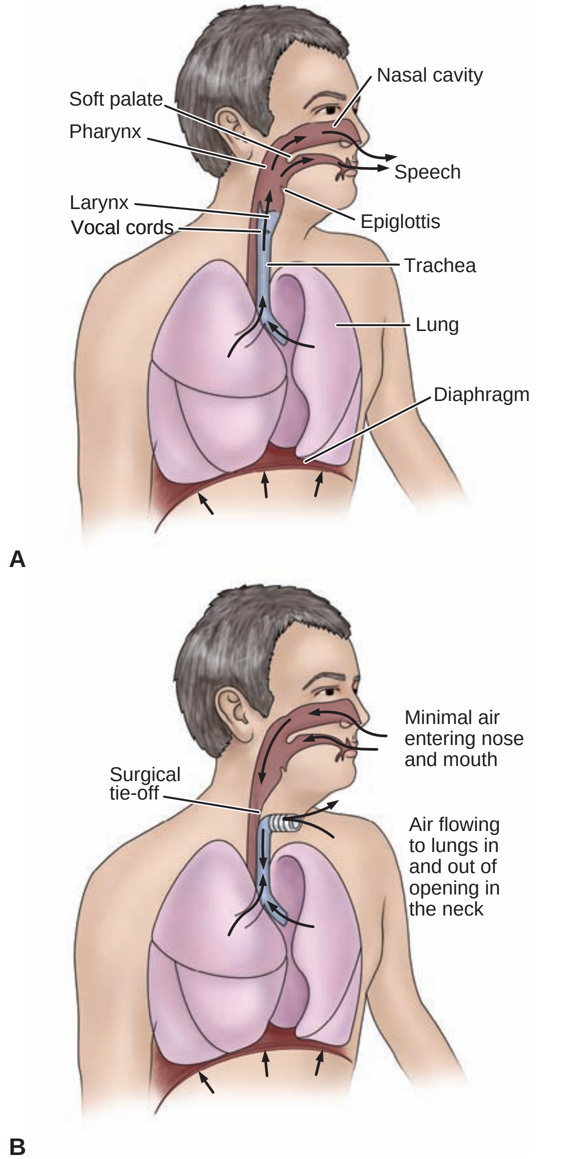



**Figure 22-4** Total laryngectomy produces a change in airflow for breathing and speaking. **A,** Normal airflow. **B,** Airflow after total laryngectomy.

### *Radiation Therapy*

The goal of radiation therapy is to eradicate the cancer and preserve the function of the larynx. The decision to use radiation therapy is based on several factors, including the staging of the tumor and the patient's overall health status, lifestyle (including occupation), and personal preference. Excellent results have been achieved with radiation therapy in patients with early stage glottic tumors when only one vocal cord is involved and there is normal mobility of the cord (ie, with phonation), as well as in small supraglottic lesions. One of the benefits of radiation therapy is that patients retain a near-normal voice. A few may develop chondritis (inflammation of the cartilage) or stenosis; a small number may later require laryngectomy.

Radiation therapy may also be used preoperatively to reduce the tumor size. Radiation therapy is combined with surgery in advanced laryngeal cancer as adjunctive therapy to surgery or chemotherapy and as a palliative measure. A variety of clinical trials have combined chemotherapy and radiation therapy in the treatment of advanced laryngeal tumors.

CHART 22-8

## NURSING RESEARCH PROFILE
### *Speech Impairment After Surgery for Head and Neck Cancer*

Rodriguez, C. S. & VanCott, M. L. (2005). Speech impairment in the postoperative head and neck cancer patient: Nurses' and patients' perceptions, *Qualitative Health Research, 15*(7), 897–911.

**Purpose**

Patients who undergo surgery for treatment of head and neck cancer are often unable to verbally communicate their needs in the immediate postoperative period. Furthermore, these patients have postoperative pain, and nurses caring for these patients need strategies to assess and manage the patients' pain. The purposes of this study were (1) to explore the experience of postoperative pain for the patient with head and neck cancer and speech impairment and (2) to explore strategies used by nurses to assess and manage pain related to head and neck cancer treatment in the immediate postoperative period.

**Design**

This qualitative study, which was part of a larger study that included quantitative and qualitative methods, used individual written interviews for nine patients following surgical treatment of head and neck cancer and individual interviews as well as a focus group of six nurses. Patients were asked about their pain and how they tried to describe the pain without the use of speech. Nurses were asked what strategies they used to measure pain in patients with pain and communication impairment and how they made decisions about pain management when the patient with head and neck cancer is unable to communicate. Interviews from both patients and nurses were analyzed to uncover patterns.

**Findings**

Two issues identified from the nurses' responses related to measuring pain and decision making about pain management. Nurses identified use of a systematic approach in measuring postoperative pain in patients with head and neck cancer, including use of questions and observation of vital signs and patient behaviors to assess the presence and severity of pain. They reported asking patients directly about the presence of pain and described the importance of giving patients time to express their needs. Decision making for nurses was based on the need to relieve the patient's pain level to promote healing and recovery.

Patients described the challenge of trying to communicate their pain with a speech impairment and the strategies that they found useful in trying to convey information about their pain to others. They used nonverbal methods (gestures, pointing to painful area, grimacing) and a pain intensity scale to indicate the presence and severity of the pain. They reported the need to be persistent in communicating pain, especially when moved from the critical care area to a general medical-surgical unit.

Both nurses and patients expressed frustration about the pain experience. Patients were more likely to report an inability to express themselves, and nurses were more likely to report problems in adequately assessing pain.

**Nursing Implications**

Strategies for assessment and management of pain following head and neck surgery for treatment of cancer should be established prior to surgery. These approaches should be developed both by nurses and patients, and strategies should address not only the immediate postoperative period spent in critical care units, but also medical-surgical units, where there are fewer nurses caring for patients than in specialized units. Methods of communication must be established for patients out of the immediate view of nurses because patients are unable to summon assistance through an intercom system. Advanced planning that targets effective assessment and management of postoperative pain is more likely to reduce the frustrations experienced by patients and nurses and result in more effective pain management.

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Advances in research and treatment of these tumors with surgery, chemotherapy, and radiation therapy have improved outcomes and decreased the incidence of posttreatment morbidities (De Vita, et al., 2005). Radiation therapy combined with chemotherapy may be an alternative to a total laryngectomy.

Complications from radiation therapy are a result of external radiation to the head and neck area, which may also include the parotid gland, which is responsible for mucus production. Symptoms may include acute mucositis, ulceration of the mucous membranes, pain, **xerostomia** (dry mouth), loss of taste, dysphasia, fatigue, and skin reactions. Later complications may include laryngeal necrosis, edema, and fibrosis.

### *Speech Therapy*

The patient who undergoes a laryngectomy and the patient's family face potentially complex challenges, including significant changes in the ability to communicate. To minimize anxiety and frustration on the part of the patient and family, it is necessary to discuss the loss or alteration of speech with them. To plan postoperative communication strategies and speech therapy, the speech therapist or pathologist conducts a preoperative evaluation. During this time, the nurse discusses with the patient and family methods of communication that will be available in the immediate postoperative period. These include writing, lip speaking and reading, and communication or word boards (Chart 22-8). A system of communication is established with the patient, family, nurse, and physician and is implemented consistently after surgery.

In addition, a long-term postoperative communication plan for **alaryngeal communication** is developed. The three most common techniques of alaryngeal communication are esophageal speech, artificial larynx (electrolarynx), and tracheoesophageal puncture. Training in these techniques begins once medical clearance is obtained from the physician.

#### Esophageal Speech

Esophageal speech was the primary method of alaryngeal speech taught to patients until the 1980s. The patient needs the ability to compress air into the esophagus and expel it,

setting off a vibration of the pharyngeal esophageal segment. The technique can be taught once the patient begins oral feedings, approximately 1 week after surgery. First, the patient learns to belch and is reminded to do so an hour after eating. Then the technique is practiced repeatedly. Later, this conscious belching action is transformed into simple explosions of air from the esophagus for speech purposes. The speech therapist continues to work with the patient to make speech intelligible and as close to normal as possible. Because it takes a long time to become proficient, the success rate is low.

#### Electric Larynx

If esophageal speech is not successful, or until the patient masters the technique, an electric larynx may be used for communication. This battery-powered apparatus projects sound into the oral cavity. When the mouth forms words (articulation), the sounds from the electric larynx become audible words. The voice that is produced sounds mechanical, and some words may be difficult to understand. The advantage is that the patient is able to communicate with relative ease while working to become proficient at either esophageal or tracheoesophageal puncture speech.

#### Tracheoesophageal Puncture

The third technique of alaryngeal speech is tracheoesophageal puncture (Fig. 22-5). This technique for voice restoration is simple and has few complications. It is associated with high phonation success, good phonation quality, and steady long-term results. This technique is widely used because the speech associated with it most resembles normal speech (the sound produced is a combination of esophageal speech and voice), and it is easily learned. A valve is placed in the tracheal stoma to divert air into the esophagus and out the mouth. Once the puncture is surgically created and has healed, a voice prosthesis (Blom-Singer) is fitted over the puncture site. A speech therapist teaches the patient how to produce sounds. Moving the tongue and lips to form the sound into words produces speech as before. To prevent airway obstruction, the prosthesis is removed and cleaned when mucus builds up.

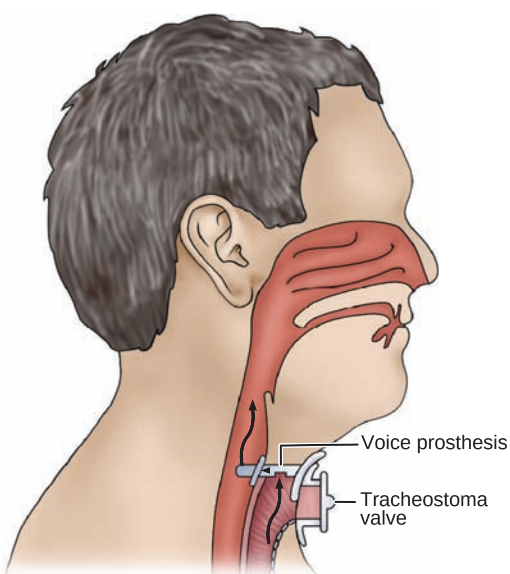



**Figure 22-5** Schematic representation of tracheoesophageal puncture speech. Air travels from the lung through a puncture in the posterior wall of the trachea into the esophagus and out the mouth. A voice prosthesis is fitted over the puncture site.

The success of these various approaches to preserve or restore speech varies. Tracheoesophageal puncture is recommended in patients without previous radiation therapy since success rates decline for patients who have had previous radiation therapy (Kummer, Chahoud, Schuster, et al., 2006).

## NURSING PROCESS

### The Patient Undergoing Laryngectomy

#### Assessment

The nurse obtains a health history and assesses the patient's physical, psychosocial, and spiritual domains. The health history addresses the following symptoms: hoarseness, sore throat, dyspnea, dysphagia, and pain or burning in the throat. The physical assessment includes a thorough head and neck examination with an emphasis on the patient's airway. In addition, the neck and thyroid are palpated for swelling, nodularity, or adenopathy.

The nurse also assesses the patient's general state of nutrition, including height and weight and body mass index and reviews laboratory values that assist in determining the patient's nutritional status (albumin, protein, glucose, and electrolyte levels). If treatment includes surgery, the nurse must know the nature of the surgery to plan appropriate care. If the patient is expected to have no voice as a result of the surgical procedure, a preoperative evaluation by the speech therapist is essential. The patient's ability to hear, see, read, and write is assessed. Visual impairment and functional illiteracy may create additional problems with communication and may require creative approaches to ensure that the patient is able to communicate any needs. Because alcohol abuse is a risk factor for cancer of the larynx, it is essential to assess the patient's pattern of alcohol intake. Patients who are accustomed to daily consumption of alcohol are at risk for alcohol withdrawal syndrome (delirium tremens) when alcohol intake is stopped suddenly.

In addition, the nurse assesses the psychological readiness of the patient and family (Chart 22-9). The thought of having cancer is frightening to most people. Fear is compounded by the possibility of permanent voice loss and, in some cases, some degree of disfigurement. The nurse evaluates the patient's and family's knowledge of the planned surgical procedure and expected postoperative course and assesses the patient's and family's coping methods and support systems. The nurse assesses the patient's spirituality needs based on the patient's individual preferences, beliefs, and culture.

#### Diagnosis

##### *Nursing Diagnoses*

Based on all the assessment data, major nursing diagnoses may include the following:

- Deficient knowledge about the surgical procedure and postoperative course

CHART 22-9 *Ethics and Related Issues*

**Situation**

You are the nurse working the morning shift on a medical-surgical unit at your local hospital. You are caring for an elderly 82-year-old man with a new diagnosis of advanced stage IV cancer of the larynx. The surgeon has determined that this patient needs to undergo a total laryngectomy for better control of the disease. Although the patient continues to live at home, he has early signs of senile dementia along with significant weight loss; he is quite debilitated and frail. He has a history of tobacco abuse and continues to smoke one pack of cigarettes per day. He is a widow with two living children: one daughter and one son. Because of his dementia, the patient is not able to sign consent for his total laryngectomy. The patient's daughter has informed the surgeon that she will not agree to sign surgical consent for a total laryngectomy. She is very concerned about the possible outcome of the surgery and has informed you that she knows for certain that her father would not want this surgery and would want to live at home and not in a nursing home facility. The daughter has asked to speak with you regarding her concerns. The patient's son is in agreement with the recommendation for a total laryngectomy and would be willing to sign surgical consent, but he lives out of state and cannot travel at this time. He is estranged from his sister. The patient does not have a designated health care surrogate or power of attorney.

**Dilemma**

This patient has been diagnosed with a life-threatening illness and needs surgical intervention for control of the disease. He is unable to make medical decisions due to his dementia, and therefore it is now the responsibility of his children in the absence of a spouse to function as his health care surrogate. Based on his physical appearance and condition, he appears to be unable to care for himself. His children are not in agreement regarding the recommended treatment plan. This poses an ethical dilemma that must be resolved so that the patient can receive adequate and timely treatment for his illness and appropriate physical, psychological, and home care should he undergo this procedure.

**Discussion**

1. Based on the above scenario, what further assessment of the patient's physical and psychosocial condition is needed prior to his surgery and why?
2. What is the relevance for evaluation of the patient's home environment in relation to his need for total laryngectomy?
3. You need to reinforce the education given by the surgeon to the patient's daughter and son regarding the possible complications of a total laryngectomy. Briefly discuss each complication as you would with the patient's daughter and son.
4. What other health care resources should be consulted given the above scenario?
5. Given the patient's dementia, would it be reasonable to communicate to him the plan of care and education about the recommended treatment and possible side effects?

- Anxiety and depression related to the diagnosis of cancer and impending surgery
- Ineffective airway clearance related to excess mucus production secondary to surgical alterations in the airway
- Impaired verbal communication related to anatomic deficit secondary to removal of the larynx and to edema
- Imbalanced nutrition: less than body requirements, related to inability to ingest food secondary to swallowing difficulties
- Disturbed body image and low self-esteem secondary to major neck surgery, change in appearance, and altered structure and function
- Self-care deficit related to pain, weakness, fatigue, musculoskeletal impairment related to surgical procedure and postoperative course

#### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications that may develop include the following:

- Respiratory distress (hypoxia, airway obstruction, tracheal edema)
- Hemorrhage, infection, and wound breakdown
- Aspiration
- Tracheostomal stenosis

### Planning and Goals

The major goals for the patient may include attainment of an adequate level of knowledge, reduction in anxiety, maintenance of a patent airway (patient is able to handle own secretions), effective use of alternative means of communication, attainment of optimal levels of nutrition and hydration, improvement in body image and self-esteem, improved self-care management, and absence of complications.

### Nursing Interventions

#### *Teaching the Patient Preoperatively*

The diagnosis of laryngeal cancer often produces misconceptions and fears. Many people assume that loss of speech and disfigurement are inevitable with this condition. Once the physician explains the diagnosis and discusses treatment options with the patient and family, the nurse clarifies any misconceptions by identifying the location of the larynx, its function, the nature of the planned surgical procedure, and its effect on speech. Further, the patient's ability to sing, laugh, and whistle will be lost. Informational materials (written and audiovisual) about the surgery are given to the patient and family for review and reinforcement. If a complete laryngectomy is planned, the patient must understand that the natural voice will be lost, but that special training can provide a means for communicating. The patient needs to know that until training is started, communication will be possible by using the call light, by writing, or by using a special communication board. The interdisciplinary team conducts an initial assessment of the patient and family. In addition to the nurse in charge of the patient's care and the physician, the team might include an advanced practice nurse or nurse practitioner, speech therapist, respiratory therapist, social worker, dietitian, and home care nurse. The

services of a spiritual advisor are made available to the patient and family, as appropriate.

The nurse also reviews equipment and treatments for postoperative care with the patient and family, teaches important coughing and deep-breathing exercises, and helps the patient perform return demonstrations. The nurse clarifies the patient's role in the postoperative and rehabilitation periods. The family's needs must also be addressed because family members are often responsible for complex care of the patient in the home.

***Reducing Anxiety and Depression***

Because surgery of the larynx is performed most often for a malignant tumor, the patient may have many questions: Will the surgeon be able to remove all of the tumor? Is it cancer? Will I die? Will I choke? Will I suffocate? Will I ever speak again? What will I look like? Because of these and other questions, the psychological preparation of the patient is as important as the physical preparation.

Any patient undergoing surgery may have many fears. In laryngeal surgery, these fears may relate to the diagnosis of cancer and the possibility of permanent loss of the voice and disfigurement. The nurse provides the patient and family with opportunities to ask questions, verbalize feelings, and discuss perceptions. The nurse should address any questions and misconceptions the patient and family have. During the preoperative or postoperative period, a visit from someone who has had a laryngectomy may reassure the patient that people are available to assist and that rehabilitation is possible.

In the immediate postoperative period, the nurse attempts to spend uninterrupted time with the patient that is focused on building trust and reducing the patient's anxiety. Active listening provides an environment that promotes open communication and allows the patient to verbalize feelings. Clear instructions and explanations are given to the patient and family in a calm, reassuring manner. The nurse listens attentively, encourages the patient, and identifies and reduces environmental stressors. The nurse seeks to learn from the patient what activities promote feelings of comfort and assists the patient in such activities (eg, listening to music, reading). Relaxation techniques such as guided imagery and meditation are often helpful. The nurse remains with the patient during episodes of severe anxiety and includes the patient in decision making. To support the family, it may be necessary to allow extra visiting periods.

***Maintaining a Patent Airway***

The nurse promotes a patent airway by positioning the patient in the semi-Fowler's or Fowler's position after recovery from anesthesia. This position decreases surgical edema and promotes lung expansion. Observing the patient for restlessness, labored breathing, apprehension, and increased pulse rate helps identify possible respiratory or circulatory problems. The nurse assesses the patient's lung sounds and reports changes that may indicate impending complications. Medications that depress respiration, particularly opioids, should be used cautiously. However, adequate use of analgesic medications is essential for pain relief because postoperative pain can result in shallow breathing and an ineffective cough. The nurse encourages the patient to turn, cough, and take deep breaths. If necessary, suctioning may be performed to remove secretions, but disruption of suture lines must be avoided. The nurse also encourages and assists the patient with early ambulation to prevent atelectasis, pneumonia, and deep vein thrombosis. Pulse oximetry is used to monitor the patient's oxygen saturation level.

If a total laryngectomy was performed, a laryngectomy tube will most likely be in place. In some instances a laryngectomy tube is not used; in others it is used temporarily; and in many it is used permanently. The laryngectomy tube, which is shorter than a tracheostomy tube but has a larger diameter, is the patient's only airway. The care of this tube is similar to that for a tracheostomy tube (see Chapter 25). The nurse changes the inner cannula (if present) every 8 hours if it is disposable. Although nondisposable tubes are used infrequently, if one is used, the nurse cleans the inner cannula every 4 to 6 hours or more often as needed. It should be replaced within 30 to 60 minutes after removal (Schiech, 2007). If a tracheostomy tube without an inner cannula is used, humidification and suctioning of this tube are essential to prevent formation of mucous plugs. If a T-shaped laryngectomy tube is used, both sides of the T-tube should be suctioned to prevent obstruction due to copious secretions. The nurse should also use secure tracheostomy ties to prevent tube dislodgement. The nurse cleans the stoma daily with soap and water or another prescribed solution and a soft cloth or gauze, taking care to prevent water and soap or solution from entering the stoma (Schiech, 2007). If a non–oil-based antibiotic ointment is prescribed, it is applied around the stoma and suture line. If crusting appears around the stoma, the crusts are removed with sterile tweezers and additional ointment is applied.

Wound drains, inserted during surgery, may be in place to assist in removal of fluid and air from the surgical site. Suction also may be used, but cautiously, to avoid trauma to the surgical site and incision. The nurse observes, measures, and records drainage. When drainage is less than 30 mL/day for 2 consecutive days, the physician usually removes the drains.

Frequently, the patient coughs up large amounts of mucus through this opening. Because air passes directly into the trachea without being warmed and moistened by the upper respiratory mucosa, the tracheobronchial tree compensates by secreting excessive amounts of mucus. Therefore, the patient has frequent coughing episodes and may develop a brassy-sounding, mucus-producing cough. The nurse reassures the patient that these problems will diminish in time, as the tracheobronchial mucosa adapts to the altered physiology.

After the patient coughs, the tracheostomy opening must be wiped clean and clear of mucus. A simple gauze dressing, washcloth, or even paper towel (because of its size and absorbency) worn below the tracheostomy may serve as a barrier to protect the clothing from the copious mucus that the patient may initially expel.

One of the most important factors in decreasing cough, mucus production, and crusting around the stoma is adequate humidification of the environment. Mechanical humidifiers and aerosol generators (nebulizers) increase the humidity and are important for the patient's comfort. The laryngectomy tube may be removed when the stoma is well healed, within 3 to 6 weeks after surgery. The nurse teaches the patient how to clean and change the tube (see Chapter 25) and remove secretions.

### Promoting Alternative Communication Methods

Establishing an effective means of communication is usually the ultimate goal in the rehabilitation of the laryngectomy patient. To understand and anticipate the patient's postoperative needs, the nurse works with the patient, speech therapist, and family to encourage use of alternative communication methods. These means of communication are established preoperatively and must be used consistently by all personnel who come in contact with the patient postoperatively. The patient is now unable to use an intercom system. A call bell or hand bell must be placed within easy reach of the patient. A Magic Slate is often used for communication, and the nurse documents which hand the patient uses for writing so that the opposite arm can be used for IV infusions. (To ensure the patient's privacy, the nurse discards notes used for communication.) If the patient cannot write, a picture-word-phrase board or hand signals can be used.

Writing everything or communicating through gestures can be very time-consuming and frustrating. The patient must be given adequate time to communicate his or her needs. The patient may become impatient and angry when not understood.

### Promoting Adequate Nutrition and Hydration

Postoperatively, the patient may not be permitted to eat or drink for several days. Alternative sources of nutrition and hydration include IV fluids, enteral feedings through a nasogastric or gastrostomy tube, and parenteral nutrition.

When the patient is ready to start oral feedings, a speech therapist or radiologist may conduct a swallow study (a video fluoroscopy radiology procedure) to evaluate the patient's risk of aspiration. Once the patient is cleared for oral feedings, the nurse explains that thick liquids will be used first because they are easy to swallow. Different swallowing maneuvers are attempted with various food consistencies. Once the patient is cleared for food intake, the nurse stays with the patient during initial oral feedings and keeps a suction setup at the bedside for needed suctioning. The nurse instructs the patient to avoid sweet foods, which increase salivation and suppress the appetite. Solid foods are introduced as tolerated. The patient is instructed to rinse the mouth with warm water or mouthwash after oral feedings and to brush the teeth frequently.

Because taste and smell are so closely related, taste sensations are altered for a while after surgery because inhaled air passes directly into the trachea, bypassing the nose and the olfactory end organs. In time, however, the patient usually accommodates to this change and olfactory sensation adapts, often with return of interest in eating. The nurse observes the patient for any difficulty in swallowing, particularly when eating resumes, and reports its occurrence to the physician.

The patient's weight and laboratory data are monitored to ensure that nutritional and fluid intake are adequate. In addition, skin turgor and vital signs are assessed for signs of decreased fluid volume.

### Promoting Positive Body Image and Self-Esteem

Disfiguring surgery and an altered communication pattern are threats to a patient's body image and self-esteem. The reaction of family members and friends is a major concern for the patient. The nurse encourages the patient to express feelings about the changes brought about by surgery, particularly feelings related to fear, anger, depression, and isolation. Encouraging use of previous effective coping strategies may be helpful. Referral to a support group, such as International Association of Laryngectomees (IAL), WebWhispers, and I Can Cope (through the American Cancer Society) may help the patient and family deal with the changes in their lives. Contact information for these support groups can be found at the end of the chapter.

### Promoting Self-Care Management

A positive approach along with promotion of self-care activities are important when caring for the patient. The patient should begin participating in self-care activities as soon as possible. The nurse assesses the patient's readiness for decision making and encourages the patient to participate actively in performing care. The nurse provides positive reinforcement when the patient makes an effort in self-care. The nurse needs to be a good listener and a support to the family, especially when explaining the tubes, dressings, and drains that are in place postoperatively.

In addition to its work through support groups, the IAL encourages an exchange of ideas and methods for learning and teaching alaryngeal methods of communication. It also works to promote employers' understanding about cancer of the larynx and to enable patients to retain or obtain employment after surgery.

### Monitoring and Managing Potential Complications

The potential complications after laryngectomy include respiratory distress and hypoxia, hemorrhage, infection, wound breakdown, aspiration, and tracheostomal stenosis.

**RESPIRATORY DISTRESS AND HYPOXIA.** The nurse monitors the patient for signs and symptoms of respiratory distress and hypoxia, particularly restlessness, irritation, agitation, confusion, tachypnea, use of accessory muscles, and decreased oxygen saturation on pulse oximetry ($SpO_2$). Any change in respiratory status requires immediate intervention. Hypoxia may cause restlessness and an initial rise in blood pressure; this is followed by hypotension and somnolence. Cyanosis is a late sign of hypoxia. Obstruction needs to be ruled out immediately by suctioning and by having the patient cough and breathe deeply. Hypoxia and airway obstruction, if not immediately treated, are life-threatening.

Other nursing measures include repositioning of the patient to ensure an open airway and administering oxygen as prescribed and used with caution in patients with chronic obstructive pulmonary disease. The nurse should always be prepared for possible intubation and mechanical ventilation. The nurse must be knowledgeable about the hospital's emergency code protocols and skilled in use of emergency equipment. The nurse must remain with the patient at all times during respiratory distress. The emergency call bell and telephone should be used to initiate a code, call for further assistance, and summon the physician immediately if nursing measures do not improve the patient's respiratory status.

**HEMORRHAGE.** Bleeding from the drains at the surgical site or with tracheal suctioning may signal the occurrence of

hemorrhage. The nurse promptly notifies the surgeon of any active bleeding, which can occur at a variety of sites, including the surgical site, drains, and trachea. Rupture of the carotid artery is especially dangerous. Should this occur, the nurse must apply direct pressure over the artery, summon assistance, and provide emotional support to the patient until the vessel is ligated. The nurse monitors vital signs for changes, particularly increased pulse rate, decreased blood pressure, and rapid deep respirations. Cold, clammy, pale skin may indicate active bleeding. IV fluids and blood components may be administered and other measures implemented to prevent or treat hemorrhagic shock. Management of the patient with shock is discussed in detail in Chapter 15.

**INFECTION.** The nurse monitors the patient for signs of postoperative infection. These include an increase in temperature and pulse, a change in the type of wound drainage, and increased areas of redness or tenderness at the surgical site. Other signs include purulent drainage, odor, and increased wound drainage. The nurse monitors the patient's white blood cell (WBC) count; a rise in WBCs may indicate the body's effort to combat infection. In elderly patients, infection can be present without an increase in the patient's WBC count; therefore, the nurse must monitor the patient for more subtle signs. WBCs are suppressed in the patient with decreased immune function (eg, patients with HIV infection, or those receiving chemotherapy or radiation therapy); this predisposes the patient to a severe infection and sepsis. Antimicrobial (antibiotic) medications must be administered as scheduled. All suspicious drainage is cultured, and the patient may be placed in isolation as indicated. Strategies are implemented to minimize the exposure of the patient to micro-organisms and their spread to others. The nurse reports any significant change in the patient's status to the surgeon.

**WOUND BREAKDOWN.** Wound breakdown caused by infection, poor wound healing, development of a fistula, radiation therapy, or tumor growth can create a life-threatening emergency. The carotid artery, which is close to the stoma, may rupture from erosion if the wound does not heal properly. The nurse observes the stoma area for wound breakdown, hematoma, and bleeding and reports their occurrence to the surgeon. If wound breakdown occurs, the patient must be monitored carefully and identified as at high risk for carotid hemorrhage.

**ASPIRATION.** The patient who has undergone a laryngectomy is at risk for aspiration and aspiration pneumonia due to depressed cough, the sedating effects of anesthetic and analgesic medications, alteration in the airway, impaired swallowing, and the administration of tube feedings. The nurse assesses for the presence of nausea and administers antiemetic medications, as prescribed. The nurse keeps a suction setup available in the hospital and instructs the family to do so at home for use if needed. Patients receiving tube feedings are positioned with the head of the bed at 30 degrees or higher during feedings and for 30 to 45 minutes after tube feedings. Patients receiving oral feedings are positioned with the head of the bed in an upright position for 30 to 45 minutes after feedings. For patients with a nasogastric or gastrostomy tube, the placement of the tube and residual gastric volume must be checked before each feeding. High amounts of residual volume (greater than 50% of previous intake) indicate delayed gastric emptying; this can lead to reflux and aspiration. Signs or symptoms of aspiration are reported to the physician immediately.

**TRACHEOSTOMAL STENOSIS.** Tracheostomal stenosis is an abnormal narrowing of the trachea or the tracheostomy stoma. Infection at the stoma site, excessive traction on the tracheostomy tube by the connecting tubing, and persistent high tracheostomy cuff pressure are risk factors for tracheostomal stenosis. The incidence of this condition varies widely, and it is often preventable. The nurse assesses the patient's stoma for signs and symptoms of infection and reports any evidence of this to the physician immediately. Tracheostomy care is performed routinely. The nurse assesses the connecting tubing (eg, ventilation tubing) and secures the tubing to avoid excessive traction on the patient's tracheostomy. The nurse ensures that the tracheostomy cuff is deflated (for a patient with a cuffed tube) except for short periods, such as when the patient is eating or taking medications.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The nurse has an important role in the recovery and rehabilitation of the patient who has had a laryngectomy. In an effort to facilitate the patient's ability to manage self-care, discharge instruction begins as soon as the patient is able to participate. Nursing care and patient teaching in the hospital, outpatient setting, and rehabilitation or long-term care facility must take into consideration the many emotions, physical changes, and lifestyle changes experienced by the patient. In preparing the patient to go home, the nurse assesses the patient's readiness to learn and the level of knowledge about self-care management. The nurse also reassures the patient and family that most self-care management strategies can be mastered. The patient needs to learn a variety of self-care behaviors, including tracheostomy and stoma care, wound care, and oral hygiene. The nurse also instructs the patient about the need for adequate dietary intake, safe hygiene, and recreational activities.

*Tracheostomy and Stoma Care.* The nurse provides specific instructions to the patient and family about what to expect with a tracheostomy and its management. The nurse teaches the patient and caregiver to perform suctioning and emergency measures and tracheostomy and stoma care. The nurse stresses the importance of humidification at home and instructs the family to obtain and set up a humidification system before the patient returns home. In addition, the nurse cautions the patient and family that air-conditioned air may be too cool or too dry, and therefore irritating for the patient with a new laryngectomy. (See Chapter 25 for details about tracheostomy care.)

*Hygiene and Safety Measures.* The nurse instructs the patient and family about safety precautions that are needed because of the changes in structure and function resulting from the surgery. Special precautions are needed in the

CHART 22-10

**HOME CARE CHECKLIST**

***The Patient With a Laryngectomy***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate methods to clear the airway and handle secretions | ✔ | ✔ |
| • Explain the rationale for maintaining adequate humidification with a humidifier or nebulizer | ✔ | ✔ |
| • Demonstrate how to clean the skin around the stoma and how to use ointments and tweezers to remove encrustations | ✔ | ✔ |
| • State the rationale for wearing a loose-fitting protective cloth at the stoma | ✔ | ✔ |
| • Discuss the need to avoid cold air from air conditioning and the environment to prevent irritation of the airway | ✔ | ✔ |
| • Demonstrate safe technique in changing the laryngectomy/tracheostomy tube | ✔ | ✔ |
| • Identify the signs and symptoms of wound infection and state what to do about them | ✔ | ✔ |
| • Describe safety or emergency measures to implement in case of breathing difficulty or bleeding | ✔ | ✔ |
| • State the rationale for wearing or carrying special medical identification and ways to obtain help in an emergency | ✔ | ✔ |
| • Explain the importance of covering the stoma when showering or bathing | ✔ | ✔ |
| • Identify fluid and caloric needs | ✔ | ✔ |
| • Describe mouth care and discuss its importance | ✔ | ✔ |
| • Demonstrate alternative communication methods | ✔ | |
| • Identify support groups and agency resources | ✔ | ✔ |
| • State the need for regular checkups and reporting of any problems immediately | ✔ | ✔ |

shower to prevent water from entering the stoma. Wearing a loose-fitting plastic bib over the tracheostomy or simply holding a hand over the opening is effective. Swimming is not recommended because a person with a laryngectomy can drown without submerging his or her face. Barbers and beauticians need to be alerted so that hair sprays, loose hair, and powder do not get near the stoma, because they can block or irritate the trachea and possibly cause infection. These self-care points are summarized in Chart 22-10.

The nurse teaches the patient and caregiver the signs and symptoms of infection and identifies indications that require contacting the physician after discharge. A discussion regarding cleanliness and infection control behaviors is essential in the education of the patient. The nurse teaches the patient and family to wash their hands before and after caring for the tracheostomy, to use tissue to remove mucus, and to dispose of soiled dressings and equipment properly. If the patient's surgery included cervical lymph node dissection, the nurse teaches the patient exercises for strengthening the shoulder and neck muscles.

Recreation and exercise are important for the patient's well-being and quality of life, and all but very strenuous exercise can be enjoyed safely. Avoidance of strenuous exercise and fatigue is important because the patient will have more difficulty speaking when tired, which can be discouraging. Additional safety points to address include the need for the patient to wear or carry medical identification, such as a bracelet or card, to alert medical personnel to the special requirements for resuscitation should this need arise. If resuscitation is needed, direct mouth-to-stoma ventilation should be performed. For home emergency situations, prerecorded emergency messages for police, the fire department, or other rescue services can be kept near the phone to be used quickly.

The nurse instructs and encourages the patient to perform oral care on a regular basis to prevent halitosis and infection. If the patient is receiving radiation therapy, synthetic saliva may be required because of decreased saliva production. The nurse instructs the patient to drink water or sugar-free liquids throughout the day and to use a humidifier at home. Brushing the teeth or dentures and rinsing the mouth several times a day will assist in maintaining proper oral hygiene.

**CONTINUING CARE.** Referral for home care is an important aspect of postoperative care for the patient who has had a laryngectomy and will assist the patient and family in the transition to the home. The home care nurse assesses the patient's general health status and the ability of the patient and family to care for the stoma and tracheostomy. The nurse assesses the surgical incisions, nutritional and respiratory status, and adequacy of pain management. The nurse assesses for signs and symptoms of complications and the patient's and family's knowledge of signs and symptoms to be reported to the physician. During the home visit, the nurse identifies and addresses other learning needs and concerns of the patient and family, such as adaptation to physical, lifestyle, and functional changes, as well as the patient's progress with learning and using new communication strategies. The nurse

assesses the patient's psychological status as well. The home care nurse reinforces previous teaching and provides reassurance and support to the patient and family caregivers as needed.

It is important that the person who has had a laryngectomy have regular physical examinations and seek advice concerning any problems related to recovery and rehabilitation. The nurse also reminds the patient to participate in health promotion activities and health screening and about the importance of keeping scheduled appointments with the physician, speech therapist, and other health care providers.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Demonstrates an adequate level of knowledge, verbalizing an understanding of the surgical procedure and performing self-care adequately
2. Demonstrates less anxiety and depression
   a. Expresses a sense of hope
   b. Is aware of available community organizations and agencies that provide patient education and support groups
   c. Participates in support group for people with a laryngectomy
3. Maintains a clear airway and handles own secretions; also demonstrates practical, safe, and correct technique for cleaning and changing the tracheostomy or laryngectomy tube
4. Acquires effective communication techniques
   a. Uses assistive devices and strategies for communication (Magic Slate, call bell, picture board, sign language, speech reading, computer aids)
   b. Follows the recommendations of the speech therapist
   c. Demonstrates ability to communicate with new communication strategy
   d. Reports availability of prerecorded messages to summon emergency assistance by telephone
5. Maintains adequate nutrition and adequate fluid intake
6. Exhibits improved body image, self-esteem, and self-concept
   a. Expresses feelings and concerns
   b. Participates in self-care and decision making
   c. Accepts information about support group
7. Adheres to rehabilitation and home care program
   a. Practices recommended speech therapy
   b. Demonstrates proper methods for caring for stoma and laryngectomy or tracheostomy tube (if present)
   c. Verbalizes understanding of symptoms that require medical attention
   d. States safety measures to take in emergencies
   e. Performs oral hygiene as prescribed
8. Absence of complications
   a. Demonstrates a patent airway
   b. No bleeding from surgical site and minimal bleeding from drains; vital signs (blood pressure, temperature, pulse, respiratory rate) are normal
   c. No redness, tenderness, or purulent drainage at surgical site
   d. No wound breakdown
   e. Clear breath sounds; oxygen saturation level within acceptable range; chest x-ray clear
   f. No indications of infection, stenosis, or obstruction of tracheal stoma

## CRITICAL THINKING EXERCISES

**1** A 20-year-old male college student comes to the student health clinic with complaints of a sore throat and a fever lasting more than 12 days. Your physical assessment reveals a fiery-red pharyngeal membrane and tonsils with white-purple exudates and a scarlatina-form rash on the chest, abdomen, and axilla. What diagnostic tests and treatment would you anticipate for this patient? What teaching is needed to ensure that he complies with the treatment plan? What additional nursing measures would be indicated for this patient if he indicates that he is opposed to use of all medications because of his cultural and religious beliefs?

**2** You are working in a sleep apnea clinic. A man has been referred to the clinic for testing. What risk factors for obstructive sleep apnea (OSA) will your health history focus on? What are the common signs and symptoms of OSA? What diagnostic tool is used to diagnose sleep apnea and how would you explain the diagnostic procedure to the patient? Once the diagnosis of OSA is confirmed, continuous positive airway pressure (CPAP) is prescribed. What instructions would you provide about CPAP? How would you modify your teaching if the patient does not speak English? If he is blind?

EBP **3** You are with your family at a company picnic and you see that a coworker is grasping her throat and is unable to speak or cough. You suspect that she is choking. You know that the abdominal thrust is used to remove a foreign object from a conscious adult who is choking. Briefly describe what you would do in this situation. What is the evidence base for your actions? How would you determine the strength of the evidence on which your actions are based?

EBP **4** You are the home health nurse for a female patient who has undergone a total laryngectomy for the treatment of cancer of the larynx. You are responsible to provide patient education regarding tracheostomy care and gastric tube feedings. The overall plan is for the patient to begin to assume responsibility for her own care and to consider speech therapy, but the patient and her husband believe she is not yet ready to do so. What are your priorities in terms of assessment of this patient? What is your plan to address the patient's fear, anxiety, communication, and nutrition needs? What is the evidence base for your actions in response to the patient's fear, anxiety, communication, and nutritional needs? How would you assess the strength of the evidence on which your actions are based?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Academy of Allergy, Asthma & Immunology, www.aaaai.org
American Academy of Otolaryngology-Head and Neck Surgery, www.entnet.org
American Cancer Society, www.cancer.org
American Lung Association, www.lungusa.org
American Sleep Apnea Association, www.sleepapnea.org/info/index.html
International Association of Laryngectomees (IAL), www.larynxlink.com
National Cancer Institute (NCI), www.cancernet.nci.nih.gov
National Comprehensive Cancer Network, www.nccn.org/about/contact.asp
National Heart, Lung, and Blood Institute (NHBLI), www.nhlbi.nih.gov
National Institute of Allergy and Infectious Disease, www.niaid.nih.gov
National Sleep Foundation, www.sleepfoundation.org
WebWhispers, www.webwhispers.org



chapter 23

# Management of Patients With Chest and Lower Respiratory Tract Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify patients at risk for atelectasis and nursing interventions related to its prevention and management.
2. Compare the various pulmonary infections with regard to causes, clinical manifestations, nursing management, complications, and prevention.
3. Use the nursing process as a framework for care of the patient with pneumonia.
4. Describe nursing measures to prevent aspiration.
5. Relate pleurisy, pleural effusion, and empyema to pulmonary infection.
6. Describe smoking and air pollution as causes of pulmonary disease.
7. Relate the therapeutic management techniques of acute respiratory distress syndrome to the underlying pathophysiology of the syndrome.
8. Describe risk factors and measures appropriate for prevention and management of pulmonary embolism.
9. Describe preventive measures appropriate for controlling and eliminating occupational lung disease.
10. Discuss the modes of therapy and related nursing management for patients with lung cancer.
11. Describe the complications of chest trauma and their clinical manifestations and nursing management.

## GLOSSARY

**acute lung injury:** an umbrella term for hypoxemic, respiratory failure; acute respiratory distress syndrome is a severe form of acute lung injury

**acute respiratory distress syndrome:** nonspecific pulmonary response to a variety of pulmonary and nonpulmonary insults to the lung; characterized by interstitial infiltrates, alveolar hemorrhage, atelectasis, decreased compliance, and refractory hypoxemia

**asbestosis:** diffuse lung fibrosis resulting from exposure to asbestos fibers

**atelectasis:** collapse or airless condition of the alveoli caused by hypoventilation, obstruction to the airways, or compression

## GLOSSARY *(Continued)*

**central cyanosis:** bluish discoloration of the skin or mucous membranes due to hemoglobin carrying reduced amounts of oxygen

**consolidation:** lung tissue that has become more solid in nature due to collapse of alveoli or infectious process (pneumonia)

**cor pulmonale:** "heart of the lungs"; enlargement of the right ventricle from hypertrophy or dilation or as a secondary response to disorders that affect the lungs

**empyema:** accumulation of purulent material in the pleural space

**fine-needle aspiration:** insertion of a needle through the chest wall to obtain cells of a mass or tumor; usually performed under fluoroscopy or chest computed tomography guidance

**hemoptysis:** the coughing up of blood from the lower respiratory tract

**hemothorax:** partial or complete collapse of the lung due to blood accumulating in the pleural space; may occur after surgery or trauma

**induration:** an abnormally hard lesion or reaction, as in a positive tuberculin skin test

**nosocomial:** pertaining to or originating from a hospitalization; not present at the time of hospital admission

**open lung biopsy:** biopsy of lung tissue performed through a limited thoracotomy incision

**orthopnea:** shortness of breath when reclining or in the supine position

**pleural effusion:** abnormal accumulation of fluid in the pleural space

**pleural friction rub:** localized grating or creaking sound caused by the rubbing together of inflamed parietal and visceral pleurae

**pleural space:** the area between the parietal and visceral pleurae; a potential space

**pneumothorax:** partial or complete collapse of the lung due to positive pressure in the pleural space

**pulmonary edema:** increase in the amount of extravascular fluid in the lung

**pulmonary embolism:** obstruction of the pulmonary vasculature with an embolus; embolus may be due to blood clot, air bubbles, or fat droplets

**purulent:** consisting of, containing, or discharging pus

**restrictive lung disease:** disease of the lung that causes a decrease in lung volumes

**tension pneumothorax:** pneumothorax characterized by increasing positive pressure in the pleural space with each breath; this is an emergency situation and the positive pressure needs to be decompressed or released immediately

**thoracentesis:** insertion of a needle into the pleural space to remove fluid that has accumulated and decrease pressure on the lung tissue; may also be used diagnostically to identify potential causes of a pleural effusion

**transbronchial:** through the bronchial wall, as in a transbronchial lung biopsy

**ventilation–perfusion ratio:** the ratio between ventilation and perfusion in the lung; matching of ventilation to perfusion optimizes gas exchange

Conditions affecting the lower respiratory tract range from acute problems to chronic disorders. Many of these disorders are serious and often life-threatening. Patients with lower respiratory tract disorders require care from nurses with astute assessment and clinical management skills who understand the impact of the particular disorder on the patient's quality of life and ability to carry out usual activities of daily living. Patient and family teaching is an important nursing intervention in the management of all lower respiratory tract disorders.

# ATELECTASIS

**Atelectasis** refers to closure or collapse of alveoli and often is described in relation to x-ray findings and clinical signs and symptoms. Atelectasis may be acute or chronic and may cover a broad range of pathophysiologic changes, from microatelectasis (which is not detectable on chest x-ray) to macroatelectasis with loss of segmental, lobar, or overall lung volume. The most commonly described atelectasis is acute atelectasis, which occurs most often in the postoperative setting or in people who are immobilized and have a shallow, monotonous breathing pattern. Excess secretions or mucous plugs may also cause obstruction of airflow and result in atelectasis in an area of the lung. Atelectasis also is observed in patients with a chronic airway obstruction that impedes or blocks air flow to an area of the lung (eg, obstructive atelectasis in the patient with lung cancer that is invading or compressing the airways). This type of atelectasis is more insidious and slower in onset.

## Pathophysiology

Atelectasis may occur in adults as a result of reduced ventilation or any blockage that obstructs passage of air to and from the alveoli, thus reducing alveolar ventilation. After the trapped alveolar air is absorbed into the bloodstream, no additional air can enter into the alveoli because of the blockage. As a result, the affected portion of the lung becomes airless and the alveoli collapse. Possible causes are altered breathing patterns, retained secretions, pain, alterations in small airway function, prolonged supine positioning, increased abdominal pressure, reduced lung volumes due to musculoskeletal or neurologic disorders, restrictive defects, and specific surgical procedures (eg, upper abdominal, thoracic, or open heart surgery).

Patients are at high risk for atelectasis postoperatively because of several factors. A monotonous, low tidal breathing pattern may cause small airway closure and alveolar collapse. This can result from the effects of anesthesia or analgesic agents, supine positioning, splinting of the chest wall because of pain, or abdominal distention. Secretion retention, airway obstruction, and an impaired cough reflex may also occur, or patients may be reluctant to cough because of pain. Figure 23-1 shows the mechanisms and consequences of acute atelectasis in postoperative patients.

Atelectasis resulting from bronchial obstruction by secretions may also occur in patients with impaired cough mechanisms (eg, musculoskeletal or neurologic disorders) as well as in those who are debilitated and bedridden. In addition, atelectasis may develop because of excessive pressure on the lung tissue, which restricts normal lung expansion on inspiration. Such pressure can be produced by fluid accumulating within the pleural space (**pleural effusion**), air in the pleural space (**pneumothorax**), or blood in the pleural space (**hemothorax**). The **pleural space** is the area between the parietal and the visceral pleurae. Pressure may also be produced by a pericardium distended with fluid (pericardial effusion), tumor growth within the thorax, or an elevated diaphragm.

## Clinical Manifestations

The development of atelectasis usually is insidious. Signs and symptoms include increasing dyspnea, cough, and sputum production.

In acute atelectasis involving a large amount of lung tissue (lobar atelectasis), marked respiratory distress may be observed. In addition to the previously mentioned signs and symptoms, tachycardia, tachypnea, pleural pain, and **central cyanosis** (a bluish skin hue that is a late sign of hypoxemia) may be anticipated. Patients characteristically have difficulty breathing in the supine position and are anxious.

In chronic atelectasis, signs and symptoms are similar to those of acute atelectasis. The chronic nature of the alveolar collapse predisposes patients to infection distal to the obstruction. Therefore, the signs and symptoms of a pulmonary infection also may be present.

## Assessment and Diagnostic Findings

When clinically significant atelectasis develops, it is generally characterized by increased work of breathing and hypoxemia. Decreased breath sounds and crackles are heard over the affected area. A chest x-ray may suggest a diagnosis of atelectasis before clinical symptoms appear; the x-ray may reveal patchy infiltrates or consolidated areas. Depending on the degree of hypoxemia, pulse oximetry ($SpO_2$) may demonstrate a low saturation of hemoglobin with oxygen (less than 90%) or a lower-than-normal partial pressure of arterial oxygen ($PaO_2$).

*NURSING ALERT*

**Tachypnea, dyspnea, and mild to moderate hypoxemia are hallmarks of the severity of atelectasis.**

## Prevention

Nursing measures to prevent atelectasis include frequent turning, early mobilization, and strategies to expand the lungs and to manage secretions. Voluntary deep-breathing maneuvers (at least every 2 hours) assist in preventing and treating atelectasis. The performance of these maneuvers requires the patient to be alert and cooperative. Patient education and reinforcement are key to the success of these interventions. The use of incentive spirometry or voluntary deep breathing enhances lung expansion, decreases the potential for airway closure, and may generate a cough. Secretion management techniques include directed cough, suctioning, aerosol nebulizer treatments followed by chest physical therapy (postural drainage and chest percussion), and bronchoscopy. In some settings, a metered-dose inhaler is used to dispense a bronchodilator rather than an aerosol nebulizer. Chart 23-1 summarizes measures used to prevent atelectasis.

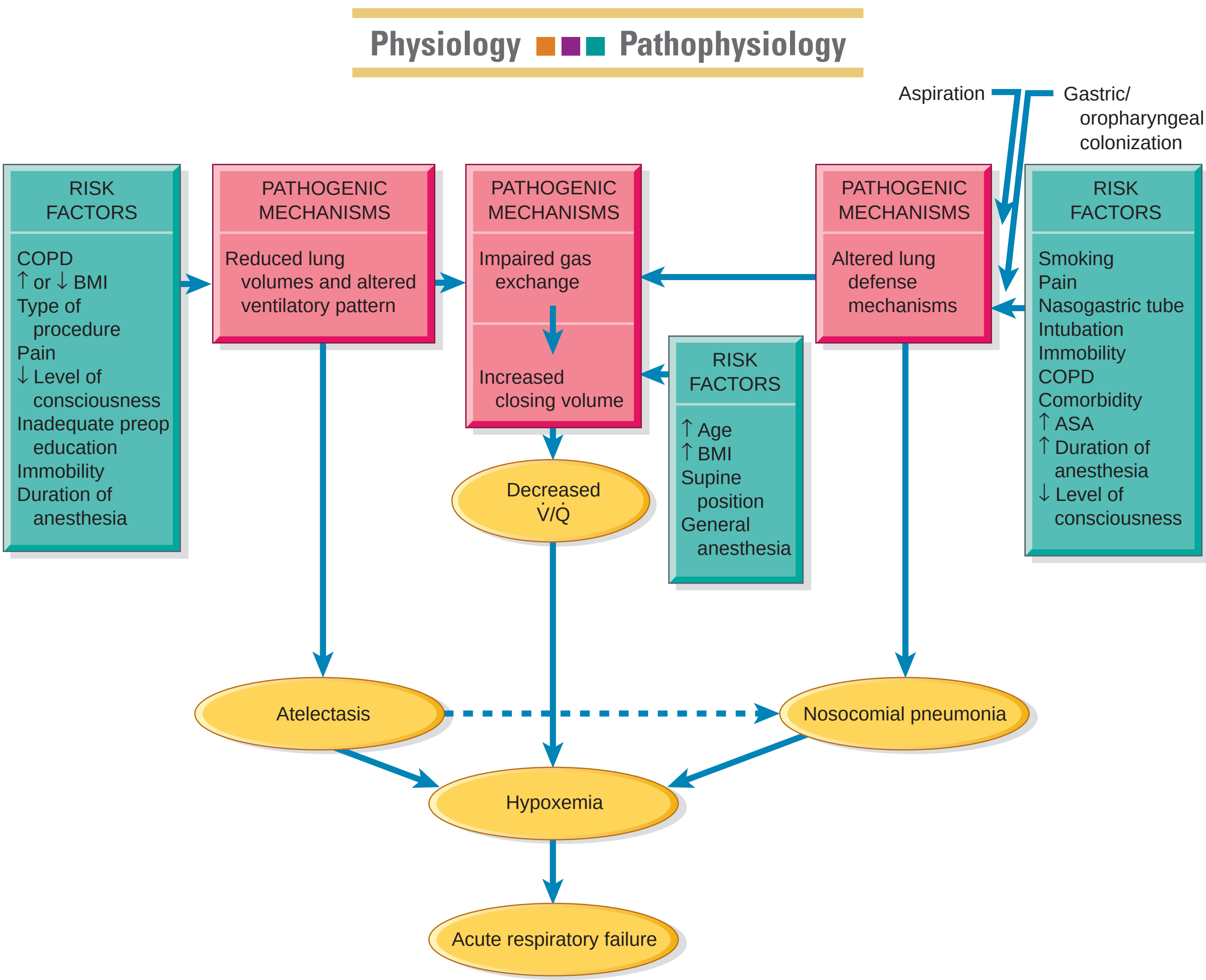



**Figure 23-1** Relationship of risk factors, pathogenic mechanisms, and consequences of acute atelectasis in the postoperative patient. ASA, acetylsalicylic acid; COPD, chronic obstructive pulmonary disease; BMI, body mass index; (V̇/Q̇), ventilation–perfusion ratio. From the work of Jo Ann Brooks-Brunn, DNS, RN, FAAN, FCCP, Indiana University Medical Center, Indianapolis.

## Management

The goal of treatment is to improve ventilation and remove secretions. Strategies to prevent atelectasis, which include frequent turning, early ambulation, lung volume expansion maneuvers (eg, deep-breathing exercises, incentive spirometry), and coughing, also serve as the first-line measures to minimize or treat atelectasis by improving ventilation. In patients who do not respond to first-line measures or who cannot perform deep-breathing exercises, other treatments such as positive end-expiratory pressure (PEEP; a simple mask and one-way valve system that provides varying amounts of expiratory resistance, usually 10 to 15 cm $H_2O$), continuous positive pressure breathing (CPPB), or bronchoscopy may be used. Before initiating more complex, costly, and labor-intensive therapies, the nurse should ask several questions:

- Has the patient been given an adequate trial of deep-breathing exercises?
- Has the patient received adequate education, supervision, and coaching to carry out the deep-breathing exercises?
- Have other factors been evaluated that may impair ventilation or prevent a good patient effort (eg, lack of turning, mobilization; excessive pain; excessive sedation)?

### Chart 23-1 • *Preventing Atelectasis*

- Change patient's position frequently, especially from supine to upright position, to promote ventilation and prevent secretions from accumulating.
- Encourage early mobilization from bed to chair followed by early ambulation.
- Encourage appropriate deep breathing and coughing to mobilize secretions and prevent them from accumulating.
- Teach/reinforce appropriate technique for incentive spirometry.
- Administer prescribed opioids and sedatives judiciously to prevent respiratory depression.
- Perform postural drainage and chest percussion, if indicated.
- Institute suctioning to remove tracheobronchial secretions, if indicated.

If the cause of atelectasis is bronchial obstruction from secretions, the secretions must be removed by coughing or suctioning to allow air to reenter that portion of the lung. Chest physical therapy (chest percussion and postural drainage) may also be used to mobilize secretions. Nebulizer treatments with a bronchodilator or sodium bicarbonate may be used to assist patients in the expectoration of secretions. If respiratory care measures fail to remove the obstruction, a bronchoscopy is performed. Although bronchoscopy is an excellent measure to acutely remove secretions and increase ventilation, it is imperative for the nurse to assist the patient with maintaining the patency of the airways after bronchoscopy, using the traditional techniques of deep breathing, coughing, and suctioning. Severe or massive atelectasis may lead to acute respiratory failure, especially in patients with underlying lung disease. Endotracheal intubation and mechanical ventilation may be necessary.

If the cause of atelectasis is compression of lung tissue, the goal is to decrease the compression. With a large pleural effusion that is compressing lung tissue and causing alveolar collapse, treatment may include **thoracentesis** (removal of the fluid by needle aspiration) or insertion of a chest tube. The measures to increase lung expansion described previously also are used.

Management of chronic atelectasis focuses on removing the cause of the obstruction of the airways or the compression of the lung tissue. For example, bronchoscopy may be used to open an airway obstructed by lung cancer or a nonmalignant lesion, and the procedure may involve cryotherapy or laser therapy. If the atelectasis is a result of obstruction caused by lung cancer, an airway stent or radiation therapy to shrink a tumor may be used to open the airways and provide ventilation to the collapsed area. However, in patients who have experienced chronic, long-term collapse, it may not be possible to reopen the airways and reaerate the area of the lung. In some cases, surgical management may be indicated.

# RESPIRATORY INFECTIONS

## *Acute Tracheobronchitis*

Acute tracheobronchitis, an acute inflammation of the mucous membranes of the trachea and the bronchial tree, often follows infection of the upper respiratory tract (see Chapter 22). Patients with viral infections have decreased resistance and can readily develop a secondary bacterial infection. Adequate treatment of upper respiratory tract infection is one of the major factors in the prevention of acute bronchitis.

### Pathophysiology

In acute tracheobronchitis, the inflamed mucosa of the bronchi produces mucopurulent sputum, often in response to infection by *Streptococcus pneumoniae*, *Haemophilus influenzae*, or *Mycoplasma pneumoniae*. In addition, a fungal infection (eg, *Aspergillus*) may also cause tracheobronchitis. A sputum culture is essential to identify the specific causative organism. In addition to infection, inhalation of physical and chemical irritants, gases, or other air contaminants can also cause acute bronchial irritation.

### Clinical Manifestations

Initially, the patient has a dry, irritating cough and expectorates a scanty amount of mucoid sputum. The patient may report sternal soreness from coughing and have fever or chills, night sweats, headache, and general malaise. As the infection progresses, the patient may be short of breath, have noisy inspiration and expiration (inspiratory stridor and expiratory wheeze), and produce **purulent** (pus-filled) sputum. In severe tracheobronchitis, blood-streaked secretions may be expectorated as a result of the irritation of the mucosa of the airways.

### Medical Management

Antibiotic treatment may be indicated depending on the symptoms, sputum purulence, and results of the sputum culture. Antihistamines usually are not prescribed, because they can cause excessive drying and make secretions more difficult to expectorate. Expectorants may be prescribed, although their efficacy is questionable. Fluid intake is increased to thin the viscous and tenacious secretions. Copious, purulent secretions that cannot be cleared by coughing place patients at risk for increasing airway obstruction and the development of more severe lower respiratory tract infections, such as pneumonia. Suctioning and bronchoscopy may be needed to remove secretions. Rarely, endotracheal intubation may be necessary in cases of acute tracheobronchitis leading to acute respiratory failure, such as in patients who are severely debilitated or who have coexisting diseases that also impair the respiratory system.

In most cases, treatment of tracheobronchitis is largely symptomatic. Increasing the vapor pressure (moisture content) in the air reduces airway irritation. Cool vapor therapy or steam inhalations may help relieve laryngeal and tracheal irritation. Moist heat to the chest may relieve the soreness and pain. Mild analgesic or antipyretic agents may be indicated.

### Nursing Management

Acute tracheobronchitis is usually treated in the home setting. A primary nursing function is to encourage bronchial hygiene, such as increased fluid intake and directed coughing to remove secretions. The nurse encourages and assists the patient to sit up frequently to cough effectively and to prevent retention of mucopurulent sputum. If the patient is taking antibiotics for an underlying infection, it is important to emphasize the need to complete the full course of antibiotics prescribed. Fatigue is a consequence of tracheobronchitis; therefore, the nurse cautions the patient against overexertion, which can induce a relapse or exacerbation of the infection. The patient is advised to rest.

## *Pneumonia*

Pneumonia is an inflammation of the lung parenchyma caused by various microorganisms, including bacteria, mycobacteria, fungi, and viruses. *Pneumonitis* is a more general term that describes an inflammatory process in the lung tissue that may predispose or place the patient at risk for microbial invasion. Pneumonia and influenza are the most

common causes of death from infectious diseases in the United States. Together they account for nearly 60,000 deaths annually and rank as the eighth leading cause of death in the United States (Minino, Heron, Murphy, et al., 2007).

## Classification

Pneumonias are classified as community-acquired pneumonia (CAP), hospital-acquired (nosocomial) pneumonia (HAP), pneumonia in the immunocompromised host, and aspiration pneumonia (Table 23-1). There is overlap in how specific pneumonias are classified, because they may occur in differing settings.

### *Community-Acquired Pneumonia*

CAP occurs either in the community setting or within the first 48 hours after hospitalization or institutionalization. The need for hospitalization for CAP depends on the severity of the pneumonia. The causative agents for CAP that requires hospitalization are most frequently *S. pneumoniae, H. influenzae, Legionella, Pseudomonas aeruginosa,* and other gram-negative rods. The specific etiologic agent is identified in about 50% of cases. It is estimated that more than 915,000 episodes of CAP occur in adults 65 years of age and older each year in the United States (Mandell, Wunderink, Anzueto, et al., 2007).

*S. pneumoniae* (pneumococcus) is the most common cause of CAP in people younger than 60 years of age without comorbidity and in those 60 years and older with comorbidity. *S. pneumoniae,* a gram-positive organism that resides naturally in the upper respiratory tract, colonizes the upper respiratory tract and can cause disseminated invasive infections, pneumonia and other lower respiratory tract infections, and upper respiratory tract infections, such as otitis media and rhinosinusitis. It may occur as a lobar or bronchopneumonic form in patients of any age and may follow a recent respiratory illness.

*H. influenzae* causes a type of CAP that frequently affects elderly people and those with comorbid illnesses (eg, chronic obstructive pulmonary disease [COPD], alcoholism, diabetes mellitus). The presentation is indistinguishable from that of other forms of bacterial CAP and may be subacute, with cough or low-grade fever for weeks before diagnosis.

Mycoplasma pneumonia is caused by *M. pneumoniae.* Mycoplasma pneumonia is spread by infected respiratory droplets through person-to-person contact. Patients can be tested for mycoplasma antibodies. The inflammatory infiltrate is primarily interstitial rather than alveolar. It spreads throughout the entire respiratory tract, including the bronchioles, and has the characteristics of a bronchopneumonia. Earache and bullous myringitis are common. Impaired ventilation and diffusion may occur.

Viruses are the most common cause of pneumonia in infants and children but are relatively uncommon causes of CAP in adults. In immunocompromised adults, cytomegalovirus is the most common viral pathogen, followed by herpes simplex virus, adenovirus, and respiratory syncytial virus. The acute stage of a viral respiratory infection occurs within the ciliated cells of the airways, followed by infiltration of the tracheobronchial tree. With pneumonia, the inflammatory process extends into the alveolar area, resulting in edema and exudation. The clinical signs and symptoms of a viral pneumonia are often difficult to distinguish from those of a bacterial pneumonia.

### *Hospital-Acquired Pneumonia*

HAP, also known as **nosocomial** pneumonia, is defined as the onset of pneumonia symptoms more than 48 hours after admission in patients with no evidence of infection at the time of admission. The most lethal nosocomial infection, HAP accounts for approximately 15% of hospital-acquired infections and is the leading cause of death in patients with such infections (File, 2007). The estimated incidence of HAP is 4 to 7 episodes per 1000 hospitalizations (File, 2007). Ventilator-associated pneumonia is considered a type of nosocomial pneumonia that is associated with endotracheal intubation and mechanical ventilation. This type of pneumonia is defined as bacterial pneumonia that develops in patients with acute respiratory failure who have been receiving mechanical ventilation for at least 48 hours.

Certain factors may predispose patients to HAP because of impaired host defenses (eg, severe acute or chronic illness), a variety of comorbid conditions, supine positioning and aspiration, coma, malnutrition, prolonged hospitalization, hypotension, and metabolic disorders. Hospitalized patients are also exposed to potential bacteria from other sources (eg, respiratory therapy devices and equipment, transmission of pathogens by the hands of health care personnel). Numerous intervention-related factors also may play a role in the development of HAP (eg, therapeutic agents leading to central nervous system depression with decreased ventilation, impaired removal of secretions, or potential aspiration; prolonged or complicated thoracoabdominal procedures, which may impair mucociliary function and cellular host defenses; endotracheal intubation; prolonged or inappropriate use of antibiotics; use of nasogastric tubes). In addition, immunocompromised patients are at particular risk. HAP is associated with a high mortality rate, in part because of the virulence of the organisms, their resistance to antibiotics, and the patient's underlying disorder.

The common organisms responsible for HAP include the pathogens *Enterobacter* species, *Escherichia coli, H. influenzae, Klebsiella* species, *Proteus, Serratia marcescens, P. aeruginosa,* methicillin-sensitive or methicillin-resistant *Staphylococcus aureus* (MRSA), and *S. pneumoniae*. Most patients with HAP are colonized by multiple organisms. Pseudomonal pneumonia occurs in patients who are debilitated, those with altered mental status, and those with prolonged intubation or with tracheostomy. Staphylococcal pneumonia can occur through inhalation of the organism or spread through the hematogenous route. It is often accompanied by bacteremia and positive blood cultures. Its mortality rate is high. Specific strains of staphylococci are resistant to all available antimicrobial agents except vancomycin. Overuse and misuse of antimicrobial agents are major risk factors for the emergence of these resistant pathogens. Because MRSA is highly virulent, steps must be taken to prevent its spread. Patients with MRSA are isolated in a private room, and contact precautions (gown, mask, glove, and antibacterial soap) are used. The number of people in contact with affected patients is minimized, and appropriate precautions must be

**Table 23-1 COMMONLY ENCOUNTERED PNEUMONIAS**

| Type (Causal Organism) | Epidemiology | Clinical Features | Treatment | Complications/ Comments |
|---|---|---|---|---|
| **Community-Acquired Pneumonia** | | | | |
| Streptococcal pneumonia (*Streptococcus pneumoniae*) | Most prevalent in winter months<br>More frequent occurrence in African Americans<br>Incidence greatest in the elderly and in patients with COPD, heart failure, alcoholism, asplenia, diabetes, and after influenza<br>Leading infectious cause of illness worldwide among young children, people with underlying chronic health conditions, and the elderly<br>Mortality in hospitalized adults with invasive disease: 14% | Abrupt onset, toxic appearance, pleuritic chest pain. Usually involves one or more lobes<br>Lobar infiltrate common on chest x-ray or bronchopneumonia pattern | Penicillin nonresistant—penicillin G, amoxicillin<br>Penicillin resistant—cefotaxime, ceftriaxone, fluoroquinolone | Shock, pleural effusion, superinfections, pericarditis, and otitis media |
| *Haemophilus influenzae* (*Haemophilus influenzae*) | Incidence greatest in alcoholics, the elderly, patients in long-term care facilities and nursing homes, patients with diabetes or COPD, and children <5 yr of age<br>Accounts for 5–20% of community-acquired pneumonias<br>Mortality rate: 30% | Frequently insidious onset associated with upper respiratory tract infection 2–6 wk before onset of illness. Fever, chills, productive cough. Usually involves one or more lobes. Bacteremia is common. Infiltrate, occasional bronchopneumonia pattern on chest x-ray | Non–beta-lactamase producing—amoxicillin; beta-lactamase producing—second- or third-generation cephalosporin, amoxicillin-clavulanate | Lung abscess, pleural effusion, meningitis, arthritis, pericarditis, epiglottitis |
| Legionnaires' disease (*Legionella pneumophila*) | Highest occurrence in summer and fall<br>May cause disease sporadically or as part of an epidemic<br>Incidence greatest in middle-aged and older men, smokers, patients with chronic diseases, those receiving immunosuppressive therapy, and those in close proximity to excavation sites<br>Accounts for 15% of community-acquired pneumonias<br>Mortality rate: 15–50%. | Flulike symptoms. High fevers, mental confusion, headache, pleuritic pain, myalgias, dyspnea, productive cough, hemoptysis, leukocytosis<br>Bronchopneumonia, unilateral or bilateral disease, lobar consolidation | Fluoroquinolone, azithromycin | Hypotension, shock, and acute renal failure |
| *Mycoplasma pneumoniae* (*Mycoplasma pneumoniae*) | Increase in fall and winter<br>Responsible for epidemics of respiratory illness<br>Most common type of atypical pneumonia<br>Accounts for 20% of community-acquired pneumonias. More common in children and young adults<br>Mortality rate: <0.1% | Onset is usually insidious. Patients not usually as ill as in other pneumonias. Sore throat, nasal congestion, ear pain, headache, low-grade fever, pleuritic pain, myalgias, diarrhea, erythematous rash, pharyngitis. Interstitial infiltrates on chest x-ray | Macrolide, a tetracycline | Aseptic meningitis, meningoencephalitis, transverse myelitis, cranial nerve palsies, pericarditis, myocarditis |
| Viral pneumonia (influenza viruses types A, B adenovirus, parainfluenza, cytomegalovirus, coronavirus, varicella-zoster) | Incidence greatest in winter months<br>Epidemics occur every 2–3 yr.<br>Most common causative organisms in adults. Other organisms in children (eg, cytomegalovirus, respiratory syncytial virus)<br>Accounts for 20% of community-acquired pneumonias | Patchy infiltrate, small pleural effusion on chest x-ray<br>In most patients, influenza begins as an acute upper respiratory infection; others have bronchitis, pleurisy, and so on, and still others develop gastrointestinal symptoms. | Oseltamivir or zanamivir<br>Treated symptomatically<br>Does not respond to treatment with currently available antimicrobials | Superimposed bacterial infection, bronchopneumonia |

(*Continued*)

**Table 23-1 COMMONLY ENCOUNTERED PNEUMONIAS (Continued)**

| Type (Causal Organism) | Epidemiology | Clinical Features | Treatment | Complications/ Comments |
|---|---|---|---|---|
| Chlamydial pneumonia (*Chlamydophilia pneumoniae)* | Reported mainly in college students, military recruits, and the elderly<br>May be a common cause of community-acquired pneumonia or observed in combination with other pathogens<br>Mortality rate is low because the majority of cases are relatively mild. The elderly with coexistent infections, comorbidities, and reinfections may require hospitalization. | Hoarseness, fever, chills, pharyngitis, rhinitis, nonproductive cough, myalgias, arthralgias<br>Single infiltrate on chest x-ray; pleural effusion possible | Fluoroquinolone | Reinfection and acute respiratory failure |
| **Hospital-Acquired Pneumonia** | | | | |
| *Pseudomonas* pneumonia *(Pseudomonas aeruginosa)* | Incidence greatest in those with preexisting lung disease, cancer (particularly leukemia); those with homograft transplants, burns; debilitated people; and patients receiving antimicrobial therapy and treatments such as tracheostomy, suctioning, and in postoperative settings. Almost always of nosocomial origin.<br>Accounts for 15% of hospital-acquired pneumonias<br>Mortality rate: 40–60% | Diffuse consolidation on chest x-ray. Toxic appearance: fever, chills, productive cough, relative bradycardia, leukocytosis | Antipseudomonal beta-lactam plus ciprofloxacin, levofloxacin or aminoglycoside | Lung cavitation. Has capacity to invade blood vessels, causing hemorrhage and lung infarction. Usually requires hospitalization |
| Staphylococcal pneumonia *(Staphylococcus aureus)* | Incidence greatest in immunocompromised patients, IV drug users, and as a complication of epidemic influenza<br>Commonly nosocomial in origin<br>Accounts for 10–30% of hospital-acquired pneumonias<br>Mortality rate: 25–60%<br>Methicillin-resistant *S. aureus* (MRSA) may also cause community-based infection. | Severe hypoxemia, cyanosis, necrotizing infection. Bacteremia is common. | Methicillin susceptible—antistaphylococcal penicillin<br>Methicillin resistant—vancomycin or linezolid | Pleural effusion/ pneumothorax, lung abscess, empyema, meningitis, endocarditis. Frequently requires hospitalization. Treatment must be vigorous and prolonged because disease tends to destroy lung tissue. |
| *Klebsiella* pneumonia *(Klebsiella pneumoniae* [Friedländer's bacillus-encapsulated gram-negative aerobic bacillus]) | Incidence greatest in the elderly; alcoholics; patients with chronic disease, such as diabetes, heart failure, COPD; patients in chronic care facilities and nursing homes<br>Accounts for 2–5% of community-acquired and 10–30% of hospital-acquired pneumonias<br>Mortality rate: 40–50% | Tissue necrosis occurs rapidly. Toxic appearance: fever, cough, sputum production, bronchopneumonia, lung abscess. Lobar consolidation, bronchopneumonia pattern on chest x-ray | Meropenem or levofloxacin or piperacillin/tazobactam plus amikacin | Multiple lung abscesses with cyst formation, empyema, pericarditis, pleural effusion. May be fulminating, progressing to fatal outcome |

*Continued on following page*

**Table 23-1 COMMONLY ENCOUNTERED PNEUMONIAS (Continued)**

| Type (Causal Organism) | Epidemiology | Clinical Features | Treatment | Complications/ Comments |
|---|---|---|---|---|
| **Pneumonia in the Immunocompromised Host** | | | | |
| *Pneumocystis* pneumonia (PCP) (*Pneumocystis jiroveci*) | Incidence greatest in patients with AIDS and patients receiving immunosuppressive therapy for cancer, organ transplantation, and other disorders. Frequently seen with cytomegalovirus infection<br>Mortality rate 15–20% in hospitalized patients and fatal if not treated | Pulmonary infiltrates on chest x-ray. Nonproductive cough, fever, dyspnea | Trimethoprim/ sulfamethoxazole (TMP-SMZ) | Respiratory failure |
| Fungal pneumonia (*Aspergillus fumigatus*) | Incidence greatest in immunocompromised and neutropenic patients<br>Mortality rate: 15–20%. | Cough, hemoptysis, infiltrates, fungus ball on chest x-ray | Voriconazole or anidulafungin or caspofungin<br>Lobectomy for fungus ball | Dissemination to brain, myocardium, and thyroid gland |
| Tuberculosis (*Mycobacterium tuberculosis*) | Incidence increased in indigent, immigrant, and prison populations, people with AIDS, and the homeless<br>Mortality rate <1% (depending on comorbidity) | Weight loss, fever, night sweats, cough, sputum production, hemoptysis, nonspecific infiltrate (lower lobe), hilar node enlargement, pleural effusion on chest x-ray | Isoniazid plus rifampin plus ethambutol plus pyrazinamide (see section on TB) | Reinfection and acute respiratory infection |
| **Pneumonia from Aspiration** | | | | |
| Anaerobic bacteria (*S. pneumonia*, *H. influenzae*, *S. aureus*) | Risk: reduced consciousness, dysphagia, disorders of upper GI tract; mechanical disruption of glottic closure (endotracheal tube, tracheostomy, nasogastric feeding) | Abrupt onset of dyspnea, low-grade fever, cough, predisposing condition for aspiration | Clindamycin or beta-lactam antibiotics | Identification of potential aspirate is important for treatment. |

AIDS, acquired immunodeficiency syndrome; COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; TB, tuberculosis.

taken when transporting these patients within or between facilities.

The usual presentation of HAP is a new pulmonary infiltrate on chest x-ray combined with evidence of infection such as fever, respiratory symptoms, purulent sputum, or leukocytosis. Pneumonias from *Klebsiella* or other gram-negative organisms (*E. coli*, *Proteus*, *Serratia*) are characterized by destruction of lung structure and alveolar walls, **consolidation** (tissue that solidifies as a result of collapsed alveoli or infectious process such as pneumonia), and bacteremia. Elderly patients and those with alcoholism, chronic lung disease, or diabetes are at particular risk. Development of a cough or increased cough and sputum production are common presentations, along with low-grade fever and general malaise. In debilitated or dehydrated patients, sputum production may be minimal or absent. Pleural effusion, high fever, and tachycardia are common.

### Pneumonia in the Immunocompromised Host

Pneumonia in immunocompromised hosts includes *Pneumocystis* pneumonia (PCP), fungal pneumonias, and *Mycobacterium tuberculosis*. The organism that causes PCP is now known as *Pneumocystis jiroveci* instead of *Pneumocystis carinii*. The acronym PCP still applies because it can be read "***P**neumo**c**ystis* **p**neumonia."

Pneumonia in the immunocompromised host occurs with use of corticosteroids or other immunosuppressive agents, chemotherapy, nutritional depletion, use of broad-spectrum antimicrobial agents, acquired immunodeficiency syndrome (AIDS), genetic immune disorders, and long-term advanced life-support technology (mechanical ventilation). It is seen with increasing frequency because affected patients constitute a growing portion of the population; however, pneumonias that typically occur in immunocompromised people may also occur in immunocompetent people. Patients with compromised immune systems commonly develop pneumonia from organisms of low virulence. In addition, increasing numbers of patients with impaired defenses develop HAP from gram-negative bacilli (*Klebsiella*, *Pseudomonas*, *E. coli*, Enterobacteriaceae, *Proteus*, *Serratia*).

Pneumonia in immunocompromised hosts may be caused by the organisms also observed in CAP or HAP (*S. pneumoniae*, *S. aureus*, *H. influenzae*, *P. aeruginosa*, *M. tuberculosis*). PCP is rarely observed in immunocompetent hosts and is often an initial AIDS-defining complication. Whether patients are immunocompromised or immunocompetent, the clinical presentation of pneumonia is similar. PCP has a subtle onset, with progressive dyspnea, fever, and a nonproductive cough.

### *Aspiration Pneumonia*

Aspiration pneumonia refers to the pulmonary consequences resulting from entry of endogenous or exogenous substances into the lower airway. The most common form of aspiration pneumonia is bacterial infection from aspiration of bacteria that normally reside in the upper airways. Aspiration pneumonia may occur in the community or hospital setting. Common pathogens are *S. pneumoniae, H. influenzae,* and *S. aureus.* Substances other than bacteria may be aspirated into the lung, such as gastric contents, exogenous chemical contents, or irritating gases. This type of aspiration or ingestion may impair the lung defenses, cause inflammatory changes, and lead to bacterial growth and a resulting pneumonia. (See later discussion of aspiration.)

## Pathophysiology

Normally, the upper airway prevents potentially infectious particles from reaching the sterile lower respiratory tract. Pneumonia arises from normal flora present in patients whose resistance has been altered or from aspiration of flora present in the oropharynx; patients often have an acute or chronic underlying disease that impairs host defenses. Pneumonia may also result from bloodborne organisms that enter the pulmonary circulation and are trapped in the pulmonary capillary bed.

Pneumonia affects both ventilation and diffusion. An inflammatory reaction can occur in the alveoli, producing an exudate that interferes with the diffusion of oxygen and carbon dioxide. White blood cells, mostly neutrophils, also migrate into the alveoli and fill the normally air-filled spaces. Areas of the lung are not adequately ventilated because of secretions and mucosal edema that cause partial occlusion of the bronchi or alveoli, with a resultant decrease in alveolar oxygen tension. Bronchospasm may also occur in patients with reactive airway disease. Because of hypoventilation, a ventilation–perfusion mismatch occurs in the affected area of the lung. Venous blood entering the pulmonary circulation passes through the underventilated area and travels to the left side of the heart poorly oxygenated. The mixing of oxygenated and unoxygenated or poorly oxygenated blood eventually results in arterial hypoxemia.

If a substantial portion of one or more lobes is involved, the disease is referred to as *lobar pneumonia.* The term *bronchopneumonia* is used to describe pneumonia that is distributed in a patchy fashion, having originated in one or more localized areas within the bronchi and extending to the adjacent surrounding lung parenchyma. Bronchopneumonia is more common than lobar pneumonia (Fig. 23-2).

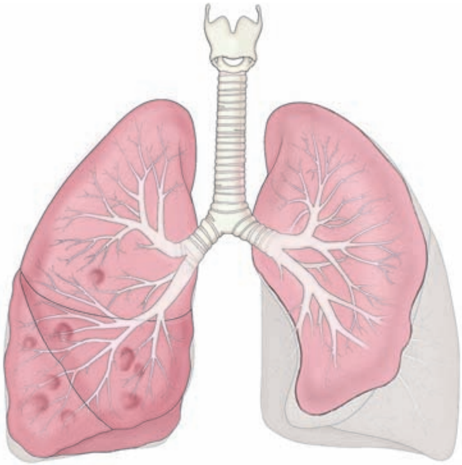



**Figure 23-2** Distribution of lung involvement in bronchial and lobar pneumonia. In bronchopneumonia (*left*), patchy areas of consolidation occur. In lobar pneumonia (*right*), an entire lobe is consolidated.

## Risk Factors

Being knowledgeable about the factors and circumstances that commonly predispose people to pneumonia helps identify patients at high risk for the disease. Table 23-2 describes risk factors for pneumonia; additional risk factors are travel or exposure to certain environments and residence in a long-term care facility. Increasing numbers of patients who have compromised defenses against infections are susceptible to pneumonia. Some types of pneumonia, such as those caused by viral infections, occur in previously healthy people, often after a viral illness.

Pneumonia occurs in patients with certain underlying disorders such as heart failure, diabetes, alcoholism, COPD, and AIDS. Certain diseases also have been associated with specific pathogens. For example, staphylococcal pneumonia has been noted after epidemics of influenza, and patients with COPD are at increased risk for development of pneumonia caused by pneumococci or *H. influenzae.* In addition, cystic fibrosis is associated with respiratory infection caused by pseudomonal and staphylococcal organisms, and PCP has been associated with AIDS. Pneumonias occurring in hospitalized patients often involve organisms not usually found in CAP, including enteric gram-negative bacilli and *S. aureus.*

## Clinical Manifestations

Pneumonia varies in its signs and symptoms depending on the type, causal organism, and presence of underlying disease. However, it is not possible to diagnose a specific form of pneumonia (CAP, HAP, immunocompromised host, or aspiration) by clinical manifestations alone. The patient with streptococcal (pneumococcal) pneumonia usually has a sudden onset of chills, rapidly rising fever (38.5° to 40.5°C [101° to 105°F]), and pleuritic chest pain that is aggravated by deep breathing and coughing. The patient is severely ill, with marked tachypnea (25 to 45 breaths/min), accompanied by other signs of respiratory distress (eg, shortness of breath, use of accessory muscles in respiration). The pulse is rapid and bounding, and it usually increases about 10 bpm for every degree (Celsius) of temperature elevation. A relative bradycardia (a pulse–temperature deficit in which the pulse is slower than that expected for a given temperature) may suggest viral infection, mycoplasma infection, or infection with a *Legionella* organism.

Some patients exhibit an upper respiratory tract infection (nasal congestion, sore throat), and the onset of symptoms of pneumonia is gradual and nonspecific. The predominant symptoms may be headache, low-grade fever, pleuritic pain, myalgia, rash, and pharyngitis. After a few

**Table 23-2 RISK FACTORS AND PREVENTIVE MEASURES FOR PNEUMONIA**

| Risk Factor | Preventive Measure |
|---|---|
| Conditions that produce mucus or bronchial obstruction and interfere with normal lung drainage (eg, cancer, cigarette smoking, chronic obstructive pulmonary disease) | Promote coughing and expectoration of secretions. Encourage smoking cessation. |
| Immunosuppressed patients and those with a low neutrophil count (neutropenic) | Initiate special precautions against infection. |
| Smoking; cigarette smoke disrupts both mucociliary and macrophage activity | Encourage smoking cessation. |
| Prolonged immobility and shallow breathing pattern | Reposition frequently and promote lung expansion exercises and coughing. Initiate suctioning and chest physical therapy if indicated. |
| Depressed cough reflex (due to medications, a debilitated state, or weak respiratory muscles); aspiration of foreign material into the lungs during a period of unconsciousness (head injury, anesthesia, depressed level of consciousness), or abnormal swallowing mechanism | Reposition frequently to prevent aspiration and administer medications judiciously, particularly those that increase risk for aspiration. Perform suctioning and chest physical therapy if indicated. |
| Nothing-by-mouth (NPO) status; placement of nasogastric, orogastric, or endotracheal tube | Promote frequent oral hygiene. Minimize risk for aspiration by checking placement of tube and proper positioning of patient. |
| Supine positioning in patients unable to protect their airway | Elevate head of bed at least 30 degrees. |
| Antibiotic therapy (in very ill people, the oropharynx is likely to be colonized by gram-negative bacteria) | Monitor patients receiving antibiotic therapy for signs and symptoms of pneumonia. |
| Alcohol intoxication (because alcohol suppresses the body's reflexes, may be associated with aspiration, and decreases white cell mobilization and tracheobronchial ciliary motion) | Encourage reduced or moderate alcohol intake (in case of alcohol stupor, position patient to prevent aspiration). |
| General anesthetic, sedative, or opioid preparations that promote respiratory depression, which causes a shallow breathing pattern and predisposes to the pooling of bronchial secretions and potential development of pneumonia | Observe the respiratory rate and depth during recovery from general anesthesia and before giving medications. If respiratory depression is apparent, withhold the medication and contact the physician. |
| Advanced age, because of possible depressed cough and glottic reflexes and nutritional depletion | Promote frequent turning, early ambulation and mobilization, effective coughing, breathing exercises, and nutritious diet. |
| Respiratory therapy with improperly cleaned equipment | Make sure that respiratory equipment is cleaned properly; participate in continuous quality improvement monitoring with the respiratory care department. |
| Transmission of organisms from health care providers | Use strict hand hygiene and gloves. Implement health care provider education. |

days, mucoid or mucopurulent sputum is expectorated. In severe pneumonia, the cheeks are flushed and the lips and nail beds demonstrate central cyanosis (a late sign of poor oxygenation [hypoxemia]).

The patient may exhibit **orthopnea** (shortness of breath when reclining), preferring to be propped up or sitting in bed leaning forward (orthopneic position) in an effort to achieve adequate gas exchange without coughing or breathing deeply. Appetite is poor, and the patient is diaphoretic and tires easily. Sputum is often purulent; however, this is not a reliable indicator of the etiologic agent. Rusty, blood-tinged sputum may be expectorated with streptococcal (pneumococcal), staphylococcal, and *Klebsiella* pneumonia.

Signs and symptoms of pneumonia may also depend on a patient's underlying condition. Different signs occur in patients with conditions such as cancer, and in those who are undergoing treatment with immunosuppressants, which decrease the resistance to infection. Such patients have fever, crackles, and physical findings that indicate consolidation of lung tissue, including increased tactile fremitus (vocal vibration detected on palpation), percussion dullness, bronchial breath sounds, egophony (when auscultated, the spoken "E" becomes a loud, nasal-sounding "A"), and whispered pectoriloquy (whispered sounds are easily auscultated through the chest wall). These changes occur because sound is transmitted better through solid or dense tissue (consolidation) than through normal air-filled tissue; these sounds are described in Chapter 21.

Purulent sputum or slight changes in respiratory symptoms may be the only sign of pneumonia in patients with COPD. It may be difficult to determine whether an increase in symptoms is an exacerbation of the underlying disease process or an additional infectious process.

## Assessment and Diagnostic Findings

The diagnosis of pneumonia is made by history (particularly of a recent respiratory tract infection), physical examination, chest x-ray, blood culture (bloodstream invasion [bacteremia] occurs frequently), and sputum examination. The sputum sample is obtained by having patients do the following: (1) rinse the mouth with water to minimize contamination by normal oral flora, (2) breathe deeply several times, (3) cough deeply, and (4) expectorate the raised sputum into a sterile container.

More invasive procedures may be used to collect specimens. Sputum may be obtained by nasotracheal or orotracheal suctioning with a sputum trap or by fiberoptic bronchoscopy (see Chapter 21). Bronchoscopy is often used in patients with acute severe infection, in patients with chronic or refractory infection, in immunocompromised patients when a diagnosis cannot be made from an expectorated or induced specimen, and in mechanically ventilated patients.

## Prevention

A pneumococcal vaccine provides specific prevention against pneumococcal pneumonia and other infections caused by *S. pneumoniae* (otitis media, other upper respiratory tract infections). Such vaccination has been demonstrated to prevent pneumonia in otherwise healthy patients with an efficiency of 65% to 85%. To reduce or prevent serious complications of CAP in high-risk groups, vaccination against pneumococcal infection is advised for the following:

- People 65 years of age or older
- Immunocompetent people who are at increased risk for illness and death associated with pneumococcal disease because of chronic illness (eg, cardiovascular disease, pulmonary disease, diabetes mellitus, chronic liver disease) or disability
- People with functional or anatomic asplenia
- People living in environments or social settings in which the risk of disease is high
- Immunocompromised people at high risk for infection

The Centers for Disease Control and Prevention (CDC) recommends one-time revaccination after 5 years for people in high-risk categories, including those previously vaccinated up to 5 years ago and those who were older than 65 years of age at the time of primary vaccination (CDC, 2007b).

In addition, the CDC (2004) has identified four specific strategies for the prevention of HAP: (1) staff education and involvement in infection prevention, (2) infection and microbiologic surveillance, (3) prevention of transmission of microorganisms, and (4) modifying host risk for infection. Important nursing measures for prevention of HAP include providing anticipatory interventions and preventive care.

### CHART 23-2 *Risk Factors for Pathogenic Lung Infections*

**Risk Factors for Infection with Penicillin-Resistant and Drug-Resistant Pneumococci**

- Age over 65 years
- Alcoholism
- Beta-lactam therapy (eg, cephalosporins) in past 3 months
- Immunosuppressive disorders
- Multiple medical comorbidities
- Exposure to a child in a day care facility

**Risk Factors for Infection with Enteric Gram-Negative Bacteria**

- Residency in a long-term care facility
- Underlying cardiopulmonary disease
- Multiple medical comorbidities
- Recent antibiotic therapy

**Risk Factors for Infection with *Pseudomonas aeruginosa***

- Structural lung disease (eg, bronchiectasis)
- Corticosteroid therapy
- Broad-spectrum antibiotic therapy (more than 7 days in the past month)
- Malnutrition

## Medical Management

### Pharmacologic Therapy

The treatment of pneumonia includes administration of the appropriate antibiotic as determined by the results of a Gram stain. However, the causative organism is not identified in half of CAP cases when therapy is started. Guidelines are used to guide antibiotic choice; however, the resistance patterns, prevalence of causative organisms, patient risk factors, treatment setting (inpatient versus outpatient), and costs and availability of newer antibiotic agents must all be considered. Examples of risk factors that may increase the risk of infection with certain types of pathogens appear in Chart 23-2. See Table 23-1 for treatment of patients with pneumonia due to specific pathogens.

Management of CAP includes blood cultures performed quickly for identification of the causal pathogen and prompt administration of antibiotics (within 4 hours) in patients in whom CAP is strongly suspected. In the outpatient setting, empirical treatment of CAP is often used, that is, treatment based on the clinician's estimation of likely causative organisms. In previously healthy people with no risk factors for drug-resistant *S. pneumoniae*, a macrolide antibiotic (azithromycin, clarithromycin, or erythromycin) is recommended. For outpatients with CAP who have cardiopulmonary disease or other modifying factors, treatment should include a respiratory fluoroquinolone (moxifloxacin, gemifloxacin, or levofloxacin) or a beta-lactam agent (cefpodoxime or cefuroxime) plus a macrolide (Mandell, et al., 2007). These are guidelines only; treatment regimens may be modified for individual patients.

For patients with CAP, criteria for hospital admission include age, home environment/caregiver support, severity of illness (eg, pneumonia severity index), and presence of comorbid conditions. For those who are not receiving intensive care, a respiratory fluoroquinolone or a beta-lactam agent plus a macrolide are recommended. Criteria for intensive care unit (ICU) admission include need for mechanical ventilation; presence of septic shock and need for vasopressors; acute respiratory failure; and at least three minor criteria, including increased respiratory rate, multilobar infiltrates, confusion, uremia, leukopenia, and hypothermia (Mandell, et al., 2007). For acutely ill ICU patients, management includes a beta-lactam agent plus azithromycin or a fluoroquinolone. For *Pseudomonas* infection, an antipneumococcal, antipseudomonal beta-lactam is used plus either ciprofloxacin or levofloxacin. Lastly, for community-acquired MRSA, vancomycin or linezolid should be added to the regimen.

Inpatients should be switched from intravenous (IV) to oral therapy when they are hemodynamically stable, are improving clinically, are able to take medications/fluids by mouth, and have a normally functioning gastrointestinal tract. As soon as patients are clinically stable, have no medical problems, and have a safe environment for continued care, they should be discharged from the hospital (Mandell, et al., 2007). Clinical stability is defined as temperature less than or equal to 37.8°C (100°F), heart rate less than or

equal to 100 bpm, respiratory rate less than or equal to 24 breaths/min, systolic blood pressure greater than or equal to 90 mm Hg, and oxygen saturation greater than or equal to 90%, with ability to maintain oral intake and normal (baseline) mental status.

In suspected HAP or nosocomial pneumonia, treatment is usually initiated with a broad-spectrum IV antibiotic and may be monotherapy or combination therapy. For patients with no known multidrug resistance, monotherapy with ceftriaxone, ampicillin/sulbactam, levofloxacin, or ertapenem is used. With known multidrug resistance, a three-drug combination therapy may be used; this drug regimen may include an antipseudomonal cephalosporin or ceftazidime or antipseudomonal carbapenem or piperacillin-tazobactam plus antipseudomonal fluoroquinolone or aminoglycoside plus linezolid or vancomycin. The patient's status must be assessed 72 hours after the initiation of therapy, and antibiotics should be discontinued or modified based on the culture results (File, 2007).

Of concern is the rampant rise in respiratory pathogens that are resistant to available antibiotics (Siegel, Rhinehart, Jackson, et al., 2006). Examples include vancomycin-resistant enterococcus (VRE), MRSA, and drug-resistant *S. pneumoniae*. There is a tendency for clinicians to use antibiotics aggressively and inappropriately; they may use broad-spectrum agents when narrow-spectrum agents are more appropriate. Mechanisms to monitor and minimize the inappropriate use of antibiotics are in place. Education of clinicians about the use of evidence-based guidelines in the treatment of respiratory infection is important, and some institutions have implemented algorithms to assist clinicians in choosing the appropriate antibiotics. Monitoring and surveillance of susceptibility patterns for pathogens are also important.

### *Other Therapeutic Regimens*

Antibiotics are ineffective in viral upper respiratory tract infections and pneumonia, and their use may be associated with adverse effects. Treatment of viral infections with antibiotics is a major reason for the overuse of these medications in the United States. Antibiotics are indicated with a viral respiratory infection *only* if a secondary bacterial pneumonia, bronchitis, or rhinosinusitis is present. With the exception of the use of antimicrobial therapy, treatment of viral pneumonia is the same as that for bacterial pneumonia.

Treatment of viral pneumonia is primarily supportive. Hydration is a necessary part of therapy, because fever and tachypnea may result in insensible fluid losses. Antipyretics may be used to treat headache and fever; antitussive medications may be used for the associated cough. Warm, moist inhalations are helpful in relieving bronchial irritation. Antihistamines may provide benefit with reduced sneezing and rhinorrhea. Nasal decongestants may also be used to treat symptoms and improve sleep; however, excessive use can cause rebound nasal congestion. Bed rest is prescribed until the infection shows signs of clearing. If hospitalized, the patient is observed carefully until the clinical condition improves.

If hypoxemia develops, oxygen is administered. Pulse oximetry or arterial blood gas analysis is used to determine the need for oxygen and to evaluate the effectiveness of the therapy. Arterial blood gases may be used to obtain a baseline measure of the patient's oxygenation and acid–base status; however, pulse oximetry is used to continuously monitor the patient's oxygen saturation and response to therapy. More aggressive respiratory support measures include administration of high concentrations of oxygen (fraction of inspired oxygen [$FiO_2$]), endotracheal intubation, and mechanical ventilation. Different modes of mechanical ventilation may be required; see Chapter 25.

### Gerontologic Considerations

Pneumonia in elderly patients may occur as a primary diagnosis or as a complication of a chronic disease. Pulmonary infections in older people frequently are difficult to treat and result in a higher mortality rate than in younger people. General deterioration, weakness, abdominal symptoms, anorexia, confusion, tachycardia, and tachypnea may signal the onset of pneumonia. The diagnosis of pneumonia may be missed because the classic symptoms of cough, chest pain, sputum production, and fever may be absent or masked in elderly patients. Also, the presence of some signs may be misleading. Abnormal breath sounds, for example, may be caused by microatelectasis that occurs as a result of decreased mobility, decreased lung volumes, or other respiratory function changes. Chest x-rays may be needed to differentiate chronic heart failure, which is often seen in the elderly, from pneumonia as the cause of clinical signs and symptoms.

Supportive treatment includes hydration (with caution and with frequent assessment because of the risk of fluid overload in the elderly), supplemental oxygen therapy, and assistance with deep breathing, coughing, frequent position changes, and early ambulation. All of these are particularly important in the care of elderly patients with pneumonia. To reduce or prevent serious complications of pneumonia in the elderly, vaccination against pneumococcal and influenza infections is recommended (Fiore, Shay, Haber, et al., 2007).

## Complications

### *Shock and Respiratory Failure*

Severe complications of pneumonia include hypotension and shock and respiratory failure (especially with gram-negative bacterial disease in elderly patients). These complications are encountered chiefly in patients who have received no specific treatment or inadequate or delayed treatment. These complications are also encountered when the infecting organism is resistant to therapy, when a comorbid disease complicates the pneumonia, or when the patient is immunocompromised.

If the patient is seriously ill, aggressive therapy may include hemodynamic and ventilatory support to combat peripheral collapse, maintain arterial blood pressure, and provide adequate oxygenation. A vasopressor agent may be administered by continuous IV infusion and at a rate adjusted in accordance with the pressure response. Corticosteroids may be administered parenterally to combat shock and toxicity in patients who are extremely ill with pneumonia and at apparent risk for death from the infection. Patients may require endotracheal intubation and mechanical ventilation. Heart failure, cardiac dysrhythmias, pericarditis,

and myocarditis also are complications of pneumonia that may lead to shock.

### Pleural Effusion

Parapneumonic pleural effusions occur in at least 40% of bacterial pneumonias. A parapneumonic effusion is any pleural effusion associated with bacterial pneumonia, lung abscess, or bronchiectasis. After the pleural effusion is detected on a chest x-ray, a thoracentesis may be performed to remove the fluid. The fluid is sent to the laboratory for analysis. There are three stages of parapneumonic pleural effusions based on pathogenesis: uncomplicated, complicated, and thoracic empyema. An **empyema** occurs when thick, purulent fluid accumulates within the pleural space, often with fibrin development and a loculated (walled-off) area where the infection is located (see later discussion). A chest tube may be inserted to treat pleural infection by establishing proper drainage of the empyema. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics, which may include clindamycin, meropenem, or piperacillin/tazobactam (Bartlett, 2007). Sometimes surgical management is required.

## NURSING PROCESS

## The Patient With Pneumonia

### Assessment

Nursing assessment is critical in detecting pneumonia. Fever, chills, or night sweats in a patient who also has respiratory symptoms should alert the nurse to the possibility of bacterial pneumonia. Respiratory assessment further identifies the clinical manifestations of pneumonia: pleuritic-type pain, fatigue, tachypnea, use of accessory muscles for breathing, bradycardia or relative bradycardia, coughing, and purulent sputum. The nurse monitors the patient for the following: changes in temperature and pulse; amount, odor, and color of secretions; frequency and severity of cough; degree of tachypnea or shortness of breath; changes in physical assessment findings (primarily assessed by inspecting and auscultating the chest); and changes in the chest x-ray findings.

In addition, it is important to assess elderly patients for unusual behavior, altered mental status, dehydration, excessive fatigue, and concomitant heart failure.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses may include the following:

- Ineffective airway clearance related to copious tracheobronchial secretions
- Activity intolerance related to impaired respiratory function
- Risk for deficient fluid volume related to fever and a rapid respiratory rate
- Imbalanced nutrition: less than body requirements
- Deficient knowledge about the treatment regimen and preventive health measures

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, collaborative problems or potential complications that may occur include the following:

- Continuing symptoms after initiation of therapy
- Shock
- Respiratory failure
- Atelectasis
- Pleural effusion
- Confusion

### Planning and Goals

The major goals may include improved airway patency, rest to conserve energy, maintenance of proper fluid volume, maintenance of adequate nutrition, an understanding of the treatment protocol and preventive measures, and absence of complications.

### Nursing Interventions

#### *Improving Airway Patency*

Removing secretions is important because retained secretions interfere with gas exchange and may slow recovery. The nurse encourages hydration (2 to 3 L/day), because adequate hydration thins and loosens pulmonary secretions. Humidification may be used to loosen secretions and improve ventilation. A high-humidity face mask (using either compressed air or oxygen) delivers warm, humidified air to the tracheobronchial tree, helps liquefy secretions, and relieves tracheobronchial irritation. Coughing can be initiated either voluntarily or by reflex. Lung expansion maneuvers, such as deep breathing with an incentive spirometer, may induce a cough. To improve airway patency, the nurse encourages the patient to perform an effective, directed cough, which includes correct positioning, a deep inspiratory maneuver, glottic closure, contraction of the expiratory muscles against the closed glottis, sudden glottic opening, and an explosive expiration. In some cases, the nurse may assist the patient by placing both hands on the lower rib cage (either anteriorly or posteriorly) to focus the patient on a slow deep breath, and then manually assisting the patient by applying constant, external pressure during the expiratory phase.

Chest physiotherapy (percussion and postural drainage) is important in loosening and mobilizing secretions (see Chapter 25). Indications for chest physiotherapy include sputum retention not responsive to spontaneous or directed cough, a history of pulmonary problems previously treated with chest physiotherapy, continued evidence of retained secretions (decreased or abnormal breath sounds, change in vital signs), abnormal chest x-ray findings consistent with atelectasis or infiltrates, and deterioration in oxygenation. The patient is placed in the proper position to drain the involved lung segments, and then the chest is percussed and vibrated either manually or with a mechanical percussor. Other devices, such as the Flutter device (Axcan Pharma), assist in secretion removal. The nurse may consult the respiratory therapist for volume-expansion protocols and secretion-management protocols that help direct the respiratory care of the patient and match the patient's needs with appropriate treatment schedules.

After each position change, the nurse encourages the patient to breathe deeply and cough. If the patient is too weak to cough effectively, the nurse may need to remove the mucus by nasotracheal suctioning (see Chapter 25). It may take time for secretions to mobilize and move into the central airways for expectoration. Therefore, it is important for the nurse to monitor the patient for cough and sputum production after the completion of chest physiotherapy.

The nurse also administers and titrates oxygen therapy as prescribed or via protocols. The effectiveness of oxygen therapy is monitored by improvement in clinical signs and symptoms, patient comfort, and adequate oxygenation values as measured by pulse oximetry or arterial blood gas analysis.

#### *Promoting Rest and Conserving Energy*

The nurse encourages the debilitated patient to rest and avoid overexertion and possible exacerbation of symptoms. The patient should assume a comfortable position to promote rest and breathing (eg, semi-Fowler's position) and should change positions frequently to enhance secretion clearance and pulmonary ventilation and perfusion. It is important to instruct outpatients not to overexert themselves and to engage in only moderate activity during the initial phases of treatment.

#### *Promoting Fluid Intake*

The respiratory rate of patients with pneumonia increases because of the increased workload imposed by labored breathing and fever. An increased respiratory rate leads to an increase in insensible fluid loss during exhalation and can lead to dehydration. Therefore, it is important to encourage increased fluid intake (at least 2 L/day), unless contraindicated. Note that hydration must be achieved more slowly and with careful monitoring in patients with preexisting conditions such as heart failure.

#### *Maintaining Nutrition*

Many patients with shortness of breath and fatigue have a decreased appetite and consume only fluids. Fluids with electrolytes (commercially available drinks, such as Gatorade) may help provide fluid, calories, and electrolytes. Other nutritionally enriched drinks or shakes may be helpful. In addition, IV fluids and nutrients may be administered if necessary.

#### *Promoting Patients' Knowledge*

The patient and family are instructed about the cause of pneumonia, management of symptoms, signs and symptoms that should be reported to the physician or nurse, and the need for follow-up. The patient also needs information about factors (both patient risk factors and external factors) that may have contributed to development of pneumonia and strategies to promote recovery and prevent recurrence. If the patient is hospitalized, he or she is instructed about the purpose and importance of management strategies that have been implemented and about the importance of adhering to them during and after the hospital stay. Explanations should be given simply and in language that the patient can understand. If possible, written instructions and information should be provided, and alternative formats should be provided for patients with hearing or vision loss, if necessary. Because of the severity of symptoms, the patient may require that instructions and explanations be repeated several times.

#### *Monitoring and Managing Potential Complications*

**CONTINUING SYMPTOMS AFTER INITIATION OF THERAPY.** The patient is observed for response to antibiotic therapy; patients usually begin to respond to treatment within 24 to 48 hours after antibiotic therapy is initiated. If the patient started taking antibiotics before evaluation by culture and sensitivity of the causative organisms, antibiotics may need to be changed once the results are available. The patient is monitored for changes in physical status (deterioration of condition or resolution of symptoms) and for persistent recurrent fever, which may be a result of medication allergy (signaled possibly by a rash); medication resistance or slow response (greater than 48 hours) of the susceptible organism to therapy; pleural effusion; or pneumonia caused by an unusual organism, such as *P. jiroveci* or *Aspergillus fumigatus*. Failure of the pneumonia to resolve or persistence of symptoms despite changes on the chest x-ray raises the suspicion of other underlying disorders, such as lung cancer. As previously described, lung cancers may invade or compress airways, causing an obstructive atelectasis that may lead to pneumonia.

In addition to monitoring for continuing symptoms of pneumonia, the nurse also monitors for other complications, such as shock and multisystem failure and atelectasis, which may develop during the first few days of antibiotic treatment.

**SHOCK AND RESPIRATORY FAILURE.** The nurse assesses for signs and symptoms of shock and respiratory failure by evaluating the patient's vital signs, pulse oximetry values, and hemodynamic monitoring parameters. The nurse reports signs of deteriorating patient status and assists in administering IV fluids and medications prescribed to combat shock. Intubation and mechanical ventilation may be required if respiratory failure occurs. Shock is described in detail in Chapter 15, and care of the patient receiving mechanical ventilation is described in Chapter 25.

**PLEURAL EFFUSION.** If pleural effusion develops and thoracentesis is performed to remove fluid, the nurse assists in the procedure and explains it to the patient. After thoracentesis, the nurse monitors the patient for pneumothorax or recurrence of pleural effusion. If a chest tube needs to be inserted, the nurse monitors the patient's respiratory status (see Chapter 25 for more information on care of patients with chest tubes).

**CONFUSION.** A patient with pneumonia is assessed for confusion and other more subtle changes in cognitive status. Confusion and changes in cognitive status resulting from pneumonia are poor prognostic signs. Confusion may be related to hypoxemia, fever, dehydration, sleep deprivation, or developing sepsis. The patient's underlying comorbid conditions may also play a part in the development of confusion. Addressing the underlying factors and ensuring patient safety are important nursing interventions.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Depending on the severity of the pneumonia, treatment may occur in the hospital or in the outpatient setting. Patient education is crucial regardless of the setting, and the proper administration of antibiotics is important. In some instances, the patient may be initially treated with IV antibiotics as an inpatient and then discharged to continue the IV antibiotics at home. It is important that a seamless system of care be maintained for the patient from hospital to home; this includes communication between the nurses caring for the patient in both settings.

If oral antibiotics are prescribed, it is important to teach the patient about their proper administration and potential side effects. The patient should be instructed about symptoms that require contacting the health care provider: difficulty breathing, worsening cough, recurrent/increasing fever, and medication intolerance.

After the fever subsides, the patient may gradually increase activities. Fatigue and weakness may be prolonged after pneumonia, especially in the elderly. The nurse encourages breathing exercises to promote secretion clearance and volume expansion. A patient who is being treated as an outpatient should be contacted by the health care team or instructed to contact the health care provider 24 to 48 hours after starting therapy. The patient is also instructed to return to the clinic or physician's office for a follow-up chest x-ray and physical examination. Often improvement in chest x-ray findings lags behind improvement in clinical signs and symptoms.

The nurse encourages the patient to stop smoking. Smoking inhibits tracheobronchial ciliary action, which is the first line of defense of the lower respiratory tract. Smoking also irritates the mucous cells of the bronchi and inhibits the function of alveolar macrophage (scavenger) cells. The patient is instructed to avoid stress, fatigue, sudden changes in temperature, and excessive alcohol intake, all of which lower resistance to pneumonia. The nurse reviews with the patient the principles of adequate nutrition and rest, because one episode of pneumonia may make a patient susceptible to recurring respiratory tract infections.

**CONTINUING CARE.** A patient who is severely debilitated or who cannot care for himself or herself may require referral for home care. During home visits, the nurse assesses the patient's physical status, monitors for complications, assesses the home environment, and reinforces previous teaching. The nurse evaluates the patient's adherence to the therapeutic regimen (ie, taking medications as prescribed, performing breathing exercises, consuming adequate fluid and dietary intake, and avoiding smoking, alcohol, and excessive activity). The nurse stresses to the patient and family the importance of monitoring for complications or exacerbation of the pneumonia. The nurse encourages the patient to obtain an influenza vaccination at the prescribed times, because influenza increases susceptibility to secondary bacterial pneumonia, especially that caused by staphylococci, *H. influenzae*, and *S. pneumoniae*. The nurse also urges the patient to seek medical advice about receiving the vaccine (Pneumovax) against *S. pneumoniae*.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Demonstrates improved airway patency, as evidenced by adequate oxygenation by pulse oximetry or arterial blood gas analysis, normal temperature, normal breath sounds, and effective coughing
2. Rests and conserves energy by limiting activities and remaining in bed while symptomatic and then slowly increasing activities
3. Maintains adequate hydration, as evidenced by an adequate fluid intake and urine output and normal skin turgor
4. Consumes adequate dietary intake, as evidenced by maintenance or increase in body weight without excess fluid gain
5. States explanation for management strategies
6. Complies with management strategies
7. Exhibits no complications
   a. Exhibits acceptable vital signs, pulse oximetry, and arterial blood gas measurements
   b. Reports productive cough that diminishes over time
   c. Has absence of signs or symptoms of shock, respiratory failure, or pleural effusion
   d. Remains oriented and aware of surroundings
   e. Maintains or increases weight
8. Complies with treatment protocol and prevention strategies

## Aspiration

Aspiration of stomach contents into the lungs is a serious complication that can cause pneumonia and result in the following clinical picture: tachycardia, dyspnea, central cyanosis, hypertension, hypotension, and finally death. It can occur when the protective airway reflexes are decreased or absent due to a variety of factors (Chart 23-3).

**CHART 23-3** ***Risk Factors for Aspiration***

- Seizure activity
- Brain injury
- Decreased level of consciousness from trauma, drug or alcohol intoxication, excessive sedation, or general anesthesia
- Nausea and vomiting in the patient with a decreased level of consciousness
- Endotracheal intubation; tube malposition; high residual volumes
- Flat body positioning
- Stroke
- Swallowing disorders
- Cardiac arrest
- Silent aspiration

*NURSING ALERT*

**When a nonfunctioning nasogastric tube allows the gastric contents to accumulate in the stomach, a condition known as silent aspiration may result. Silent aspiration often occurs unobserved and may be more common than suspected. If untreated, massive inhalation of gastric contents develops in a period of several hours.**

## Pathophysiology

The primary factors responsible for death and complications after aspiration of gastric contents are the volume and character of the aspirated gastric contents. For example, a small, localized aspiration from regurgitation can cause pneumonia and acute respiratory distress; a massive aspiration is usually fatal.

A full stomach contains solid particles of food. If these are aspirated, the problem then becomes one of mechanical blockage of the airways and secondary infection. During periods of fasting, the stomach contains acidic gastric juice, which, if aspirated, can be very destructive to the alveoli and capillaries. Fecal contamination (more likely seen in intestinal obstruction) increases the likelihood of death, because the endotoxins produced by intestinal organisms may be absorbed systemically, or the thick proteinaceous material found in the intestinal contents may obstruct the airway, leading to atelectasis and secondary bacterial invasion.

Aspiration pneumonitis may develop from aspiration of substances with a low pH. The aspiration of gastric contents causes a chemical burn of the tracheobronchial tree and pulmonary parenchyma, and an inflammatory response. This leads to the destruction of alveolar–capillary endothelial cells, with a consequent outpouring of protein-rich fluids into the interstitial and intra-alveolar spaces. As a result, surfactant is lost, which in turn causes the airways to close and the alveoli to collapse. Finally, the impaired exchange of oxygen and carbon dioxide causes respiratory failure.

Aspiration pneumonia develops after inhalation of colonized oropharyngeal material. The pathologic process involves an acute inflammatory response to bacteria and bacterial products. Most commonly, the bacteriologic findings include gram-positive cocci, gram-negative rods, and occasionally anaerobic bacteria (Bartlett, 2006).

## Prevention

Prevention is the primary goal when caring for patients at risk for aspiration. Several preventive interventions, including positioning, dietary changes, drugs, oral hygiene, and tube feeding, have been proposed, especially for elderly patients. However, a systematic review of these measures is insufficient to confirm their effectiveness (Bartlett, 2006).

### Compensating for Absent Reflexes

Aspiration may occur if the patient cannot adequately coordinate protective glottic, laryngeal, and cough reflexes. This hazard is increased if the patient has a distended abdomen, is supine, has the upper extremities immobilized by IV infusions or hand restraints, receives local anesthetic agents to the oropharyngeal or laryngeal area for diagnostic procedures, has been sedated, or has had long-term intubation.

When vomiting, people can normally protect their airway by sitting up or turning on the side and coordinating breathing, coughing, gag, and glottic reflexes. If these reflexes are active, an oral airway should not be inserted. If an airway is in place, it should be pulled out the moment the patient gags so as not to stimulate the pharyngeal gag reflex and promote vomiting and aspiration. Suctioning of oral secretions with a catheter should be performed with minimal pharyngeal stimulation.

### Assessing Feeding Tube Placement

When a patient is intubated, aspiration may occur even with a nasogastric tube in place and may result in nosocomial pneumonia. Assessment of nasogastric tube placement is key to prevention of aspiration. The best method for determining tube placement is via x-ray. Other methods have been studied; research results are inconsistent, although observation of the aspirate and testing of its pH are the most reliable (Bourgault, Ipe, Weaver, et al., 2007; Metheny, Meert & Clouse, 2007). Inadvertent tube placement in the respiratory tract is only one source of complications related to tube insertion. A tube with feeding ports in the esophagus significantly increases the risk of aspiration.

Patients who receive continuous or timed-interval tube feedings must be positioned properly. Patients receiving continuous infusions are given small volumes under low pressure in an upright position, which helps prevent aspiration. Patients receiving tube feedings at timed intervals are maintained in an upright or semirecumbent position (elevation of the head of the bed to a 30- to 45-degree angle) during the feeding (Bourgault, et al., 2007). Tube feedings must be given only when it is certain that the feeding tube is positioned correctly in the stomach. Many patients today receive enteral feeding directly into the duodenum through a small-bore flexible feeding tube or surgically implanted tube. Correct placement is confirmed by chest x-ray. Feedings are given slowly and are regulated by a feeding pump.

### Identifying Delayed Stomach Emptying

A full stomach can cause aspiration because of increased intragastric or extragastric pressure. Situations that delay emptying of the stomach include intestinal obstruction; increased gastric secretions in gastroesophageal reflex disease; increased gastric secretions during anxiety, stress, or pain; and abdominal distention because of paralytic ileus, ascites, peritonitis, use of opioids or sedatives, severe illness, or vaginal delivery.

When a feeding tube is present, contents are aspirated, usually every 4 hours, to determine the amount of the last feeding left in the stomach (residual volume). Preliminary evidence suggests that gastric residuals are insensitive and sometimes unreliable markers of tolerance to tube feedings. Patients should be assessed for indications of intolerance to feedings if gastric residual volume is greater than 200 to 250 mL. Prokinetic agents and small bowel feeding should be considered if gastric residual volumes remain high. Stopping enteral nutrition because of a single elevated gastric residual volume should be avoided (Bourgault, et al., 2007).

### Managing Effects of Prolonged Intubation

Prolonged endotracheal intubation or tracheostomy can depress the laryngeal and glottic reflexes because of disuse. Patients with prolonged tracheostomies are encouraged to phonate and exercise their laryngeal muscles. For patients who have had long-term intubation or tracheostomies, it may be helpful to have a speech therapist experienced in swallowing disorders work with the patient to address swallowing problems.

## Severe Acute Respiratory Syndrome

Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by a coronavirus, called SARS-associated coronavirus. It was first reported in Asia in 2003 and quickly spread to countries in North America, South America, Europe, and Asia. The World Health Organization (WHO) reported that 8422 people worldwide became sick with SARS during the 2003 outbreak, and 916 died (Hirsch, 2007).

SARS develops in people who either have close contact with a person who has been diagnosed with the disease or a history of travel or residence in an area with known cases. The SARS-associated coronavirus is transmitted via respiratory droplets when an infected person coughs or sneezes; the droplets may be deposited on the mucous membranes (mouth, nose, eyes) of a nearby person. The virus may also be spread when a person touches a surface or object contaminated by the droplets and then touches his or her mucous membranes. The virus may be transmitted in other ways, including sewage and water, but these methods of transmission are unclear at this time (Hirsch, 2007).

Characteristic symptoms of SARS are a fever (greater than 38.0°C [100.4°F]), coughing, and difficulty breathing. The incubation period is usually 2 to 7 days; however, longer periods have been reported. About 95% of patients develop symptoms within 10 days (Hirsch, 2007). Risk factors associated with poor outcomes include older age, comorbid conditions (eg, diabetes, chronic hepatitis B, COPD), atypical symptoms, elevated serum lactate dehydrogenase on admission, and acute renal failure. Currently, no treatment except supportive care is recommended (Hirsch, 2007). Antibiotics, antiviral agents, and corticosteroids have been given, but there are no data to support their efficacy.

Infection control measures designed to limit transmission of SARS are a priority. In health care settings, the general CDC guidelines for infection control in health care facilities should be followed; in addition, specific strategies for SARS should be in place including use of negative pressure isolation rooms, personal protective equipment, hand hygiene, environmental cleaning and disinfection techniques, and source control measures to contain patients' secretions (Hirsch, 2007). Additional and updated information is available on the CDC Web site (www.cdc.gov/ncidod/sars).

## Pulmonary Tuberculosis

Tuberculosis (TB) is an infectious disease that primarily affects the lung parenchyma. It also may be transmitted to other parts of the body, including the meninges, kidneys, bones, and lymph nodes. The primary infectious agent, *M. tuberculosis*, is an acid-fast aerobic rod that grows slowly and is sensitive to heat and ultraviolet light. *Mycobacterium bovis* and *Mycobacterium avium* have rarely been associated with the development of a TB infection.

TB is a worldwide public health problem that is closely associated with poverty, malnutrition, overcrowding, substandard housing, and inadequate health care. Mortality and morbidity rates continue to rise; *M. tuberculosis* infects an estimated one third of the world's population and remains the leading cause of death from infectious disease in the world. According to the WHO, an estimated 1.6 million deaths resulted from TB in 2005 (WHO, 2007).

In the United States, almost 15,000 cases of TB are reported annually to the CDC (2005a). Factors that prevent elimination of TB in the United States are the prevalence of TB among foreign-born residents, delays in detecting and reporting cases of TB, lack of protection of contacts of people with infections cases of TB, presence of substantial number of people with latent TB, and maintaining clinical and public health expertise in TB (CDC, 2005a).

### Transmission and Risk Factors

TB spreads from person to person by airborne transmission. An infected person releases droplet nuclei (usually particles 1 to 5 μm in diameter) through talking, coughing, sneezing, laughing, or singing. Larger droplets settle; smaller droplets remain suspended in the air and are inhaled by a susceptible person. Chart 23-4 lists risk factors for TB. Chart 23-5 summarizes the CDC's recommendations for prevention of TB transmission in health care settings.

**CHART 23-4** ***Risk Factors for Tuberculosis (TB)***

- Close contact with someone who has active TB. Inhalation of airborne nuclei from an infected person is proportional to the amount of time spent in the same air space, the proximity of the person, and the degree of ventilation.
- Immunocompromised status (eg, those with HIV infection, cancer, transplanted organs, and prolonged high-dose corticosteroid therapy)
- Substance abuse (IV/injection drug users and alcoholics)
- Any person without adequate health care (the homeless; impoverished; minorities, particularly children under age 15 year and young adults between ages 15 and 44 year)
- Preexisting medical conditions or special treatment (eg, diabetes, chronic renal failure, malnourishment, selected malignancies, hemodialysis, transplanted organ, gastrectomy, jejunoileal bypass)
- Immigration from countries with a high prevalence of TB (southeastern Asia, Africa, Latin America, Caribbean)
- Institutionalization (eg, long-term care facilities, psychiatric institutions, prisons)
- Living in overcrowded, substandard housing
- Being a health care worker performing high-risk activities: administration of aerosolized pentamidine and other medications, sputum induction procedures, bronchoscopy, suctioning, coughing procedures, caring for the immunosuppressed patient, home care with the high-risk population, and administering anesthesia and related procedures (eg, intubation, suctioning)

### Chart 23-5 • *CDC Recommendations for Preventing Transmission of Tuberculosis (TB) in Health Care Settings*

1. Early identification and treatment of persons with active TB
   a. Maintain a high index of suspicion for TB to identify cases rapidly.
   b. Promptly initiate effective multidrug anti-TB therapy based on clinical and drug-resistance surveillance data.
2. Prevention of spread of infectious droplet nuclei by source control methods and by reduction of microbial contamination of indoor air
   a. Initiate acid-fast bacilli (AFB) isolation precautions immediately for all patients who are suspected or confirmed to have active TB and who may be infectious. AFB isolation precautions include use of a private room with negative pressure in relation to surrounding areas and a minimum of six air exchanges per hour. Air from the room should be exhausted directly to the outside. Use of ultraviolet lamps and/or high-efficiency particulate air filters to supplement ventilation may be considered.
   b. Persons entering the AFB isolation room should use disposable particulate respirators that fit snugly around the face.
   c. Continue AFB isolation precautions until there is clinical evidence of reduced infectiousness (ie, cough has substantially decreased, and the number of organisms on sequential sputum smears is decreasing). If drug resistance is suspected or confirmed, continue AFB precautions until the sputum smear is negative for AFB.
   d. Use special precautions during cough-inducing procedures.
3. Surveillance for TB transmission
   a. Maintain surveillance for TB infection among health care workers (HCWs) by routine, periodic tuberculin skin testing. Recommend appropriate preventive therapy for HCWs when indicated.
   b. Maintain surveillance for TB cases among patients and HCWs.
   c. Promptly initiate contact investigation procedures among HCWs, patients, and visitors exposed to an untreated, or ineffectively treated, patient with infectious TB for whom appropriate AFB procedures are not in place. Recommend appropriate therapy or preventive therapy for contacts with disease or TB infection without current disease. Therapeutic regimens should be chosen based on the clinical history and local drug-resistance surveillance data.

## Pathophysiology

TB begins when a susceptible person inhales mycobacteria and becomes infected. The bacteria are transmitted through the airways to the alveoli, where they are deposited and begin to multiply. The bacilli also are transported via the lymph system and bloodstream to other parts of the body (kidneys, bones, cerebral cortex) and other areas of the lungs (upper lobes). The body's immune system responds by initiating an inflammatory reaction. Phagocytes (neutrophils and macrophages) engulf many of the bacteria, and TB-specific lymphocytes lyse (destroy) the bacilli and normal tissue. This tissue reaction results in the accumulation of exudate in the alveoli, causing bronchopneumonia. The initial infection usually occurs 2 to 10 weeks after exposure.

Granulomas, new tissue masses of live and dead bacilli, are surrounded by macrophages, which form a protective wall. They are then transformed to a fibrous tissue mass, the central portion of which is called a Ghon tubercle. The material (bacteria and macrophages) becomes necrotic, forming a cheesy mass. This mass may become calcified and form a collagenous scar. At this point, the bacteria become dormant, and there is no further progression of active disease.

After initial exposure and infection, active disease may develop because of a compromised or inadequate immune system response. Active disease also may occur with reinfection and activation of dormant bacteria. In this case, the Ghon tubercle ulcerates, releasing the cheesy material into the bronchi. The bacteria then become airborne, resulting in further spread of the disease. Then the ulcerated tubercle heals and forms scar tissue. This causes the infected lung to become more inflamed, resulting in further development of bronchopneumonia and tubercle formation.

Unless this process is arrested, it spreads slowly downward to the hilum of the lungs and later extends to adjacent lobes. The process may be prolonged and is characterized by long remissions when the disease is arrested, followed by periods of renewed activity. Approximately 10% of people who are initially infected develop active disease. Some people develop reactivation TB (also called adult-type TB). This type of TB results from a breakdown of the host defenses. It most commonly occurs in the lungs, usually in the apical or posterior segments of the upper lobes or the superior segments of the lower lobes.

## Clinical Manifestations

The signs and symptoms of pulmonary TB are insidious. Most patients have a low-grade fever, cough, night sweats, fatigue, and weight loss. The cough may be nonproductive, or mucopurulent sputum may be expectorated. Hemoptysis also may occur. Both the systemic and the pulmonary symptoms are chronic and may have been present for weeks to months. Elderly patients usually present with less pronounced symptoms than younger patients. Extrapulmonary disease occurs in up to 16% of cases in the United States. In patients with AIDS, extrapulmonary disease is more prevalent.

## Assessment and Diagnostic Findings

A complete history, physical examination, tuberculin skin test, chest x-ray, acid-fast bacillus smear, and sputum culture are used to diagnose TB. If the patient is infected with TB, the chest x-ray usually reveals lesions in the upper lobes, and the acid-fast bacillus smear contains mycobacteria.

Clinical manifestations of fever, anorexia, weight loss, night sweats, fatigue, cough, and sputum production prompt a more thorough assessment of respiratory function, for example, assessing the lungs for consolidation by evaluating breath sounds (diminished, bronchial sounds; crackles), fremitus, and egophony.

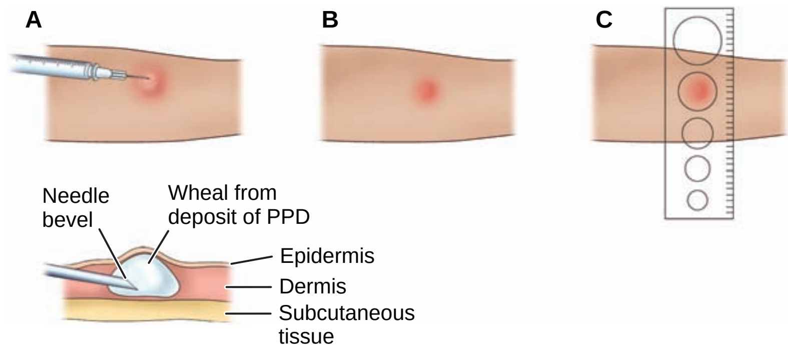



**Figure 23-3** The Mantoux test for tuberculosis. **A,** Correct technique for inserting the needle involves depositing the purified protein derivative (PPD) subcutaneously with the needle bevel facing upward. **B,** The reaction to the Mantoux test usually consists of a wheal, a hivelike, firm welt. **C,** To determine the extent of the reaction, the wheal is measured using a commercially prepared gauge. Interpretation of the Mantoux test is discussed in the text.

### *Tuberculin Skin Test*

The Mantoux method is used to determine whether a person has been infected with the TB bacillus. The Mantoux method is a standardized, intracutaneous injection procedure and should be performed only by those trained in its administration and reading. Tubercle bacillus extract (tuberculin), purified protein derivative (PPD), is injected into the intradermal layer of the inner aspect of the forearm, approximately 4 inches below the elbow (Fig. 23-3). Intermediate-strength PPD, in a tuberculin syringe with a half-inch 26- or 27-gauge needle, is used. The needle, with the bevel facing up, is inserted beneath the skin. Then 0.1 mL of PPD is injected, creating an elevation in the skin, a well-demarcated wheal 6 to 10 mm in diameter. The site, antigen name, strength, lot number, date, and time of the test are recorded. The test result is read 48 to 72 hours after injection. Tests read after 72 hours tend to underestimate the true size of **induration** (hardening). A delayed localized reaction indicates that the person is sensitive to tuberculin.

A reaction occurs when both induration and erythema (redness) are present. After the area is inspected for induration, it is lightly palpated across the injection site, from the area of normal skin to the margins of the induration. The diameter of the induration (not erythema) is measured in millimeters at its widest part (see Fig. 23-3), and the size of the induration is documented. Erythema without induration is not considered significant.

The size of the induration determines the significance of the reaction. A reaction of 0 to 4 mm is considered not significant. A reaction of 5 mm or greater may be significant in people who are considered to be at risk. It is defined as positive in patients who are human immunodeficiency virus (HIV) positive or have HIV risk factors and are of unknown HIV status, in those who are close contacts of someone with active TB, and in those who have chest x-ray results consistent with TB. An induration of 10 mm or greater is usually considered significant in people who have normal or mildly impaired immunity. A significant reaction indicates past exposure to *M. tuberculosis* or vaccination with bacille Calmette-Guérin (BCG) vaccine. The BCG vaccine is given to produce a greater resistance to development of TB. It is effective in up to 76% of people who receive it. The BCG vaccine is used in Europe and Latin America but not routinely in the United States.

A significant (positive) reaction does not necessarily mean that active disease is present in the body. More than 90% of people who are tuberculin-significant reactors do not develop clinical TB. However, all significant reactors are candidates for active TB. In general, the more intense the reaction, the greater the likelihood of an active infection.

A nonsignificant (negative) skin test does not exclude TB infection or disease, because patients who are immunosuppressed cannot develop an immune response that is adequate to produce a positive skin test. This is referred to as anergy.

### *QuantiFERON-TB Gold Test*

In 2005, the U.S. Food and Drug Administration approved a new test for the detection of TB. The QuantiFERON-TB Gold (QFT-G) test is an enzyme-linked immunosorbent assay (ELISA) that detects the release of interferon-gamma by white blood cells when the blood of a patient with TB is incubated with peptides similar to those in *M. tuberculosis*. The results of the QFT-G test are available in less than 24 hours and are not affected by prior vaccination with BCG. A positive tuberculin skin test or QFT-G only indicates that a person has been infected with TB. It does not indicate whether or not the person has active progression of the disease (CDC, 2005c).

## Classification

Data from the history, physical examination, TB test, chest x-ray, and microbiologic studies are used to classify TB into one of five classes. A classification scheme provides public health officials with a systematic way to monitor epidemiology and treatment of the disease.

- Class 0: no exposure; no infection
- Class 1: exposure; no evidence of infection
- Class 2: latent infection; no disease (eg, positive PPD reaction but no clinical evidence of active TB)
- Class 3: disease; clinically active
- Class 4: disease; not clinically active
- Class 5: suspected disease; diagnosis pending

## Gerontologic Considerations

TB may have atypical manifestations in elderly patients, whose symptoms may include unusual behavior and altered mental status, fever, anorexia, and weight loss. In many elderly patients, the tuberculin skin test produces no reaction (loss of immunologic memory) or delayed reactivity for up to 1 week (recall phenomenon). A second skin test is performed in 1 to 2 weeks.

## Medical Management

Pulmonary TB is treated primarily with antituberculosis agents for 6 to 12 months. A prolonged treatment duration is necessary to ensure eradication of the organisms

and to prevent relapse. The continuing and increasing resistance of *M. tuberculosis* to TB medications is a worldwide concern and challenge in TB therapy. Several types of drug resistance must be considered when planning effective therapy:

- Primary drug resistance: resistance to one of the first-line antituberculosis agents in people who have not had previous treatment
- Secondary or acquired drug resistance: resistance to one or more antituberculosis agents in patients undergoing therapy
- Multidrug resistance: resistance to two agents, isoniazid (INH) and rifampin. The populations at greatest risk for multidrug resistance are those who are HIV positive, institutionalized, or homeless.

The increasing prevalence of drug resistance points out the need to begin TB treatment with four or more medications, to ensure completion of therapy, and to develop and evaluate new anti-TB medications.

### Pharmacologic Therapy

In current TB therapy, four first-line medications are used (Table 23-3), INH, rifampin (Rifadin), pyrazinamide, and ethambutol (Myambutol). Combination medications, such as INH and rifampin (Rifamate) or INH, pyrazinamide (PZA), and rifampin (Rifater) and medications administered twice a week (eg, rifapentine [Priftin]) are available to help improve patient adherence. Capreomycin (Capastat), ethionamide (Trecator), para-aminosalicylate sodium, and cycloserine (Seromycin) are second-line medications. Additional potentially effective medications include other aminoglycosides, quinolones, rifabutin, and clofazimine (Lamprene).

Recommended treatment guidelines for newly diagnosed cases of pulmonary TB (CDC, 2003) have two parts: an initial treatment phase and a continuation phase. The initial phase consists of a multiple-medication regimen of INH, rifampin, pyrazinamide, and ethambutol. This initial intensive-treatment regimen is administered daily for 8 weeks, after which options for the continuation phase of treatment include INH and rifampin or INH and rifapentine. The continuation regimen lasts for an additional 4 or 7 months. The 4-month period is used for the large majority of patients (CDC, 2003). The 7-month period is recommended for patients with cavitary pulmonary TB whose sputum culture after the initial 2 months of treatment is positive, for those whose initial phase of treatment did not include PZA, and for those being treated once weekly with INH and rifapentine whose sputum culture is positive at the end of the initial phase of treatment. People are considered noninfectious after 2 to 3 weeks of continuous medication therapy. Vitamin B (pyridoxine) is usually

**Table 23-3 FIRST-LINE ANTITUBERCULOSIS MEDICATIONS**

| Commonly Used Agents | Adult Daily Dosage* | Most Common Side Effects | Drug Interactions[†] | Remarks* |
|---|---|---|---|---|
| Isoniazid (INH) | 5 mg/kg (300 mg maximum daily) | Peripheral neuritis, hepatic enzyme elevation, hepatitis, hypersensitivity | Phenytoin—synergistic<br>Antabuse<br>Alcohol | Bactericidal<br>Pyridoxine is used as prophylaxis for neuritis. Monitor AST and ALT. |
| Rifampin (Rifadin) | 10 mg/kg (600 mg maximum daily) | Hepatitis, febrile reaction, purpura (rare), nausea, vomiting | Rifampin increases metabolism of oral contraceptives, quinidine, corticosteroids, coumarin derivatives and methadone, digoxin, oral hypoglycemics; PAS may interfere with absorption of rifampin. | Bactericidal<br>Orange urine and other body secretions<br>Discoloring of contact lenses<br>Monitor AST and ALT |
| Rifabutin (Mycobutin) | 5 mg/kg (300 mg maximum daily) | | | |
| Rifapentine (Priftin) | 10 mg/kg (600 mg twice weekly) | Hepatotoxicity, thrombocytopenia | Avoid protease inhibitors. | Orange-red coloration of body secretions, contact lenses, dentures<br>Use with caution in elderly or in those with renal disease. |
| Pyrazinamide | 15–30 mg/kg (2.0 g maximum daily)* | Hyperuricemia, hepatotoxicity, skin rash, arthralgias, GI distress | | Bactericidal<br>Monitor uric acid, AST, ALT |
| Ethambutol (Myambutol) | 15–25 mg/kg (no maximum daily dose, but base on lean body wt)* | Optic neuritis (may lead to blindness; very rare at 15 mg/kg), skin rash | | Bacteriostatic<br>Use with caution with renal disease or when eye testing is not feasible. Monitor visual acuity, color discrimination.[‡] |
| Combinations: INH + rifampin (eg, Rifamate) | 150-mg & 300-mg caps (2 caps daily) | | | |

*Check product labeling for detailed information on dose, contraindications, drug interactions, adverse reactions, and monitoring.
[†]Refer to current literature, particularly on rifampin, because it increases hepatic microenzymes and therefore interacts with many drugs.
[‡]Initial examination should be performed at start of treatment.

administered with INH to prevent INH-associated peripheral neuropathy (see Table 23-3). The total number of doses taken, not simply the duration of treatment, more accurately determines whether a course of therapy has been completed.

INH also may be used as a prophylactic (preventive) measure for people who are at risk for significant disease, including:

- Household family members of patients with active disease
- Patients with HIV infection who have a PPD test reaction with 5 mm of induration or more
- Patients with fibrotic lesions suggestive of old TB detected on a chest x-ray and a PPD reaction with 5 mm of induration or more
- Patients whose current PPD test results show a change from former test results, suggesting recent exposure to TB and possible infection (skin test converters)
- Users of IV/injection drugs who have PPD test results with 10 mm of induration or more
- Patients with high-risk comorbid conditions and a PPD result with 10 mm of induration or more

Other candidates for preventive INH therapy are those 35 years or younger who have PPD test results with 10 mm of induration or more and one of the following criteria:

- Foreign-born individuals from countries with a high prevalence of TB
- High-risk, medically underserved populations
- Institutionalized patients

Prophylactic INH treatment involves taking daily doses for 6 to 12 months. Liver enzymes, blood urea nitrogen (BUN), and creatinine levels are monitored monthly. Sputum culture results are monitored for acid-fast bacillus to evaluate the effectiveness of treatment and the patient's adherence to the treatment regimen.

## Nursing Management

Nursing management includes promoting airway clearance, advocating treatment regimen, promoting activity and nutrition, and preventing transmission.

### Promoting Airway Clearance

Copious secretions obstruct the airways in many patients with TB and interfere with adequate gas exchange. Increasing the fluid intake promotes systemic hydration and serves as an effective expectorant. The nurse instructs the patient about correct positioning to facilitate airway drainage (postural drainage); this is described in Chapter 25.

### Advocating Adherence to Treatment Regimen

The multiple-medication regimen that the patient must follow can be quite complex. Understanding of the medications, schedule, and side effects is important. The nurse teaches the patient that TB is a communicable disease and that taking medications is the most effective means of preventing transmission. The major reason treatment fails is that patients do not take their medications regularly and for the prescribed duration. This may be due to side effects or the complexity of the treatment regimen.

The nurse instructs the patient to take the medication either on an empty stomach or at least 1 hour before meals because food interferes with medication absorption (although taking medications on an empty stomach frequently results in gastrointestinal upset). Patients taking INH should avoid foods that contain tyramine and histamine (tuna, aged cheese, red wine, soy sauce, yeast extracts), because eating them while taking INH may result in headache, flushing, hypotension, lightheadedness, palpitations, and diaphoresis.

In addition, rifampin can alter the metabolism of certain other medications, making them less effective. These medications include beta-blockers, oral anticoagulants such as warfarin (Coumadin), digoxin, quinidine, corticosteroids, oral hypoglycemic agents, oral contraceptives, theophylline, and verapamil (Calan, Isoptin). This issue should be discussed with the physician and pharmacist so that medication dosages can be adjusted accordingly. The nurse informs the patient that rifampin may discolor contact lenses and that the patient may want to wear eyeglasses during treatment. The nurse monitors for other side effects of anti-TB medications, including hepatitis, neurologic changes (hearing loss, neuritis), and rash. Liver enzymes, BUN, and serum creatinine levels are monitored to detect changes in liver and kidney function. Sputum culture results are monitored for acid-fast bacilli to evaluate the effectiveness of the treatment regimen and adherence to therapy.

The nurse instructs the patient about the risk of drug resistance if the medication regimen is not strictly and continuously followed. The nurse carefully monitors vital signs and observes for spikes in temperature or changes in the patient's clinical status. Caregivers of patients who are not hospitalized are taught to monitor the patient's temperature and respiratory status. Changes in the patient's respiratory status are reported to the primary health care provider.

### Promoting Activity and Adequate Nutrition

Patients with TB are often debilitated from prolonged chronic illness and impaired nutritional status. The nurse plans a progressive activity schedule that focuses on increasing activity tolerance and muscle strength. Anorexia, weight loss, and malnutrition are common in patients with TB. The patient's willingness to eat may be altered by fatigue from excessive coughing; sputum production; chest pain; generalized debilitated state; or cost, if the patient has few resources. Identifying facilities (eg, shelters, soup kitchens, Meals on Wheels) that provide meals in the patient's neighborhood may increase the likelihood that the patient with limited resources and energy will have access to a more nutritious intake. A nutritional plan that allows for small, frequent meals may be required. Liquid nutritional supplements may assist in meeting basic caloric requirements.

### Preventing Spreading of Tuberculosis Infection

In an effort to prevent transmission of TB to others, the nurse carefully instructs the patient about important hygiene measures, including mouth care, covering the mouth and nose when coughing and sneezing, proper disposal of tissues, and handwashing. TB is a disease that must be reported to the health department so that people who have been in contact with the affected patient during the infectious stage can undergo screening and possible treatment, if indicated.

In addition to the risk of transmission of TB infection to other people, it can also be spread to other parts of the body of affected patients. Spread or dissemination of TB infection to nonpulmonary sites of the body is known as miliary TB. It is the result of invasion of the bloodstream by the tubercle bacillus. Usually it results from late reactivation of a dormant infection in the lung or elsewhere. The origin of the bacilli that enter the bloodstream is either a chronic focus that has ulcerated into a blood vessel or multitudes of miliary tubercles lining the inner surface of the thoracic duct. The organisms migrate from these foci into the bloodstream, are carried throughout the body, and disseminate throughout all tissues, with tiny miliary tubercles developing in the lungs, spleen, liver, kidneys, meninges, and other organs.

The clinical course of miliary TB may vary from an acute, rapidly progressive infection with high fever to a slowly developing process with low-grade fever, anemia, and debilitation. At first, there may be no localizing signs except an enlarged spleen and a reduced number of leukocytes. However, within a few weeks, the chest x-ray reveals small densities scattered diffusely throughout both lung fields; these are the miliary tubercles, which gradually grow.

The possibility of spread to nonpulmonary sites in the body requires careful monitoring for this very serious form of TB. The nurse monitors vital signs and observes for spikes in temperature as well as changes in renal and cognitive function. Few physical signs may be elicited on physical examination of the chest, but at this stage, the patient has a severe cough and dyspnea. Treatment of miliary TB is the same as for pulmonary TB.

## *Lung Abscess*

A lung abscess is necrosis of the pulmonary parenchyma caused by microbial infection (Bartlett, 2007). It is generally caused by aspiration of anaerobic bacteria. By definition, in a lung abscess, the chest x-ray demonstrates a cavity of at least 2 cm. Patients who are at risk for aspiration of foreign material and development of a lung abscess include those with impaired cough reflexes who cannot close the glottis and those with swallowing difficulties. Other at-risk patients include those with central nervous system disorders (eg, seizure, stroke), drug addiction, alcoholism, esophageal disease, or compromised immune function; patients without teeth and those receiving nasogastric tube feedings; and patients with an altered state of consciousness due to anesthesia.

### Pathophysiology

Most lung abscesses are a complication of bacterial pneumonia or are caused by aspiration of oral anaerobes into the lung. Abscesses also may occur secondary to mechanical or functional obstruction of the bronchi by a tumor, foreign body, or bronchial stenosis, or from necrotizing pneumonias, TB, pulmonary embolism (PE), or chest trauma.

Most lung abscesses are found in areas of the lung that may be affected by aspiration. The site of the lung abscess is related to gravity and is determined by position. For patients who are confined to bed, the posterior segment of an upper lobe and the superior segment of the lower lobe are the most common areas. However, atypical presentations may occur, depending on the position of the patient when the aspiration occurred.

Initially, the cavity in the lung may or may not extend directly into a bronchus. Eventually, the abscess becomes surrounded, or encapsulated, by a wall of fibrous tissue. The necrotic process may extend until it reaches the lumen of a bronchus or the pleural space and establishes communication with the respiratory tract, the pleural cavity, or both. If the bronchus is involved, the purulent contents are expectorated continuously in the form of sputum. If the pleura is involved, an empyema results. A communication or connection between the bronchus and pleura is known as a bronchopleural fistula.

The organisms frequently associated with lung abscesses are *S. aureus*, *Klebsiella*, and other gram-negative species (Bartlett, 2007). However, anaerobic organisms may also be present. The organisms vary depending on the underlying predisposing factors.

### Clinical Manifestations

The clinical manifestations of a lung abscess may vary from a mild productive cough to acute illness. Most patients have a fever and a productive cough with moderate to copious amounts of foul-smelling, sometimes bloody, sputum. The fever and cough may develop insidiously and may have been present for several weeks before diagnosis. Leukocytosis may be present. Pleurisy or dull chest pain, dyspnea, weakness, anorexia, and weight loss are common.

### Assessment and Diagnostic Findings

Physical examination of the chest may reveal dullness on percussion and decreased or absent breath sounds with an intermittent **pleural friction rub** (grating or rubbing sound) on auscultation. Crackles may be present. Confirmation of the diagnosis is made by chest x-ray, sputum culture, and, in some cases, fiberoptic bronchoscopy. The chest x-ray reveals an infiltrate with an air–fluid level. A computed tomography (CT) scan of the chest may be required to provide more detailed images of different cross-sectional areas of the lung.

### Prevention

The following measures reduce the risk of lung abscess:

- Appropriate antibiotic therapy before any dental procedures in patients who must have teeth extracted while their gums and teeth are infected
- Adequate dental and oral hygiene, because anaerobic bacteria play a role in the pathogenesis of lung abscess
- Appropriate antimicrobial therapy for patients with pneumonia

### Medical Management

The findings of the history, physical examination, chest x-ray, and sputum culture indicate the type of organism and the treatment required. Adequate drainage of the lung abscess may be achieved through postural drainage and chest physiotherapy. Patients should be assessed for an adequate cough. Some patients require insertion of a percutaneous chest catheter for long-term drainage of the abscess. Therapeutic use of bronchoscopy to drain an abscess is uncommon. A diet

high in protein and calories is necessary, because chronic infection is associated with a catabolic state, necessitating increased intake of calories and protein to facilitate healing. Surgical intervention is rare, but pulmonary resection (lobectomy) is performed if massive **hemoptysis** (coughing up of blood) occurs or if there is little or no response to medical management.

#### *Pharmacologic Therapy*

IV antimicrobial therapy depends on the results of the sputum culture and sensitivity and is administered for an extended period. Standard treatment for an anaerobic lung infection is clindamycin (Cleocin). Large IV doses are usually required, because the antibiotic must penetrate the necrotic tissue and the fluid in the abscess. The IV dose is continued until there is evidence of symptom improvement.

Long-term therapy with oral antibiotics replaces IV therapy after the patient shows signs of improvement (usually 3 to 5 days). Improvement is demonstrated by normal temperature, decreased white blood cell count, and improvement on chest x-ray (resolution of surrounding infiltrate, reduction in cavity size, absence of fluid). Oral administration of antibiotic therapy is continued for an additional 4 to 8 weeks and sometimes longer. If treatment is stopped too soon, a relapse may occur.

### Nursing Management

The nurse administers antibiotics and IV treatments as prescribed and monitors for adverse effects. Chest physiotherapy is initiated as prescribed to facilitate drainage of the abscess. The nurse teaches the patient to perform deep-breathing and coughing exercises to help expand the lungs. To ensure proper nutritional intake, the nurse encourages a diet that is high in protein and calories. The nurse also offers emotional support, because the abscess may take a long time to resolve.

#### *Promoting Home and Community-Based Care*

##### Teaching Patients Self-Care

A patient who has had surgery may return home before the wound closes entirely or with a drain or tube in place. In these cases, the nurse teaches the patient or caregivers about how to change the dressings to prevent skin excoriation and odor, how to monitor for signs and symptoms of infection, and how to care for and maintain the drain or tube. The nurse also reminds the patient to perform deep-breathing and coughing exercises every 2 hours during the day and shows caregivers how to perform chest percussion and postural drainage to facilitate expectoration of lung secretions.

##### Continuing Care

A patient whose condition requires therapy at home may need referral for home care. During home visits, the nurse assesses the patient's physical condition, nutritional status, and home environment, as well as the ability of the patient and family to carry out the therapeutic regimen. Patient teaching is reinforced, and nutritional counseling is provided with the goal of attaining and maintaining an optimal state of nutrition. To prevent relapses, the nurse emphasizes the importance of completing the antibiotic regimen and of following suggestions for rest and appropriate activity. If IV antibiotic therapy is to continue at home, the services of home care nurses may be arranged to initiate IV therapy and to evaluate its administration by the patient or family.

Although most outpatient IV therapy is administered in the home setting, the patient may visit a nearby clinic or physician's office for this treatment. In some cases, patients with lung abscess may have ignored their health. Therefore, it is important to use this opportunity to address health promotion strategies and health screening with the patient.

# PLEURAL CONDITIONS

Pleural conditions are disorders that involve the membranes covering the lungs (visceral pleura) and the surface of the chest wall (parietal pleura) or disorders affecting the pleural space.

## *Pleurisy*

### Pathophysiology

Pleurisy (pleuritis) refers to inflammation of both layers of the pleurae (parietal and visceral). Pleurisy may develop in conjunction with pneumonia or an upper respiratory tract infection, TB, or collagen disease; after trauma to the chest, pulmonary infarction, or PE; in patients with primary or metastatic cancer; and after thoracotomy. The parietal pleura has nerve endings, and the visceral pleura does not. When the inflamed pleural membranes rub together during respiration (intensified on inspiration), the result is severe, sharp, knifelike pain.

### Clinical Manifestations

The key characteristic of pleuritic pain is its relationship to respiratory movement. Taking a deep breath, coughing, or sneezing worsens the pain. Pleuritic pain is limited in distribution rather than diffuse; it usually occurs only on one side. The pain may become minimal or absent when the breath is held. It may be localized or radiate to the shoulder or abdomen. Later, as pleural fluid develops, the pain decreases.

### Assessment and Diagnostic Findings

In the early period, when little fluid has accumulated, a pleural friction rub can be heard with the stethoscope, only to disappear later as more fluid accumulates and separates the inflamed pleural surfaces. Diagnostic tests may include chest x-rays, sputum analysis, thoracentesis to obtain a specimen of pleural fluid for examination, and, less commonly, a pleural biopsy.

### Medical Management

The objectives of treatment are to discover the underlying condition causing the pleurisy and to relieve the pain. As the underlying disease (pneumonia, infection) is treated, the pleuritic inflammation usually resolves. At the same time, it is necessary to monitor for signs and symptoms of pleural effusion, such as shortness of breath, pain, assumption of a position that decreases pain, and decreased chest wall excursion.

Prescribed analgesic agents and topical applications of heat or cold provide symptomatic relief. Indomethacin (Indocin), a nonsteroidal anti-inflammatory agent, may provide pain relief while allowing the patient to take deep breaths and cough more effectively. If the pain is severe, an intercostal nerve block may be required.

### Nursing Management

Because the patient has considerable pain on inspiration, the nurse offers suggestions to enhance comfort, such as turning frequently onto the affected side to splint the chest wall and reduce the stretching of the pleurae. The nurse also teaches the patient to use the hands or a pillow to splint the rib cage while coughing.

## Pleural Effusion

Pleural effusion, a collection of fluid in the pleural space, is rarely a primary disease process; it is usually secondary to other diseases. Normally, the pleural space contains a small amount of fluid (5 to 15 mL), which acts as a lubricant that allows the pleural surfaces to move without friction (Fig. 23-4). Pleural effusion may be a complication of heart failure, TB, pneumonia, pulmonary infections (particularly viral infections), nephrotic syndrome, connective tissue disease, pulmonary embolus, and neoplastic tumors. The most common malignancy associated with a pleural effusion is bronchogenic carcinoma.

### Pathophysiology

In certain disorders, fluid may accumulate in the pleural space to a point at which it becomes clinically evident. This almost always has pathologic significance. The effusion can be a relatively clear fluid, or it can be bloody or purulent. An effusion of clear fluid may be a transudate or an exudate. A transudate (filtrate of plasma that moves across intact capillary walls) occurs when factors influencing the formation and reabsorption of pleural fluid are altered, usually by imbalances in hydrostatic or oncotic pressures. The finding of a transudative effusion generally implies that the pleural membranes are not diseased. A transudative effusion most commonly results from heart failure. An exudate (extravasation of fluid into tissues or a cavity) usually results from inflammation by bacterial products or tumors involving the pleural surfaces.

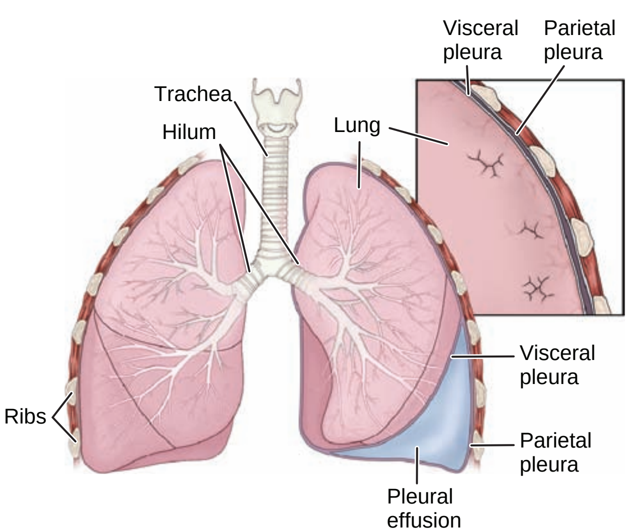



**Figure 23-4** In pleural effusion, an abnormal volume of fluid collects in the pleural space, causing pain and shortness of breath. Pleural effusion is usually secondary to other disease processes.

### Clinical Manifestations

Usually, the clinical manifestations are caused by the underlying disease. Pneumonia causes fever, chills, and pleuritic chest pain, whereas a malignant effusion may result in dyspnea, difficulty lying flat, and coughing. The severity of symptoms is determined by the size of the effusion, the speed of its formation, and the underlying lung disease. A large pleural effusion causes dyspnea (shortness of breath). A small to moderate pleural effusion causes minimal or no dyspnea.

### Assessment and Diagnostic Findings

Assessment of the area of the pleural effusion reveals decreased or absent breath sounds, decreased fremitus, and a dull, flat sound on percussion. In the case of an extremely large pleural effusion, the assessment reveals a patient in acute respiratory distress. Tracheal deviation away from the affected side may also be apparent.

Physical examination, chest x-ray, chest CT, and thoracentesis confirm the presence of fluid. In some instances, a lateral decubitus x-ray is obtained. For this x-ray, the patient lies on the affected side in a side-lying position. A pleural effusion can be diagnosed because this position allows for the "layering out" of the fluid, and an air–fluid line is visible.

Pleural fluid is analyzed by bacterial culture, Gram stain, acid-fast bacillus stain (for TB), red and white blood cell counts, chemistry studies (glucose, amylase, lactate dehydrogenase, protein), cytologic analysis for malignant cells, and pH. A pleural biopsy also may be performed as a diagnostic tool.

### Medical Management

The objectives of treatment are to discover the underlying cause of the pleural effusion; to prevent reaccumulation of fluid; and to relieve discomfort, dyspnea, and respiratory compromise. Specific treatment is directed at the underlying cause (eg, heart failure, pneumonia, cirrhosis). If the pleural fluid is an exudate, more extensive diagnostic procedures are performed to determine the cause. Treatment for the primary cause is then instituted.

Thoracentesis is performed to remove fluid, to obtain a specimen for analysis, and to relieve dyspnea and respiratory compromise (see Chapter 21). Thoracentesis may be performed under ultrasound guidance. Depending on the size of the pleural effusion, the patient may be treated by removing the fluid during the thoracentesis procedure or by inserting a chest tube connected to a water-seal drainage system or suction to evacuate the pleural space and re-expand the lung.

However, if the underlying cause is a malignancy, the effusion tends to recur within a few days or weeks. Repeated thoracenteses result in pain, depletion of protein and electrolytes, and sometimes pneumothorax. Once the

pleural space is adequately drained, a chemical pleurodesis may be performed to obliterate the pleural space and prevent reaccumulation of fluid. Pleurodesis may be performed using either a thoracoscopic approach or a chest tube. A chemically irritating agent (eg, talc or another chemical irritant) is instilled or aerosolized into the pleural space. With the chest tube approach, after the agent is instilled, the chest tube is clamped for 60 to 90 minutes and the patient is assisted to assume various positions to promote uniform distribution of the agent and to maximize its contact with the pleural surfaces. The tube is unclamped as prescribed, and chest drainage may be continued several days longer to prevent reaccumulation of fluid and to promote the formation of adhesions between the visceral and parietal pleurae.

Other treatments for pleural effusions caused by malignancy include surgical pleurectomy, insertion of a small catheter attached to a drainage bottle for outpatient management (Pleurx catheter [Denver Biomedical]), or implantation of a pleuroperitoneal shunt. A pleuroperitoneal shunt consists of two catheters connected by a pump chamber containing two one-way valves. Fluid moves from the pleural space to the pump chamber and then to the peritoneal cavity. The patient manually pumps on the reservoir daily to move fluid from the pleural space to the peritoneal space.

### Nursing Management

The nurse's role in the care of patients with a pleural effusion includes implementing the medical regimen. The nurse prepares and positions the patient for thoracentesis and offers support throughout the procedure. The nurse is responsible for making sure the thoracentesis fluid amount is recorded and sent for appropriate laboratory testing. If a chest tube drainage and water-seal system is used, the nurse is responsible for monitoring the system's function and recording the amount of drainage at prescribed intervals. Nursing care related to the underlying cause of the pleural effusion is specific to the underlying condition. Care of the patient with a chest tube is discussed in Chapter 25.

If a chest tube is inserted for talc instillation, pain management is a priority and the nurse helps the patient assume positions that are the least painful. However, frequent turning and movement are important to facilitate adequate spreading of the talc over the pleural surface. The nurse evaluates the patient's pain level and administers analgesic agents as prescribed and as needed.

If the patient is to be managed as an outpatient with a pleural catheter for drainage, the nurse educates the patient and family about management and care of the catheter and drainage system.

## *Empyema*

An empyema is an accumulation of thick, purulent fluid within the pleural space, often with fibrin development and a loculated (walled-off) area where infection is located.

### Pathophysiology

Most empyemas occur as complications of bacterial pneumonia or lung abscess. They also result from penetrating chest trauma, hematogenous infection of the pleural space, nonbacterial infections, and iatrogenic causes (after thoracic surgery or thoracentesis). At first the pleural fluid is thin, with a low leukocyte count, but it frequently progresses to a fibropurulent stage and, finally, to a stage where it encloses the lung within a thick exudative membrane (loculated empyema).

### Clinical Manifestations

The patient is acutely ill and has signs and symptoms similar to those of an acute respiratory infection or pneumonia (fever, night sweats, pleural pain, cough, dyspnea, anorexia, weight loss). If the patient is immunocompromised, the symptoms may be vague. If the patient has received antimicrobial therapy, the clinical manifestations may be less obvious.

### Assessment and Diagnostic Findings

Chest auscultation demonstrates decreased or absent breath sounds over the affected area, and there is dullness on chest percussion as well as decreased fremitus. The diagnosis is established by chest CT. Usually a diagnostic thoracentesis is performed, often under ultrasound guidance.

### Medical Management

The objectives of treatment are to drain the pleural cavity and to achieve complete expansion of the lung. The fluid is drained, and appropriate antibiotics, in large doses, are prescribed based on the causative organism. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics. Drainage of the pleural fluid depends on the stage of the disease and is accomplished by one of the following methods:

- Needle aspiration (thoracentesis) with a thin percutaneous catheter, if the volume is small and the fluid is not too purulent or too thick
- Tube thoracostomy (chest drainage using a large-diameter intercostal tube attached to water-seal drainage [see Chapter 25]) with fibrinolytic agents instilled through the chest tube in patients with loculated or complicated pleural effusions
- Open chest drainage via thoracotomy, including potential rib resection, to remove the thickened pleura, pus, and debris and to remove the underlying diseased pulmonary tissue

With long-standing inflammation, an exudate can form over the lung, trapping it and interfering with its normal expansion. This exudate must be removed surgically (decortication). The drainage tube is left in place until the pus-filled space is obliterated completely. The complete obliteration of the pleural space is monitored by serial chest x-rays, and the patient should be informed that treatment may be long term. Patients are frequently discharged from the hospital with a chest tube in place, with instructions to monitor fluid drainage at home.

### Nursing Management

Resolution of empyema is a prolonged process. The nurse helps the patient cope with the condition and instructs the patient in lung-expanding breathing exercises to restore normal respiratory function. The nurse also provides care specific to the method of drainage of the pleural fluid (eg, needle aspiration, closed chest drainage, rib resection and

drainage). When the patient is discharged home with a drainage tube or system in place, the nurse instructs the patient and family on care of the drainage system and drain site, measurement and observation of drainage, signs and symptoms of infection, and how and when to contact the health care provider. (See Nursing Process: The Patient Undergoing Thoracic Surgery in Chapter 25.)

## Pulmonary Edema

**Pulmonary edema** is defined as abnormal accumulation of fluid in the lung tissue, the alveolar space, or both. It is a severe, life-threatening condition.

### Pathophysiology

Pulmonary edema most commonly occurs as a result of increased microvascular pressure from abnormal cardiac function. The backup of blood into the pulmonary vasculature resulting from inadequate left ventricular function causes an increased microvascular pressure, and fluid begins to leak into the interstitial space and the alveoli. Other causes of pulmonary edema are hypervolemia or a sudden increase in the intravascular pressure in the lung. One example, which may occur in the patient who has undergone pneumonectomy, is sometimes termed “flash” pulmonary edema. When one lung has been removed, all the cardiac output goes to the remaining lung. If the patient’s fluid status is not monitored closely, pulmonary edema can quickly develop in the postoperative period as the patient’s pulmonary vasculature attempts to adapt. A second example is called re-expansion pulmonary edema. This may result from a rapid reinflation of the lung after removal of air from a pneumothorax or evacuation of fluid from a large pleural effusion.

### Clinical Manifestations

Increasing respiratory distress, characterized by dyspnea, air hunger, and central cyanosis, is present. Patients are usually very anxious and often agitated. As the fluid leaks into the alveoli and mixes with air, a foam or froth is formed. The patient coughs up (or the nurse suctions out) these foamy, frothy, and often blood-tinged secretions. The patient experiences acute respiratory distress and may become confused.

### Assessment and Diagnostic Findings

Auscultation reveals crackles in the lung bases (especially in the posterior bases) that rapidly progress toward the apices of the lungs. These crackles are caused by the movement of air through the alveolar fluid. The chest x-ray reveals increased interstitial markings. The patient may have tachycardia. Pulse oximetry values begin to fall, and arterial blood gas analysis demonstrates worsening hypoxemia.

### Medical Management

Management focuses on correcting the underlying disorder. If the pulmonary edema is cardiac in origin, then improvement in left ventricular function is the goal. Vasodilators, inotropic medications, afterload or preload agents, or contractility medications may be administered. Additional cardiac measures (eg, intra-aortic balloon pump) may be indicated if there is no response. If the problem is fluid overload, diuretics are administered and fluids are restricted. Oxygen is administered to correct the hypoxemia; in some circumstances, intubation and mechanical ventilation are necessary. The patient is extremely anxious, and morphine is prescribed to reduce anxiety and control pain.

### Nursing Management

Nursing management includes assisting with administration of oxygen and intubation and mechanical ventilation if respiratory failure occurs. The nurse also administers medications (eg, morphine, vasodilators, inotropic medications, preload and afterload agents) as prescribed and monitors the patient’s responses. Nursing management in pulmonary edema is described in more detail in Chapter 30.

## Acute Respiratory Failure

Respiratory failure is a sudden and life-threatening deterioration of the gas exchange function of the lung and indicates failure of the lungs to provide adequate oxygenation or ventilation for the blood. Acute respiratory failure is defined as a decrease in arterial oxygen tension ($PaO_2$) to less than 50 mm Hg (hypoxemia) and an increase in arterial carbon dioxide tension ($PaCO_2$) to greater than 50 mm Hg (hypercapnia), with an arterial pH of less than 7.35.

It is important to distinguish between acute and chronic respiratory failure. Chronic respiratory failure is defined as deterioration in the gas exchange function of the lung that has developed insidiously or has persisted for a long period after an episode of acute respiratory failure. The absence of acute symptoms and the presence of a chronic respiratory acidosis suggest the chronicity of the respiratory failure. Two causes of chronic respiratory failure are COPD (discussed in Chapter 24) and neuromuscular diseases (discussed in Chapter 65). Patients with these disorders develop a tolerance to the gradually worsening hypoxemia and hypercapnia. However, patients with chronic respiratory failure can develop acute failure. For example, a patient with COPD may develop an exacerbation or infection that causes additional deterioration of gas exchange. The principles of management of acute versus chronic respiratory failure are different; the following discussion is limited to acute respiratory failure.

### Pathophysiology

In acute respiratory failure, the ventilation or perfusion mechanisms in the lung are impaired. Ventilatory failure mechanisms leading to acute respiratory failure include impaired function of the central nervous system (drug overdose, head trauma, infection, hemorrhage, sleep apnea), neuromuscular dysfunction (myasthenia gravis, Guillain-Barré syndrome, amyotrophic lateral sclerosis, spinal cord trauma), musculoskeletal dysfunction (chest trauma, kyphoscoliosis, malnutrition), and pulmonary dysfunction (COPD, asthma, cystic fibrosis).

Oxygenation failure mechanisms leading to acute respiratory failure include pneumonia, acute respiratory distress syndrome, heart failure, COPD, pulmonary embolism, and **restrictive lung diseases**.

In the postoperative period, especially after major thoracic or abdominal surgery, inadequate ventilation and res-

piratory failure may occur because of several factors. During this period, for example, acute respiratory failure may be caused by the effects of anesthetic, analgesic, and sedative agents, which may depress respiration (as described earlier) or enhance the effects of opioids and lead to hypoventilation. Pain may interfere with deep breathing and coughing. A ventilation–perfusion mismatch is the usual cause of respiratory failure after major abdominal, cardiac, or thoracic surgery.

### Clinical Manifestations

Early signs are those associated with impaired oxygenation and may include restlessness, fatigue, headache, dyspnea, air hunger, tachycardia, and increased blood pressure. As the hypoxemia progresses, more obvious signs may be present, including confusion, lethargy, tachycardia, tachypnea, central cyanosis, diaphoresis, and finally respiratory arrest. Physical findings are those of acute respiratory distress, including use of accessory muscles, decreased breath sounds if the patient cannot adequately ventilate, and other findings related specifically to the underlying disease process and cause of acute respiratory failure.

### Medical Management

The objectives of treatment are to correct the underlying cause and to restore adequate gas exchange in the lung. Intubation and mechanical ventilation may be required to maintain adequate ventilation and oxygenation while the underlying cause is corrected.

### Nursing Management

Nursing management of patients with acute respiratory failure includes assisting with intubation and maintaining mechanical ventilation (described in Chapter 25). Patients are usually managed in the intensive care unit. The nurse assesses the patient's respiratory status by monitoring the level of responsiveness, arterial blood gases, pulse oximetry, and vital signs. In addition, the nurse assesses the entire respiratory system and implements strategies (eg, turning schedule, mouth care, skin care, range of motion of extremities) to prevent complications. The nurse also assesses the patient's understanding of the management strategies that are used and initiates some form of communication to enable the patient to express concerns and needs to the health care team.

Finally, the nurse addresses the problems that led to the acute respiratory failure. As the patient's status improves, the nurse assesses the patient's knowledge of the underlying disorder and provides teaching as appropriate to address the disorder.

## Acute Respiratory Distress Syndrome

**Acute respiratory distress syndrome** (ARDS) is a severe form of **acute lung injury**. This clinical syndrome is characterized by a sudden and progressive pulmonary edema, increasing bilateral infiltrates on chest x-ray, hypoxemia unresponsive to oxygen supplementation regardless of the amount of PEEP, and the absence of an elevated left atrial pressure. Patients often demonstrate reduced lung compliance. A wide range of factors are associated with the development of ARDS (Chart 23-6), including direct injury to the lungs (eg, smoke inhalation) or indirect insult to the lungs (eg, shock). ARDS has been associated with a mortality rate ranging from 25% to 58% (Hansen-Flaschen & Siegel, 2007). The major cause of death in ARDS is nonpulmonary multiple-system organ failure, often with sepsis.

**Chart 23-6• *Etiologic Factors Related to Acute Respiratory Distress Syndrome (ARDS)***

- Aspiration (gastric secretions, drowning, hydrocarbons)
- Drug ingestion and overdose
- Hematologic disorders (disseminated intravascular coagulopathy [DIC], massive transfusions, cardiopulmonary bypass)
- Prolonged inhalation of high concentrations of oxygen, smoke, or corrosive substances
- Localized infection (bacterial, fungal, viral pneumonia)
- Metabolic disorders (pancreatitis, uremia)
- Shock (any cause)
- Trauma (pulmonary contusion, multiple fractures, head injury)
- Major surgery
- Fat or air embolism
- Systemic sepsis

### Pathophysiology

ARDS occurs as a result of diffuse alveolar damage. Inflammatory triggers initiate the release of cellular and chemical mediators, causing injury to the alveolar capillary membrane in addition to other structural damage to the lungs. Severe ventilation–perfusion mismatching occurs. Alveoli collapse because of the inflammatory infiltrate, blood, fluid, and surfactant dysfunction. Small airways are narrowed because of interstitial fluid and bronchial obstruction. Lung compliance may markedly decrease, resulting in decreased functional residual capacity and severe hypoxemia. The blood returning to the lung for gas exchange is pumped through the nonventilated, nonfunctioning areas of the lung, causing shunting. This means that blood is interfacing with nonfunctioning alveoli and gas exchange is markedly impaired, resulting in severe, refractory hypoxemia. Figure 23-5 shows the sequence of pathophysiologic events leading to ARDS.

### Clinical Manifestations

By definition, ARDS is an acute event that typically develops over 4 to 48 hours (Hansen-Flaschen & Siegel, 2007). Initially, ARDS closely resembles severe hemodynamic pulmonary edema. The acute phase of ARDS is marked by a rapid onset of severe dyspnea that usually occurs 12 to 48 hours after the initiating event. Arterial hypoxemia that does not respond to supplemental oxygen is characteristic. Findings on chest x-ray are similar to those seen with cardiogenic pulmonary edema and are visible as bilateral infiltrates that quickly worsen. The acute lung injury then progresses to fibrosing alveolitis with persistent, severe hypoxemia. The patient also has increased alveolar dead space (ventilation to alveoli, but poor perfusion) and decreased pulmonary compliance ("stiff lungs," which are difficult to ventilate).

**Physiology ■■■ Pathophysiology**

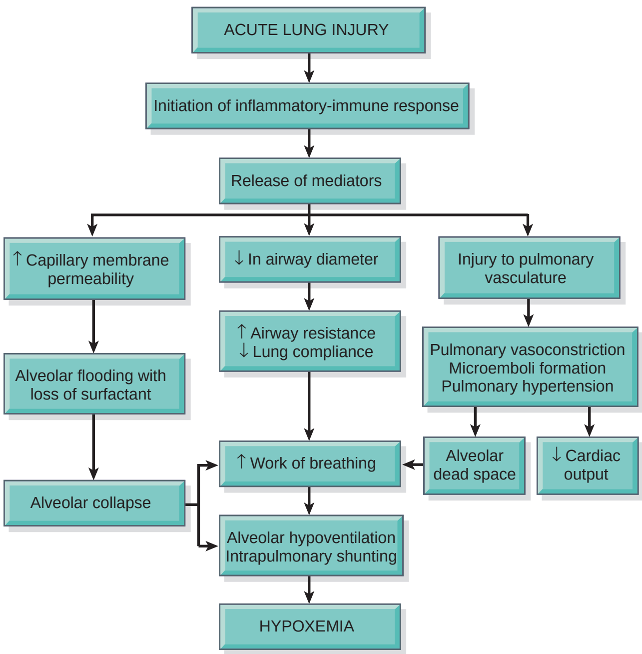



**Figure 23-5** Pathogenesis and pathophysiology of acute respiratory distress syndrome.

Clinically, the patient is thought to be in the recovery phase if the hypoxemia gradually resolves, the chest x-ray improves, and the lungs become more compliant.

## Assessment and Diagnostic Findings

On physical examination, intercostal retractions and crackles may be present as the fluid begins to leak into the alveolar interstitial space. Common diagnostic tests performed in patients with potential ARDS include plasma brain natriuretic peptide (BNP) levels, echocardiography, and pulmonary artery catheterization. The BNP level is helpful in distinguishing ARDS from hemodynamic pulmonary edema. Transthoracic echocardiography may be used if the BNP is not conclusive. Pulmonary artery catheterization is the definitive method to distinguish between hemodynamic (heart failure) and permeability pulmonary edema (ARDS) (Hansen-Flaschen & Siegel, 2007).

## Medical Management

The primary focus in the management of ARDS includes identification and treatment of the underlying condition. Aggressive, supportive care must be provided to compensate for the severe respiratory dysfunction. This supportive therapy almost always includes intubation and mechanical ventilation. In addition, circulatory support, adequate fluid volume, and nutritional support are important. Supplemental oxygen is used as the patient begins the initial spiral of hypoxemia. As the hypoxemia progresses, intubation and mechanical ventilation are instituted. The concentration of oxygen and ventilator settings and modes are determined by the patient's status. This is monitored by arterial blood gas analysis, pulse oximetry, and bedside pulmonary function testing.

PEEP is a critical part of the treatment of ARDS. PEEP usually improves oxygenation, but it does not influence the natural history of the syndrome. Use of PEEP helps increase functional residual capacity and reverse alveolar collapse by keeping the alveoli open, resulting in improved arterial oxygenation and a reduction in the severity of the ventilation–perfusion imbalance. By using PEEP, a lower $FiO_2$ may be required. The goal is a $PaO_2$ greater than 60 mm Hg or an oxygen saturation level of greater than 90% at the lowest possible $FiO_2$. PEEP and modes of mechanical ventilation are discussed in Chapter 25.

Systemic hypotension may occur in ARDS as a result of hypovolemia secondary to leakage of fluid into the interstitial spaces and depressed cardiac output from high levels of PEEP therapy. Hypovolemia must be carefully treated without causing further overload. Inotropic or vasopressor agents may be required. Pulmonary artery pressure catheters are used to monitor the patient's fluid status and the severe and progressive pulmonary hypertension sometimes observed in ARDS.

### Pharmacologic Therapy

There is no specific pharmacologic treatment for ARDS except supportive care. Numerous pharmacologic treatments are under investigation to stop the cascade of events leading to ARDS. These include surfactant replacement therapy, pulmonary antihypertensive agents, and antisepsis agents.

### Nutritional Therapy

Adequate nutritional support is vital in the treatment of ARDS. Patients with ARDS require 35 to 45 kcal/kg/day to meet caloric requirements. Enteral feeding is the first consideration; however, parenteral nutrition also may be required.

## Nursing Management

### General Measures

A patient with ARDS is critically ill and requires close monitoring in the intensive care unit, because the patient's condition could quickly become life-threatening. Most of the respiratory modalities discussed in Chapter 25 are used in this situation (oxygen administration, nebulizer therapy, chest physiotherapy, endotracheal intubation or tracheostomy, mechanical ventilation, suctioning, bronchoscopy). Frequent assessment of the patient's status is necessary to evaluate the effectiveness of treatment.

In addition to implementing the medical plan of care, the nurse considers other needs of the patient. Positioning is important. The nurse turns the patient frequently to improve ventilation and perfusion in the lungs and enhance secretion drainage. However, the nurse must closely monitor the patient for deterioration in oxygenation with changes in position. Oxygenation in patients with ARDS is sometimes improved in the prone position. This position may be evaluated for improvement in oxygenation and used in special circumstances. Devices and specialty beds are available to assist the nurse in placing the patient in a prone position.

The patient is extremely anxious and agitated because of the increasing hypoxemia and dyspnea. It is important to

reduce the patient's anxiety because anxiety increases oxygen expenditure by preventing rest. Rest is essential to limit oxygen consumption and reduce oxygen needs.

### Ventilator Considerations

If the patient is intubated and receiving mechanical ventilation with PEEP, several considerations must be addressed. PEEP, which causes increased end-expiratory pressure, is an unnatural pattern of breathing and feels strange to patients. The patients may be anxious and "fight" the ventilator. Nursing assessment is important to identify problems with ventilation that may be causing the anxiety reaction: tube blockage by kinking or retained secretions; other acute respiratory problems (eg, pneumothorax, pain); a sudden decrease in the oxygen level; the level of dyspnea; or ventilator malfunction. In some cases, sedation may be required to decrease the patient's oxygen consumption, allow the ventilator to provide full support of ventilation, and decrease the patient's anxiety. Sedatives that may be used are lorazepam (Ativan), midazolam (Versed), dexmedetomidine (Precedex), propofol (Diprivan), and short-acting barbiturates.

If the PEEP level cannot be maintained despite the use of sedatives, neuromuscular blocking agents (paralytic agents) may be administered to paralyze the patient. Examples of these agents include pancuronium (Pavulon), vecuronium (Norcuron), atracurium (Tracrium), and rocuronium (Zemuron). The resulting paralysis allows the patient to be ventilated more easily. With paralysis, the patient appears to be unconscious; loses motor function; and cannot breathe, talk, or blink independently. However, the patient retains sensation and is awake and able to hear. The nurse must reassure the patient that the paralysis is a result of the medication and is temporary. Paralysis should be used for the shortest possible time and never without adequate sedation and pain management.

Use of paralytic agents has many dangers and side effects. The nurse must be sure the patient does not become disconnected from the ventilator, because respiratory muscles are paralyzed and the patient will be apneic. Consequently, the nurse ensures that the patient is closely monitored, and all ventilator and patient alarms must be on at all times. Eye care is important as well, because the patient cannot blink, increasing the risk of corneal abrasions. Neuromuscular blockers predispose the patient to deep venous thrombi, muscle atrophy, and skin breakdown. Nursing assessment is essential to minimize the complications related to neuromuscular blockade. The patient may have discomfort or pain but cannot communicate these sensations. Analgesia is usually administered concurrently with neuromuscular blocking agents. The nurse must anticipate the patient's needs regarding pain and comfort. The nurse checks the patient's position to ensure it is comfortable and in normal alignment and talks to, and not about, the patient while in the patient's presence.

In addition, it is important for the nurse to describe the purpose and effects of the paralytic agents to the patient's family. If family members are unaware that these agents have been administered, they may become distressed by the change in the patient's status.

# Pulmonary Arterial Hypertension

Pulmonary arterial hypertension exists when the mean pulmonary artery pressure exceeds 25 mm Hg with a pulmonary capillary wedge pressure of less than 15 mm Hg (Badesch, Abman, Simonneau, et al., 2007). Unlike systemic blood pressure, these pressures cannot be measured indirectly; instead, they must be measured directly during right-sided heart catheterization. In the absence of these measurements, clinical recognition becomes the only indicator of pulmonary hypertension. However, pulmonary arterial hypertension is a condition that is not clinically evident until late in its progression.

There are two types of pulmonary arterial hypertension: idiopathic (or primary) pulmonary arterial hypertension and pulmonary arterial hypertension due to a known cause (Badesch, et al., 2007). It occurs most often in women 20 to 40 years of age, either sporadically or in patients with a family history, and is usually fatal within 5 years of diagnosis. There are several possible causes, but the exact cause is unknown (Chart 23-7). The clinical presentation may occur with no evidence of pulmonary or cardiac disease.

In contrast, pulmonary arterial hypertension due to a known cause is more common and results from existing cardiac or pulmonary disease. The prognosis depends on the severity of the underlying disorder and the changes in the pulmonary vascular bed. A common cause of pulmonary arterial hypertension is pulmonary artery constriction due to hypoxemia from COPD (cor pulmonale), which is discussed below.

## Pathophysiology

Conditions such as collagen vascular disease, congenital heart disease, anorexigens (specific appetite depressants), chronic use of stimulants, portal hypertension, and HIV infection increase the risk of pulmonary arterial hypertension in susceptible patients. Vascular injury occurs with endothelial dysfunction and vascular smooth muscle dysfunction, which leads to disease progression (vascular smooth

**Chart 23-7 • *Causes of Pulmonary Arterial Hypertension***

**Idiopathic (Primary) Arterial Hypertension and Pulmonary Arterial Hypertension Due to a Known Cause**

- Collagen vascular diseases
- Congenital systemic-to-pulmonary shunts
- Portal hypertension
- Altered immune mechanisms (HIV infection)
- Diseases associated with significant venous or capillary involvement
- Chronic thrombotic or embolic disease
- Pulmonary venous hypertension
- Pulmonary vasoconstriction due to hypoxemia
- Chronic obstructive pulmonary disease (COPD), interstitial lung disease, sleep-disordered breathing
- Miscellaneous causes: sarcoidosis, histiocytosis, compression of pulmonary vessels

muscle hypertrophy, adventitial and intimal proliferation [thickening of the wall], and advanced vascular lesion formation). Normally, the pulmonary vascular bed can handle the blood volume delivered by the right ventricle. It has a low resistance to blood flow and compensates for increased blood volume by dilation of the vessels in the pulmonary circulation. However, if the pulmonary vascular bed is destroyed or obstructed, as in pulmonary hypertension, the ability to handle whatever flow or volume of blood it receives is impaired, and the increased blood flow then increases the pulmonary artery pressure. As the pulmonary arterial pressure increases, the pulmonary vascular resistance also increases. Both pulmonary artery constriction (as in hypoxemia or hypercapnia) and a reduction of the pulmonary vascular bed (which occurs with pulmonary emboli) result in increased pulmonary vascular resistance and pressure. This increased workload affects right ventricular function. The myocardium ultimately cannot meet the increasing demands imposed on it, leading to right ventricular hypertrophy (enlargement and dilation) and failure. Passive hepatic congestion may also develop.

## Clinical Manifestations

Dyspnea, the main symptom of pulmonary hypertension, occurs at first with exertion and eventually at rest. Substernal chest pain also is common. Other signs and symptoms include weakness, fatigue, syncope, occasional hemoptysis, and signs of right-sided heart failure (peripheral edema, ascites, distended neck veins, liver engorgement, crackles, heart murmur). Anorexia and abdominal pain in the right upper quadrant may also occur.

## Assessment and Diagnostic Findings

Several tests are used to determine if there is a known cause for the pulmonary hypertension. If the diagnostic tests and thorough evaluation of the patient reveal no known cause, a diagnosis of primary pulmonary hypertension is made. Complete diagnostic evaluation includes a history, physical examination, chest x-ray, pulmonary function studies, electrocardiogram (ECG), echocardiogram, ventilation–perfusion scan, sleep studies, autoantibody tests (to identify diseases of collagen vascular origin), HIV tests, liver function testing, and cardiac catheterization. Pulmonary function studies may be normal or show a slight decrease in vital capacity and lung compliance, with a mild decrease in the diffusing capacity. The $PaO_2$ also is decreased (hypoxemia). The ECG reveals right ventricular hypertrophy, right axis deviation, and tall peaked P waves in inferior leads; tall anterior R waves; and ST-segment depression, T-wave inversion, or both anteriorly. An echocardiogram can assess the progression of the disease and rule out other conditions with similar signs and symptoms. A ventilation–perfusion scan or pulmonary angiography detects defects in pulmonary vasculature, such as pulmonary emboli. Cardiac catheterization of the right side of the heart reveals elevated pulmonary arterial pressure and determines whether there is a vasoactive component to the pulmonary hypertension.

## Medical Management

The goal of treatment is to manage the underlying condition related to pulmonary hypertension of known cause. Recommendations regarding therapy are tailored to the patient's individual situation, functional New York Heart Association class, and specific needs (Badesch, et al., 2007). Anticoagulation should be considered for patients with pulmonary hypertension and patients with an indwelling catheter for administration of medications. Most patients with pulmonary hypertension do not have hypoxemia at rest but require supplemental oxygen with exercise. Diuretics and oxygen should be added as needed. Appropriate oxygen therapy (see Chapter 25) reverses the vasoconstriction and reduces the pulmonary hypertension in a relatively short time.

Different classes of medications are used to treat pulmonary hypertension; these include calcium channel blockers, phosphodiesterase-5 inhibitors, endothelin antagonists, and prostanoids. The choice of therapeutic agents is based on the severity of the disease.

A small number of patients with pulmonary hypertension respond favorably to acute vasodilation and do well with a calcium channel blocking agent. However, because calcium channel blockers are effective in only a small percentage of patients, other treatment options, including prostacyclin, are often necessary (Badesch, et al., 2007).

The oral medication sildenafil (Revatio, Viagra) is a potent specific phosphodiesterase-5 inhibitor that degrades cyclic 3′,5′-guanosine monophosphate (cGMP) and promotes pulmonary vasodilation.

Bosentan (Tracleer), an endothelin receptor antagonist, causes vasodilation and is prescribed for its antihypertensive effects in patients with pulmonary hypertension. It is administered orally twice a day. Liver function must be monitored in patients using bosentan. Other endothelin receptor antagonists are sitaxsentan (Thelin) and ambrisentan (Letairis).

Prostanoids mimic prostaglandin. Prostaglandin (prostacyclin) relaxes vascular smooth muscle by stimulating the production of cyclic 3′,5′-adenosine monophosphate (AMP) and inhibiting the growth of smooth muscle cells. Epoprostenol (Flolan), treprostinil (Remodulin), and iloprost (Ventavis) are examples of prostanoids. Because of its short half-life in the circulation (ie, 3 minutes), epoprostenol can be administered only by continuous IV infusion and requires training of the patient and caregiver. Treprostinil has a longer half-life than epoprostenol and is subcutaneously infused. Iloprost is more stable than the other two prostanoids and is inhaled. The frequency of dosing is six to eight times per day.

Lung transplantation remains an option for all eligible patients who have severe disease and symptoms after 3 months of receiving epoprostenol. Atrial septostomy may be considered for selected patients with severe disease (Badesch, et al., 2007); this procedure results in shunting of blood from the right side of the heart to the left, decreasing the strain on the right side of the heart and maintaining left ventricular output.

## Nursing Management

The major nursing goal is to identify patients at high risk for pulmonary arterial hypertension, such as those with COPD, pulmonary emboli, congenital heart disease, and mitral valve disease. The nurse must be alert for signs and symptoms, administer oxygen therapy appropriately,

and instruct the patient and family about the use of home oxygen therapy. In patients treated with prostanoids (ie, epoprostenol or treprostinil), education about the need for central venous access (epoprostenol), subcutaneous infusion (treprostinil), proper administration and dosing of the medication, pain at the injection site, and potential severe side effects is extremely important. Emotional and psychosocial aspects of this disease must be addressed. Formal and informal support groups for patients and families are extremely valuable.

# Pulmonary Heart Disease (Cor Pulmonale)

**Cor pulmonale** is a condition in which the right ventricle of the heart enlarges (with or without right-sided heart failure) as a result of diseases that affect the structure or function of the lung or its vasculature. It is a type of pulmonary arterial hypertension due to a known cause. Any disease affecting the lungs and accompanied by hypoxemia may result in cor pulmonale. The most frequent cause is severe COPD (see Chapter 24), in which changes in the airway and retained secretions reduce alveolar ventilation. Other causes are conditions that restrict or compromise ventilatory function, leading to hypoxemia or acidosis (eg, deformities of the thoracic cage, massive obesity) and conditions that reduce the pulmonary vascular bed (eg, primary idiopathic pulmonary arterial hypertension, pulmonary embolus). Certain disorders of the nervous system, respiratory muscles, chest wall, and pulmonary arterial tree also may be responsible for cor pulmonale.

## Pathophysiology

Pulmonary disease can produce physiologic changes that in time affect the heart and cause the right ventricle to enlarge and eventually fail. Any condition that deprives the lungs of oxygen can cause hypoxemia and hypercapnia, resulting in ventilatory insufficiency. Hypoxemia and hypercapnia cause pulmonary arterial vasoconstriction and possibly reduction of the pulmonary vascular bed, as in emphysema or pulmonary emboli. The result is increased resistance in the pulmonary circulatory system, with a subsequent rise in pulmonary blood pressure (pulmonary hypertension). A mean pulmonary arterial pressure of 45 mm Hg or more may occur in cor pulmonale. Right ventricular hypertrophy may result, followed by right ventricular failure. In short, cor pulmonale results from pulmonary hypertension, which causes the right side of the heart to enlarge because of the increased work required to pump blood against high resistance through the pulmonary vascular system.

## Clinical Manifestations

Symptoms of cor pulmonale are usually related to the underlying lung disease, such as COPD. With right ventricular failure, the patient may develop increasing edema of the feet and legs, distended neck veins, an enlarged palpable liver, pleural effusion, ascites, and heart murmurs. Headache, confusion, and somnolence may occur as a result of increased levels of carbon dioxide (hypercapnia). Patients often complain of increasing shortness of breath, wheezing, cough, and fatigue.

## Medical Management

The objectives of treatment are to improve ventilation and to treat both the underlying lung disease and the manifestations of heart disease. Supplemental oxygen is administered to improve gas exchange and to reduce pulmonary arterial pressure and pulmonary vascular resistance. Improved oxygen transport relieves the pulmonary hypertension that is causing the cor pulmonale.

Continuous, 24-hour oxygen therapy in patients with severe hypoxemia reportedly leads to better survival rates and greater reduction in pulmonary vascular resistance. Substantial improvement may require 4 to 6 weeks of oxygen therapy, usually in the home. Periodic assessment of pulse oximetry and arterial blood gases is necessary to determine the adequacy of alveolar ventilation and to monitor the effectiveness of oxygen therapy.

Chest physical therapy and bronchial hygiene maneuvers as indicated to remove accumulated secretions and the administration of bronchodilators further improve ventilation. Additional measures depend on the patient's condition. If the patient is in respiratory failure, endotracheal intubation and mechanical ventilation may be necessary. If the patient is in heart failure, hypoxemia and hypercapnia must be relieved to improve cardiac function and output. Bed rest, sodium restriction, and diuretic therapy also are instituted judiciously to reduce peripheral edema (ie, to lower pulmonary arterial pressure through a decrease in total blood volume) and the circulatory load on the right side of the heart. Digitalis may be prescribed to relieve pulmonary hypertension if the patient also has left ventricular failure, a supraventricular dysrhythmia, or right ventricular failure that does not respond to other therapy.

ECG monitoring may be indicated because of the high incidence of dysrhythmias in patients with cor pulmonale. Any respiratory infection must be treated promptly to avoid further impaired gas exchange and exacerbations of hypoxemia and pulmonary heart disease. The prognosis depends on whether the pulmonary hypertension is reversible. (See earlier discussion of the management of acute respiratory failure.)

## Nursing Management

Nursing care addresses the underlying disorder leading to cor pulmonale as well as the problems related to pulmonary hyperventilation and right-sided cardiac failure. If intubation and mechanical ventilation are required to manage acute respiratory failure, the nurse assists with the intubation procedure and maintains mechanical ventilation. The nurse assesses the patient's respiratory and cardiac status and administers medications as prescribed.

During the patient's hospital stay, the nurse instructs the patient about the importance of close self-monitoring (fluid retention, weight gain, edema) and adherence to the therapeutic regimen, especially the 24-hour use of oxygen. It is important to address factors that affect the patient's adherence to the treatment regimen.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

Because cor pulmonale is a chronic disorder, most of the care and monitoring of patients with cor pulmonale is performed by patients and families in the home. If supplemental oxygen is administered, the nurse instructs the patient and family in its safe and correct use. Nutrition counseling is warranted if the patient is on a sodium-restricted diet or is taking diuretics. The nurse teaches the family to monitor for signs and symptoms of right ventricular failure and about emergency interventions and when to call for assistance. Most importantly, the nurse works with the patient to stop smoking.

#### Continuing Care

Referral for home care may be warranted for patients who cannot manage self-care and for those whose physical condition warrants close assessment. During home visits, the home care nurse evaluates the patient's status and the patient's and family members' understanding of the therapeutic regimen and their adherence to it. If oxygen is used in the home, the nurse determines whether it is being administered safely and as prescribed. It is important to assess the patient's progress in stopping smoking and to reinforce the importance of smoking cessation with the patient and family. The nurse identifies strategies to assist with smoking cessation and refers the patient and family to community support groups. In addition, the nurse reminds the patient about the importance of other health promotion and screening practices.

## Pulmonary Embolism

**Pulmonary embolism** (PE) refers to the obstruction of the pulmonary artery or one of its branches by a thrombus (or thrombi) that originates somewhere in the venous system or in the right side of the heart. Deep venous thrombosis (DVT), a related condition, refers to thrombus formation in the deep veins, usually in the calf or thigh, but sometimes in the arm, especially in patients with peripherally inserted central catheters. DVT is discussed in detail in Chapter 31. Venous thromboembolism (VTE) is a term that includes both DVT and PE.

PE is a common disorder and often is associated with trauma, surgery (orthopedic, major abdominal, pelvic, gynecologic), pregnancy, heart failure, age older than 50 years, hypercoagulable states, and prolonged immobility. It also may occur in apparently healthy people. An estimated 237,000 nonfatal and 294,000 fatal cases of PE occur in the United States each year (AlMahmeed & Carman, 2007). Risk factors for PE are identified in Chart 23-8.

### CHART 23-8 Risk Factors for Pulmonary Embolus

**Venous Stasis (slowing of blood flow in veins)**

- Prolonged immobilization (especially postoperative)
- Prolonged periods of sitting/traveling
- Varicose veins
- Spinal cord injury

**Hypercoagulability (due to release of tissue thromboplastin after injury/surgery)**

- Injury
- Tumor (pancreatic, gastrointestinal, genitourinary, breast, lung)
- Increased platelet count (polycythemia, splenectomy)

**Venous Endothelial Disease**

- Thrombophlebitis
- Vascular disease
- Foreign bodies (IV/central venous catheters)

**Certain Disease States (combination of stasis, coagulation alterations, and venous injury)**

- Heart disease (especially heart failure)
- Trauma (especially fracture of hip, pelvis, vertebra, lower extremities)
- Postoperative state/postpartum period
- Diabetes mellitus
- Chronic obstructive pulmonary disease (COPD)

**Other Predisposing Conditions**

- Advanced age
- Obesity
- Pregnancy
- Oral contraceptive use
- History of previous thrombophlebitis, pulmonary embolism
- Constrictive clothing

### Pathophysiology

Most commonly, PE is due to a blood clot or thrombus. However, there are other types of emboli: air, fat, amniotic fluid, and septic (from bacterial invasion of the thrombus).

When a thrombus completely or partially obstructs a pulmonary artery or its branches, the alveolar dead space is increased. The area, although continuing to be ventilated, receives little or no blood flow. Therefore, gas exchange is impaired or absent in this area. In addition, various substances are released from the clot and surrounding area that cause regional blood vessels and bronchioles to constrict. This results in an increase in pulmonary vascular resistance. This reaction compounds the ventilation–perfusion imbalance.

The hemodynamic consequences are increased pulmonary vascular resistance due to the regional vasoconstriction and reduced size of the pulmonary vascular bed. This results in an increase in pulmonary arterial pressure and, in turn, an increase in right ventricular work to maintain pulmonary blood flow. When the work requirements of the right ventricle exceed its capacity, right ventricular failure occurs, leading to a decrease in cardiac output followed by a decrease in systemic blood pressure and the development of shock. Atrial fibrillation also causes PE. An enlarged right atrium in fibrillation causes blood to stagnate and form clots in this area. These clots are prone to travel into the pulmonary circulation.

A massive PE is best defined by the degree of hemodynamic instability rather than the percentage of pulmonary vasculature occlusion. It is described as an occlusion of the outflow tract of the main pulmonary artery or of the bifurcation of the pulmonary arteries. Multiple small emboli

can lodge in the terminal pulmonary arterioles, producing multiple small infarctions of the lungs. A pulmonary infarction causes ischemic necrosis of part of the lung.

## Clinical Manifestations

Symptoms of PE depend on the size of the thrombus and the area of the pulmonary artery occluded by the thrombus; they may be nonspecific. Dyspnea is the most frequent symptom; the duration and intensity of the dyspnea depend on the extent of embolization. Chest pain is common and is usually sudden and pleuritic in origin. It may be substernal and may mimic angina pectoris or a myocardial infarction. Other symptoms include anxiety, fever, tachycardia, apprehension, cough, diaphoresis, hemoptysis, and syncope. The most frequent sign is tachypnea (very rapid respiratory rate).

The clinical picture may mimic that of bronchopneumonia or heart failure. In atypical instances, PE causes few signs and symptoms, whereas in other instances it mimics various other cardiopulmonary disorders. Obstruction of the pulmonary artery results in pronounced dyspnea, sudden substernal pain, rapid and weak pulse, shock, syncope, and sudden death.

## Assessment and Diagnostic Findings

Death from PE commonly occurs within 1 hour after the onset of symptoms; therefore, early recognition and diagnosis are priorities. Because the symptoms of PE can vary from few to severe, a diagnostic workup is performed to rule out other diseases. The initial diagnostic workup may include chest x-ray, ECG, arterial blood gas analysis, and ventilation–perfusion ($\dot{V}/\dot{Q}$) scan. The chest x-ray is usually normal but may show infiltrates, atelectasis, elevation of the diaphragm on the affected side, or a pleural effusion. The chest x-ray is most helpful in excluding other possible causes. The ECG usually shows sinus tachycardia, PR-interval depression, and nonspecific T-wave changes. Arterial blood gas analysis may show hypoxemia and hypocapnia (from tachypnea); however, arterial blood gas measurements may be normal even in the presence of PE.

Pulmonary angiography is considered the best method to diagnose PE; however, it may not be feasible, cost-effective, or easily performed, especially with critically ill patients. The pulmonary angiogram allows for direct visualization under fluoroscopy of the arterial obstruction and accurate assessment of the perfusion deficit. A specially trained team must be available to perform the procedure, in which a catheter is threaded through the vena cava to the right side of the heart to inject dye, similar to a cardiac catheterization.

The $\dot{V}/\dot{Q}$ scan continues to be used to diagnose PE, especially in facilities that do not use pulmonary angiography or do not have access to a spiral CT scanner. The $\dot{V}/\dot{Q}$ scan is minimally invasive, involving the IV administration of a contrast agent. This scan evaluates different regions of the lung (upper, middle, lower) and allows comparisons of the percentage of ventilation and perfusion in each area. This test has a high sensitivity but can be more cumbersome than a CT scan and is not as accurate as a pulmonary angiogram.

A high suspicion of PE may warrant a spiral computed CT scan of the lung, D-dimer assay (blood test for evidence of blood clots), and pulmonary arteriogram. Spiral CT of the chest may also assist in the diagnosis. In spiral CT, the examination table advances at a constant rate through the scanner while the x-ray tube rotates continuously around the patient, following a spiral path, thus allowing the gathering of continuous data with no gaps between images. Unlike the traditional CT scan, the spiral CT scan evaluates slices as narrow as 1.0 mm, as compared with 5.0-mm slices obtained by traditional CT scan. This allows for a more accurate visualization of a PE. However, spiral CT has limitations. It cannot be performed at the bedside, so unstable patients must be transported to a CT scanner. In addition, IV infusion of contrast agent is necessary for visualization.

## Prevention

For patients at risk for PE, the most effective approach for prevention is to prevent DVT. Active leg exercises to avoid venous stasis, early ambulation, and use of anti-embolism stockings are general preventive measures. Mechanical prophylaxis can be classified as either static or dynamic. Graduated compression stockings of either thigh or knee length are considered static devices; there is little evidence to support their use. Problematic issues include inappropriate application and inappropriate fit of the stockings. Sequential compression devices (SCDs), plastic sleeves that can be inflated with air, are dynamic and are used to prevent venous stasis through compression and relaxation of the calf muscles, as in muscle contraction. SCDs have been proven to successfully reduce the risk of DVT and have been shown to be an effective therapy when used in combination with pharmacologic prophylaxis (Limpus, Chaboyer, McDonald, et al., 2006). Several types of SCDs are used as sources of compression and use foot, calf, and thigh-high compression, as well as graduated, asymmetric, and circumferential compression. Little evidence supports any particular type of compression. Graduated compression involves the sequential movement of air in the sleeve up the leg, followed by relaxation of the sleeve. The advantage of this therapy is the extended duration of compression compared with standard inflation. Asymmetric compression involves inflating only the area on the back of the leg or foot. Circumferential compression involves even compression of the entire leg. Other interventions for preventing DVT and PE are shown in Chart 23-9.

Several organizations publish suggested regimens for the prevention of VTE in surgical patients. These recommendations include both nonpharmacologic (mechanical) and pharmacologic strategies. Patients are stratified by risk of DVT by type of surgical procedure and risk of VTE. The most widely used guidelines are those from the American College of Chest Physicians (2008). Surgical patients are the primary target for prevention of VTE, although all hospitalized patients are at risk. Anticoagulant therapy may be prescribed for patients whose hemostasis is adequate and who are undergoing major elective abdominal or thoracic surgery.

## Medical Management

Because PE is often a medical emergency, emergency management is of primary concern. After emergency measures have been initiated and the patient is stabilized, the treatment goal is to dissolve (lyse) the existing emboli

**CHART 23-9** HOME CARE CHECKLIST
***Prevention of Recurrent Pulmonary Embolism***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the underlying process leading to pulmonary embolism. | ✔ | ✔ |
| • Describe the need for continued anticoagulant therapy after the initial embolism. | ✔ | ✔ |
| • Name the anticoagulant prescribed and identify dosage and schedule of administration. | ✔ | ✔ |
| • Describe potential side effects of coagulation such as bruising and bleeding and identify ways to prevent bleeding:<br>• Avoid the use of sharps (razors, knives, etc.) to prevent cuts; shave with an electric shaver.<br>• Use a toothbrush with soft bristles to prevent gum injury.<br>• Do not take aspirin or antihistamines while taking warfarin sodium (Coumadin).<br>• Always check with health care provider before taking any medicine, including over-the-counter medications.<br>• Avoid laxatives, because they may affect vitamin K absorption.<br>• Report the occurrence of dark, tarry stools to the health care provider immediately.<br>• Wear an identification bracelet or carry a medicine card stating that you are taking anticoagulants. | ✔ | ✔ |
| • Describe strategies to prevent recurrent deep venous thrombosis and pulmonary emboli:<br>• Continue to wear anti-embolism stockings (compression hose) as long as directed.<br>• Avoid sitting with legs crossed or sitting for prolonged periods of time.<br>• When traveling, change position regularly, walk occasionally, and do active exercises of moving the legs and ankles while sitting.<br>• Drink fluids, especially while traveling and in warm weather, to avoid hemoconcentration due to fluid deficit. | ✔ | ✔ |
| • Describe the signs and symptoms of lower extremity circulatory compromise and potential deep venous thrombosis: calf or leg pain, swelling, pedal edema. | ✔ | ✔ |
| • Describe the signs and symptoms of pulmonary compromise related to recurrent pulmonary embolism. | ✔ | ✔ |
| • Describe how and when to contact the health care provider if symptoms of circulatory compromise or pulmonary compromise are identified. | ✔ | ✔ |

and prevent new ones from forming. Treatment may include a variety of modalities: general measures to improve respiratory and vascular status, anticoagulation therapy, thrombolytic therapy, and surgical intervention.

### *Emergency Management*

Massive PE is a life-threatening emergency. The immediate objective is to stabilize the cardiopulmonary system. A sudden increase in pulmonary resistance increases the work of the right ventricle, which can cause acute right-sided heart failure with cardiogenic shock. Emergency management consists of the following actions:

- Nasal oxygen is administered immediately to relieve hypoxemia, respiratory distress, and central cyanosis.
- Intravenous infusion lines are inserted to establish routes for medications or fluids that will be needed.
- A perfusion scan, hemodynamic measurements, and arterial blood gas determinations are performed. Spiral (helical) CT or pulmonary angiography may be performed.
- Hypotension is treated by a slow infusion of dobutamine (Dobutrex), which has a dilating effect on the pulmonary vessels and bronchi, or dopamine (Intropin).
- The ECG is monitored continuously for dysrhythmias and right ventricular failure, which may occur suddenly.
- Digitalis glycosides, IV diuretics, and antiarrhythmic agents are administered when appropriate.
- Blood is drawn for serum electrolytes, complete blood count, and hematocrit.
- If clinical assessment and arterial blood gas analysis indicate the need, the patient is intubated and placed on a mechanical ventilator.
- If the patient has suffered massive embolism and is hypotensive, an indwelling urinary catheter is inserted to monitor urinary output.
- Small doses of IV morphine or sedatives are administered to relieve patient anxiety, to alleviate chest discomfort, to improve tolerance of the endotracheal tube, and to ease adaptation to the mechanical ventilator.

### *General Management*

Measures are initiated to improve respiratory and vascular status. Oxygen therapy is administered to correct the hypoxemia, relieve the pulmonary vascular vasoconstriction, and reduce the pulmonary hypertension. Use of anti-embolism stockings or intermittent pneumatic leg compression devices reduces venous stasis. These measures compress the superficial veins and increase the velocity of blood

in the deep veins by redirecting the blood through the deep veins. Elevating the leg (above the level of the heart) also increases venous flow.

### Pharmacologic Therapy

#### Anticoagulation Therapy

Anticoagulant therapy (heparin, warfarin sodium [Coumadin]) has traditionally been the primary method for managing acute DVT and PE. Unfractionated and low-molecular-weight heparins may be used to prevent recurrence of emboli, but they have no effect on emboli that are already present. Heparin is generally recommended for patients who have been diagnosed with PE; numerous specific options for treatment are available.

Unfractionated heparin administration is dosed by actual body weight and is associated with several concerns. Because the half-life of heparin is dose dependent, it is difficult and time-consuming to adjust and maintain the IV drip infusion at a therapeutic level; frequent laboratory testing is necessary. With long-term heparin use, there is also the risk of antibody formation and bleeding. Despite the risks, anticoagulation after initial clot formation and dislodgement is necessary because of the high risk for a recurrent thrombus. Therapy may be changed to an oral regimen, such as warfarin, as soon as the patient is able to take oral medications. Heparin must be continued until the international normalized ratio (INR) is within a therapeutic range, typically 2.0 to 2.5. Once the patient starts an oral regimen, it is important that he or she continue to take the same brand of warfarin, because the bioavailability may vary greatly among brands.

High doses of subcutaneous low-molecular-weight heparin (enoxaparin [Lovenox]) or heparinoids may also be used for PE. These include enoxaparin, fondaparinux (Arixtra), dalteparin (Fragmin), inzaparin (Innohep), lepirudin (Refludan), and argatroban (Novastan). These agents are direct thrombin inhibitors; therefore, they require less frequent monitoring and dose adjustment. All medications have contraindications and side effects that the nurse must be aware of before administration. Lepirudin and argatroban are both contraindicated in patients with overt major bleeding and in patients who are hypersensitive to these agents or at high risk for bleeding (eg, recent cerebrovascular accident [CVA, stroke], anomaly of vessels or organs, recent major surgery, recent puncture of large vessels or organ biopsy). Major side effects are bleeding anywhere in the body and anaphylactic reaction resulting in shock or death. Other side effects include fever, abnormal liver function, and allergic skin reaction. All patients must continue to take some form of anticoagulation for at least 3 to 6 months after the embolic event.

#### Thrombolytic Therapy

Thrombolytic therapy (urokinase, streptokinase, alteplase) is used in treating PE, particularly in patients who are severely compromised (eg, those who are hypotensive and have significant hypoxemia despite oxygen supplementation) (Carlbom & Davidson, 2007). Thrombolytic therapy resolves the thrombi or emboli quickly and restores more normal hemodynamic functioning of the pulmonary circulation, thereby reducing pulmonary hypertension and improving perfusion, oxygenation, and cardiac output. However, bleeding is a significant side effect. Contraindications to thrombolytic therapy include a CVA within the past 2 months, other active intracranial processes, active bleeding, surgery within 10 days of the thrombotic event, recent labor and delivery, trauma, or severe hypertension. Consequently, thrombolytic agents are advocated only for PE affecting a significant area of blood flow to the lung and causing hemodynamic instability.

Before thrombolytic therapy is started, INR, partial thromboplastin time (PTT), hematocrit, and platelet counts are obtained. An anticoagulant is stopped prior to administration of a thrombolytic agent. During therapy, all but essential invasive procedures are avoided because of potential bleeding. If necessary, fresh whole blood, packed red cells, cryoprecipitate, or frozen plasma is administered to replace blood loss and reverse the bleeding tendency. After the thrombolytic infusion is completed (which varies in duration according to the agent used), anticoagulant therapy is initiated.

### Surgical Management

A surgical embolectomy is rarely performed but may be indicated if the patient has a massive PE or hemodynamic instability or if there are contraindications to thrombolytic therapy. This invasive procedure involves removal of the actual clot and must be performed by a cardiovascular surgical team with the patient on cardiopulmonary bypass. It may be used for patients who fail to improve with thrombolytic therapy, have contraindications to thrombolytic therapy and have had a massive PE, or must have the clot removed to help reduce right-sided heart failure. Although surgical embolectomy ensures removal of the clot, it is not without risk. It has a mortality rate of 30% (Carlbom & Davidson, 2007).

Transvenous catheter embolectomy is a technique in which a vacuum-cupped catheter is introduced transvenously into the affected pulmonary artery. Suction is applied to the end of the embolus, and the embolus is aspirated into the cup. The surgeon maintains suction to hold the embolus within the cup, and the entire catheter is withdrawn through the right side of the heart and out the femoral vein. Catheters are available that pulverize the clot with high-velocity jets of normal saline solution. An inferior vena cava filter is usually inserted at the time of surgery to protect against a recurrence.

Interrupting the inferior vena cava is another surgical technique used when PE recurs or when the patient does not tolerate anticoagulant therapy. This approach prevents dislodged thrombi from being swept into the lungs while allowing adequate blood flow. The preferred approach is the application of Teflon clips to the inferior vena cava to divide the lumen into small channels without occluding caval blood flow. Also, the use of transvenous devices that occlude or filter the blood through the inferior vena cava is a fairly safe way to prevent recurrent PE. One such technique involves insertion of a filter (eg, Greenfield filter) through the internal jugular vein or common femoral vein (Fig. 23-6). This filter is advanced into the inferior vena

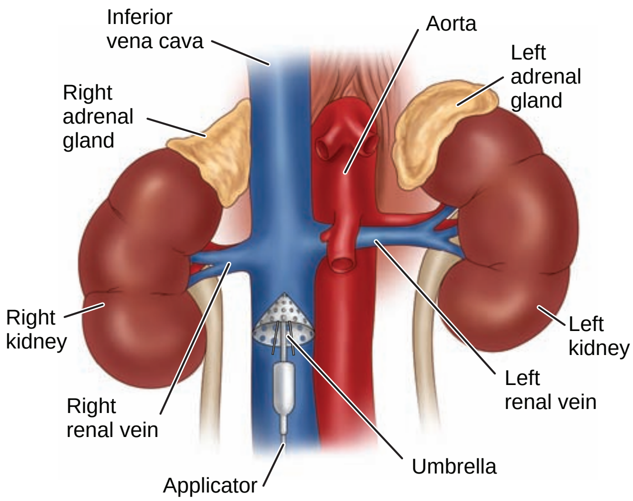



**Figure 23-6** An umbrella filter is in place in the inferior vena cava to prevent pulmonary embolism. The filter (compressed within an applicator catheter) is inserted through an incision in the right internal jugular vein. The applicator is withdrawn when the filter fixes itself to the wall of the inferior vena cava after ejection from the applicator.

cava, where it is opened. The perforated umbrella permits the passage of blood but prevents the passage of large thrombi. It is recommended that anticoagulation be continued in patients with a vena cava filter if there are no contraindications to its use.

## Nursing Management

### Minimizing the Risk of Pulmonary Embolism

A key role of the nurse is to identify the patient at high risk for PE and to minimize the risk of PE in all patients. The nurse must have a high degree of suspicion for PE in all patients, but particularly in those with conditions predisposing to a slowing of venous return (see Chart 23-8).

### Preventing Thrombus Formation

Preventing thrombus formation is a major nursing responsibility. The nurse encourages ambulation and active and passive leg exercises to prevent venous stasis in patients prescribed bed rest. The nurse instructs the patient to move the legs in a "pumping" exercise so that the leg muscles can help increase venous flow. The nurse also advises the patient not to sit or lie in bed for prolonged periods, not to cross the legs, and not to wear constrictive clothing. Legs should not be dangled or feet placed in a dependent position while the patient sits on the edge of the bed; instead, feet should rest on the floor or on a chair. In addition, IV catheters (for parenteral therapy or measurements of central venous pressure) should not be left in place for prolonged periods.

### Assessing Potential for Pulmonary Embolism

All patients are evaluated for risk factors for thrombus formation and pulmonary embolus. The nurse conducts a careful assessment of the patient's health history, family history, and medication record. On a daily basis, the patient is asked about pain or discomfort in the extremities. In addition, the extremities are evaluated for warmth, redness, and inflammation.

### Monitoring Thrombolytic Therapy

The nurse is responsible for monitoring thrombolytic and anticoagulant therapy. Thrombolytic therapy (streptokinase, urokinase, tissue plasminogen activator) causes lysis of deep vein thrombi and pulmonary emboli, which helps dissolve the clots. During thrombolytic infusion, while the patient remains on bed rest, vital signs are assessed every 2 hours and invasive procedures are avoided. Tests to determine INR or PTT are performed 3 to 4 hours after the thrombolytic infusion is started to confirm that the fibrinolytic systems have been activated. See Chapter 31 for nursing management for the patient receiving anticoagulant or thrombolytic therapy.

*NURSING ALERT*

**Because of the prolonged clotting time, only essential arterial punctures or venipunctures are performed, and manual pressure is applied to any puncture site for at least 30 minutes. Pulse oximetry is used to monitor changes in oxygenation. The thrombolytic infusion is discontinued immediately if uncontrolled bleeding occurs.**

### Managing Pain

Chest pain, if present, is usually pleuritic rather than cardiac in origin. A semi-Fowler's position provides a more comfortable position for breathing. However, it is important to continue to turn patients frequently and reposition them to improve the **ventilation–perfusion ratio** in the lung. The nurse administers opioid analgesic agents as prescribed for severe pain.

### Managing Oxygen Therapy

Careful attention is given to the proper use of oxygen. It is important to ensure that the patient understands the need for continuous oxygen therapy. The nurse assesses the patient frequently for signs of hypoxemia and monitors the pulse oximetry values to evaluate the effectiveness of the oxygen therapy. Deep breathing and incentive spirometry are indicated for all patients to minimize or prevent atelectasis and improve ventilation. Nebulizer therapy or percussion and postural drainage may be used for management of secretions.

### Relieving Anxiety

The nurse encourages the stabilized patient to talk about any fears or concerns related to this frightening episode, answers the patient's and family's questions concisely and accurately, explains the therapy, and describes how to recognize untoward effects early.

### Monitoring for Complications

When caring for a patient who has had PE, the nurse must be alert for the potential complication of cardiogenic shock or right ventricular failure subsequent to the effect of PE on the cardiovascular system. Nursing activities for managing shock are found in Chapter 15.

#### *Providing Postoperative Nursing Care*

If the patient has undergone surgical embolectomy, the nurse measures the patient's pulmonary arterial pressure and urinary output. The nurse also assesses the insertion site of the arterial catheter for hematoma formation and infection. It is important to maintain the blood pressure at a level that supports perfusion of vital organs. To prevent peripheral venous stasis and edema of the lower extremities, the nurse elevates the foot of the bed and encourages isometric exercises, use of anti-embolism stockings, and walking when the patient is permitted out of bed. Sitting is discouraged, because hip flexion compresses the large veins in the legs.

#### *Promoting Home and Community-Based Care*

##### Teaching Patients Self-Care

Before hospital discharge and at follow-up visits to the clinic, the nurse instructs the patient about preventing recurrence and reporting signs and symptoms. Patient instructions, presented in Chart 23-9, are intended to help prevent recurrences and side effects of treatment.

##### Continuing Care

During follow-up or home care visits, the nurse monitors the patient's adherence to the prescribed management plan and reinforces previous instructions. The nurse also monitors the patient for residual effects of the PE and recovery. The patient is reminded about the importance of keeping follow-up appointments for coagulation tests and appointments with the primary care provider. The nurse also reminds the patient about the importance of participation in health promotion activities (eg, immunizations) and health screening.

## *Sarcoidosis*

Sarcoidosis is a multisystem, granulomatous disease of unknown etiology. It may involve almost any organ or tissue but most commonly involves the lungs, lymph nodes, liver, spleen, central nervous system, skin, eyes, fingers, and parotid glands. The disease is not gender specific, but some manifestations are more common in women. In the United States, the disease is more common in African Americans (36 cases per 100,000) than in Caucasians (11 cases per 100,000), and the disease affects young and middle-aged adults (Weinberger, 2006).

### Pathophysiology

Sarcoidosis is thought to be a hypersensitivity response to one or more exogenous agents (bacteria, fungi, virus, chemicals) in people with an inherited or acquired predisposition to the disorder. The hypersensitivity response results in noncaseating granuloma formation due to the release of cytokines and other substances that promote replication of fibroblasts. In the lung, granuloma infiltration and fibrosis may occur, resulting in low lung compliance, impaired diffusing capacity, and reduced lung volumes.

### Clinical Manifestations

Hallmarks of sarcoidosis are its insidious onset and lack of prominent clinical signs or symptoms. The clinical picture depends on the systems affected. The lung is most commonly involved; signs and symptoms may include dyspnea, cough, hemoptysis, and congestion. Generalized symptoms include anorexia, fatigue, and weight loss. Other signs include uveitis, joint pain, fever, and granulomatous lesions of the skin, liver, spleen, kidney, and central nervous system. The granulomas may disappear or gradually convert to fibrous tissue. With multisystem involvement, patients may also have fatigue, fever, anorexia, and weight loss.

### Assessment and Diagnostic Findings

Chest x-rays and CT are used to assess pulmonary adenopathy. These may show hilar adenopathy and disseminated miliary and nodular lesions in the lungs. A mediastinoscopy or **transbronchial** biopsy (in which a tissue specimen is obtained through the bronchial wall) may be used to confirm the diagnosis. In rare cases, an **open lung biopsy** is performed. Diagnosis is confirmed by a biopsy that shows noncaseating granulomas. Pulmonary function test results are abnormal if there is restriction of lung function (reduction in total lung capacity). Arterial blood gas measurements may be normal or may show reduced oxygen levels (hypoxemia) and increased carbon dioxide levels (hypercapnia).

### Medical Management

Many patients undergo remission without specific treatment. Corticosteroids may be beneficial because of their anti-inflammatory effects, which relieve symptoms and improve organ function. They have shown to be useful in patients with ocular and myocardial involvement, skin involvement, extensive pulmonary disease that compromises pulmonary function, hepatic involvement, and hypercalcemia. However, it is not known if steroids alter the long-term course of the disease (Weinberger, 2006). Other cytotoxic and immunosuppressive agents have been used, but without the benefit of controlled clinical trials. There is no single test that monitors the progression or recurrence of sarcoidosis. Multiple tests are used to monitor involved systems.

## OCCUPATIONAL LUNG DISEASES: PNEUMOCONIOSES

Pneumoconiosis refers to a nonneoplastic alteration of the lung resulting from inhalation of mineral or inorganic dust (eg, "dusty lung"). Pneumoconioses are caused by inhalation and deposition of mineral dusts in the lungs, resulting in pulmonary fibrosis and parenchymal changes. Usually, extended exposure to irritating or toxic substances accounts for these changes, although severe single exposures may also lead to chronic lung disease. Occupational lung disease is the number one work-related illness in the United States based on the frequency, severity, and preventability. Many people with early pneumoconiosis are asymptomatic, but advanced disease often is accompanied by disability and premature death.

**Table 23-4 OCCUPATIONAL LUNG DISEASES: PNEUMOCONIOSES**

| Disease (Source) | Pathophysiology | Clinical Manifestations |
|---|---|---|
| Silicosis (glass manufacturing, foundry work, stone cutting) | Inhaled silica dust produces nodular lesions in the lungs. Nodules enlarge and coalesce. Dense masses form on upper portion of lungs, resulting in loss of pulmonary volume. Fibrotic destruction of pulmonary tissue can lead to restrictive lung disease, emphysema, pulmonary hypertension, and cor pulmonale. | *Acute silicosis:* Dyspnea, fever, cough, weight loss<br>*Chronic silicosis:* Progressive symptoms indicative of hypoxemia, severe airflow obstruction, and right-sided heart failure |
| Asbestosis (shipbuilding, building demolition) | Inhaled asbestos fibers enter alveoli and are surrounded by fibrous tissue. Fibrous changes can also affect the pleura, which thicken and develop plaque. These changes lead to restrictive lung disease, with a decrease in lung volume, diminished exchange of oxygen and carbon dioxide, hypoxemia, cor pulmonale, and respiratory failure. It also increases risk for lung cancer, mesothelioma, and pleural effusion. | Progressive dyspnea; persistent, dry cough; mild to moderate chest pain; anorexia; weight loss; malaise; clubbing of the fingers |
| Coal worker's pneumoconiosis | Encompasses a variety of lung diseases; is also known as black lung disease. Inhaled dusts that are mixtures of coal, kaolin, mica, and silica are deposited in the alveoli and respiratory bronchioles. When macrophages that engulf the dust can no longer be cleared, they aggregate and fibroblasts appear. The bronchioles and alveoli become clogged with dust, dying macrophages, and fibroblasts, leading to formation of coal macules. Fibrotic lesions develop and subsequently localized emphysema develops, with cor pulmonale and respiratory failure. | Chronic cough, dyspnea, and expectoration of black or gray sputum, especially in miners who are smokers with cavitation in the lungs |

Diseases of the lungs occur in numerous occupations as a result of exposure to several different types of agents, such as mineral dusts, metal dusts, biologic dusts, and toxic fumes. Smoking may compound the problem and may increase the risk of lung cancers in people exposed to the mineral asbestos and other potential carcinogens. The effects of inhaling these materials depend on the composition of the substance, its concentration, its ability to initiate an immune response, its irritating properties, the duration of exposure, and the individual's response or susceptibility to the irritant.

These diseases are not treatable once they develop, but they are preventable. Therefore, a major role for nurses, especially occupational health nurses, is that of advocate for employees. Nurses need to make every effort to promote measures to reduce the exposure of workers to industrial products. Strategies to control exposure should be identified and encouraged; these strategies include the use of protective devices (face masks, hoods, industrial respirators) to minimize exposure and screening/monitoring of individuals at risk.

Key aspects of any assessment of patients with a potential occupational respiratory history include job and job activities, exposure levels, general hygiene, time frame of exposure, effectiveness of respiratory protection used, and direct versus indirect exposures. Specific information that should be obtained includes the following:

- Exposure to an agent known to cause an occupational disorder
- Length of time from exposure of agent to onset of symptoms
- Congruence of symptoms with those of known exposure-related disorder
- Lack of other more likely explanations of the signs and symptoms

The most common pneumoconioses are silicosis, asbestosis, and coal worker's pneumoconiosis (Table 23-4). The nurse teaches preventive measures to patients and their families, assesses patients for a history of exposure to environmental agents, and makes referrals so that pulmonary function can be evaluated and the patient can be treated early in the course of the disease. There is no effective treatment for these diseases because damage is irreversible. Supportive therapy is aimed at preventing infections and managing complications.

## CHEST TUMORS

Tumors of the lung may be benign or malignant. A malignant chest tumor can be primary, arising within the lung, chest wall, or mediastinum, or it can be a metastasis from a primary tumor site elsewhere in the body.

### *Lung Cancer (Bronchogenic Carcinoma)*

Lung cancer is the leading cancer killer among men and women in the United States, with almost 162,000 deaths estimated in 2008. It is estimated that 31% of cancer deaths in men and 26% in women are related to lung or bronchus

cancers. Approximately 213,000 new cases of lung cancer are diagnosed annually; 15% of new cancers for men and women involve the lung or bronchus (American Cancer Society, 2008). In approximately 70% of patients with lung cancer, the disease has spread to regional lymphatics and other sites by the time of diagnosis. As a result, the long-term survival rate is low. Overall, the 5-year survival rate is 16%.

## Pathophysiology

The most common cause of lung cancer is inhaled carcinogens, most often cigarette smoke (90%); other carcinogens include radon gas and occupational and environmental agents (American College of Chest Physicians [ACCP], 2007). Lung cancers arise from a single transformed epithelial cell in the tracheobronchial airways, in which the carcinogen binds to and damages the cell's DNA. This damage results in cellular changes, abnormal cell growth, and eventually a malignant cell. As the damaged DNA is passed on to daughter cells, the DNA undergoes further changes and becomes unstable. With the accumulation of genetic changes, the pulmonary epithelium undergoes malignant transformation from normal epithelium eventually to invasive carcinoma. Carcinoma tends to arise at sites of previous scarring (TB, fibrosis) in the lung.

## Classification and Staging

For purposes of staging and treatment, most lung cancers are classified into one of two major categories: small cell lung cancer and non–small cell lung cancer. Small cell carcinoma represents 15% to 20% of tumors; non–small cell lung carcinoma (NSCLC) represents approximately 80% of tumors (ACCP, 2007). In NSCLC, the cell types include squamous cell carcinoma (20% to 30%), large cell carcinoma (15%), and adenocarcinoma (40%), including bronchoalveolar carcinoma. Most small cell cancers arise in the major bronchi and spread by infiltration along the bronchial wall (Yoder, 2006).

Non–small cell lung cancer is further classified by cell type. Squamous cell cancer is usually more centrally located and arises more commonly in the segmental and subsegmental bronchi. Adenocarcinoma is the most prevalent carcinoma of the lung in both men and women; it occurs peripherally as peripheral masses or nodules and often metastasizes. Large cell carcinoma (also called undifferentiated carcinoma) is a fast-growing tumor that tends to arise peripherally. Bronchoalveolar cell cancer is found in the terminal bronchi and alveoli and is usually slower growing compared with other bronchogenic carcinomas.

In addition to classification according to cell type, lung cancers are staged. The stage of the tumor refers to the size of the tumor, its location, whether lymph nodes are involved, and whether the cancer has spread (Collaborative Staging Task Force of the American Joint Committee on Cancer, 2007). NSCLC is staged as I to IV. Stage I is the earliest stage and has the highest cure rate, whereas stage IV designates metastatic spread. Estimated 5-year survival rates for the stages of NSCLC are as follows: stages IA and IB, 50% to 80%; stage IIA and IIB, 30% to 50%; stage IIIA, 10% to 40%; stage IIIB, 5% to 20%; and stage IV, less than 5% (ACCP, 2007). Small cell lung cancers are classified as limited or extensive. Diagnostic tools and further information on staging are described in Chapter 16.

## Risk Factors

Various factors have been associated with the development of lung cancer, including tobacco smoke, secondhand (passive) smoke, environmental and occupational exposures, gender, genetics, and dietary deficits. Other factors that have been associated with lung cancer include genetic predisposition and underlying respiratory diseases, such as COPD and TB.

### *Tobacco Smoke*

Tobacco use is responsible for more than one of every six deaths in the United States from pulmonary and cardiovascular diseases. Smoking is the most important single preventable cause of death and disease in this country. Lung cancer is 10 times more common in cigarette smokers than nonsmokers. Risk is determined by the pack-year history (number of packs of cigarettes used each day, multiplied by the number of years smoked), the age of initiation of smoking, the depth of inhalation, and the tar and nicotine levels in the cigarettes smoked. The younger a person is when he or she starts smoking, the greater the risk of developing lung cancer.

### *Secondhand Smoke*

Passive smoking has been identified as a possible cause of lung cancer in nonsmokers (U.S. Department of Health and Human Services, 2006). It is estimated that secondhand smoke causes about 3000 deaths per year (ACCP, 2007). People who are involuntarily exposed to tobacco smoke in a closed environment (house, automobile, building) have an increased risk of lung cancer when compared with unexposed nonsmokers.

### *Environmental and Occupational Exposure*

Various carcinogens have been identified in the atmosphere, including motor vehicle emissions and pollutants from refineries and manufacturing plants. Evidence suggests that the incidence of lung cancer is greater in urban areas as a result of the buildup of pollutants and motor vehicle emissions.

Radon is a colorless, odorless gas found in soil and rocks. For many years, it has been associated with uranium mines, but it is now known to seep into homes through ground rock. High levels of radon have been associated with the development of lung cancer, especially when combined with cigarette smoking. Homeowners are advised to have radon levels checked in their houses and to arrange for special venting if the levels are high.

Chronic exposure to industrial carcinogens, such as arsenic, asbestos, mustard gas, chromates, coke oven fumes, nickel, oil, and radiation, has been associated with the development of lung cancer. Laws have been passed to control exposure to these carcinogens in the workplace.

### *Genetics*

Some familial predisposition to lung cancer seems apparent, because the incidence of lung cancer in close relatives of patients with lung cancer appears to be two to three times that in the general population regardless of smoking status.

## Clinical Manifestations

Often, lung cancer develops insidiously and is asymptomatic until late in its course. The signs and symptoms depend on the location and size of the tumor, the degree of obstruction, and the existence of metastases to regional or distant sites.

The most frequent symptom of lung cancer is cough or change in a chronic cough. People frequently ignore this symptom and attribute it to smoking or a respiratory infection. The cough may start as a dry, persistent cough, without sputum production. When obstruction of airways occurs, the cough may become productive due to infection. Cough is present in 65% to 75% of patients with lung cancer, and more than 25% have a productive cough (Yoder, 2006).

*NURSING ALERT*

**A cough that changes in character should arouse suspicion of lung cancer.**

Dyspnea occurs in up to 60% of patients early in their disease (Yoder, 2006). Causes of dyspnea may include tumor occlusion of the airway or lung parenchyma, pleural effusion, pneumonia, or complications of treatment. Hemoptysis or blood-tinged sputum may be expectorated. Chest or shoulder pain may indicate chest wall or pleural involvement by a tumor. Pain also is a late manifestation and may be related to metastasis to the bone.

In some patients, a recurring fever is an early symptom in response to a persistent infection in an area of pneumonitis distal to the tumor. In fact, cancer of the lung should be suspected in people with repeated unresolved upper respiratory tract infections. If the tumor spreads to adjacent structures and regional lymph nodes, the patient may present with chest pain and tightness, hoarseness (involving the recurrent laryngeal nerve), dysphagia, head and neck edema, and symptoms of pleural or pericardial effusion. The most common sites of metastases are lymph nodes, bone, brain, contralateral lung, adrenal glands, and liver (Fig. 23-7). Nonspecific symptoms of weakness, anorexia, and weight loss also may be present.

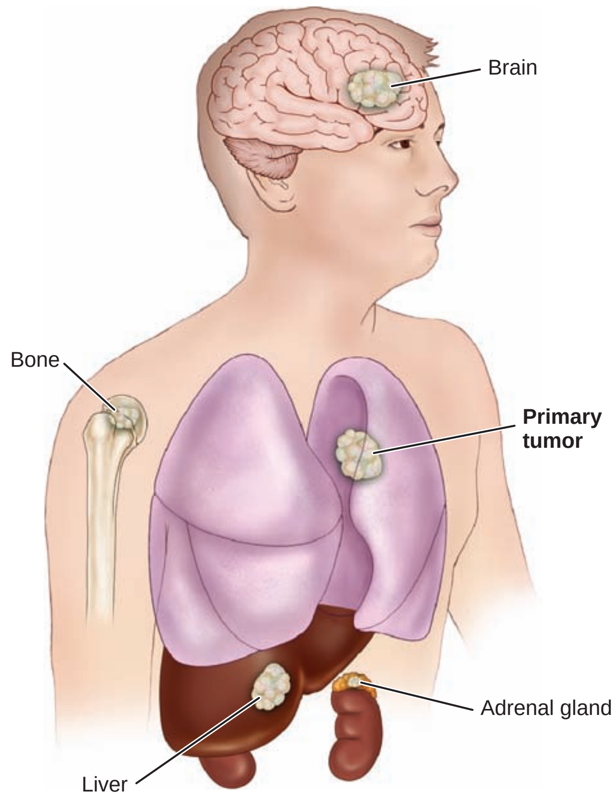



**Figure 23-7** Frequent sites of lung cancer metastasis.

## Assessment and Diagnostic Findings

If pulmonary symptoms occur in heavy smokers, cancer of the lung should always be considered. A chest x-ray is performed to search for pulmonary density, a solitary pulmonary nodule (coin lesion), atelectasis, and infection. CT scans of the chest are used to identify small nodules not easily visualized on the chest x-ray and also to serially examine areas for lymphadenopathy.

Sputum cytology is rarely used to make a diagnosis of lung cancer. Fiberoptic bronchoscopy is more commonly used; it provides a detailed study of the tracheobronchial tree and allows for brushings, washings, and biopsies of suspicious areas. For peripheral lesions not amenable to bronchoscopic biopsy, a transthoracic **fine-needle aspiration** may be performed under CT guidance to aspirate cells from a suspicious area. In some circumstances, an endoscopy with esophageal ultrasound may be used to obtain a transesophageal biopsy of enlarged subcarinal lymph nodes that are not easily accessible by other means.

A variety of scans may be used to assess for metastasis of the cancer. These may include bone scans, abdominal scans, positron emission tomography (PET) scans, and liver ultrasound. CT of the brain, magnetic resonance imaging (MRI), and other neurologic diagnostic procedures are used to detect central nervous system metastases. Mediastinoscopy or mediastinotomy may be used to obtain biopsy samples from lymph nodes in the mediastinum.

If surgery is a potential treatment, the patient is evaluated to determine whether the tumor is resectable and whether the patient can tolerate the physiologic impairment resulting from such surgery. Pulmonary function tests, arterial blood gas analysis, $\dot{V}/\dot{Q}$ scans, and exercise testing may all be used as part of the preoperative assessment.

## Medical Management

The objective of management is to provide a cure, if possible. Treatment depends on the cell type, the stage of the disease, and the patient's physiologic status (particularly cardiac and pulmonary status). In general, treatment may involve surgery, radiation therapy, or chemotherapy—or a combination of these. Newer and more specific therapies to modulate the immune system (gene therapy, therapy with defined tumor antigens) are under study and show promise.

### *Surgical Management*

Surgical resection is the preferred method of treating patients with localized non–small cell tumors, no evidence of metastatic spread, and adequate cardiopulmonary function. If the patient's cardiovascular status, pulmonary function,

**Chart 23-10• *Types of Lung Resection***

- Lobectomy: a single lobe of the lung is removed
- Bilobectomy: two lobes of the lung are removed
- Sleeve resection: cancerous lobe(s) is removed and a segment of the main bronchus is resected
- Pneumonectomy: removal of entire lung
- Segmentectomy: a segment of the lung is removed*
- Wedge resection: removal of a small, pie-shaped area of the segment*
- Chest wall resection with removal of cancerous lung tissue: for cancers that have invaded the chest wall

*Not recommended as curative resection for lung cancer.

and functional status are satisfactory, surgery is generally well tolerated. However, coronary artery disease, pulmonary insufficiency, and other comorbidities may contraindicate surgical intervention. The cure rate of surgical resection depends on the type and stage of the cancer. Surgery is primarily used for NSCLCs, because small cell cancer of the lung grows rapidly and metastasizes early and extensively. Lesions of many patients with bronchogenic cancer are inoperable at the time of diagnosis.

Several different types of lung resection may be performed (Chart 23-10). The most common surgical procedure for a small, apparently curable tumor of the lung is lobectomy (removal of a lobe of the lung). In some cases, an entire lung may be removed (pneumonectomy) (see Chapter 25 for further details).

### *Radiation Therapy*

Radiation therapy may offer cure in a small percentage of patients. It is useful in controlling neoplasms that cannot be surgically resected but are responsive to radiation. Irradiation also may be used to reduce the size of a tumor, to make an inoperable tumor operable, or to relieve the pressure of the tumor on vital structures. It can reduce symptoms of spinal cord metastasis and superior vena caval compression. Also, prophylactic brain irradiation is used in certain patients to treat microscopic metastases to the brain. Radiation therapy may help relieve cough, chest pain, dyspnea, hemoptysis, and bone and liver pain. Relief of symptoms may last from a few weeks to many months and is important in improving the quality of the remaining period of life.

Radiation therapy usually is toxic to normal tissue within the radiation field, and this may lead to complications such as esophagitis, pneumonitis, and radiation lung fibrosis. These may impair ventilatory and diffusion capacity and significantly reduce pulmonary reserve. The patient's nutritional status, psychological outlook, fatigue level, and signs of anemia and infection are monitored throughout the treatment. See Chapter 16 for management of the patient receiving radiation therapy.

### *Chemotherapy*

Chemotherapy is used to alter tumor growth patterns, to treat distant metastases or small cell cancer of the lung, and as an adjunct to surgery or radiation therapy. Chemotherapy may provide relief, especially of pain, but it does not usually cure the disease or prolong life to any great degree. Chemotherapy is also accompanied by side effects. It is valuable in reducing pressure symptoms of lung cancer and in treating brain, spinal cord, and pericardial metastasis. See Chapter 16 for a discussion of chemotherapy for the patient with cancer.

The choice of agent depends on the growth of the tumor cell and the specific phase of the cell cycle that the medication affects. In combination with surgery, chemotherapy may be administered before surgery (neoadjuvant therapy) or after surgery (adjuvant therapy). Combinations of two or more medications may be more beneficial than single-dose regimens. A variety of agents are used, including platinum analogues (cisplatin [Platinol] and carboplatin [Paraplatin]) and non–platinum-containing agents—taxanes (paclitaxel [Taxol, Onxol], docetaxel [Taxotere]), vinca alkaloids (vinblastine [Velban] and vindesine [Eldisine]), doxorubicin (Adriamycin, Doxil), gemcitabine (Gemzar), vinorelbine (Navelbine), irinotecan (Camptosar), etoposide (Toposar), and pemetrexed (Alimta). Other approved chemotherapeutic agents in oral form are gefitinib (Iressa) and erlotinib (Tarceva), which are epidermal growth factor tyrosine kinase inhibitors. Numerous new agents with cellular targets, including protein kinase C, vascular endothelial growth factor, cyclo-oxygenase-2, and farnesyl transferase, are being investigated for various types of lung cancer.

### *Palliative Therapy*

Palliative therapy may include radiation therapy to shrink the tumor to provide pain relief, a variety of bronchoscopic interventions to open a narrowed bronchus or airway, and pain management and other comfort measures. Evaluation and referral for hospice care are important in planning for comfortable and dignified end-of-life care for the patient and family.

## Treatment-Related Complications

A variety of complications may occur as a result of treatment for lung cancer. Surgical resection may result in respiratory failure, particularly if the cardiopulmonary system is compromised before surgery. Surgical complications and prolonged mechanical ventilation are potential outcomes. Radiation therapy may result in diminished cardiopulmonary function and other complications, such as pulmonary fibrosis, pericarditis, myelitis, and cor pulmonale. Chemotherapy, particularly in combination with radiation therapy, can cause pneumonitis. Pulmonary toxicity is a potential side effect of chemotherapy.

## Nursing Management

Nursing care of patients with lung cancer is similar to that for other patients with cancer (see Chapter 16) and addresses the physiologic and psychological needs of the patient. The physiologic problems are primarily due to the respiratory manifestations of the disease. Nursing care includes strategies to ensure relief of pain and discomfort and to prevent complications.

### *Managing Symptoms*

The nurse instructs the patient and family about the potential side effects of the specific treatment and strategies to manage them. Strategies for managing such symptoms as

CHART 23-11 NURSING RESEARCH PROFILE

## Quality of Life of Women With Lung Cancer and Their Families

Sarna, L., Cooley, M. E., Brown, J. K., et al. (2006). Quality of life and health status of dyads of women with lung cancer and family members. *Oncology Nursing Forum, 33*(6), 1109–1116.

**Purpose**

The purpose of this study was to describe and compare the quality of life and health status of dyads of women with lung cancer and their family members. Primary outcomes evaluated included quality of life and health status for both patients and family members.

**Design**

The investigators used a descriptive, cross-sectional research approach in which a convenience sample of 51 dyads of subjects participated. The patient sample consisted of women, and the family sample consisted primarily of men. A one-time assessment was conducted to evaluate quality of life (QOL), with a generic questionnaire, Short Form-36 (SF-36); comorbidities, with the Charlson Comorbidity Index; and depression, with the Center for Epidemiologic Studies Depression (CES-D). The participants also provided a self-report of smoking and drinking history as well as demographic data.

**Findings**

Analysis of data from 50 dyads revealed that the QOL of the patients and families was not significantly correlated. Family members of patients with lung cancer reported a significantly higher quality of life than patients with the disease. Poorer physical QOL of family members was related to increased age, comorbid conditions, less education, and alcohol use. Significantly more family members continued to smoke and use alcohol following the patient's diagnosis.

**Nursing Implications**

Nurses should consider not only the health status of patients with lung cancer but also the health status and QOL of family members. The health and QOL of these caregivers can affect their ability to care for the patient with cancer and to cope with the family member's illness.

dyspnea, fatigue, nausea and vomiting, and anorexia help the patient and family cope with therapeutic measures.

### Relieving Breathing Problems

Airway clearance techniques are key to maintaining airway patency through the removal of excess secretions. This may be accomplished through deep-breathing exercises, chest physiotherapy, directed cough, suctioning, and in some instances bronchoscopy. Bronchodilator medications may be prescribed to promote bronchial dilation. As the tumor enlarges or spreads, it may compress a bronchus or involve a large area of lung tissue, resulting in an impaired breathing pattern and poor gas exchange. At some stage of the disease, supplemental oxygen will probably be necessary.

Nursing measures focus on decreasing dyspnea by encouraging the patient to assume positions that promote lung expansion and to perform breathing exercises for lung expansion and relaxation. Patient education about energy conservation and airway clearance techniques is also necessary. Many of the techniques used in pulmonary rehabilitation can be applied to patients with lung cancer. Depending on the severity of disease and the patient's wishes, a referral to a pulmonary rehabilitation program may be helpful in managing respiratory symptoms.

### Reducing Fatigue

Fatigue is a devastating symptom that affects quality of life in patients with cancer. It is commonly experienced by patients with lung cancer and may be related to the disease itself, the cancer treatment and complications (eg, anemia), sleep disturbances, pain and discomfort, hypoxemia, poor nutrition, or the psychological ramifications of the disease (eg, anxiety, depression). Nursing strategies to promote energy conservation and reduce fatigue are presented in Chapter 16.

### Providing Psychological Support

Another important part of the nursing care of patients with lung cancer is provision of psychological support and identification of potential resources for the patient and family. Often, the nurse must help the patient and family deal with the following:

- The poor prognosis and relatively rapid progression of this disease
- Informed decision making regarding the possible treatment options
- Methods to maintain the patient's quality of life during the course of this disease (Chart 23-11)
- End-of-life treatment options

## Gerontologic Considerations

At the time of diagnosis of lung cancer, most patients are older than 65 years of age and have stage III or IV disease. Although age is not a significant prognostic factor for overall survival and response to treatment for either NSCLC or small cell lung cancer, older patients have specific needs. Depending on the comorbidities and functional status of elderly patients, chemotherapy agents, doses, and cycles may need to be adjusted to maintain quality of life. Issues that must be considered in care of elderly patients with lung cancer include functional status, comorbid conditions, nutritional status, cognition, concomitant medications, and psychological and social support (ACCP, 2007; Yoder, 2006).

# Tumors of the Mediastinum

Tumors of the mediastinum include neurogenic tumors, tumors of the thymus, lymphomas, germ cell tumors, cysts, and mesenchymal tumors. These tumors may be malignant

or benign. They are usually described in relation to location: anterior, middle, or posterior masses or tumors.

### Clinical Manifestations

Nearly all symptoms of mediastinal tumors result from the pressure of the mass against important intrathoracic organs. Symptoms may include cough, wheezing, dyspnea, anterior chest or neck pain, bulging of the chest wall, heart palpitations, angina, other circulatory disturbances, central cyanosis, superior vena cava syndrome (ie, swelling of the face, neck, and upper extremities), marked distention of the veins of the neck and the chest wall (evidence of the obstruction of large veins of the mediastinum by extravascular compression or intravascular invasion), and dysphagia and weight loss from pressure or invasion into the esophagus.

### Assessment and Diagnostic Findings

Chest x-rays are the major method used initially to diagnose mediastinal tumors and cysts. CT is the standard diagnostic test for assessment of the mediastinum and surrounding structures. MRI, as well as PET, may be used in some circumstances.

### Medical Management

If the tumor is malignant and has infiltrated the surrounding tissue and complete surgical removal is not feasible, radiation therapy, chemotherapy, or both are used.

#### *Surgical Management*

Many mediastinal tumors are benign and operable. The location of the tumor (anterior, middle, or posterior compartment) in the mediastinum dictates the type of incision. The common incision used is a median sternotomy; however, a thoracotomy may be used, depending on the location of the tumor. Additional approaches include a bilateral anterior thoracotomy (clamshell incision) and video-assisted thoracoscopic surgery (see Chapter 25). The care is the same as for any patient undergoing thoracic surgery. Major complications include hemorrhage, injury to the phrenic or recurrent laryngeal nerve, and infection.

# CHEST TRAUMA

Major chest trauma may occur alone or in combination with multiple other injuries. Chest trauma is classified as either blunt or penetrating. Blunt chest trauma results from sudden compression or positive pressure inflicted to the chest wall. Penetrating trauma occurs when a foreign object penetrates the chest wall.

## *Blunt Trauma*

Although blunt chest trauma is more common than penetrating trauma, it is often difficult to identify the extent of the damage because the symptoms may be generalized and vague. In addition, patients may not seek immediate medical attention, which may complicate the problem.

### Pathophysiology

The most common causes of blunt chest trauma are motor vehicle crashes (trauma from steering wheel, seat belt), falls, and bicycle crashes (trauma from handlebars). Mechanisms of blunt chest trauma include acceleration (moving object hitting the chest or patient being thrown into an object), deceleration (sudden decrease in rate of speed or velocity, such as a motor vehicle crash), shearing (stretching forces to areas of the chest causing tears, ruptures, or dissections), and compression (direct blow to the chest, such as a crush injury). Injuries to the chest are often life-threatening and result in one or more of the following pathologic states:

- Hypoxemia from disruption of the airway; injury to the lung parenchyma, rib cage, and respiratory musculature; massive hemorrhage; collapsed lung; and pneumothorax
- Hypovolemia from massive fluid loss from the great vessels, cardiac rupture, or hemothorax
- Cardiac failure from cardiac tamponade, cardiac contusion, or increased intrathoracic pressure

These pathologic states frequently result in impaired ventilation and perfusion leading to acute renal failure, hypovolemic shock, and death.

### Assessment and Diagnostic Findings

Time is critical in treating chest trauma. Therefore, it is essential to assess the patient immediately to determine the following: time elapsed since injury occurred, mechanism of injury, level of responsiveness, specific injuries, estimated blood loss, recent drug or alcohol use, and prehospital treatment. Initial assessment of thoracic injuries includes assessment for airway obstruction, tension pneumothorax, open pneumothorax, massive hemothorax, flail chest, and cardiac tamponade. These injuries are life-threatening and require immediate treatment. Secondary assessment includes assessment for simple pneumothorax, hemothorax, pulmonary contusion, traumatic aortic rupture, tracheobronchial disruption, esophageal perforation, traumatic diaphragmatic injury, and penetrating wounds to the mediastinum. Although listed as secondary, these injuries may be life-threatening as well.

The physical examination includes inspection of the airway, thorax, neck veins, and breathing difficulty. Specifics include assessing the rate and depth of breathing for abnormalities such as stridor, cyanosis, nasal flaring, use of accessory muscles, drooling, and overt trauma to the face, mouth, or neck. The chest is assessed for symmetric movement, symmetry of breath sounds, open chest wounds, entrance or exit wounds, impaled objects, tracheal shift, distended neck veins, subcutaneous emphysema, and paradoxical chest wall motion. In addition, the chest wall is assessed for bruising, petechiae, lacerations, and burns. The vital signs and skin color are assessed for signs of shock. The thorax is palpated for tenderness and crepitus, and the position of the trachea is also assessed.

The initial diagnostic workup includes a chest x-ray, CT scan, complete blood count, clotting studies, type and cross-match, electrolytes, oxygen saturation, arterial blood gas analysis, and ECG. The patient is completely undressed to avoid missing additional injuries that may complicate care.

Many patients with injuries involving the chest have associated head and abdominal injuries that require attention. Ongoing assessment is essential to monitor the patient's response to treatment and to detect early signs of clinical deterioration.

### Medical Management

The goals of treatment are to evaluate the patient's condition and to initiate aggressive resuscitation. An airway is immediately established with oxygen support and, in some cases, intubation and ventilatory support. Reestablishing fluid volume and negative intrapleural pressure and draining intrapleural fluid and blood are essential.

The potential for massive blood loss and exsanguination with blunt or penetrating chest injuries is high because of injury to the great blood vessels. Many patients die at the scene of the injury or are in shock by the time help arrives. Agitation and irrational and combative behavior are signs of decreased oxygen delivery to the cerebral cortex. Strategies to restore and maintain cardiopulmonary function include ensuring an adequate airway and ventilation; stabilizing and reestablishing chest wall integrity; occluding any opening into the chest (open pneumothorax); and draining or removing any air or fluid from the thorax to relieve pneumothorax, hemothorax, or cardiac tamponade. Hypovolemia and low cardiac output must be corrected. Many of these treatment efforts, along with the control of hemorrhage, are carried out simultaneously at the scene of the injury or in the emergency department. Depending on the success of efforts to control the hemorrhage in the emergency department, the patient may be taken immediately to the operating room. Principles of management are essentially those pertaining to care of the postoperative thoracic patient (see Chapter 25).

## STERNAL AND RIB FRACTURES

Sternal fractures are most common in motor vehicle crashes with a direct blow to the sternum via the steering wheel. Rib fractures are the most common type of chest trauma, occurring in more than 60% of patients admitted with blunt chest injury (Wilkins, Dexter & Gold, 2007). Most rib fractures are benign and are treated conservatively. Fractures of the first three ribs are rare but can result in a high mortality rate because they are associated with laceration of the subclavian artery or vein. The fifth through ninth ribs are the most common sites of fractures. Fractures of the lower ribs are associated with injury to the spleen and liver, which may be lacerated by fragmented sections of the rib.

### Clinical Manifestations

Patients with sternal fractures have anterior chest pain, overlying tenderness, ecchymosis, crepitus, swelling, and possible chest wall deformity. For patients with rib fractures, clinical manifestations are similar: severe pain, point tenderness, and muscle spasm over the area of the fracture that are aggravated by coughing, deep breathing, and movement. The area around the fracture may be bruised. To reduce the pain, the patient splints the chest by breathing in a shallow manner and avoids sighs, deep breaths, coughing, and movement. This reluctance to move or breathe deeply results in diminished ventilation, atelectasis (collapse of unaerated alveoli), pneumonitis, and hypoxemia. Respiratory insufficiency and failure can be the outcomes of such a cycle.

### Assessment and Diagnostic Findings

The patient must be closely evaluated for underlying cardiac injuries. A crackling, grating sound in the thorax (subcutaneous crepitus) may be detected with auscultation. The diagnostic workup may include a chest x-ray, rib films of a specific area, ECG, continuous pulse oximetry, and arterial blood gas analysis.

### Medical Management

Medical management is directed toward relieving pain, avoiding excessive activity, and treating any associated injuries. Surgical fixation is rarely necessary unless fragments are grossly displaced and pose a potential for further injury.

The goals of treatment for rib fractures are to control pain and to detect and treat the injury. Sedation is used to relieve pain and to allow deep breathing and coughing. Care must be taken to avoid oversedation and suppression of respiratory drive. Alternative strategies to relieve pain include an intercostal nerve block and ice over the fracture site. A chest binder may be used as supportive treatment to provide stability to the chest wall and may decrease pain. The patient is instructed to apply the binder snugly enough to provide support, but not to impair respiratory excursion. Usually the pain abates in 5 to 7 days, and discomfort can be relieved with epidural analgesia, patient-controlled analgesia, or nonopioid analgesia. Most rib fractures heal in 3 to 6 weeks. The patient is monitored closely for signs and symptoms of associated injuries.

## FLAIL CHEST

Flail chest is frequently a complication of blunt chest trauma from a steering wheel injury. It usually occurs when three or more adjacent ribs (multiple contiguous ribs) are fractured at two or more sites, resulting in free-floating rib segments. It may also result as a combination fracture of ribs and costal cartilages or sternum. As a result, the chest wall loses stability, causing respiratory impairment and usually severe respiratory distress.

### Pathophysiology

During inspiration, as the chest expands, the detached part of the rib segment (flail segment) moves in a paradoxical manner (pendelluft movement) in that it is pulled inward during inspiration, reducing the amount of air that can be drawn into the lungs. On expiration, because the intrathoracic pressure exceeds atmospheric pressure, the flail segment bulges outward, impairing the patient's ability to exhale. The mediastinum then shifts back to the affected side (Fig. 23-8). This paradoxical action results in increased dead space, a reduction in alveolar ventilation, and decreased compliance. Retained airway secretions and atelectasis frequently accompany flail chest. The patient has hypoxemia, and if gas exchange is greatly compromised, respiratory acidosis develops as a result of carbon dioxide retention. Hypotension, inadequate tissue perfusion, and metabolic acidosis often follow

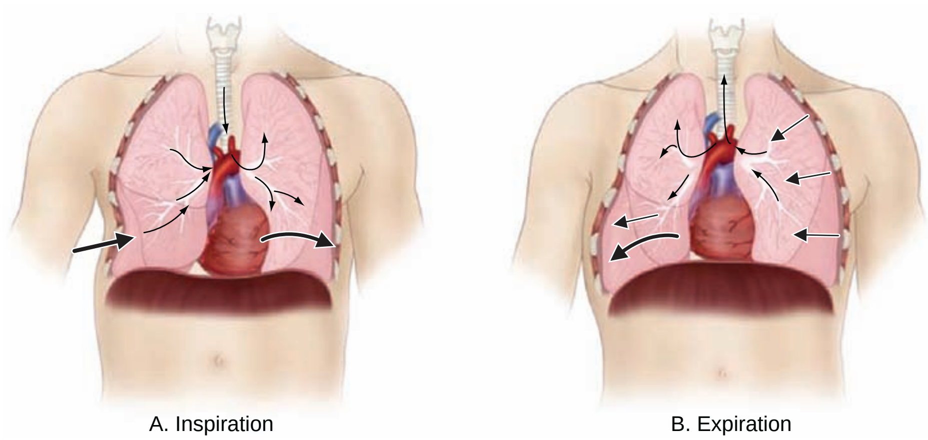



**Figure 23-8** Flail chest is caused by a free-floating segment of rib cage resulting from multiple rib fractures. **A,** Paradoxical movement on inspiration occurs when the flail rib segment is sucked inward and the mediastinal structures shift to the unaffected side. The amount of air drawn into the affected lung is reduced. **B,** On expiration, the flail segment bulges outward and the mediastinal structures shift back to the affected side.

as the paradoxical motion of the mediastinum decreases cardiac output.

### Medical Management

As with rib fracture, treatment of flail chest is usually supportive. Management includes providing ventilatory support, clearing secretions from the lungs, and controlling pain. Specific management depends on the degree of respiratory dysfunction. If only a small segment of the chest is involved, the objectives are to clear the airway through positioning, coughing, deep breathing, and suctioning to aid in the expansion of the lung, and to relieve pain by intercostal nerve blocks, high thoracic epidural blocks, or cautious use of IV opioids.

For mild to moderate flail chest injuries, the underlying pulmonary contusion is treated by monitoring fluid intake and appropriate fluid replacement while relieving chest pain. Pulmonary physiotherapy focusing on lung volume expansion, and secretion management techniques are performed. The patient is closely monitored for further respiratory compromise.

For severe flail chest injuries, endotracheal intubation and mechanical ventilation are required to provide internal pneumatic stabilization of the flail chest and to correct abnormalities in gas exchange. This helps treat the underlying pulmonary contusion, serves to stabilize the thoracic cage to allow the fractures to heal, and improves alveolar ventilation and intrathoracic volume by decreasing the work of breathing. This treatment modality requires endotracheal intubation and ventilator support. Differing modes of ventilation are used depending on the patient's underlying disease and specific needs (see Chapter 25).

In rare circumstances, surgery may be required to more quickly stabilize the flail segment. This may be used for patients who are difficult to ventilate or for high-risk patients with underlying lung disease who may be difficult to wean from mechanical ventilation.

Regardless of the type of treatment, the patient is carefully monitored by serial chest x-rays, arterial blood gas analysis, pulse oximetry, and bedside pulmonary function monitoring. Pain management is key to successful treatment. Patient-controlled analgesia, intercostal nerve blocks, epidural analgesia, and intrapleural administration of opioids may be used to relieve or manage thoracic pain.

## PULMONARY CONTUSION

Pulmonary contusion is a common thoracic injury and is frequently associated with flail chest. It is defined as damage to the lung tissues resulting in hemorrhage and localized edema. It is associated with chest trauma when there is rapid compression and decompression to the chest wall (ie, blunt trauma). Pulmonary contusion represents a spectrum of lung injury characterized by the development of infiltrates and various degrees of respiratory dysfunction and sometimes respiratory failure. It is often cited as the most common potentially life-threatening chest injury; however, mortality is often attributed to other associated injuries. A contusion is sustained in 30% to 70% of patients who experience blunt force trauma. Pulmonary contusion may not be evident initially on examination but develops in the posttraumatic period; it may involve a small portion of one lung, a massive section of a lung, one entire lung, or both lungs.

### Pathophysiology

The primary pathologic defect is an abnormal accumulation of fluid in the interstitial and intra-alveolar spaces. It is thought that injury to the lung parenchyma and its capillary network results in a leakage of serum protein and plasma. The leaking serum protein exerts an osmotic pressure that enhances loss of fluid from the capillaries. Blood, edema, and cellular debris (from cellular response to injury) enter the lung and accumulate in the bronchioles and alveoli, where they interfere with gas exchange. An increase in pulmonary vascular resistance and pulmonary artery pressure occurs. The patient has hypoxemia and carbon dioxide retention. Occasionally, a contused lung occurs on the other side of the point of body impact; this is called a contrecoup contusion.

### Clinical Manifestations

Pulmonary contusion may be mild, moderate, or severe. The clinical manifestations vary from decreased breath sounds, tachypnea, tachycardia, chest pain, hypoxemia, and blood-tinged secretions to more severe tachypnea, tachycardia, crackles, frank bleeding, severe hypoxemia (cyanosis), and respiratory acidosis. Changes in sensorium,

including increased agitation or combative irrational behavior, may be signs of hypoxemia.

In addition, patients with moderate pulmonary contusion have a large amount of mucus, serum, and frank blood in the tracheobronchial tree; patients often have a constant cough but cannot clear the secretions. Patients with severe pulmonary contusion have the signs and symptoms of ARDS; these may include central cyanosis, agitation, combativeness, and productive cough with frothy, bloody secretions.

### Assessment and Diagnostic Findings

The efficiency of gas exchange is determined by pulse oximetry and arterial blood gas measurements. Pulse oximetry is also used to measure oxygen saturation continuously. The initial chest x-ray may show no changes; changes may not appear for 1 or 2 days after the injury and appear as pulmonary infiltrates on chest x-ray.

### Medical Management

Treatment priorities include maintaining the airway, providing adequate oxygenation, and controlling pain. In mild pulmonary contusion, adequate hydration via IV fluids and oral intake is important to mobilize secretions. However, fluid intake must be closely monitored to avoid hypervolemia. Volume expansion techniques, postural drainage, physiotherapy including coughing, and endotracheal suctioning are used to remove the secretions. Pain is managed by intercostal nerve blocks or by opioids via patient-controlled analgesia or other methods. Usually, antimicrobial therapy is administered because the damaged lung is susceptible to infection. Supplemental oxygen is usually given by mask or cannula for 24 to 36 hours.

In patients with moderate pulmonary contusions, bronchoscopy may be required to remove secretions. Intubation and mechanical ventilation with PEEP (see Chapter 25) may also be necessary to maintain the pressure and keep the lungs inflated. Diuretics may be administered to reduce edema. A nasogastric tube is inserted to relieve gastrointestinal distention.

In patients with severe contusion, who may develop respiratory failure, aggressive treatment with endotracheal intubation and ventilatory support, diuretics, and fluid restriction may be necessary. Colloids and crystalloid solutions may be used to treat hypovolemia.

Antimicrobial medications may be prescribed for the treatment of pulmonary infection. This is a common complication of pulmonary contusion (especially pneumonia in the contused segment), because the fluid and blood that extravasates into the alveolar and interstitial spaces serve as an excellent culture medium.

## Penetrating Trauma: Gunshot and Stab Wounds

Gunshot and stab wounds are the most common causes of penetrating chest trauma. These wounds are classified according to their velocity. Stab wounds are generally considered low-velocity trauma because the weapon destroys a small area around the wound. Knives and switchblades cause most stab wounds. The appearance of the external wound may be very deceptive, because pneumothorax, hemothorax, lung contusion, and cardiac tamponade, along with severe and continuing hemorrhage, can occur from any small wound, even one caused by a small-diameter instrument such as an ice pick.

Gunshot wounds may be classified as low, medium, or high velocity. The factors that determine the velocity and resulting extent of damage include the distance from which the gun was fired, the caliber of the gun, and the construction and size of the bullet. A bullet can cause damage at the site of penetration and along its pathway, and a gunshot wound to the chest can produce a variety of pathophysiologic changes. The bullet may ricochet off bony structures and damage the chest organs and great vessels. If the diaphragm is involved in a gunshot wound or a stab wound, injury to the chest cavity must be considered.

### Medical Management

The objective of immediate management is to restore and maintain cardiopulmonary function. After an adequate airway is ensured and ventilation is established, examination for shock and intrathoracic and intra-abdominal injuries is necessary. The patient is undressed completely so that additional injuries are not missed. There is a high risk for associated intra-abdominal injuries with stab wounds below the level of the fifth anterior intercostal space. Death can result from exsanguinating hemorrhage or intra-abdominal sepsis.

The diagnostic workup includes a chest x-ray, chemistry profile, arterial blood gas analysis, pulse oximetry, and ECG. The patient's blood is typed and cross-matched in case blood transfusion is required. After the status of the peripheral pulses is assessed, a large-bore IV line is inserted. An indwelling catheter is inserted to monitor urinary output. A nasogastric tube is inserted and connected to low suction to prevent aspiration, minimize leakage of abdominal contents, and decompress the gastrointestinal tract.

Shock is treated simultaneously with colloid solutions, crystalloids, or blood, as indicated by the patient's condition. Diagnostic procedures are carried out as dictated by the needs of the patient (eg, CT scans of chest or abdomen, flat plate x-ray of the abdomen, abdominal tap to check for bleeding).

A chest tube is inserted into the pleural space in most patients with penetrating wounds of the chest to achieve rapid and continuing re-expansion of the lungs. The insertion of the chest tube frequently results in a complete evacuation of the blood and air. The chest tube also allows early recognition of continuing intrathoracic bleeding, which would make surgical exploration necessary. If the patient has a penetrating wound of the heart or great vessels, the esophagus, or the tracheobronchial tree, surgical intervention is required.

## Pneumothorax

Pneumothorax occurs when the parietal or visceral pleura is breached and the pleural space is exposed to positive atmospheric pressure. Normally the pressure in the pleural

space is negative or subatmospheric; this negative pressure is required to maintain lung inflation. When either pleura is breached, air enters the pleural space, and the lung or a portion of it collapses.

## Types of Pneumothorax

Types of pneumothorax include simple, traumatic, and tension pneumothorax.

### Simple Pneumothorax

A simple, or spontaneous, pneumothorax occurs when air enters the pleural space through a breach of either the parietal or visceral pleura. Most commonly, this occurs as air enters the pleural space through the rupture of a bleb or a bronchopleural fistula. A spontaneous pneumothorax may occur in an apparently healthy person in the absence of trauma due to rupture of an air-filled bleb, or blister, on the surface of the lung, allowing air from the airways to enter the pleural cavity. It may be associated with diffuse interstitial lung disease and severe emphysema.

### Traumatic Pneumothorax

A traumatic pneumothorax occurs when air escapes from a laceration in the lung itself and enters the pleural space or from a wound in the chest wall. It may result from blunt trauma (eg, rib fractures), penetrating chest or abdominal trauma (eg, stab wounds or gunshot wounds), or diaphragmatic tears. Traumatic pneumothorax may occur during invasive thoracic procedures (ie, thoracentesis, transbronchial lung biopsy, insertion of a subclavian line) in which the pleura is inadvertently punctured, or with barotrauma from mechanical ventilation.

A traumatic pneumothorax resulting from major injury to the chest is often accompanied by hemothorax (collection of blood in the pleural space resulting from torn intercostal vessels, lacerations of the great vessels, or lacerations of the lungs). Often both blood and air are found in the chest cavity (hemopneumothorax) after major trauma. Chest surgery can be classified as a traumatic pneumothorax as a result of the entry into the pleural space and the accumulation of air and fluid in the pleural space.

Open pneumothorax is one form of traumatic pneumothorax. It occurs when a wound in the chest wall is large enough to allow air to pass freely in and out of the thoracic cavity with each attempted respiration. Because the rush of air through the wound in the chest wall produces a sucking sound, such injuries are termed sucking chest wounds. In such patients, not only does the lung collapse, but the structures of the mediastinum (heart and great vessels) also shift toward the uninjured side with each inspiration and in the opposite direction with expiration. This is termed mediastinal flutter or swing, and it produces serious circulatory problems.

*NURSING ALERT*

**Traumatic open pneumothorax calls for emergency interventions. Stopping the flow of air through the opening in the chest wall is a lifesaving measure.**

### Tension Pneumothorax

A **tension pneumothorax** occurs when air is drawn into the pleural space from a lacerated lung or through a small opening or wound in the chest wall. It may be a complication of other types of pneumothorax. In contrast to open pneumothorax, the air that enters the chest cavity with each inspiration is trapped; it cannot be expelled during expiration through the air passages or the opening in the chest wall. In effect, a one-way valve or ball valve mechanism occurs where air enters the pleural space but cannot escape. With each breath, tension (positive pressure) is increased within the affected pleural space. This causes the lung to collapse and the heart, the great vessels, and the trachea to shift toward the unaffected side of the chest (mediastinal shift). Both respiration and circulatory function are compromised because of the increased intrathoracic pressure, which decreases venous return to the heart, causing decreased cardiac output and impairment of peripheral circulation. In extreme cases, the pulse may be undetectable—this is known as pulseless electrical activity.

*NURSING ALERT*

**Relief of tension pneumothorax is considered an emergency measure.**

## Clinical Manifestations

The signs and symptoms associated with pneumothorax depend on its size and cause. Pain is usually sudden and may be pleuritic. The patient may have only minimal respiratory distress with slight chest discomfort and tachypnea with a small simple or uncomplicated pneumothorax. If the pneumothorax is large and the lung collapses totally, acute respiratory distress occurs. The patient is anxious, has dyspnea and air hunger, has increased use of the accessory muscles, and may develop central cyanosis from severe hypoxemia.

In assessing the chest for any type of pneumothorax, the nurse assesses tracheal alignment, expansion of the chest, breath sounds, and percussion of the chest. In a simple pneumothorax, the trachea is midline, expansion of the chest is decreased, breath sounds may be diminished, and percussion of the chest may reveal normal sounds or hyperresonance depending on the size of the pneumothorax. In a tension pneumothorax, the trachea is shifted away from the affected side, chest expansion may be decreased or fixed in a hyperexpansion state, breath sounds are diminished or absent, and percussion to the affected side is hyperresonant. The clinical picture is one of air hunger, agitation, increasing hypoxemia, central cyanosis, hypotension, tachycardia, and profuse diaphoresis. Figure 23-9 compares open and tension pneumothorax.

## Medical Management

Medical management of pneumothorax depends on its cause and severity. The goal of treatment is to evacuate the air or blood from the pleural space. A small chest tube (28 Fr) is inserted near the second intercostal space; this space is used because it is the thinnest part of the chest wall, minimizes the danger of contacting the thoracic nerve, and

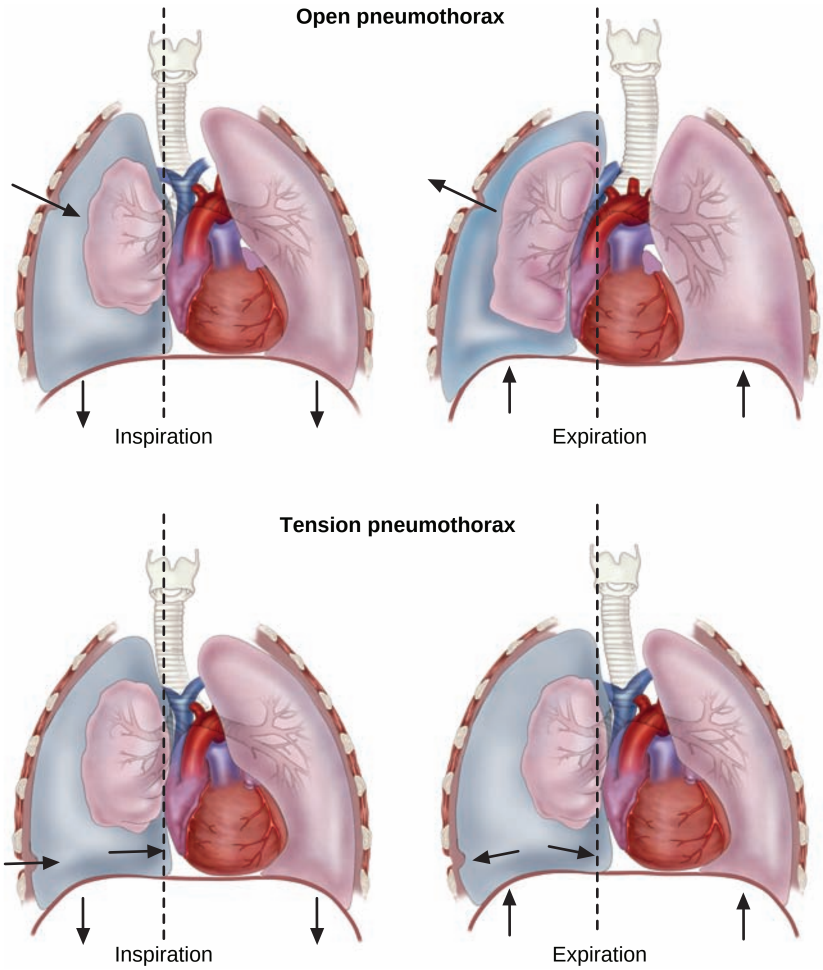



**Figure 23-9** Open pneumothorax (*top*) and tension pneumothorax (*bottom*). In open pneumothorax, air enters the chest during inspiration and exits during expiration. A slight shift of the affected lung may occur because of a decrease in pressure as air moves out of the chest. In tension pneumothorax, air enters but cannot leave the chest. As the pressure increases, the heart and great vessels are compressed and the mediastinal structures are shifted toward the opposite side of the chest. The trachea is pushed from its normal midline position toward the opposite side of the chest, and the unaffected lung is compressed.

leaves a less visible scar. If a patient also has a hemothorax, a large-diameter chest tube (32 Fr or greater) is inserted, usually in the fourth or fifth intercostal space at the midaxillary line. The tube is directed posteriorly to drain the fluid and air. Once the chest tube or tubes are inserted and suction is applied (usually to 20 mm Hg suction), effective decompression of the pleural cavity (drainage of blood or air) occurs.

If an excessive amount of blood enters the chest tube in a relatively short period, an autotransfusion may be needed. This technique involves taking the patient's own blood that has been drained from the chest, filtering it, and then transfusing it back into the vascular system.

In such an emergency, anything may be used that is large enough to fill the chest wound—a towel, a handkerchief, or the heel of the hand. If conscious, the patient is instructed to inhale and strain against a closed glottis. This action assists in re-expanding the lung and ejecting the air from the thorax. In the hospital, the opening is plugged by sealing it with gauze impregnated with petrolatum. A pressure dressing is applied. Usually, a chest tube connected to water-seal drainage is inserted to remove air and fluid. Antibiotics usually are prescribed to combat infection from contamination.

The severity of open pneumothorax depends on the amount and rate of thoracic bleeding and the amount of air in the pleural space. The pleural cavity can be decompressed by needle aspiration (thoracentesis) or by chest tube drainage of the blood or air. The lung is then able to re-expand and resume the function of gas exchange. As a rule of thumb, the chest wall is opened surgically (thoracotomy) if more than 1500 mL of blood is aspirated initially by thoracentesis (or is the initial chest tube output) or if chest tube output continues at greater than 200 mL/h. The urgency with which the blood must be removed is determined by the degree of respiratory compromise. An emergency thoracotomy may also be performed in the emergency department if a cardiovascular injury secondary to chest or penetrating trauma is suspected. The patient with a possible tension pneumothorax should immediately be given a high concentration of supplemental oxygen to treat the hypoxemia, and pulse oximetry should be used to monitor oxygen saturation. In an emergency situation, a tension pneumothorax can be decompressed or quickly converted to a simple pneumothorax by inserting a large-bore needle (14-gauge) at the second intercostal space, midclavicular line on the affected side. This relieves the pressure and vents the positive pressure to the external environment. A chest tube is then inserted and connected to suction to remove the remaining air and fluid, reestablish the negative pressure, and re-expand the lung. If the lung re-expands and air leakage from

the lung parenchyma stops, further drainage may be unnecessary. If a prolonged air leak continues despite chest tube drainage to underwater seal, surgery may be necessary to close the leak.

## Cardiac Tamponade

Cardiac tamponade is compression of the heart resulting from fluid or blood within the pericardial sac. It usually is caused by blunt or penetrating trauma to the chest. A penetrating wound of the heart is associated with a high mortality rate. Cardiac tamponade also may follow diagnostic cardiac catheterization, angiographic procedures, and pacemaker insertion, which can produce perforations of the heart and great vessels. Pericardial effusion with fluid compressing the heart also may develop from metastases to the pericardium from malignant tumors of the breast, lung, or mediastinum and may occur with lymphomas and leukemias, renal failure, TB, and high-dose radiation to the chest. Cardiac tamponade is discussed in detail in Chapter 30.

## Subcutaneous Emphysema

No matter what kind of chest trauma a patient has, when the lung or the air passages are injured, air may enter the tissue planes and pass for some distance under the skin (eg, neck, chest). The tissues give a crackling sensation when palpated, and the subcutaneous air produces an alarming appearance as the face, neck, body, and scrotum become misshapen by subcutaneous air. Fortunately, subcutaneous emphysema is of itself usually not a serious complication. The subcutaneous air is spontaneously absorbed if the underlying air leak is treated or stops spontaneously. In severe cases in which there is widespread subcutaneous emphysema, a tracheostomy is indicated if airway patency is threatened by pressure of the trapped air on the trachea.

## CRITICAL THINKING EXERCISES

**1** You are caring for a 42-year-old woman who underwent gastric bypass surgery. After being in the intensive care unit for 3 days, she was transferred to a general surgery unit. She is a former smoker and is taking multiple medications for high blood pressure and diabetes. When you started your shift, she was stable, but she has become increasingly anxious with some shortness of breath in the past hour. What are potential risk factors you might observe or identify in this patient? What assessment strategies would you use to evaluate changes in her respiratory status? What are the potential causes of the shortness of breath? What decision process would you use to determine when the physician should be contacted?

EBP **2** An 89-year-old woman is admitted to your unit from a long-term care facility. She is extremely frail and has multiple comorbidities. She has been diagnosed with community-acquired pneumonia. What evidence-based nursing interventions are important in her care and recovery? How would you determine the strength of the evidence for the interventions you choose?

EBP **3** A 48-year-old patient is admitted to the hospital with a diagnosis of malnutrition, possible aspiration pneumonia, and stage 4 pressure ulcer. The patient experienced a traumatic brain injury 4 years ago; he is not fully aware of his surroundings and has difficulty swallowing. Tube feedings have been prescribed in an effort to improve his nutritional status prior to débridement and skin grafting to the pressure ulcer. Identify evidence-based nursing interventions appropriate for this patient related to possible aspiration pneumonia. How would you assess the strength of that evidence?

EBP **4** You are on a surgical unit caring for a 68-year-old man who has undergone a left pneumonectomy for lung cancer. The patient has COPD and continues to smoke despite the diagnoses of COPD and lung cancer. What strategies would you use to prevent or minimize pulmonary complications in this patient? What parameters would you use to monitor the patient's postoperative respiratory status? What strategies would you consider to encourage the patient to stop smoking? What is the evidence base for the strategies that you consider? How would you evaluate the strength of the evidence?

**5** You are caring for a 34-year-old patient who experienced her third spontaneous pneumothorax. A chest tube was inserted, relieving the patient's acute symptoms. She has, however, become increasingly short of breath during the past hour. What physical assessment skills and strategies would you use to determine potential changes in the patient's respiratory condition? What are potential causes of this increasing shortness of breath? What would you do to prepare for an emergency situation in this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

Agency for Healthcare Quality and Research, www.ahrq.gov
American Association for Respiratory Care, www.aarc.org
American Cancer Society, www.cancer.org
American College of Chest Physicians, www.chestnet.org
American Lung Association, www.lungusa.org
American Thoracic Society, www.thoracic.org
Centers for Disease Control and Prevention, www.cdc.gov
National Cancer Institute, www.cancer.gov
National Heart, Lung and Blood Institute, www.nhlbi.nih.gov
Occupational Safety and Health Administration (OSHA), www.osha.gov
Pulmonary Hypertension Association (PHA), www.phassociation.org
Respiratory Nursing Society, www.respiratorynursingsociety.org



chapter 24

# Management of Patients With Chronic Pulmonary Disease

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the pathophysiology of chronic obstructive pulmonary disease (COPD).
2. Discuss the major risk factors for developing COPD and nursing interventions to minimize or prevent these risk factors.
3. Describe nursing management of patients with COPD.
4. Develop a teaching plan for patients with COPD.
5. Describe the pathophysiology of bronchiectasis and relate it to signs and symptoms of bronchiectasis.
6. Identify medical and nursing management of bronchiectasis.
7. Describe the pathophysiology of asthma.
8. Discuss the medications used in asthma management.
9. Describe asthma self-management strategies.
10. Describe the pathophysiology of cystic fibrosis.

## GLOSSARY

**air trapping:** incomplete emptying of alveoli during expiration due to loss of lung tissue elasticity (emphysema), bronchospasm (asthma), or airway obstruction

**alpha$_1$-antitrypsin deficiency:** genetic disorder resulting from deficiency of alpha$_1$ antitrypsin, a protective agent for the lung; increases patient's risk for developing panacinar emphysema even in the absence of smoking

**asthma:** a disease with multiple precipitating mechanisms resulting in a common clinical outcome of reversible airflow obstruction; no longer considered a category of COPD

**bronchiectasis:** chronic dilation of a bronchus or bronchi; the dilated airways become saccular and are a medium for chronic infection; no longer considered a category of COPD

**bronchitis:** a disease of the airways defined as the presence of cough and sputum production for at least a combined total of 3 months in each of 2 consecutive years; a category of COPD

**chronic obstructive pulmonary disease:** disease state characterized by airflow limitation that is not fully reversible; sometimes referred to as chronic airway obstruction or chronic obstructive lung disease

**emphysema:** a disease of the airways characterized by destruction of the walls of overdistended alveoli; a category of COPD

**metered-dose inhaler:** patient-activated medication canister that provides aerosolized medication that the patient inhales into the lungs

**polycythemia:** increase in the red blood cell concentration in the blood; in COPD, the body attempts to improve oxygen carrying capacity by producing increasing amounts of red blood cells

**spirometry:** pulmonary function tests that measure specific lung volumes (eg, $FEV_1$, FVC) and rates ($FEF_{25–75\%}$); may be measured before and after bronchodilator administration

Chronic pulmonary disorders are a leading cause of morbidity and mortality in the United States. Nurses care for patients with chronic pulmonary disease across the spectrum of care, from outpatient and home care to emergency department, critical care, and hospice settings. To care for these patients, nurses need not only have astute assessment and clinical management skills but also knowledge of how these disorders can affect quality of life. In addition, the nurse's knowledge of palliative and end-of-life care is important for affected patients. Patient and family teaching is an important nursing intervention to enhance self-management in patients with any chronic pulmonary disorder.

## *Chronic Obstructive Pulmonary Disease*

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) has defined **chronic obstructive pulmonary disease** (COPD) as "a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases" (GOLD, 2008, p. 2). This updated definition is a broad description that explains COPD and its signs and symptoms. Although previous definitions have categorized emphysema and chronic bronchitis as types of COPD, this was often confusing because most patients with COPD present with overlapping signs and symptoms of these two distinct disease processes.

COPD may include diseases that cause airflow obstruction (eg, emphysema, chronic bronchitis) or any combination of these disorders. Other diseases such as cystic fibrosis, bronchiectasis, and asthma that were previously classified as types of COPD are now classified as chronic pulmonary disorders. Asthma is now considered a distinct, separate disorder and is classified as an abnormal airway condition characterized primarily by reversible inflammation. COPD can coexist with asthma. Both of these diseases have the same major symptoms; however, symptoms are generally more variable in asthma than in COPD. This chapter discusses COPD as a disease and describes chronic bronchitis and emphysema as distinct disease states, providing a foundation for understanding the pathophysiology of COPD. Bronchiectasis, asthma, and cystic fibrosis are discussed separately.

While mortality from other major causes of death has been decreasing, deaths from COPD have continued to rise. Currently, COPD and associated conditions (chronic lower respiratory diseases) are the fourth leading cause of death in the United States and account for the death of almost 125,000 Americans per year (National Heart, Lung, and Blood Institute [NHLBI], 2007). Mortality from COPD among women has dramatically increased since World War II, and in 2005, more women than men died of COPD. Approximately 12 million Americans live with a diagnosis of COPD; however, many patients do not receive optimal treatment. An additional 12 million Americans may have COPD but remain undiagnosed. The annual cost of COPD (annual expenditures for health and low productivity) is approximately $42.6 billion with overall health care expenditures (hospital care, physician services, medications, and home health and nursing home care) of $26.7 billion (NHLBI, 2007).

People with COPD commonly become symptomatic during the middle adult years, and the incidence of the disease increases with age. Although certain aspects of lung function normally decrease with age—for example, vital capacity and forced expiratory volume in 1 second ($FEV_1$), COPD accentuates and accelerates these physiologic changes.

### Pathophysiology

In COPD, the airflow limitation is both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases. The inflammatory response occurs throughout the proximal and peripheral airways, lung parenchyma, and pulmonary vasculature (GOLD, 2008). Because of the chronic inflammation and the body's attempts to repair it, changes and narrowing occur in the airways. In the proximal airways (trachea and bronchi greater than 2 mm in diameter), changes include increased numbers of goblet cells and enlarged submucosal glands, both of which lead to hypersecretion of mucus. In the peripheral airways (bronchioles less than 2 mm diameter), inflammation causes thickening of the airway wall, peribronchial fibrosis, exudate in the airway, and overall airway narrowing (obstructive bronchiolitis). Over time, this ongoing injury-and-repair process causes scar tissue formation and narrowing of the airway lumen (GOLD, 2008). Inflammatory and structural changes also occur in the lung parenchyma (respiratory bronchioles and alveoli). Alveolar wall destruction leads to loss of alveolar attachments and a decrease in elastic recoil. Finally, the chronic inflammatory process affects the pulmonary vasculature and causes thickening of the lining of the vessel and hypertrophy of smooth muscle, which may lead to pulmonary hypertension (GOLD, 2008).

Processes related to imbalances of substances (proteinases and antiproteinases) in the lung may also contribute to airflow limitation. When activated by chronic inflammation, proteinases and other substances may be released, damaging the parenchyma of the lung. These parenchymal changes may also occur as a consequence of inflammation or environmental or genetic factors (eg, $alpha_1$-antitrypsin deficiency).

#### *Chronic Bronchitis*

Chronic **bronchitis,** a disease of the airways, is defined as the presence of cough and sputum production for at least 3 months in each of 2 consecutive years. Although, chronic bronchitis is a clinically and epidemiologically useful term, it does not reflect the major impact of airflow limitation on morbidity and mortality in COPD (GOLD, 2008). In many cases, smoke or other environmental pollutants irritate the airways, resulting in inflammation and hypersecretion of mucus. Constant irritation causes the mucus-secreting glands and goblet cells to increase in number, leading to increased mucus production. Mucus plugging of the airway reduces ciliary function. Bronchial walls also become

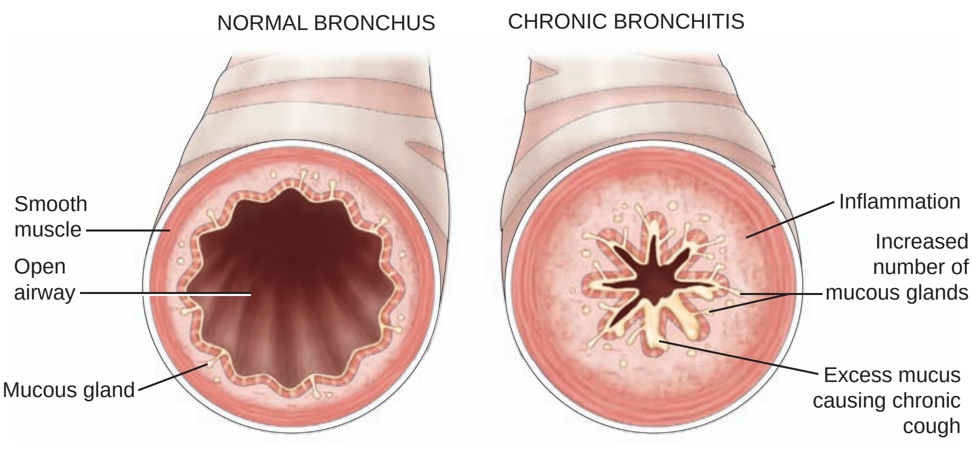



**Figure 24-1** Pathophysiology of chronic bronchitis as compared to a normal bronchus. The bronchus in chronic bronchitis is narrowed and has impaired air flow due to multiple mechanisms: inflammation, excess mucus production, and potential smooth muscle constriction (bronchospasm).

thickened, further narrowing the bronchial lumen (Fig. 24-1). Alveoli adjacent to the bronchioles may become damaged and fibrosed, resulting in altered function of the alveolar macrophages. This is significant because the macrophages play an important role in destroying foreign particles, including bacteria. As a result, the patient becomes more susceptible to respiratory infection. A wide range of viral, bacterial, and mycoplasmal infections can produce acute episodes of bronchitis. Exacerbations of chronic bronchitis are most likely to occur during the winter when viral and bacterial infections are more prevalent.

### *Emphysema*

In **emphysema,** impaired oxygen and carbon dioxide exchange results from destruction of the walls of overdistended alveoli. *Emphysema* is a pathologic term that describes an abnormal distention of the airspaces beyond the terminal bronchioles and destruction of the walls of the alveoli (GOLD, 2008). This is the end stage of a process that progresses slowly for many years. As the walls of the alveoli are destroyed (a process accelerated by recurrent infections), the alveolar surface area in direct contact with the pulmonary capillaries continually decreases. This causes an increase in dead space (lung area where no gas exchange can occur) and impaired oxygen diffusion, which leads to hypoxemia. In the later stages of disease, carbon dioxide elimination is impaired, resulting in increased carbon dioxide tension in arterial blood (hypercapnia) leading to respiratory acidosis. As the alveolar walls continue to break down, the pulmonary capillary bed is reduced in size. Consequently, resistance to pulmonary blood flow is increased, forcing the right ventricle to maintain a higher blood pressure in the pulmonary artery. Hypoxemia may further increase pulmonary artery pressures. For this reason, right-sided heart failure (cor pulmonale) is one of the complications of emphysema. Congestion, dependent edema, distended neck veins, or pain in the region of the liver suggests the development of cardiac failure.

There are two main types of emphysema, based on the changes taking place in the lung (Fig. 24-2). Both types may occur in the same patient. In the panlobular (panacinar) type of emphysema, there is destruction of the respiratory bronchiole, alveolar duct, and alveolus. All airspaces within the lobule are essentially enlarged, but there is little inflammatory disease. A hyperinflated (hyperexpanded) chest, marked dyspnea on exertion, and weight loss typically occur. To move air into and out of the lungs, negative pressure is required during inspiration, and an adequate level of positive pressure must be attained and maintained during expiration. Instead of being an involuntary passive act, expiration becomes active and requires muscular effort.

In the centrilobular (centroacinar) form, pathologic changes take place mainly in the center of the secondary lobule, preserving the peripheral portions of the acinus. Frequently, there is a derangement of ventilation–perfusion ratios, producing chronic hypoxemia, hypercapnia, **polycythemia,** and episodes of right-sided heart failure. This leads to central cyanosis and respiratory failure. The patient also develops peripheral edema, which is treated with diuretic therapy.

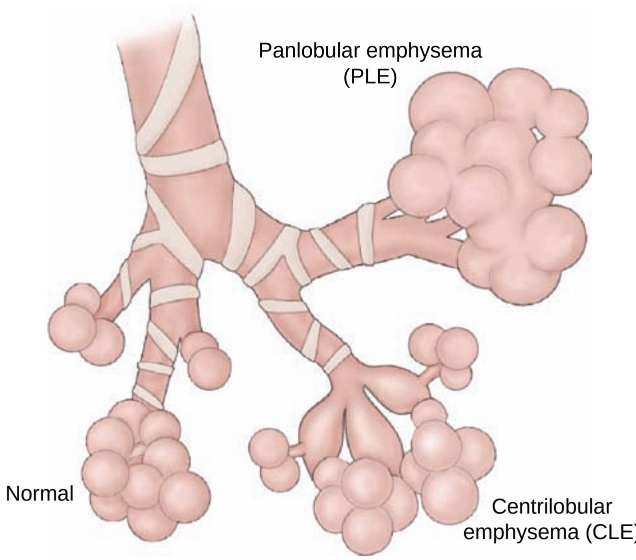



**Figure 24-2** Changes in alveolar structure in centrilobular and panlobular emphysema. In panlobular emphysema, the bronchioles, alveolar ducts, and alveoli are destroyed, and the airspaces within the lobule are enlarged. In centrilobular emphysema, the pathologic changes occur in the lobule, whereas the peripheral portions of the acinus are preserved.

### CHART 24-1 Risk Factors for Chronic Obstructive Pulmonary Disease (COPD)

- Exposure to tobacco smoke accounts for an estimated 80% to 90% of COPD cases
- Passive smoking
- Occupational exposure—dust, chemicals
- Ambient air pollution
- Genetic abnormalities, including a deficiency of alpha$_1$-antitrypsin, an enzyme inhibitor that normally counteracts the destruction of lung tissue by certain other enzymes

## Risk Factors

Risk factors for COPD include environmental exposures and host factors (Chart 24-1). The most important environmental risk factor for COPD is cigarette smoking. Other environmental risk factors include smoking pipes, cigars, and other types of tobacco. Passive smoking (ie, second-hand smoke) also contributes to respiratory symptoms and COPD (GOLD, 2008). Smoking depresses the activity of scavenger cells and affects the respiratory tract's ciliary cleansing mechanism, which keeps breathing passages free of inhaled irritants, bacteria, and other foreign matter. When smoking damages this cleansing mechanism, airflow is obstructed and air becomes trapped behind the obstruction. The alveoli greatly distend, diminishing lung capacity. Smoking also irritates the goblet cells and mucous glands, causing an increased accumulation of mucus, which in turn produces more irritation, infection, and damage to the lung. In addition, carbon monoxide (a byproduct of smoking) combines with hemoglobin to form carboxyhemoglobin. Hemoglobin that is bound by carboxyhemoglobin cannot carry oxygen efficiently.

Other environmental risk factors for COPD include prolonged and intense exposure to occupational dusts and chemicals, indoor air pollution, and outdoor air pollution (GOLD, 2008). In the United States, it has been estimated that COPD in 19% of smokers and in as many as 31% of nonsmokers may be attributable to such exposure (GOLD, 2008).

One of six Americans with COPD has never smoked (NHLBI, 2007), and COPD involves a gene–environment interaction (GOLD, 2008). The well-documented genetic risk factor is a deficiency of alpha$_1$-antitrypsin, an enzyme inhibitor that protects the lung parenchyma from injury. This deficiency of alpha$_1$-antitrypsin predisposes young people to rapid development of lobular emphysema, even if they do not smoke. **$\alpha_1$-antitrypsin deficiency** is one of the most common genetically linked lethal diseases among Caucasians. There are approximately 25 million carriers of this genetic defect in the United States, and the disease affects approximately 100,000 Americans (American Lung Association, 2007a). Genetically susceptible people are sensitive to environmental factors (eg, smoking, air pollution, infectious agents, allergens) and eventually develop chronic obstructive symptoms. Carriers must be identified so that they can modify environmental risk factors to delay or prevent overt symptoms of disease. Genetics counseling should be offered. Alpha-protease inhibitor replacement therapy, which slows the progression of the disease, is available for patients with this genetic defect and for those with severe disease. However, this intermittent infusion therapy is costly and is required on an ongoing basis.

## Clinical Manifestations

Although the natural history of COPD is variable, it is generally a progressive disease characterized by three primary symptoms: chronic cough, sputum production, and dyspnea on exertion (GOLD, 2008). These symptoms often worsen over time. Chronic cough and sputum production often precede the development of airflow limitation by many years. However, not all people with cough and sputum production develop COPD. The cough may be intermittent and may be unproductive in some patients (GOLD, 2008). Dyspnea may be severe and often interferes with the patient's activities. It is usually progressive, is worse with exercise, and is persistent. As COPD progresses, dyspnea may occur at rest. Weight loss is common, because dyspnea interferes with eating and the work of breathing is energy depleting. As the work of breathing increases over time, the accessory muscles are recruited in an effort to breathe. Patients with COPD are at risk for respiratory insufficiency and respiratory infections, which in turn increase the risk of acute and chronic respiratory failure.

In patients with COPD that has a primary emphysematous component, chronic hyperinflation leads to the "barrel chest" thorax configuration. This configuration results from a more fixed position of the ribs in the inspiratory position (due to hyperinflation) and from loss of lung elasticity (Fig. 24-3).

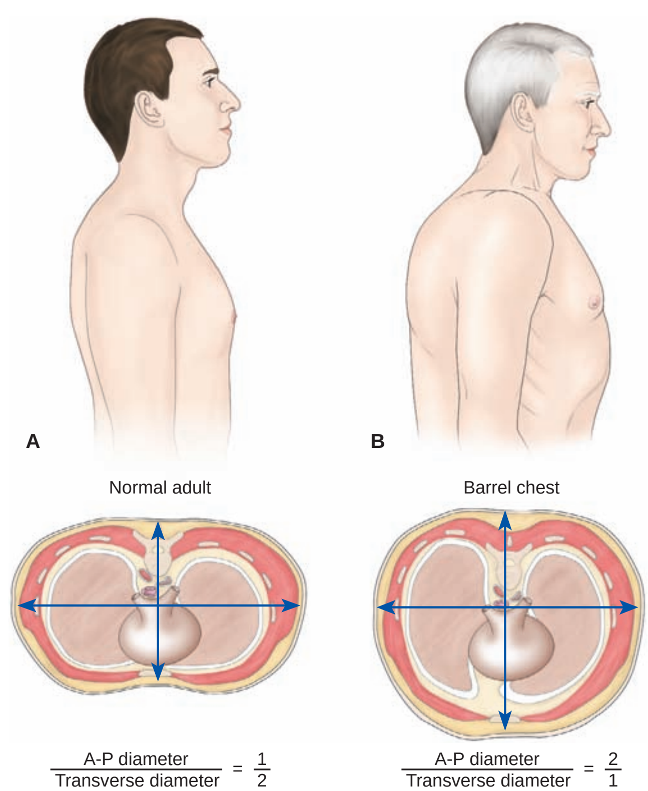



**Figure 24-3** Characteristics of normal chest wall and chest wall in emphysema. **A,** The normal chest wall and its cross-section. **B,** The barrel-shaped chest of emphysema and its cross-section

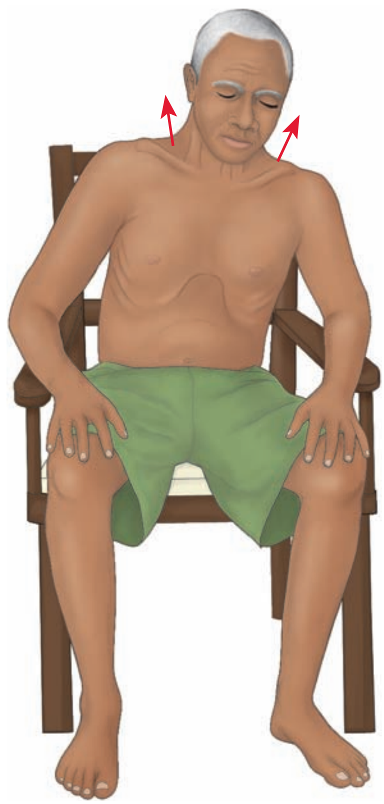


**Figure 24-4** Typical posture of a person with chronic obstructive pulmonary disease (COPD)—primarily emphysema. The person tends to lean forward and uses the accessory muscles of respiration to breathe, forcing the shoulder girdle upward and causing the supraclavicular fossae to retract on inspiration.

Retraction of the supraclavicular fossae occurs on inspiration, causing the shoulders to heave upward (Fig. 24-4). In advanced emphysema, the abdominal muscles may also contract on inspiration.

## Assessment and Diagnostic Findings

The nurse should obtain a thorough health history from patients with known or potential COPD. Chart 24-2 lists the key factors to assess. Pulmonary function studies are used to help confirm the diagnosis of COPD, determine disease severity, and monitor disease progression. **Spirometry** is used to evaluate airflow obstruction, which is determined by the ratio of $FEV_1$ to forced vital capacity (FVC). Spirometric results are expressed as an absolute volume and as a percentage of the predicted value using appropriate normal values for gender, age, and height. With obstruction, the patient either has difficulty exhaling or cannot forcibly exhale air from the lungs, reducing the $FEV_1$. Spirometry is also used to determine reversibility of obstruction after use of bronchodilators (GOLD, 2008). Spirometry is initially performed, the patient is given an inhaled bronchodilator treatment according to a standard protocol, and then spirometry is repeated. The patient demonstrates a degree of reversibility if the pulmonary function values improve after administration of the bronchodilator. Even patients who do not show a significant response to a short-acting bronchodilator test may benefit symptomatically from long-term bronchodilator treatment.

Arterial blood gas measurements may also be obtained to assess baseline oxygenation and gas exchange and are especially important in advanced COPD. A chest x-ray may be obtained to exclude alternative diagnoses. A computed tomography (CT) chest scan is not routinely obtained in the diagnosis of COPD, but a high-resolution CT scan may help in the differential diagnosis. Lastly, screening for $alpha_1$-antitrypsin deficiency may be performed for patients younger than 45 years of age and for those with a strong family history of COPD.

COPD is classified into four stages depending upon the severity (measured by pulmonary function tests) and symptoms (GOLD, 2008). Stage I (mild) is defined by an $FEV_1$/FVC less than 70% and an $FEV_1$ greater than or equal to 80% predicted, and the patient may be with or without symptoms of cough and sputum production. Stage II (moderate) is defined by an $FEV_1$/FVC less than 70%, an $FEV_1$ 50% to 80% predicted, and shortness of breath typically developing upon exertion. Stage III (severe) is defined as an $FEV_1$/FVC less than 70% and an $FEV_1$ less than 30% to 50% predicted. Severe COPD symptoms include increased shortness of breath, reduced exercise capacity, and repeated exacerbations. Lastly, stage IV (very severe) is defined as an $FEV_1$/FVC less than 70%, an $FEV_1$ less than 30% to 50% predicted, and symptoms/signs of chronic respiratory failure.

Factors that determine the clinical course and survival of patients with COPD include history of cigarette smoking, passive smoking exposure, age, rate of decline of $FEV_1$, hypoxemia, pulmonary artery pressure, resting heart rate, weight loss, and reversibility of airflow obstruction. See Chart 24-3 for additional information about the assessment of symptoms in COPD.

In diagnosing COPD, several differential diagnoses must be ruled out. The primary differential diagnosis is asthma. It may be difficult to differentiate between a patient with COPD and one with chronic asthma. Other diseases that must be considered in the differential diagnosis include heart failure, bronchiectasis, tuberculosis, obliterative bronchiolitis, and diffuse panbronchiolitis (GOLD, 2008). Key factors in determining the diagnosis are the patient's history and the patient's responsiveness to bronchodilators.

## Complications

Respiratory insufficiency and failure are major life-threatening complications of COPD. The acuity of the onset and the severity of respiratory failure depend on baseline pulmonary function, pulse oximetry or arterial blood gas values, comorbid conditions, and the severity of other complications of COPD. Respiratory insufficiency and failure may be chronic (with severe COPD) or acute (with severe bronchospasm or pneumonia in a patient with severe COPD). Acute respiratory insufficiency and failure may necessitate ventilatory support until other acute complications, such as infection, can be treated. Management of the patient requiring ventilatory support is discussed in Chapter 25. Other complications of COPD include pneumonia, chronic atelectasis, pneumothorax, and pulmonary arterial hypertension (cor pulmonale).

## CHART 24-2 Assessing Patients With Chronic Obstructive Pulmonary Disease (COPD)

### Health History

- Has the patient been exposed to risk factors (types, intensity, duration)?
- Does the patient have a past medical history of respiratory diseases/problems, including asthma, allergy, sinusitis, nasal polyps, or respiratory infections?
- Does the patient have a family history of COPD or other chronic respiratory diseases?
- How long has the patient had respiratory difficulty?
- What is the pattern of symptom development?
- Does exertion increase the dyspnea? What type of exertion?
- What are the limits of the patient's tolerance for exercise?
- At what times during the day does the patient complain most of fatigue and shortness of breath?
- Which eating and sleeping habits have been affected?
- What is the impact of respiratory disease on quality of life?
- What does the patient know about the disease and his or her condition?
- What is the patient's smoking history (primary and secondary)?
- Is there occupational exposure to smoke or other pollutants?
- What are the triggering events (eg, exertion, strong odors, dust, exposure to animals)?
- Does the patient have a history of exacerbations or previous hospitalizations for respiratory problems?
- Are comorbidities present?
- How appropriate are current medical treatments?
- Does the patient have available social and family support?
- What is the potential for reducing risk factors (eg, smoking cessation)?

### Physical Assessment

- What position does the patient assume during the interview?
- What are the pulse and the respiratory rates?
- What is the character of respirations? Even and without effort? Other?
- Can the patient complete a sentence without having to take a breath?
- Does the patient contract the abdominal muscles during inspiration?
- Does the patient use accessory muscles of the shoulders and neck when breathing?
- Does the patient take a long time to exhale (prolonged expiration)?
- Is central cyanosis evident?
- Are the patient's neck veins engorged?
- Does the patient have peripheral edema?
- Is the patient coughing?
- What are the color, amount, and consistency of the sputum?
- Is clubbing of the fingers present?
- What types of breath sounds (ie, clear, diminished or distant, crackles, wheezes) are heard? Describe and document findings and locations.
- What is the status of the patient's sensorium?
- Is there short-term or long-term memory impairment?
- Is there increasing stupor?
- Is the patient apprehensive?

## CHART 24-3 NURSING RESEARCH PROFILE
## Symptom Assessment of Patients With Chronic Obstructive Pulmonary Disease

Jablonski, A., Gift, A. & Cook, K. E. (2007). Symptom assessment of patients with chronic obstructive pulmonary disease. *Western Journal of Nursing Research, 29*(7), 845–863.

### Purpose

The purpose of this secondary analysis of data was to evaluate the Memorial Symptom Assessment Scale (MSAS) for use in patients with severe chronic obstructive pulmonary disease (COPD). Although the multidimensional MSAS was developed for patients with cancer, it has potential for assessment of symptoms of people with other diseases.

### Design

This descriptive study was a secondary analysis of data that examined the relationship between symptoms and functional status in patients with COPD. The investigators recruited the convenience sample of 72 subjects who met the criteria for severe COPD from an outpatient pulmonary clinic. Ages ranged from 36 to 79 years. The MSAS has 32 items but for the purposes of the study, the researchers shortened it to the 19 items, or symptoms, that patients with COPD most frequently identify. The included symptoms related to prevalence, frequency, severity, and distress.

### Findings

The top 10 symptoms identified by this COPD population were shortness of breath, lack of energy, dry mouth, cough, feeling nervous, feeling sad, feeling irritable, worrying, feeling drowsy, and difficulty sleeping. Shortness of breath and lack of energy were the most severe, frequent, and distressful symptoms. When researchers evaluated the prevalence and characteristics of symptoms, they found that both clinical and emotional symptoms (feeling nervous, sad, or irritable; worrying) were equally represented. Reliability of the revised MSAS tool, with 19 items, remained high (Cronbach's alpha = 0.86), and this study also confirmed content and convergent validity.

### Nursing Implications

Although many tools are available to measure the frequency of symptoms, few tools are available to evaluate symptoms on a multidimensional perspective; the MSAS enables assessment of symptom prevalence, severity, frequency, and distress. Nursing implications of this study include not only a potential new tool to evaluate patients with severe COPD but also the need to recognize that emotional symptoms are as important as clinical symptoms in people with this disease. Nursing interventions need to focus not only on patients' clinical symptoms but also on their emotional needs.

## Medical Management

### Risk Reduction

Smoking cessation is the single most cost-effective intervention to reduce the risk of developing COPD and to stop its progression (GOLD, 2008). However, smoking cessation is difficult to achieve and even more difficult to sustain in the long term. Nurses are key in promoting smoking cessation and educating patients about its importance. Patients diagnosed with COPD who continue to smoke must be encouraged and assisted to quit. Factors associated with continued smoking vary among patients and may include the strength of the nicotine addiction, continued exposure to smoking-associated stimuli (at work or in social settings), stress, depression, and habit. Continued smoking is also more prevalent among those with low incomes, low levels of education, or psychosocial problems (CDC, 2007b).

Because multiple factors are associated with continued smoking, successful cessation often requires multiple strategies. Health care providers should promote cessation by explaining the risks of smoking and personalizing the "at-risk" message to the patient. After giving a strong warning about smoking, health care providers should work with the patient to set a definite "quit date." Referral to a smoking cessation program may be helpful. Follow-up within 3 to 5 days after the "quit date" to review progress and to address any problems is associated with an increased rate of success; this should be repeated as needed. Continued reinforcement with telephone calls or clinic visits is extremely beneficial. Relapses should be analyzed, and the patient and health care provider should jointly identify possible solutions to prevent future backsliding. It is important to emphasize successes rather than failures. Nicotine replacement, first-line pharmacotherapy that reliably increases long-term smoking abstinence rates, comes in a variety of forms (gum, inhaler, nasal spray, transdermal patch, sublingual tablet, or lozenges). Bupropion SR (Wellbutrin, Zyban) and nortriptyline (Aventyl), both antidepressants, may also increase long-term quit rates. Other pharmacologic agents include the antihypertensive agent clonidine (Catapres); however, its side effects limit its use. Varenicline (Chantix), a nicotinic acetylcholine receptor partial agonist, may assist in smoking cessation (GOLD, 2008). Patients who are not appropriate candidates for the use of pharmacotherapy include those with medical contraindications, light smokers (less than 10 cigarettes per day), and pregnant and adolescent smokers.

Smoking cessation can begin in a variety of health care settings—outpatient clinic, nursing center, pulmonary rehabilitation, community, hospital, and in the home. Regardless of the setting, nurses have the opportunity to teach patients about the risks of smoking and the benefits of smoking cessation. Various materials, resources, and programs developed by several organizations (eg, Agency for Healthcare Research and Quality, U.S. Public Health Service, CDC, National Cancer Institute, American Lung Association, American Cancer Society) are available to assist with this effort.

### Pharmacologic Therapy

#### Bronchodilators

Bronchodilators relieve bronchospasm by altering smooth muscle tone and reduce airway obstruction by allowing increased oxygen distribution throughout the lungs and improving alveolar ventilation. Although regular use of bronchodilators that act primarily on the airway smooth muscle does not modify the decline of function or the prognosis of COPD, their use is central in the management of COPD (GOLD, 2008). These agents can be delivered through a metered-dose inhaler or other type of inhaler, by nebulization, or via the oral route in pill or liquid form. Bronchodilators are often administered regularly throughout the day as well as on an as-needed basis. They may also be used prophylactically to prevent breathlessness by having the patient use them before participating in or completing an activity, such as eating or walking.

Several devices are available to deliver medication via an aerosolized method. These include **metered-dose inhalers** (MDIs), breath-actuated MDIs, dry powder inhalers, spacer or valved-holding chambers, and nebulizers. Key aspects of each are described in Table 24-1. An MDI is a pressurized device that contains an aerosolized powder of medication. A precise amount of medication is released with each activation of the canister. Patients must be instructed on the correct use of the device. A spacer or valved-holding chamber may also be used to enhance deposition of the medication in the lung and help the patient coordinate activation of the MDI with inspiration. Spacers come in several designs, but all are attached to the MDI and have a mouthpiece on the opposite end (Fig. 24-5). Specific package insert information is available for different types of aerosol delivery devices.

Several classes of bronchodilators are used, including beta-adrenergic agonists (short- and long-acting), anticholinergic agents (short- and long-acting), methylxanthines, and combination agents. These medications may be used in combination to optimize bronchodilation. Long-acting bronchodilators are more convenient for patient use. Examples of these medications are described in Table 24-2. Nebulized medications also known as wet nebulizers (nebulization of medication via an air compressor) may also be effective in patients who cannot use an MDI properly or who prefer this method of administration. However, wet nebulizers are more expensive than other devices and require appropriate maintenance (GOLD, 2008).

Bronchodilators are key to symptom management in stable COPD. Before these agents are used, the following information should be considered: Inhaled therapy is preferred, choice of bronchodilator is dependent on availability and individual response in terms of symptom relief and side effects, they may be prescribed on an as-needed or regular basis to reduce symptoms, long-acting bronchodilators are more convenient for patient use, and combining bronchodilators with different durations of action and different mechanisms may optimize symptom management (GOLD, 2008).

#### Corticosteroids

Although inhaled and systemic corticosteroids may improve the symptoms of COPD, they do not slow the decline in lung function. Their effects are less dramatic than in asthma. A short trial course of oral corticosteroids may be prescribed for patients to determine whether pulmonary function improves and symptoms decrease. Long-term

**Table 24-1 AEROSOL DELIVERY DEVICES**

| Devices/Drugs | Optimal Technique | Therapeutic Issues |
|---|---|---|
| Metered-dose inhaler (MDI)<br>Beta$_2$-agonists<br>Corticosteroids<br>Cromolyn sodium<br>Anticholinergics | Actuation during a slow (30 L/min or 3–5 sec) deep inhalation, followed by 10-sec breathhold | Slow inhalation and coordination of actuation may be difficult for some patients. Patients may incorrectly stop inhalation at actuation. Deposition of 50–80% of actuated dose in the oropharynx. Mouth washing and spitting is effective in reducing the amount of drug swallowed and absorbed systemically. |
| Breath-actuated MDI<br>Beta$_2$-agonists | Tight seal around mouthpiece and slightly more rapid inhalation than standard MDI (see above) followed by 10-sec breathhold | May be particularly useful for patients unable to coordinate inhalation and actuation. May also be useful for elderly patients. Patients may incorrectly stop inhalation at actuation. Cannot be used with currently available spacer/valved-holding chamber devices. |
| Dry powder inhaler (DPI)<br>Beta$_2$-agonists<br>Corticosteroids<br>Anticholinergics | Rapid (1–2 sec) deep inhalation. Minimally effective inspiratory flow is device dependent. | Dose is lost if patient exhales through device after actuating. Delivery may be greater or lesser than MDIs, depending on device and technique. Delivery is more flow dependent in devices with highest internal resistance. Rapid inhalation promotes greater deposition in larger central airways. Mouth washing and spitting are effective in reducing amount of drug swallowed and absorbed systemically. |
| Spacer or valved-holding chamber (VHC) | Slow (30 L/min or 3–5 sec) deep inhalation, followed by 10-sec breathhold immediately following actuation. Actuate only once into spacer/VHC per inhalation. Rinse plastic VHCs once a month with low concentration of liquid household dishwashing detergent (1:5000 or 1–2 drops per cup of water) and let drip dry. | Indicated for patients who have difficult performing adequate MDI technique. May be bulky. Simple tubes do not obviate coordinating actuation and inhalation. VHCs are preferred. Spacers or VHCs may increase delivery of inhalational corticosteroids to the lungs. |
| Nebulizer<br>Beta$_2$-agonists<br>Corticosteroids<br>Cromolyn sodium<br>Anticholinergics | Slow tidal breathing with occasional deep breaths. Tightly fitting face mask for those unable to use mouthpiece. | Less dependent on patient's coordination and cooperation.<br>May be expensive, time consuming, and bulky; output is dependent on device and operating parameters (fill volume, driving gas flow); internebulizer and intranebulizer output variances are significant. Use of a face mask reduces delivery to lungs by 50%. Choice of delivery system is dependent on resources, availability, and clinical judgment of clinician caring for patient.<br>There is potential for infections if device is not cleaned properly. |

From Expert Panel Report 3. (2007). *Guidelines for the diagnosis and management of asthma* (pp. 31–32). NIH Publication Number 08-5846. National Asthma Education and Prevention Program. Summary Report. Bethesda, MD: U.S. Department of Health and Human Services, National Heart, Lung and Blood Institute.

treatment with oral corticosteroids is not recommended in COPD and can cause steroid myopathy, leading to muscle weakness, decreased ability to function, and, in advanced disease, respiratory failure (GOLD, 2008).

Medication regimens used to manage COPD are based on disease severity. For stage I (mild) COPD, a short-acting bronchodilator may be prescribed. For stage II or III COPD, a short-acting bronchodilator along with regular treatment of one or more long-acting bronchodilators may be used. For stage III or IV (severe or very severe) COPD, medication therapy includes regular treatment with one or more bronchodilators and inhaled corticosteroids for repeated exacerbations. Combination long-term beta$_2$-agonists plus corticosteroids in one inhaler may be appropriate; examples include formoterol/budesonide (Symbicort) and salmeterol/fluticasone (Seretide).

### Other Medications

Other pharmacologic treatments that may be used in COPD include alpha$_1$-antitrypsin augmentation therapy, antibiotic agents, mucolytic agents, antitussive agents, vasodilators, and narcotics. Vaccines may also be effective. Influenza vaccines can reduce serious morbidity and death in patients with COPD by approximately 50% (GOLD, 2008). It is recommended that people limit their risk through influenza vaccination and smoking cessation. Pneumococcal vaccination also reduces the incidence of pneumonia, hospitalizations for cardiac conditions, and deaths in the

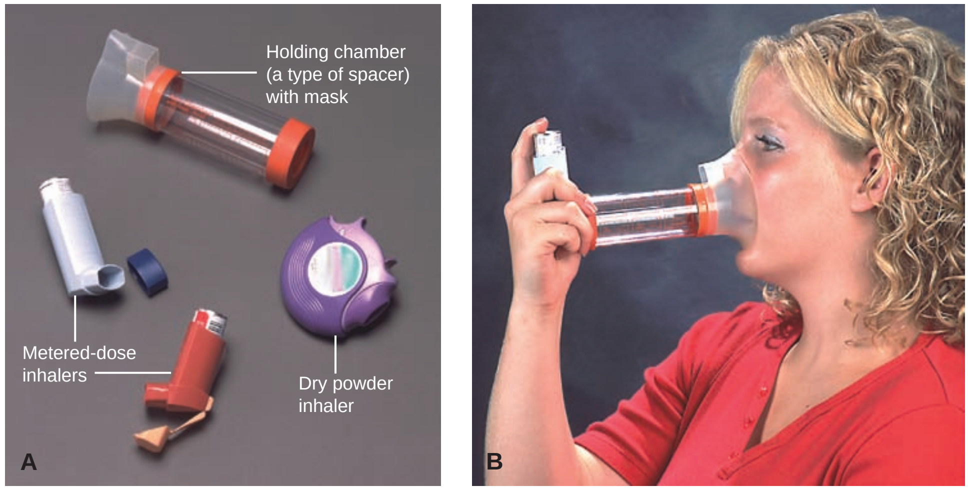



**Figure 24-5** **A**, Examples of metered-dose inhalers and spacers. **B,** A metered-dose inhaler and spacer in use.

general elderly population. Pneumococcal pneumonia is responsible for approximately 175,000 hospitalized cases per year (National Pneumonia Medicare Quality Improvement Project, 2007). Vaccination is recommended in patients 65 years or older who have COPD (GOLD, 2008).

### Management of Exacerbations

An exacerbation of COPD is defined as an event in the natural course of the disease characterized by an acute change in the patient's baseline dyspnea, cough, or sputum production beyond the normal day-to-day variations. It may warrant a change in regular medications (GOLD, 2008). Primary causes of an acute exacerbation include tracheobronchial infection and air pollution. However, the cause of approximately one third of severe exacerbations cannot be identified (GOLD, 2008). If possible, the primary cause of the exacerbation is identified, and specific treatment is administered. Optimization of bronchodilator medications is first-line therapy and involves identifying the best medication or combinations of medications taken on a regular schedule for a specific patient. Depending on the signs and symptoms, corticosteroids, antibiotic agents, oxygen therapy, and intensive respiratory interventions may also be used. Indications for hospitalization for acute exacerbation of COPD include severe dyspnea that does not respond adequately to initial therapy, confusion or lethargy, respiratory muscle fatigue, paradoxical chest wall movement, peripheral edema, worsening or new onset of central cyanosis, persistent or worsening hypoxemia, and need for noninvasive or invasive assisted mechanical ventilation (GOLD, 2008). The outcome from an exacerbation of COPD is closely related to the development of respiratory acidosis, the presence of significant comorbidities, and the need for noninvasive or invasive positive pressure ventilatory support.

**Table 24-2 COMMON TYPES OF BRONCHODILATOR MEDICATIONS FOR COPD**

| | Method of Administration | | | |
|---|---|---|---|---|
| **Class/Drug (Trade Name)** | **Inhaler*** | **Nebulizer** | **Oral** | **Duration of Action†** |
| **Beta$_2$-Adrenergic Agonist Agents** | | | | |
| salbutamol, albuterol (Proventil, Ventolin) | X | X | X | Short |
| fenoterol (Alupent, Isuprel) | X | X | X | Short |
| terbutaline (Brethine) | X | | | Short |
| formoterol (Foradil) | X | | | Long |
| salmeterol (Serevent Diskus) | X | | | Long |
| **Anticholinergic Agents** | | | | |
| Ipratropium bromide (Atrovent) | X | X | | Short |
| **Combination Short-Acting Beta-2 Adrenergic Agonist and Anticholinergic Agents** | | | | |
| fenoterol/ipratropium (Duovent) | X | X | | |
| salbutamol/ipratropium (Combivent) | X | X | | |
| **Methylxanthines** | | | | |
| aminophylline (Phyllocontin, Truphylline) | | | X | Variable |
| theophylline (Theo-Dur, Slo-Bid) | | | X | Variable |

*Inhaler may include metered-dose inhaler, powdered inhalation with inhaler, or discus.
†Short-acting, 4–6 h; long-acting, 12+ h.

The GOLD guidelines (2008) provide indications for assessment, hospital admission, and intensive care admission for patients with exacerbations of COPD. These include signs of increasing severity on physical examination (use of accessory muscles, paradoxical chest wall movement, worsening or new onset of central cyanosis, peripheral edema, signs of right heart failure, reduced alertness).

On the patient's arrival at the emergency department, the first line of treatment is supplemental oxygen therapy and rapid assessment to determine if the exacerbation is life-threatening (GOLD, 2008). A short-acting inhaled bronchodilator may be used to assess response to treatment. Oral or intravenous corticosteroids, in addition to bronchodilators, are recommended in the hospital management of a COPD exacerbation. Antibiotics have been shown to be of some benefit in patients with increased dyspnea, increased sputum volume, and increased sputum purulence, and in those needing mechanical ventilation (GOLD, 2008).

### Oxygen Therapy

Oxygen therapy can be administered as long-term continuous therapy, during exercise, or to prevent acute dyspnea during an exacerbation. The goal of supplemental oxygen therapy is to increase the baseline resting partial arterial pressure of oxygen ($PaO_2$) to at least 60 mm Hg at sea level and an arterial oxygen saturation ($SaO_2$) at least 90% (GOLD, 2008). Long-term oxygen therapy (more than 15 hours per day) has also been shown to improve quality of life, reduce pulmonary arterial pressure and dyspnea, and improve survival (GOLD, 2008). Long-term oxygen therapy is usually introduced in very severe COPD, and indications generally include a $PaO_2$ of 55 mm Hg or less or evidence of tissue hypoxia and organ damage such as cor pulmonale, secondary polycythemia, edema from right-sided heart failure, or impaired mental status (GOLD, 2008). For patients with exercise-induced hypoxemia, oxygen supplementation during exercise may improve performance. There is no evidence to support the idea that short bursts of oxygen before or after exercise provide any symptomatic relief (GOLD, 2008). Patients who are hypoxemic while awake are likely to be so during sleep. Therefore, nighttime oxygen therapy is recommended as well, and the prescription for oxygen therapy is for continuous, 24-hour use. Intermittent oxygen therapy is indicated for patients who desaturate only during exercise or sleep.

The main objective in treating patients with hypoxemia and hypercapnia is to give sufficient oxygen to improve oxygenation. Patients with COPD who require oxygen may have respiratory failure that is caused primarily by a ventilation–perfusion mismatch. These patients respond to oxygen therapy and should be treated to keep the resting oxygen saturation above 90%. However, a small subset of patients with COPD and chronic hypercapnia (elevated partial pressure of arterial carbon dioxide [$PaCO_2$] levels) may be more oxygen sensitive; their respiratory failure is caused more by alveolar hypoventilation. Administering too much oxygen can result in the retention of carbon dioxide. Patients with alveolar hypoventilation cannot increase ventilation to adjust for this increased load, and increasing hypercapnia occurs. Monitoring and assessment are key in the care of patients with COPD on supplemental oxygen. Pulse oximetry is helpful in assessing response to therapy but does not assess $PaCO_2$ levels. Optimal oxygenation of patients is important while monitoring for any possible complications of oxygen supplementation.

**NURSING ALERT**

**Oxygen therapy is variable in COPD patients; its aim in COPD is to achieve an acceptable oxygen level without a fall in the pH (increasing hypercapnia).**

### Surgical Management

#### Bullectomy

A bullectomy is a surgical option for select patients with bullous emphysema. Bullae are enlarged airspaces that do not contribute to ventilation but occupy space in the thorax; these areas may be surgically excised. These bullae compress areas of the lung and may impair gas exchange. Bullectomy may help reduce dyspnea and improve lung function. It can be performed via a video-assisted thoracoscope or a limited thoracotomy incision (see Chapter 25).

#### Lung Volume Reduction Surgery

Treatment options for patients with end-stage COPD (stage IV) with a primary emphysematous component are limited, although lung volume reduction surgery is a palliative surgical option in a selected subset of patients. This subset includes patients with homogenous disease or disease that is focused in one area and not widespread throughout the lungs. Lung volume reduction surgery involves the removal of a portion of the diseased lung parenchyma. This reduces hyperinflation and allows the functional tissue to expand, resulting in improved elastic recoil of the lung and improved chest wall and diaphragmatic mechanics. This type of surgery does not cure the disease or improve life expectancy, but it may decrease dyspnea, improve lung function, and improve the patient's overall quality of life (GOLD, 2008).

Careful selection of patients for lung volume reduction surgery is essential to decrease morbidity and mortality. A large multisite trial, the National Emphysema Treatment Trial, found that the addition of lung volume reduction surgery to optimal medical management and rehabilitation led to overall improvement in exercise tolerance and survival in a very select subgroup of patients with predominantly upper lobe disease (American Lung Association, 2007b; GOLD, 2008).

#### Lung Transplantation

Lung transplantation is a viable option for definitive surgical treatment of end-stage emphysema. It has been shown to improve quality of life and functional capacity in a selected group of patients with COPD. Limited not only by the shortage of donor organs, it is also a costly procedure with financial implications for months to years because of complications and the need for costly immunosuppressive medication regimens (GOLD, 2008).

### Pulmonary Rehabilitation

Pulmonary rehabilitation for patients with COPD is well established and widely accepted as a means to alleviate symptoms and optimize functional status (Ries, Bauldoff, Carlin, et al., 2007). The primary goals of rehabilitation are to reduce symptoms, improve quality of life, and increase physical and emotional participation in everyday activities (GOLD, 2008). The benefits of this therapy include improvement of exercise capacity, reduction of the perceived intensity of breathlessness, improvement in health-related quality of life, reduction in the number of hospitalizations and days in the hospital, and reduction of the anxiety and depression associated with COPD (GOLD, 2008). Pulmonary rehabilitation services are multidisciplinary and include assessment, education, smoking cessation, physical reconditioning, nutritional counseling, skills training, and psychological support. Patients are taught methods to alleviate symptoms. Breathing exercises as well as retraining and exercise programs are used to improve functional status.

Pulmonary rehabilitation is appropriate for stages II through IV (GOLD, 2008). The minimum length of an effective program is 6 weeks; the longer the program, the more effective the results (GOLD, 2008; Ries, et al., 2007). It may be conducted in inpatient, outpatient, or home settings, and the lengths of programs vary. Program selection depends on the patient's physical, functional, and psychosocial status; insurance coverage; availability of programs; and preference. Pulmonary rehabilitation may also be used therapeutically in other disorders besides COPD, including asthma, cystic fibrosis, lung cancer, interstitial lung disease, thoracic surgery, and lung transplantation.

#### Patient Education

Nurses play a key role in identifying potential candidates for pulmonary rehabilitation and in facilitating and reinforcing the material learned in the rehabilitation program. Not all patients have access to a formal rehabilitation program. However, nurses can be instrumental in teaching patients and families as well as facilitating specific services, such as respiratory therapy education, physical therapy for exercise and breathing retraining, occupational therapy for conserving energy during activities of daily living, and nutritional counseling. Patient education is a major component of pulmonary rehabilitation and includes a broad variety of topics.

Depending on the length and setting of the educational program, topics may include normal anatomy and physiology of the lung, pathophysiology and changes with COPD, medications and home oxygen therapy, nutrition, respiratory therapy treatments, symptom alleviation, smoking cessation, sexuality and COPD, coping with chronic disease, communicating with the health care team, and planning for the future (advance directives, living wills, informed decision making about health care alternatives). Education, including that relating to smoking cessation, should be incorporated into all aspects of care for COPD and in many settings (physicians' offices, clinics, hospitals, home and community health care settings, and comprehensive rehabilitation programs).

#### Breathing Exercises

The breathing pattern of most people with COPD is shallow, rapid, and inefficient; the more severe the disease, the more inefficient the breathing pattern. With practice, this type of upper chest breathing can be changed to diaphragmatic breathing, which reduces the respiratory rate, increases alveolar ventilation, and sometimes helps expel as much air as possible during expiration (see Chapter 25 for technique). Pursed-lip breathing helps slow expiration, prevents collapse of small airways, and helps the patient control the rate and depth of respiration. It also promotes relaxation, enabling the patient to gain control of dyspnea and reduce feelings of panic.

#### Activity Pacing

People with COPD have decreased exercise tolerance during specific periods of the day, especially in the morning on arising, because bronchial secretions have collected in the lungs during the night while the person was lying down. The patient may have difficulty bathing or dressing and may become fatigued. Activities that require the arms to be supported above the level of the thorax may produce fatigue or respiratory distress but may be tolerated better after the patient has been up and moving around for an hour or more. The nurse can help the patient reduce these limitations by planning self-care activities and determining the best times for bathing, dressing, and other daily activities.

#### Self-Care Activities

As gas exchange, airway clearance, and the breathing pattern improve, the patient is encouraged to assume increasing participation in self-care activities. The patient is taught to coordinate diaphragmatic breathing with activities such as walking, bathing, bending, or climbing stairs. The patient should bathe, dress, and take short walks, resting as needed to avoid fatigue and excessive dyspnea. Fluids should always be readily available, and the patient should begin to drink fluids without having to be reminded. If management of secretions is a problem and some type of postural drainage or airway clearance maneuver is to be performed at home, the nurse or respiratory therapist instructs and supervises the patient before discharge or in an outpatient setting.

#### Physical Conditioning

People with COPD of all stages benefit from exercise training programs, which result in increased exercise tolerance and decreased dyspnea and fatigue (GOLD, 2008). Physical conditioning techniques include breathing exercises and general exercises intended to conserve energy and increase pulmonary ventilation. Graded exercises and physical conditioning programs using treadmills, stationary bicycles, and measured level walks can improve symptoms and increase work capacity and exercise tolerance. Any physical activity that can be performed regularly is helpful. Walking aids may be beneficial (GOLD, 2008). Lightweight portable oxygen systems are available for ambulatory patients who require oxygen therapy during physical activity.

#### Oxygen Therapy

Oxygen supplied to the home comes in compressed gas, liquid, or concentrator systems. Portable oxygen systems allow the patient to exercise, work, and travel. To help the patient

adhere to the oxygen prescription, the nurse explains the proper flow rate and required number of hours for oxygen use as well as the dangers of arbitrary changes in flow rate or duration of therapy. The nurse should caution the patient that smoking with or near oxygen is extremely dangerous. The nurse also reassures the patient that oxygen is not "addictive" and explains the need for regular evaluations of blood oxygenation by pulse oximetry or arterial blood gas analysis.

**Nutritional Therapy**

Nutritional assessment and counseling are important aspects in the rehabilitation process for patients with COPD. Nutritional status is important in COPD and is reflected in severity of symptoms, degree of disability, and prognosis. Significant weight loss is often a major problem, but excessive weight can also be problematic although it occurs less often. Most people have difficulty gaining and maintaining weight. A thorough assessment of caloric needs and counseling about meal planning and supplementation is part of the rehabilitation process. Continual monitoring of weight and interventions as necessary are important parts of the care of patients with COPD.

**Coping Measures**

Any factor that interferes with normal breathing quite naturally induces anxiety, depression, and changes in behavior. Constant shortness of breath and fatigue may make the patient irritable and apprehensive to the point of panic. Restricted activity (and reversal of family roles due to loss of employment), the frustration of having to work to breathe, and the realization that the disease is prolonged and unrelenting may cause the patient to become angry, depressed, and demanding. Sexual function may be compromised, which also diminishes self-esteem. The nurse should provide education and support to spouses or significant others and families, because the caregiver role in end-stage COPD can be difficult.

## Nursing Management

### *Assessing the Patient*

Assessment involves obtaining information about current symptoms as well as previous disease manifestations. See Chart 24-2 for sample questions that may be used to obtain a clear history of the disease process. In addition to the history, nurses review the results of available diagnostic tests.

### *Achieving Airway Clearance*

Bronchospasm, which occurs in many pulmonary diseases, reduces the caliber of the small bronchi and may cause dyspnea, static secretions, and infection. Bronchospasm can sometimes be detected on auscultation with a stethoscope when wheezing or diminished breath sounds are heard. Increased mucus production, along with decreased mucociliary action, contributes to further reduction in the caliber of the bronchi and results in decreased airflow and decreased gas exchange. This is further aggravated by the loss of lung elasticity that occurs with COPD (GOLD, 2008). These changes in the airway require that the nurse monitor the patient for dyspnea and hypoxemia. If bronchodilators or corticosteroids are prescribed, the nurse must administer the medications properly and be alert for potential side effects. The relief of bronchospasm is confirmed by measuring improvement in expiratory flow rates and volumes (the force of expiration, how long it takes to exhale, and the amount of air exhaled) as well as by assessing the dyspnea and making sure that it has lessened.

Diminishing the quantity and viscosity of sputum can clear the airway and improve pulmonary ventilation and gas exchange. All pulmonary irritants should be eliminated or reduced, particularly cigarette smoking, which is the most persistent source of pulmonary irritation. The nurse instructs the patient in directed or controlled coughing, which is more effective and reduces the fatigue associated with undirected forceful coughing. Directed coughing consists of a slow, maximal inspiration followed by breath-holding for several seconds and then two or three coughs. "Huff" coughing may also be effective. The technique consists of one or two forced exhalations ("huffs") from low to medium lung volumes with the glottis open.

Chest physiotherapy with postural drainage, intermittent positive pressure breathing, increased fluid intake, and bland aerosol mists (with normal saline solution or water) may be useful for some patients with COPD. The use of these measures must be based on the response and tolerance of each patient.

### *Improving Breathing Patterns*

Ineffective breathing patterns and shortness of breath are due to the ineffective respiratory mechanics of the chest wall and lung resulting from **air trapping,** ineffective diaphragmatic movement, airway obstruction, the metabolic cost of breathing, and stress. Inspiratory muscle training and breathing retraining may help improve breathing patterns. Training in diaphragmatic breathing reduces the respiratory rate, increases alveolar ventilation, and sometimes helps expel as much air as possible during expiration. Pursed-lip breathing helps slow expiration, prevent collapse of small airways, and control the rate and depth of respiration. It also promotes relaxation, which allows patients to gain control of dyspnea and reduce feelings of panic.

### *Improving Activity Tolerance*

Patients with COPD experience progressive activity and exercise intolerance and disability. Education is focused on rehabilitative therapies to promote independence in executing activities of daily living. These may include pacing activities throughout the day or using supportive devices to decrease energy expenditure. The nurse evaluates the patient's activity tolerance and limitations and uses teaching strategies to promote independent activities of daily living. The patient may be a candidate for exercise training to strengthen the muscles of the upper and lower extremities and to improve exercise tolerance and endurance. Use of walking aids may be recommended to improve activity levels and ambulation (GOLD, 2008). Other health care professionals (rehabilitation therapist, occupational therapist, physical therapist) may be consulted as additional resources.

### Monitoring and Managing Potential Complications

The nurse must assess for various complications of COPD, such as life-threatening respiratory insufficiency and failure, as well as respiratory infection and chronic atelectasis, which may increase the risk of respiratory failure. The nurse monitors for cognitive changes (personality and behavioral changes, memory impairment), increasing dyspnea, tachypnea, and tachycardia, which may indicate increasing hypoxemia and impending respiratory failure.

The nurse monitors pulse oximetry values to assess the patient's need for oxygen and administers supplemental oxygen as prescribed. The nurse also instructs the patient about signs and symptoms of respiratory infection that may worsen hypoxemia and reports changes in the patient's physical and cognitive status to the physician.

Bronchopulmonary infections must be controlled to diminish inflammatory edema and to permit recovery of normal ciliary action. Minor respiratory infections that are of no consequence to people with normal lungs can be life-threatening to people with COPD. Infection compromises lung function and is a common cause of respiratory failure in people with COPD. In COPD, infection may be accompanied by subtle changes. The nurse instructs the patient to report any signs of infection, such as a fever or change in sputum color, character, consistency, or amount. Any worsening of symptoms (increased tightness of the chest, increased dyspnea, and fatigue) also suggests infection and must be reported. Viral infections are hazardous to the patient because they are often followed by infections caused by bacterial organisms, such as *Streptococcus pneumoniae* and *Haemophilus influenzae*.

To prevent infection, the nurse should encourage the patient with COPD to be immunized against influenza and *S. pneumoniae*, because the patient is prone to respiratory infection. It is important to caution the patient to avoid going outdoors if the pollen count is high or if there is significant air pollution, because of the risk of bronchospasm. The patient also should avoid exposure to high outdoor temperatures with high humidity.

Pneumothorax is a potential complication of COPD and can be life-threatening in patients with COPD who have minimal pulmonary reserve. Patients with severe emphysematous changes can develop large bullae, which may rupture and cause a pneumothorax. Development of a pneumothorax may be spontaneous or related to an activity such as severe coughing or large intrathoracic pressure changes. If a rapid onset of shortness of breath occurs, the nurse should quickly evaluate the patient for potential pneumothorax by assessing the symmetry of chest movement, differences in breath sounds, and pulse oximetry.

Over time, pulmonary hypertension may occur as a result of chronic hypoxemia. The pulmonary arteries respond to hypoxemia by constricting, which results in pulmonary hypertension. The complication may be prevented by maintaining adequate oxygenation through an adequate hemoglobin level, improved ventilation–perfusion of the lungs, or continuous administration of supplemental oxygen (if needed).

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

When providing instructions about self-management, it is important for the nurse to assess the knowledge of patients and family members about self-care and the therapeutic regimen. The nurse should also consider whether they are comfortable with this knowledge. Familiarity with prescribed medications' potential side effects is essential. In addition, patients and family members need to learn the early signs and symptoms of infection and other complications so that they seek appropriate health care promptly.

**NURSING ALERT**

**Teaching is essential and should be tailored to the stage of COPD.**

A major area of teaching involves setting and accepting realistic short-term and long-range goals. If the COPD is mild, the objectives of treatment are to increase exercise tolerance and prevent further loss of pulmonary function. If the COPD is severe, these objectives are to preserve current pulmonary function and relieve symptoms as much as possible. It is important to plan and share the goals and expectations of treatment with the patient. Both the patient and the care provider need patience to achieve these goals.

The nurse instructs the patient to avoid extremes of heat and cold. Heat increases the body temperature, thereby raising oxygen requirements, and cold tends to promote bronchospasm. Air pollutants such as fumes, smoke, dust, and even talcum, lint, and aerosol sprays may initiate bronchospasm. High altitudes aggravate hypoxemia.

A patient with COPD should adopt a lifestyle of moderate activity, ideally in a climate with minimal shifts in temperature and humidity. As much as possible, the patient should avoid emotional disturbances and stressful situations that might trigger a coughing episode. The medication regimen can be quite complex; patients receiving aerosol medications by an MDI or other type of inhaler may be particularly challenged. It is crucial to review educational information and to have the patient demonstrate correct MDI use before discharge, during follow-up visits to a caregiver's office or clinic, and during home visits (Chart 24-4).

Smoking cessation goes hand in hand with lifestyle changes, and reinforcement of the patient's efforts is a key nursing activity. Smoking cessation is the single most important therapeutic intervention for patients with COPD. There are many strategies, including prevention, cessation with or without oral or topical patch medications, and behavior modification techniques.

Numerous educational materials are available to assist nurses in teaching patients with COPD. Potential resources include those of organizations such as the American Lung Association, the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Thoracic Society, the American College of Chest Physicians, and the American Association for Respiratory Therapy.

**CHART 24-4 PATIENT EDUCATION**
***Use of Metered-Dose Inhaler (MDI)***

To administer medication:

- Remove the cap and hold the inhaler upright.
- Shake the inhaler.
- Tilt your head back slightly and breathe out slowly and all the way.
- Position the inhaler approximately 1–2 inches away from the open mouth, or use a spacer/holding chamber. When using a medicine chamber, place the lips around the mouthpiece.
- Start breathing in slowly through your mouth, and press down on the inhaler one time. If using a chamber, first press down on the inhaler and within 5 seconds, begin to breathe in slowly.
- Breathe in slowly and deeply for as long as possible.
- Hold your breath as you count to 10 slowly to allow the medication to reach down into your airways.
- Repeat puffs as directed, allowing 15–30 seconds between puffs for quick-acting medications. There is no need to wait for other medications.
- Apply the cap to the MDI for storage.
- After inhalation, rinse mouth with water when using a corticosteroid-containing MDI.

Expert Panel Report 3. (2007). *Guidelines for the diagnosis and management of asthma.* Bethesda, MD: National Asthma Education and Prevention Program, National Institutes of Health.

### Continuing Care

Referral for home care is important to enable the nurse to assess the patient's home environment and physical and psychological status, to evaluate the patient's adherence to a prescribed regimen, and to assess the patient's ability to cope with changes in lifestyle and physical status. Home care visits provide an opportunity to reinforce the information and activities learned in the inpatient or outpatient pulmonary rehabilitation program and to have the patient and family demonstrate correct administration of medications and oxygen, if indicated, and performance of exercises. If the patient does not have access to a formal pulmonary rehabilitation program, it is important to provide the education and breathing retraining necessary to optimize the patient's functional status.

The nurse may direct the patient to community resources such as pulmonary rehabilitation programs and smoking cessation programs to help improve the patient's ability to cope with his or her chronic condition and the therapeutic regimen and to give the patient a sense of worth, hope, and well-being. In addition, the nurse reminds the patient and family about the importance of participating in general health promotion activities and health screening.

It is important to address quality of life and issues surrounding the end of life in patients with end-stage COPD. Patients with COPD have indicated that information about their end-of-life needs is limited. Based on a structured literature review, the following end-of-life care issues are important: symptom management, quality of life, satisfaction with care, information/communication, use of care professionals, use of care facilities, hospital admission, and place of death (Habraken, Willems, de Kort, et al., 2007). It is crucial that patients know what to expect as the disease progresses. In addition, they should have information about their role in decisions regarding aggressiveness of care near the end of life and access to specialists who may help them and their families. As the disease course progresses, a holistic assessment of physical and psychological needs should be undertaken at each hospitalization, clinic visit, or home visit. This helps gauge the patient's assessment of the progression of the disease and its impact on quality of life and guides planning for future interventions and management.

Chart 24-5 provides further information on providing nursing care for the patient with COPD.

## Bronchiectasis

**Bronchiectasis** is a chronic, irreversible dilation of the bronchi and bronchioles. Under the new definition of COPD, it is considered a disease process separate from COPD (GOLD, 2008). Bronchiectasis may be caused by a variety of conditions, including

- Airway obstruction
- Diffuse airway injury
- Pulmonary infections and obstruction of the bronchus or complications of long-term pulmonary infections
- Genetic disorders such as cystic fibrosis
- Abnormal host defense (eg, ciliary dyskinesia or humoral immunodeficiency)
- Idiopathic causes

People may be predisposed to bronchiectasis as a result of recurrent respiratory infections in early childhood, measles, influenza, tuberculosis, or immunodeficiency disorders.

### Pathophysiology

The inflammatory process associated with pulmonary infections damages the bronchial wall, causing a loss of its supporting structure and resulting in thick sputum that ultimately obstructs the bronchi. The walls become permanently distended and distorted, impairing mucociliary clearance. In saccular bronchiectasis, each dilated peribronchial tube virtually amounts to a lung abscess, the exudate of which drains freely through the bronchus. Bronchiectasis is usually localized, affecting a segment or lobe of a lung, most frequently the lower lobes.

The retention of secretions and subsequent obstruction ultimately cause the alveoli distal to the obstruction to collapse (atelectasis). Inflammatory scarring or fibrosis replaces functioning lung tissue. In time, the patient develops respiratory insufficiency with reduced vital capacity, decreased ventilation, and an increased ratio of residual volume to total lung capacity. There is impairment in the match of ventilation to perfusion (ventilation–perfusion imbalance) and hypoxemia.

CHART 24-5

## PLAN OF NURSING CARE
## *Care of the Patient With COPD*

**NURSING DIAGNOSIS:** Impaired gas exchange and airway clearance due to chronic inhalation of toxins
**GOAL:** Improvement in gas exchange

### Nursing Interventions

1. Evaluate current smoking status, educate regarding smoking cessation, and facilitate efforts to quit.
   a. Evaluate current smoking habits of patient and family.
   b. Educate regarding hazards of smoking and relationship to COPD.
   c. Evaluate previous smoking cessation attempts.
   d. Provide educational materials.
   e. Refer to a smoking cessation program or resource.
2. Evaluate current exposure to occupational toxins or pollutants and indoor/outdoor pollution.
   a. Evaluate current exposures to occupational toxins, indoor and outdoor air pollution (eg, smog, toxic fumes, chemicals).
   b. Emphasize primary prevention to occupational exposures. This is best achieved by elimination or reduction of exposures in the workplace.
   c. Educate regarding types of indoor and outdoor air pollution (eg, biomass fuel burned for cooking and heating in poorly ventilated buildings, outdoor air pollution).
   d. Advise patient to monitor public announcements regarding air quality.

### Rationale

1. Smoking causes permanent damage to the lung and diminishes the lungs' protective mechanisms. Airflow is obstructed, secretions are increased, and lung capacity is reduced. Continued smoking increases morbidity and mortality in COPD and is also a risk factor for lung cancer.
2. Chronic inhalation of both indoor and outdoor toxins causes damage to the airways and impairs gas exchange.

### Expected Outcomes

- Identifies the hazards of cigarette smoking
- Identifies resources for smoking cessation
- Enrolls in smoking cessation program
- Reports success in stopping smoking
- Verbalizes types of inhaled toxins
- Minimizes or eliminates exposures
- Monitors public announcements regarding air quality and minimizes or eliminates exposures during episodes of severe pollution

**NURSING DIAGNOSIS:** Impaired gas exchange related to ventilation–perfusion inequality
**GOAL:** Improvement in gas exchange

### Nursing Interventions

1. Administer bronchodilators as prescribed:
   a. Inhalation is the preferred route.
   b. Observe for side effects: tachycardia, dysrhythmias, central nervous system excitation, nausea, and vomiting.
   c. Assess for correct technique of metered-dose inhaler (MDI) or other type of administration.
2. Evaluate effectiveness of nebulizer or MDI treatments.
   a. Assess for decreased shortness of breath, decreased wheezing or crackles, loosened secretions, and decreased anxiety.
   b. Ensure that treatment is given before meals to avoid nausea and to reduce fatigue that accompanies eating.

### Rationale

1. Bronchodilators dilate the airways. The medication dosage is carefully adjusted for each patient, in accordance with clinical response.
2. Combining medication with aerosolized bronchodilators is typically used to control bronchoconstriction in an acute exacerbation. Generally, however, the MDI with spacer is the preferred route (less cost and time to treatment).

### Expected Outcomes

- Verbalizes need for bronchodilators and for taking them as prescribed
- Evidences minimal side effects; heart rate near normal, absence of dysrhythmias, normal mentation
- Reports a decrease in dyspnea
- Shows an improved expiratory flow rate
- Uses and cleans respiratory therapy equipment as applicable
- Demonstrates diaphragmatic breathing and coughing
- Uses oxygen equipment appropriately when indicated
- Evidences improved arterial blood gases or pulse oximetry
- Demonstrates correct technique for use of MDI

*Continued on following page*

CHART 24-5

**PLAN OF NURSING CARE**

## Care of the Patient With COPD (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Instruct and encourage patient in diaphragmatic breathing and effective coughing. | 3. These techniques improve ventilation by opening airways to facilitate clearing the airways of sputum. Gas exchange is improved and fatigue is minimized. | |
| 4. Administer oxygen by the method prescribed.<br>a. Explain rationale and importance to patient.<br>b. Evaluate effectiveness; observe for signs of hypoxemia. Notify physician if restlessness, anxiety, somnolence, cyanosis, or tachycardia is present.<br>c. Analyze arterial blood gases and compare with baseline values. When arterial puncture is performed and a blood sample is obtained, hold puncture site for 5 minutes to prevent arterial bleeding and development of ecchymoses.<br>d. Initiate pulse oximetry to monitor oxygen saturation.<br>e. Explain that no smoking is permitted by patient or visitors while oxygen is in use. | 4. Oxygen will correct the hypoxemia. Careful observation of the liter flow or the percentage administered and its effect on the patient is important. These patients generally require low-flow oxygen rates of 1 to 2 L/min. Monitor and titrate to achieve desired $PaO_2$. Periodic arterial blood gases and pulse oximetry help evaluate adequacy of oxygenation. Smoking may render pulse oximetry inaccurate because the carbon monoxide from cigarette smoke also saturates hemoglobin. | |

**NURSING DIAGNOSIS:** Ineffective airway clearance related to bronchoconstriction, increased mucus production, ineffective cough, bronchopulmonary infection, and other complications
**GOAL:** Achievement of airway clearance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Adequately hydrate the patient. | 1. Systemic hydration keeps secretions moist and easier to expectorate. Fluids must be given with caution if right- or left-sided heart failure is present. | • Verbalizes need to drink fluids<br>• Demonstrates diaphragmatic breathing and coughing<br>• Performs postural drainage correctly<br>• Coughing is minimized<br>• Does not smoke<br>• Verbalizes that pollens, fumes, gases, dusts, and extremes of temperature and humidity are irritants to be avoided<br>• Identifies signs of early infection<br>• Is free of infection (no fever, no change in sputum, lessening of dyspnea)<br>• Verbalizes need to notify health care provider at the earliest sign of infection<br>• Verbalizes need to stay away from crowds or people with colds in flu season<br>• Discusses flu and pneumonia vaccines with clinician to help prevent infection |
| 2. Teach and encourage the use of diaphragmatic breathing and coughing techniques. | 2. These techniques help to improve ventilation and mobilize secretions without causing breathlessness and fatigue. | |
| 3. Assist in administering nebulizer or MDI. | 3. This ensures adequate delivery of medication to the airways. | |
| 4. If indicated, perform postural drainage with percussion and vibration in the morning and at night as prescribed. | 4. This uses gravity to help raise secretions so they can be more easily expectorated or suctioned. | |
| 5. Instruct patient to avoid bronchial irritants such as cigarette smoke, aerosols, extremes of temperature, and fumes. | 5. Bronchial irritants cause bronchoconstriction and increased mucus production, which then interfere with airway clearance. | |
| 6. Teach early signs of infection that are to be reported to the clinician immediately:<br>a. Increased sputum production<br>b. Change in color of sputum<br>c. Increased thickness of sputum<br>d. Increased shortness of breath, tightness in chest, or fatigue<br>e. Increased coughing<br>f. Fever or chills | 6. Minor respiratory infections that are of no consequence to the person with normal lungs can produce fatal disturbances in the lungs of the person with emphysema. Early recognition is crucial. | |

*Continued*

CHART 24-5

PLAN OF NURSING CARE

## Care of the Patient With COPD (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 7. Administer antibiotics as prescribed. | 7. Antibiotics may be prescribed to prevent or treat infection. | |
| 8. Encourage patient to be immunized against influenza and *Streptococcus pneumoniae.* | 8. People with respiratory conditions are prone to respiratory infections and are encouraged to be immunized. | |

**NURSING DIAGNOSIS:** Ineffective breathing pattern related to shortness of breath, mucus, bronchoconstriction, and airway irritants
**GOAL:** Improvement in breathing pattern

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Teach patient diaphragmatic and pursed-lip breathing. | 1. This helps patient prolong expiration time and decreases air trapping. With these techniques, patient will breathe more efficiently and effectively. | • Practices pursed-lip and diaphragmatic breathing and uses them when short of breath and with activity<br>• Shows signs of decreased respiratory effort and paces activities<br>• Uses inspiratory muscle trainer as prescribed |
| 2. Encourage alternating activity with rest periods. Allow patient to make some decisions (bath, shaving) about care based on tolerance level. | 2. Pacing activities permit patient to perform activities without excessive distress. | |
| 3. Encourage use of an inspiratory muscle trainer if prescribed. | 3. This strengthens and conditions the respiratory muscles. | |

**NURSING DIAGNOSIS:** Self-care deficits related to fatigue secondary to increased work of breathing and insufficient ventilation and oxygenation
**GOAL:** Independence in self-care activities

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Teach patient to coordinate diaphragmatic breathing with activity (eg, walking, bending). | 1. This will allow the patient to be more active and to avoid excessive fatigue or dyspnea during activity. | • Uses controlled breathing while bathing, bending, and walking<br>• Paces activities of daily living to alternate with rest periods to reduce fatigue and dyspnea<br>• Describes energy conservation strategies<br>• Performs same self-care activities as before<br>• Performs postural drainage correctly |
| 2. Encourage patient to begin to bathe self, dress self, walk, and drink fluids. Discuss energy conservation measures. | 2. As condition resolves, patient will be able to do more but needs to be encouraged to avoid increasing dependence. | |
| 3. Teach postural drainage if appropriate. | 3. This encourages patient to become involved in own care and prepares patient to manage at home. | |

**NURSING DIAGNOSIS:** Activity intolerance due to fatigue, hypoxemia, and ineffective breathing patterns
**GOAL:** Improvement in activity tolerance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Support patient in establishing a regular regimen of exercise using treadmill and exercise bicycle, walking, or other appropriate exercises, such as mall walking.<br>a. Assess the patient's current level of functioning and develop exercise plan based on baseline functional status.<br>b. Suggest consultation with a physical therapist or pulmonary rehabilitation program to determine an exercise program specific to the patient's capability. Have portable oxygen unit available if oxygen is prescribed for exercise. | 1. Muscles that are deconditioned consume more oxygen and place an additional burden on the lungs. Through regular, graded exercise, these muscle groups become more conditioned, and the patient can do more without getting as short of breath. Graded exercise breaks the cycle of debilitation. | • Performs activities with less shortness of breath<br>• Verbalizes need to exercise daily and demonstrates an exercise plan to be carried out at home<br>• Walks and gradually increases walking time and distance to improve physical condition<br>• Exercises both upper and lower body muscle groups |

*Continued on following page*

CHART 24-5

## PLAN OF NURSING CARE
### *Care of the Patient With COPD (Continued)*

**NURSING DIAGNOSIS:** Ineffective coping related to reduced socialization, anxiety, depression, lower activity level, and the inability to work
**GOAL:** Attainment of an optimal level of coping

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Help the patient develop realistic goals.<br>2. Encourage activity to level of symptom tolerance.<br>3. Teach relaxation technique or provide a relaxation tape for patient.<br>4. Enroll patient in pulmonary rehabilitation program where available. | 1. Developing realistic goals will promote a sense of hope and accomplishment rather than defeat and hopelessness.<br>2. Activity reduces tension and decreases degree of dyspnea as patient becomes conditioned.<br>3. Relaxation reduces stress, anxiety, and dyspnea and helps patient to cope with disability.<br>4. Pulmonary rehabilitation programs have been shown to promote a subjective improvement in a patient's status and self-esteem as well as increased exercise tolerance and decreased hospitalizations. | • Expresses interest in the future<br>• Participates in the discharge plan<br>• Discusses activities or methods that can be performed to ease shortness of breath<br>• Uses relaxation techniques appropriately<br>• Expresses interest in a pulmonary rehabilitation program |

**NURSING DIAGNOSIS:** Deficient knowledge about self-management to be performed at home
**GOAL:** Adherence to therapeutic program and home care

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Help patient identify/develop short- and long-term goals.<br>a. Teach the patient about disease, medications, procedures, and how and when to seek help.<br>b. Refer patient to pulmonary rehabilitation.<br>2. Give strong message to stop smoking. Discuss smoking cessation strategies. Provide information about resource groups (eg, SmokEnders, American Cancer Society, American Lung Association). | 1. Patient needs to be a partner in developing the plan of care and needs to know what to expect. Teaching about the condition is one of the most important aspects of care; it will prepare the patient to live and cope with the condition and improve quality of life.<br>2. Smoking causes permanent damage to the lung and diminishes the lungs' protective mechanisms. Air flow is obstructed and lung capacity is reduced. Smoking increases morbidity and mortality and is also a risk factor for lung cancer. | • Understands disease and what affects it<br>• Verbalizes the need to preserve existing lung function by adhering to the prescribed program<br>• Understands purposes and proper administration of medications<br>• Stops smoking or enrolls in a smoking cessation program<br>• Identifies when and whom to call for assistance |

**COLLABORATIVE PROBLEM:** Atelectasis
**GOAL:** Absence of atelectasis on x-ray and physical examination

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, signs and symptoms of respiratory distress, and pulse oximetry.<br>2. Instruct in and encourage diaphragmatic breathing and effective coughing techniques.<br>3. Promote use of lung expansion techniques (eg, deep-breathing exercises, incentive spirometry) as prescribed. | 1. A change in respiratory status, including tachypnea, dyspnea, and diminished or absent breath sounds, may indicate atelectasis.<br>2. These techniques improve ventilation and lung expansion and ideally improve gas exchange.<br>3. Deep-breathing exercises and incentive spirometry promote maximal lung expansion. | • Normal (baseline for patient) respiratory rate and pattern<br>• Normal breath sounds for patient<br>• Demonstrates diaphragmatic breathing and effective coughing<br>• Performs deep-breathing exercises, incentive spirometry as prescribed<br>• Pulse oximetry is ≥90% |

*Continued*

CHART 24-5

PLAN OF NURSING CARE

## Care of the Patient With COPD *(Continued)*

**COLLABORATIVE PROBLEM:** Pneumothorax
**GOAL:** Absence of signs and symptoms of pneumothorax

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor respiratory status, including rate and pattern of respirations, symmetry of chest wall movement, breath sounds, signs and symptoms of respiratory distress, and pulse oximetry. | 1. Dyspnea, tachypnea, tachycardia, acute pleuritic chest pain, tracheal deviation away from the affected side, absence of breath sounds on the affected side, and decreased tactile fremitus may indicate pneumothorax. | • Normal respiratory rate and pattern for patient<br>• Normal breath sounds bilaterally<br>• Normal pulse for patient<br>• Normal tactile fremitus<br>• Absence of pain<br>• Tracheal position is midline<br>• Pulse oximetry ≥90%<br>• Maintains normal oxygen saturation and arterial blood gas measurements<br>• Exhibits no hypoxemia and hypercapnia (or returns to baseline values)<br>• Absence of pain<br>• Symmetric chest wall movement<br>• Lung is re-expanded on chest x-ray<br>• Breath sounds are heard on the affected side |
| 2. Assess pulse. | 2. Tachycardia is associated with pneumothorax and anxiety. | |
| 3. Assess for chest pain and precipitating factors. | 3. Pain may accompany pneumothorax. | |
| 4. Palpate for tracheal deviation/ shift away from the affected side. | 4. Early detection of pneumothorax and prompt intervention will prevent other serious complications. | |
| 5. Monitor pulse oximetry and, if indicated, arterial blood gases. | 5. Recognition of a deterioration in respiratory function will prevent serious complications. | |
| 6. Administer supplemental oxygen therapy, as indicated. | 6. Oxygen will correct hypoxemia; administer it with caution. | |
| 7. Administer analgesics agents, as indicated, for chest pain. | 7. Pain interferes with deep breathing, resulting in a decrease in lung expansion. | |
| 8. Assist with chest tube insertion and use pleural drainage system, as prescribed. | 8. Removal of air from the pleural space will re-expand the lung. | |

**COLLABORATIVE PROBLEM:** Respiratory failure
**GOAL:** Absence of signs and symptoms of respiratory failure; no evidence of respiratory failure on laboratory tests

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, and signs and symptoms of acute respiratory distress. | 1. Early recognition of a deterioration in respiratory function will avert further complications, such as respiratory failure, severe hypoxemia, and hypercapnia. | • Normal respiratory rate and pattern for patient with no acute distress<br>• Recognizes symptoms of hypoxemia and hypercapnia<br>• Maintains normal arterial blood gases/pulse oximetry or returns to baseline values |
| 2. Monitor pulse oximetry and arterial blood gases. | 2. Recognition of changes in oxygenation and acid–base balance will guide in correcting and preventing complications. | |
| 3. Administer supplemental oxygen and initiate mechanisms for mechanical ventilation, as prescribed. | 3. Acute respiratory failure is a medical emergency. Hypoxemia is a hallmark sign. Administration of oxygen therapy and mechanical ventilation (if indicated) are critical to survival. | |

**COLLABORATIVE PROBLEM:** Pulmonary arterial hypertension
**GOAL:** Absence of evidence of pulmonary arterial hypertension on physical examination or laboratory tests

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, pulse oximetry, and signs and symptoms of acute respiratory distress. | 1. Dyspnea is the primary symptom of pulmonary arterial hypertension. Other symptoms include fatigue, angina, near syncope, edema, and palpitations. | • Normal respiratory rate and pattern for patient<br>• Exhibits no signs and symptoms of right-sided failure<br>• Maintains baseline pulse oximetry values and arterial blood gases |
| 2. Assess for signs and symptoms of right-sided heart failure, including peripheral edema, ascites, distended neck veins, crackles, and heart murmur. | 2. Right-sided heart failure is a common clinical manifestation of pulmonary arterial hypertension due to increased right ventricular workload. | |
| 3. Administer oxygen therapy, as prescribed. | 3. Continuous oxygen therapy is a major component of management of pulmonary arterial hypertension by preventing hypoxemia and thereby reducing pulmonary vascular constriction (resistance) secondary to hypoxemia. | |

## Clinical Manifestations

Characteristic symptoms of bronchiectasis include chronic cough and the production of purulent sputum in copious amounts. Many patients with this disease have hemoptysis. Clubbing of the fingers also is common because of respiratory insufficiency. Patients usually have repeated episodes of pulmonary infection. Even with modern treatment approaches, the average age at death is approximately 55 years.

## Assessment and Diagnostic Findings

Bronchiectasis is not readily diagnosed because the symptoms can be mistaken for those of simple chronic bronchitis. A definite sign is a prolonged history of productive cough, with sputum consistently negative for tubercle bacilli. The diagnosis is established by a CT scan, which reveals bronchial dilation.

## Medical Management

Treatment objectives are to promote bronchial drainage to clear excessive secretions from the affected portion of the lungs and to prevent or control infection. Postural drainage is part of all treatment plans, because draining of the bronchiectatic areas by gravity reduces the amount of secretions and the degree of infection. Sometimes mucopurulent sputum must be removed by bronchoscopy. Chest physiotherapy, including percussion and postural drainage, is important in the management of secretions. Smoking cessation is important, because smoking impairs bronchial drainage by paralyzing ciliary action, increasing bronchial secretions, and causing inflammation of the mucous membranes, resulting in hyperplasia of the mucous glands.

Antimicrobial therapy based on the results of sensitivity studies on organisms cultured from sputum is used to control infection. A year-round regimen of antibiotic agents may be prescribed, with different types of antibiotics at intervals. Some clinicians prescribe antibiotic agents throughout the winter or when acute upper respiratory tract infections occur. Patients should be vaccinated against influenza and pneumococcal pneumonia. Bronchodilators, which may be prescribed for patients who also have reactive airway disease, may also assist with secretion management.

Surgical intervention, although used infrequently, may be indicated for patients who continue to expectorate large amounts of sputum and have repeated bouts of pneumonia and hemoptysis despite adherence to treatment regimens. The disease must involve only one or two areas of the lung that can be removed without producing respiratory insufficiency. The goals of surgical treatment are to conserve normal pulmonary tissue and to avoid infectious complications. Diseased tissue is removed, provided that postoperative lung function will be adequate. It may be necessary to remove a segment of a lobe (segmental resection), a lobe (lobectomy), or rarely an entire lung (pneumonectomy). (See Chart 25-18 in Chapter 25 for further information.) Segmental resection is the removal of an anatomic subdivision of a pulmonary lobe. The chief advantage is that only diseased tissue is removed, and healthy lung tissue is conserved.

The surgery is preceded by a period of careful preparation. The objective is to obtain a dry (free of infection) tracheobronchial tree to prevent complications (atelectasis, pneumonia, bronchopleural fistula, and empyema). This is accomplished by postural drainage or, depending on the location, by direct suction through a bronchoscope. A course of antibacterial therapy may be prescribed. After surgery, care is the same as for any patient who has undergone chest surgery (see Chapter 25).

## Nursing Management

Nursing management focuses on alleviating symptoms and helping patients clear pulmonary secretions. Patient teaching targets smoking and other factors that increase the production of mucus and hamper its removal. Patients and families are taught to perform postural drainage and to avoid exposure to people with upper respiratory or other infections. If the patient experiences fatigue and dyspnea, he or she is informed about strategies to conserve energy while maintaining as active a lifestyle as possible. The patient is taught about the early signs of respiratory infection and the progression of the disorder, so that appropriate treatment can be implemented promptly. The presence of a large amount of mucus may decrease the patient's appetite and result in an inadequate dietary intake; therefore, the patient's nutritional status is assessed and strategies are implemented to ensure an adequate diet.

# Asthma

**Asthma** is a chronic inflammatory disease of the airways that causes airway hyperresponsiveness, mucosal edema, and mucus production. This inflammation ultimately leads to recurrent episodes of asthma symptoms: cough, chest tightness, wheezing, and dyspnea (Fig. 24-6). In the United

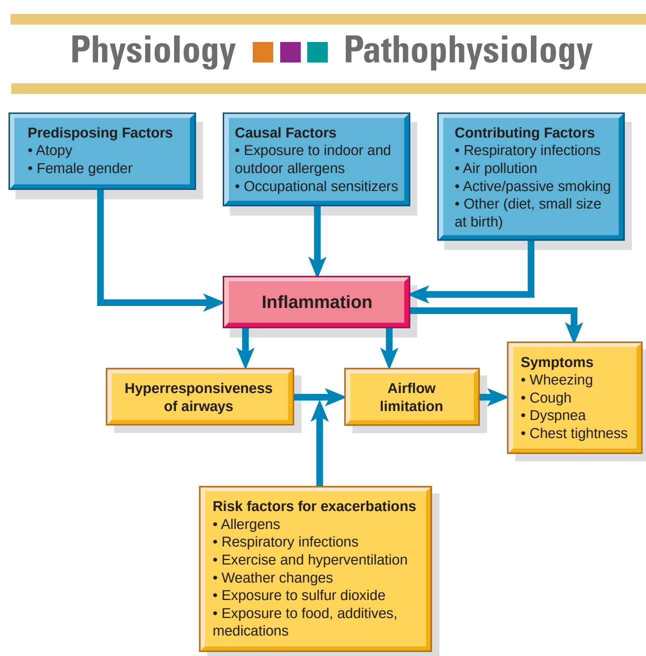



**Figure 24-6** Pathophysiology of asthma. Adapted from materials developed for the Global Initiative for Asthma (GINA). *Global Strategy for Asthma Management and Prevention,* Global Initiative for Asthma (GINA) 2008. Available from: http://www.ginasthma.org.

States, asthma affects more than 22 million people (Expert Panel Report 3, 2007). Asthma accounts for more than 497,000 hospitalizations annually (Agency for Healthcare Research and Quality [AHRQ, 2007). The total economic cost of asthma exceeds $27.6 billion (AHRQ, 2007).

The most common chronic disease of childhood, asthma can occur at any age. For most patients, asthma is a disruptive disease, affecting school and work attendance, occupational choices, physical activity, and general quality of life.

Despite increased knowledge regarding the pathology of asthma and the development of improved medications and management plans, the death rate from the disease continues to rise. Ethnic and racial disparities affect morbidity and mortality in asthma, which are higher in inner-city African Americans and Latinos (Wright & Subramanian, 2007). Contributing to these disparities are epidemiology and risk factors; genetics and molecular aspects; inner-city environments; limited community assets; health care access, delivery, and quality; and lack of insurance coverage.

Unlike other obstructive lung diseases, asthma is largely reversible, either spontaneously or with treatment. Patients with asthma may experience symptom-free periods alternating with acute exacerbations that last from minutes to hours or days.

Allergy is the strongest predisposing factor for asthma. Chronic exposure to airway irritants or allergens also increases the risk of asthma. Common allergens can be seasonal (grass, tree, and weed pollens) or perennial (eg, mold, dust, roaches, animal dander). Common triggers for asthma symptoms and exacerbations include airway irritants (eg, air pollutants, cold, heat, weather changes, strong odors or perfumes, smoke), exercise, stress or emotional upset, rhinosinusitis with postnasal drip, medications, viral respiratory tract infections, and gastroesophageal reflux. Most people who have asthma are sensitive to a variety of triggers.

## Pathophysiology

The underlying pathology in asthma is reversible and diffuse airway inflammation that leads to airway narrowing. This narrowing, which is exacerbated by a variety of changes in the airway, includes bronchoconstriction, airway edema, airway hyperresponsiveness, and airway remodeling. The interaction of these factors determines the clinical manifestations and severity of asthma (Expert Panel Report 3, 2007).

Mast cells, neutrophils, eosinophils, and lymphocytes play a key role in the inflammation of asthma. When activated, mast cells release several chemicals called mediators. These chemicals, which include histamine, bradykinin, prostaglandins, and leukotrienes, perpetuate the inflammatory response, causing increased blood flow, vasoconstriction, fluid leak from the vasculature, attraction of white blood cells to the area, and bronchoconstriction (Expert Panel Report 3, 2007).

In acute exacerbations of asthma, bronchial smooth muscle contraction or bronchoconstriction occurs quickly to narrow the airway in response to an exposure. Acute bronchoconstriction due to allergens results from an immunoglobulin E (IgE)–dependent release of mediators from mast cells; these mediators include histamine, tryptase, leukotrienes, and prostaglandins that directly contract the airway. There are also non–IgE-mediated responses and proinflammatory cytokines (Expert Panel Report 3, 2007). In addition, alpha- and beta$_2$-adrenergic receptors of the sympathetic nervous system located in the bronchi play a role. When the alpha-adrenergic receptors are stimulated, bronchoconstriction occurs. When the beta$_2$-adrenergic receptors are stimulated, bronchodilation occurs. The balance between alpha- and beta$_2$-adrenergic receptors is controlled primarily by cyclic 3′,5′-adenosine monophosphate (cAMP). Beta$_2$-adrenergic stimulation results in increased levels of cAMP, which inhibits the release of chemical mediators and causes bronchodilation.

As asthma becomes more persistent, the inflammation progresses and other factors may be involved in airflow limitation. These include airway edema, mucus hypersecretion, and the formation of mucous plugs. Also, airway "remodeling" may occur in response to chronic inflammation, causing further airway narrowing.

## Clinical Manifestations

The three most common symptoms of asthma are cough, dyspnea, and wheezing. In some instances, cough may be the only symptom. An asthma attack often occurs at night or early in the morning, possibly because of circadian variations that influence airway receptor thresholds.

An asthma exacerbation may begin abruptly but most frequently is preceded by increasing symptoms over the previous few days. There is cough, with or without mucus production. At times, the mucus is so tightly wedged in the narrowed airway that the patient cannot cough it up. There may be generalized wheezing (the sound of airflow through narrowed airways), first on expiration and then possibly during inspiration as well. Generalized chest tightness and dyspnea occur. Expiration requires effort and becomes prolonged. As the exacerbation progresses, diaphoresis, tachycardia, and a widened pulse pressure may occur along with hypoxemia and central cyanosis (a late sign of poor oxygenation). Although severe, life-threatening hypoxemia can occur in asthma, it is relatively uncommon. The hypoxemia is secondary to a ventilation–perfusion mismatch and readily responds to supplemental oxygenation.

Symptoms of exercise-induced asthma include maximal symptoms during exercise, absence of nocturnal symptoms, and sometimes only a description of a "choking" sensation during exercise.

## Assessment and Diagnostic Findings

To establish the diagnosis, the clinician must determine that episodic symptoms of airflow obstruction are present, airflow is at least partially reversible, and other causes have been excluded. A positive family history and environmental factors, including seasonal changes, high pollen counts, mold, pet dander, climate changes (particularly cold air), and air pollution, are primarily associated with asthma. In addition, asthma is associated with a variety of occupation-related chemicals and compounds. Comorbid conditions that may accompany asthma include gastroesophageal reflux disease (GERD), drug-induced asthma, and allergic bronchopulmonary aspergillosis. Other possible allergic reactions that may accompany asthma include eczema, rashes, and temporary edema.

During acute episodes, sputum and blood tests may disclose eosinophilia (elevated levels of eosinophils). Serum levels of IgE may be elevated if allergy is present. Arterial blood gas analysis and pulse oximetry reveal hypoxemia during acute attacks. Initially, hypocapnia and respiratory alkalosis are present. As the patient's condition worsens and he or she becomes more fatigued, the $PaCO_2$ may increase. Because carbon dioxide is 20 times more diffusible than oxygen, it is rare for $PaCO_2$ to be normal or elevated in a person who is breathing very rapidly.

**NURSING ALERT**

**Normal $PaCO_2$ during an asthma attack may be a signal of impending respiratory failure.**

During an exacerbation, the $FEV_1$ and FVC are markedly decreased but improve with bronchodilator administration (demonstrating reversibility). Pulmonary function is usually normal between exacerbations. The occurrence of a severe, continuous reaction is referred to as status asthmaticus and is considered life-threatening (see later discussion).

Asthma severity is considered in the selection of the initial type, amount, and schedule of treatment (Expert Panel Report 3, 2007). The severity of disease is classified by current impairment and future risk of adverse events. Impairment is defined by the following factors: nighttime awakenings, need for short-acting bronchodilators for relief of symptoms, work/school days missed, ability to engage in normal activities, and quality of life. Lung function is evaluated by spirometry. Assessment of risk of future adverse events is evaluated by numbers of exacerbations, need for emergency department care or hospitalizations in the past year, demographic data (gender, ethnicity, nonuse of prescribed inhaled corticosteroid therapy, existing smoking), psychosocial factors and attitudes, and beliefs about taking medication (Expert Panel Report 3, 2007).

## Prevention

Patients with recurrent asthma should undergo tests to identify the substances that precipitate the symptoms. Possible causes are dust, dust mites, roaches, certain types of cloth, pets, horses, detergents, soaps, certain foods, molds, and pollens. If the attacks are seasonal, pollens can be strongly suspected. Patients are instructed to avoid the causative agents whenever possible. Knowledge is the key to quality asthma care. Evaluation of impairment and risk are key in the control.

## Complications

Complications of asthma may include status asthmaticus, respiratory failure, pneumonia, and atelectasis. Airway obstruction, particularly during acute asthmatic episodes, often results in hypoxemia, requiring the administration of oxygen and the monitoring of pulse oximetry and arterial blood gases. Fluids are administered, because people with asthma are frequently dehydrated from diaphoresis and insensible fluid loss with hyperventilation.

## Medical Management

Immediate intervention may be necessary, because continuing and progressive dyspnea leads to increased anxiety, aggravating the situation. The Expert Panel 3 Guidelines for the Diagnosis and Management of Asthma (2007) are based on the concept of severity and control of asthma along with the domains of impairment and risk as keys to improving care. Primary concerns in the treatment of patients are impairment of lung function and normal life and risk of exacerbations, decline in lung function, and adverse effects from medications (Expert Panel Report 3, 2007).

### Pharmacologic Therapy

Figure 24-7 shows the pharmacologic treatment of asthma using a stepwise approach. There are two general classes of asthma medications: quick-relief medications for immediate treatment of asthma symptoms and exacerbations and long-acting medications to achieve and maintain control of persistent asthma (Tables 24-3 and 24-4). Because the underlying pathology of asthma is inflammation, control of persistent asthma is accomplished primarily with regular use of anti-inflammatory medications. These medications have systemic side effects when used over the long term. The route of choice for administration of these medications is an MDI or other type of inhaler, because it allows for topical administration (see Chart 24-4 and Table 24-1).

#### Quick-Relief Medications

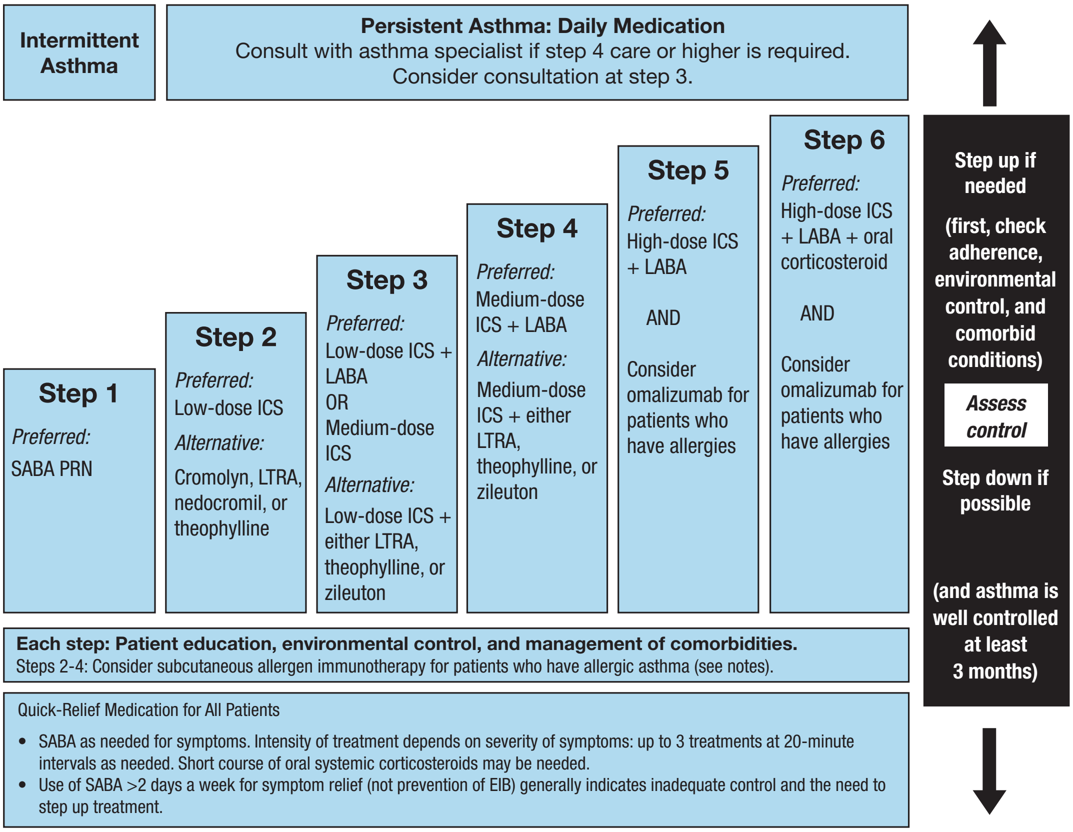
*Short-acting beta$_2$-adrenergic agonists* (albuterol [Proventil, Ventolin], levalbuterol [Xopenex], and pirbuterol [Maxair]) are the medications of choice for relief of acute symptoms and prevention of exercise-induced asthma. They are used to relax smooth muscle.

*Anticholinergics* (eg, ipratropium bromide [Atrovent]) inhibit muscarinic cholinergic receptors and reduce intrinsic vagal tone of the airway. These may be used in patients who do not tolerate short-acting beta$_2$-adrenergic agonists.

#### Long-Acting Control Medications

*Corticosteroids* are the most potent and effective anti-inflammatory medications currently available. They are broadly effective in alleviating symptoms, improving airway function, and decreasing peak flow variability. Initially, an inhaled form is used. A spacer should be used with inhaled corticosteroids, and patients should rinse their mouth after administration to prevent thrush, a common complication associated with use of inhaled corticosteroids. A systemic preparation may be used to gain rapid control of the disease; to manage severe, persistent asthma; to treat moderate to severe exacerbations; to accelerate recovery; and to prevent recurrence. Cromolyn sodium (Crolom, NasalCrom) and nedocromil (Alocril, Tilade) are mild to moderate anti-inflammatory agents and are considered alternative medications for treatment. These medications stabilize mast cells. They also are effective on a prophylactic basis to prevent exercise-induced asthma or in unavoidable exposure to known triggers. These medications are contraindicated in acute asthma exacerbations.

Long-acting beta$_2$-adrenergic agonists are used with anti-inflammatory medications to control asthma symptoms, particularly those that occur during the night. These agents are also effective in the prevention of exercise-induced asthma. Long-acting beta$_2$-adrenergic agonists are not indicated for immediate relief of symptoms. Theophylline (Slo-Bid, Theo-Dur) is a mild to moderate bronchodilator that is




Key: **Alphabetical order is used when more than one treatment option is listed within either preferred or alternative therapy.** EIB, exercise-induced bronchospasm; ICS, inhaled corticosteroid; LABA, inhaled long-acting beta$_2$-agonist; LTRA, leukotriene receptor antagonist; SABA, inhaled short-acting beta$_2$-agonist

**Notes:**

- The stepwise approach is meant to assist, not replace, the clinical decision making required to meet individual patient needs.
- If alternative treatment is used and response is inadequate, discontinue it and use the preferred treatment before stepping up.
- Zileuton is a less desirable alternative due to limited studies as adjunctive therapy and the need to monitor liver function. Theophylline requires monitoring of serum concentration levels.
- In step 6, before oral systemic corticosteroids are introduced, a trial of high-dose ICS + LABA + either LTRA, theophylline, or zileuton may be considered, although this approach has not been studied in clinical trials.
- Steps 1, 2, and 3 preferred therapies are based on evidence A; step 3 alternative therapy is based on evidence A for LTRA, evidence B for theophylline, and evidence D for zileuton. Step 4 preferred therapy is based on evidence B, and alternative therapy is based on evidence B for LTRA and theophylline and evidence D for zileuton. Step 5 preferred therapy is based on evidence B. Step 6 preferred therapy is based on (EPR—2 1997) and evidence B for omalizumab.
- Immunotherapy for steps 2-4 is based on evidence B for house-dust mites, animal danders, and pollens; evidence is weak or lacking for molds and cockroaches. Evidence is strongest for immunotherapy with single allergens. The role of allergy in asthma is greater in children than in adults.
- Clinicians who administer immunotherapy or omalizumab should be prepared and equipped to identify and treat anaphylaxis that may occur.

**Figure 24-7** Stepwise approach for managing asthma in youths 12 years of age and older and adults. Redrawn from Expert Panel Report 3. (2007). *Guidelines for the diagnosis and management of asthma* (p. 343). NIH Publication Number 08-5846. National Asthma Education and Prevention Program. Summary Report. Bethesda, MD: U.S. Department of Health and Human Services, National Heart, Lung and Blood Institute.

**Table 24-3 LONG-TERM MEDICATIONS FOR TREATMENT OF ASTHMA (CONTROLLER MEDICATIONS)**

| Medication | Indications/Mechanisms | Potential Adverse Effects | Nursing Considerations |
|---|---|---|---|
| **Inhaled Corticosteroids (ICs)**<br>beclomethasone dipropionate (QVAR)<br>beclomethasone (Beconase-AQ)<br>budesonide (Pulmicort)<br>ciclesonide (Alvesco)<br>flunisolide (AeroBid)<br>fluticasone (Flovent)<br>mometasone furoate (Asmanex)<br>triamcinolone acetonide (Azmacort) | *Indications*<br>Long-term prevention of symptoms; suppression, control, and reversal of inflammation<br>Reduce need for oral corticosteroid.<br><br>*Mechanisms*<br>Anti-inflammatory. Block late reaction to allergen and reduce airway hyperresponsiveness.<br>Inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation. Reverse beta-2 receptor down-regulation. Inhibit microvascular leakage. | Cough, dysphonia, oral thrush (candidiasis), headache.<br>In high doses, systemic effects may occur (eg, adrenal suppression, osteoporosis, skin thinning, and easy bruising). | Instruct patient in correct use of metered-dose inhaler (MDI) and use of spacer/holding chamber devices.<br>Instruct patient to rinse mouth after inhalation to reduce local side effects. |
| **Systemic Corticosteroids**<br>methylprednisolone (Medrol)<br>prednisolone (Prelone)<br>prednisone (Deltasone, Orasone) | *Indications*<br>For short-term (3–10 days) "burst": to gain prompt control of inadequately controlled persistent asthma.<br>For long-term prevention of symptoms in severe persistent asthma: suppression, control, and reversal of inflammation.<br><br>*Mechanisms*<br>Same as inhaled corticosteroids. | Short-term use: reversible abnormalities in glucose metabolism, increased appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer, and rarely aseptic necrosis.<br>Long-term use: adrenal axis suppression, growth suppression, dermal thinning, hypertension, diabetes, Cushing's syndrome, cataracts, muscle weakness, and—in rare instances—impaired immune function.<br>Consideration should be given to comorbidities that could be worsened by systemic corticosteroids. | Instruct patient about possible side effects and the importance of taking the medication as prescribed (usually a single dose in the morning daily or on an alternate-day schedule, which may produce less adrenal suppression). |
| **Long-Acting Beta$_2$-Agonists (LABAs)**<br>*Inhaled:*<br>salmeterol (Serevent Diskus)<br>formoterol (Foradil Aerolizer) | *Indications*<br>Long-term prevention of symptoms, added to ICS.<br>Prevention of exercise-induced bronchospasm.<br><br>*Mechanisms*<br>Bronchodilation. Smooth muscle relaxation following adenylate cyclase activation and increase incyclic AMP, producing functional antagonism of bronchoconstriction.<br>Compared to SABA, salmeterol (but not formoterol) has slower onset of action (15–30 min). Both salmeterol and formoterol have longer duration (>12 h) compared to SABA. | Should *not* be used to treat acute symptoms or exacerbations.<br>Decreased protection against exercise-induced bronchospasm may occur with regular use.<br>Tachycardia, muscle tremor, hypokalemia, ECG changes with overdose. A diminished bronchoprotective effect may occur within 1 wk of chronic therapy.<br>Potential risk of uncommon, severe, life-threatening or fatal exacerbation. | Reinforce to patient that these medications should *not* be used to treat acute asthma symptoms or exacerbations.<br>Instruct patient about correct use of MDI or aerolizer inhaler. |
| *Oral:*<br>albuterol (Proventil) sustained-release | | Inhaled route is preferred to oral route because LABAs are longer acting and have fewer side effects than oral sustained-release agents. | |
| **Methylxanthines**<br>theophylline (Theo-Dur) sustained-release tablets and capsules | *Indications*<br>Long-term control and prevention of symptoms in mild persistent asthma or as adjunctive with ICS, in moderate or persistent asthma. | Dose-related acute toxicities include tachycardia, nausea and vomiting, tachyarrhythmias (SVT), central nervous system stimulation, headache, seizures, hematemesis, hyperglycemia, and hypokalemia. | Maintain steady-state serum concentrations between 5 and 15 μg/mL. |

*Continued*

**Table 24-3 LONG-TERM MEDICATIONS FOR TREATMENT OF ASTHMA (CONTROLLER MEDICATIONS) (Continued)**

| Medication | Indications/Mechanisms | Potential Adverse Effects | Nursing Considerations |
|---|---|---|---|
| | *Mechanisms*<br>Bronchodilation. Smooth muscle relaxation from phosphodiesterase inhibition and possibly adenosine antagonism.<br>May affect eosinophilic infiltration into bronchial mucosa as well as decrease T-lymphocyte numbers in epithelium.<br>Increases diaphragm contractility and mucociliary clearance. | Adverse effects at usual therapeutic doses include insomnia, gastric upset, aggravation of ulcer or reflux, difficulty in urination in elderly males who have prostatism.<br>Not generally recommended for exacerbations. There is minimal evidence for added benefit to optimal doses of SABA. Serum concentration monitoring is mandatory.<br>Available as sustained-release tablets and capsules. | Absorption and metabolism may be affected by numerous factors that can produce significant changes in steady-state serum theophylline concentrations.<br>Instruct patients to discontinue if they experience toxicity.<br>Inform patients about the importance of blood tests to monitor serum concentration.<br>Instruct patient to check with primary health care provider before taking any new medication. |
| **Combined Medication** | | | |
| fluticasone/salmeterol (Advair) | DPI<br>100 μg/50 μg<br>250 μg/50 μg<br>500 μg/50 μg | Lowest dose of DPI or HFA used for patients whose asthma is not controlled on low- to medium-dose ICS. | |
| | HFA<br>45 μg/21 μg<br>115 μg/21 μg<br>230 μg/21 μg | Higher doses of DPI or HFA used for patients whose asthma is not controlled on medium- to high-dose ICS. | |
| budesonide/formoterol (Symbicort) | HFA MDI<br>80 μg/4.5 μg<br>160 μg/4.5 μg | Lower dose used for patients who have asthma not controlled on low- to medium-dose ICS.<br>Higher dose used for patients who have asthma not controlled on medium- to high-dose ICS. | |
| **Cromolyn and Nedocromil** | | | |
| Cromolyn sodium (Intal)<br>nedocromil (Tilade) | *Indications*<br>Long-term prevention of symptoms in mild persistent asthma; may modify inflammation.<br>Preventive treatment prior to exposure to exercise or known allergen.<br><br>*Mechanisms*<br>Anti-inflammatory. Blocks *early* and late reaction to allergen.<br>Stabilizes mast cell membranes and inhibits activation and release of mediators from eosinophils and epithelial cells.<br>Inhibits acute response to exercise, cold dry air, and $SO_2$. | Cough and irritation.<br>15–20% of patients complain of an unpleasant taste from nedocromil.<br>Dose of cromolyn by MDI may be inadequate to affect airway hyperresponsiveness.<br>Nebulizer delivery may be preferred for some patients.<br>Safety is the primary advantage of these agents.<br>One dose before exercise or exposure to allergen provides effective prophylaxis for 1–2 h. Not as effective for exercise-induced bronchospasm as short-acting $beta_2$-agonist. | Inform patient that 4–6-wk trial may be needed to determine maximum benefit.<br>Instruct patient about correct use of inhaler. |
| **Leukotriene Modifiers** | | | |
| Leukotriene Receptor Antagonists<br>montelukast (Singulair) | *Mechanism*<br>Selective competitive inhibitor of CysLT1 receptor.<br><br>*Indications*<br>Long-term control and prevention of symptoms in mild persistent asthma for patients ≥1 yr of age.<br>May also be used with ICS as combination therapy in moderate persistent asthma. | May attenuate EIB in some patients, but less effective than ICS therapy.<br><br>LTRA + LABA should not be used as a substitute for ICS + LABA.<br>No specific adverse effects have been identified.<br>Available in tablets and granules. | Instruct patient to take at least 1 h before meals or 2 h after meals.<br><br>Inform patient that zafirlukast can inhibit the metabolism of warfarin. INRs should be monitored if patient is taking both medications. |
| zafirlukast (Accolate) | Long-term control and prevention of symptoms in mild persistent asthma. May also be used with ICS as combination therapy in moderate persistent asthma. | Cases of reversible hepatitis have been reported along with rare cases of irreversible hepatic failure resulting in death and liver transplantation.<br>Available in tablets. | Instruct patients to discontinue use if they experience signs and symptoms of liver dysfunction (right upper quadrant pain, pruritus, lethargy, jaundice, nausea), and to notify their primary health care provider. |

*Continued on following page*

**Table 24-3 LONG-TERM MEDICATIONS FOR TREATMENT OF ASTHMA (CONTROLLER MEDICATIONS) (Continued)**

| Medication | Indications/Mechanisms | Potential Adverse Effects | Nursing Considerations |
|---|---|---|---|
| **5-Lipoxygenase Inhibitor**<br>zileuton (Zyflo) | *Mechanism*<br>Inhibits the production of leukotrienes from arachidonic acid, both LTB and the cysteinyl leukotrienes.<br>*Indications*<br>Long-term control and prevention of symptoms in mild persistent asthma for patients.<br>May be used with ICS as combination therapy in moderate persistent asthma in patients. | Elevation of liver enzymes has been reported. Limited case reports of reversible hepatitis and hyperbilirubinemia. | Inform patient that zileuton can inhibit the metabolism of warfarin and theophylline. Therefore, the doses of these medications should be monitored accordingly.<br>Teach patient the importance of monitoring medication levels and tests of liver function. |
| **Immunomodulators**<br>omalizumab (Xolair) | *Indications*<br>Long-term control and prevention of symptoms in adults with moderate or severe persistent allergic asthma inadequately controlled with ICS.<br>*Mechanisms*<br>Monoclonal antibody (anti-IgE) that binds to circulating IgE, preventing it from binding to the high-affinity receptors on basophils and mast cells.<br>Decreases mast cell mediator release from allergen exposure. | Administered by subcutaneous injection.<br>Anaphylaxis has been reported in 0.2% of treated patients.<br>Pain, bruising and skin reactions (itching, redness, stinging) at injection sites.<br>The dose is administered either every 2 or 4 wk and is dependent on the patient's body weight and IgE level before therapy.<br>A maximum of 150 mg can be administered in one injection.<br>Medication needs to be stored under refrigeration at 2–8°C.<br>It is unknown if patients will develop significant antibody titers to the drug with long-term administration. | Monitor patients for allergic reactions or anaphylaxis following administration.<br>Be prepared to initiate emergency treatment if anaphylaxis occurs.<br>Instruct patient about signs and symptoms that indicate allergic reaction and immediate action to take.<br>Remind patient to continue to take other medications prescribed for treatment of asthma. |

AMP, 3′,5′-adenosine monophosphate; DPI, dry powder inhaler; ECG, electrocardiogram; EIB, exercise-induced bronchospasm; HFA, hydrofluoroalkane; ICS, inhaled corticosteroid; INR, international normalized ratio; LTB, leukotriene B; LTRA, leukotriene receptor antagonist; SABA, inhaled short-acting beta$_2$-agonist; SVT, supraventricular tachycardia.

usually used in addition to inhaled corticosteroids, mainly for relief of nighttime asthma symptoms. Salmeterol (Serevent) and formoterol (Foradil) have a duration of bronchodilation for at least 12 hours. They are used with other medications in long-term control of asthma.

*Leukotriene modifiers (inhibitors)*, or *antileukotrienes*, are a class of medications that include montelukast (Singulair), zafirlukast (Accolate), and zileuton (Zyflo). Leukotrienes, which are synthesized from membrane phospholipids through a cascade of enzymes, are potent bronchoconstrictors that also dilate blood vessels and alter permeability. Leukotriene inhibitors act either by interfering with leukotriene synthesis or by blocking the receptors where leukotrienes exert their action. They may provide an alternative to inhaled corticosteroids for mild persistent asthma, or they may be added to a regimen of inhaled corticosteroids in more severe asthma to attain further control.

*Immunomodulators* prevent binding of IgE to the high-affinity receptors of basophils and mast cells. Omalizumab (Xolair) is a monoclonal antibody and may be used for patients with allergies and severe persistent asthma.

### Management of Exacerbations

Asthma exacerbations are best managed by early treatment and education, including the use of written action plans as part of any overall effort to educate patients about self-management techniques, especially those with moderate or severe persistent asthma or with a history of severe exacerbations (Expert Panel Report 3, 2007). Quick-acting beta$_2$-adrenergic agonist medications are first used for prompt relief of airflow obstruction. Systemic corticosteroids may be necessary to decrease airway inflammation in patients who fail to respond to inhaled beta-adrenergic medications. In some patients, oxygen supplementation may be required to relieve hypoxemia associated with moderate to severe exacerbations. In addition, response to treatment may be monitored by serial measurements of lung function.

Evidence from clinical trials suggests that antibiotic therapy, whether administered routinely or when suspicion

**Table 24-4 QUICK-RELIEF MEDICATIONS FOR TREATMENT OF ASTHMA**

| Medication | Indications/Mechanisms | Potential Adverse Effects | Nursing Considerations |
|---|---|---|---|
| **Inhaled Short-Acting Beta$_2$-Agonists (SABAs)** | | | |
| albuterol (Proventil HFA, Ventolin HFA)<br>levalbuterol HFA (Xopenex)<br>pirbuterol CFC (Maxair)<br>metaproterenol sulfate (Alupent) | *Indications:*<br>Relief of acute symptoms; quick-relief medication.<br>Preventive treatment for exercise-induced bronchospasm.<br><br>*Mechanisms:*<br>Bronchodilation. Binds to the beta-2 adrenergic receptor, producing smooth muscle relaxation and decreased bronchoconstriction. | Tachycardia, muscle tremor, hypokalemia, increased lactic acid, headache, and hyperglycemia. Inhaled route causes few systematic adverse effects. Patients with preexisting cardiovascular disease, especially the elderly, may have adverse cardiovascular reactions with inhaled therapy.<br>Lack of effect or need for regular use indicates inadequate asthma control. | Patients need to be instructed in correct use of inhaled agents and understanding of how to evaluate amount of remaining medication in MDI.<br>Periodic cleaning of device recommended.<br>Patient is informed about possible side effects and need to inform health care provider about increased use of medication to control symptoms. |
| **Anticholinergics** | | | |
| ipratropium (Atrovent) | *Indications:*<br>Relief of acute bronchospasm.<br><br>*Mechanisms:*<br>Bronchodilation. Inhibition of muscarinic cholinergic receptors.<br>Reduction of vagal tone of airways.<br>May decrease mucous gland secretion. | Dryness of mouth and respiratory secretions. May cause increased wheezing in some patients.<br>Does not block exercise-induced bronchospasm.<br>Is not effective in long-term control of asthma. | Instruct patient in correct use of inhaled agents.<br>Ensure adequate fluid intake.<br>Assess patient for hypersensitivity to atropine, soybeans, peanuts; glaucoma, prostatic hypertrophy. |
| **Corticosteroids** | | | |
| Systemic: methylprednisolone (Medrol)<br>prednisolone (Prelone)<br>prednisone (Deltasone, Orasone) | *Indications:*<br>For moderate or severe exacerbations to prevent progression of exacerbation, reverse inflammation, speed recovery, and reduce rate of relapse.<br><br>*Mechanisms:*<br>Anti-inflammatory. Block reaction to allergen and reduce hyperresponsiveness. Inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation. Revers beta-2 receptor down-regulation. | Short-term use: reversible blood glucose abnormalities, increased appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer.<br>Consideration must be given to comorbidities that may be worsened by systemic corticosteroids. | Explain to patient that action is often rapid in onset, although resolution of symptoms may take 3–10 days.<br>Instruct patient about possible side effects and the importance of taking the medication as prescribed. |

CFC, chlorofluracarbons; HFA, hydrofluoroalkane; MDI, metered-dose inhaler.

of bacterial infection is low, is not beneficial for asthma exacerbations (Expert Panel Report 3, 2007). Antibiotics may be appropriate in the treatment of acute asthma exacerbations in patients with comorbid conditions (eg, fever and purulent sputum, evidence of pneumonia, suspected bacterial sinusitis).

Despite insufficient data supporting or refuting the benefits of using a written asthma action plan as compared to medical management alone, the 2007 Expert Panel Report 3 recommends the use of a written asthma action plan to educate patients about self-management (Fig. 24-8). Plans can be based on either symptoms or peak flow measurements. They should focus on daily management as well as the recognition and handling of worsening symptoms. Patient self-management and early recognition of problems lead to more efficient communication with health care providers about asthma exacerbations (Expert Panel Report 3, 2007).

### *Peak Flow Monitoring*

Peak flow meters measure the highest airflow during a forced expiration (Fig. 24-9). Daily peak flow monitoring is recommended for patients who meet one or more of the following criteria: have moderate or severe persistent asthma, have poor perception of changes in airflow or worsening symptoms, have unexplained response to environmental or occupational exposures, or at the discretion of the clinician and patient (Expert Panel Report 3, 2007). If peak flow monitoring is used, it helps measure asthma severity and, when added to symptom monitoring, indicates the current degree of asthma control.

The patient is instructed in the proper technique (Chart 24-6), particularly about using maximal effort; peak flows are monitored for 2 or 3 weeks after receipt of optimal asthma therapy. Then the patient's "personal best" value is measured. The green (80% to 100% of personal best), yellow (60% to 80%), and red (less than 60%) zones are

**Asthma Action Plan**

**For:** ______ **Doctor:** ______ **Date:** ______
**Doctor's Phone Number** ______ **Hospital/Emergency Department Phone Number** ______

**GREEN ZONE**

**Doing Well**
- No cough, wheeze, chest tightness, or shortness of breath during the day or night
- Can do usual activites

**And, if a peak flow meter is used,**
**Peak flow:** more than ______
(80% or more of my best peak flow)
My best peak flow is: ______

**Take these long-term-control medicines each day (include an anti-inflammatory).**

| Medicine | How much to take | When to take it |
|---|---|---|
| ______ | ______ | ______ |
| ______ | ______ | ______ |

**Identify and avoid and control the things that make your asthma worse, like (list here):**
______ ______ ______
______ ______ ______

**Before exercise, if prescribed, take:** □ 2 or □ 4 puffs ______ 5 to 60 minutes before exercise

**YELLOW ZONE**

**Asthma Is Getting Worse**
- Cough, wheeze, chest tightness, or shortness of breath, or
- Waking at night due to asthma, or
- Can do some, but not all, usual activites

**-Or-**
**Peak flow:** ______ to ______
(50% to 79% of my best peak flow)

**First** — **Add: quick-relief medicine—and keep taking your GREEN ZONE medicine.**
______ **(short-acting beta$_2$-agonist)** □ **2 or** □**4 puffs, every 20 minutes for up to 1 hour** □ **Nebulizer, once**

**If applicable, remove yourself from the thing that made your asthma worse.**

**Second** — **If your symptoms (and peak flow, if used) return to GREEN ZONE after 1 hour of above treatment:**
Continue monitoring to be sure you stay in the green zone.
**-Or-**
**If your symptoms (and peak flow, if used) do not return to GREEN ZONE after 1 hour of above treatment:**
□ Take: ______ (short-acting beta$_2$-agonist) □ 2 or □ 4 puffs or □Nebulizer
□ Add: ______ (oral corticosteroid) mg per day For ______ (3-10) days
□ Call the doctor: ______ (phone) ,□before/□ within ____ hours after taking the oral corticosteroid.

**RED ZONE**

**Medical Alert!**
- Very short of breath, or
- Quick-relief medicines have not helped, or
- Cannot do usual activites, or
- Symptoms are same or get worse after 24 hours in Yellow Zone

**-Or-**
**Peak flow:** less than ______
(50% of my best peak flow)

**Take this medicine:**
□ ______ **(short-acting beta$_2$-agonist)** □ **4 or** □**6 puffs or** □ **Nebulizer**
□ ______ **(oral corticosteroid)** **mg**

**Then call your doctor NOW.** Go to the hospital or call an ambulance if:
- You are still in the red zone after 15 minutes AND
- You have not reached your doctor.

**DANGER SIGNS**
- **Trouble walking and talking due to shortness of breath**
- **Lips or fingernails are blue**

→
- **Take** □**4 or** □**6 puffs of your quick-relief medicine AND**
- **Go to the hospital or call for an ambulance** ______ **(phone)** **NOW!**

**Figure 24-8** Asthma action plan. Redrawn from Expert Panel Report 3. (2007). *Guidelines for the diagnosis and management of asthma* (p. 119). NIH Publication Number 08-5846. National Asthma Education and Prevention Program. Bethesda, MD: U.S. Department of Health and Human Services, National Heart, Lung and Blood Institute.

determined, and specific actions are delineated for each zone, enabling the patient to monitor and manipulate his or her own therapy after careful instruction (Expert Panel Report 3, 2007).

The Expert Panel Report 3 (2007) recommends that peak flow monitoring be considered an adjunct to asthma management for patients with moderate to severe persistent asthma. Peak flow monitoring plans may enhance communication between the patient and health care providers and may increase the patient's awareness of disease status and control.

## Nursing Management

The immediate nursing care of patients with asthma depends on the severity of symptoms. The patient may be treated successfully as an outpatient if asthma symptoms are relatively mild or may require hospitalization and intensive care if symptoms are acute and severe. The patient and family are often frightened and anxious because of the patient's dyspnea. Therefore, a calm approach is an important aspect of care. The nurse assesses the patient's respiratory status by monitoring the severity of symptoms, breath sounds, peak flow, pulse oximetry, and vital signs.

The nurse generally performs the following interventions:

- Obtains a history of allergic reactions to medications before administering medications
- Identifies medications the patient is currently taking
- Administers medications as prescribed and monitors the patient's responses to those medications. These medications may include an antibiotic if the patient has an underlying respiratory infection.
- Administers fluids if the patient is dehydrated

If the patient requires intubation because of acute respiratory failure, the nurse assists with the intubation procedure, continues close monitoring of the patient, and keeps the patient and family informed about procedures. Intubation and mechanical ventilation are discussed in Chapter 25.




**Figure 24-9** Peak flow meters measure the highest volume of air flow during a forced expiration (*left*). Volume is measured in color-coded zones (*right*): the green zone signifies 80% to 100% of personal best; yellow, 60% to 80%; and red, less than 60%. If peak flow falls below the red zone, the patient should take the appropriate actions prescribed by his or her health care provider.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

A major challenge is to implement basic asthma management principles at the community level. Strategies include education of health care providers, establishment of programs for asthma education (for patients and providers), use of outpatient follow-up care for patients, and a focus on chronic management versus acute episodic care. Nurses are pivotal to achievement of these objectives.

Patient teaching is a critical component of care for patients with asthma. Multiple inhalers, different types of inhalers, antiallergy therapy, antireflux medications, and avoidance measures are essential for long-term control. This complex therapy requires a partnership between the patient and the health care providers to determine the desired outcomes and to formulate a plan to achieve those outcomes. The patient then carries out daily therapy as part of self-care management, with input and guidance by his or her health care providers. Before a partnership can be established, the patient must understand the following:

- The nature of asthma as a chronic inflammatory disease
- The definitions of inflammation and bronchoconstriction
- The purpose and action of each medication
- Triggers to avoid, and how to do so
- Proper inhalation technique

**CHART 24-6** HOME CARE CHECKLIST
***Use of Peak Flow Meter***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the rationale for using a peak flow meter in asthma management. | ✔ | ✔ |
| • Explain how peak flow monitoring is used along with symptoms to determine severity of asthma. | ✔ | ✔ |
| • Demonstrate steps for using the peak flow meter correctly. | ✔ | |
| • Move the indicator to the bottom of the numbered scale. | ✔ | |
| • Stand up. | ✔ | |
| • Take a deep breath and fill the lungs completely. | ✔ | |
| • Place mouthpiece in mouth and close lips around mouthpiece. (do not put tongue inside opening). | ✔ | |
| • Blow out hard and fast with a single blow. | ✔ | |
| • Record the number achieved on the indicator. If patient coughs or a mistake is made in the process, do it over. | ✔ | |
| • Repeat steps 1–5 two more times and write the highest number in the asthma diary. | ✔ | |
| • Explain how to determine the "personal best" peak flow reading. | ✔ | ✔ |
| • Describe the significance of the color zones for peak flow monitoring. | ✔ | ✔ |
| • Demonstrate how to clean the peak flow meter. | ✔ | ✔ |
| • Discuss how and when to contact the health care provider about changes or decreases in peak flow values. | ✔ | ✔ |

- How to perform peak flow monitoring (see Chart 24-6)
- How to implement an action plan
- When to seek assistance, and how to do so

An assortment of excellent educational materials is available from the NHLBI and other sources. The nurse should obtain current educational materials for the patient based on the patient's diagnosis, causative factors, educational level, and cultural background. If a patient has a coexisting sensory impairment (ie, vision loss or hearing impairment), materials should be provided in an alternative format.

**Continuing Care**

Nurses who have contact with patients in the hospital, clinic, school, or office use the opportunity to assess the patient's respiratory status and ability to manage self-care to prevent serious exacerbations. Nurses emphasize adherence to the prescribed therapy, preventive measures, and the need to keep follow-up appointments with health care providers. Home visits to assess the home environment for allergens may be indicated for patients with recurrent exacerbations. Nurses refer patients to community support groups. In addition, nurses remind patients and families about the importance of health promotion strategies and recommended health screening.

## Status Asthmaticus

Status asthmaticus is severe and persistent asthma that does not respond to conventional therapy. The attacks can occur with little or no warning and can progress rapidly to asphyxiation. Infection, anxiety, nebulizer abuse, dehydration, increased adrenergic blockage, and nonspecific irritants may contribute to these episodes. An acute episode may be precipitated by hypersensitivity to aspirin.

### Pathophysiology

The basic characteristics of asthma (inflammation of bronchial mucosa, constriction of the bronchiolar smooth muscle, and thickened secretions) decrease the diameter of the bronchi and occur in status asthmaticus. The most common scenario is severe bronchospasm, with mucus plugging leading to asphyxia. A ventilation–perfusion abnormality results in hypoxemia. There is a reduced $PaO_2$ and initial respiratory alkalosis, with a decreased $PaCO_2$ and an increased pH. As status asthmaticus worsens, the $PaCO_2$ increases and the pH decreases, reflecting respiratory acidosis.

### Clinical Manifestations

The clinical manifestations are the same as those seen in severe asthma; signs and symptoms include labored breathing, prolonged exhalation, engorged neck veins, and wheezing. However, the extent of wheezing does not indicate the severity of the attack. As the obstruction worsens, the wheezing may disappear; this is frequently a sign of impending respiratory failure.

### Assessment and Diagnostic Findings

Pulmonary function studies are the most accurate means of assessing acute airway obstruction. Arterial blood gas measurements are obtained if the patient cannot perform pulmonary function maneuvers because of severe obstruction or fatigue, or if the patient does not respond to treatment. Respiratory alkalosis (low $PaCO_2$) is the most common finding in patients with asthma.

*NURSING ALERT*

**Frequently, increasing $PaCO_2$ (to normal levels or levels indicating respiratory acidosis) is a danger sign signifying impending respiratory failure.**

### Medical Management

Close monitoring of the patient and objective reevaluation for response to therapy are key in status asthmaticus. In the emergency setting, the patient is treated initially with a short-acting beta$_2$-adrenergic agonist and subsequently a short course of systemic corticosteroids, especially if the patient does not respond to the short-acting beta$_2$-adrenergic agonist. Corticosteroids are critical in the therapy of status asthmaticus and are used to decrease the intense airway inflammation and swelling. Short-acting inhaled beta$_2$-adrenergic agonists provide the most rapid relief from bronchospasm. An MDI with or without a spacer may be used for nebulization of the medications. The patient usually requires supplemental oxygen and intravenous (IV) fluids for hydration. Oxygen therapy is initiated to treat dyspnea, central cyanosis, and hypoxemia. High-flow supplemental oxygen is best delivered using a partial or complete nonrebreather mask with the objective of maintaining the $PaO_2$ at a minimum of 92 mm Hg or $O_2$ saturation greater than 95%. Sedatives are contraindicated. Magnesium sulfate, a calcium antagonist, may be administered to induce smooth muscle relaxation; the magnesium can relax smooth muscle and hence cause bronchodilation by competing with calcium at calcium-mediated smooth muscle binding sites. Adverse effects of magnesium sulfate may include facial warmth, flushing, tingling, nausea, central nervous system depression, respiratory depression, and hypotension.

If there is no response to repeated treatments, hospitalization is required. Other criteria for hospitalization include poor pulmonary function test results and deteriorating blood gas levels (respiratory acidosis), which may indicate that the patient is tiring and will require mechanical ventilation. Most patients do not need mechanical ventilation, but it is used for patients in respiratory failure, for those who tire and are too fatigued by the attempt to breathe, and for those whose condition does not respond to initial treatment.

Death from asthma is associated with several risk factors, including the following (Expert Panel Report 3, 2007):

- Past history of severe exacerbation (eg, intubation or intensive care unit admission)
- Two or more hospitalizations for asthma within the past year
- Three or more emergency care visits for asthma in the past year
- Hospitalization or emergency care visit for asthma in the past month
- Use of more than two canisters of short-acting beta-agonist inhalers per month

- Difficulty in perceiving asthma symptoms or severity of exacerbations
- Lack of written asthma action plan
- Concurrent cardiovascular disease, COPD, or chronic psychiatric disease
- Low socioeconomic status or inner-city residence
- Illicit drug use

### Nursing Management

The main focus of nursing management is to actively assess the airway and the patient's response to treatment. The nurse should be prepared for the next intervention if the patient does not respond to treatment.

The nurse constantly monitors the patient for the first 12 to 24 hours, or until status asthmaticus is under control. The nurse also assesses the patient's skin turgor for signs of dehydration. Fluid intake is essential to combat dehydration, to loosen secretions, and to facilitate expectoration. Nurses administer IV fluids as prescribed, up to 3 to 4 L/day, unless contraindicated. Blood pressure and cardiac rhythm should be monitored continuously during the acute phase and until the patient stabilizes and responds to therapy. The patient's energy needs to be conserved, and his or her room should be quiet and free of respiratory irritants, including flowers, tobacco smoke, perfumes, or odors of cleaning agents. Nonallergenic pillows should be used.

## Cystic Fibrosis

Cystic fibrosis (CF) is the most common fatal autosomal recessive disease among the Caucasian population. A person must inherit a defective copy of the CF gene (one from each parent) to have CF. One in 31 Americans is an unknowing carrier of this gene, and approximately 30,000 children and adults in the United States have CF (Cystic Fibrosis Foundation, 2007). CF is less frequently found among Hispanic, Asian, and African Americans. CF was once considered a fatal childhood disease, but the median expected survival age is now 37 years (Flume, O'Sullivan, Robinson, et al., 2007). Patients' quality of life has also improved.

This multisystem genetic disease is usually diagnosed in infancy or early childhood but may be diagnosed later in life. Respiratory symptoms are frequently the major manifestation of CF when it is diagnosed later in life. However, a good number of patients will not demonstrate the classic symptoms of CF, which may potentially cause a diagnostic dilemma (Boyle, 2007).

### Pathophysiology

CF is caused by mutations or dysfunction in the protein cystic fibrosis transmembrane conductance regulator (CFTR), which normally transports chloride ions across epithelial cell membranes. Gene mutations affect transport of these ions, leading to CF, which is characterized by thick, viscous secretions in the lungs, pancreas, liver, intestine, and reproductive tract as well as increased salt content in sweat gland secretions. More than 1500 mutations of the *CFTR* gene have been identified, thus creating multiple variations in presentation and progression of the disease (Boyle, 2007).

The ability to detect the common mutations of this gene allows for routine screening for CF and the detection of carriers of the disease. Genetics counseling is an important part of health care for couples at risk. People who are heterozygous for CF (ie, have one defective gene and one normal gene) do not have the disease but can be carriers and pass the defective gene on to their children. If both parents are carriers, their risk of having a child with CF is one in four (25%) with each pregnancy. Genetic testing should be offered to adults with a positive family history of CF and to partners of people with CF who are planning a pregnancy or seeking prenatal counseling. Currently, genetic testing for CF is not recommended for the general population.

The hallmark pathology of CF is bronchial mucus plugging, inflammation, and eventual bronchiectasis. Commonly, the bronchiectasis begins in the upper lobes and progresses to involve all lobes. Progressive loss of lung function averaging from 1% to 4% per year begins in the teenage years (Boyle, 2007).

### Clinical Manifestations

The pulmonary manifestations of CF include a productive cough, wheezing, hyperinflation of the lung fields on chest x-ray, and pulmonary function test results consistent with obstructive disease of the airways. Chronic respiratory inflammation and infection are caused by impaired mucus clearance. Colonization of the airways with pathogenic bacteria usually occurs early in life. *Staphylococcus aureus* and *H. influenzae* are common organisms during early childhood. As the disease progresses, *Pseudomonas aeruginosa* is ultimately isolated from the sputum of most patients. Upper respiratory manifestations of the disease include sinusitis and nasal polyps.

Nonpulmonary manifestations include gastrointestinal problems (eg, pancreatic insufficiency, recurrent abdominal pain, biliary cirrhosis, vitamin deficiencies, recurrent pancreatitis, weight loss), CF-related diabetes, genitourinary problems (male and female infertility), and clubbing of the digits (fingers and toes). (See Chapter 40 for a discussion of pancreatitis.)

### Assessment and Diagnostic Findings

The diagnosis of CF requires a clinical picture consistent with the CF phenotype and laboratory evidence of *CFTR* dysfunction. The consensus statement of the Cystic Fibrosis Foundation on the diagnosis of CF identifies key aspects of the phenotype (Boyle, 2007):

- Chronic sinopulmonary disease as manifested by chronic cough and sputum production, persistent infection consistent with typical CF pathogens, and x-ray evidence of bronchiectasis and chronic sinusitis, often with nasal polyps
- Gastrointestinal tract and nutritional abnormalities (pancreatic insufficiency, meconium ileus or distal intestinal obstruction syndrome, failure to thrive or chronic malnutrition)
- Male urogenital problems as manifested by congenital bilateral absence of the vas deferens and obstructive azoospermia

### Medical Management

CF requires both acute and chronic therapy. Because chronic bacterial infection of the airways occurs in CF, control of infections is essential to treatment. For acute airway

exacerbations, aggressive therapy involves airway clearance and antibiotics based on results of sputum cultures. The majority of patients are colonized with *P. aeruginosa,* and antibiotics are usually given for 14 to 21 days. Because patients with CF may be infected with bacteria that are resistant to multiple antibiotics, they may require several courses of antibiotic agents over long periods. In an acute exacerbation, airway clearance treatments may be used three to four times per day.

For chronic disease, the therapeutic options for CF have undergone tremendous changes. Cornerstones of treatment include airway clearance measures, mucolytic dornase alpha, nebulized antibiotics, oral antibiotics, inhaled hypertonic saline, nutritional support, and exercise (Boyle, 2007).

Airway clearance is a key intervention in the care of patients with CF, and various pulmonary techniques are used to enhance secretion clearance. Examples include manual postural drainage and chest physical therapy, high-frequency chest wall oscillation, autogenic drainage (a combination of breathing techniques at different lung volume levels to move the secretions to where they can be "huff"-coughed out), and other devices that assist in airway clearance, such as masks that generate positive expiratory pressure (PEP masks) and "flutter devices" (devices that provide an oscillatory expiratory pressure pattern with positive expiratory pressure and assist with expectoration of secretions).

Dornase alpha (Pulmozyme) is a nebulized medication administered to degrade the large amount of deoxyribonucleic acid (DNA) that accumulates within CF mucus. This agent helps decrease the viscosity of the sputum and promotes expectoration of secretions. It is recommended for patients with moderate to severe disease (severity of lung disease classification is based on predicted $FEV_1$ percentage) (Flume, et al., 2007).

Nebulized antibiotics include tobramycin (TOBI), colistin (Colimycin), gentamicin (Garamycin), and ceftazidime (Fortaz, Ceptaz) (Flume, et al., 2007). Inhaled antibiotics provide the advantage of high intrapulmonary drug concentrations and minimal systemic absorption.

Acute infections are treated with a variety of antibiotics. Such infections remain a major cause of mortality related to pulmonary exacerbations in adults with CF (Elpern, Patel & Balk, 2007). Antibiotics such as the macrolide azithromycin (Zithromax) may also be used. Inhaled hypertonic saline may also be used in the chronic treatment of CF. Inhalations increase hydration of the airway surface liquid in patients with CF and improve airway clearance. Regular inhalations have been shown to improve $FEV_1$ and decreased frequency of pulmonary exacerbations (Boyle, 2007).

Approximately 90% of patients with CF have pancreatic exocrine insufficiency and require oral pancreatic enzyme supplementation with meals (Boyle, 2007). Given the fat malabsorption in CF and increased caloric needs due to the work of breathing, nutritional counseling and monitoring of weight are extremely important. Supplements of fat-soluble vitamins A, D, E, and K are necessary (Boyle, 2007).

Other therapeutic measures may also be necessary. Anti-inflammatory agents may also be used to treat inflammatory response in the airways. The Cystic Fibrosis Foundation states that there is insufficient evidence for the use of routine inhaled or oral corticosteroids. However, chronic use of nonsteroidal anti-inflammatory agents is recommended to slow the loss of lung function (Flume, et al., 2007). Inhaled bronchodilators may be used in patients who have a significant bronchoconstrictive component as indicated by spirometry pre– and post–bronchodilator therapy.

Supplemental oxygen is used to treat the progressive hypoxemia that occurs with CF. It helps correct the hypoxemia and may minimize the complications seen with chronic hypoxemia (pulmonary hypertension).

Lung transplantation is an option for a small, selected population of patients with CF. A double-lung transplantation technique is used because of chronic infection of both lungs in end-stage CF. Because there is a long waiting list for lung transplants, many patients die while waiting for suitable lungs for transplantation.

## Nursing Management

Nursing management is crucial to the interdisciplinary approach required for care of adults with CF. Nursing care includes helping patients manage pulmonary symptoms and prevent complications of CF. Specific measures include strategies that promote removal of pulmonary secretions; chest physiotherapy (including postural drainage, chest percussion, and vibration); and breathing exercises, which are implemented and are taught to the patient and family when the patient is very young. The patient is reminded of the need to reduce risk factors associated with respiratory infections (eg, exposure to crowds or to people with known infections). In addition, the patient is taught the early signs and symptoms of respiratory infection and disease progression that indicate the need to notify a primary health care provider.

Nurses emphasize the importance of an adequate fluid and dietary intake to promote removal of secretions and to ensure an adequate nutritional status. Because CF is a lifelong disorder, patients often have learned to modify their daily activities to accommodate their symptoms and treatment modalities. However, as the disease progresses, assessment of the home environment may be warranted to identify modifications required to address changes in the patient's needs, increasing dyspnea and fatigue, and nonpulmonary symptoms.

As with any chronic disease, palliative care and end-of-life issues and concerns need to be addressed with the patient when warranted. For the patient whose disease is progressing and who is developing increasing hypoxemia, preferences for end-of-life care should be discussed, documented, and honored (see Chapter 17). Patients and family members require support as they face a shortened lifespan and an uncertain future.

## CRITICAL THINKING EXERCISES

**1** A 71-year-old white man presents to the clinic for follow-up of end-stage COPD and weight loss. He has been seen regularly for 5 years in the clinic, and his wife usually accompanies him. Today he is anxious and short of breath. He is receiving supplemental oxygen at 2 L/min, and his wife states he is unable to lie flat to sleep. What tests or examinations might be appropriate to assess the severity of his shortness of breath, oxygenation status, and

inability to lie flat? What information or tests would be helpful in assessing his weight loss? What are potential causes and interventions for his weight loss?

EBP **2** A 68-year-old retired businessman with COPD reports that he has been using continuous oxygen for the past 5 years. He reports increasing shortness of breath and asks you to increase his oxygen flow. How do you respond to his request? What evidence base would you use to determine your intervention? How would you determine the strength of the evidence?

EBP **3** A 35-year-old Mexican American single mother presents to the emergency department extremely short of breath. She is only able to speak in short phrases in broken English and is extremely anxious. It is noted in her chart that she has been in the hospital three times in the past year for asthma exacerbations. What are the key aspects of your physical examination, and what laboratory tests might you anticipate? What treatments may be used? What other aspects of care of this patient are important to assess and what resources may be necessary? Identify evidence-based interventions for this patient and the evidence used to select those interventions.

**4** A 46-year-old woman newly diagnosed with asthma has come to your clinic for the first time. She is a smoker and has had asthmatic symptoms for the last 36 hours. Previous diagnoses have included acute bronchitis, sinusitis, and GERD. She has been prescribed a short-acting bronchodilator via inhaler and a long-acting medication with a return appointment in 1 month. What key educational topics need to be covered during this initial clinic visit? Describe an educational plan you would develop to implement at her next clinic visit.

**5** A 21-year-old male college student with CF is admitted to your unit from the emergency department. He obtains his routine CF care closer to home. He has become progressively short of breath over the past week, and his roommate accompanied him to the hospital. In short and choppy phrases, the young man tells you that he is extremely short of breath; he is having paroxysms of coughing. You note the cough is productive of thick, yellow sputum. His roommate says that he has not been following his usual routine of CF care (airway clearance and nebulized medications) for the past 2 weeks. What pathophysiology is associated with these signs and symptoms? What medical and nursing interventions might be used to decrease or alleviate these signs and symptoms? What members of the health care team would you consult and why?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*


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## RESOURCES

Agency for Healthcare Research and Quality, www.ahrq.gov or www.ahcpr.gov
Alpha-1 Association, www.alpha1.org
American Academy of Allergy, Asthma, and Immunology, www.aaaai.org
American Association for Respiratory Care, www.aarc.org
American Association of Cardiovascular and Pulmonary Rehabilitation, www.aacvpr.org
American College of Chest Physicians, www.chestnet.org
American Lung Association, www.lungusa.org.
American Thoracic Society, www.thoracic.org
Centers for Disease Control and Prevention, www.cdc.gov
Cystic Fibrosis Foundation, www.cff.org
National Heart, Lung and Blood Institute, www.nhlbi.nih.gov
Respiratory Nursing Society, www.respiratorynursingsociety.org
U.S. Department of Health and Human Services, Department of Health and Human Services, www.hhs.gov or www.healthfinder.gov



chapter 25

# Respiratory Care Modalities

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the nursing management for patients receiving oxygen therapy, intermittent positive-pressure breathing, mini-nebulizer therapy, incentive spirometry, chest physiotherapy, and breathing retraining.
2. Describe the patient education and home care considerations for patients receiving oxygen therapy.
3. Describe the nursing care for a patient with an endotracheal tube and for a patient with a tracheostomy.
4. Demonstrate the procedure of tracheal suctioning.
5. Use the nursing process as a framework for care of patients who are mechanically ventilated.
6. Describe the process of weaning the patient from mechanical ventilation.
7. Describe the significance of preoperative nursing assessment and patient teaching for the patient who is going to have thoracic surgery.
8. Explain the principles of chest drainage and the nursing responsibilities related to the care of the patient with a chest drainage system.
9. Describe the patient education and home care considerations for patients who have had thoracic surgery.

## GLOSSARY

**airway pressure release ventilation (APRV):** mode of mechanical ventilation that allows unrestricted, spontaneous breaths throughout the ventilatory cycle; on inspiration patient receives preset level of continuous positive airway pressure, and pressure is periodically released to aid expiration

**assist–control ventilation (A/C):** mode of mechanical ventilation in which the patient's breathing pattern may trigger the ventilator to deliver a preset tidal volume; in the absence of spontaneous breathing, the machine delivers a controlled breath at a preset minimum rate and tidal volume

**chest drainage system:** use of a chest tube and closed drainage system to re-expand the lung and to remove excess air, fluid, and blood

**chest percussion:** manually cupping over the chest wall to mobilize secretions by mechanically dislodging viscous or adherent secretions in the lungs

**chest physiotherapy (CPT):** therapy used to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles; types include postural drainage, chest percussion, and vibration

## GLOSSARY *(Continued)*

**continuous positive airway pressure (CPAP):** positive pressure applied throughout the respiratory cycle to a spontaneously breathing patient to promote alveolar and airway stability; may be administered with endotracheal or tracheostomy tube or by mask

**controlled ventilation:** mode of mechanical ventilation in which the ventilator completely controls the patient's ventilation according to preset tidal volumes and respiratory rate; because of problems with synchrony, it is rarely used except in paralyzed or anesthetized patients

**endotracheal intubation:** insertion of a breathing tube through the nose or mouth into the trachea

**fraction of inspired oxygen ($FiO_2$):** concentration of oxygen delivered (1.0 = 100% oxygen)

**hypoxemia:** decrease in arterial oxygen tension in the blood

**hypoxia:** decrease in oxygen supply to the tissues and cells

**incentive spirometry:** method of deep breathing that provides visual feedback to help the patient inhale deeply and slowly and achieve maximum lung inflation

**intermittent mandatory ventilation (IMV):** mode of mechanical ventilation that provides a combination of mechanically assisted breaths and spontaneous breaths

**mechanical ventilator:** a positive- or negative-pressure breathing device that supports ventilation and oxygenation

**pneumothorax:** partial or complete collapse of the lung due to positive pressure in the pleural space

**positive end-expiratory pressure (PEEP):** positive pressure maintained by the ventilator at the end of exhalation (instead of a normal zero pressure) to increase functional residual capacity and open collapsed alveoli; improves oxygenation with lower fraction of inspired oxygen

**postural drainage:** positioning the patient to allow drainage from all the lobes of the lungs and airways

**pressure support ventilation (PSV):** mode of mechanical ventilation in which preset positive pressure is delivered with spontaneous breaths to decrease work of breathing

**proportional assist ventilation (PAV):** mode of mechanical ventilation that provides partial ventilatory support in proportion to the patient's inspiratory efforts; decreases the work of breathing

**respiratory weaning:** process of gradual, systematic withdrawal or removal of ventilator, breathing tube, and oxygen

**synchronized intermittent mandatory ventilation (SIMV):** mode of mechanical ventilation in which the ventilator allows the patient to breathe spontaneously while providing a preset number of breaths to ensure adequate ventilation; ventilated breaths are synchronized with spontaneous breathing

**thoracotomy:** surgical opening into the chest cavity

**tracheostomy tube:** indwelling tube inserted directly into the trachea to assist with ventilation

**tracheotomy:** surgical opening into the trachea

**vibration:** a type of massage administered by quickly tapping the chest with the fingertips or alternating the fingers in a rhythmic manner, or by using a mechanical device to assist in mobilizing lung secretions

Numerous treatment modalities are used when caring for patients with various respiratory conditions. The choice of modality is based on the oxygenation disorder and whether there is a problem with gas ventilation, diffusion, or both. Therapies range from simple and noninvasive (oxygen and nebulizer therapy, chest physiotherapy, breathing retraining) to complex and highly invasive treatments (intubation, mechanical ventilation, surgery). Assessment and management of the patient with respiratory disorders are best accomplished when the approach is multidisciplinary and collaborative.

# NONINVASIVE RESPIRATORY THERAPIES

## Oxygen Therapy

Oxygen therapy is the administration of oxygen at a concentration greater than that found in the environmental atmosphere. At sea level, the concentration of oxygen in room air is 21%. The goal of oxygen therapy is to provide adequate transport of oxygen in the blood while decreasing the work of breathing and reducing stress on the myocardium.

Oxygen transport to tissues depends on factors such as cardiac output, arterial oxygen content, concentration of hemoglobin, and metabolic requirements. These factors must be kept in mind when oxygen therapy is considered. (Respiratory physiology and oxygen transport are discussed in Chapter 21.)

### Indications

A change in the patient's respiratory rate or pattern may be one of the earliest indicators of the need for oxygen therapy. These changes may result from hypoxemia or hypoxia. **Hypoxemia,** a decrease in the arterial oxygen tension in the blood, is manifested by changes in mental status (progressing through impaired judgment, agitation, disorientation, confusion, lethargy, and coma), dyspnea, increase in blood pressure, changes in heart rate, dysrhythmias, central cyanosis (late sign), diaphoresis, and cool extremities. Hypoxemia usually leads to **hypoxia,** a decrease in oxygen supply to the tissues, which can also be caused by problems outside the respiratory system. Severe hypoxia can be life-threatening.

The signs and symptoms signaling the need for oxygen may depend on how suddenly this need develops. With rapidly developing hypoxia, changes occur in the central nervous system because the higher neurologic centers are very sensitive to oxygen deprivation. The clinical picture may resemble that of alcohol intoxication, with the patient exhibiting lack of coordination and impaired judgment. With long-standing hypoxia (as seen in chronic obstructive pulmonary disease [COPD] and chronic heart failure), fatigue, drowsiness, apathy, inattentiveness, and delayed reaction time may occur. The need for oxygen is assessed by arterial blood gas analysis, pulse oximetry, and clinical evaluation. More information about hypoxia is presented in Chart 25-1.

### Complications

As with other medications, the nurse administers oxygen with caution and carefully assesses its effects on each patient. Oxygen is a medication, and except in emergency situations it is administered only when prescribed by a physician.

### Chart 25-1 • *Types of Hypoxia*

Hypoxia can occur from either severe pulmonary disease (inadequate oxygen supply) or from extrapulmonary disease (inadequate oxygen delivery) affecting gas exchange at the cellular level. The four general types of hypoxia are hypoxemic hypoxia, circulatory hypoxia, anemic hypoxia, and histotoxic hypoxia.

**Hypoxemic Hypoxia**

Hypoxemic hypoxia is a decreased oxygen level in the blood resulting in decreased oxygen diffusion into the tissues. It may be caused by hypoventilation, high altitudes, ventilation–perfusion mismatch (as in pulmonary embolism), shunts in which the alveoli are collapsed and cannot provide oxygen to the blood (commonly caused by atelectasis), and pulmonary diffusion defects. It is corrected by increasing alveolar ventilation or providing supplemental oxygen.

**Circulatory Hypoxia**

Circulatory hypoxia is hypoxia resulting from inadequate capillary circulation. It may be caused by decreased cardiac output, local vascular obstruction, low-flow states such as shock, or cardiac arrest. Although tissue partial pressure of oxygen ($PO_2$) is reduced, arterial oxygen ($PaO_2$) remains normal. Circulatory hypoxia is corrected by identifying and treating the underlying cause.

**Anemic Hypoxia**

Anemic hypoxia is a result of decreased effective hemoglobin concentration, which causes a decrease in the oxygen-carrying capacity of the blood. It is rarely accompanied by hypoxemia. Carbon monoxide poisoning, because it reduces the oxygen-carrying capacity of hemoglobin, produces similar effects but is not strictly anemic hypoxia because hemoglobin levels may be normal.

**Histotoxic Hypoxia**

Histotoxic hypoxia occurs when a toxic substance, such as cyanide, interferes with the ability of tissues to use available oxygen.

In general, patients with respiratory conditions are given oxygen therapy only to increase the arterial oxygen pressure ($PaO_2$) back to the patient's normal baseline, which may vary from 60 to 95 mm Hg. In terms of the oxyhemoglobin dissociation curve (see Chapter 21), the blood at these levels is 80% to 98% saturated with oxygen; higher **fraction of inspired oxygen ($FiO_2$)** flow values add no further significant amounts of oxygen to the red blood cells or plasma. Instead of helping, increased amounts of oxygen may produce toxic effects on the lungs and central nervous system or may depress ventilation (see later discussion).

It is important to observe for subtle indicators of inadequate oxygenation when oxygen is administered by any method. Therefore, the nurse assesses the patient frequently for confusion, restlessness progressing to lethargy, diaphoresis, pallor, tachycardia, tachypnea, and hypertension. Intermittent or continuous pulse oximetry is used to monitor oxygen levels.

#### Oxygen Toxicity

Oxygen toxicity may occur when too high a concentration of oxygen (greater than 50%) is administered for an extended period (longer than 48 hours). It is caused by overproduction

of oxygen free radicals, which are by-products of cell metabolism.

If oxygen toxicity is untreated, these radicals can severely damage or kill cells. Antioxidants such as vitamin E, vitamin C, and beta-carotene may help defend against oxygen free radicals. The dietitian can adjust the patient's diet so that it is rich in antioxidants; supplements are also available for patients who have a decreased appetite or who are unable to eat.

Signs and symptoms of oxygen toxicity include substernal discomfort, paresthesias, dyspnea, restlessness, fatigue, malaise, progressive respiratory difficulty, refractory hypoxemia, alveolar atelectasis, and alveolar infiltrates evident on chest x-rays.

Prevention of oxygen toxicity is achieved by using oxygen only as prescribed. If high concentrations of oxygen are necessary, it is important to minimize the duration of administration and reduce its concentration as soon as possible. Often, **positive end-expiratory pressure (PEEP)** or **continuous positive airway pressure (CPAP)** is used with oxygen therapy to reverse or prevent microatelectasis, thus allowing a lower percentage of oxygen to be used. The level of PEEP that allows the best oxygenation without hemodynamic compromise is known as "best PEEP."

### *Suppression of Ventilation*

In many patients with COPD, the stimulus for respiration is a decrease in blood oxygen rather than an elevation in carbon dioxide levels. The administration of a high concentration of oxygen removes the respiratory drive that has been created largely by the patient's chronic low oxygen tension. The resulting decrease in alveolar ventilation can cause a progressive increase in arterial carbon dioxide pressure ($PaCO_2$). This hypoventilation can, in rare cases, lead to acute respiratory failure secondary to carbon dioxide narcosis, acidosis, and death. Oxygen-induced hypoventilation is prevented by administering oxygen at low flow rates (1 to 2 L/min) and by closely monitoring the respiratory rate and the oxygen saturation as measured by pulse oximetry ($SpO_2$).

### *Other Complications*

Because oxygen supports combustion, there is always a danger of fire when it is used. It is important to post "No Smoking" signs when oxygen is in use. Oxygen therapy equipment is also a potential source of bacterial cross-infection; therefore, the nurse (or respiratory therapist) changes the tubing according to infection control policy and the type of oxygen delivery equipment.

## Methods of Oxygen Administration

Oxygen is dispensed from a cylinder or a piped-in system. A reduction gauge is necessary to reduce the pressure to a working level, and a flow meter regulates the flow of oxygen in liters per minute. When oxygen is used at high flow rates, it should be moistened by passing it through a humidification system to prevent it from drying the mucous membranes of the respiratory tract.

The use of oxygen concentrators is another means of providing varying amounts of oxygen, especially in the home setting. These devices are relatively portable, easy to operate, and cost-effective. However, they require more maintenance than tank or liquid systems and probably cannot deliver oxygen flows in excess of 4 L/min, which provides an $FiO_2$ of about 36%.

Many different oxygen devices are used, and all deliver oxygen if they are used as prescribed and maintained correctly (Table 25-1). The amount of oxygen delivered is expressed as

**Table 25-1 OXYGEN ADMINISTRATION DEVICES**

| Device | Suggested Flow Rate (L/min) | $O_2$ Percentage Setting | Advantages | Disadvantages |
|---|---|---|---|---|
| **Low-Flow Systems** | | | | |
| Cannula | 1–2<br>3–5<br>6 | 23–30<br>30–40<br>42 | Lightweight, comfortable, inexpensive, continuous use with meals and activity | Nasal mucosal drying, variable $FiO_2$ |
| Oropharyngeal catheter | 1–6 | 23–42 | Inexpensive, does not require a tracheostomy | Nasal mucosa irritation; catheter should be changed frequently to alternate nostril |
| Mask, simple | 6–8 | 40–60 | Simple to use, inexpensive | Poor fitting, variable $FiO_2$, must remove to eat |
| Mask, partial rebreather | 8–11 | 50–75 | Moderate $O_2$ concentration | Warm, poorly fitting, must remove to eat |
| Mask, non-rebreather | 12 | 80–100 | High $O_2$ concentration | Poorly fitting, must remove to eat |
| **High-Flow Systems** | | | | |
| Transtracheal catheter | ¼–4 | 60–100 | More comfortable, concealed by clothing, less oxygen liters per minute needed than nasal cannula | Requires frequent and regular cleaning, requires surgical intervention |
| Mask, Venturi | 4–6<br>6–8 | 24, 26, 28<br>30, 35, 40 | Provides low levels of supplemental $O_2$<br>Precise $FiO_2$, additional humidity available | Must remove to eat |
| Mask, aerosol | 8–10 | 30–100 | Good humidity, accurate $FiO_2$ | Uncomfortable for some |
| Tracheostomy collar | 8–10 | 30–100 | Good humidity, comfortable, fairly accurate $FiO_2$ | |
| T-piece | 8–10 | 30–100 | Same as tracheostomy collar | Heavy with tubing |
| Face tent | 8–10 | 30–100 | Good humidity, fairly accurate $FiO_2$ | Bulky and cumbersome |
| **Oxygen Conserving Devices** | | | | |
| Pulse dose (or demand) | 10–40 mL/breath | | Deliver $O_2$ only on inspiration, conserve 50% to 75% of $O_2$ used | Must carefully evaluate function individually |

a percentage concentration (eg, 70%). The appropriate form of oxygen therapy is best determined by arterial blood gas levels, which indicate the patient's oxygenation status.

Oxygen delivery systems are classified as low-flow or high-flow delivery systems. Low-flow systems contribute partially to the inspired gas the patient breathes, which means that the patient breathes some room air along with the oxygen. These systems do not provide a constant or known concentration of inspired oxygen. The amount of inspired oxygen changes as the patient's breathing changes. Examples of low-flow systems include nasal cannula, oropharyngeal catheter, simple mask, partial-rebreather, and non-rebreather masks. In contrast, high-flow systems provide the total inspired air. A specific percentage of oxygen is delivered independent of the patient's breathing. High-flow systems are indicated for patients who require a constant and precise amount of oxygen. Examples of such systems include transtracheal catheters, Venturi masks, aerosol masks, tracheostomy collars, T-pieces, and face tents.

A nasal cannula is used when the patient requires a low to medium concentration of oxygen for which precise accuracy is not essential. This method is relatively simple and allows the patient to move about in bed, talk, cough, and eat without interrupting oxygen flow. Flow rates in excess of 6 to 8 L/min may lead to swallowing of air or may cause irritation and drying of the nasal and pharyngeal mucosa.

The oropharyngeal catheter is rarely used but may be prescribed for short-term therapy to administer low to moderate concentrations of oxygen. The catheter should be changed every 8 hours, alternating nostrils to prevent nasal irritation and infection.

When oxygen is administered via cannula or catheter, the percentage of oxygen reaching the lungs varies with the depth and rate of respirations, particularly if the nasal mucosa is swollen or if the patient is a mouth breather.

Oxygen masks come in several forms. Each is used for different purposes (Fig. 25-1). *Simple masks* are used to administer low to moderate concentrations of oxygen. The body of the mask itself gathers and stores oxygen between breaths. The patient exhales directly through openings or ports in the body of the mask. If oxygen flow ceases, the patient can draw air in through these openings around the mask edges. Although widely used, these masks cannot be used for controlled oxygen concentrations and must be adjusted for proper fit. They should not press too tightly against the skin because this can cause a sense of claustrophobia as well as skin breakdown; adjustable elastic bands are provided to ensure comfort and security.

*Partial-rebreathing masks* have a reservoir bag that must remain inflated during both inspiration and expiration. The nurse adjusts the oxygen flow to ensure that the bag does not collapse during inhalation. A high concentration of oxygen can be delivered because both the mask and the bag serve as reservoirs for oxygen. Oxygen enters the mask through small-bore tubing that connects at the junction of the mask and bag. As the patient inhales, gas is drawn from the mask, from the bag, and potentially from room air through the exhalation ports. As the patient exhales, the first third of the exhalation fills the reservoir bag. This is mainly dead space and does not participate in gas exchange in the lungs. Therefore, it has a high oxygen concentration. The remainder of the exhaled gas is vented through the exhalation ports. The actual percentage of oxygen delivered is influenced by the patient's ventilatory pattern (Kacmarek, Dimas & Mack, 2005).

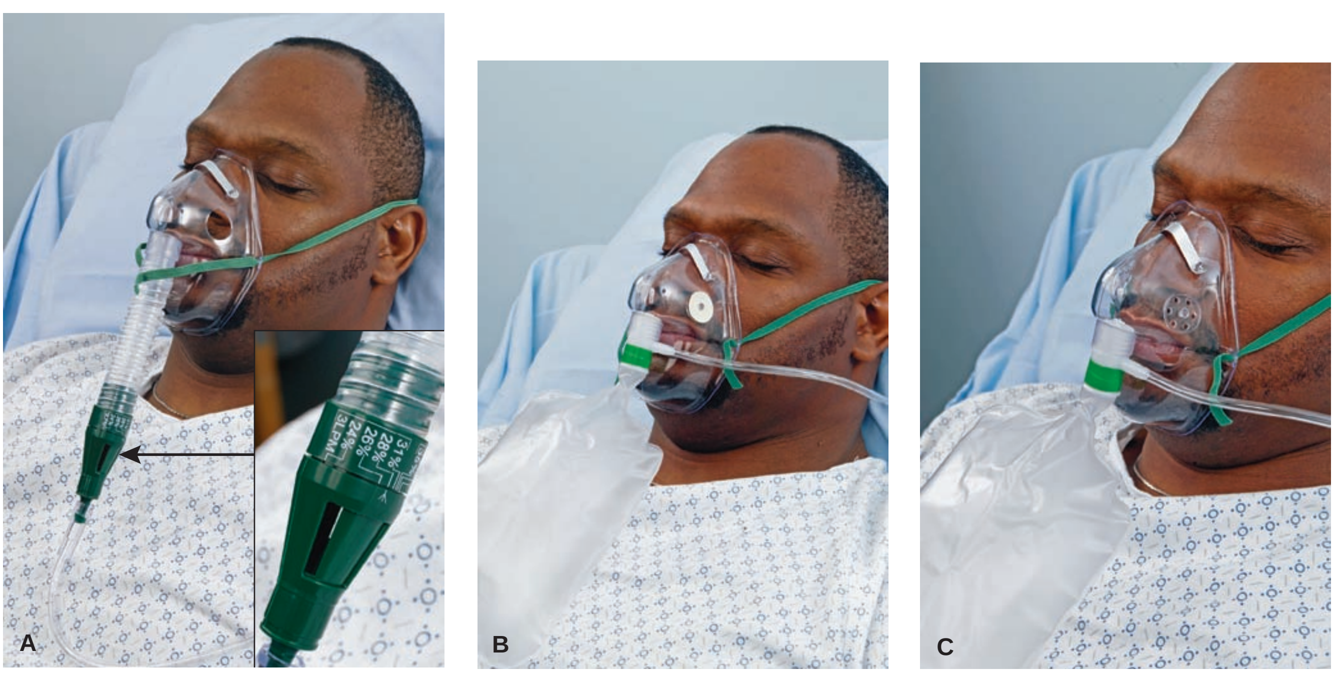



**Figure 25-1** Types of oxygen masks used to deliver varying concentrations of oxygen. **A,** Venturi mask. **B,** Non-rebreathing mask. **C,** Partial-rebreathing mask.

*Non-rebreathing masks* are similar in design to partial-rebreathing masks except that they have additional valves. A one-way valve located between the reservoir bag and the base of the mask allows gas from the reservoir bag to enter the mask on inhalation but prevents gas in the mask from flowing back into the reservoir bag during exhalation. One-way valves located at the exhalation ports prevent room air from entering the mask during inhalation. They also allow the patient's exhaled gases to exit the mask on exhalation. As with the partial-rebreathing mask, it is important to adjust the oxygen flow so that the reservoir bag does not completely collapse on inspiration. In theory, if the non-rebreathing mask fits the patient snugly and both side exhalation ports have one-way valves, it is possible for the patient to receive 100% oxygen, making the non-rebreathing mask a high-flow oxygen system. However, because it is difficult to get an exact fit from the mask on every patient, and some non-rebreathing masks have only one one-way exhalation valve, it is almost impossible to ensure 100% oxygen delivery, making it a low-flow oxygen system.

The *Venturi mask* is the most reliable and accurate method for delivering precise concentrations of oxygen through noninvasive means. The mask is constructed in a way that allows a constant flow of room air blended with a fixed flow of oxygen. It is used primarily for patients with COPD because it can accurately provide appropriate levels of supplemental oxygen, thus avoiding the risk of suppressing the hypoxic drive.

The Venturi mask uses the Bernoulli principle of air entrainment (trapping the air like a vacuum), which provides a high airflow with controlled oxygen enrichment. For each liter of oxygen that passes through a jet orifice, a fixed proportion of room air is entrained. A precise volume of oxygen can be delivered by varying the size of the jet orifice and adjusting the flow of oxygen. Excess gas leaves the mask through the two exhalation ports, carrying with it the exhaled carbon dioxide. This method allows a constant oxygen concentration to be inhaled regardless of the depth or rate of respiration.

The mask should fit snugly enough to prevent oxygen from flowing into the patient's eyes. The nurse checks the patient's skin for irritation. It is necessary to remove the mask so that the patient can eat, drink, and take medications, at which time supplemental oxygen is provided through a nasal cannula.

The *transtracheal oxygen catheter* is inserted directly into the trachea and is indicated for patients with chronic oxygen therapy needs. These catheters are more comfortable, less dependent on breathing patterns, and less obvious than other oxygen delivery methods. Because no oxygen is lost into the surrounding environment, the patient achieves adequate oxygenation at lower rates, making this method less expensive and more efficient.

The *T-piece* connects to the endotracheal tube and is useful in weaning patients from mechanical ventilation (Fig. 25-2).

Other oxygen devices include *aerosol masks, tracheostomy collars,* and *face tents,* all of which are used with aerosol devices (nebulizers) that can be adjusted for oxygen concentrations from 27% to 100% (0.27 to 1.00). If the gas mixture flow falls below patient demand, room air is pulled in, diluting the concentration. The aerosol mist must be available for the patient during the entire inspiratory phase.

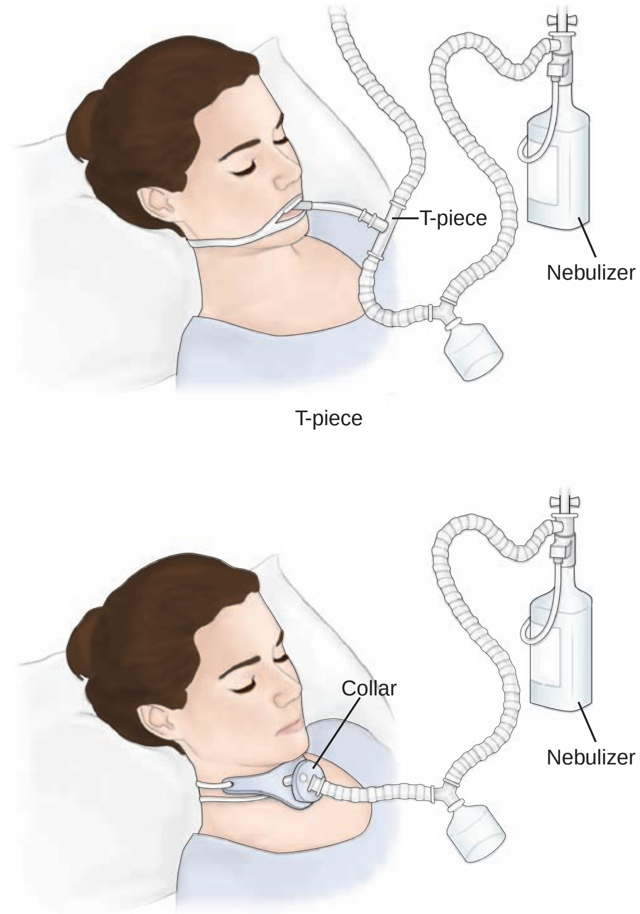



**Figure 25-2** T-pieces and tracheostomy collars are devices used when weaning patients from mechanical ventilation.

Although most oxygen therapy is administered as continuous flow oxygen, new methods of oxygen conservation are coming into use. The *demand oxygen delivery system* (DODS) interrupts the flow of oxygen during exhalation, when it is otherwise mostly wasted. Several versions of the DODS are being evaluated for their effectiveness. Studies show that DODS models conserve oxygen and maintain oxygen saturation better than continuous-flow oxygen systems when the respiratory rate increases (Langenhof & Fichter, 2005).

Hyperbaric oxygen therapy is the administration of oxygen at pressures greater than 1 atm. As a result, the amount of oxygen dissolved in plasma is increased, which increases oxygen levels in the tissues. During therapy, the patient is placed in a small (single patient use) or large (multiple patient use) cylinder chamber. Hyperbaric oxygen therapy is used to treat conditions such as air embolism, carbon monoxide poisoning, gangrene, tissue necrosis, and hemorrhage. Although controversial, hyperbaric oxygen has also been used to treat multiple sclerosis, diabetic foot ulcers (Londahl, Katzman, Nilsson, et al., 2006; McMillan, Glover, McMillan, et al., 2007), closed head trauma, acute myocardial infarction, and unstable angina (Bennett, Jepson & Lehm, 2005), as well as slow-to-heal bone fractures (Bennett, Stanford & Turner, 2005). Potential side effects include ear trauma, central nervous system disorders, oxygen toxicity, and claustrophobia.

## Gerontologic Considerations

The respiratory system changes throughout the aging process, and it is important for nurses to be aware of these changes when assessing patients who are receiving oxygen therapy. As the respiratory muscles weaken and the large bronchi and alveoli become enlarged, the available surface area of the lungs decreases, resulting in reduced ventilation and respiratory gas exchange. The number of functional cilia is also reduced, decreasing ciliary action and the cough reflex. As a result of osteoporosis and calcification of the costal cartilages, chest wall compliance is decreased. Patients may display increased chest rigidity and respiratory rate and decreased $PaO_2$ and lung expansion. Nurses should be aware that the older adult is at risk for aspiration and infection related to these changes. In addition, patient education regarding adequate nutrition is essential because appropriate dietary intake can help diminish the excess buildup of carbon dioxide and maintain optimal respiratory functioning.

## Nursing Management

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

At times oxygen must be administered to the patient at home. The nurse instructs the patient or family in the methods for administering oxygen safely and informs the patient and family that oxygen is available in gas, liquid, and concentrated forms. The gas and liquid forms come in portable devices so that the patient can leave home while receiving oxygen therapy. Humidity must be provided while oxygen is used (except with portable devices) to counteract the dry, irritating effects of compressed oxygen on the airway (Chart 25-2).

#### Continuing Care

Home visits by a home health nurse or respiratory therapist may be arranged based on the patient's status and needs. It is important to assess the patient's home environment, the patient's physical and psychological status, and the need for further teaching. The nurse reinforces the teaching points on how to use oxygen safely and effectively, including fire safety tips. To maintain a consistent quality of care and to maximize the patient's financial reimbursement for home oxygen therapy, the nurse ensures that the physician's prescription includes the diagnosis, the prescribed oxygen flow, and conditions for use (eg, continuous use, nighttime use only). Because oxygen is a medication, the nurse reminds the patient receiving long-term oxygen therapy and the family about the importance of keeping follow-up appointments with the physician. The patient is instructed to see the physician every 6 months or more often, if indicated. Arterial blood gas measurements and laboratory tests are repeated annually or more often if the patient's condition changes.

## *Incentive Spirometry (Sustained Maximal Inspiration)*

**Incentive spirometry** is a method of deep breathing that provides visual feedback to encourage the patient to inhale slowly and deeply to maximize lung inflation and prevent or

CHART 25-2 HOME CARE CHECKLIST
*Oxygen Therapy*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State proper care of and administration of oxygen to patient | | |
| • State physician's prescription for oxygen and the manner in which it is to be used | ✔ | ✔ |
| • Indicate when a humidifier should be used | ✔ | ✔ |
| • Identify signs and symptoms indicating the need for change in oxygen therapy | ✔ | ✔ |
| • Describe precautions and safety measures to be used when oxygen is in use | ✔ | ✔ |
| • Know ***NOT*** to smoke while using oxygen | ✔ | ✔ |
| • Post "No smoking—oxygen in use" signs on doors | ✔ | ✔ |
| • Notify local fire department and electric company of oxygen use in home | ✔ | ✔ |
| • Keep oxygen tank at least 15 feet away from matches, candles, gas stove, or other source of flame | ✔ | ✔ |
| • Keep oxygen tank 5 feet away from TV, radio, and other appliances | ✔ | ✔ |
| • Keep oxygen tank out of direct sunlight | ✔ | ✔ |
| • When traveling in automobile, place oxygen tank on floor behind front seat | ✔ | ✔ |
| • If traveling by airplane, notify air carrier of need for oxygen at least 2 weeks in advance | ✔ | ✔ |
| • State how and when to place an order for more oxygen | ✔ | ✔ |
| • Describe a diet that meets energy demands | ✔ | ✔ |
| • Maintain equipment properly | | |
| • Demonstrate correct adjustment of prescribed flow rate | ✔ | ✔ |
| • Describe how to clean and when to replace oxygen tubing | ✔ | ✔ |
| • Identify when a portable oxygen delivery device should be used | ✔ | ✔ |
| • Demonstrate safe and appropriate use of portable oxygen delivery device | ✔ | ✔ |
| • Identify causes of malfunction of equipment and when to call for replacement of equipment | ✔ | ✔ |
| • Describe the importance of determining that all electrical outlets are working properly | ✔ | ✔ |

reduce atelectasis. The purpose of an incentive spirometer is to ensure that the volume of air inhaled is increased gradually as the patient takes deeper and deeper breaths.

Incentive spirometers are available in two types: volume or flow. In the volume type, the tidal volume is set using the manufacturer's instructions. The patient takes a deep breath through the mouthpiece, pauses at peak lung inflation, and then relaxes and exhales. Taking several normal breaths before attempting another with the incentive spirometer helps avoid fatigue. The volume is periodically increased as tolerated.

In the flow type, the volume is not preset. The spirometer contains a number of movable balls that are pushed up by the force of the breath and held suspended in the air while the patient inhales. The amount of air inhaled and the flow of the air are estimated by how long and how high the balls are suspended.

### Indications

Incentive spirometry is used after surgery, especially thoracic and abdominal surgery, to promote the expansion of the alveoli and to prevent or treat atelectasis.

### Nursing Management

Nursing management of the patient using incentive spirometry includes placing the patient in the proper position, teaching the technique for using the incentive spirometer, setting realistic goals for the patient, and recording the results of the therapy (Chart 25-3). Ideally, the patient assumes a sitting or semi-Fowler's position to enhance diaphragmatic excursion; however, this procedure may be performed with the patient in any position.

## Mini-Nebulizer Therapy

The mini-nebulizer is a handheld apparatus that disperses a moisturizing agent or medication, such as a bronchodilator or mucolytic agent, into microscopic particles and delivers it to the lungs as the patient inhales. The mini-nebulizer is usually air driven by means of a compressor through connecting tubing. In some instances, the nebulizer is oxygen driven rather than air driven. To be effective, a visible mist must be available for the patient to inhale.

### Indications

The indications for use of a mini-nebulizer include difficulty in clearing respiratory secretions, reduced vital capacity with ineffective deep breathing and coughing, and unsuccessful trials of simpler and less costly methods for clearing secretions, delivering aerosol, or expanding the lungs. The patient must be able to generate a deep breath. Diaphragmatic breathing (Chart 25-4) is a helpful technique to prepare for proper use of the mini-nebulizer. Mini-nebulizers are frequently used for

**CHART 25-3 PATIENT EDUCATION**
***Performing Incentive Spirometry***

- The inspired air helps inflate the lungs. The ball or weight in the spirometer rises in response to the intensity of the intake of air. The higher the ball rises, the deeper the breath.
- Assume a semi-Fowler's position or an upright position before initiating therapy.
- Use diaphragmatic breathing.
- Place the mouthpiece of the spirometer firmly in the mouth, breathe air in (inspire) through the mouth, and hold the breath at the end of inspiration for about 3 seconds. Exhale slowly through the mouthpiece.
- Coughing during and after each session is encouraged. Splint the incision when coughing postoperatively.
- Perform the procedure approximately 10 times in succession, repeating the 10 breaths with the spirometer each hour during waking hours.

**CHART 25-4 PATIENT EDUCATION**
***Breathing Exercises***

**General Instructions**

- Breathe slowly and rhythmically to exhale completely and empty the lungs completely.
- Inhale through the nose to filter, humidify, and warm the air before it enters the lungs.
- If you feel out of breath, breathe more slowly by prolonging the exhalation time.
- Keep the air moist with a humidifier.

**Diaphragmatic Breathing**

Goal: To use and strengthen the diaphragm during breathing

- Place one hand on the abdomen (just below the ribs) and the other hand on the middle of the chest to increase the awareness of the position of the diaphragm and its function in breathing.
- Breathe in slowly and deeply through the nose, letting the abdomen protrude as far as possible.
- Breathe out through pursed lips while tightening (contracting) the abdominal muscles.
- Press firmly inward and upward on the abdomen while breathing out.
- Repeat for 1 minute; follow with a rest period of 2 minutes.
- Gradually increase duration up to 5 minutes, several times a day (before meals and at bedtime).

**Pursed-Lip Breathing**

Goal: To prolong exhalation and increase airway pressure during expiration, thus reducing the amount of trapped air and the amount of airway resistance.

- Inhale through the nose while slowly counting to 3—the amount of time needed to say "Smell a rose."
- Exhale slowly and evenly against pursed lips while tightening the abdominal muscles. (Pursing the lips increases intratracheal pressure; exhaling through the mouth offers less resistance to expired air.)
- Count to 7 slowly while prolonging expiration through pursed lips—the length of time to say "Blow out the candle."
- While sitting in a chair:
  Fold arms over the abdomen.
  Inhale through the nose while counting to 3 slowly.
  Bend forward and exhale slowly through pursed lips while counting to 7 slowly.
- While walking:
  Inhale while walking two steps.
  Exhale through pursed lips while walking four or five steps.

patients with COPD to dispense inhaled medications, and they are commonly used at home on a long-term basis.

### Nursing Management

The nurse instructs the patient to breathe through the mouth, taking slow, deep breaths, and then to hold the breath for a few seconds at the end of inspiration to increase intrapleural pressure and reopen collapsed alveoli, thereby increasing functional residual capacity. The nurse encourages the patient to cough and to monitor the effectiveness of the therapy. The nurse instructs the patient and family about the purpose of the treatment, equipment setup, medication additive, and proper cleaning and storage of the equipment.

## Intermittent Positive-Pressure Breathing

Intermittent positive-pressure breathing (IPPB) is an older form of assisted or controlled respiration in which compressed gas is delivered under positive pressure into a person's airways until a preset pressure is reached. Passive exhalation is allowed through a valve. It is infrequently used today.

## Chest Physiotherapy

**Chest physiotherapy (CPT)** includes **postural drainage, chest percussion,** and **vibration,** and breathing retraining. In addition, teaching the patient effective coughing technique is an important part of CPT. The goals of CPT are to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles.

### Postural Drainage (Segmented Bronchial Drainage)

Postural drainage allows the force of gravity to assist in the removal of bronchial secretions. The secretions drain from the affected bronchioles into the bronchi and trachea and are removed by coughing or suctioning. Postural drainage is used to prevent or relieve bronchial obstruction caused by accumulation of secretions.

Because the patient usually sits in an upright position, secretions are likely to accumulate in the lower parts of the lungs. Several other positions (Fig. 25-3) are used so that the force of gravity helps move secretions from the smaller bronchial airways to the main bronchi and trachea. Each position contributes to effective drainage of a different lobe of the lungs; lower and middle lobe bronchi drain more effectively when the head is down, while the upper lobe bronchi drain more effectively when the head is up. The secretions then are removed by coughing. The nurse instructs the patient to inhale bronchodilators and mucolytic agents, if prescribed, before postural drainage, because these medications improve drainage of the bronchial tree.

#### *Nursing Management*

The nurse should be aware of the patient's diagnosis as well as the lung lobes or segments involved, the cardiac status, and any structural deformities of the chest wall and spine. Auscultating the chest before and after the procedure is used to identify the areas that need drainage and assess the effectiveness of treatment. The nurse teaches family members who will assist the patient at home to evaluate breath sounds before and after treatment. The nurse explores strategies that will enable the patient to assume the indicated positions at home. This may require the creative use of objects readily available at home, such as pillows, cushions, or cardboard boxes.

Postural drainage is usually performed two to four times daily, before meals (to prevent nausea, vomiting, and aspiration) and at bedtime. Prescribed bronchodilators, water, or saline may be nebulized and inhaled before postural drainage to dilate the bronchioles, reduce bronchospasm, decrease the thickness of mucus and sputum, and combat edema of the bronchial walls. The recommended sequence starts with positions to drain the lower lobes, followed by positions to drain the upper lobes.

The nurse makes the patient as comfortable as possible in each position and provides an emesis basin, sputum cup, and paper tissues. The nurse instructs the patient to remain in each position for 10 to 15 minutes and to breathe in slowly through the nose and out slowly through pursed lips to help keep the airways open so that secretions can drain while in each position. If a position cannot be tolerated, the nurse helps the patient assume a modified position. When the patient changes position, the nurse explains how to cough and remove secretions (Chart 25-5).

If the patient cannot cough, the nurse may need to suction the secretions mechanically. It also may be necessary to use chest percussion and vibration or a high-frequency chest wall oscillation (HFCWO) vest to loosen bronchial secretions and mucus plugs that adhere to the bronchioles and bronchi and to propel sputum in the direction of gravity drainage (see later discussion). If suctioning is required at home, the nurse instructs caregivers in safe suctioning technique and care of the suctioning equipment.

After the procedure, the nurse notes the amount, color, viscosity, and character of the expelled sputum. It is important to evaluate the patient's skin color and pulse the first few times the procedure is performed. It may be necessary to administer oxygen during postural drainage.

If the sputum is foul-smelling, it is important to perform postural drainage in a room away from other patients or family members. (Deodorizers may be used to counter-

**CHART 25-5** PATIENT EDUCATION
***Effective Coughing Technique***

- Assume a sitting position and bend slightly forward. This upright position permits a stronger cough.
- Flex your knees and hips to promote relaxation and reduce the strain on the abdominal muscles while coughing.
- Inhale slowly through the nose and exhale through pursed lips several times.
- Cough twice during each exhalation while contracting (pulling in) the abdomen sharply with each cough.
- Splint the incisional area, if any, with firm hand pressure or support it with a pillow or rolled blanket while coughing (see Fig. 25-12). (The nurse can initially demonstrate this by using the patient's hands.)

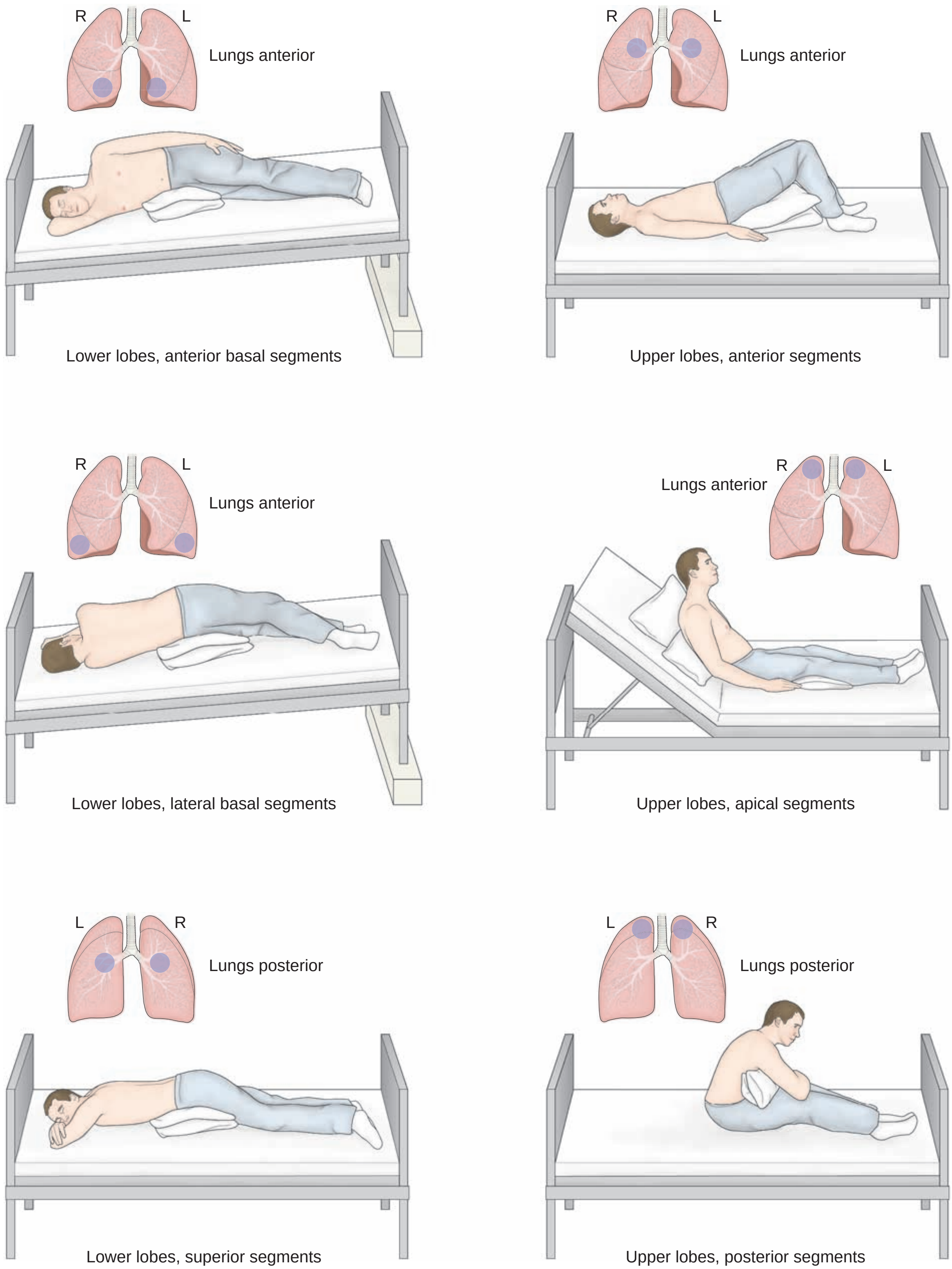



**Figure 25-3** Postural drainage positions and the areas of lung drained by each position.

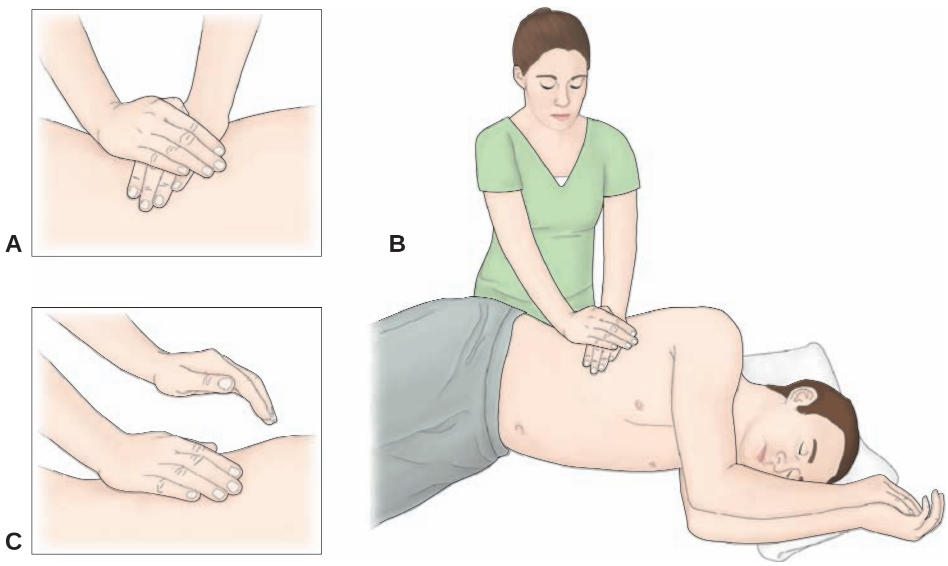


**Figure 25-4** Percussion and vibration. **A,** Proper hand position for vibration. **B,** Proper technique for vibration. The wrists and elbows remain stiff; the vibrating motion is produced by the shoulder muscles. **C,** Proper hand position for percussion.

act the odor. Because aerosol sprays can cause bronchospasm and irritation, they should be used sparingly and with caution.) After the procedure, the patient may find it refreshing to brush the teeth and use a mouthwash before resting.

## Chest Percussion and Vibration

Thick secretions that are difficult to cough up may be loosened by tapping (percussing) and vibrating the chest or through use of an HFCWO vest. Chest percussion and vibration help dislodge mucus adhering to the bronchioles and bronchi. A scheduled program of coughing and clearing sputum, together with hydration, reduces the amount of sputum in most patients.

Percussion is carried out by cupping the hands and lightly striking the chest wall in a rhythmic fashion over the lung segment to be drained. The wrists are alternately flexed and extended so that the chest is cupped or clapped in a painless manner (Fig. 25-4). A soft cloth or towel may be placed over the segment of the chest that is being cupped to prevent skin irritation and redness from direct contact. Percussion, alternating with vibration, is performed for 3 to 5 minutes for each position. The patient uses diaphragmatic breathing during this procedure to promote relaxation (see later discussion). As a precaution, percussion over chest drainage tubes, the sternum, spine, liver, kidneys, spleen, or breasts (in women) is avoided. Percussion is performed cautiously in the elderly because of their increased incidence of osteoporosis and risk of rib fracture.

Vibration is the technique of applying manual compression and tremor to the chest wall during the exhalation phase of respiration (see Fig. 25-4). This helps increase the velocity of the air expired from the small airways, thus freeing the mucus. After three or four vibrations, the patient is encouraged to cough, contracting the abdominal muscles to increase the effectiveness of the cough.

The number of times the percussion and coughing cycle is repeated depends on the patient's tolerance and clinical response. It is important to evaluate breath sounds before and after the procedures.

An inflatable HFCWO vest (Fig. 25-5) may be used to provide chest therapy. The vest uses air pulses to compress the chest wall 8 to 18 times/sec, causing secretions to detach from the airway wall and enabling the patient to expel them by coughing. Vest therapy is considered more effective than manual percussion because it is gentler and acts on all lobes of the lung simultaneously. Research has shown that the vest is equally effective to manual CPT, and some patients prefer it (Main, Prasad & van der Schans, 2005).

To increase the effectiveness of coughing, a flutter valve is sometimes used, especially by people who have cystic fibrosis. The flutter valve looks like a pipe but has a cap covering the bowl, which contains a steel ball. When the patient exhales actively into the valve, movement of the ball causes pressure oscillations, thereby decreasing mucus viscosity, allowing it to move within the airways and be coughed out.



**Figure 25-5** High-frequency chest wall oscillation vest. 

### *Nursing Management*

When performing CPT, the nurse ensures that the patient is comfortable, is not wearing restrictive clothing, and has not just eaten. The nurse gives medication for pain, as prescribed, before percussion and vibration and splints any incision and provides pillows for support as needed. The positions are varied, but focus is placed on the affected areas. On completion of the treatment, the nurse assists the patient to assume a comfortable position.

If an HFCWO vest is being used, the patient may assume whatever position is most comfortable and may even continue to perform light activity during therapy within the length of the compressed air hose. It is not necessary for the patient to assume specific positions for the vest to be effective.

The nurse must stop treatment if any of the following occur: increased pain, increased shortness of breath, weakness, lightheadedness, or hemoptysis. Therapy is indicated until the patient has normal respirations, can mobilize secretions, and has normal breath sounds, and until the chest x-ray findings are normal.

#### Promoting Home and Community-Based Care

***Teaching Patients Self-Care.*** CPT is frequently indicated at home for patients with COPD, bronchiectasis, or cystic fibrosis. The techniques are the same as described previously, but gravity drainage is achieved by placing the hips over a box, a stack of magazines, or pillows (unless a hospital bed is available). The nurse instructs the patient and family in the positions and techniques of percussion and vibration so that therapy can be continued in the home. In addition, the nurse instructs the patient to maintain an adequate fluid intake and air humidity to prevent secretions from becoming thick and tenacious. It also is important to teach the patient to recognize early signs of infection, such as fever and a change in the color or character of sputum. Resting 5 to 10 minutes in each postural drainage position before CPT maximizes the amount of secretions obtained.

***Continuing Care.*** CPT may be carried out during visits by a home care nurse. The nurse also assesses the patient's physical status, understanding of the treatment plan, compliance with recommended therapy, and the effectiveness of therapy. It is important to reinforce patient and family teaching during these visits. The nurse reports to the patient's physician any deterioration in the patient's physical status or inability to clear secretions.

## Breathing Retraining

Breathing retraining consists of exercises and breathing practices that are designed to achieve more efficient and controlled ventilation and to decrease the work of breathing. Breathing retraining is especially indicated in patients with COPD and dyspnea. These exercises promote maximal alveolar inflation and muscle relaxation; relieve anxiety; eliminate ineffective, uncoordinated patterns of respiratory muscle activity; slow the respiratory rate; and decrease the work of breathing. Slow, relaxed, rhythmic breathing also helps to control the anxiety that occurs with dyspnea. Specific breathing exercises include diaphragmatic and pursed-lip breathing (see Chart 25-4).

Diaphragmatic breathing can become automatic with sufficient practice and concentration. Pursed-lip breathing, which improves oxygen transport, helps induce a slow, deep breathing pattern and assists the patient to control breathing, even during periods of stress. This type of breathing helps prevent airway collapse secondary to loss of lung elasticity in emphysema. The nurse instructs the patient in diaphragmatic breathing and pursed-lip breathing, as described in Chart 25-4. Breathing exercises should be practiced in several positions because air distribution and pulmonary circulation vary with the position of the chest.

Many patients require additional oxygen, using a low-flow method, while performing breathing exercises. Emphysema-like changes in the lung occur as part of the natural aging process of the lung; therefore, breathing exercises are appropriate for all elderly patients, whether hospitalized or not, who are sedentary, even without primary lung disease.

### *Nursing Management*

The nurse instructs the patient to breathe slowly and rhythmically in a relaxed manner and to exhale completely to empty the lungs. The patient is instructed to always inhale through the nose because this filters, humidifies, and warms the air. If short of breath, the patient should be instructed to concentrate on prolonging the length of exhalation; this helps avoid initiating a cycle of increasing shortness of breath and panic. Minimizing the amount of dust or particles in the air and providing adequate humidification may also make it easier for the patient to breathe. Dust and particles in the air can be decreased by removing drapes and upholstered furniture, using air filters, and washing floors, dusting, and vacuuming frequently.

The nurse instructs the patient that an adequate dietary intake promotes gas exchange and increases energy levels. It is important to obtain adequate nutrition without overeating by consuming small, frequent meals and snacks. Having ready-prepared meals and favorite foods available helps encourage nutrient consumption. Gas-producing foods such as beans, legumes, broccoli, cabbage, and brussels sprouts should be avoided to prevent gastric distress. Because many patients lack the energy to eat, they should be taught to rest before and after meals to conserve energy.

# AIRWAY MANAGEMENT

Adequate ventilation is dependent on free movement of air through the upper and lower airways. In many disorders, the airway becomes narrowed or blocked as a result of disease, bronchoconstriction (narrowing of airway by contraction of muscle fibers), a foreign body, or secretions. Maintaining a patent (open) airway is achieved through meticulous airway management, whether in an emergency situation such as airway obstruction or in long-term management, as in caring for a patient with an endotracheal or a tracheostomy tube.

## *Emergency Management of Upper Airway Obstruction*

Upper airway obstruction has a variety of causes. Acute upper airway obstruction may be caused by food particles, vomitus, blood clots, or anything that obstructs the larynx or

trachea. It also may occur from enlargement of tissue in the wall of the airway, as in epiglottitis, obstructive sleep apnea, laryngeal edema, laryngeal carcinoma, or peritonsillar abscess, or from thick secretions. Pressure on the walls of the airway, as occurs in retrosternal goiter, enlarged mediastinal lymph nodes, hematoma around the upper airway, and thoracic aneurysm, also may result in upper airway obstruction.

The patient with an altered level of consciousness from any cause is at risk for upper airway obstruction because of loss of the protective reflexes (cough and swallowing) and loss of the tone of the pharyngeal muscles, which causes the tongue to fall back and block the airway.

The nurse makes the following rapid observations to assess for signs and symptoms of upper airway obstruction:

- Inspection: Is the patient conscious? Is there any inspiratory effort? Does the chest rise symmetrically? Is there use or retraction of accessory muscles? What is the skin color? Are there any obvious signs of deformity or obstruction (trauma, food, teeth, vomitus)? Is the trachea midline?
- Palpation: Do both sides of the chest rise equally with inspiration? Are there any specific areas of tenderness, fracture, or subcutaneous emphysema (crepitus)?
- Auscultation: Is there any audible air movement, stridor (inspiratory sound), or wheezing (expiratory sound)? Are breath sounds present over the lower trachea and all lobes?
- As soon as an upper airway obstruction is identified, the nurse takes emergency measures (Chart 25-6). (See Chapter 22 or Chapter 71 for more details on managing a foreign body airway obstruction.)

## Endotracheal Intubation

**Endotracheal intubation** involves passing an endotracheal tube through the mouth or nose into the trachea (Fig. 25-6). Intubation provides a patent airway when the patient is having respiratory distress that cannot be treated with simpler methods and is the method of choice in emergency care. Endotracheal intubation is a means of providing an airway for patients who cannot maintain an adequate airway on their own (e.g., comatose patients, patients with upper airway obstruction), for patients needing mechanical ventilation, and for suctioning secretions from the pulmonary tree.

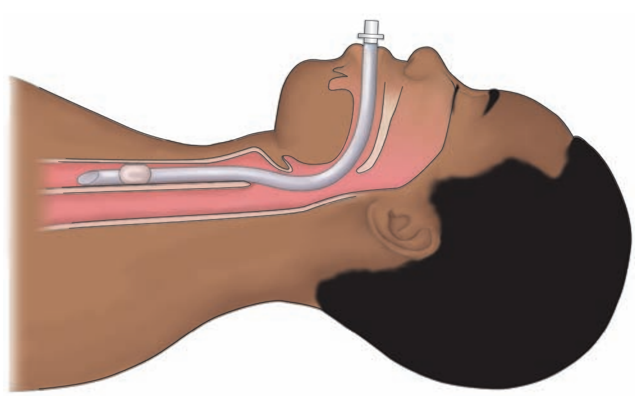


**Figure 25-6** Endotracheal tube in place. The tube has been inserted using the oral route. The cuff has been inflated to maintain the tube's position and to minimize the risk of aspiration.

An endotracheal tube usually is passed with the aid of a laryngoscope by specifically trained medical, nursing, or respiratory therapy personnel (see Chapter 71). Once the tube is inserted, a cuff is inflated to prevent air from leaking around the outer part of the tube, to minimize the possibility of aspiration, and to prevent movement of the tube. Chart 25-7 discusses the nursing care of the patient with an endotracheal tube.

Complications can occur from pressure exerted by the cuff on the tracheal wall. Cuff pressures should be maintained between 15 and 20 mm Hg (Morton, Fontaine, Hudak, et al., 2009). High cuff pressure can cause tracheal bleeding, ischemia, and pressure necrosis, whereas low cuff pressure can increase the risk of aspiration pneumonia. Routine deflation of the cuff is not recommended because of the increased risk of aspiration and hypoxia. Tracheobronchial secretions are suctioned through the tube. Warmed, humidified oxygen should always be introduced through the tube, whether the patient is breathing spontaneously or is receiving ventilatory support. Endotracheal intubation may be used for no longer than 3 weeks, by which time a tracheostomy must be considered to decrease irritation of and trauma to the tracheal lining, to reduce the incidence of vocal cord paralysis (secondary to laryngeal nerve damage), and to decrease the work of breathing.

Endotracheal and tracheostomy tubes have several disadvantages. The tubes cause discomfort. The cough reflex is depressed because glottis closure is hindered. Secretions tend to become thicker because the warming and humidifying effect of the upper respiratory tract has been bypassed. The swallowing reflexes (glottic, pharyngeal, and laryngeal reflexes) are depressed because of prolonged disuse and the mechanical trauma produced by the endotracheal or tracheostomy tube, increasing the risk of aspiration. In addition, ulceration and stricture of the larynx or trachea may develop. Of great concern to the patient is the inability to talk and to communicate needs.

Unintentional or premature removal of the tube is a potentially life-threatening complication of endotracheal intubation. Removal of the tube is a frequent problem in intensive care units and occurs mainly during nursing care or by the patient. It is important that nurses instruct and remind patients and family members about the purpose of the tube and the dangers of removing it. Baseline and ongoing assessment of the patient and of the equipment ensures effective care. Providing comfort measures, including opioid analgesia and sedation, can improve the patient's tolerance of the endotracheal tube.

### *NURSING ALERT*

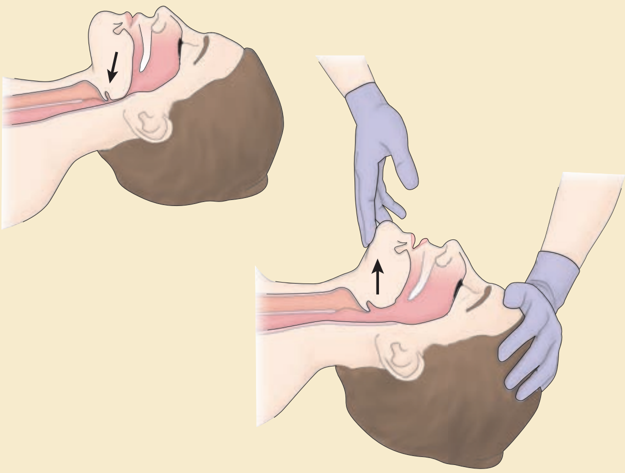
**Inadvertent removal of an endotracheal tube can cause laryngeal swelling, hypoxemia, bradycardia, hypotension, and even death. Measures must be taken to prevent premature or inadvertent removal.**

To prevent tube removal by the patient, the nurse should explain to the patient and family the purpose of the tube, distract the patient through one-to-one interaction or with

## Chart 25-6 • *Clearing an Upper Airway Obstruction*

### Clearing the Airway

Hyperextend the patient's neck by placing one hand on the forehead and placing the fingers of the other hand underneath the jaw and lifting upward and forward. This action pulls the tongue away from the back of the pharynx.



Opening the airway.

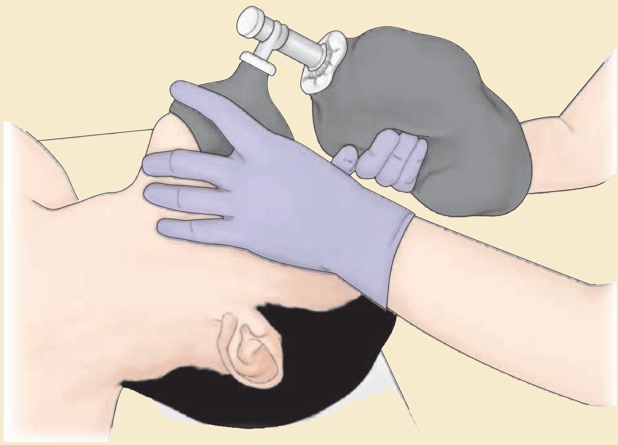
- Assess the patient by observing the chest and listening and feeling for the movement of air.
- Use a cross-finger technique to open the mouth and observe for obvious obstructions such as secretions, blood clots, or food particles.
- If no passage of air is detected, apply five quick sharp abdominal thrusts just below the xiphoid process to expel the obstruction. Repeat this procedure until the obstruction is expelled.
- After the obstruction is expelled, roll the patient as a unit onto the side for recovery.
- When the obstruction is relieved, if the patient can breathe spontaneously but not cough, swallow, or gag, insert an oral or nasopharyngeal airway.



Abdominal thrust (Heimlich) maneuver administered to unconscious patient.

### Bag and Mask Resuscitation

- Apply the mask to the patient's face and create a seal by pressing the thumb of the nondominant hand on the bridge of the nose and the index finger on the chin.
- Using the rest of the fingers on that hand, pull on the chin and the angle of the mandible to maintain the head in extension.
- Use the dominant hand to inflate the lungs by squeezing the bag to its full volume.



Resuscitation via bag and mask apparatus.

## Chart 25-7 • *Care of the Patient With an Endotracheal Tube*

**Immediately After Intubation**

1. Check symmetry of chest expansion.
2. Auscultate breath sounds of anterior and lateral chest bilaterally.
3. Obtain order for chest x-ray to verify proper tube placement.
4. Check cuff pressure every 6–8 hours.
5. Monitor for signs and symptoms of aspiration.
6. Ensure high humidity; a visible mist should appear in the T-piece or ventilator tubing.
7. Administer oxygen concentration as prescribed by physician.
8. Secure the tube to the patient's face with tape, and mark the proximal end for position maintenance.
   a. Cut proximal end of tube if it is longer than 7.5 cm (3 inches) to prevent kinking.
   b. Insert an oral airway or mouth device to prevent the patient from biting and obstructing the tube.
9. Use sterile suction technique and airway care to prevent iatrogenic contamination and infection.
10. Continue to reposition patient every 2 hours and as needed to prevent atelectasis and to optimize lung expansion.
11. Provide oral hygiene and suction the oropharynx whenever necessary.

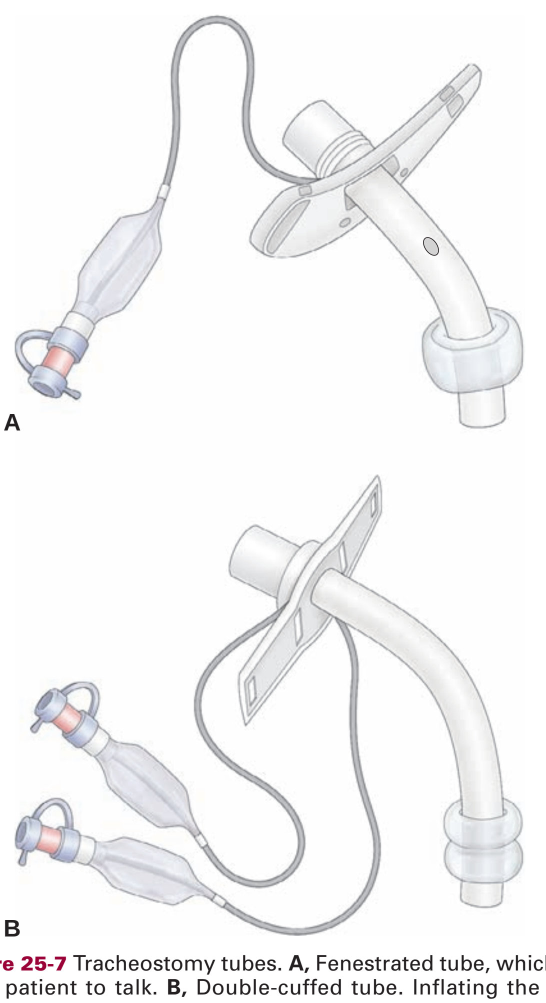
**Extubation (Removal of Endotracheal Tube)**

1. Explain procedure.
2. Have self-inflating bag and mask ready in case ventilatory assistance is required immediately after extubation.
3. Suction the tracheobronchial tree and oropharynx, remove tape, and then deflate the cuff.
4. Give 100% oxygen for a few breaths, then insert a new, sterile suction catheter inside tube.
5. Have the patient inhale. At peak inspiration remove the tube, suctioning the airway through the tube as it is pulled out.

*Note*: In some hospitals this procedure can be performed by respiratory therapists; in others, by nurses. Check hospital policy.

**Care of Patient Following Extubation**

1. Give heated humidity and oxygen by face mask and maintain the patient in a sitting or high Fowler's position.
2. Monitor respiratory rate and quality of chest excursions. Note stridor, color change, and change in mental alertness or behavior.
3. Monitor the patient's oxygen level using a pulse oximeter.
4. Keep NPO or give only ice chips for next few hours.
5. Provide mouth care.
6. Teach patient how to perform coughing and deep-breathing exercises.



A

B

**Figure 25-7** Tracheostomy tubes. **A,** Fenestrated tube, which allows patient to talk. **B,** Double-cuffed tube. Inflating the two cuffs alternately can help prevent tracheal damage.

television, and maintain comfort measures. As a last resort, soft wrist restraints may be used. Discretion and caution must always be used before applying any restraint. If the patient cannot move the arms and hands to the endotracheal tube, restraints are not needed. If the patient is alert, oriented, able to follow directions, and cooperative to the point that it is highly unlikely that he or she will remove the endotracheal tube, restraints are not needed. However, if the nurse determines there is a risk that the patient may try to remove the tube, soft wrist restraints are appropriate with a physician's order (check agency policy). Close monitoring of the patient is essential to ensure safety and prevent harm.

## *Tracheostomy*

A **tracheotomy** is a surgical procedure in which an opening is made into the trachea. The indwelling tube inserted into the trachea is called a **tracheostomy tube** (Fig. 25-7). A tracheostomy may be either temporary or permanent.

A tracheotomy is used to bypass an upper airway obstruction, to allow removal of tracheobronchial secretions, to permit the long-term use of mechanical ventilation, to prevent aspiration of oral or gastric secretions in the unconscious or paralyzed patient (by closing off the trachea from the esophagus), and to replace an endotracheal tube. Many disease processes and emergency conditions make a tracheotomy necessary.

### Procedure

The surgical procedure is usually performed in the operating room or in an intensive care unit, where the patient's ventilation can be well controlled and optimal aseptic technique can be maintained. A surgical opening is made between the

second and third tracheal rings. After the trachea is exposed, a cuffed tracheostomy tube of an appropriate size is inserted. The cuff is an inflatable attachment to the tracheostomy tube that is designed to occlude the space between the tracheal walls and the tube, to permit effective mechanical ventilation, and to minimize the risk of aspiration. See Figure 25-7 for the different types of tracheostomy tubes.

The tracheostomy tube is held in place by tapes fastened around the patient's neck. Usually a square of sterile gauze is placed between the tube and the skin to absorb drainage and reduce the risk for infection.

## Complications

Complications may occur early or late in the course of tracheostomy tube management. They may even occur years after the tube has been removed. Early complications include bleeding, pneumothorax, air embolism, aspiration, subcutaneous or mediastinal emphysema, recurrent laryngeal nerve damage, and posterior tracheal wall penetration. Long-term complications include airway obstruction from accumulation of secretions or protrusion of the cuff over the opening of the tube, infection, rupture of the innominate artery, dysphagia, tracheoesophageal fistula, tracheal dilation, tracheal ischemia, and necrosis. Tracheal stenosis may develop after the tube is removed. Chart 25-8 outlines measures nurses can take to prevent complications.

## Nursing Management

The patient requires continuous monitoring and assessment. The newly made opening must be kept patent by proper suctioning of secretions. After the vital signs are stable, the patient is placed in a semi-Fowler's position to facilitate ventilation, promote drainage, minimize edema, and prevent strain on the suture lines. Analgesia and sedative agents must be administered with caution because of the risk of suppressing the cough reflex.

Major objectives of nursing care are to alleviate the patient's apprehension and to provide an effective means of communication. The nurse keeps paper and pencil or a Magic Slate and the call light within the patient's reach at all times to ensure a means of communication. Chart 25-9 summarizes the care of the patient with a tracheostomy tube.

### Chart 25-8 • *Preventing Complications Associated With Endotracheal and Tracheostomy Tubes*

- Administer adequate warmed humidity.
- Maintain cuff pressure at appropriate level.
- Suction as needed per assessment findings.
- Maintain skin integrity. Change tape and dressing as needed or per protocol.
- Auscultate lung sounds.
- Monitor for signs and symptoms of infection, including temperature and white blood cell count.
- Administer prescribed oxygen and monitor oxygen saturation.
- Monitor for cyanosis.
- Maintain adequate hydration of the patient.
- Use sterile technique when suctioning and performing tracheostomy care.

### *Suctioning the Tracheal Tube (Tracheostomy or Endotracheal Tube)*

When a tracheostomy or endotracheal tube is in place, it is usually necessary to suction the patient's secretions because of the decreased effectiveness of the cough mechanism. Tracheal suctioning is performed when adventitious breath sounds are detected or whenever secretions are obviously present. Unnecessary suctioning can initiate bronchospasm and cause mechanical trauma to the tracheal mucosa.

All equipment that comes into direct contact with the patient's lower airway must be sterile to prevent overwhelming pulmonary and systemic infections. Chart 25-10 presents the procedure for suctioning a patient with a tracheostomy tube. In mechanically ventilated patients, an in-line suction catheter may be used to allow rapid suction when needed and to minimize cross-contamination by airborne pathogens. An in-line suction device allows the patient to be suctioned without being disconnected from the ventilator circuit. In-line suctioning (also called closed suctioning) decreases hypoxemia, sustains PEEP, and can decrease patient anxiety associated with suctioning. Because it protects staff from patient secretions, it can be performed without using personal protective gear.

### *Managing the Cuff*

The cuff on an endotracheal or tracheostomy tube should be inflated if the patient requires mechanical ventilation or is at high risk for aspiration. The pressure within the cuff should be the lowest possible pressure that allows delivery of adequate tidal volumes and prevents pulmonary aspiration. Usually the pressure is maintained at less than 25 mm Hg to prevent injury and at more than 15 mm Hg to prevent aspiration. Cuff pressure must be monitored at least every 8 hours by attaching a handheld pressure gauge to the pilot balloon of the tube or by using the minimal leak volume or minimal occlusion volume technique. With long-term intubation, higher pressures may be needed to maintain an adequate seal.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

If the patient is at home with a tracheostomy tube, the nurse instructs the patient and family about daily care, including techniques to prevent infection, as well as measures to take in an emergency. The nurse provides the patient and family with a list of community contacts for education and support needs.

#### Continuing Care

A referral for home care is indicated for ongoing assessment of the patient and of the ability of the patient and family to provide appropriate and safe care. The home care nurse assesses the patient's and family's ability to cope with the physical changes and psychological issues associated with having a tracheostomy. The nurse also identifies resources and makes referrals for appropriate services to assist the patient and family to manage the tracheostomy tube at home.

## CHART 25-9 *Guidelines for Care of the Patient With a Tracheostomy Tube*

### Equipment

- Sterile gloves
- Hydrogen peroxide
- Normal saline solution or sterile water
- Cotton-tipped applicators
- Dressing
- Twill tape
- Type of tube prescribed, if the tube is to be changed

### Implementation

| Actions | Rationale |
|---|---|
| 1. Provide patient and family instruction on the key points for tracheostomy care, beginning with how to inspect the tracheostomy dressing for moisture or drainage. A cuffed tube (air injected into cuff) is required during mechanical ventilation. A low-pressure cuff is most commonly used. Patients requiring long-term use of a tracheostomy tube and who can breathe spontaneously commonly use an uncuffed, metal tube. | The tracheostomy dressing is changed as needed to keep the skin clean and dry. To prevent potential breakdown, moist or soiled dressings should not remain on the skin. A cuffed tube prevents air from leaking during positive-pressure ventilation and also prevents tracheal aspiration of gastric contents. An adequate seal is indicated by the disappearance of any air leakage from the mouth or tracheostomy or by the disappearance of the harsh, gurgling sound of air coming from the throat. Low-pressure cuffs exert minimal pressure on the tracheal mucosa and thus reduce the danger of tracheal ulceration and stricture. |
| 2. Perform hand hygiene. | Hand hygiene reduces bacteria on hands. |
| 3. Explain procedure to patient and family as appropriate. | A patient with a tracheostomy is apprehensive and requires ongoing assurance and support. |
| 4. Put on clean gloves; remove and discard the soiled dressing in a biohazard container. | Observing body substance isolation reduces cross-contamination from soiled dressings. |
| 5. Prepare sterile supplies, including hydrogen peroxide, normal saline solution or sterile water, cotton-tipped applicators, dressing, and tape. | Having necessary supplies and equipment readily available allows the procedure to be completed efficiently. |
| 6. Put on sterile gloves. (Some physicians approve clean technique for long-term tracheostomy patients in the home.) | Sterile equipment minimizes transmission of surface flora to the sterile respiratory tract. Clean technique may be used in the home because of decreased exposure to potential pathogens. |
| 7. Cleanse the wound and the plate of the tracheostomy tube with sterile cotton-tipped applicators moistened with hydrogen peroxide. Rinse with sterile saline solution. | Hydrogen peroxide is effective in loosening crusted secretions. Rinsing prevents skin residue. |
| 8. Soak inner cannula in peroxide or sterile saline, per manufacturer's instructions; rinse with saline solution; and inspect to be sure all dried secretions have been removed. Dry and reinsert inner cannula or replace with a new disposable inner cannula. | Soaking loosens and removes secretions from the inner lumen of the tracheostomy tube. Retained secretions could harbor bacteria, leading to infection. Some plastic tracheostomy tubes may be damaged by using peroxide. |
| 9. Place clean twill tape in position to secure the tracheostomy tube by inserting one end of the tape through the side opening of the outer cannula. Take the tape around the back of the patient's neck and thread it through the opposite opening of the outer cannula. Bring both ends around so that they meet on one side of the neck. Tighten the tape until only two fingers can be comfortably inserted under it. Secure with a knot. For a new tracheostomy, two people should assist with tape changes. Remove soiled twill tape after the new tape is in place. | This taping technique provides a double thickness of tape around the neck, which is needed because the tracheostomy tube can be dislodged by movement or by a forceful cough if left unsecured. A dislodged tracheostomy tube is difficult to reinsert, and respiratory distress may occur. Dislodgement of the tube with a new tracheostomy is a medical emergency. |
| 10. Remove old tapes and discard in a biohazard container after the new tape is in place. | Tapes with old secretions may harbor bacteria. |
| 11. Although some long-term tracheostomies with healed stomas may not require a dressing, other tracheostomies do. In such cases, use a sterile tracheostomy dressing, fitting it securely under the twill tapes and flange of tracheostomy tube so that the incision is covered, as shown below. | Healed tracheostomies with minimal secretions do not need a dressing. Dressings that will shred are not used around a tracheostomy because of the risk that pieces of material, lint, or thread may get into the tube, and eventually into the trachea, causing obstruction or abscess formation. Special dressings that do not have a tendency to shred are used. |

*Continued on following page*

CHART 25-9 *Guidelines for Care of the Patient With a Tracheostomy Tube* (Continued)

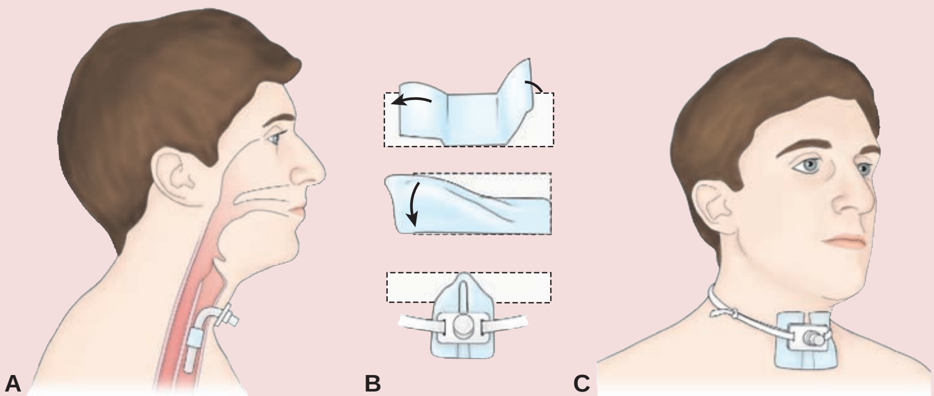



**Figure 25-9.1 A,** The cuff of the tracheostomy tube fits smoothly and snugly in the trachea in a way that promotes circulation but seals off the escape of secretions and air surrounding the tube. **B,** For a dressing change, a 4- by 4-inch gauze pad may be folded (cutting would promote shredding, placing the patient at risk for aspiration) around the tracheostomy tube and **C,** stabilized by slipping the neck tape ties through the neck plate slots of the tracheostomy tube. The ties may be fastened to the side of the neck to eliminate the discomfort of lying on the knot.

# Mechanical Ventilation

Mechanical ventilation may be required for a variety of reasons: to control the patient's respirations during surgery or during treatment of severe head injury, to oxygenate the blood when the patient's ventilatory efforts are inadequate, and to rest the respiratory muscles, among others. Many patients placed on a ventilator can breathe spontaneously, but the effort needed to do so may be exhausting.

A **mechanical ventilator** is a positive- or negative-pressure breathing device that can maintain ventilation and oxygen delivery for a prolonged period. Caring for a patient on mechanical ventilation has become an integral part of nursing care in critical care or general medical-surgical units, extended care facilities, and the home. Nurses, physicians, and respiratory therapists must understand each patient's specific pulmonary needs and work together to set realistic goals. Positive patient outcomes depend on an understanding of the principles of mechanical ventilation and the patient's care needs as well as open communication among members of the health care team about the goals of therapy, weaning plans, and the patient's tolerance of changes in ventilator settings.

## Indications

If a patient has a continuous decrease in oxygenation ($PaO_2$), an increase in arterial carbon dioxide levels ($PaCO_2$), and a persistent acidosis (decreased pH), mechanical ventilation may be necessary. Conditions such as thoracic or abdominal surgery, drug overdose, neuromuscular disorders, inhalation injury, COPD, multiple trauma, shock, multisystem failure, and coma all may lead to respiratory failure and the need for mechanical ventilation. The criteria for mechanical ventilation guide the decision to place a patient on a ventilator (Chart 25-11). A patient with apnea that is not readily reversible also is a candidate for mechanical ventilation.

## Classification of Ventilators

Mechanical ventilators are classified according to the method by which they support ventilation. The two general categories are negative-pressure and positive-pressure ventilators.

### *Negative-Pressure Ventilators*

Negative-pressure ventilators exert a negative pressure on the external chest. Decreasing the intrathoracic pressure during inspiration allows air to flow into the lung, filling its volume. Physiologically, this type of assisted ventilation is similar to spontaneous ventilation. It is used mainly in chronic respiratory failure associated with neuromuscular conditions, such as poliomyelitis, muscular dystrophy, amyotrophic lateral sclerosis, and myasthenia gravis. It is inappropriate for the patient whose condition is unstable or complex or who requires frequent ventilatory changes. Negative-pressure ventilators are simple to use and do not require intubation of the airway; consequently, they are especially adaptable for home use.

There are several types of negative-pressure ventilators: iron lung, body wrap, and chest cuirass.

#### Iron Lung (Drinker Respirator Tank)

The iron lung is a negative-pressure chamber used for ventilation. It was used extensively during polio epidemics in the past and currently is used by a few polio survivors and patients with other neuromuscular disorders (eg, amyotrophic lateral sclerosis, muscular dystrophy).

#### Body Wrap (Pneumo-Wrap) and Chest Cuirass (Tortoise Shell)

The body wrap and chest cuirass are portable devices that require a rigid cage or shell to create a negative-pressure chamber around the thorax and abdomen. Because of problems with proper fit and system leaks, these types of ventilators are used only with carefully selected patients.

CHART 25-10

## Guidelines for Performing Tracheal Suction

**Equipment**

- Suction catheters
- Gloves (sterile and nonsterile), gown, mask, and goggles for eye protection
- Basin for sterile normal saline solution for irrigation
- Manual resuscitation bag with supplemental oxygen
- Suction source

**Implementation**

| Step | Rationale |
|---|---|
| 1. Assess the patient's lung sounds and oxygen saturation via pulse oximeter. | Assessment data indicate the need for suctioning and allow the nurse to monitor the effect of suction on the patient's level of oxygenation. |
| 2. Explain the procedure to the patient before beginning and offer reassurance during suctioning. | The patient may be apprehensive about choking and about an inability to communicate. |
| 3. Performing hand hygiene. Put on nonsterile gloves, goggles, gown, and mask. | Hand hygiene reduces bacteria on hands. |
| 4. Turn on suction source (pressure should not exceed 120 mm Hg). | Suction pressure should be set high enough to be effective without causing trauma to the tissues. |
| 5. Open suction catheter kit. | Having equipment ready prevents interruption of the procedure. |
| 6. Fill basin with sterile water. | This provides sterile solution for clearing suction catheter of secretions. |
| 7. Put sterile glove on dominant hand. | Equipment that will contact the patient's lower airway must remain sterile to prevent infection. |
| 8. Ventilate the patient with manual resuscitation bag and high-flow oxygen for about 30 seconds or turn on suction mode of ventilator (if available) to hyperoxygenate the patient. Instill normal saline solution into airway only if there are thick, tenacious secretions. | This prevents hypoxia during suctioning. |
| 9. Instill normal saline solution into airway if there are thick, tenacious secretions. | Solution facilitates their removal. |
| 10. Pick up suction catheter in sterile gloved hand and connect to suction. | Prevents contamination of sterile catheter. |
| 11. Insert suction catheter at least as far as the end of the tube without applying suction, just far enough to stimulate the cough reflex. | Inserting the catheter without applying suction permits insertion without causing trauma to the tissues. |
| 12. Apply suction while withdrawing and gently rotating the catheter 360 degrees (no longer than 10 to 15 seconds). | Prolonged suctioning may result in hypoxia and dysrhythmias, leading to cardiac arrest. |
| 13. Reoxygenate and inflate the patient's lungs for several breaths with manual resuscitation bag, or allow ventilator to reoxygenate patient for several breaths using suction mode. | Prevents hypoxia during procedure and restores oxygen supply. |
| 14. Rinse catheter by suctioning a few milliliters of sterile saline solution from the basin between suction attempts. | Keeps suction catheter patent. |
| 15. Repeat steps 9 to 14 until the airway is clear. | This ensures removal of all tracheal secretions. |
| 16. Suction oropharyngeal cavity after completing tracheal suctioning. | Avoids contamination of trachea with oropharyngeal secretions and organisms. |
| 17. Rinse suction tubing and discard catheter, gloves, and basin appropriately. | Safe disposal of equipment avoids cross-contamination. |
| 18. Assess the patient's lung sounds and oxygen saturation via pulse oximeter after procedure. | Provides information about effectiveness of procedure. |
| 19. Document the amount, color, and consistency of secretions. | Documentation allows monitoring of patient's status over time. |

### *Positive-Pressure Ventilators*

Today, the most common ventilators use positive pressure. Positive-pressure ventilators inflate the lungs by exerting positive pressure on the airway, pushing air in, similar to a bellows mechanism, forcing the alveoli to expand during inspiration. Expiration occurs passively. Endotracheal intubation or tracheostomy is usually necessary. These ventilators are widely used in the hospital setting and are increasingly used in the home for patients with primary lung disease. Three types of positive-pressure ventilators are classified by the method of ending the inspiratory phase of respiration:

### Chart 25-11 • *Indications for Mechanical Ventilation*

$PaO_2$ <50 mm Hg with $FiO_2$ >0.60
$PaO_2$ >50 mm Hg with pH <7.25
Vital capacity <2 times tidal volume
Negative inspiratory force <25 cm $H_2O$
Respiratory rate >35/min

pressure-cycled, time-cycled, and volume-cycled. The fourth type, noninvasive positive-pressure ventilation, does not require intubation.

#### Pressure-Cycled Ventilators

When the pressure-cycled ventilator cycles on, it delivers a flow of air (inspiration) until it reaches a preset pressure, and then cycles off, and expiration occurs passively. Its major limitation is that the volume of air or oxygen can vary as the patient's airway resistance or compliance changes. As a result, the tidal volume delivered may be inconsistent, possibly compromising ventilation. Consequently, in adults, pressure-cycled ventilators are intended only for short-term use. The most common type is the IPPB machine (see earlier discussion).

#### Time-Cycled Ventilators

Time-cycled ventilators terminate or control inspiration after a preset time. The volume of air the patient receives is regulated by the length of inspiration and the flow rate of the air. Most ventilators have a rate control that determines the respiratory rate, but pure time cycling is rarely used for adults. These ventilators are used in newborns and infants.

#### Volume-Cycled Ventilators

Volume-cycled ventilators are by far the most commonly used positive-pressure ventilators today (Fig. 25-8). The volume of air delivered with each inspiration is preset. Once this preset volume is delivered to the patient, the ventilator cycles off and exhalation occurs passively. From breath to breath, the volume of air delivered by the ventilator is relatively constant, ensuring consistent, adequate breaths despite varying airway pressures.



**Figure 25-8** Positive-pressure ventilators. **A,** The AVEA can be used to both ventilate and monitor neonatal, pediatric, and adult patients. It can also deliver noninvasive ventilation with Heliox to adult and pediatric patients. Courtesy of VIASYS Healthcare, Inc., Yorba Linda, CA. **B,** The Puritan-Bennett 840 Ventilator System has volume, pressure, and mixed modes designed for adult, pediatric, and infant ventilation. Courtesy of Tyco Healthcare/Nelicor Puritan Bennett, Pleasanton, CA.

#### Noninvasive Positive-Pressure Ventilation

Noninvasive positive-pressure ventilation (NIPPV) is a method of positive-pressure ventilation that can be given via face masks that cover the nose and mouth, nasal masks, or other oral or nasal devices such as the nasal pillow (a small nasal cannula that seals around the nares to maintain the prescribed pressure). It eliminates the need for endotracheal intubation or tracheostomy and decreases the risk of nosocomial infections such as pneumonia. The most comfortable mode for the patient is pressure-controlled ventilation with pressure support. This eases the work of breathing and enhances gas exchange. The ventilator can be set with a minimum backup rate for patients with periods of apnea.

Patients are candidates for NIPPV if they have acute or chronic respiratory failure, acute pulmonary edema, COPD, chronic heart failure, or a sleep-related breathing disorder. The technique also may be used at home to improve tissue oxygenation and to rest the respiratory muscles while patients sleep at night. NIPPV is contraindicated for those who have experienced respiratory arrest, serious dysrhythmias, cognitive impairment, or head or facial trauma. NIPPV may also be used for obstructive sleep apnea, for patients at the end of life, and for those who do not want endotracheal intubation but may need short- or long-term ventilatory support (Bauman, 2009).

Continuous positive airway pressure (CPAP) provides positive pressure to the airways throughout the respiratory cycle. Although it can be used as an adjunct to mechanical ventilation with a cuffed endotracheal tube or tracheostomy tube to open the alveoli, it is also used with a leak-proof mask to keep alveoli open, thereby preventing respiratory failure. CPAP is the most effective treatment for obstructive sleep apnea because the positive pressure acts as a splint, keeping the upper airway and trachea open during sleep. To use CPAP, the patient must be breathing independently.

Bilevel positive airway pressure (bi-PAP) ventilation offers independent control of inspiratory and expiratory pressures while providing pressure support ventilation. It delivers two levels of positive airway pressure provided via a nasal or oral mask, nasal pillow, or mouthpiece with a tight seal and a portable ventilator. Each inspiration can be initiated either by the patient or by the machine if it is programmed with a backup rate. The backup rate ensures that the patient receives a set number of breaths per minute. Bi-PAP is most often used for patients who require ventilatory assistance at night, such as those with severe COPD or sleep apnea. Tolerance is variable; bi-PAP usually is most successful with highly motivated patients.

## Ventilator Modes

Ventilator mode refers to how breaths are delivered to the patient. The most commonly used modes are assist–control, intermittent mandatory ventilation, synchronized intermittent

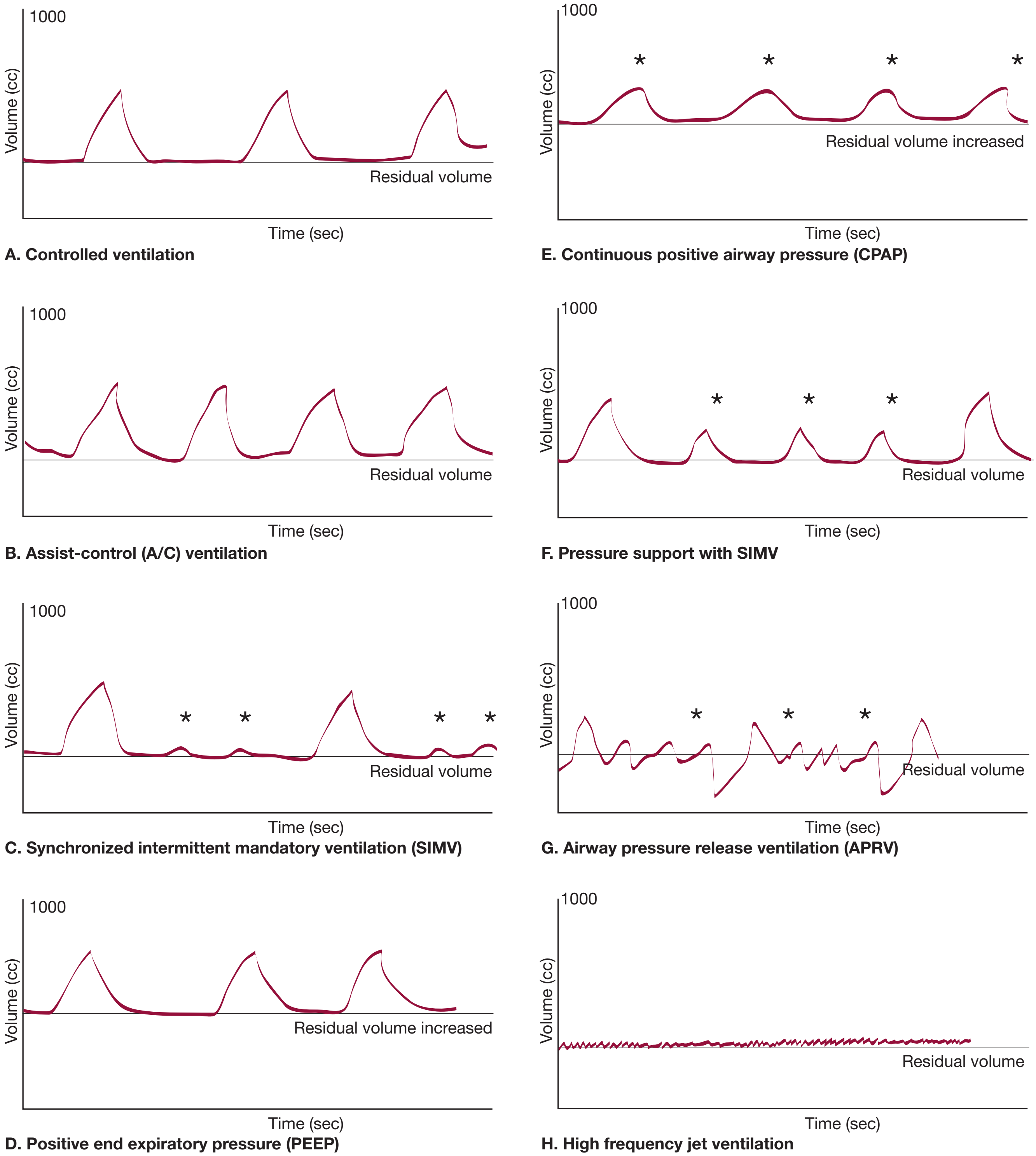



**Figure 25-9** Modes of mechanical ventilation with airflow waveforms. Inhalations marked with an asterisk (*) are spontaneous.

mandatory ventilation, pressure support ventilation, and airway pressure release ventilation (Fig. 25-9).

**Assist–control (A/C) ventilation** provides full ventilatory support by delivering a preset tidal volume and respiratory rate. If the patient initiates a breath between the machine's breaths, the ventilator delivers at the preset volume (assisted breath). Therefore, every breath is the preset volume.

**Intermittent mandatory ventilation (IMV)** provides a combination of mechanically assisted breaths and spontaneous breaths. Mechanical breaths are delivered at preset intervals and a preselected tidal volume, regardless of the patient's

efforts. Although the patient can increase the respiratory rate by initiating inspiration between ventilator-delivered breaths, these spontaneous breaths are limited to the tidal volume generated by the patient. IMV allows patients to use their own muscles for ventilation to help prevent muscle atrophy. It lowers mean airway pressure, which can assist in preventing barotrauma. However, bucking the ventilator (trying to exhale when the ventilator is delivering a breath) may be increased.

**Synchronized intermittent mandatory ventilation (SIMV)** also delivers a preset tidal volume and number of breaths per minute. Between ventilator-delivered breaths, the patient can breathe spontaneously with no assistance from the ventilator on those extra breaths. Because the ventilator senses patient breathing efforts and does not initiate a breath in opposition to the patient's efforts, bucking the ventilator is reduced. As the patient's ability to breathe spontaneously increases, the preset number of ventilator breaths is decreased and the patient does more of the work of breathing. Like IMV, SIMV can be used to provide full or partial ventilatory support. Nursing interventions for patients receiving IMV or SIMV include monitoring progress by recording respiratory rate, minute volume, spontaneous and machine-generated tidal volume, $FiO_2$, and arterial blood gas levels.

**Pressure support ventilation (PSV)** applies a pressure plateau to the airway throughout the patient-triggered inspiration to decrease resistance within the tracheal tube and ventilator tubing. Pressure support is reduced gradually as the patient's strength increases. A SIMV backup rate may be added for extra support. The nurse must closely observe the patient's respiratory rate and tidal volumes on initiation of PSV. It may be necessary to adjust the pressure support to avoid tachypnea or large tidal volumes.

**Airway pressure release ventilation (APRV)** is a time-triggered, pressure-limited, time-cycled mode of mechanical ventilation that allows unrestricted, spontaneous breathing throughout the ventilatory cycle. The inflation period is long, and breaths may be initiated spontaneously as well as by the ventilator. APRV allows alveolar gas to be expelled through the lungs' natural recoil. Further research is needed on the effectiveness of this mode of mechanical ventilation, but it has been suggested that APRV has the important advantages of causing less ventilator-induced lung injury and fewer adverse effects on cardiocirculatory function and being associated with lower need for sedation and neuromuscular blockade (MacIntyre, 2007).

A relatively new mode of support, **proportional assist ventilation (PAV),** provides partial ventilatory support in which the ventilator generates pressure in proportion to the patient's inspiratory efforts. With every breath, the ventilator synchronizes with the patient's ventilatory efforts. The more inspiratory pressure the patient generates, the more pressure the ventilator generates, amplifying the patient's inspiratory effort without any specific preselected target pressure or volume. It generally adds "additional muscle" to the patient's effort; the depth and frequency of breaths are controlled by the patient (Ambrosino & Rossi, 2002).

New modes of mechanical ventilation that incorporate computerized control of ventilation are being developed. In some of these modes, the ventilator constantly monitors many variables and adjusts gas delivery during individual breaths; these within-breath adjustment systems include automatic tube compensation, volume-ensured pressure support, and proportional support ventilation. In other modes, the ventilator evaluates gas delivery during one breath and uses that information to adjust the next breath; these between-breath adjustment systems can be made to ensure a preset tidal volume by adjusting pressure, up to a preset maximum, and include pressure volume support, pressure-regulated volume control, and adaptive support ventilation.

High-frequency oscillatory ventilators deliver small breaths approximately equal to the ventilatory dead space, at rates up to more than 100 times a minute. These small pulses of oxygen-enriched air move down the center of the airways, allowing alveolar air to exit the lungs along the margins of the airways. This ventilatory mode is used to open the alveoli in situations characterized by closed small airways, such as atelectasis and acute respiratory distress syndrome (ARDS), and it is also thought to protect the lung from pressure injury (MacIntyre, 2007).

## Adjusting the Ventilator

The ventilator is adjusted so that the patient is comfortable and breathes "in sync" with the machine. Minimal alteration of the normal cardiovascular and pulmonary dynamics is desired. Figure 25-9 describes modes of mechanical ventilation. If the volume ventilator is adjusted appropriately, the patient's arterial blood gas values will be satisfactory and there will be little or no cardiovascular compromise. Chart 25-12 describes initial ventilator settings.

### Chart 25-12 • *Initial Ventilator Settings*

The following guide is an example of the steps involved in operating a mechanical ventilator. The nurse, in collaboration with the respiratory therapist, always reviews the manufacturer's instructions, which vary according to the equipment, before beginning mechanical ventilation.

1. Set the machine to deliver the tidal volume required (10 to 15 mL/kg).
2. Adjust the machine to deliver the lowest concentration of oxygen to maintain normal $PaO_2$ (80 to 100 mm Hg). This setting may be high initially but will gradually be reduced based on arterial blood gas results.
3. Record peak inspiratory pressure.
4. Set mode (assist–control or synchronized intermittent mandatory ventilation) and rate according to physician order. (See the glossary for definitions of modes of mechanical ventilation.) Set PEEP and pressure support if ordered.
5. Adjust sensitivity so that the patient can trigger the ventilator with a minimal effort (usually 2 mm Hg negative inspiratory force).
6. Record minute volume and obtain ABGs to measure carbon dioxide partial pressure ($PaCO_2$), pH, and $PaO_2$ after 20 minutes of continuous mechanical ventilation.
7. Adjust setting ($FiO_2$ and rate) according to results of arterial blood gas analysis to provide normal values or those set by the physician.
8. If the patient suddenly becomes confused or agitated or begins bucking the ventilator for some unexplained reason, assess for hypoxia and manually ventilate on 100% oxygen with a resuscitation bag.

## Assessing the Equipment

The ventilator needs to be assessed to make sure that it is functioning properly and that the settings are appropriate. Although the nurse may not be primarily responsible for adjusting the settings on the ventilator or measuring ventilator parameters (these are usually responsibilities of the respiratory therapist), the nurse is responsible for the patient and therefore needs to evaluate how the ventilator affects the patient's overall status.

When monitoring the ventilator, the nurse notes the following:

- Type of ventilator (eg, volume-cycled, pressure-cycled, negative-pressure)
- Controlling mode (eg, **controlled ventilation,** assist–control ventilation, synchronized intermittent mandatory ventilation)
- Tidal volume and rate settings (tidal volume is usually set at 6 to 12 mL/kg [ideal body weight]; rate is usually set at 12 to 16 breaths/min)
- $FiO_2$ setting
- Inspiratory pressure reached and pressure limit (normal is 15 to 20 cm $H_2O$; this increases if there is increased airway resistance or decreased compliance)
- Sensitivity (a 2-cm $H_2O$ inspiratory force should trigger the ventilator)
- Inspiratory-to-expiratory ratio (usually 1:3 [1 second of inspiration to 3 seconds of expiration] or 1:2)
- Minute volume (tidal volume × respiratory rate, usually 6 to 8 L/min)
- Sigh settings (usually set at 1.5 times the tidal volume and ranging from 1 to 3 per hour), if applicable
- Water in the tubing, disconnection or kinking of the tubing
- Humidification (humidifier filled with water) and temperature
- Alarms (turned on and functioning properly)
- PEEP and pressure support level, if applicable (PEEP is usually set at 5 to 15 cm $H_2O$)

## Problems With Mechanical Ventilation

Because of the seriousness of the patient's condition and the highly complex and technical nature of mechanical ventilation, a number of problems or complications can occur. Such situations fall into two categories: ventilator problems and patient problems (Table 25-2). In either case, the patient must be supported while the problem is identified and corrected.

*NURSING ALERT*

**If the ventilator system malfunctions and the problem cannot be identified and corrected immediately, the nurse must ventilate the patient with a manual resuscitation bag until the problem is resolved.**

**Table 25-2 TROUBLESHOOTING PROBLEMS WITH MECHANICAL VENTILATION**

| Problem | Cause | Solution |
|---|---|---|
| **Ventilator Problems** | | |
| Increase in peak airway pressure | Coughing or plugged airway tube | Suction airway for secretions, empty condensation fluid from circuit |
| | Patient "bucking" ventilator | Adjust sensitivity |
| | Decreasing lung compliance | Manually ventilate patient<br>Assess for hypoxia or bronchospasm<br>Check arterial blood gas values<br>Sedate only if necessary |
| | Tubing kinked | Check tubing; reposition patient; insert oral airway if necessary |
| | Pneumothorax | Manually ventilate patient; notify physician |
| | Atelectasis or bronchospasm | Clear secretions |
| Decrease in pressure or loss of volume | Increase in compliance | None |
| | Leak in ventilator or tubing; cuff on tube/humidifier not tight | Check entire ventilator circuit for patency<br>Correct leak |
| **Patient Problems** | | |
| Cardiovascular compromise | Decrease in venous return due to application of positive pressure to lungs | Assess for adequate volume status by measuring heart rate, blood pressure, central venous pressure, pulmonary capillary wedge pressure, and urine output; notify physician if values are abnormal |
| Barotrauma/pneumothorax | Application of positive pressure to lungs; high mean airway pressures lead to alveolar rupture | Notify physician<br>Prepare patient for chest tube insertion<br>Avoid high pressure settings for patients with COPD, ARDS, or history of pneumothorax |
| Pulmonary infection | Bypass of normal defense mechanisms; frequent breaks in ventilator circuit; decreased mobility; impaired cough reflex | Use meticulous aseptic technique<br>Provide frequent mouth care<br>Optimize nutritional status |

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease.

#### *Bucking the Ventilator*

The patient is "in sync" with the ventilator when thoracic expansion coincides with the inspiratory phase of the machine and exhalation occurs passively. The patient is said to fight or buck the ventilator when he or she is out of phase with the machine. This is manifested when the patient attempts to breathe out during the ventilator's mechanical inspiratory phase or when there is jerky and increased abdominal muscle effort. Anxiety, hypoxia, increased secretions, hypercapnia, inadequate minute volume, long expiratory time, and pulmonary edema can all contribute to this problem. These problems must be corrected before resorting to the use of paralyzing agents to reduce bucking; otherwise, the underlying problem is simply masked and the patient's condition will continue to deteriorate.

Muscle relaxants, tranquilizers, analgesic agents, and paralyzing agents are sometimes administered to patients receiving mechanical ventilation. Their purpose is ultimately to increase the patient–machine synchrony by decreasing the patient's anxiety, hyperventilation, or excessive muscle activity. The selection and dose of the appropriate medication are determined by the patient's requirements and the cause of his or her restlessness. Paralyzing agents are always used as a last resort, and they are administered with a sedative medication and often an analgesic medication.

## NURSING PROCESS

## The Patient Receiving Mechanical Ventilation

### Assessment

The nurse plays a vital role in assessing the patient's status and the functioning of the ventilator. In assessing the patient, the nurse evaluates the patient's physiologic status and how he or she is coping with mechanical ventilation. Physical assessment includes systematic assessment of all body systems, with an in-depth focus on the respiratory system. Respiratory assessment includes vital signs, respiratory rate and pattern, breath sounds, evaluation of spontaneous ventilatory effort, and potential evidence of hypoxia (eg, skin color). Increased adventitious breath sounds may indicate a need for suctioning. The nurse also evaluates the settings and functioning of the mechanical ventilator, as described previously.

Assessment also addresses the patient's neurologic status and effectiveness of coping with the need for assisted ventilation and the changes that accompany it. The nurse assesses the patient's comfort level and ability to communicate as well. Because weaning from mechanical ventilation requires adequate nutrition, it is important to assess the patient's gastrointestinal system and nutritional status.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include:

- Impaired gas exchange related to underlying illness, ventilator setting adjustments, or weaning.
- Ineffective airway clearance related to increased mucus production associated with presence of the tube in trachea or continuous positive-pressure mechanical ventilation
- Risk for trauma and infection related to endotracheal intubation or tracheostomy
- Impaired physical mobility related to ventilator dependency
- Impaired verbal communication related to endotracheal tube or tracheostomy tube and attachment to ventilator
- Defensive coping and powerlessness related to ventilator dependency

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include the following:

- Alterations in cardiac function
- Barotrauma (trauma to the trachea or alveoli secondary to positive pressure) and pneumothorax
- Pulmonary infection
- Sepsis

### Planning and Goals

The major goals for the patient may include achievement of optimal gas exchange, maintenance of a patent airway, absence of trauma or infection, attainment of optimal mobility, adjustment to nonverbal methods of communication, acquisition of successful coping measures, and absence of complications.

### Nursing Interventions

Nursing care of the mechanically ventilated patient requires expert technical and interpersonal skills. Nursing interventions are similar regardless of the setting; however, the frequency of interventions and the stability of the patient vary from setting to setting. Nursing interventions for the mechanically ventilated patient are not uniquely different from those for patients with other pulmonary disorders; but astute nursing assessment and a therapeutic nurse–-patient relationship are critical. The specific interventions used by the nurse are determined by the underlying disease process and the patient's response.

Two general nursing interventions that are important in the care of the mechanically ventilated patient are pulmonary auscultation and interpretation of arterial blood gas measurements. The nurse is often the first to note changes in physical assessment findings or significant trends in blood gases that signal the development of a serious problem (eg, pneumothorax, tube displacement, pulmonary embolus).

#### *Enhancing Gas Exchange*

The purpose of mechanical ventilation is to optimize gas exchange by maintaining alveolar ventilation and oxygen delivery. The alteration in gas exchange may be caused by the underlying illness or by mechanical factors related to adjustment of the machine to the patient. The health care team, including the nurse, physician, and respiratory therapist,

continually assesses the patient for adequate gas exchange, signs and symptoms of hypoxia, and response to treatment. Therefore, the nursing diagnosis of impaired gas exchange is, by its complex nature, multidisciplinary and collaborative. The team members must share goals and information freely. All other goals directly or indirectly relate to this primary goal.

Nursing interventions to promote optimal gas exchange include judicious administration of analgesic agents to relieve pain without suppressing the respiratory drive and frequent repositioning to diminish the pulmonary effects of immobility. The nurse also monitors for adequate fluid balance by assessing for the presence of peripheral edema, calculating daily intake and output, and monitoring daily weights. The nurse administers medications prescribed to control the primary disease and monitors for their side effects.

***Promoting Effective Airway Clearance***

Continuous positive-pressure ventilation increases the production of secretions regardless of the patient's underlying condition. The nurse assesses for the presence of secretions by lung auscultation at least every 2 to 4 hours. Measures to clear the airway of secretions include suctioning, CPT, frequent position changes, and increased mobility as soon as possible. Frequency of suctioning should be determined by patient assessment. If excessive secretions are identified by inspection or auscultation techniques, suctioning should be performed. Sputum is not produced continuously or every 1 to 2 hours but as a response to a pathologic condition. Therefore, there is no rationale for routine suctioning of all patients every 1 to 2 hours. Although suctioning is used to aid in the clearance of secretions, it can damage the airway mucosa and impair cilia action.

The sigh mechanism on the ventilator may be adjusted to deliver at least 1 to 3 sighs per hour at 1.5 times the tidal volume if the patient is receiving assist–control ventilation. Periodic sighs prevent atelectasis and the further retention of secretions. Because of the risk for hyperventilation and trauma to pulmonary tissue from excess ventilator pressure (barotrauma, pneumothorax), the sigh feature is not used frequently. If the SIMV mode is being used, the mandatory ventilations act as sighs because they are of greater volume than the patient's spontaneous breaths.

Humidification of the airway via the ventilator is maintained to help liquefy secretions so that they are more easily removed. Bronchodilators are administered to dilate the bronchioles and are classified as adrenergic or anticholinergic. Adrenergic bronchodilators (see Chapter 24) are mostly inhaled and work by stimulating the beta-receptor sites, mimicking the effects of epinephrine in the body. The desired effect is smooth muscle relaxation, which dilates the constricted bronchial tubes. Anticholinergic bronchodilators produce airway relaxation by blocking cholinergic-induced bronchoconstriction. Patients receiving bronchodilator therapy of either type should be monitored for adverse effects, including dizziness, nausea, decreased oxygen saturation, hypokalemia, increased heart rate, and urine retention. Mucolytic agents are administered to liquefy secretions so that they are more easily mobilized. Nursing management of patients receiving mucolytic therapy includes assessment for an adequate cough reflex, sputum characteristics, and (in patients not receiving mechanical ventilation) improvement in incentive spirometry. Side effects include nausea, vomiting, bronchospasm, stomatitis (oral ulcers), urticaria, and rhinorrhea (runny nose).

***Preventing Trauma and Infection***

Maintaining the endotracheal or tracheostomy tube is an essential part of airway management. The nurse positions the ventilator tubing so that there is minimal pulling or distortion of the tube in the trachea, reducing the risk of trauma to the trachea. Cuff pressure is monitored every 6 to 8 hours to maintain the pressure at less than 25 mm Hg (optimal cuff pressure is 15 to 20 mm Hg). The nurse assesses for the presence of a cuff leak at the same time.

Patients with an endotracheal or tracheostomy tube do not have the normal defenses of the upper airway. In addition, these patients frequently have multiple additional body system disturbances that lead to immunocompromise. Tracheostomy care is performed at least every 8 hours, and more frequently if needed, because of the increased risk for infection. The ventilator circuit tubing and in-line suction tubing are replaced periodically, according to infection control guidelines, to decrease the risk for infection.

The nurse administers oral hygiene frequently because the oral cavity is a primary source of contamination of the lungs in the intubated and compromised patient (American Thoracic Society, 2005). The presence of a nasogastric tube in the intubated patient can increase the risk for aspiration, leading to nosocomial pneumonia. The nurse positions the patient with the head elevated above the stomach as much as possible. Although antiulcer medications such as cimetidine (Tagamet) or ranitidine (Zantac) are sometimes administered, an oral antiulcer medication such as sucralfate (Carafate) is preferable because it maintains normal gastric pH, decreasing the incidence of aspiration pneumonia.

***Promoting Optimal Level of Mobility***

Being connected to a ventilator limits the patient's mobility. The nurse helps the patient whose condition has become stable to get out of bed and move to a chair as soon as possible. Mobility and muscle activity are beneficial because they stimulate respirations and improve morale. If the patient is unable to get out of bed, the nurse encourages performance of active range-of-motion exercises every 6 to 8 hours. If the patient cannot perform these exercises, the nurse performs passive range-of-motion exercises every 8 hours to prevent contractures and venous stasis.

***Promoting Optimal Communication***

It is important to develop alternative methods of communication for the patient who is receiving mechanical ventilation. The nurse assesses the patient's communication abilities to evaluate for limitations. Questions to consider when assessing the ventilator-dependent patient's ability to communicate include the following:

- Is the patient conscious and able to communicate? Can the patient nod or shake his or her head?
- Is the patient's mouth unobstructed by the tube so that words can be mouthed?

- Is the patient's dominant hand strong and available for writing? For example, if the patient is right-handed, the intravenous (IV) line should be placed in the left arm if possible so that the right hand is free.
- Is the patient a candidate for a fenestrated tracheostomy tube or a one-way speaking valve (such as Passy-Muir valve or Olympic Trach-Talk) that permit talking?

Once the patient's limitations are known, the nurse offers several appropriate communication approaches: lip or speech reading (use single key words), pad and pencil or Magic Slate, communication board, gesturing, sign language, or electric larynx. Use of a "talking" or fenestrated tracheostomy tube or one-way valve may be suggested to the physician; these allow the patient to talk while on the ventilator. The nurse makes sure that the patient's eyeglasses, hearing aid, sign interpreter, and language translator are available if needed to enhance the patient's ability to communicate.

Some communication methods may be frustrating to the patient, family, and nurse; these need to be identified and minimized. A speech therapist can assist in determining the most appropriate method.

### *Promoting Coping Ability*

Dependence on a ventilator is frightening to both the patient and the family and disrupts even the most stable families. Encouraging the family to verbalize their feelings about the ventilator, the patient's condition, and the environment in general is beneficial. Explaining procedures every time they are performed helps reduce anxiety and familiarizes the patient with ventilator procedures. To restore a sense of control, the nurse encourages the patient to participate in decisions about care, schedules, and treatment when possible. The patient may become withdrawn or depressed while receiving mechanical ventilation, especially if its use is prolonged (Chart 25-13). To promote effective coping, the nurse informs the patient about progress when appropriate. It is important to provide diversions such as watching television, playing music, or taking a walk (if appropriate and possible). Stress reduction techniques (eg, a back rub, relaxation measures) relieve tension and help the patient deal with anxieties and fears about both the condition and the dependence on the ventilator.

### *Monitoring and Managing Potential Complications*

**ALTERATIONS IN CARDIAC FUNCTION.** Alterations in cardiac output may occur as a result of positive-pressure ventilation. The positive intrathoracic pressure during inspiration compresses the heart and great vessels, thereby reducing venous return and cardiac output. This is usually corrected during exhalation when the positive pressure is off. The patient

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**CHART 25-13 NURSING RESEARCH PROFILE**

## *What It's Like to Live on a Ventilator*

Johnson, P., St. John, W. & Moyle, W. (2006). Long-term mechanical ventilation in a critical care unit: Existing in an uneveryday world. *Journal of Advanced Nursing, 53*(5), 551–558.

**Purpose**

Because of the aging of the population and improvements in health care technology, more patients are undergoing mechanical ventilation for long periods—that is, for 7 or more days. This use of technology may be uncomfortable and frightening to the patient, who may also feel helpless and anxious; the patient may even experience episodes of panic, nightmares, or hallucinations. Researchers conducted this study to learn what it means to the patient to be dependent on long-term mechanical ventilation.

**Design**

Data collection for this qualitative study consisted of interviews with nine people, 21 to 69 years of age, who had required mechanical ventilation for at least 7 days while in a critical care unit. Participants had been conscious for some of the time while on the ventilator and were able to recall and discuss their experience. The interviews lasted 45 to 140 minutes. The investigators read transcriptions of the interviews several times and found four major themes that ran through the interviews. The investigators then went back to five of the participants and reviewed their preliminary findings to ensure that they had interpreted the data correctly.

**Findings**

Participants' reactions had four themes, including "existing in an uneveryday world." The participants' fluctuating levels of consciousness, difficulty distinguishing reality, and losing track of time caused them to feel removed from the real world. Hallucinations and unpleasant dreams remained vivid even following discharge. Their bodies felt strange and unfamiliar, and their inability to communicate effectively was frustrating. The technology that they depended on was irritating at times and made them feel vulnerable; they wondered if they would survive.

**Nursing Implications**

Despite the near universal complaint of discomfort, there was little mention of pain in this sample. This may be related to adequate management of pain. However, participants described other unpleasant sensations, such as those associated with suctioning. Therefore, it is vital that nurses caring for patients on long-term mechanical ventilation comfort and support them; in addition, the nurses must carry out interventions with sensitivity and gentleness. Because participants had not been able to make sense of what occurred while they were in the critical care unit, they found the interviews therapeutic; discussing their memories of the critical care unit helped them understand what had happened. The authors recommend, therefore, that nurses provide opportunities for patients to discuss their hospitalization following discharge. More research is needed to determine optimal care and postdischarge services for people who need to be mechanically ventilated while in intensive care.

may have decreased cardiac output and resultant decreased tissue perfusion and oxygenation.

To evaluate cardiac function, the nurse first observes for signs and symptoms of hypoxia (restlessness, apprehension, confusion, tachycardia, tachypnea, pallor progressing to cyanosis, diaphoresis, transient hypertension, and decreased urine output). If a pulmonary artery catheter is in place, cardiac output, cardiac index, and other hemodynamic values can be used to assess the patient's status.

**BAROTRAUMA AND PNEUMOTHORAX.** Excessive positive pressure can cause lung damage, or barotrauma, which may result in a spontaneous **pneumothorax,** which may quickly develop into a tension pneumothorax, further compromising venous return, cardiac output, and blood pressure. The nurse considers any sudden changes in oxygen saturation or the onset of respiratory distress to be a life-threatening emergency requiring immediate action.

**PULMONARY INFECTION.** The patient is at high risk for infection, as described earlier. The nurse reports fever or a change in the color or odor of sputum to the physician for follow-up.

### *Promoting Home and Community-Based Care*

Increasingly, patients are being cared for in extended care facilities or at home while receiving mechanical ventilation, with a tracheostomy tube, or receiving oxygen therapy. Patients receiving home ventilator care usually have a chronic neuromuscular condition or COPD. Providing the opportunity for ventilator-dependent patients to return home to live with their families in familiar surroundings can be a positive experience. The ultimate goal of home ventilator therapy is to enhance the patient's quality of life, not simply to support or prolong life.

**TEACHING PATIENTS SELF-CARE.** Caring for the patient with mechanical ventilator support at home can be accomplished successfully. A home care team consisting of the nurse, physician, respiratory therapist, social service or home care agency, and equipment supplier is needed. The home is evaluated to determine whether the electrical equipment needed can be operated safely. Chart 25-14 summarizes the basic assessment criteria needed for successful home care.

Once the decision to initiate mechanical ventilation at home is made, the nurse prepares the patient and family for home care. The nurse teaches the patient and family about the ventilator, suctioning, tracheostomy care, signs of pulmonary infection, cuff inflation and deflation, and assessment of vital signs. Teaching begins in the hospital and continues at home. Nursing responsibilities include evaluating the patient's and family's understanding of the information presented.

The nurse teaches the family cardiopulmonary resuscitation, including mouth-to-tracheostomy tube (instead of mouth-to-mouth) breathing. The nurse also explains how to handle a power failure, which usually involves converting the ventilator from an electrical power source to a battery power source. Conversion is automatic in most types of home ventilators and lasts approximately 1 hour. The nurse instructs the family on the use of a manual self-inflation bag should it be necessary. Chart 25-15 lists some of the patient's and family's responsibilities.

### Chart 25-14 • *Criteria for Successful Home Ventilator Care*

The decision to proceed with home ventilation therapy is usually based on the following parameters.

**Patient Criteria**

- The patient has a chronic underlying pulmonary or neuromuscular disorder.
- The patient's clinical pulmonary status is stable.
- The patient is willing to go home on mechanical ventilation.

**Home Criteria**

- The home environment is conducive to care of the patient.
- The electrical facilities are adequate to operate all equipment safely.
- The home environment is controlled, without drafts in cold weather and with proper ventilation in warm weather.
- Space is available for cleaning and storing ventilator equipment.

**Family Criteria**

- Family members are competent, dependable, and willing to spend the time required for proper training as primary caregivers.
- Family members understand the diagnosis and prognosis.
- Family has sufficient financial and supportive resources and can obtain professional support if necessary.

**CONTINUING CARE.** A home care nurse monitors and evaluates how well the patient and family are adapting to providing care in the home. The nurse assesses the adequacy of the patient's ventilation and oxygenation as well as airway patency. The nurse addresses any unique adaptation problems the patient may have and listens to the patient's and family's anxieties and frustrations, offering support and encouragement where possible. The home care nurse helps identify and contact community resources that may assist in home management of the patient with mechanical ventilation.

The technical aspects of the ventilator are managed by vendor follow-up. A respiratory therapist usually is assigned to the patient and makes frequent home visits to evaluate the patient and perform a maintenance check of the ventilator.

Transportation services are identified in case the patient requires transportation in an emergency. These arrangements must be made before an emergency arises.

## Evaluation

Expected patient outcomes may include the following:

1. Exhibits adequate gas exchange, as evidenced by normal breath sounds, acceptable arterial blood gas levels, and vital signs

CHART 25-15

HOME CARE CHECKLIST
## Ventilator Care

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State proper care of patient on ventilator | | |
| • Observe physical signs such as color, secretions, breathing pattern, and state of consciousness. | | ✔ |
| • Perform physical care such as suctioning, postural drainage, and ambulation. | | ✔ |
| • Observe the tidal volume and pressure manometer regularly. Intervene when they are abnormal (ie, suction if airway pressure increases). | | ✔ |
| • Provide a communication method for the patient (eg, pad and pencil, electric larynx, talking tracheostomy tube, sign language). | | ✔ |
| • Monitor vital signs as directed. | | ✔ |
| • Use a predetermined signal to indicate when feeling short of breath or in distress. | ✔ | |
| • Care for and maintain equipment properly | | |
| • Check the ventilator settings twice each day and whenever the patient is removed from the ventilator. | | ✔ |
| • Adjust the volume and pressure alarms if needed. | | ✔ |
| • Fill humidifier as needed and check its level three times a day. | | ✔ |
| • Empty water in tubing as needed. | ✔ | ✔ |
| • Use a clean humidifier when circuitry is changed. | | ✔ |
| • Keep exterior of ventilator clean and free of any objects. | | ✔ |
| • Change external circuitry once a week or more often as indicated. | | ✔ |
| • Report malfunction or strange noises immediately. | ✔ | ✔ |

2. Demonstrates adequate ventilation with minimal mucus accumulation
3. Is free of injury or infection, as evidenced by normal temperature, white blood cell count, and clear sputum
4. Is mobile within limits of ability
   a. Gets out of bed to chair, bears weight, or ambulates as soon as possible
   b. Performs range-of-motion exercises every 6 to 8 hours
5. Communicates effectively through written messages, gestures, or other communication strategies
6. Copes effectively
   a. Verbalizes fears and concerns about condition and equipment
   b. Participates in decision making when possible
   c. Uses stress reduction techniques when necessary
7. Absence of complications
   a. Absence of cardiac compromise, as evidenced by stable vital signs and adequate urine output
   b. Absence of pneumothorax, as evidenced by bilateral chest excursion, normal chest x-ray, and adequate oxygenation
   c. Absence of pulmonary infection, as evidenced by normal temperature, clear pulmonary secretions, and negative sputum cultures

## Weaning the Patient From the Ventilator

**Respiratory weaning,** the process of withdrawing the patient from dependence on the ventilator, takes place in three stages: the patient is gradually removed from the ventilator, then from the tube, and finally from oxygen. Weaning from mechanical ventilation is performed at the earliest possible time consistent with patient safety. The decision must be made from a physiologic rather than a mechanical viewpoint. A thorough understanding of the patient's clinical status is required in making this decision. Weaning is started when the patient is recovering from the acute stage of medical and surgical problems and when the cause of respiratory failure is sufficiently reversed. Chart 25-16 presents information about patient care during weaning from mechanical ventilation.

Successful weaning involves collaboration among the physician, respiratory therapist, and nurse. Each health care provider must understand the scope and function of other team members in relation to patient weaning to conserve the patient's strength, use resources efficiently, and maximize successful outcomes.

### *Criteria for Weaning*

Careful assessment is required to determine whether the patient is ready to be removed from mechanical ventilation. If the patient is stable and showing signs of improvement or reversal of the disease or condition that caused the need for mechanical ventilation, weaning indices should be assessed (see Chart 25-16).

Stable vital signs and arterial blood gases are also important predictors of successful weaning. Once readiness has been determined, the nurse records baseline measurements of weaning indices to monitor progress.

### *Patient Preparation*

To maximize the chances of success of weaning, the nurse must consider the patient as a whole, taking into account factors that impair the delivery of oxygen and elimination

## Chart 25-16 • *Care of the Patient Being Weaned From Mechanical Ventilation*

- Assess patient for weaning criteria:
  a. Vital capacity:10 to 15 mL/kg
  b. Maximum inspiratory pressure (MIP) at least –20 cm $H_2O$
  c. Tidal volume: 7 to 9 mL/kg
  d. Minute ventilation: 6 L/min
  e. Rapid/shallow breathing index: below 100 breaths/minute/L; $PaO_2$ >60 mm Hg with $FiO_2$ less than 40%
- Monitor activity level, assess dietary intake, and monitor results of laboratory tests of nutritional status. Reestablishing independent spontaneous ventilation can be physically exhausting. It is crucial that the patient have enough energy reserves to succeed.
- Assess the patient's and family's understanding of the weaning process and address any concerns about the process. Explain that the patient may feel short of breath initially and provide encouragement as needed. Reassure the patient that he or she will be attended closely and that if the weaning attempt is not successful, it can be tried again later.
- Implement the weaning method prescribed: A/C ventilation, IMV, SIMV, PSV, PAV, CPAP, or T-piece.
- Monitor vital signs, pulse oximetry, ECG, and respiratory pattern constantly for the first 20 to 30 minutes and every 5 minutes after that until weaning is complete. Monitoring the patient closely provides ongoing indications of success or failure.
- Maintain a patent airway; monitor arterial blood gas levels and pulmonary function tests. Suction the airway as needed.
- In collaboration with the physician, terminate the weaning process if adverse reactions occur. These include a heart rate increase of 20 beats/min, systolic blood pressure increase of 20 mm Hg, a decrease in oxygen saturation to less than 90%, respiratory rate less than 8 or greater than 20 breaths/min, ventricular dysrhythmias, fatigue, panic, cyanosis, erratic or labored breathing, paradoxical chest movement.
- If the weaning process continues, measure tidal volume and minute ventilation every 20 to 30 minutes; compare with the patient's desired values, which have been determined in collaboration with the physician.
- Assess for psychological dependence if the physiologic parameters indicate weaning is feasible and the patient still resists. Possible causes of psychological dependence include fear of dying and depression from chronic illness. It is important to address this issue before the next weaning attempt.

of carbon dioxide as well as those that increase oxygen demand (eg, sepsis, seizures, thyroid imbalances) or decrease the patient's overall strength (eg, inadequate nutrition, neuromuscular disease). Adequate psychological preparation is necessary before and during the weaning process.

### Methods of Weaning

Successful weaning depends on the combination of adequate patient preparation, available equipment, and an interdisciplinary approach to solve patient problems (see Chart 25-16). All usual modes of ventilation can be used for weaning.

When assist–control (A/C) ventilation is used, the control rate is decreased, so that the patient strengthens the respiratory muscles by triggering progressively more breaths. The nurse assesses the patient for signs of distress: rapid or shallow breathing, use of accessory muscles, reduced level of consciousness, increase in carbon dioxide levels, decrease in oxygen saturation, and tachycardia.

SIMV is indicated if the patient satisfies all the criteria for weaning but cannot sustain adequate spontaneous ventilation for long periods. As the patient's respiratory muscles become stronger, the rate is decreased until the patient is breathing spontaneously.

The PAV mode of partial ventilatory support allows the ventilator to generate pressure in proportion to the patient's efforts. With every breath, the ventilator synchronizes with the patient's ventilatory efforts. Nursing assessment includes careful monitoring of the patient's respiratory rate, arterial blood gases, tidal volume, minute ventilation, and breathing pattern.

CPAP allows the patient to breathe spontaneously while applying positive pressure throughout the respiratory cycle to keep the alveoli open and promote oxygenation. Providing CPAP during spontaneous breathing also offers the advantage of an alarm system and may reduce patient anxiety if the patient has been taught that the machine is keeping track of breathing. It also maintains lung volumes and improves the patient's oxygenation status. CPAP is often used in conjunction with PSV. Nurses should carefully assess for tachypnea, tachycardia, reduced tidal volumes, decreasing oxygen saturations, and increasing carbon dioxide levels.

When the patient can breathe spontaneously, weaning trials using a T-piece or tracheostomy mask (see Fig. 25-2) are normally conducted with the patient disconnected from the ventilator, receiving humidified oxygen only and performing all work of breathing. Because patients do not have to overcome the resistance of the ventilator, they may find this mode more comfortable, or they may become anxious as they breathe with no support from the ventilator. During T-piece trials, the nurse monitors the patient closely and provides encouragement. This method of weaning is usually used when the patient is awake and alert, is breathing without difficulty, has good gag and cough reflexes, and is hemodynamically stable. During the weaning process, the patient is maintained on the same or a higher oxygen concentration than when receiving mechanical ventilation. While the patient is using the T-piece, he or she is observed for signs and symptoms of hypoxia, increasing respiratory muscle fatigue, or systemic fatigue. These include rest-

lessness, increased respiratory rate (greater than 35 breaths/min), use of accessory muscles, tachycardia with premature ventricular contractions, and paradoxical chest movement (asynchronous breathing, chest contraction during inspiration and expansion during expiration). Fatigue or exhaustion is initially manifested by an increased respiratory rate associated with a gradual reduction in tidal volume; later there is a slowing of the respiratory rate.

If the patient appears to be tolerating the T-piece trial, a second set of arterial blood gas measurements is drawn 20 minutes after the patient has been on spontaneous ventilation at a constant $FiO_2$ pressure support ventilation. (Alveolar–arterial equilibration takes 15 to 20 minutes to occur.)

Signs of exhaustion and hypoxia correlated with deterioration in the blood gas measurements indicate the need for ventilatory support. The patient is placed back on the ventilator each time signs of fatigue or deterioration develop.

If clinically stable, the patient usually can be extubated within 2 or 3 hours after weaning and allowed spontaneous ventilation by means of a mask with humidified oxygen. Patients who have had prolonged ventilatory assistance usually require more gradual weaning; it may take days or even weeks. They are weaned primarily during the day and placed back on the ventilator at night to rest.

Because patients respond in different manners to weaning methods, there is no definitive way to assess which method is best. Regardless of the weaning method being used, ongoing assessment of respiratory status is essential to monitor patient progress.

Successful weaning from the ventilator is supplemented by intensive pulmonary care. The following methods are used: oxygen therapy; arterial blood gas evaluation; pulse oximetry; bronchodilator therapy; CPT; adequate nutrition, hydration, and humidification; blood pressure measurement; and incentive spirometry. Daily spontaneous breathing trials may be used to evaluate the patient's ability to breathe without ventilatory support. There is some evidence that such trials are best performed if sedation is temporarily withdrawn for the trial (MacIntyre, 2007). A patient may still have borderline pulmonary function and need vigorous supportive therapy before his or her respiratory status returns to a level that supports activities of daily living.

### Weaning From the Tube

Weaning from the tube is considered when the patient can breathe spontaneously, maintain an adequate airway by effectively coughing up secretions, swallow, and move the jaw. If frequent suctioning is needed to clear secretions, tube weaning may be unsuccessful. Secretion clearance and aspiration risks are assessed to determine whether active pharyngeal and laryngeal reflexes are intact.

Once the patient can clear secretions adequately, a trial period of mouth breathing or nose breathing is conducted. This can be accomplished by several methods. The first method requires changing to a smaller size tube to increase the resistance to airflow or plugging the tracheostomy tube (deflating the cuff first). The smaller tube is sometimes replaced by a cuffless tracheostomy tube, which allows the tube to be plugged at lengthening intervals to monitor patient progress. A second method involves changing to a fenestrated tube (a tube with an opening or window in its bend). This permits air to flow around and through the tube to the upper airway and enables talking. A third method involves switching to a smaller tracheostomy button (stoma button). A tracheostomy button is a plastic tube approximately 1 inch long that helps keep the windpipe open after the larger tracheostomy tube has been removed. Finally, when the patient demonstrates the ability to maintain a patent airway, the tube can be removed. An occlusive dressing is placed over the stoma, which heals in several days to weeks.

### Weaning From Oxygen

The patient who has been successfully weaned from the ventilator, cuff, and tube and has adequate respiratory function is then weaned from oxygen. The $FiO_2$ is gradually reduced until the $PaO_2$ is in the range of 70 to 100 mm Hg while the patient is breathing room air. If the $PaO_2$ is less than 70 mm Hg on room air, supplemental oxygen is recommended. To be eligible for financial reimbursement from the Centers for Medicare and Medicaid Services for in-home oxygen, the patient must have a $PaO_2$ of less than 60 mm Hg while awake and at rest.

### Nutrition

Success in weaning the long-term ventilator-dependent patient requires early and aggressive but judicious nutritional support. The respiratory muscles (diaphragm and especially intercostals) become weak or atrophied after just a few days of mechanical ventilation and may be catabolized for energy, especially if nutrition is inadequate. Compensation for inadequate nutrition must be undertaken with care; excessive intake can increase production of carbon dioxide and the demand for oxygen and lead to prolonged ventilator dependence and difficulty in weaning (O'Leary-Kelley, Puntillo, Barr, et al., 2005). Because the metabolism of fat produces less carbon dioxide than the metabolism of carbohydrates, a high-fat diet, in which 50% of daily kilocalories are from fat, may assist patients with respiratory failure, both during mechanical ventilation and while being weaned. The evidence on the value of a limited carbohydrate intake versus a carbohydrate-enriched diet is uncertain. Adequate protein intake is important in increasing respiratory muscle strength. Protein intake should be approximately 25% of total daily kilocalories, or 1.2 to 1.5 g/kg/day. Daily nutrition should be closely monitored.

Soon after the patient is admitted, a consultation with a dietitian or nutrition support team should be arranged to plan the best form of nutritional replacement. Adequate nutrition may decrease the duration of mechanical ventilation and prevent other complications, especially sepsis. Sepsis can occur if bacteria enter the bloodstream and release toxins that, in turn, cause vasodilation and

hypotension, fever, tachycardia, increased respiratory rate, and coma. Aggressive treatment of sepsis is essential to reverse this threat to survival and to promote weaning from the ventilator when the patient's condition improves.

# THE PATIENT UNDERGOING THORACIC SURGERY

Assessment and management are particularly important for the patient undergoing thoracic surgery. Frequently, patients undergoing such surgery also have obstructive pulmonary disease or other chronic disease. Preoperative preparation and careful postoperative management are crucial for successful patient outcomes because these patients may have a narrow range between their physical tolerance for certain activities and their limitations, which, if exceeded, can lead to distress. Various types of thoracic surgical procedures are performed to relieve disease conditions such as lung abscesses, lung cancer, cysts, benign tumors, and emphysema (Chart 25-17). An exploratory **thoracotomy** (creation of a surgical opening into the thoracic cavity) may be performed to diagnose lung or chest disease. A biopsy may be performed in this procedure with a small amount of lung tissue removed for analysis; the chest incision is then closed.

The objectives of preoperative care for the patient undergoing thoracic surgery are to ascertain the patient's functional reserve, to determine whether the patient is likely to survive and recover from the surgery, and to ensure that the patient is in optimal condition for surgery.

## *Preoperative Management*

### Assessment and Diagnostic Findings

The nurse performs chest auscultation to assess breath sounds in all regions of the lungs (see Chapter 21). It is important to note whether breath sounds are normal, indicating a free flow of air in and out of the lungs. (In the patient with emphysema, the breath sounds may be markedly decreased or even absent on auscultation.) The nurse notes crackles and wheezes and assesses for hyperresonance and decreased diaphragmatic motion. Unilateral diminished breath sounds and rhonchi can be the result of occlusion of the bronchi by mucus plugs. The nurse assesses for retained secretions during auscultation by asking the patient to cough. It is important to note any signs of rhonchi or wheezing. The patient history and assessment should include the following questions:

- What signs and symptoms (cough, sputum expectorated [amount and color], hemoptysis, chest pain, dyspnea) are present?
- If there is a smoking history, how long has the patient smoked? Does the patient smoke currently? How many packs a day?
- What is the patient's cardiopulmonary tolerance while resting, eating, bathing, and walking?
- What is the patient's breathing pattern? How much exertion is required to produce dyspnea?
- Does the patient need to sleep in an upright position or with more than two pillows?
- What is the patient's general physiologic status (eg, general appearance, mental alertness, behavior, nutritional status)?
- What other medical conditions exist (eg, allergies, cardiac disorders, diabetes)?

A number of tests are performed to determine the patient's preoperative status and to assess the patient's physical assets and limitations. Many patients are seen by their surgeons in the office, and many tests and examinations are performed on an outpatient basis. The decision to perform any pulmonary resection is based on the patient's cardiovascular status and pulmonary reserve. Pulmonary function studies (especially lung volume and vital capacity) are performed to determine whether the planned resection will leave sufficient functioning lung tissue. Arterial blood gas values are assessed to provide a more complete picture of the functional capacity of the lung. Exercise tolerance tests are useful to determine whether the patient who is a candidate for pneumonectomy can tolerate removal of one of the lungs.

Preoperative studies are performed to provide a baseline for comparison during the postoperative period and to detect any unsuspected abnormalities. These studies may include a bronchoscopic examination (a lighted scope is inserted into the airways to examine the bronchi), chest x-ray, magnetic resonance imaging (MRI), electrocardiogram (ECG) for arteriosclerotic heart disease, conduction defects), nutritional assessment, determination of blood urea nitrogen and serum creatinine levels (to assess renal function), determination of glucose tolerance or blood glucose level (to check for diabetes), serum electrolytes and protein levels, blood volume determinations, and complete blood cell count.

### Preoperative Nursing Management

#### *Improving Airway Clearance*

The underlying lung condition often is associated with increased respiratory secretions. Before surgery, the airway is cleared of secretions to reduce the possibility of postoperative atelectasis or infection. Chart 25-18 lists the risk factors for postoperative atelectasis and pneumonia. Strategies to reduce the risk for atelectasis and infection include humidification, postural drainage, and chest percussion after bronchodilators are administered, if prescribed. The nurse estimates the volume of sputum if the patient expectorates large amounts of secretions. Such measurements are carried out to determine whether and when the amount decreases. Antibiotics are administered as prescribed for infection, which can cause excessive secretions.

#### *Teaching the Patient*

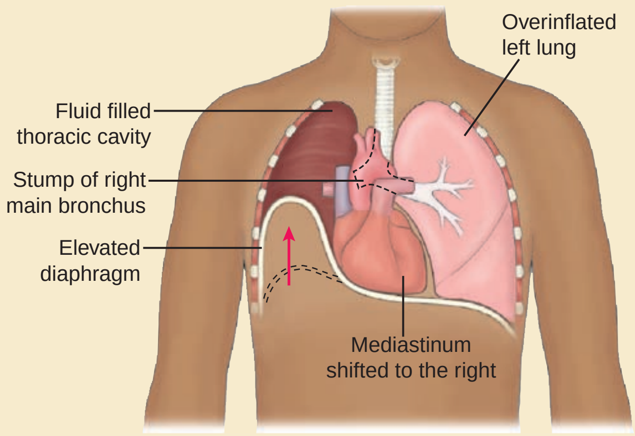
Increasingly, patients are admitted on the day of surgery, which does not provide much time for preoperative assessment or teaching. Nurses in all settings must take an active role in educating the patient and relieving anxiety. The

## Chart 25-17 • *Thoracic Surgeries and Procedures*

### Pneumonectomy

The removal of an entire lung (pneumonectomy) is performed chiefly for cancer when the lesion cannot be removed by a less extensive procedure. It also may be performed for lung abscesses, bronchiectasis, or extensive unilateral tuberculosis. The removal of the right lung is more dangerous than the removal of the left, because the right lung has a larger vascular bed and its removal imposes a greater physiologic burden.

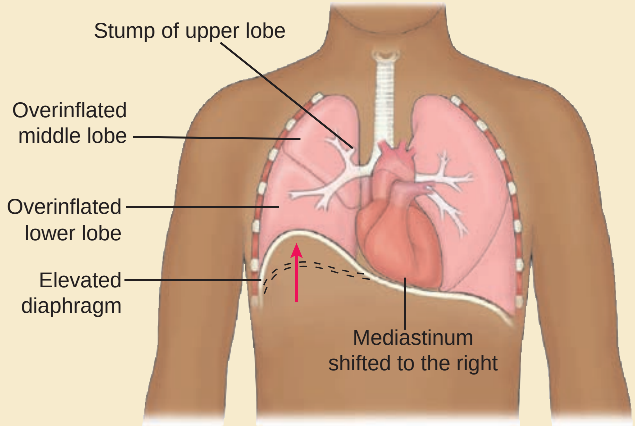
A posterolateral or anterolateral thoracotomy incision is made, sometimes with resection of a rib. The pulmonary artery and the pulmonary veins are ligated and severed. The main bronchus is divided and the lung removed. The bronchial stump is stapled, and usually no drains are used because the accumulation of fluid in the empty hemithorax prevents mediastinal shift.




Pneumonectomy

### Lobectomy

When the pathology is limited to one area of a lung, a lobectomy (removal of a lobe of a lung) is performed. Lobectomy, which is more common than pneumonectomy, may be carried out for bronchogenic carcinoma, giant emphysematous blebs or bullae, benign tumors, metastatic malignant tumors, bronchiectasis, and fungus infections.




Lobectomy

The surgeon makes a thoracotomy incision: its exact location depends on the lobe to be resected. When the pleural space is entered, the involved lung collapses and the lobar vessels and the bronchus are ligated and divided. After the lobe is removed, the remaining lobes of the lung are re-expanded. Usually, two chest catheters are inserted for drainage. The upper tube is for air removal; the lower one is for fluid drainage. Sometimes, only one catheter is needed. The chest tube is connected to a chest drainage apparatus for several days.

### Segmentectomy (Segmental Resection)

Some lesions are located in only one segment of the lung. Bronchopulmonary segments are subdivisions of the lung that function as individual units. They are held together by delicate connective tissue. Disease processes may be limited to a single segment. Care is used to preserve as much healthy and functional lung tissue as possible, especially in patients who already have limited cardiopulmonary reserve. Single segments can be removed from any lobe; the right middle lobe, which has only two small segments, invariably is removed entirely. On the left side, corresponding to a middle lobe, is a "lingular" segment of the upper lobe. This can be removed as a single segment or by lingulectomy. This segment frequently is involved in bronchiectasis.

### Wedge Resection

A wedge resection of a small, well-circumscribed lesion may be performed without regard for the location of the intersegmental planes. The pleural cavity usually is drained because of the possibility of an air or blood leak. This procedure is performed for diagnostic lung biopsy and for the excision of small peripheral nodules.

### Bronchoplastic or Sleeve Resection

Bronchoplastic resection is a procedure in which only one lobar bronchus, together with a part of the right or left bronchus, is excised. The distal bronchus is reanastomosed to the proximal bronchus or trachea.

### Lung Volume Reduction

Lung volume reduction is a surgical procedure involving the removal of 20% to 30% of a patient's lung through a midsternal incision or video thoracoscopy. The diseased lung tissue is identified on a lung perfusion scan. This surgery leads to significant improvements in dyspnea, exercise capacity, quality of life, and survival of a subgroup of people with end-stage emphysema (Naunheim, 2004).

### Video Thoracoscopy

A video thoracoscopy is an endoscopic procedure that allows the surgeon to look into the thorax without making a large incision. The procedure is performed to obtain specimens of tissue for biopsy, to treat recurrent spontaneous pneumothorax, and to diagnose either pleural effusions or pleural masses. Thoracoscopy has also been found to be an effective diagnostic and therapeutic alternative for the treatment of mediastinal disorders (Cirino, Campos, Jatene, et al., 2000). Some advantages of video thoracoscopy are rapid diagnosis and treatment of some conditions, a decrease in postoperative complications, and a shortened hospital stay (see Chapter 21).

**CHART 25-18** ***Risk Factors for Surgery-Related Atelectasis and Pneumonia***

**Preoperative Risk Factors**

- Increased age
- Obesity
- Poor nutritional status
- Smoking history
- Abnormal pulmonary function tests
- Preexisting lung disease
- Emergency surgery
- History of aspiration
- Comorbid states
- Preexisting disability

**Intraoperative Risk Factors**

- Thoracic incision
- Prolonged anesthesia

**Postoperative Risk Factors**

- Immobilization
- Supine position
- Decreased level of consciousness
- Inadequate pain management
- Prolonged intubation/mechanical ventilation
- Presence of nasogastric tube
- Inadequate preoperative education

nurse informs the patient what to expect, from administration of anesthesia to thoracotomy and the likely use of chest tubes and a drainage system in the postoperative period. The patient is also informed about the usual postoperative administration of oxygen to facilitate breathing and the possible use of a ventilator. It is essential to explain the importance of frequent turning to promote drainage of lung secretions. Instruction in the use of incentive spirometry begins before surgery to familiarize the patient with its correct use. The nurse teaches diaphragmatic and pursed-lip breathing, and the patient should begin practicing these techniques (see Charts 25-3 and 25-4).

Because a coughing schedule is necessary in the postoperative period to promote the clearance or removal of secretions, the nurse instructs the patient in the technique of coughing and warns the patient that the coughing routine may be uncomfortable. The nurse teaches the patient to splint the incision with the hands, a pillow, or a folded towel (see Chart 25-5).

Another technique, "huffing," may be helpful for the patient with diminished expiratory flow rates or for the patient who refuses to cough because of severe pain. Huffing is the expulsion of air through an open glottis. This type of forced expiration technique (FET) stimulates pulmonary expansion and assists in alveolar inflation. The nurse instructs the patient as follows:

- Take a deep diaphragmatic breath and exhale forcefully against your hand in a quick, distinct pant, or huff.
- Practice doing small huffs and progress to one strong huff during exhalation.

Patients should be informed preoperatively that blood and other fluids may be administered, oxygen will be administered, and vital signs will be checked often for several hours after surgery. If a chest tube is needed, the patient should be informed that it will drain the fluid and air that normally accumulate after chest surgery. The patient and family are informed that the patient may be admitted to the intensive care unit for 1 to 2 days after surgery, that the patient may experience pain at the incision site, and that medication is available to relieve pain and discomfort.

### *Relieving Anxiety*

The nurse listens to the patient to evaluate his or her feelings about the illness and proposed treatment. The nurse also determines the patient's motivation to return to normal or baseline function. The patient may reveal significant concerns: fear of hemorrhage because of bloody sputum, fear of discomfort from a chronic cough and chest pain, fear of ventilator dependence, or fear of death because of dyspnea and the underlying disease (eg, tumor).

The nurse helps the patient to overcome these fears and to cope with the stress of surgery by correcting any misconceptions, supporting the patient's decision to undergo surgery, reassuring the patient that the incision will "hold," and dealing honestly with questions about pain and discomfort and the patient's treatment. The management and control of pain begin before surgery, when the nurse informs the patient that many postoperative problems can be overcome by following certain routines related to deep breathing, coughing, turning, and moving. If patient-controlled analgesia (PCA) or epidural analgesia is to be used after surgery, the nurse instructs the patient in its use.

## Postoperative Management

After surgery, the vital signs are checked frequently. Oxygen is administered by a mechanical ventilator, nasal cannula, or mask for as long as necessary. A reduction in lung capacity requires a period of physiologic adjustment, and fluids may be given at a low hourly rate to prevent fluid overload and pulmonary edema. After the patient is conscious and the vital signs have stabilized, the head of the bed may be elevated 30 to 45 degrees. Careful positioning of the patient is important. After pneumonectomy, a patient is usually turned every hour from the back to the operative side and should not be completely turned to the unoperated side. This allows the fluid left in the space to consolidate and prevents the remaining lung and the heart from shifting (mediastinal shift) toward the operative side. The patient with a lobectomy may be turned to either side, and a patient with a segmental resection usually is not turned onto the operative side unless the surgeon prescribes this position.

Medication for pain is needed for several days after surgery; it is usually a combination of epidural analgesia, PCA, and scheduled or as-needed oral analgesics (Gottschalk, Cohen, Yang, et al., 2006). Because coughing can be painful, the patient should be taught to splint the chest. Exercises are resumed early in the postoperative period to facilitate lung ventilation. The nurse assesses for signs of complications, including cyanosis, dyspnea, and acute chest pain. These may indicate atelectasis and should be reported immediately.

Increased temperature or white blood cell count may indicate an infection, and pallor and increased pulse may indicate internal hemorrhage. Dressings are assessed for fresh bleeding.

## Mechanical Ventilation

Depending on the nature of the surgery, the patient's underlying condition, the intraoperative course, and the depth of anesthesia, the patient may require mechanical ventilation after surgery. The physician is responsible for determining the ventilator settings and modes, as well as determining the overall method and pace of weaning. It is important to assess the patient's tolerance and weaning progress. Early extubation from mechanical ventilation can lead to earlier removal of arterial lines.

## Chest Drainage

A crucial intervention for improving gas exchange and breathing in the postoperative period is the proper management of chest drainage and the **chest drainage system**. After thoracic surgery, chest tubes and a closed drainage system are used to re-expand the involved lung and to remove excess air, fluid, and blood. Chest drainage systems also are used in treatment of spontaneous pneumothorax and trauma resulting in pneumothorax. Table 25-3 describes and compares the main features of these systems, and Chart 25-19 explains the management of chest drainage systems. Chart 25-20 discusses actions that may prevent cardiopulmonary complications after thoracic surgery.

The normal breathing mechanism operates on the principle of negative pressure; that is, the pressure in the chest cavity normally is lower than the pressure of the atmosphere, causing air to move into the lungs during inspiration. Whenever the chest is opened, there is a loss of negative pressure, which results in collapse of the lung. The collection of air, fluid, or other substances in the chest can compromise cardiopulmonary function and can also cause the lung to collapse. Pathologic substances that collect in the pleural space include fibrin or clotted blood, liquids (serous fluids, blood, pus, chyle), and gases (air from the lung, tracheobronchial tree, or esophagus).

Chest tubes may be inserted to drain fluid or air from any of the three compartments of the thorax (the right and left pleural spaces and the mediastinum). The pleural space, located between the visceral and parietal pleura, normally contains 20 mL or less of fluid, which helps lubricate the visceral and parietal pleura. Surgical incision of the chest wall almost always causes some degree of pneumothorax (air accumulating in the pleural space) or hemothorax (buildup of serous fluid or blood in the pleural space). Air and fluid collect in the pleural space, restricting lung expansion and reducing gas exchange. Placement of a chest tube in the pleural space restores the negative intrathoracic pressure needed for lung re-expansion after surgery or trauma.

The mediastinal space is an extrapleural space that lies between the right and left thoracic cavities and contains the large blood vessels, heart, mainstem bronchus, and thymus gland. If fluid accumulates here, the heart can become compressed and stop beating, causing death. Mediastinal chest tubes can be inserted either anteriorly or posteriorly to the heart to drain blood after surgery.

There are two types of chest tubes: small-bore and large-bore catheters. Small-bore catheters (7 Fr to 12 Fr) have a one-way valve apparatus to prevent air from moving back into the chest. They can be inserted through a small skin incision. Large-bore catheters, which range in size up to 40 Fr, are usually connected to a chest drainage system to collect any pleural fluid and monitor for air leaks. After the

**Table 25-3 COMPARISON OF CHEST DRAINAGE SYSTEMS***

| Types of Chest Drainage Systems | Description | Comments |
|---|---|---|
| **Traditional Water Seal** | | |
| Also referred to as wet suction | Has three chambers: a collection chamber, water seal chamber (middle chamber), and wet suction control chamber | Requires that sterile fluid be instilled into water seal and suction chambers<br>Has positive- and negative-pressure release valves<br>Intermittent bubbling indicates that the system is functioning properly<br>Additional suction can be added by connecting system to a suction source |
| **Dry Suction Water Seal** | | |
| Also referred to as dry suction | Has three chambers: a collection chamber, water seal chamber (middle chamber), and wet suction control chamber | Requires that sterile fluid be instilled in water seal chamber at 2-cm level<br>No need to fill suction chamber with fluid<br>Suction pressure is set with a regulator<br>Has positive- and negative-pressure release valves<br>Has an indicator to signify that the suction pressure is adequate<br>Quieter than traditional water seal systems |
| **Dry Suction** | | |
| Also referred to as one-way valve system | Has a one-way mechanical value that allows air to leave the chest and prevents air from moving back into the chest | No need to fill suction chamber with fluid; thus, can be set up quickly in an emergency<br>Works even if knocked over, making it ideal for patients who are ambulatory |

*If no fluid drainage is expected, a drainage collection device may not be needed.

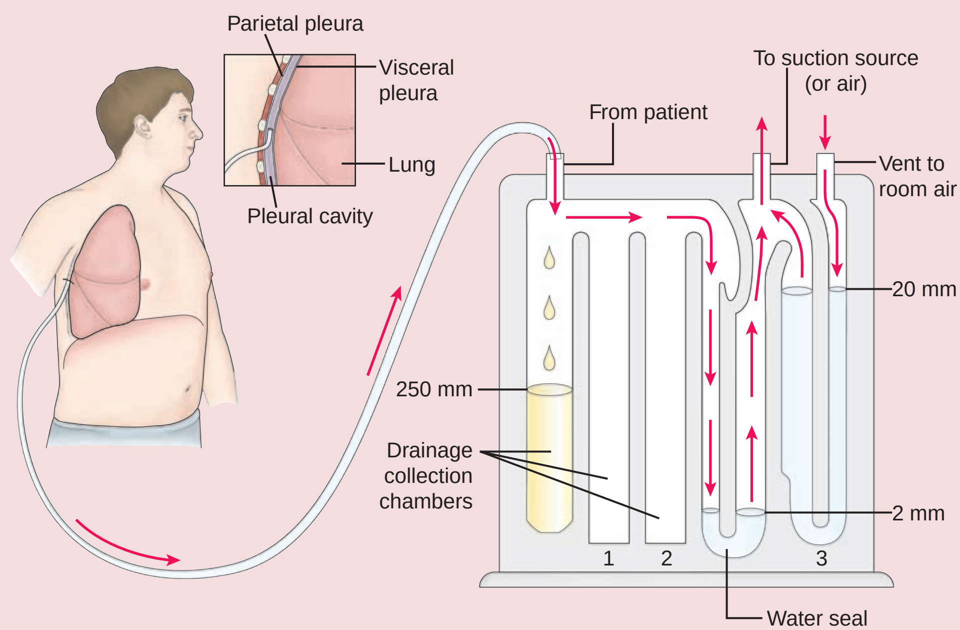
## CHART 25-19 Guidelines for Managing Chest Drainage Systems

### Equipment

- Chest tube insertion tray (contains chest tube, scalpel, gloves)
- Antiseptic solution
- Local anesthetic agent
- Chest drainage system
- Adhesive tape

### Implementation

| Actions | Rationale |
|---|---|
| 1. If using a chest drainage system with a water seal, fill the water seal chamber with sterile water to the level specified by the manufacturer. | Water seal drainage allows air and fluid to escape into a drainage chamber. The water acts as a seal and keeps the air from being drawn back into the pleural space. |
| 2. When using suction in chest drainage systems with a water seal, fill the suction control chamber with sterile water to the 20-cm level or as prescribed. In systems without a water seal, set the regulator dial at the appropriate suction level. | The water level regulator dial setting determines the degree of suction applied. |
| 3. Attach the drainage catheter exiting the thoracic cavity to the tubing coming from the collection chamber. Tape securely with adhesive tape. | In chest drainage units, the system is closed. The only connection is the one to the patient's catheter. |
| 4. If suction is used, connect the suction control chamber tubing to the suction unit. If using a wet suction system, turn on the suction unit and increase pressure until slow but steady bubbling appears in the suction control chamber. If using a chest drainage system with a dry suction control chamber, turn the regulator dial to 20 cm $H_2O$. | With a wet suction system, the degree of suction is determined by the amount of water in the suction control chamber and is not dependent on the rate of bubbling or the pressure gauge setting on the suction unit. With a dry suction control chamber, the regulator dial replaces the water. |




Example of a disposable chest drainage system.

| Actions | Rationale |
|---|---|
| 5. Mark the drainage from the collection chamber with tape on the outside of the drainage unit. Mark hourly/daily increments (date and time) at the drainage level. | This marking shows the amount of fluid loss and how fast fluid is collecting in the drainage chamber. It serves as a basis for determining the need for blood replacement, if the fluid is blood. Visibly bloody drainage will appear in the chamber in the immediate postoperative period but should gradually becomes serous. If the patient is bleeding as heavily as 100 mL every 15 minutes, check the drainage every few minutes. A reoperation or autotransfusion may be needed. The transfusion of blood collected in the drainage chamber must be reinfused within 4 to 6 hours. Usually, however, drainage decreases progressively in the first 24 hours. |

Continued

## CHART 25-19 *Guidelines for Managing Chest Drainage Systems* (Continued)

| Actions | Rationale |
|---|---|
| 6. Ensure that the drainage tubing does not kink, loop, or interfere with the patient's movements. | Kinking, looping, or pressure on the drainage tubing can produce back-pressure, which may force fluid back into the pleural space or impede its drainage. |
| 7. Encourage the patient to assume a comfortable position with good body alignment. With the lateral position, make sure that the patient's body does not compress the tubing. The patient should be turned and repositioned every 1.5 to 2 hours. Provide adequate analgesia. | Frequent position changes promote drainage, and good body alignment helps prevent postural deformities and contractures. Proper positioning also helps breathing and promotes better air exchange. Analgesics may be needed to promote comfort. |
| 8. Assist the patient with range-of-motion exercises for the affected arm and shoulder several times daily. Provide adequate analgesia. | Exercise helps to prevent ankylosis of the shoulder and to reduce postoperative pain and discomfort. Analgesics may be needed to relieve pain. |
| 9. Gently "milk" the tubing in the direction of the drainage chamber as needed. | "Milking" prevents the tubing from becoming obstructed by clots and fibrin. Constant attention to maintaining the patency of the tube facilitates prompt expansion of the lung and minimizes complications. |
| 10. Make sure there is fluctuation ("tidaling") of the fluid level in the water seal chamber (in wet systems), or check the air leak indicator for leaks (in dry systems with a one-way valve). *Note:* Fluid fluctuations in the water seal chamber or air leak indicator area will stop when:<br>a. The lung has re-expanded<br>b. The tubing is obstructed by blood clots, fibrin, or kinks<br>c. A loop of tubing hangs below the rest of the tubing<br>d. Suction motor or wall suction is not working properly | Fluctuation of the water level in the water seal shows effective connection between the pleural cavity and the drainage chamber and indicates that the drainage system remains patent. Fluctuation is also a gauge of intrapleural pressure in systems with a water seal (wet and dry, but not with the one-way valve).<br>An air leak indicator shows changes in intrathoracic pressure in dry systems with a one-way valve. Bubbles will appear if a leak is present. The air leak indicator takes the place of fluid fluctuations in the water seal chamber. |
| 11. With a dry system, assess for the presence of the indicator (bellows or float device) when setting the regulator dial to the desired level of suction. | The indicator shows that the vacuum is adequate to maintain the desired level of suction. |
| 12. Observe for air leaks in the drainage system; they are indicated by constant bubbling in the water seal chamber, or by the air leak indicator in dry systems with a one-way valve. Also assess the chest tube system for correctable external leaks. Notify the physician immediately of excessive bubbling in the water seal chamber not due to external leaks. | Leaking and trapping of air in the pleural space can result in tension pneumothorax. |
| 13. When turning down the dry suction, depress the manual high-negativity vent, and assess for a rise in the water level of the water seal chamber. | A rise in the water level of the water seal chamber indicates high negative pressure in the system that could lead to increased intrathoracic pressure. |
| 14. Observe and immediately report rapid and shallow breathing, cyanosis, pressure in the chest, subcutaneous emphysema, symptoms of hemorrhage, or significant changes in vital signs. | Many clinical conditions can cause these signs and symptoms, including tension pneumothorax, mediastinal shift, hemorrhage, severe incisional pain, pulmonary embolus, and cardiac tamponade. Surgical intervention may be necessary. |
| 15. Encourage the patient to breathe deeply and cough at frequent intervals. Provide adequate analgesia. If needed, request an order for patient-controlled analgesia. Also teach the patient how to perform incentive spirometry. | Deep breathing and coughing help to raise the intrapleural pressure, which promotes drainage of accumulated fluid in the pleural space. Deep breathing and coughing also promote removal of secretions from the tracheobronchial tree, which in turn promotes lung expansion and prevents atelectasis (alveolar collapse). |
| 16. If the patient is lying on a stretcher and must be transported to another area, place the drainage system below the chest level. If the tubing disconnects, cut off the contaminated tips of the chest tube and tubing, insert a sterile connector in the cut ends, and reattach to the drainage system. Do *not* clamp the chest tube during transport. | The drainage apparatus must be kept at a level lower than the patient's chest to prevent fluid from flowing backward into the pleural space. Clamping can result in a tension pneumothorax. |
| 17. When assisting in the chest tube's removal, instruct the patient to perform a gentle Valsalva maneuver or to breathe quietly. The chest tube is then clamped and quickly removed. Simultaneously, a small bandage is applied and made airtight with petrolatum gauze covered by a 4 × 4-inch gauze pad and thoroughly covered and sealed with nonporous tape. | The chest tube is removed as directed when the lung is re-expanded (usually 24 hours to several days), depending on the cause of the pneumothorax. During tube removal, the chief priorities are preventing air from entering the pleural cavity as the tube is withdrawn and preventing infection. |

## Chart 25-20 • *Preventing Postoperative Cardiopulmonary Complications After Thoracic Surgery*

**Patient Management**

- Auscultate lung sounds and assess for rate, rhythm, and depth.
- Monitor oxygenation with pulse oximetry.
- Monitor electrocardiogram for rate and rhythm changes.
- Assess capillary refill, skin color, and status of the surgical dressing.
- Encourage and assist the patient to turn, cough, and take deep breaths.

**Chest Drainage Management**

- Verify that all connection tubes are patent and connected securely.
- Assess that the water seal is intact when using a wet suction system and assess the regulator dial in dry suction systems.
- Monitor characteristics of drainage including color, amount, and consistency. Assess for significant increases or decreases in drainage output.
- Note fluctuations in the water seal chamber for wet suction systems and the air leak indicator for dry suction systems.
- Keep system below the patient's chest level.
- Assess suction control chamber for bubbling in wet suction systems.
- Keep suction at prescribed level.
- Maintain appropriate fluid in water seal for wet suction systems.
- Keep air vent open when suction is off.

chest tube is positioned, it is sutured to the skin and connected to a drainage apparatus (Fig. 25-10) to remove the residual air and fluid from the pleural or mediastinal space. This results in the re-expansion of remaining lung tissue.

### *Chest Drainage Systems*

Chest drainage systems have a suction source, a collection chamber for pleural drainage, and a mechanism to prevent air from re-entering the chest with inhalation. Various types of chest drainage systems are available for use in removal of air and fluid from the pleural space and re-expansion of the lungs. Chest drainage systems come with either wet (water seal) or dry suction control. In wet suction systems, the amount of suction is determined by the amount of water instilled in the suction chamber. The amount of bubbling in the suction chamber indicates how strong the suction is. Wet systems use a water seal to prevent air from moving back into the chest on inspiration. Dry systems use a one-way valve and may have a suction control dial in place of the water. Both systems can operate by gravity drainage, without a suction source.

*NURSING ALERT*

**When the wall vacuum is turned off, the drainage system must be open to the atmosphere so that intrapleural air can escape from the system. This can be done by detaching the tubing from the suction port to provide a vent.**

#### Water Seal Systems

The traditional water seal system (or wet suction) for chest drainage has three chambers: a collection chamber, a water seal chamber, and a wet suction control chamber. The collection chamber acts as a reservoir for fluid draining from the chest tube. It is graduated to permit easy measurement of drainage. Suction may be added to create negative pressure and promote drainage of fluid and removal of air. The suction control chamber regulates the amount of negative pressure applied to the chest. The amount of suction is determined by the water level. It is usually set at 20 cm $H_2O$; adding more fluid results in more suction. After the suction is turned on, bubbling appears in the suction chamber. A positive-pressure valve is located at the top of the suction chamber that automatically opens with increases in positive pressure within the system. Air is automatically released through a positive-pressure relief valve if the suction tubing is inadvertently clamped or kinked.

The water seal chamber has a one-way valve or water seal that prevents air from moving back into the chest when the patient inhales. There is an increase in the water level with inspiration and a return to the baseline level during exhalation; this is referred to as tidaling. Intermittent bubbling in the water seal chamber is normal, but continuous bubbling can indicate an air leak. Bubbling and tidaling do not occur when the tube is placed in the mediastinal space; however, fluid may pulsate with the patient's heartbeat. If the chest tube is connected to gravity drainage only, suction is not used. The pressure is equal to the water seal only. Two-chamber chest drainage systems (water seal chamber and collection chamber) are available for use with patients who need only gravity drainage.

The water level in the water seal chamber reflects the negative pressure present in the intrathoracic cavity. A rise in the water level indicates negative pressure in the pleural or mediastinal space. Excessive negative pressure can cause trauma to tissue. Most chest drainage systems have an automatic means to prevent excessive negative pressure. By pressing and holding a manual high-negativity vent (usually located on the top of the chest drainage system) until the water level in the water seal chamber returns to the 2-cm mark, excessive negative pressure is avoided, preventing damage to tissue.

*NURSING ALERT*

**If the chest tube and drainage system become disconnected, air can enter the pleural space, producing a pneumothorax. To prevent pneumothorax if the chest tube is inadvertently disconnected from the drainage system, a temporary water seal can be established by immersing the chest tube's open end in a bottle of sterile water.**

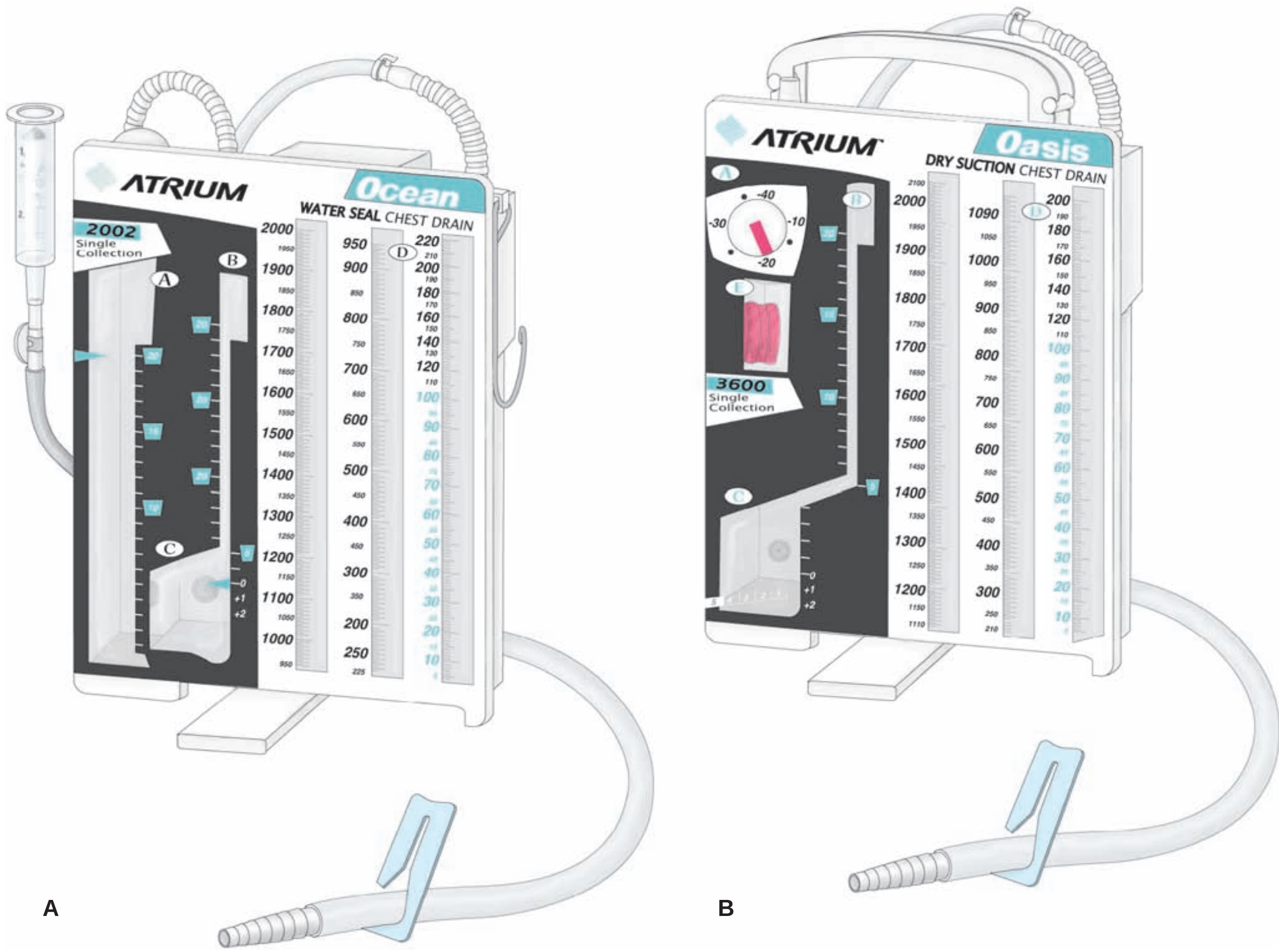



**Figure 25-10** Chest drainage systems. **A,** The Atrium Ocean is an example of a water seal chest drain system composed of a drainage chamber and water seal chamber. The suction control is determined by the height of the water column in that chamber (usually 20 cm). (*A,* suction control chamber; *B,* water seal chamber; *C,* air leak zone; *D,* collection chamber.) **B,** The Atrium Oasis is an example of a dry suction water seal system that uses a mechanical regulator for vacuum control, a water seal chamber, and a drainage chamber. (*A,* dry suction regulator; *B,* water seal chamber; *C,* air leak monitor; *D,* collection chamber; *E,* suction monitor bellows.) Art redrawn with permission from Atrium Medical Corporation, Hudson, NH.

### Dry Suction Water Seal Systems

Dry suction water seal systems, also referred to as dry suction, have a collection chamber for drainage, a water seal chamber, and a dry suction control chamber. The water seal chamber is filled with water to the 2-cm level. Bubbling in this area can indicate an air leak. The dry suction control chamber contains a regulator dial that conveniently regulates vacuum to the chest drain. Water is not needed for suction in these systems. Without the bubbling in the suction chamber, the machine is quieter. However, if the container is knocked over, the water seal may be lost.

Once the tube is connected to the suction source, the regulator dial allows the desired level of suction to be set; the suction is increased until an indicator appears. The indicator has the same function as the bubbling in the traditional water seal system; that is, it indicates that the vacuum is adequate to maintain the desired level of suction. Some drainage systems use a bellows (a chamber that can be expanded or contracted) or an orange-colored float device as an indicator of when the suction control regulator is set.

When the water in the water seal rises above the 2-cm level, intrathoracic pressure increases. Dry suction water seal systems have a manual high-negativity vent located on top of the drain. The manual high-negativity vent is pressed until the indicator appears (either a float device or bellows), and the water level in the water seal returns to the desired level, indicating that the intrathoracic pressure is decreased.

*NURSING ALERT*

**The manual vent should not be used to lower the water level in the water seal when the patient is on gravity drainage (no suction) because intrathoracic pressure is equal to the pressure in the water seal.**

### Dry Suction Systems With a One-Way Valve

A third type of chest drainage system is dry suction with a one-way mechanical valve. This system has a collection chamber, a one-way mechanical valve, and a dry suction control chamber. The valve permits air and fluid to leave the chest but prevents their movement back into the pleural space. This model lacks a water seal chamber and therefore can be set up quickly in emergency situations, and the dry control drain still works even if it is knocked over. This makes the dry suction systems useful for the patient who is ambulating or being transported. However, without the water seal chamber, there is no way to tell by inspection whether the pressure in the chest has changed, even though an air leak indicator is present so that the system can be checked. If an air leak is suspected, 30 mL of water is injected into the air leak indicator or the container is tipped so that fluid enters the air leak detection chamber. Bubbles will appear if a leak is present.

If the chest tube has been inserted to re-expand a lung after pneumothorax, or if very little fluid drainage is expected, a one-way valve (Heimlich valve) may be connected to the chest tube. This valve may be attached to a collection bag (Fig. 25-11) or covered with a sterile dressing if no drainage is expected.

## Postoperative Nursing Management

Postoperative nursing care of the patient who has undergone thoracic surgery addresses close monitoring of the patients respiratory and cardiovascular status, interventions to prevent complications, and the psychological reactions that often occur in response to this major surgical procedure and the fears that it often engenders in patients and their families.

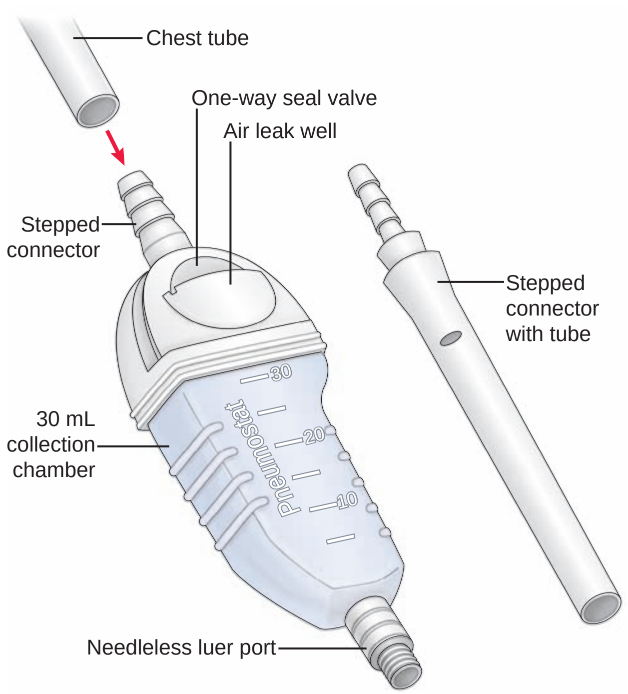



**Figure 25-11** One-way (Heimlich) valve, a disposable, single-use chest drainage system with 30 mL collection volume. Used when minimal volume of chest drainage is expected.

### *Monitoring Respiratory and Cardiovascular Status*

The nurse monitors the heart rate and rhythm by auscultation and ECG because episodes of major dysrhythmias are common after thoracic and cardiac surgery. In the immediate postoperative period, an arterial line may be maintained to allow frequent monitoring of arterial blood gases, serum electrolytes, hemoglobin and hematocrit values, and arterial pressure. Central venous pressure may be monitored to detect early signs of fluid volume disturbances; however, central venous pressure monitoring devices are being used less than in the past. Early extubation from mechanical ventilation can also lead to earlier removal of arterial lines. Another important component of postoperative assessment is to note the results of the preoperative evaluation of the patient's lung reserve by pulmonary function testing. A preoperative $FEV_1$ (the volume of air that the patient can forcibly exhale in 1 second) of more than 2 L or more than 70% of predicted value indicates a good lung reserve. Patients who have a postoperative $FEV_1$ of less than 40% of predicted value have decreased tidal volume, which places them at risk for respiratory failure, other morbidity, and death.

### *Improving Gas Exchange and Breathing*

Gas exchange is determined by evaluating oxygenation and ventilation. In the immediate postoperative period, this is achieved by measuring vital signs (blood pressure, pulse, and respirations) at least every 15 minutes for the first 1 to 2 hours, and then less frequently as the patient's condition stabilizes. Pulse oximetry is used for continuous monitoring of the adequacy of oxygenation. Arterial blood gas measurements are obtained early in the postoperative period to establish a baseline to assess the adequacy of oxygenation and ventilation and the possible retention of carbon dioxide. The frequency with which postoperative arterial blood gases are measured depends on whether the patient is mechanically ventilated and whether he or she exhibits signs of respiratory distress; these measurements can help determine appropriate therapy. It also is common practice for patients to have an arterial line in place to obtain blood for blood gas measurements and to monitor blood pressure closely. Hemodynamic monitoring may be used to assess hemodynamic stability.

Breathing techniques, such as diaphragmatic and pursed-lip breathing, taught prior to surgery should be performed by the patient every 2 hours to expand the alveoli and prevent atelectasis. Sustained maximal inspiration therapy or incentive spirometry promotes lung inflation, improves the cough mechanism, and allows early assessment of acute pulmonary changes. (See Charts 25-3 and 25-4 for more information.)

If the patient is oriented and blood pressure is stabilized, the head of the bed is elevated 30 to 40 degrees during the immediate postoperative period. This position facilitates ventilation, promotes chest drainage from the lower chest tube, and helps residual air to rise in the upper portion of the pleural space, where it can be removed through the upper chest tube.

The nurse consults with the surgeon about patient positioning to determine the best side-laying position. In general, the patient should be positioned from back to side

frequently and moved from a flat to a semiupright position as soon as tolerated. Most commonly, the patient is instructed to lie on the operative side. However, the patient with unilateral lung pathology may not be able to turn well onto that side because of pain. In addition, positioning the patient with the "good lung" (the nonoperated lung) down allows a better match of ventilation and perfusion and therefore may actually improve oxygenation. The patient's position is changed from flat to semiupright as soon as possible because remaining in one position tends to promote the retention of secretions in the dependent portion of the lungs, and the upright position increases diaphragmatic excursion, enhancing lung expansion. After a pneumonectomy, the operated side should be dependent so that fluid in the pleural space remains below the level of the bronchial stump and the other lung can fully expand.

### Improving Airway Clearance

Retained secretions are a threat to the patient after thoracotomy surgery. Trauma to the tracheobronchial tree during surgery, diminished lung ventilation, and diminished cough reflex all result in the accumulation of excessive secretions. If the secretions are retained, airway obstruction occurs. This, in turn, causes the air in the alveoli distal to the obstruction to become absorbed and the affected portion of the lung to collapse. Atelectasis, pneumonia, and respiratory failure may result.

To maintain a patent airway, secretions are suctioned from the tracheobronchial tree before the endotracheal tube is discontinued. Secretions continue to be removed by suctioning until the patient can cough up secretions effectively. Nasotracheal suctioning may be needed to stimulate a deep cough and aspirate secretions that the patient cannot clear by coughing. However, it should be used only after other methods to raise secretions have been unsuccessful (Chart 25-21).

The patient is encouraged to cough effectively to maintain a patent airway; ineffective coughing results in exhaustion and retention of secretions (see Chart 25-5). To be effective, the cough must be low-pitched, deep, and controlled. Because it is difficult to cough in a supine position, the patient is helped to a sitting position on the edge of the bed, with the feet resting on a chair. The patient should cough at least every hour during the first 24 hours and when necessary thereafter. If audible crackles are present, it may be necessary to use chest percussion with the cough routine until the lungs are clear. Aerosol therapy is helpful in humidifying and mobilizing secretions so that they can easily be cleared with coughing. To minimize incisional pain during coughing, the nurse supports the incision or encourages the patient to do so (Fig. 25-12). If a patient is identified as being at high risk for postoperative pulmonary complications, then CPT is started immediately (perhaps even before surgery). The techniques of postural drainage, vibration, and percussion help loosen and mobilize the secretions so that they can be coughed up or suctioned.

Following the use of these measures, the nurse listens to both lungs, anteriorly and posteriorly, to determine whether there are any changes in breath sounds. Diminished breath sounds may indicate collapsed or hypoventilated alveoli.

### Chart 25-21 • *Performing Nasotracheal Suction*

- Explain procedure to the patient.
- Medicate patient for pain if necessary.
- Place the patient in a sitting or semi-Fowler's position. Make sure the patient's head is not flexed forward. Remove excess pillows if necessary.
- Oxygenate the patient several minutes before initiating the suctioning procedure. Have oxygen source ready nearby during procedure.
- Put on sterile gloves.
- Lubricate catheter with water-soluble gel.
- Gently pass catheter through the patient's nose to the pharynx. If it is difficult to pass the catheter, and repeated suctioning is expected, a soft rubber nasal trumpet may be placed nasopharyngeally to provide easier catheter passage. Check the position of the tip of the catheter by asking the patient to open the mouth to inspect it; the tip of the catheter should be in the lower pharynx.
- Instruct the patient to take a deep breath or stick out the tongue. This action opens the epiglottis and promotes downward movement of the catheter.
- Advance the catheter into the trachea only during inspiration. Listen for cough or for passage of air through the catheter.
- Attach the catheter to suction apparatus. Apply intermittent suction while slowly withdrawing the catheter. Do not let suction exceed 120 mm Hg.
- Do not suction for longer than 10 to 15 seconds, as dysrhythmias, bradycardia, or cardiac arrest may occur in patients with borderline oxygenation.
- If additional suctioning is needed, withdraw the catheter to the back of the pharynx. Reassure patient and oxygenate for several minutes before resuming suctioning.

### Relieving Pain and Discomfort

Pain after a thoracotomy may be severe, depending on the type of incision and the patient's reaction and ability to cope with pain. Pain can impair the patient's ability to breathe deeply and cough. Immediately after the surgical procedure and before the incision is closed, the surgeon may perform a nerve block with a long-acting local anesthetic such as bupivacaine (Marcaine, Sensorcaine). Bupivacaine is titrated to relieve postoperative pain while allowing the patient to cooperate in deep breathing, coughing, and mobilization. An epidural catheter may be placed for continuous or PCA using a combination of a long-acting local anesthetic and an opioid, or a continuous epidural infusion may be combined with IV PCA using an opioid (Gottschalk, et al., 2006). Opioid analgesic agents such as morphine are commonly used in PCA, which allows the patient to control the frequency and total dosage. Preset limits on the pump avoid overdosage. With proper instruction, PCA is well tolerated and allows earlier mobilization and cooperation with the treatment regimen. (See Chapter 13 for a more extensive discussion of PCA and pain management.)

It is important to avoid depressing the respiratory system with excessive analgesia: the patient should not be so sedated as to be unable to cough. Inadequate treatment of



A. Nurse's hands should support the chest incision anteriorly and posteriorly. The patient is instructed to take several deep breaths, inhale, and then cough forcibly.

B. With one hand, the nurse exerts downward pressure on the soulder of the affected side while firmly supporting the area beneath the wound. The patient is instructed to take several deep breaths, inhale, and then cough forcibly.

C. The nurse can wrap a towel or sheet around the patient's chest and hold the ends together, pulling slightly as the patient coughs, and releasing during deep breaths.

D. The patient can be taught to hold a pillow firmly against the incision while coughing. This can be done while lying down or sitting in an upright position.



**Figure 25-12** Techniques for supporting incision while a patient recovering from thoracic surgery coughs.

pain, however, may also lead to hypoventilation and decreased coughing.

*NURSING ALERT*

**It is important not to confuse the restlessness of hypoxia with the restlessness caused by pain. Dyspnea, restlessness, increasing respiratory rate, increasing blood pressure, and tachycardia are warning signs of impending respiratory insufficiency. Pulse oximetry is used to monitor oxygenation and to differentiate causes of restlessness.**

Lidocaine (Xylocaine) and prilocaine (Citanest) are local anesthetic agents that may be used to treat pain at the site of the chest tube insertion. These medications are administered as topical transdermal analgesics that penetrate the skin; they have also been found to be effective when used together. EMLA cream, which is a mixture of the two medications, may be effective in treating pain from chest tube removal. However, many physicians prefer not to use analgesia when removing chest tubes because the pain, although severe, is of short duration (usually less than a few minutes) and the analgesia might interfere with respiratory effort.

### Promoting Mobility and Shoulder Exercises

Because large shoulder girdle muscles are transected during a thoracotomy, the arm and shoulder must be mobilized by full range of motion of the shoulder. As soon as physiologically possible, usually within 8 to 12 hours, the patient is helped to get out of bed. Although this may be painful initially, the earlier the patient moves, the sooner the pain will subside. In addition to getting out of bed, the patient begins arm and shoulder exercises to restore movement and prevent painful stiffening of the affected arm and shoulder (Chart 25-22). Regular doses of acetaminophen can help relieve shoulder pain (Gottschalk, et al., 2006).

### Maintaining Fluid Volume and Nutrition

During the surgical procedure or immediately after, the patient may receive a transfusion of blood products, followed by a continuous IV infusion. Because a reduction in lung capacity often occurs after thoracic surgery, a period of physiologic adjustment is needed. Fluids should be administered at a low hourly rate and titrated (as prescribed) to prevent overloading the vascular system and precipitating pulmonary edema. The nurse performs careful respiratory and cardiovascular assessments and monitors intake and output, vital signs, and jugular vein distention. The nurse also monitors the infusion site for signs of infiltration, including swelling, tenderness, and redness.

Patients undergoing thoracotomy may have poor nutritional status before surgery because of dyspnea, sputum production, and poor appetite. Therefore, it is especially important that adequate nutrition be provided. A liquid diet is provided as soon as bowel sounds return, and the patient is progressed to a full diet as soon as possible. Small, frequent meals are better tolerated and are crucial to the recovery and maintenance of lung function.

### Monitoring and Managing Potential Complications

Complications after thoracic surgery are always a possibility and must be identified and managed early. In addition, the nurse monitors the patient at regular intervals for signs of respiratory distress or developing respiratory failure,

CHART 25-22

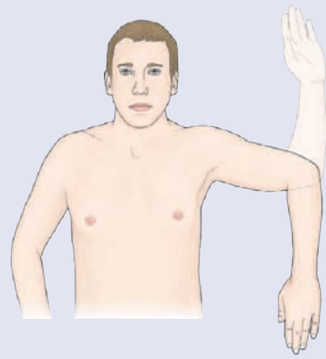
PATIENT EDUCATION

## *Performing Arm and Shoulder Exercises*

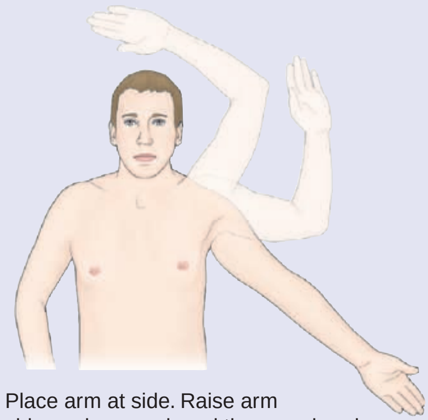
Arm and shoulder exercises are performed after thoracic surgery to restore movement, prevent painful stiffening of the shoulder, and improve muscle power.



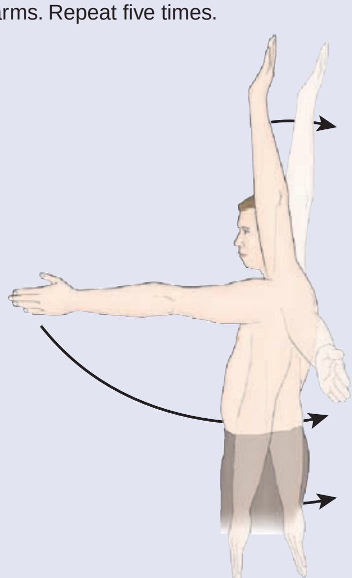
Hold hand of the affected side with the other hand, palms facing in. Raise the arms forward, upward, and then overhead, while taking a deep breath. Exhale while lowering the arms. Repeat five times.



Raise arm sideward, upward, and downward in a waving motion



Place arm at side. Raise arm sideward, upward, and then overhead. Repeat five times. These exercises can also be performed while lying in bed.



Extend the arm up and back, out to the side and back, down at the side, and back.



Place hands in small of back. Push elbows as far back as possible.



Sit erect in an armchair; place the hands on arms of the chair. Press down on hands, consciously pulling the abdomen in and stretching up from the waist. Inhale while raising the body until elbows are extended completely. Hold this position a moment, and begin exhaling while lowering the body slowly to the original position.

dysrhythmias, bronchopleural fistula, hemorrhage and shock, atelectasis, and incisional or pulmonary infection.

Respiratory distress is treated by identifying and eliminating its cause while providing supplemental oxygen. If the patient progresses to respiratory failure, intubation and mechanical ventilation are necessary.

Dysrhythmias are often related to the effects of hypoxia or the surgical procedure. They are treated with antiarrhythmic medication and supportive therapy (see Chapter 27). Pulmonary infections or effusion, often preceded by atelectasis, may occur a few days into the postoperative course.

Pneumothorax may occur after thoracic surgery if there is an air leak from the surgical site to the pleural cavity or from the pleural cavity to the environment. Failure of the chest drainage system prevents return of negative pressure in the pleural cavity and results in pneumothorax. In the

CHART 25-23

HOME CARE CHECKLIST
*The Patient With a Thoracotomy*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Use local heat and oral analgesia to relieve intercostal pain. | ✔ | ✔ |
| • Alternate walking and other activities with frequent rest periods, expecting weakness and fatigue for the first 3 weeks. | ✔ | ✔ |
| • Perform breathing exercises several times daily for the first few weeks at home. | ✔ | |
| • Avoid lifting more than 20 pounds until complete healing has taken place; the chest muscles and incision may be weaker than normal for 3 to 6 months after surgery. | ✔ | |
| • Walk at a moderate pace, gradually and persistently extending walking time and distance. | ✔ | |
| • Immediately stop any activity that causes undue fatigue, increased shortness of breath, or chest pain. | ✔ | |
| • Avoid bronchial irritants (smoke, fumes, air pollution, aerosol sprays). | ✔ | ✔ |
| • Avoid others with known colds or lung infections. | ✔ | ✔ |
| • Obtain an annual influenza vaccine and discuss vaccination against pneumonia with the physician. | ✔ | |
| • Report for follow-up care by the surgeon or clinic as necessary. | ✔ | ✔ |
| • Stop smoking, if applicable, and avoid exposure to secondhand smoke. | ✔ | ✔ |

postoperative patient, pneumothorax is often accompanied by hemothorax. The nurse maintains the chest drainage system and monitors the patient for signs and symptoms of pneumothorax: increasing shortness of breath, tachycardia, increased respiratory rate, and increasing respiratory distress.

Bronchopleural fistula is a serious but rare complication that prevents the return of negative intrathoracic pressure and lung re-expansion. Depending on its severity, it is treated with closed chest drainage, mechanical ventilation, and possibly talc pleurodesis (described in Chapter 23).

Hemorrhage and shock are managed by treating the underlying cause, whether by reoperation or by administration of blood products or fluids. Pulmonary edema from overinfusion of IV fluids is a significant danger. Early symptoms are dyspnea, crackles, bubbling sounds in the chest, tachycardia, and pink, frothy sputum. This constitutes an emergency and must be reported and treated immediately.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The nurse instructs the patient and family about postoperative care that will be continued at home. The nurse explains signs and symptoms that should be reported to the physician. These include the following:

- Change in respiratory status: increasing shortness of breath, fever, increased restlessness or other changes in mental or cognitive status, increased respiratory rate, change in respiratory pattern, change in amount or color of sputum
- Bleeding or other drainage from the surgical incision or chest tube exit sites
- Increased chest pain

In addition, respiratory care and other treatment modalities (oxygen, incentive spirometry, CPT, and oral, inhaled, or IV medications) may be continued at home. Therefore, the nurse needs to instruct the patient and family in their correct and safe use.

The nurse emphasizes the importance of progressively increased activity. The nurse instructs the patient to ambulate within limits and explains that return of strength is likely to be very gradual. Another important aspect of patient teaching addresses shoulder exercises. The patient is instructed to do these exercises five times daily. Additional patient teaching is described in Chart 25-23.

#### Continuing Care

Depending on the patient's physical status and the availability of family assistance, a home care referral may be indicated. The home care nurse assesses the patient's recovery from surgery, with special attention to respiratory status, the surgical incision, chest drainage, pain control, ambulation, and nutritional status. The patient's use of respiratory modalities is assessed to ensure that they are being used correctly and safely. In addition, the nurse assesses the patient's adherence to the postoperative treatment plan and identifies acute or late postoperative complications.

The recovery process may take longer than the patient had expected, and providing support to the patient is an important task for the home care nurse. Because of shorter hospital stays, follow-up appointments with the physician are essential. The nurse teaches the patient about the importance of keeping follow-up appointments and completing laboratory tests as prescribed to assist the physician in evaluating recovery. The home care nurse provides continuous encouragement and education to the patient and family during the process. As recovery progresses, the nurse also reminds the patient and family about the importance of participating in health promotion activities and recommended health screening.

For a detailed plan of nursing care for the patient who has had a thoracotomy, see Chart 25-24.

CHART 25-24

## PLAN OF NURSING CARE
### *Care of the Patient After Thoracotomy*

**NURSING DIAGNOSIS:** Impaired gas exchange related to lung impairment and surgery
**GOAL:** Improvement of gas exchange and breathing

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor pulmonary status as directed and as needed:<br>a. Auscultate breath sounds.<br>b. Check rate, depth, and pattern of respirations.<br>c. Assess blood gases for signs of hypoxemia or $CO_2$ retention.<br>d. Evaluate patient's color for cyanosis. | 1. Changes in pulmonary status indicate improvement or onset of complications. | • Lungs are clear on auscultation<br>• Respiratory rate is within acceptable range with no episodes of dyspnea<br>• Vital signs are stable<br>• Dysrhythmias are not present or are under control<br>• Demonstrates deep, controlled, effective breathing to allow maximal lung expansion<br>• Uses incentive spirometer every 2 hours while awake<br>• Demonstrates deep, effective coughing technique<br>• Lungs are expanded to capacity (evidenced by chest x-ray) |
| 2. Monitor and record blood pressure, apical pulse, and temperature every 2–4 hours, central venous pressure (if indicated) every 2 hours. | 2. Aid in evaluating effect of surgery on cardiac status. | |
| 3. Monitor continuous electrocardiogram for pattern and dysrhythmias. | 3. Dysrhythmias (especially atrial fibrillation and atrial flutter) are more frequently seen after thoracic surgery. A patient with total pneumonectomy is especially prone to cardiac irregularity. | |
| 4. Elevate head of bed 30–40 degrees when patient is oriented and hemodynamic status is stable. | 4. Maximum lung excursion is achieved when patient is as close to upright as possible. | |
| 5. Encourage deep-breathing exercises (see section on Breathing Retraining) and effective use of incentive spirometer (sustained maximal inspiration). | 5. Helps to achieve maximal lung inflation and to open closed airways. | |
| 6. Encourage and promote an effective cough routine to be performed every 1–2 hours during first 24 hours. | 6. Coughing is necessary to remove retained secretions. | |
| 7. Assess and monitor the chest drainage system*<br>a. Assess for leaks and patency as needed (See Chart 25–19).<br>b. Monitor amount and character of drainage and document every 2 hours. Notify physician if drainage is 150 mL/h or greater. | 7. System is used to eliminate any residual air or fluid after thoracotomy. | |

**NURSING DIAGNOSIS:** Ineffective airway clearance related to lung impairment, anesthesia, and pain
**GOAL:** Improvement of airway clearance and achievement of a patent airway

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Maintain an open airway. | 1. Provides for adequate ventilation and gas exchange. | • Airway is patent<br>• Coughs effectively<br>• Splints incision while coughing<br>• Sputum is clear or colorless<br>• Lungs are clear on auscultation |
| 2. Perform endotracheal suctioning until patient can raise secretions effectively. | 2. Endotracheal secretions are present in excessive amounts in postthoracotomy patients due to trauma to the tracheo-bronchial tree during surgery, diminished lung ventilation, and cough reflex. | |
| 3. Assess and medicate for pain. Encourage deep-breathing and coughing exercises. Help splint incision during coughing. | 3. Helps to achieve maximal lung inflation and to open closed airways. Coughing is painful; incision needs to be supported. | |

*A patient with a pneumonectomy usually does not have water seal chest drainage because it is desirable that the pleural space fill with an effusion, which eventually obliterates this space. Some surgeons do use a modified water seal system.

*Continued on following page*

CHART 25-24

PLAN OF NURSING CARE

## Care of the Patient After Thoracotomy (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 4. Monitor amount, viscosity, color, and odor of sputum. Notify physician if sputum is excessive or contains bright-red blood. | 4. Changes in sputum suggest presence of infection or change in pulmonary status. Colorless sputum is not unusual; opacification or coloring of sputum may indicate dehydration or infection. | |
| 5. Administer humidification and mini-nebulizer therapy as prescribed. | 5. Secretions must be moistened and thinned if they are to be raised from the chest with the least amount of effort. | |
| 6. Perform postural drainage, percussion, and vibration as prescribed. Do not percuss or vibrate directly over operative site. | 6. Chest physiotherapy uses gravity to help remove secretions from the lung. | |
| 7. Auscultate both sides of chest to determine changes in breath sounds. | 7. Indications for tracheal suctioning are determined by chest auscultation. | |

**NURSING DIAGNOSIS:** Acute pain related to incision, drainage tubes, and the surgical procedure
**GOAL:** Relief of pain and discomfort

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Evaluate location, character, quality, and severity of pain. Administer analgesic medication as prescribed and as needed. Observe for respiratory effect of opioid. Is patient too somnolent to cough? Are respirations depressed? | 1. Pain limits chest excursions and thereby decreases ventilation. | • Asks for pain medication, but verbalizes that he or she expects some discomfort while deep breathing and coughing<br>• Verbalizes that he or she is comfortable and not in acute distress<br>• No signs of incisional infection evident |
| 2. Maintain care postoperatively in positioning the patient:<br>a. Place patient in semi-Fowler's position.<br>b. Patients with limited respiratory reserve may not be able to turn on unoperated side.<br>c. Assist or turn patient every 2 hours. | 2. The patient who is comfortable and free of pain will be less likely to splint the chest while breathing. A semi-Fowler's position permits residual air in the pleural space to rise to upper portion of pleural space and be removed via the upper chest catheter. | |
| 3. Assess incision area every 8 hours for redness, heat, induration, swelling, separation, and drainage. | 3. These signs indicate possible infection. | |
| 4. Request order for patient-controlled analgesia pump if appropriate for patient. | 4. Allowing patient control over frequency and dose improves comfort and compliance with treatment regimen. | |

**NURSING DIAGNOSIS:** Anxiety related to outcomes of surgery, pain, technology
**GOAL:** Reduction of anxiety to a manageable level

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Explain all procedures in understandable language. | 1. Explaining what can be expected in understandable terms decreases anxiety and increases cooperation. | • States that anxiety is at a manageable level<br>• Participates with health care team in treatment regimen<br>• Uses appropriate coping skills (verbalization, pain relief strategies, use of support systems such as family, clergy)<br>• Demonstrates basic understanding of technology used in care |
| 2. Assess for pain and medicate, especially before potentially painful procedures. | 2. Premedication before painful procedures or activities improves comfort and minimizes undue anxiety. | |
| 3. Silence all *unnecessary* alarms on technology (monitors, ventilators). | 3. *Unnecessary* alarms increase the risk of sensory overload and may increase anxiety. *Essential* alarms must be turned on at all times. | |

*Continued*

CHART 25-24

**PLAN OF NURSING CARE**

## Care of the Patient After Thoracotomy (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 4. Encourage and support patient while increasing activity level. | 4. Positive reinforcement improves patient motivation and independence. | |
| 5. Mobilize resources (family, clergy, social worker) to help patient cope with outcomes of surgery (diagnosis, change in functional abilities). | 5. A multidisciplinary approach promotes the patient's strengths and coping mechanisms. | |

**NURSING DIAGNOSIS:** Impaired physical mobility of the upper extremities related to thoracic surgery
**GOAL:** Increased mobility of the affected shoulder and arm

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Assist patient with normal range of motion and function of shoulder and trunk:<br>a. Teach breathing exercises to mobilize thorax.<br>b. Encourage skeletal exercises to promote abduction and mobilization of shoulder (see Chart 25-22).<br>c. Assist out of bed to chair as soon as pulmonary and circulatory systems are stable (usually by evening of surgery). | 1. Necessary to regain normal mobility of arm and shoulder and to speed recovery and minimize discomfort. | • Demonstrates arm and shoulder exercises and verbalizes intent to perform them on discharge<br>• Regains previous range of motion in shoulder and arm |
| 2. Encourage progressive activities according to level of fatigue. | 2. Increases patient's use of affected shoulder and arm. | |

**NURSING DIAGNOSIS:** Risk for imbalanced fluid volume related to the surgical procedure
**GOAL:** Maintenance of adequate fluid volume

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Monitor and record hourly intake and output. Urine output should be at least 30 mL/h after surgery. | 1. Fluid management may be altered before, during, and after surgery, and patient's response to and need for fluid management must be assessed. | • Patient is adequately hydrated, as evidenced by:<br>• Urine output greater than 30 mL/h<br>• Vital signs stable, heart rate, and central venous pressure approaching normal<br>• No excessive peripheral edema |
| 2. Administer blood component therapy and parenteral fluids and/or diuretics as prescribed to restore and maintain fluid volume. | 2. Pulmonary edema due to transfusion or fluid overload is an ever-present threat; after pneumonectomy, the pulmonary vascular system has been greatly reduced. | |

**NURSING DIAGNOSIS:** Deficient knowledge of home care procedures
**GOAL:** Increased ability to carry out care procedures at home

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Encourage patient to practice arm and shoulder exercises five times daily at home. | 1. Exercise accelerates recovery of muscle function and reduces long-term pain and discomfort. | • Demonstrates arm and shoulder exercises<br>• Verbalizes need to try to assume an erect posture<br>• Verbalizes the importance of relieving discomfort, alternating walking and rest, performing breathing exercises, avoiding heavy lifting, avoiding undue fatigue, avoiding bronchial irritants, preventing colds or lung infections, getting influenza vaccine, keeping follow-up visits, and stopping smoking |
| 2. Instruct patient to practice assuming a functionally erect position in front of a full-length mirror. | 2. Practice will help restore normal posture. | |
| 3. Instruct patient about home care (see chart 25-3). | 3. Knowing what to expect facilitates recovery. | |

## CRITICAL THINKING EXERCISES

**1** A 20-year-old woman who was admitted to your unit because of sudden onset of severe chest pain is diagnosed with spontaneous pneumothorax. A physician will insert a chest tube with a Heimlich valve shortly. What do your patient and her family need to know about the procedure? What supplies do you think you will need in the room for the chest tube insertion? What assessments will be necessary immediately after chest tube insertion? In 1 hour?

**2** A 72-year-old man who has COPD from working as a coal miner has pneumonia in his right lower and middle lobes. To help mobilize and drain the secretions, CPT is prescribed. The patient only wants to sit in bed because it is easier for him to breathe when in the semi-Fowler's position. What positions are the most important for successful CPT? What can you do to aid him during the treatments?

**3** Oxygen therapy is required for the following patients: a 59-year-old patient who has just been diagnosed with severe COPD and will need lifelong supplemental oxygen; a 21-year-old patient who was rescued from a house fire and needs short-term oxygen therapy because of exposure to smoke; and a 65-year-old patient with terminal metastatic cancer. Compare and contrast the similarities and differences in the oxygen therapy necessary for each patient, and discuss teaching and safety precautions indicated for each patient and his or her family. Describe the patient teaching that will be required for the patients who will be discharged from the hospital with a prescription for oxygen therapy.

**4** EBP Following an episode of flu, a 50-year-old woman developed respiratory failure and was intubated. Three weeks later, because of complications that prevented extubation, a tracheostomy was performed. She has been relying on the ventilator for more than 2 months and is now strong enough to begin weaning. However, whenever the respiratory technician adjusts the ventilator settings, she becomes extremely anxious and starts hyperventilating. How will you explain the weaning process to her? What other antianxiety measures may be helpful? Develop an evidence-based practice weaning plan for this patient.

**5** Your patient has just returned from the operating room after thoracic surgery. She has an endotracheal tube, two chest tubes, two IV lines, an epidural catheter, and an indwelling urinary catheter in place. The surgeon's orders include ventilator settings, a cardiac monitor, "stat" complete blood cell (CBC) count on arrival to the intensive care unit, and arterial blood gases in 1 hour. What are your immediate priorities for assessment for this patient? What observations need to be reported to the surgeon immediately? What other nursing interventions are warranted immediately? In 8 hours? At 24 hours and 48 hours postoperatively?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Association for Respiratory Care, www.aarc.org

American Lung Association, www.lungusa.org

American Thoracic Society, www.thoracic.org

National Heart, Lung, and Blood Institute/National Institutes of Health, www.nhlbi.nih.gov/index.htm

National Lung Health Education Program, www.nlhep.org (has easy-to-read teaching resources for patients)

unit 6

# Cardiovascular, Circulatory, and Hematologic Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient Who Has Intermittent Claudication and Ulceration

**Mr. Black,** age 63 years, has a history of peripheral arterial occlusive disease (2 years), hypertension, hypercholesterolemia, type 2 diabetes, and smoking. He eats low-fat foods and cut back on smoking to half a pack a day. His home-monitored blood glucose levels range from 180 to 215 mg/dL. Because he has severe calf pain after walking, he now walks only two blocks a day—one block from home and one block back. He now receives medical treatment for a nonhealing ulcer on the plantar aspect of his left foot.



Visit the Point to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **INEFFECTIVE PERIPHERAL TISSUE PERFUSION**—Decrease in oxygen resulting in the failure to nourish tissues at the capillary level | **CIRCULATORY CARE: ARTERIAL INSUFFICIENCY**—Promotion of arterial circulation<br>**CIRCULATORY PRECAUTIONS**—Protection of localized area with limited perfusion | **CIRCULATION STATUS**—Unobstructed, unidirectional blood flow at an appropriate pressure through large vessels of the systemic and pulmonary circuits<br>**PERIPHERAL TISSUE PERFUSION**—Adequacy of blood flow through the small vessels of the extremities to maintain tissue function |
| **CHRONIC PAIN**—Unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage; sudden or slow onset of any intensity from mild to severe, constant or recurring without an anticipated or predictable end and a duration of greater than 6 months | **PAIN MANAGEMENT**—Alleviation of pain or reduction in pain to a level of comfort that is acceptable to the patient | **SYMPTOM CONTROL**—Personal actions to minimize perceived adverse changes in physical and emotional functioning<br>**COMFORT LEVEL**—Extent of positive perception of physical and psychological ease |
| **ACTIVITY INTOLERANCE**—Insufficient physiological or psychological energy to endure or complete required or desired daily activities | **EXERCISE THERAPY: AMBULATION**—Promotion and assistance with walking to maintain or restore autonomic and voluntary body functions during treatment and recovery from illness or injury | **ACTIVITY TOLERANCE**—Physiologic response to energy-consuming movements with daily activities |


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# chapter 26 Assessment of Cardiovascular Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Explain cardiac physiology in relation to cardiac anatomy and the conduction system of the heart.
2. Incorporate assessment of cardiac risk factors into the health history and physical assessment of the patient with cardiovascular disease.
3. Discuss the clinical indications, patient preparation, and other related nursing implications for common tests and procedures used to assess cardiovascular function and diagnose cardiovascular diseases.
4. Compare the various methods of hemodynamic monitoring (eg, central venous pressure, pulmonary artery pressure, and arterial pressure monitoring) with regard to indications for use, potential complications, and nursing responsibilities.

## GLOSSARY

**acute coronary syndrome:** refers to rupture of an atheromatous plaque in a diseased coronary artery, which rapidly forms an obstructive thrombus
**afterload:** the amount of resistance to ejection of blood from the ventricle
**apical impulse** (also called **point of maximum impulse):** impulse normally palpated at the fifth intercostal space, left midclavicular line; caused by contraction of the left ventricle
**atrioventricular (AV) node:** secondary pacemaker of the heart, located in the right atrial wall near the tricuspid valve
**baroreceptors:** nerve fibers located in the aortic arch and carotid arteries that are responsible for reflex control of the blood pressure
**cardiac catheterization:** an invasive procedure used to measure cardiac chamber pressures and assess patency of the coronary arteries
**cardiac conduction system:** specialized heart cells strategically located throughout the heart that are responsible for methodically generating and coordinating the transmission of electrical impulses to the myocardial cells
**cardiac output:** amount of blood pumped by each ventricle in liters per minute
**cardiac stress test:** a test used to evaluate the functioning of the heart during a period of increased oxygen demand
**contractility:** ability of the cardiac muscle to shorten in response to an electrical impulse
**depolarization:** electrical activation of a cell caused by the influx of sodium into the cell while potassium exits the cell
**diastole:** period of ventricular relaxation resulting in ventricular filling
**ejection fraction:** percentage of the end-diastolic blood volume ejected from the ventricle with each heartbeat

## GLOSSARY *(Continued)*

**hemodynamic monitoring:** use of pressure monitoring devices to directly measure cardiovascular function
**hypertension:** blood pressure that is persistently greater than 140/90 mm Hg
**hypotension:** a decrease in blood pressure to less than 100/60 mm Hg that compromises systemic perfusion
**murmurs:** sounds created by abnormal, turbulent flow of blood in the heart
**myocardial ischemia:** condition in which heart muscle cells receive less oxygen than needed
**myocardium:** muscle layer of the heart responsible for the pumping action of the heart
**normal heart sounds:** sounds produced when the valves close; normal heart sounds are $S_1$ (atrioventricular valves) and $S_2$ (semilunar valves)
**opening snaps:** abnormal diastolic sound generated during opening of a rigid AV valve leaflet
**postural (orthostatic) hypotension:** a significant drop in blood pressure (usually 10 mm Hg systolic or more) after an upright posture is assumed
**preload:** degree of stretch of the cardiac muscle fibers at the end of diastole
**pulmonary vascular resistance:** resistance to right ventricular ejection of blood
**radioisotopes:** unstable atoms that emit small amounts of energy in the form of gamma rays; used in cardiac nuclear medicine studies
**repolarization:** return of the cell to resting state, caused by reentry of potassium into the cell while sodium exits the cell
**$S_1$:** the first heart sound produced by closure of the atrioventricular (mitral and tricuspid) valves
**$S_2$:** the second heart sound produced by closure of the semilunar (aortic and pulmonic) valves
**$S_3$:** an abnormal heart sound detected early in diastole as resistance is met to blood entering either ventricle; most often due to volume overload associated with heart failure
**$S_4$:** an abnormal heart sound detected late in diastole as resistance is met to blood entering either ventricle during atrial contraction; most often caused by hypertrophy of the ventricle
**sinoatrial (SA) node:** primary pacemaker of the heart, located in the right atrium
**stroke volume:** amount of blood ejected from the ventricle per heartbeat
**summation gallop:** the abnormal sound created during tachycardia by the presence of an $S_3$ and $S_4$
**systemic vascular resistance:** resistance to left ventricle ejection
**systole:** period of ventricular contraction resulting in ejection of blood from the ventricles into the pulmonary artery and aorta
**systolic click:** abnormal systolic sound created by the opening of a calcified aortic or pulmonic valve during ventricular contraction
**telemetry:** the process of continuous electrocardiographic monitoring by the transmission of radio waves from a battery-operated transmitter worn by the patient

More than 80 million Americans have one or more types of cardiovascular disease (CVD), including hypertension, coronary artery disease (CAD), heart failure (HF), stroke, and congenital cardiovascular defects (American Heart Association [AHA], 2009). Because of the prevalence of CVD, nurses practicing in any setting across the continuum of care, whether in the home, office, hospital, long-term care facility, or rehabilitation facility, must be able to assess the cardiovascular system. Key components of assessment include a health history, physical assessment, and monitoring of a variety of laboratory and diagnostic test results. This assessment provides the data necessary to identify nursing diagnoses, formulate an individualized plan of care, evaluate the response of the patient to the care provided, and revise the plan as needed.

## Anatomic and Physiologic Overview

An understanding of the structure and function of the heart in health and in disease is essential to develop cardiovascular assessment skills.

### Anatomy of the Heart

The heart is a hollow, muscular organ located in the center of the thorax, where it occupies the space between the lungs (mediastinum) and rests on the diaphragm. It weighs approximately 300 g (10.6 oz); the weight and size of the heart are influenced by age, gender, body weight, extent of physical exercise and conditioning, and heart disease. The heart pumps blood to the tissues, supplying them with oxygen and other nutrients.

The heart is composed of three layers (Fig. 26-1). The inner layer, or endocardium, consists of endothelial tissue and lines the inside of the heart and valves. The middle layer, or **myocardium,** is made up of muscle fibers and is responsible for the pumping action. The exterior layer of the heart is called the epicardium.

The heart is encased in a thin, fibrous sac called the pericardium, which is composed of two layers. Adhering to the epicardium is the visceral pericardium. Enveloping the visceral pericardium is the parietal pericardium, a tough fibrous tissue that attaches to the great vessels, diaphragm, sternum, and vertebral column and supports the heart in the mediastinum. The space between these two layers (pericardial space) is normally filled with about 20 mL of fluid, which lubricates the surface of the heart and reduces friction during systole.

#### Heart Chambers

The pumping action of the heart is accomplished by the rhythmic relaxation and contraction of the muscular walls of its four chambers. During the relaxation phase, called **diastole,** all four chambers relax simultaneously, which allows the ventricles to fill in preparation for contraction. Diastole is commonly referred to as the period of ventricular filling.

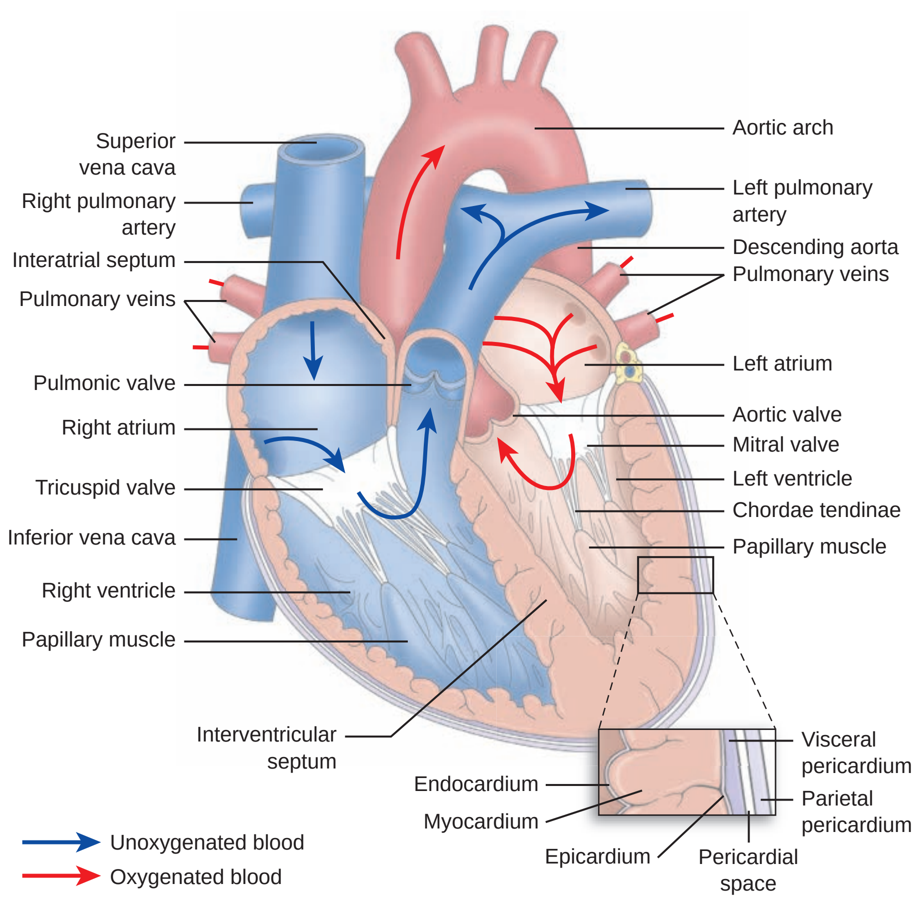



**Figure 26-1** Structure of the heart. Arrows show course of blood flow through the heart chambers.

**Systole** refers to the events in the heart during contraction of the two top chambers (atria) and two bottom chambers (ventricles). Unlike diastole, atrial and ventricular systole are not simultaneous events. Atrial systole occurs first, just at the end of diastole, followed by ventricular systole. This synchronization allows the ventricles to completely fill prior to ejection of blood from their chambers.

The right side of the heart, made up of the right atrium and right ventricle, distributes venous blood (deoxygenated blood) to the lungs via the pulmonary artery (pulmonary circulation) for oxygenation. The right atrium receives blood returning from the superior vena cava (head, neck, and upper extremities), inferior vena cava (trunk and lower extremities), and coronary sinus (coronary circulation). The left side of the heart, composed of the left atrium and left ventricle, distributes oxygenated blood to the remainder of the body via the aorta (systemic circulation). The left atrium receives oxygenated blood from the pulmonary circulation via four pulmonary veins. The relationships among the four heart chambers are shown in Figure 26-1.

The varying thicknesses of the atrial and ventricular walls relate to the workload required by each chamber. The myocardial layer of both atria is much thinner than that of the ventricles because there is little resistance as blood flows out of the atria and into the ventricles during diastole. In contrast, the ventricular walls are much thicker than the atrial walls. During ventricular systole, the right and left ventricles must overcome resistance to blood flow from the pulmonary and systemic circulatory systems, respectively. The left ventricle is two-and-a-half times more muscular than the right ventricle. It must overcome high aortic and arterial pressures, whereas the right ventricle contracts against a low-pressure system within the pulmonary arteries and capillaries. Figure 26-2 identifies the pressures in each of these areas.

The heart lies in a rotated position within the chest cavity. The right ventricle lies anteriorly (just beneath the sternum) and the left ventricle is situated posteriorly. As a result of this close proximity to the chest wall, the pulsation created during normal ventricular contraction, called the **apical impulse** (also called the **point of maximal impulse** [PMI]), is easily detected. In the normal heart, the PMI is located at the intersection of the midclavicular line of the left chest wall and the fifth intercostal space.

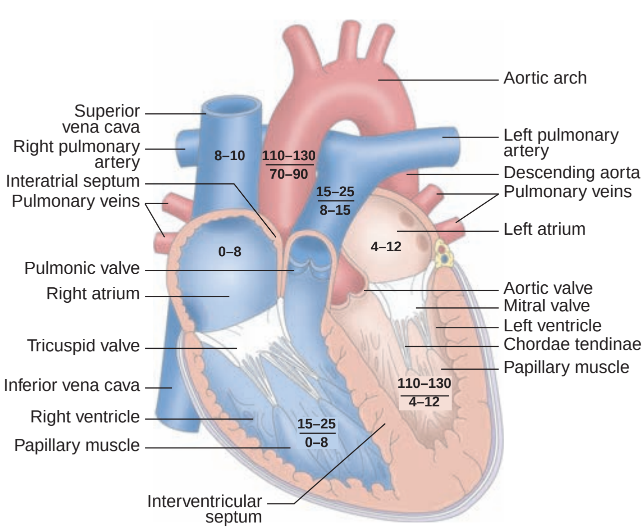



**Figure 26-2** Great vessel and chamber pressures. Pressures are identified in mm Hg as mean pressure or systolic over diastolic pressure.

## Heart Valves

The four valves in the heart permit blood to flow in only one direction. The valves, which are composed of thin leaflets of fibrous tissue, open and close in response to the movement of blood and pressure changes within the chambers. There are two types of valves: atrioventricular and semilunar.

### Atrioventricular Valves

The atrioventricular valves separate the atria from the ventricles. The tricuspid valve, so named because it is composed of three cusps or leaflets, separates the right atrium from the right ventricle. The mitral or bicuspid (two cusps) valve lies between the left atrium and the left ventricle (see Fig. 26-1).

During diastole, the tricuspid and mitral valves are open, allowing the blood in the atria to flow freely into the relaxed ventricles. As ventricular systole begins, the ventricles contract and blood flows upward into the cusps of the tricuspid and mitral valves, causing them to close. As the pressure against these valves increases, two additional structures, the papillary muscles and the chordae tendineae, maintain valve closure. The papillary muscles, located on the sides of the ventricular walls, are connected to the valve leaflets by thin fibrous bands called chordae tendineae. During ventricular systole, contraction of the papillary muscles causes the chordae tendineae to become taut, keeping the valve leaflets approximated and closed. This action prevents backflow of blood into the atria (regurgitation) as blood is ejected out into the pulmonary artery and aorta.

### Semilunar Valves

The two semilunar valves are composed of three leaflets, which are shaped like half-moons. The valve between the right ventricle and the pulmonary artery is called the pulmonic valve. The valve between the left ventricle and the aorta is called the aortic valve. The semilunar valves are closed during diastole. At this point, the pressure in the pulmonary artery and aorta decreases, causing blood to flow back toward the semilunar valves. This action fills the cusps with blood and closes the valves. The semilunar valves are forced open during ventricular systole as blood is ejected from the right and left ventricles into the pulmonary artery and aorta.

## Coronary Arteries

CONCEPTS IN ACTION

The left and right coronary arteries and their branches supply arterial blood to the heart. These arteries originate from the aorta just above the aortic valve leaflets. The heart has high metabolic requirements, extracting approximately 70% to 80% of the oxygen delivered (other organs extract,

on average, 25%). Unlike other arteries, the coronary arteries are perfused during diastole. With a normal heart rate of 60 to 80 bpm there is ample time during diastole for myocardial perfusion. However, as heart rate increases, diastolic time is shortened, which may not allow adequate time for myocardial perfusion. As a result, patients are at risk for **myocardial ischemia** (inadequate oxygen supply) during tachycardias (heart rate greater than 100), especially patients with CAD.

The left coronary artery has three branches. The artery from the point of origin to the first major branch is called the left main coronary artery. Two branches arise from the left main coronary artery: the left anterior descending artery, which courses down the anterior wall of the heart, and the circumflex artery, which circles around to the lateral left wall of the heart.

The right side of the heart is supplied by the right coronary artery, which leads to the inferior wall of the heart. The posterior wall of the heart receives its blood supply by an additional branch from the right coronary artery called the posterior descending artery (see Chapter 28, Fig. 28-2).

Superficial to the coronary arteries are the coronary veins. Venous blood from these veins returns to the heart primarily through the coronary sinus, which is located posteriorly in the right atrium.

### Myocardium

The myocardium is the middle, muscular layer of the atrial and ventricular walls. It is composed of specialized cells called myocytes, which form an interconnected network of muscle fibers. These fibers encircle the heart in a figure-of-eight pattern, forming a spiral from the base (top) of the heart to the apex (bottom). During contraction, this muscular configuration facilitates a twisting and compressive movement of the heart that begins in the atria and moves to the ventricles. The sequential and rhythmic pattern of contraction, followed by relaxation of the muscle fibers, maximizes the volume of blood ejected with each contraction. This cyclical pattern of myocardial contraction is controlled by the conduction system.

## Function of the Heart

### Cardiac Electrophysiology

The **cardiac conduction system** generates and transmits electrical impulses that stimulate contraction of the myocardium. Under normal circumstances, the conduction system first stimulates contraction of the atria and then the ventricles. The synchronization of the atrial and ventricular events allows the ventricles to fill completely before ventricular ejection, thereby maximizing cardiac output. Three physiologic characteristics of two types of specialized electrical cells, the nodal cells and the Purkinje cells, provide this synchronization:

*Automaticity:* ability to initiate an electrical impulse
*Excitability:* ability to respond to an electrical impulse
*Conductivity:* ability to transmit an electrical impulse from one cell to another

Both the **sinoatrial (SA) node** and the **atrioventricular (AV) node** are composed of nodal cells. The SA node, the primary pacemaker of the heart, is located at the junction of the superior vena cava and the right atrium (Fig. 26-3). The SA node in a normal resting adult heart has an inherent firing rate of 60 to 100 impulses per minute, but the rate changes in response to the metabolic demands of the body.

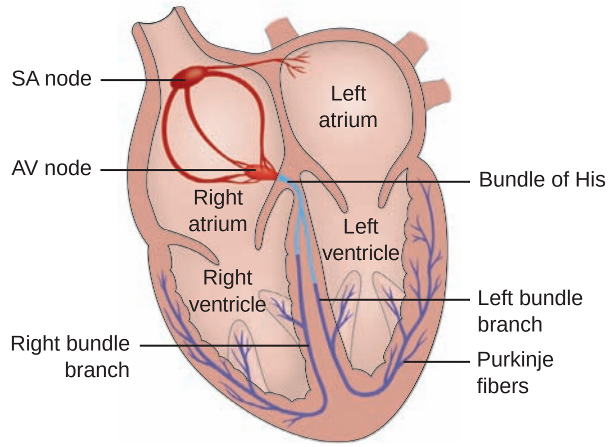



**Figure 26-3** Cardiac conduction system. AV, atrioventricular; SA, sinoatrial.

The electrical impulses initiated by the SA node are conducted along the myocardial cells of the atria via specialized tracts called internodal pathways. The impulses cause electrical stimulation and subsequent contraction of the atria. The impulses are then conducted to the AV node, which is located in the right atrial wall near the tricuspid valve (see Fig. 26-3). The AV node coordinates the incoming electrical impulses from the atria and after a slight delay (allowing the atria time to contract and complete ventricular filling) relays the impulse to the ventricles.

Initially, the impulse is conducted through a bundle of specialized conducting tissue, referred to as the bundle of His, which then divides into the right bundle branch (conducting impulses to the right ventricle) and the left bundle branch (conducting impulses to the left ventricle). To transmit impulses to the left ventricle, the largest chamber of the heart, the left bundle branch divides into the left anterior and left posterior bundle branches. Impulses travel through the bundle branches to reach the terminal point in the conduction system, called the Purkinje fibers. These fibers are composed of Purkinje cells, specialized to rapidly conduct the impulses through the thick walls of the ventricles. This is the point at which the myocardial cells are stimulated, causing ventricular contraction.

The heart rate is determined by the myocardial cells with the fastest inherent firing rate. Under normal circumstances, the SA node has the highest inherent rate (60 to 100 impulses per minute), the AV node has the second-highest inherent rate (40 to 60 impulses per minute), and the ventricular pacemaker sites have the lowest inherent rate (30 to 40 impulses per minute). If the SA node malfunctions, the AV node generally takes over the pacemaker function of the heart at its inherently lower rate.

Should both the SA and the AV nodes fail in their pacemaker function, a pacemaker site in the ventricle will fire at its inherent bradycardic rate of 30 to 40 impulses per minute.

### Cardiac Action Potential

The nodal and Purkinje cells (electrical cells) generate and transmit impulses across the heart, stimulating the cardiac myocytes (working cells) to contract. Stimulation of the myocytes occurs due to the exchange of electrically charged particles, called ions, across channels located in the cell membrane. The channels regulate the movement and speed of specific ions, namely, sodium, potassium, and calcium, as they enter and exit the cell. Sodium rapidly enters into the cell through sodium fast channels, in contrast to calcium, which enters the cell through calcium slow channels. In the resting or polarized state, sodium is the primary extracellular ion, whereas potassium is the primary intracellular ion. This difference in ion concentration means that the inside of the cell has a negative charge compared to the positive charge on the outside. This relationship changes during cellular stimulation, when sodium or calcium crosses the cell membrane into the cell and potassium ions exit into the extracellular space. This exchange of ions creates a positively charged intracellular space and a negatively charged extracellular space that characterizes the period known as **depolarization**. Once depolarization is complete, the exchange of ions reverts to its resting state; this period is known as **repolarization**. The repeated cycle of depolarization and repolarization is called the cardiac action potential.

As shown in Figure 26-4, the cardiac action potential has five phases:

- Phase 0: Cellular depolarization is initiated as positive ions influx into the cell. During this phase, the atrial and ventricular myocytes rapidly depolarize as sodium moves into the cells through sodium fast channels. The myocytes have a fast response action potential. In contrast, the cells of the SA and AV node depolarize when calcium enters these cells through calcium slow channels. These cells have a slow response action potential.

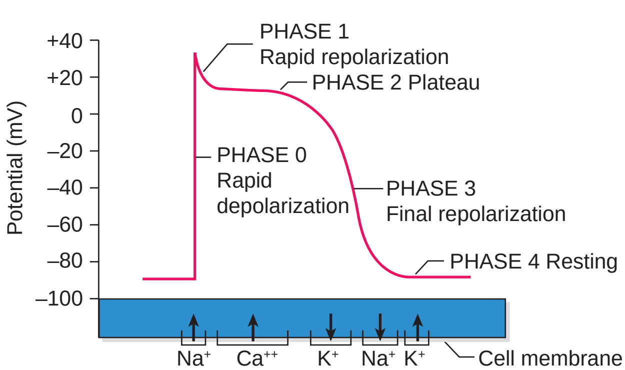



**Figure 26-4** Cardiac action potential of a fast-response Purkinje fiber. The arrows indicate the approximate time and direction of movement of each ion influencing membrane potential. $Ca^{++}$ movement out of the cell is not well defined but is thought to occur during phase 4.

- Phase 1: Early cellular repolarization begins during this phase as potassium exits the intracellular space.
- Phase 2: This phase is called the plateau phase because the rate of repolarization slows. Calcium ions enter the intracellular space.
- Phase 3: This phase marks the completion of repolarization and return of the cell to its resting state.
- Phase 4: This phase is considered the resting phase before the next depolarization.

### Refractory Periods

As reviewed previously, myocardial cells must completely repolarize before they can depolarize again. During this time, the cells are in what is called a refractory period. There are two phases of the refractory period, the effective (or absolute) refractory period and the relative refractory period. During the effective refractory period, the cell is completely unresponsive to any electrical stimulus; it is incapable of initiating an early depolarization. The effective refractory period corresponds with the time in phase 0 to the middle of phase 3 of the action potential. The relative refractory period corresponds with the short time at the end of phase 3. During the relative refractory period, if an electrical stimulus is stronger than normal, the cell may depolarize prematurely. Early depolarizations of the atrium or ventricle cause premature contractions, placing the patient at risk for dysrhythmias. Premature ventricular contractions in certain situations, such as the presence of myocardial ischemia, are of concern because these early ventricular depolarizations can trigger life-threatening dysrhythmias, including ventricular tachycardia or ventricular fibrillation. Several circumstances make the heart more susceptible to early depolarization during the relative refractory period, thus increasing the risk for serious dysrhythmias. These dysrhythmias and others are discussed in detail in Chapter 27.

## *Cardiac Hemodynamics*

An important determinant of blood flow in the cardiovascular system is the principle that fluid flows from a region of higher pressure to one of lower pressure (see Fig. 26-2). The pressures responsible for blood flow in the normal circulation are generated during systole and diastole.

### Cardiac Cycle

A cardiac cycle is composed of both systole and diastole. It refers to the events that occur in the heart from one heartbeat to the next. These events cause blood to flow through the heart due to changes in chamber pressures and valvular function during atrial and ventricular diastole and systole. During atrial and ventricular diastole, the heart chambers are relaxed. As a result, the atrioventricular valves are open, whereas the semilunar valves are closed. Pressures in all of the chambers are the lowest during diastole, which facilitates ventricular filling. Venous blood returns to the right atrium from the superior and inferior vena cava, then into the right ventricle. On the left side, oxygenated blood returns from the lungs via the four pulmonary veins into the left atrium and ventricle.

Toward the end of this diastolic period, atrial systole occurs as the atrial muscles contract in response to an electrical impulse initiated by the SA node. Atrial systole increases the pressure inside the atria, ejecting the remaining blood into the ventricles. Atrial systole augments ventricular blood volume by 15% to 25% and is sometimes referred to as the "atrial kick." At this point, ventricular systole begins in response to propagation of the electrical impulse that began in the SA node some milliseconds earlier.

Beginning with ventricular systole, the pressure inside the ventricles rapidly increases, forcing the atrioventricular valves to close. As a result, blood ceases to flow from the atria into the ventricles, and regurgitation (backflow) of blood into the atria is prevented. The rapid increase of pressure inside the right and left ventricles forces the pulmonic and aortic valves to open, and blood is ejected into the pulmonary artery and aorta, respectively. The exit of blood is at first rapid; then, as the pressure in each ventricle and its corresponding artery equalizes, the flow of blood gradually decreases. At the end of systole, pressure within the right and left ventricles rapidly decreases. As a result, pulmonary arterial and aortic pressures decrease, causing closure of the semilunar valves. These events mark the onset of diastole and the cardiac cycle is repeated.

Chamber pressures can be measured with the use of special monitoring catheters and equipment. This technique is called hemodynamic monitoring. Methods of hemodynamic monitoring are covered in more detail at the end of this chapter.

### Cardiac Output

**Cardiac output** refers to the amount of blood pumped by each ventricle during a given period. The cardiac output in a resting adult is about 5 L/min but varies greatly depending on the metabolic needs of the body. Cardiac output is computed by multiplying the stroke volume by the heart rate. **Stroke volume** is the amount of blood ejected per heartbeat. The average resting stroke volume is about 70 mL, and the heart rate is 60 to 80 bpm. Cardiac output can be affected by changes in either stroke volume or heart rate.

***Control of Heart Rate.*** Cardiac output must be responsive to changes in the metabolic demands of the tissues. For example, during exercise the total cardiac output may increase fourfold, to 20 L/min. This increase is normally accomplished by approximately doubling both the heart rate and the stroke volume. Changes in heart rate are accomplished by reflex controls mediated by the autonomic nervous system, including its sympathetic and parasympathetic divisions.

The parasympathetic impulses, which travel to the heart through the vagus nerve, can slow the cardiac rate, whereas sympathetic impulses increase it. These effects on heart rate result from action on the SA node, to either decrease or increase its inherent rate. The balance between these two reflex control systems normally determines the heart rate. The heart rate is increased by the sympathetic nervous system through an increased level of circulating catecholamines (secreted by the adrenal gland) and by excess thyroid hormone, which produces a catecholamine-like effect.

In addition, the heart rate is affected by central nervous system and baroreceptor activity. **Baroreceptors** are specialized nerve cells located in the aortic arch and in both right and left internal carotid arteries (at the point of bifurcation from the common carotid arteries). The baroreceptors are sensitive to changes in blood pressure (BP). During significant elevations in BP **(hypertension),** these cells increase their rate of discharge, transmitting impulses to the cerebral medulla. This initiates parasympathetic activity and inhibits sympathetic response, lowering the heart rate and the BP. The opposite is true during **hypotension** (low BP). Hypotension results in less baroreceptor stimulation, which prompts a decrease in parasympathetic inhibitory activity in the SA node, allowing for enhanced sympathetic activity. The resultant vasoconstriction and increased heart rate elevate the BP.

***Control of Stroke Volume.*** Stroke volume is primarily determined by three factors: preload, afterload, and contractility.

**Preload** refers to the degree of stretch of the ventricular cardiac muscle fibers at the end of diastole. The end of diastole is the period when filling volume in the ventricles is the highest and the degree of stretch on the muscle fibers is the greatest. The volume of blood within the ventricle at the end of diastole determines preload, which directly affects stroke volume. Therefore, preload is commonly referred to as left ventricular end-diastolic pressure (LVEDP). As the volume of blood returning to the heart increases, muscle fiber stretch also increases (increased preload), resulting in stronger contraction and a greater stroke volume. This relationship, called the Frank-Starling (or Starling) law of the heart, is maintained until the physiologic limit of the muscle is reached.

The Frank-Starling law is based on the fact that, within limits, the greater the initial length or stretch of the cardiac muscle cells (sarcomeres), the greater the degree of shortening that occurs. This result is caused by increased interaction between the thick and thin filaments within the cardiac muscle cells. Preload is decreased by a reduction in the volume of blood returning to the ventricles. Diuresis, venodilating agents (eg, nitrates), excessive loss of blood, or dehydration (excessive loss of body fluids from vomiting, diarrhea, or diaphoresis) reduce preload. Preload is increased by increasing the return of circulating blood volume to the ventricles. Controlling the loss of blood or body fluids and replacing fluids (ie, blood transfusions and intravenous [IV] fluid administration) are examples of ways to increase preload.

**Afterload,** or resistance to ejection of blood from the ventricle, is the second determinant of stroke volume. The resistance of the systemic BP to left ventricular ejection is called **systemic vascular resistance**. The resistance of the pulmonary BP to right ventricular ejection is called **pulmonary vascular resistance**. There is an inverse relationship between afterload and stroke volume. For example, afterload is increased by arterial vasoconstriction, which leads to decreased stroke volume. The opposite is true

with arterial vasodilation: Afterload is reduced because there is less resistance to ejection, and stroke volume increases.

**Contractility** refers to the force generated by the contracting myocardium. Contractility is enhanced by circulating catecholamines, sympathetic neuronal activity, and certain medications (eg, digoxin [Lanoxin], dopamine [Intropin], or dobutamine [Dobutrex]). Increased contractility results in increased stroke volume. Contractility is depressed by hypoxemia, acidosis, and certain medications (eg, beta-adrenergic blocking agents such as atenolol [Tenormin]).

The heart can achieve an increase in stroke volume (eg, during exercise) if preload is increased (through increased venous return), if contractility is increased (through sympathetic nervous system discharge), and if afterload is decreased (through peripheral vasodilation with decreased aortic pressure).

The percentage of the end-diastolic blood volume that is ejected with each heartbeat is called the **ejection fraction**. The ejection fraction of the normal left ventricle is 55% to 65%. The right ventricular ejection fraction is rarely measured. The ejection fraction is used as a measure of myocardial contractility. An ejection fraction of less than 40% indicates that the patient has decreased left ventricular function and likely requires treatment for heart failure (HF) (refer to Chapter 30 for further discussion).

## Gerontologic Considerations

Changes in cardiac structure and function are clearly observable in the aging heart. To understand the changes specifically related to aging, it is helpful to distinguish the normal aging process from changes related to CVD. The anatomic and functional changes in the aging heart are summarized in Table 26-1.

These changes lead to decreased myocardial contractility, increased left ventricular ejection time (prolonged systole), and delayed conduction. Therefore, stressful physical and emotional conditions, especially those that occur suddenly, may have adverse effects on the aged person. The heart cannot respond to such conditions with an adequate rate increase and needs more time to return to a normal resting rate after even a minimal increase in heart rate. In some patients, the added stress may precipitate HF.

## Gender Considerations

Structural differences between the hearts of men and women have significant implications. A woman's heart tends to be smaller as compared to a man's heart, and has smaller coronary arteries. Because the coronary arteries of a woman are smaller, they become occluded from atherosclerosis more easily, making procedures such as cardiac catheterization and angioplasty technically more difficult,

**Table 26-1 AGE-RELATED CHANGES OF THE CARDIAC SYSTEM**

| Cardiovascular Structure | Structural Changes | Functional Changes | History and Physical Findings |
|---|---|---|---|
| Atria | ↑ Size of left atrium<br>Thickening of the endocardium | ↑ Atrial irritability | Irregular heart rhythm from atrial dysrhythmias |
| Left ventricle | Endocardial fibrosis<br>Myocardial thickening (hypertrophy)<br>Infiltration of fat into myocardium | Left ventricle stiff and less compliant<br>Progressive decline in cardiac output<br>↑ Risk for ventricular dysrhythmias<br>Prolonged systole | Fatigue<br>↓ Exercise tolerance<br>Signs and symptoms of HF or ventricular dysrhythmias<br>Point of maximal impulse palpated lateral to the midclavicular line<br>↓ Intensity $S_1$, $S_2$; split $S_2$<br>$S_4$ may be present |
| Valves | Thickening and rigidity of AV valves<br>Calcification of aortic valve | Abnormal blood flow across valves during cardiac cycle | Murmurs may be present<br>Thrill may be palpated if significant murmur is present |
| Conduction system | Connective tissue collects in SA node, AV node, and bundle branches<br>↓ Number of SA node cells<br>↓ Number of AV, bundle of His, and right and left bundle branch cells | Slower SA node rate of impulse discharge<br>Slowed conduction across AV node and ventricular conduction system | Bradycardia<br>Heart block<br>ECG changes consistent with slowed conduction (↑ PR interval, widened QRS complex) |
| Sympathetic nervous system | ↓ Response to beta-adrenergic stimulation | ↓ Adaptive response to exercise: contractility and heart rate slower to respond to exercise demands<br>Heart rate takes more time to return to baseline | Fatigue<br>Diminished exercise tolerance<br>↓ Ability to respond to stress |
| Aorta and arteries | Stiffening of vasculature<br>↓ Elasticity and widening of aorta<br>Elongation of aorta, displacing the brachiocephalic artery upward | Left ventricular hypertrophy | Progressive increase in systolic BP; slight ↑ in diastolic BP<br>Widening pulse pressure<br>Pulsation visible above right clavicle |
| Baroreceptor response | ↓ Sensitivity of baroreceptors in the carotid artery and aorta to transient episodes of hypertension and hypotension | Baroreceptors unable to regulate heart rate and vascular tone, causing slow response to postural changes in body position | Postural blood pressure changes and reports of feeling dizzy, fainting when moving from lying to sitting or standing position |

AV, atrioventricular; BP, blood pressure; ECG, electrocardiographic; HF, heart failure; SA, sinoatrial.

with a higher incidence of postprocedural complications. In addition, the resting rate, stroke volume, and ejection fraction of a woman's heart are higher than those of a man's heart, and the conduction time of an electrical impulse traveling from the SA node through the AV node to the Purkinje fibers is briefer.

For many years, it was believed that the female hormone estrogen had cardioprotective effects. Hormone therapy was routinely prescribed for postmenopausal women in the belief that this pharmacologic therapy would deter the onset and progression of coronary atherosclerosis. This belief was supported by anecdotal evidence that the onset of heart disease in women tends to occur later than in men, at a time when most women had experienced menopause and were largely bereft of estrogen. However, based on results from the multisite, prospective, longitudinal study called the Women's Health Initiative, the AHA no longer recommends the use of hormone therapy as a prevention strategy for women (Mosca, Banka, Benjamin, et al., 2007).

# Assessment of the Cardiovascular System

The frequency and extent of the nursing assessment of cardiovascular function are based on several factors, including the severity of the patient's symptoms, the presence of risk factors, the practice setting, and the purpose of the assessment. An acutely ill patient with CVD who is admitted to the emergency department or coronary intensive care unit requires a very different assessment than a person who is being examined for a chronic stable condition. Although the key components of the cardiovascular assessment remain the same, the assessment priorities vary according to the needs of the patient. For example, an emergency department nurse performs a rapid and focused assessment of a patient in which **acute coronary syndrome** (ACS), rupture of an atheromatous plaque in a diseased coronary artery, is suspected. Diagnosis and treatment must be started within minutes of arrival to the emergency department. The physical assessment is ongoing and concentrates on evaluating the patient for ACS complications, such as dysrhythmias and HF, and determining the effectiveness of medical treatment.

## Health History

The patient's ability to recognize cardiac symptoms and to know what to do when they occur is essential for effective self-care management. All too often, a patient's new symptoms or those of progressing cardiac dysfunction go unrecognized. This results in prolonged delays in seeking lifesaving treatment. Major barriers to seeking prompt medical care include lack of knowledge about the symptoms of heart disease, attributing symptoms to a benign source, denying symptom significance, and feeling embarrassed about having symptoms (Moser, Kimble, Alberts, et al., 2007). Therefore, during the health history the nurse needs to determine if the patient and involved family members are able to recognize symptoms of an acute cardiac problem, such as ACS or HF, and seek timely treatment for these symptoms. Responses to this level of inquiry will help the nurse individualize the plan for patient and family education.

### Common Symptoms

The signs and symptoms experienced by people with CVD are related to dysrhythmias and conduction problems (see Chapter 27); CAD (see Chapter 28); structural, infectious, and inflammatory disorders of the heart (see Chapter 29); and complications of CVD such as HF and cardiogenic shock (see Chapter 30). These disorders have many signs and symptoms in common; therefore, the nurse must be skillful at recognizing these signs and symptoms so that patients are given timely and often lifesaving care.

The following are the most common signs and symptoms of CVD, with related medical diagnoses in parentheses:

- Chest pain or discomfort (angina pectoris, ACS, dysrhythmias, valvular heart disease)
- Shortness of breath or dyspnea (ACS, cardiogenic shock, HF, valvular heart disease)
- Peripheral edema, weight gain, abdominal distention due to enlarged spleen and liver or ascites (HF)
- Palpitations (tachycardia from a variety of causes, including ACS, caffeine or other stimulants, electrolyte imbalances, stress, valvular heart disease, ventricular aneurysms)
- Vital fatigue, sometimes referred to as vital exhaustion (an early warning symptom of ACS, HF, or valvular heart disease, characterized by feeling unusually tired or fatigued, irritable, and dejected)
- Dizziness, syncope, or changes in level of consciousness (cardiogenic shock, cerebrovascular disorders, dysrhythmias, hypotension, postural hypotension, vasovagal episode)

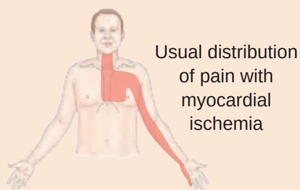
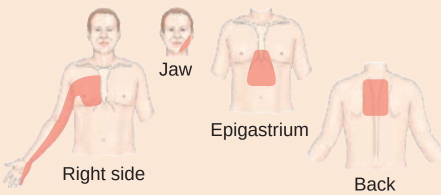
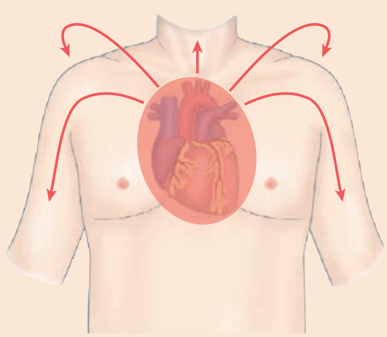
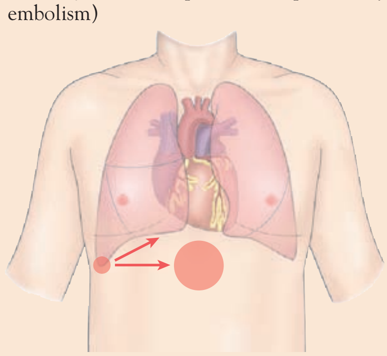
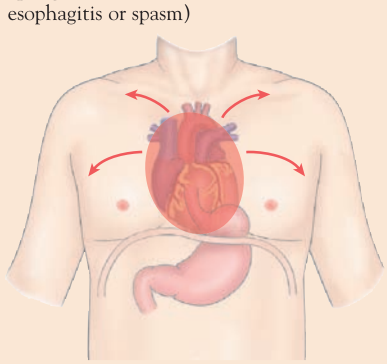
#### Chest Pain

Chest pain and discomfort are common symptoms that may be caused by a number of cardiac and noncardiac problems. When a patient experiences chest symptoms, the nurse asks questions that aid in differentiating among these sources of chest symptoms. Table 26-2 summarizes the characteristics and patterns of the more common cardiac and noncardiac causes of chest symptoms. During the assessment the patient is asked to identify the quantity of pain using a 0 (no pain) to 10 (worst pain) scale. Next, the nurse asks the patient to describe the character or quality of the pain or discomfort and its location. The nurse needs to determine whether there is radiation to or discomfort in other areas and must assess for associated signs and symptoms such as diaphoresis or nausea. It is important to identify the events that precipitate the onset of symptoms, the duration of the symptoms, and measures that aggravate or relieve the symptoms.

The nurse should keep the following important points in mind when assessing patients reporting chest pain or discomfort:

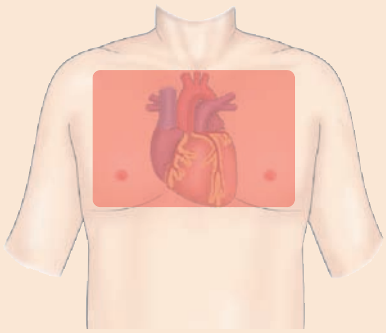
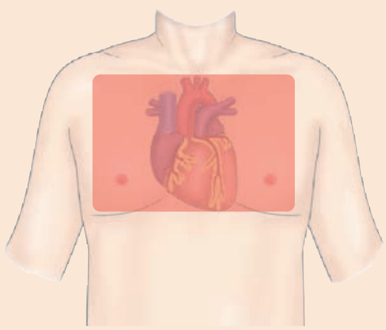
- The location of chest symptoms is not well correlated with the cause of the pain. For example, substernal

**Table 26-2 ASSESSING CHEST PAIN**

| Location | Character | Duration | Precipitating Events and Aggravating Factors | Alleviating Factors |
|---|---|---|---|---|
| ***Angina pectoris***<br>***Acute coronary syndrome*** (ACS) (unstable angina, myocardial infarction [MI])<br><br><br>Less common sites of pain with myocardial ischemia | Angina:<br>Uncomfortable pressure, squeezing, or fullness in substernal chest area<br>Can radiate across chest to the medial aspect of one or both arms and hands, jaw, shoulders, upper back, or epigastrium<br>Radiation to arms and hands, described as numbness, tingling, or aching<br>ACS:<br>Same as angina pectoris<br>Pain or discomfort ranges from mild to severe<br>Associated with shortness of breath, diaphoresis, palpitations, fatigue, and nausea or vomiting | Angina:<br>5–15 min<br>ACS:<br>>15 min | Angina: Physical exertion, emotional upset, eating large meal, or exposure to extremes in temperature<br>ACS: Emotional upset or unusual physical exertion occurring within 24 hr of symptom onset<br>Can occur at rest or while asleep | Angina: Rest, nitroglycerin, oxygen<br>ACS: Morphine, reperfusion of coronary artery with thrombolytic agent or percutaneous coronary intervention |
| ***Pericarditis***<br> | Sharp, severe substernal or epigastric pain<br>Can radiate to neck, arms, and back<br>Associated symptoms include fever, malaise, dyspnea, cough, nausea, dizziness, and palpitations | Intermittent | Sudden onset<br>Pain increases with inspiration, swallowing, coughing, and rotation of trunk | Sitting upright, analgesia, anti-inflammatory medications |
| ***Pulmonary disorders*** (pneumonia, pulmonary embolism)<br> | Sharp, severe substernal or epigastric pain arising from inferior portion of pleura (referred to as pleuritic pain) Patient may be able to localize the pain | ≥30 min | Follows an infectious or noninfectious process (MI, cardiac surgery, cancer, immune disorders, uremia)<br>Pleuritic pain increases with inspiration, coughing, movement, and supine positioning<br>Occurs in conjunction with community-acquired or nosocomial lung infections (pneumonia) or deep vein thrombosis (pulmonary embolism) | Treatment of underlying cause |
| ***Esophageal disorders*** (hiatal hernia, reflux esophagitis or spasm)<br> | Substernal pain described as sharp, burning, or heavy<br>Often mimics angina<br>Can radiate to neck, arm, or shoulders | 5–60 min | Recumbency, cold liquids, exercise | Food or antacid<br>Nitroglycerin |

(*Continued*)

**Table 26-2 ASSESSING CHEST PAIN (Continued)**

| Location | Character | Duration | Precipitating Events and Aggravating Factors | Alleviating Factors |
|---|---|---|---|---|
| *Anxiety and panic disorders*  | Pain described as stabbing to dull ache<br>Associated with diaphoresis, palpitations, shortness of breath, tingling of hands or mouth, feeling of unreality, or fear of losing control | Peaks in 10 min | Can occur at any time including during sleep<br>Can be associated with a specific trigger | Removal of stimulus, relaxation, medications to treat anxiety or underlying disorder |
| *Musculoskeletal disorders* (costochondritis)  | Sharp or stabbing pain localized in anterior chest<br>Most often unilateral<br>Can radiate across chest to epigastrium or back | Hours to days | Most often follows respiratory tract infection with significant coughing, vigorous exercise, or posttrauma<br>Some cases are idiopathic<br>Exacerbated by deep inspiration, coughing, sneezing, and movement of upper torso or arms | Rest, ice, or heat<br>Analgesic or anti-inflammatory medications |

chest pain can result from a number of causes as outlined in Table 26-2.

- The severity or duration of chest pain or discomfort does not predict the seriousness of its cause. For example, a patient experiencing esophageal spasm may rate chest pain as a "10/10" (eg, the worst pain the patient has ever felt), whereas a patient experiencing a myocardial infarction (MI) may report only mild to moderate chest pressure.
- More than one clinical cardiac condition may occur simultaneously. During an MI, patients may report chest pain from myocardial ischemia, shortness of breath from HF, and palpitations from dysrhythmias. Both HF and dysrhythmias can be complications of an acute MI.

### Symptoms of Acute Coronary Syndrome

Nurses and other health care professionals must take a patient's complaint of CVD-related symptoms seriously until the cause is determined. Because CAD is so prevalent, all patients reporting new or worsening cardiac symptoms, particularly those at risk for CAD or who have a history of CAD, should be evaluated initially for ACS. There are several distinct characteristics of ACS symptoms that need to be kept in mind during assessment of the patient in which ACS is suspected:

- The majority of patients with ACS experience prodromal symptoms sometimes a month or more prior to developing this acute event. Prodromal symptoms include fatigue, shortness of breath, sleep disturbances, anxiety, or fleeting chest discomfort (aching, pressure) that wax and wane. Because these symptoms are less severe than those experienced during ACS, patients often attribute them to a benign problem such as stress, and fail to seek medical care. Nurses should include questions regarding presence of prodromal symptoms when assessing patients with CVD-related symptoms.
- Approximately 50% of men and women with ACS experience chest symptoms, whereas the remainder may develop a variety of symptoms such as upper back, shoulder, arm, or neck pain; epigastric burning; or shortness of breath.
- At least four symptoms herald the onset of ACS, sometimes referred to as ACS symptom clusters (Ryan, DeVon, Horne, et al., 2007) (Chart 26-1).
- Neuropathies in elderly patients and those with diabetes may prevent these patients from experiencing pain or discomfort associated with myocardial ischemia. Instead, they may report vital fatigue or shortness of breath. In some patients, ACS may be asymptomatic, which is referred to as silent ischemia.
- A 12-lead electrocardiogram (ECG) and serum laboratory analysis of cardiac biomarkers are necessary to determine if the patient with ACS symptoms has

CHART 26-1 NURSING RESEARCH PROFILE
## Symptom Clusters in Acute Myocardial Infarction

Ryan, C. J., DeVon, H. A., Horne, R., et al. (2007). Symptom clusters in acute myocardial infarction. *Nursing Research, 56*(2), 72–81.

**Purpose**

The majority of lay people associate an acute myocardial infarction (MI) with severe debilitating chest pain. Unfortunately, this misinformation leads to significant delays in receiving lifesaving care. People who are in the midst of an acute MI tend to attribute less severe chest pain or other less known symptoms (shortness of breath, upper abdominal pain, or neck, arm, or shoulder discomfort) to benign sources rather than MI. The purpose of this study was to identify symptom clusters that represent an acute MI.

**Design**

In this secondary data analysis, data sets from nine descriptive, cross-sectional studies were combined to create a sample of 1073 patients from the United States and England who experienced an acute MI. A latent class cluster analysis was used to classify similar symptoms into groups. Variables in this analysis included 12 MI symptoms and demographic characteristics.

**Findings**

The analysis revealed five different acute MI symptom clusters. Symptom membership in a particular cluster was based on high, moderate, and low probability. The following identify these clusters and their rates of occurrence:

- Chest discomfort; shoulder, arm, or hand pain; weakness ($n$ = 462; 43%)
- Chest discomfort; shoulder, arm, or hand pain ($n$ = 253; 23%)
- Chest discomfort; shoulder, arm, or hand pain; nausea or vomiting; shortness of breath; sweating; dizziness/lightheadedness; weakness; fatigue ($n$ = 186; 17%)
- Shoulder, arm, or hand discomfort; abdominal pain; indigestion ($n$ = 95; 8%)
- No symptoms ($n$ = 75; 6%)

**Nursing Implications**

Although secondary analysis has its limitations, these results demonstrate that chest pain is not the only symptom experienced during an acute MI. Acute MI symptoms occur in clusters. In addition, chest pain was not a symptom heralding acute MI in 14% of this sample. Demographic characteristics, such as age, gender, and race, may help to predict what type of symptoms patients will experience. To save lives and reduce morbidity associated with MI, the severe, debilitating chest pain myth needs to be dispelled. Nurses are in a unique position to educate their patients and the public about the various MI symptom clusters and actions to take to manage these symptoms. These interventions will help to ensure that people promptly recognize the seriousness of a variety of MI-related symptoms and access the emergency medical system quickly.

unstable angina, a non–ST- segment elevation MI (NSTEMI), or an ST-segment elevation MI (STEMI) (see Chapter 28).

### *Past Health, Family, and Social History*

In an effort to determine how the patient perceives his or her current health status, the nurse must ask some of the following questions:

- What type of health concerns do you have? Are you able to identify any family history (Chart 26-2) or behaviors (risk factors) that put you at risk for this health condition?
- What are your risk factors for heart disease? What do you do to stay healthy and take care of your heart?
- How is your health? Have you noticed any changes from last year? From 5 years ago?
- Do you have a cardiologist or primary health care provider? How often do you go for checkups?
- Do you use tobacco or consume alcohol?

Patients who do not understand that their behaviors or diagnoses pose a threat to their health may be less motivated to make lifestyle changes or to manage their illness effectively. On the other hand, patients who perceive that their modifiable risk factors for heart disease affect their health and believe that they have the power to modify or change them may be more likely to change these behaviors.

#### Medications

Nurses collaborate with physicians and pharmacists to obtain a complete list of the patient's medications including dose and frequency. Vitamins, herbals, and other over-the-counter medications are included on this list. During this aspect of the health assessment, the nurse solicits answers to the following questions to ensure that patients are safely and effectively taking their medications.

- Is the patient independent in taking medications?
- Are the medications taken as prescribed?
- Does the patient know what side effects to report to the prescriber?
- Does the patient understand why the medication regimen is important?
- Are doses ever forgotten or skipped, or does the patient ever decide to stop taking a medication?

An aspirin a day is a common nonprescription medication that improves outcomes in patients with CAD. However, if patients are not aware of this benefit, they may be inclined to stop taking aspirin if they think it is a trivial medication. A careful medication history often uncovers common medication errors and causes for nonadherence to the medication regimen.

#### Nutrition

Dietary modifications, exercise, weight loss, and careful monitoring are important strategies for managing three

CHART 26-2

GENETICS IN NURSING PRACTICE
*Cardiovascular Disorders*

Several cardiovascular disorders are associated with genetic abnormalities. Some examples are:
- Familial hypercholesterolemia
- Hypertrophic cardiomyopathy
- Long QT syndrome
- Hereditary hemochromatosis
- Elevated homocysteine levels

**Nursing Assessments**

**Family History Assessment**
- Assess all patients with cardiovascular symptoms for coronary artery disease (CAD), regardless of age (early-onset CAD occurs).
- Assess family history of sudden death in people who may or may not have been diagnosed with coronary disease (especially of early onset).
- Ask about sudden death in a previously asymptomatic child, adolescent, or adult.
- Ask about other family members with biochemical or neuromuscular conditions (eg, hemochromatosis or muscular dystrophy).
- Assess whether DNA mutation or other genetic testing has been performed on an affected family member.

**Patient Assessment**
- Assess for signs and symptoms of hyperlipidemias (xanthomas, corneal arcus, abdominal pain of unexplained origin).
- Assess for muscular weakness.

**Management Issues Specific to Genetics**
- If indicated, refer for further genetic counseling and evaluation so that the family can discuss inheritance, risk to other family members, availability of genetic testing, and gene-based interventions.
- Offer appropriate genetic information and resources (eg, Genetic Alliance Web site, American Heart Association).
- Provide support to families newly diagnosed with genetics-related cardiovascular disease.

**Genetics Resources**

**Genetic Alliance—**a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Tests—**a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling, and testing information, www.geneclinics.org

**National Organization of Rare Disorders—**a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man—**a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/omim/stats/html

major cardiovascular risk factors: hyperlipidemia, hypertension, and diabetes mellitus. Diets that are restricted in sodium, fat, cholesterol, or calories are commonly prescribed. The nurse obtains the following information:

- The patient's current height and weight (to determine body mass index [BMI]), waist measurement (assessment for obesity), BP, and any laboratory test results such as blood glucose, glycosylated hemoglobin (diabetes), total blood cholesterol, high-density and low-density lipoprotein levels, and triglyceride levels (hyperlipidemia)
- How often the patient self-monitors BP, blood glucose, and weight as appropriate to the medical diagnoses
- The patient's level of awareness regarding his or her target goals for each of the risk factors, and any problems achieving or maintaining these goals
- What the patient normally eats and drinks in a typical day and any food preferences (including cultural or ethnic preferences)
- Eating habits (canned or commercially prepared foods versus fresh foods, restaurant cooking versus home cooking, assessing for high-sodium foods, dietary intake of fats)
- Who shops for groceries and prepares meals

### Elimination

Typical bowel and bladder habits need to be identified. Nocturia (awakening at night to urinate) is common in patients with HF. Fluid collected in gravity-dependent tissues (extremities) during the day (ie, edema) redistributes into the circulatory system once the patient is recumbent at night. The increased circulatory volume is excreted by the kidneys (increased urine production).

When straining during defecation, the patient bears down (the Valsalva maneuver), which momentarily increases pressure on the baroreceptors. This triggers a vagal response, causing the heart rate to slow and resulting in syncope in some patients. Straining during urination can produce the same response.

Because many cardiac medications can cause gastrointestinal side effects or bleeding, the nurse asks about bloating, diarrhea, constipation, stomach upset, heartburn, loss of appetite, nausea, and vomiting. Patients taking platelet-inhibiting medications such as aspirin and clopidogrel (Plavix); platelet aggregation inhibitors such as abciximab (ReoPro), eptifibatide (Integrilin), and tirofiban (Aggrastat); and anticoagulants such as low-molecular-weight heparin (ie, dalteparin [Fragmin], enoxaparin [Lovenox]), heparin, or warfarin (Coumadin) are screened for bloody urine or stools.

### Activity and Exercise

As the nurse assesses the patient's activity and exercise history, it is important to note that decreases in activity tolerance are typically gradual and may go unnoticed by

the patient. Therefore, the nurse needs to determine whether there has been a change in the activity pattern during the past 6 to 12 months. The patient's subjective response to activity is an essential assessment parameter. New symptoms or a change in the usual anginal symptoms during activity is a significant finding. Fatigue, associated with a low left ventricular ejection fraction (less than 40%) and certain medications (eg, beta-adrenergic blocking agents), can result in activity intolerance. Patients with fatigue may benefit from having their medications adjusted and learning energy conservation techniques.

Additional areas to ask about include possible architectural barriers and challenges in the home, and what the patient does for exercise. If the patient exercises, the nurse asks additional questions: What is the intensity, duration, and frequency of exercise? Has the patient ever participated in a cardiac rehabilitation program? Functional levels are known to improve for almost all patients who participate in a cardiac rehabilitation program, and participation is highly recommended (Leon, Franklin, Costa, et al., 2005; Smith, Allen, Blair, et al., 2006). Patients with disabilities may require an individually tailored exercise program.

#### Sleep and Rest

Clues to worsening cardiac disease, especially HF, can be revealed by sleep-related events. Determining where and how the patient sleeps or rests is important. Recent changes, such as sleeping upright in a chair instead of in bed, increasing the number of pillows used, awakening short of breath at night (paroxysmal nocturnal dyspnea [PND]), or awakening with angina (nocturnal angina), are all indicative of worsening HF.

#### Self-Perception and Self-Concept

Self-perception and self-concept are both related to the cognitive and emotional processes that people use to formulate their beliefs and feelings about themselves. Having a chronic cardiac illness, such as HF, or experiencing an acute cardiac event, such as an MI, can alter an individual's self-perception and self-concept. It is important for the nurse to understand that patients' beliefs and feelings about their health are key determinants in adherence to health regimen recommendations and recovery after an acute cardiac event (Astin & Jones, 2006; van der Wal, Jaarsma, Moser, et al., 2007). To reduce or minimize the reoccurrence of future cardiovascular-related health problems, patients are asked to make difficult lifestyle changes, such as quitting smoking. How well patients adhere to these recommendations is directly related to their health outcomes. Patients who do not understand the health consequences of their disease process and its management are at risk for noncompliance. On the contrary, patients with misperceptions about the consequences of their cardiac illness on their health may fail to return to their usual level of function, including work, despite being physically able. The health history is used to discover how patients perceive their health by asking questions that may include the following:

- What is your cardiac condition?
- How has this illness changed your feelings about your health?
- What do you think caused this illness?
- What consequences do you think this illness will have on your physical activity, work, social relationships, and role in your family?
- How much of an influence do you think you have on controlling this illness?

The patient's responses to these questions can guide the nurse in planning interventions to ensure that the patient is prepared to manage the illness and that adequate services are in place to support the patient's recovery and self-management needs.

#### Roles and Relationships

Hospital stays for cardiac disorders have shortened, with many invasive diagnostic cardiac procedures, such as cardiac catheterization and percutaneous coronary intervention (PCI), being performed as outpatient procedures.

To assess support systems, the nurse needs to ask: Who is the primary caregiver? With whom does the patient live? Are there adequate services in place to provide a safe home environment? The nurse also assesses for any significant effects the cardiac illness has had on the patient's role in the family. Are there adequate finances and health insurance? The answers to these questions help the nurse develop a plan to meet the patient's home care needs.

#### Sexuality and Reproduction

Although people recovering from cardiac illnesses or procedures are often concerned about sexual activity, they are unlikely to ask their nurse or other health care provider for information to help them resume their normal sex life. Therefore, the nurse needs to initiate a discussion about sexuality with the patient.

The most commonly cited reasons for changes in sexual activity are fear of another heart attack or sudden death; untoward symptoms such as angina, dyspnea, or palpitations; and problems with impotence or depression. In men, impotence may develop as a side effect of cardiac medications (eg, beta-blockers); some men will stop taking their medication as a result. Other medications may be substituted, so patients should be encouraged to discuss this problem with their health care providers. Often, patients and their partners do not have adequate information about the physical demands related to sexual activity and ways in which these demands can be modified. The physiologic demands are greatest during orgasm, reaching 5 or 6 metabolic equivalents (METs). This level of activity is equivalent to walking 3 to 4 miles per hour on a treadmill. The METs expended before and after orgasm are considerably less, at 3.7 METs. Sharing this information may make the patient and his or her partner more comfortable about resuming sexual activity.

A reproductive history is necessary for women of childbearing age, particularly those with seriously compromised cardiac function. The reproductive history includes information about previous pregnancies, plans for future pregnancies, oral contraceptive use (especially in women older than 35 years of age who smoke), menopausal status, and use of hormone therapy.

### Coping and Stress Tolerance

Anxiety, depression, and stress are known to influence both the development of and recovery from CAD and HF. High levels of anxiety are associated with an increased incidence of CAD and in-hospital complication rates after MI. Patients with a diagnosis of an acute MI and depression have an increased risk of rehospitalization, death, more frequent angina, more physical limitations, and poorer quality of life, compared with patients without depression (Parashar, Rumsfield & Spertus, 2006). Although the association between depression and CAD is not completely understood, both biologic factors (eg, platelet abnormalities, inflammatory responses) and lifestyle factors may contribute to the development of CAD. Patients who are depressed are less motivated to adhere to recommended lifestyle changes and medical regimens necessary to prevent future cardiac events (Konstam, Moser & De Jong, 2005). Patients with cardiovascular disease should be assessed for depression by asking them if they are feeling sad or blue, if they have lost interest in things they usually enjoy, or if they have thoughts about death or suicide. Other indications of depression include feelings of worthlessness or guilt, problems falling asleep or staying asleep, having difficulty concentrating, restlessness, and recent changes in appetite or weight.

Stress initiates a variety of responses, including increased level of catecholamines and cortisol, and has been strongly linked to cardiovascular events. Therefore, patients need to be assessed for sources of stress; the nurse should ask about recent or ongoing stressors, previous coping styles and effectiveness, and the patient's perception of his or her current mood and coping ability. Consultation with a psychiatric advanced practice nurse, psychologist, psychiatrist, or social worker is indicated for anxious or depressed patients or those patients having difficulty coping with their cardiac illness.

### Prevention Strategies

The health history also addresses risk factors for heart disease and measures taken by the patient to prevent disease. The nurse asks the patient about health promotion practices. Certain conditions or behaviors (ie, risk factors) are associated with a greater incidence of coronary artery, peripheral vascular, and cerebrovascular disease (AHA, 2007). Risk factors are classified by the extent to which they can be modified by changing one's lifestyle or modifying personal behaviors.

Once a patient's risk factors are determined, the nurse assesses whether the patient has a plan for making necessary behavioral changes and whether assistance is needed to support these lifestyle changes. For example, tobacco use is one of the most commonly implicated and readily modifiable risk factors for CAD. The first step in treating this health risk is to identify patients who use tobacco products and those who have recently quit. Every encounter that a nurse has with a patient provides an opportunity to assess for tobacco use. If the patient uses tobacco, the next steps are to assess motivation to quit, formulate a smoking cessation plan, and make referrals to community smoking cessation programs. For patients who are obese or who have hyperlipidemia, hypertension, or diabetes, the nurse determines any problems the patient may be having following the prescribed management plan (ie, diet, exercise, and medications). It may be necessary to clarify the patient's responsibilities, assist with finding additional resources, or make alternative plans for risk factor modification.

## Physical Assessment

Physical assessment is conducted to confirm information obtained from the health history, establish the patient's current or baseline condition, and in subsequent assessments, evaluate the patient's response to treatment. Once the initial physical assessment is completed, the frequency of future assessments is determined by the purpose of the encounter and the patient's condition. For example, a focused cardiac assessment may be performed each time the patient is seen in the outpatient setting, whereas patients in the acute care setting may require a more extensive assessment at least every 8 hours. During the physical assessment, the nurse evaluates the cardiovascular system for any deviations from normal with regard to the following (examples of abnormalities are in parentheses):

- The heart as a pump (reduced pulse pressure, deviation of PMI from fifth intercostal space midclavicular line, gallop sounds, murmurs)
- Atrial and ventricular filling volumes and pressures (elevated jugular venous distension [JVD], peripheral edema, ascites, crackles, postural changes in BP)
- Cardiac output (reduced pulse pressure, hypotension, tachycardia, reduced urine output, lethargy, or disorientation)
- Compensatory mechanisms (peripheral vasoconstriction, tachycardia)

### *General Appearance*

This part of the assessment evaluates the patient's level of consciousness (alert, lethargic, stuporous, comatose) and mental status (oriented to person, place, time; coherence). Changes in level of consciousness and mental status may be attributed to inadequate perfusion of the brain from a compromised cardiac output or thromboembolic event (stroke). Patients are observed for signs of distress, which include pain or discomfort, shortness of breath, or anxiety.

The nurse notes the size of the patient (normal, overweight, underweight, or cachectic). The patient's height and weight are measured to calculate BMI (weight in kilograms/square of the height in meters), as well as the waist circumference (refer to Chapter 5). These measures are used to determine if obesity (BMI greater than 30 kg/m$^2$) and abdominal fat (males: waist greater than 40 inches; females: waist greater than 35 inches) are placing the patient at risk for CAD.

### *Inspection of the Skin*

Examination of the skin begins with assessment of the patient's general appearance. It includes all body surfaces, starting with the head and finishing with the lower extremities. Skin color, temperature, and texture are assessed. Table 26-3 summarizes common findings associated with cardiovascular disease.

**Table 26-3 COMMON SKIN FINDINGS ASSOCIATED WITH CARDIOVASCULAR DISEASE**

| Findings | Associated Conditions |
|---|---|
| Pallor (decreased color of the skin, often noted around the fingernails, lips, and oral mucosa, or in patients with dark skin, the palms of the hands and soles of the feet) | Caused by lack of oxyhemoglobin, it is a result of anemia or decreased arterial perfusion. |
| Peripheral cyanosis (a bluish tinge, most often of the nails and skin of the nose, lips, earlobes, and extremities) | It suggests decreased blood flow to a particular area, which allows more time for the hemoglobin molecule to become desaturated. This may occur normally in peripheral vasoconstriction associated with a cold environment, in patients with anxiety, or in disease states such as heart failure. |
| Central cyanosis (a bluish tinge observed in the tongue and buccal mucosa) | It denotes serious cardiac disorders (pulmonary edema and congenital heart disease) in which venous blood passes through the pulmonary circulation without being oxygenated. |
| Xanthelasma (yellowish, slightly raised plaques in the skin observed along the nasal portion of one or both eyelids) | It may indicate elevated cholesterol levels (hypercholesterolemia). |
| Ecchymosis (bruise, a purplish-blue color fading to green, yellow, or brown over time) | Patients who are receiving platelet-inhibiting medications or anticoagulant therapy should be carefully observed for unexplained ecchymosis. In these patients, excessive bruising indicates reduced platelet function (platelet-inhibiting medications) or prolonged clotting times (prothrombin, international normalized ratio, or partial thromboplastin time) caused by an anticoagulant dosage that is too high. |
| Thinning of skin surrounding a pacemaker or implantable cardioverter-defibrillator (ICD) | This could indicate erosion of the device through the skin. |
| Cool/cold and moist skin | In cardiogenic shock, sympathetic nervous system stimulation causes vasoconstriction, and the skin becomes cold and clammy. During acute coronary syndrome, diaphoresis is common. |

### Blood Pressure

Systemic arterial BP is the pressure exerted on the walls of the arteries during ventricular systole and diastole. It is affected by factors such as cardiac output; distention of the arteries; and the volume, velocity, and viscosity of the blood. A normal BP in adults is considered a systolic BP less than 120 mm Hg over a diastolic BP less than 80 mm Hg. High blood pressure or hypertension is defined by having a systolic blood pressure that is consistently greater than 140 mm Hg or a diastolic BP greater than 90 mm Hg. Hypotension refers to an abnormally low systolic and diastolic blood pressure that can result in lightheadedness or fainting (see Chapter 32 for additional definitions, measurement, and management).

#### Pulse Pressure

The difference between the systolic and the diastolic pressures is called the pulse pressure. It is a reflection of stroke volume, ejection velocity, and systemic vascular resistance. Pulse pressure, which normally is 30 to 40 mm Hg, indicates how well the patient maintains cardiac output. The pulse pressure increases in conditions that elevate the stroke volume (anxiety, exercise, bradycardia), reduce systemic vascular resistance (fever), or reduce distensibility of the arteries (atherosclerosis, aging, hypertension). Decreased pulse pressure reflects reduced stroke volume and ejection velocity (shock, HF, hypovolemia, mitral regurgitation) or obstruction to blood flow during systole (mitral or aortic stenosis). A pulse pressure of less than 30 mm Hg signifies a serious reduction in cardiac output and requires further cardiovascular assessment.

#### Postural Blood Pressure Changes

**Postural (orthostatic) hypotension** occurs when the BP decreases significantly after the patient assumes an upright posture. It is usually accompanied by dizziness, lightheadedness, or syncope.

Although there are many causes of postural hypotension, the three most common causes in patients with cardiac problems are a reduced volume of fluid or blood in the circulatory system (intravascular volume depletion, dehydration), inadequate vasoconstrictor mechanisms, and insufficient autonomic effect on vascular constriction. Postural changes in BP and an appropriate history help health care providers differentiate among these causes. The following recommendations are important when assessing postural BP changes:

- The patient should be positioned supine and flat (as symptoms permit) for 10 minutes before taking the initial BP and heart rate measurements.
- Supine measurements should be checked before obtaining sitting or standing measurements.
- Postural BP changes should be assessed with the patient sitting on the edge of the bed with feet dangling and, if appropriate, with the patient standing at the side of the bed.
- One to three minutes should elapse after each postural change before measuring BP and heart rate.
- If the patient exhibits any signs or symptoms of distress, he or she is returned to a supine position before completing the test.
- Both heart rate and BP are recorded. The patient's position (eg, supine, sitting, standing) and any signs or symptoms that accompany the postural change are also noted.

Normal postural responses that occur when a person stands up or changes from a lying to a sitting position include (1) a heart rate increase of 5 to 20 bpm above the resting rate (to offset reduced stroke volume and maintain cardiac output); (2) an unchanged systolic pressure, or a slight decrease of up to 10 mm Hg; and (3) a slight increase of 5 mm Hg in diastolic pressure.

A decrease in the amount of blood or fluid in the circulatory system should be suspected after diuretic therapy or bleeding, when a postural change results in an increased heart rate and either a decrease in systolic pressure by 15 mm Hg or a decrease in diastolic pressure by 10 mm Hg. Vital signs alone do not differentiate between a decrease in intravascular volume and inadequate constriction of the blood vessels as a cause of postural hypotension. With intravascular volume depletion, the reflexes that maintain cardiac output (increased heart rate and peripheral vasoconstriction) function correctly; the heart rate increases and the peripheral vessels constrict. However, because of lost volume, the BP falls. With inadequate vasoconstrictor mechanisms, the heart rate again responds appropriately, but because of diminished peripheral vasoconstriction, the BP drops. The following is an example of a postural BP recording showing either intravascular volume depletion or inadequate vasoconstrictor mechanisms:

Supine: BP 120/70 mm Hg, heart rate 70 bpm
Sitting: BP 100/55 mm Hg, heart rate 90 bpm
Standing: BP 98/52 mm Hg, heart rate 94 bpm

In autonomic insufficiency, the heart rate cannot increase to completely compensate for the gravitational effects of an upright posture. Peripheral vasoconstriction may be absent or diminished. Autonomic insufficiency does not rule out a concurrent decrease in intravascular volume. The following is an example of autonomic insufficiency as demonstrated by postural BP changes:

Supine: BP 150/90 mm Hg, heart rate 60 bpm
Sitting: BP 100/60 mm Hg, heart rate 60 bpm

## Arterial Pulses

Factors to be evaluated in examining the pulse are rate, rhythm, quality, configuration of the pulse wave, and quality of the arterial vessel.

### Pulse Rate

The normal pulse rate varies from a low of 50 bpm in healthy, athletic young adults to rates well in excess of 100 bpm after exercise or during times of excitement. Anxiety frequently raises the pulse rate during the physical examination. If the rate is higher than expected, it is appropriate to reassess it near the end of the physical examination, when the patient may be more relaxed.

### Pulse Rhythm

The rhythm of the pulse is as important to assess as the rate. Minor variations in regularity of the pulse are normal. The pulse rate may increase during inhalation and slow during exhalation. This phenomenon, called sinus arrhythmia, occurs most commonly in children and young adults.

For the initial cardiac examination, or if the pulse rhythm is irregular, the heart rate should be counted by auscultating the apical pulse, located at the PMI, for a full minute while simultaneously palpating the radial pulse. Any discrepancy between contractions heard and pulses felt is noted. Disturbances of rhythm (dysrhythmias) often result in a pulse deficit, a difference between the apical pulse and the radial rate. Pulse deficits commonly occur with atrial fibrillation, atrial flutter, premature ventricular contractions, and varying degrees of heart block (see Chapter 27 for a detailed discussion of these dysrhythmias).

### Pulse Quality

The quality, or amplitude, of the pulse can be described as absent, diminished, normal, or bounding. It should be assessed bilaterally. Scales can be used to rate the strength of the pulse. The following is an example of a 0-to-4 scale:

0: pulse not palpable or absent
+1: weak, thready pulse; difficult to palpate; obliterated with pressure
+2: diminished pulse; cannot be obliterated
+3: easy to palpate, full pulse; cannot be obliterated
+4: strong, bounding pulse; may be abnormal

The numerical classification is subjective; therefore, when documenting the pulse quality, it helps to specify a scale range (eg, "left radial +3/+4").

### Pulse Configuration

The configuration (contour) of the pulse conveys important information. In patients with stenosis of the aortic valve, the valve opening is narrowed, reducing the amount of blood ejected into the aorta. The pulse pressure is narrow, and the pulse feels feeble. In aortic insufficiency, the aortic valve does not close completely, allowing blood to flow back from the aorta into the left ventricle. The rise of the pulse wave is abrupt and strong, and its fall is precipitous—a "collapsing" or "water hammer" pulse. The true configuration of the pulse is best appreciated by palpating over the carotid artery rather than the distal radial artery, because the dramatic characteristics of the pulse wave may be distorted when the pulse is transmitted to smaller vessels.

### Effect of Vessel Quality on Pulse

The condition of the vessel wall also influences the pulse and is of concern, especially in older patients. Once rate and rhythm have been determined, the nurse assesses the quality of the vessel by palpating along the radial artery and comparing it with normal vessels. Does the vessel wall feel thickened? Is it tortuous?

### Palpation of Arterial Pulses

To assess peripheral circulation, the nurse locates and evaluates all arterial pulses. Arterial pulses are palpated at points where the arteries are near the skin surface and are easily compressed against bones or firm musculature. Pulses are detected over the right and left temporal, common carotid, brachial, radial, femoral, popliteal, dorsalis pedis, and posterior tibial arteries (see Fig. 31-9). A reliable assessment of the pulses depends on accurate identification of the location of the artery and careful palpation of the area. Light palpation is essential; firm finger pressure can obliterate the temporal, dorsalis pedis, and posterior tibial pulses and confuse the examiner. In approximately 10% of patients, the dorsalis pedis pulses are not palpable. In such circumstances, both are usually absent and the posterior tibial arteries alone provide adequate blood supply to the feet. Arteries in the extremities are often palpated simultaneously to facilitate comparison of quality.

**NURSING ALERT**

**Do not simultaneously palpate both the temporal and carotid arteries, because it is possible to decrease the blood flow to the brain.**

### Jugular Venous Pulsations

Right-sided heart function can be estimated by observing the pulsations of the jugular veins of the neck and the central venous pressure (CVP), which reflects right atrial or right ventricular end-diastolic pressure (the pressure immediately preceding the contraction of the right ventricle).

Pulsations of the internal jugular veins are commonly assessed. If they are difficult to see, pulsations of the external jugular veins may be noted. These veins are more superficial and are visible just above the clavicles, adjacent to the sternocleidomastoid muscles. The external jugular veins are frequently distended while the patient lies supine on the examining table or bed. As the patient's head is elevated, distention of the veins normally disappears. The veins normally are not apparent if the patient's head is elevated more than 30 degrees.

Obvious distention of the veins with the patient's head elevated 45 to 90 degrees indicates an abnormal increase in the volume of the venous system. This occurs with right ventricular failure, pulmonary hypertension, and pulmonary stenosis; less commonly with obstruction of blood flow in the superior vena cava; and rarely with acute massive pulmonary embolism.

### Heart Inspection and Palpation

The heart is examined by inspection, palpation, and auscultation of the chest wall. A systematic approach is used to examine the chest wall in the following six areas. Figure 26-5 identifies these important landmarks:

1. *Aortic area*—second intercostal space to the right of the sternum. To determine the correct intercostal space, the nurse first finds the angle of Louis by locating the bony ridge near the top of the sternum, at the junction of the body and the manubrium. From this angle, the second intercostal space is located by sliding one finger to the left or right of the sternum. Subsequent intercostal spaces are located from this reference point by palpating down the rib cage.
2. *Pulmonic area*—second intercostal space to the left of the sternum
3. *Erb's point*—third intercostal space to the left of the sternum
4. *Tricuspid area*—lower half of the sternum along the left parasternal area
5. *Mitral (apical) area*—left fifth intercostal space at the midclavicular line
6. *Epigastric area*—below the xiphoid process

For most of the examination, the patient lies supine, with the head of the bed slightly elevated. A right-handed examiner stands at the right side of the patient, a left-handed examiner at the left side.

Each area of the precordium is inspected and then palpated. Oblique lighting is used to assist the examiner in identifying subtle pulsations. The apical impulse is easier to discern in young patients and adults who have a thin chest wall, compared with patients who are obese or who have chest wall abnormalities.

In many cases, the apical impulse is palpable and is normally felt as a light pulsation, 1 to 2 cm in diameter. It is felt at the onset of the first heart sound and lasts for only half of ventricular systole (see the next section for a discussion of heart sounds). The nurse uses the palm of the hand to locate the apical impulse initially and the fingerpads to assess its size and quality. If the apical impulse cannot be palpated while the patient is supine, the patient is repositioned into the left lateral position as shown in Figure 26-6, to put the heart into closer contact with the chest wall and facilitate palpation of the apical impulse.

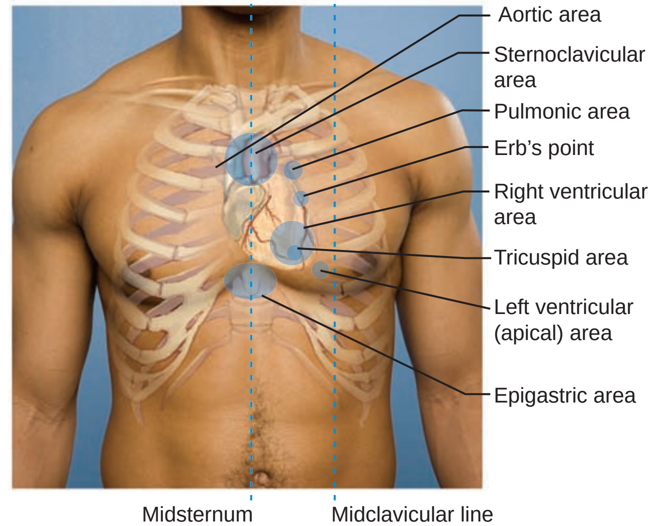



**Figure 26-5** Areas of the precordium to be assessed when evaluating heart function. (Numerals identify ribs of adjacent intercostal spaces.)



**Figure 26-6** Locating and palpating the apical impulse (also called the point of maximal impulse [PMI]) in the left lateral position. The apical impulse normally is located at the fifth intercostal space to the left of the sternum at the midclavicular line. The nurse locates the impulse with the palm of the hand and palpates with the fingerpads. © B. Proud in Weber, J. W. & Kelley, J. (2006). *Health assessment in nursing* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins.

There are several abnormalities that the nurse may find during palpation of the precordium. Normally, the apical impulse is palpable in only one intercostal space; palpability in two or more adjacent intercostal spaces indicates left ventricular enlargement. An apical impulse below the fifth intercostal space or lateral to the midclavicular line usually denotes left ventricular enlargement from left ventricular failure. If the apical impulse can be palpated in two distinctly separate areas and the pulsation movements are paradoxical (not simultaneous), a ventricular aneurysm may be suspected. A broad and forceful apical impulse is known as a left ventricular heave or lift because it appears to lift the hand from the chest wall during palpation.

A vibration or purring sensation may be felt over areas where abnormal, turbulent blood flow is present. It is best detected by using the palm of the hand. This vibration is called a thrill and is associated with a loud murmur. Depending on the location of the thrill, it may be indicative of serious valvular heart disease, an atrial or ventricular septal defect (abnormal opening), or stenosis of a large artery, such as the carotid artery.

### Heart Auscultation

A stethoscope is used to auscultate each of the locations identified in Figure 26-5, with the exception of the epigastric area. The purpose of cardiac auscultation is to determine heart rate and rhythm and evaluate heart sounds. The apical area is auscultated for 1 minute to determine the apical pulse rate and the regularity of the heartbeat. Normal and abnormal heart sounds detected during auscultation are described in the following section.

#### Normal Heart Sounds

**Normal heart sounds,** referred to as **$S_1$** and **$S_2$**, are produced by closure of the AV valves and the semilunar valves, respectively. The period between $S_1$ and $S_2$ corresponds with ventricular systole (Fig. 26-7). When the heart rate is within the normal range, systole is much shorter than the period between $S_2$ and $S_1$ (diastole). However, as the heart rate increases, diastole shortens.

Normally, $S_1$ and $S_2$ are the only sounds heard during the cardiac cycle.

***$S_1$—First Heart Sound.*** Tricuspid and mitral valve closure creates the first heart sound ($S_1$). The word "lub" is used to replicate its sound. $S_1$ is usually heard the loudest at the apical area. $S_1$ is easily identifiable and serves as the point of reference for the remainder of the cardiac cycle.

The intensity of $S_1$ increases during tachycardias or with mitral stenosis. In these circumstances, the AV valves are wide open during ventricular contraction. The accentuated $S_1$ occurs as the AV valves close with greater force than normal. Similarly, dysrhythmias can vary the intensity of $S_1$ from beat to beat due to lack of synchronized atrial and ventricular contraction.

***S2—Second Heart Sound.*** Closure of the pulmonic and aortic valves produces the second heart sound ($S_2$), commonly referred to as the "dub" sound. The aortic component of $S_2$ is heard the loudest over the aortic and pulmonic areas. However, the pulmonic component of $S_2$ is a softer sound and is heard best over the pulmonic area.

Although these valves close almost simultaneously, the pulmonic valve lags slightly behind the aortic valve. In some individuals, it is possible to distinguish between the closure of the aortic and pulmonic valves. When this situation occurs, the patient is said to have a split $S_2$. Normal physiologic splitting of $S_2$ is accentuated on inspiration and disappears on expiration. During inspiration, there is a decrease in intrathoracic pressure and subsequent increase in venous return to the right atrium and ventricle. The right ventricle takes a little longer to eject this extra volume, which causes the pulmonic valve to close a little later than normal. Splitting of $S_2$ that remains constant during inspiration and expiration is an abnormal finding. Abnormal

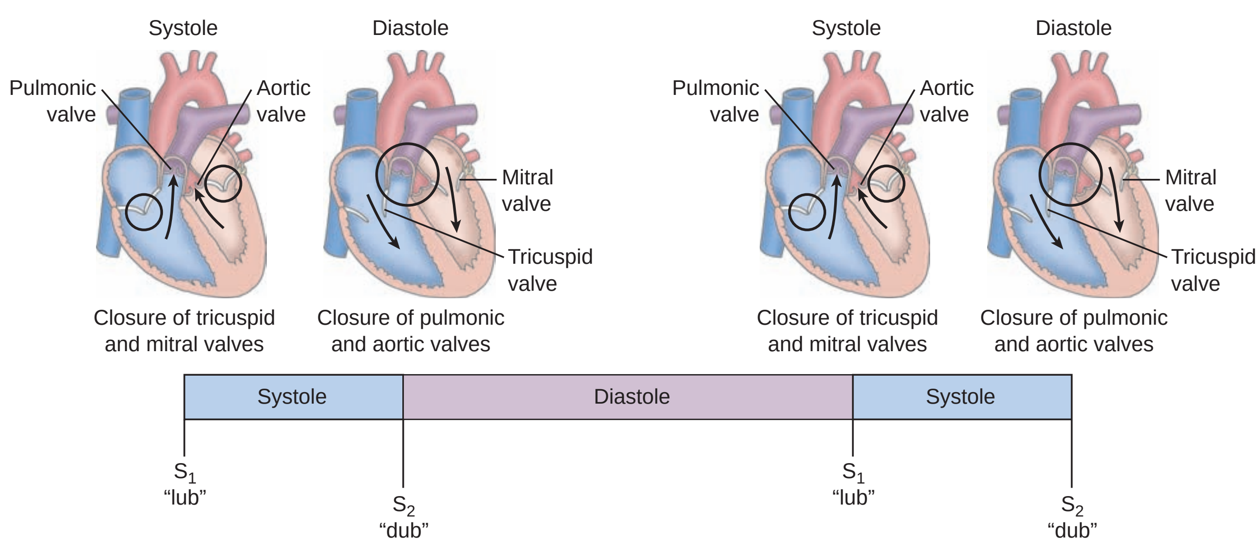



**Figure 26-7** Normal heart sounds. The first heart sound ($S_1$) is produced by closure of the mitral and tricuspid valves ("lub"). The second heart sound ($S_2$) is produced by closure of the aortic and pulmonic valves ("dub"). Arrows represent the direction of blood flow.

splitting of the second heart sound can be caused by a variety of disease states (valvular heart disease, septal defects, bundle branch blocks). Splitting of $S_2$ is best heard over the pulmonic area.

### Abnormal Heart Sounds

Abnormal sounds develop during systole or diastole when structural or functional heart problems are present. These sounds are called **$S_3$**, or **$S_4$** gallops, opening snaps, systolic clicks, and murmurs. $S_3$ and $S_4$ gallop sounds are heard during diastole. These sounds are created by the vibration of the ventricle and surrounding structures as blood meets resistance during ventricular filling. The term *gallop* evolved from the cadence that is produced by the addition of a third or fourth heart sound, similar to the sound of a galloping horse. Gallop sounds are very low-frequency sounds and are heard with the bell of the stethoscope placed very lightly against the chest.

***$S_3$—Third Heart Sound.*** An $S_3$ occurs early in diastole during the period of rapid ventricular filling. It is heard immediately after $S_2$. "Lub-dub DUB" ($S_3$) is used to imitate the sound of the beating heart with this gallop sound. It represents a normal finding in children and adults up to 35 or 40 years of age. In these cases, it is called a physiologic $S_3$ (Fig. 26-8). On the other hand, in older adults, it is a sign of significant pathophysiology, most commonly due to volume overload of one or both ventricles. It is a significant finding in patients with HF. If the right ventricle is involved, a right-sided $S_3$ is heard over the tricuspid area with the patient in a supine position. A left-sided $S_3$ is best heard over the apical area. Having the patient turn to the left lateral position may facilitate auscultation of an $S_3$ generated by the left ventricle.

***$S_4$—Fourth Heart Sound.*** $S_4$ occurs late in diastole (see Fig. 26-8). An $S_4$ occurs just before $S_1$ and is generated during atrial contraction as blood forcefully enters a noncompliant ventricle. This resistance to blood flow is due to ventricular hypertrophy caused by hypertension, CAD, cardiomyopathies, aortic stenosis, and numerous other conditions. "LUB ($S_4$) lub-dub" is used to imitate this gallop sound. An $S_4$ produced in the left ventricle is auscultated over the apical area with the patient in the left lateral position. A right-sided $S_4$, although less common, is heard best over the tricuspid area with the patient in supine position. There are times when both $S_3$ and $S_4$ are present, creating a quadruple rhythm, which sounds like "LUB lub-dub DUB". During tachycardia, all four sounds combine into a loud sound, referred to as a **summation gallop**.

***Opening Snaps and Systolic Clicks.*** Normally no sound is produced when valves open. However, diseased valve leaflets create abnormal sounds as they open during diastole or systole. **Opening snaps** are abnormal diastolic sounds heard during opening of an AV valve. For example, mitral stenosis can cause an opening snap, which is an unusually high-pitched sound very early in diastole. This sound is caused by high pressure in the left atrium that abruptly displaces or "snaps" open a rigid valve leaflet. Timing helps to distinguish an opening snap from the other gallop sounds. It occurs too long after $S_2$ to be mistaken for a split $S_2$ and too early in diastole to be mistaken for an $S_3$. The high-pitched, snapping quality of the sound is another way to differentiate an opening snap from an $S_3$. Hearing a murmur or the sound of turbulent blood flow is expected following the opening snap. An opening snap is heard best using the diaphragm of the stethoscope placed medial to the apical area and along the lower left sternal border.

In a similar manner, stenosis of one of the semilunar valves creates a short, high-pitched sound in early systole, immediately after $S_1$. This sound, called a **systolic click,** is the result of the opening of a rigid and calcified aortic or pulmonic valve during ventricular contraction. Mid- to late systolic clicks may be heard in patients with mitral or tricuspid valve prolapse, as the malfunctioning valve leaflet is displaced into the atrium during ventricular systole. Murmurs are expected to be heard following these abnormal systolic sounds. These sounds are the loudest in the areas directly over the malfunctioning valve.

***Murmurs.*** **Murmurs** are created by turbulent flow of blood. The causes of the turbulence may be a critically narrowed valve, a malfunctioning valve that allows regurgitant blood

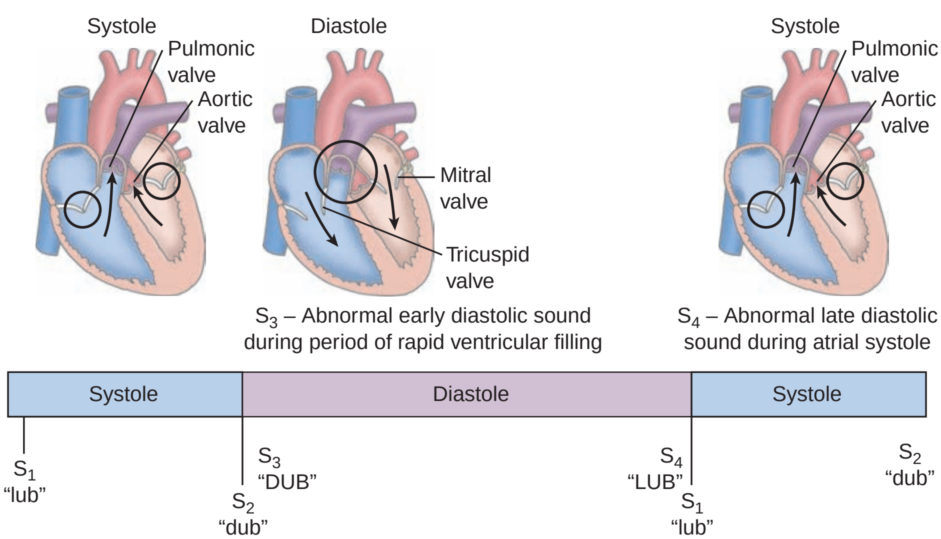



**Figure 26-8** Gallop sounds. An $S_3$ ("DUB") is an abnormal sound heard immediately following $S_2$ (closure of semilunar valves). This sound is generated very early in diastole as blood flowing into the right or left ventricle is met with resistance. $S_4$ ("LUB") is an abnormal sound created during atrial systole as blood flowing into the right or left ventricle is met with resistance. Arrows represent the direction of blood flow.

## Chart 26-3 • *Characteristics of Heart Murmurs*

Heart murmurs are described in terms of location, timing, intensity, pitch, quality, and radiation. These characteristics provide information needed to determine the cause of the murmur and its clinical significance.

**Location**

Pinpointing the location of the murmur helps to determine the underlying structures that are involved in generating the abnormal sounds. The locations described in Figure 26-5 are used to identify where the loudest sounds are detected. It is helpful to include in the description the exact location from which the sound emanates, such as the location of the intercostal space and other important landmarks (right or left sternal border; midsternal, midclavicular, anterior axillary, or midaxillary lines). For example, a ventricular septal defect can be located at the left sternal border in the third and fourth intercostal spaces.

**Timing**

A murmur is described in terms of when it occurs during the cardiac cycle (systole or diastole). Murmurs are further differentiated by identifying exactly when during systole or diastole they are heard. A skilled clinician can detect that the murmur is occurring during early, mid-, or late systole or diastole. Some murmurs have sounds that occur in both systole and diastole.

**Intensity**

A grading system is used to describe the intensity or loudness of a murmur.

Grade 1: very faint and difficult for the inexperienced clinician to hear
Grade 2: quiet, but readily perceived by the experienced clinician
Grade 3: moderately loud
Grade 4: loud and may be associated with a thrill
Grade 5: very loud; heard when stethoscope is partially off the chest; associated with a thrill
Grade 6: extremely loud; detected with the stethoscope off the chest; associated with a thrill

**Pitch**

Pitch is used to describe the sound frequency, identified as high, medium, or low pitched. High-pitched murmurs are heard best with the stethoscope's diaphragm, whereas low-pitched sounds are detected using the bell of the stethoscope placed lightly on the chest wall.

**Quality**

Quality is the term used to describe the sound that the murmur resembles. Murmurs can produce a rumbling, blowing, whistling, harsh, or musical sound. For example, murmurs caused by mitral or tricuspid regurgitation have a blowing quality, whereas mitral stenosis generates a rumbling sound.

**Radiation**

Radiation refers to the transmission of the murmur from the point of maximal intensity to other areas in the upper chest. The examiner determines if radiation is present by listening carefully to areas of the heart adjacent to the point where the murmur is the loudest. If radiation is present, the exact location is described. A murmur associated with aortic stenosis, for example, can radiate into the neck, down the left sternal border, and into the apical area.

flow, a congenital defect of the ventricular wall, a defect between the aorta and the pulmonary artery, or an increased flow of blood through a normal structure (eg, with fever, pregnancy, hyperthyroidism). Murmurs are characterized and consequently described by several characteristics, including their timing in the cardiac cycle, location on the chest wall, intensity, pitch, quality, and pattern of radiation (Chart 26-3).

***Friction Rub.*** A harsh, grating sound that can be heard in both systole and diastole is called a friction rub. It is caused by abrasion of the inflamed pericardial surfaces from pericarditis. Because a friction rub may be confused with a murmur, care should be taken to identify the sound and to distinguish it from murmurs that may be heard in both systole and diastole. A pericardial friction rub can be heard best using the diaphragm of the stethoscope, with the patient sitting up and leaning forward.

### Auscultation Procedure

During auscultation, the patient remains supine and the examining room is as quiet as possible. A stethoscope with both diaphragm and bell functions is necessary for accurate auscultation of the heart.

Using the diaphragm of the stethoscope, the examiner starts at the apical area and progresses upward along the left sternal border to the pulmonic and aortic areas. Alternatively, the examiner may begin the examination at the aortic and pulmonic areas and progress downward to the apex of the heart. Initially, $S_1$ is identified and evaluated with respect to its intensity and splitting. Next, $S_2$ is identified, and its intensity and any splitting are noted. After concentrating on $S_1$ and $S_2$, the examiner listens for extra sounds in systole and then in diastole.

Sometimes it helps to ask the following questions: Do I hear snapping or clicking sounds? Do I hear any high-pitched blowing sounds? Is this sound in systole, or diastole, or both? The examiner again proceeds to move the stethoscope to all of the designated areas of the precordium, listening carefully for these sounds. Finally, the patient is turned on the left side and the stethoscope is placed on the apical area, where an $S_3$, an $S_4$ and a mitral murmur are more readily detected.

Once an abnormality is heard, the entire chest surface is reexamined to determine the exact location of the sound and its radiation. The patient may be concerned about the prolonged examination and must be supported and reassured. The auscultatory findings, particularly murmurs, are documented by identifying the following characteristics (see Chart 26-3): location on chest wall, timing, intensity, pitch, quality, and radiation.

### Interpretation of Heart Sounds

Interpreting heart sounds requires detailed knowledge of cardiac physiology and pathophysiology. However, all nurses should have adequate knowledge and skill to recognize

normal heart sounds ($S_1$, $S_2$) and the presence of abnormal sounds. When assessment is at this very basic level of practice, abnormal findings are reported for further evaluation and treatment. More advanced skills are required of nurses caring for critically ill patients with CVD or those nurses functioning in advanced practice roles. Nurses in these roles readily identify abnormal heart sounds, recognize the diagnostic significance of their findings, and use their assessment skills to evaluate patients' responses to medical interventions. For example, these highly skilled nurses monitor heart sounds in patients with HF to detect the resolution of an $S_3$ after treatment with a diuretic.

### Inspection of the Extremities

The hands, arms, legs, and feet are observed for skin and vascular changes. The most noteworthy changes include the following:

- Decreased capillary refill time indicates a slower peripheral flow rate from sluggish reperfusion and is often observed in patients with hypotension or HF. Capillary refill time provides the basis for estimating the rate of peripheral blood flow. To test capillary refill, the nurse briefly compresses the nailbed so that it blanches, and then releases the pressure. Normally, reperfusion occurs within 3 seconds, as evidenced by the return of color.
- Vascular changes from decreased arterial circulation include a decrease in quality or loss of pulse, discomfort or pain, paresthesia, numbness, decrease in temperature, pallor, and loss of movement. During the first few hours after invasive cardiac procedures (eg, cardiac catheterization), affected extremities should be assessed frequently for vascular changes.
- Hematoma, or a localized collection of clotted blood in the tissue, may be observed in patients who have undergone invasive cardiac procedures such as cardiac catheterization, PCI, or cardiac electrophysiology testing. Major blood vessels of the arms and legs may be used for catheter insertion. During these procedures, systemic anticoagulation with heparin is necessary, and minor or small hematomas may occur at the catheter puncture site. However, large hematomas are a serious complication that can compromise circulating blood volume and cardiac output. Patients who have undergone these procedures must have their puncture sites frequently observed until hemostasis is adequately achieved.
- Peripheral edema is fluid accumulation in dependent areas of the body (feet and legs, sacrum in the bedridden patient). Pitting edema (a depression over an area of pressure) is assessed by pressing firmly for 5 seconds with the thumb over the dorsum of each foot, behind each medial malleolus, and over the shins. It is graded as absent or as present on a scale from slight (1+ = 0 to 2 mm) to very marked (4+ = more than 8 mm). Peripheral edema is observed in patients with HF and in those with peripheral vascular diseases such as deep vein thrombosis or chronic venous insufficiency.
- Clubbing of the fingers and toes implies chronic hemoglobin desaturation, as in congenital heart disease.
- Lower extremity ulcers are observed in patients with arterial or venous insufficiency (see Chapter 31 for a complete description of these conditions).

### Assessment of Other Systems

#### Lungs

The details of respiratory assessment are described in Chapter 21. Findings frequently exhibited by patients with cardiac disorders include the following:

*Hemoptysis:* Pink, frothy sputum is indicative of acute pulmonary edema.

*Cough:* A dry, hacking cough from irritation of small airways is common in patients with pulmonary congestion from HF.

*Crackles:* HF or atelectasis associated with bed rest, splinting from ischemic pain, or the effects of analgesic, sedative, or anesthetic agents often results in the development of crackles. Typically, crackles are first noted at the bases (because of gravity's effect on fluid accumulation and decreased ventilation of basilar tissue), but they may progress to all portions of the lung fields.

*Wheezes:* Compression of the small airways by interstitial pulmonary edema may cause wheezing. Beta-adrenergic blocking agents (beta-blockers), such as propranolol (Inderal), may cause airway narrowing, especially in patients with underlying pulmonary disease.

#### Abdomen

For the patient with a cardiovascular disorder, several components of the abdominal examination are relevant:

*Abdominal distension:* A protuberant abdomen with bulging flanks indicates ascites. Ascites develops in patients with right ventricular or biventricular HF (both right- and left-sided HF). In the failing right heart, abnormally high chamber pressures impede the return of venous blood. As a result, the liver and spleen become engorged with excessive venous blood (hepatosplenomegaly). As pressure in the portal system rises, fluid shifts from the vascular bed into the abdominal cavity. Ascitic fluid, found in the dependent or lowest points in the abdomen, will shift with position changes.

*Hepatojugular reflux:* This test is performed when right ventricular or biventricular HF is suspected. The patient is positioned so that the jugular venous pulse is visible in the lower part of the neck. While observing the jugular venous pulse, firm pressure is applied over the right upper quadrant of the abdomen for 30 to 60 seconds. An increase of 1 cm or more in jugular venous pressure is indicative of a positive hepatojugular reflux. This positive test aids in confirming the diagnosis of HF.

*Bladder distention:* Urine output is an important indicator of cardiac function. Reduced urine output may indicate inadequate renal perfusion or a less serious problem such as one caused by urinary retention. When urine output is decreased, the patient must be assessed

for a distended bladder or difficulty voiding. The bladder may be assessed with an ultrasound scanner or the suprapubic area palpated for an oval mass and percussed for dullness, indicative of a full bladder.

### Gerontologic Considerations

When performing a cardiovascular examination on an elderly patient, the nurse may note such differences as more readily palpable peripheral pulses because of decreased elasticity of the arteries and a loss of adjacent connective tissue. Palpation of the precordium in the elderly is affected by the changes in the shape of the chest. For example, a cardiac impulse may not be palpable in patients with chronic obstructive pulmonary disease, because these patients usually have an increased anterior–posterior chest diameter. Kyphoscoliosis, a spinal deformity that occurs in many elderly patients, may move the cardiac apex downward so that palpation of the apical impulse is obscured.

Systolic BP increases with age, but diastolic BP usually plateaus after 50 years of age. Isolated systolic hypertension occurs most commonly among the elderly and is associated with significant cardiovascular morbidity and mortality. Orthostatic hypotension may reflect decreased sensitivity of postural reflexes, which must be considered when medication therapy is prescribed.

An $S_4$ is heard in about 90% of elderly patients and is thought to be due to decreased compliance of the left ventricle. The $S_2$ is usually split. At least 60% of elderly patients have murmurs, the most common being a soft systolic ejection murmur resulting from sclerotic changes of the aortic leaflets (see Table 26-1).

# Diagnostic Evaluation

## Laboratory Tests

Laboratory tests may be performed for the following reasons:

- To assist in diagnosing the cause of cardiac-related signs and symptoms
- To determine baseline values before initiating therapeutic interventions
- To screen for modifiable CAD risk factors
- To ensure that therapeutic levels of medications (eg, antiarrhythmic agents and warfarin) are maintained
- To evaluate the patient's response to the therapeutic regimen (eg, effects of diuretics on serum potassium levels)
- To identify abnormalities that affect the prognosis of a patient with CVD

Normal values for laboratory tests may vary depending on the laboratory and the health care institution. This variation is due to the differences in equipment and methods of measurement across organizations.

### Cardiac Biomarker Analysis

The diagnosis of MI is made by evaluating the history and physical examination, the 12-lead ECG, and results of laboratory tests that measure serum cardiac biomarkers. Myocardial cells that become necrotic from prolonged ischemia or trauma release specific enzymes (creatine kinase [CK]), CK isoenzymes (CK-MB), and proteins (myoglobin, troponin T, and troponin I). These substances leak into the interstitial spaces of the myocardium and are carried by the lymphatic system into general circulation. As a result, abnormally high levels of these substances can be detected in serum blood samples. See Chapter 28 for further discussion of cardiac biomarker analysis.

### Blood Chemistry, Hematology, and Coagulation Studies

Table 26-4 provides information about some common serum laboratory tests and the implications for patients with CVD. Discussion of lipid, brain (B-type) natriuretic peptide, C-reactive protein, and homocysteine measurements follows.

#### Lipid Profile

Cholesterol, triglycerides, and lipoproteins are measured to evaluate a person's risk of developing atherosclerotic disease, especially if there is a family history of premature heart disease, or to diagnose a specific lipoprotein abnormality. Cholesterol and triglycerides are transported in the blood by combining with plasma proteins to form lipoproteins. The lipoproteins are referred to as low-density lipoproteins (LDLs) and high-density lipoproteins (HDLs). The risk of CAD increases as the ratio of LDL to HDL or the ratio of total cholesterol (LDL + HDL) to HDL increases. Although cholesterol levels remain relatively constant over 24 hours, the blood specimen for the lipid profile should be obtained after a 12-hour fast.

***Cholesterol Levels.*** Cholesterol (normal level is less than 200 mg/dL) is a lipid required for hormone synthesis and cell membrane formation. It is found in large quantities in brain and nerve tissue. Two major sources of cholesterol are diet (animal products) and the liver, where cholesterol is synthesized. Elevated cholesterol levels are known to increase the risk of CAD. Factors that contribute to variations in cholesterol levels include age, gender, diet, exercise patterns, genetics, menopause, tobacco use, and stress levels.

LDLs (normal level is less than 160 mg/dL) are the primary transporters of cholesterol and triglycerides into the cell. One harmful effect of LDL is the deposition of these substances in the walls of arterial vessels. Elevated LDL levels are associated with a greater incidence of CAD. In people with known CAD or diabetes, the primary goal for lipid management is reduction of LDL levels to less than 70 mg/dL.

HDLs (normal range in men is 35 to 70 mg/dL; in women, 35 to 85 mg/dL) have a protective action. They transport cholesterol away from the tissue and cells of the arterial wall to the liver for excretion. Therefore, there is an inverse relationship between HDL levels and risk of CAD. Factors that lower HDL levels include smoking, diabetes, obesity, and physical inactivity. In patients with CAD, a secondary goal of lipid management is the increase of HDL levels to more than 40 mg/dL.

***Triglycerides.*** Triglycerides (normal range is 100 to 200 mg/dL), composed of free fatty acids and glycerol, are stored in the adipose tissue and are a source of energy. Triglyceride

**Table 26-4 COMMON SERUM LABORATORY TESTS AND IMPLICATIONS FOR PATIENTS WITH CARDIOVASCULAR DISEASE (CVD)**

| Laboratory Test<br>Reference Range | Implications |
|---|---|
| **Blood Chemistries** | |
| Sodium ($Na^+$)<br>135–145 mEq/L | Low or high serum sodium levels do not directly affect cardiac function.<br>*Hyponatremia:* Decreased sodium levels indicate fluid excess and can be caused by heart failure or administration of thiazide diuretics.<br>*Hypernatremia:* Increased sodium levels indicate fluid deficits and can result from decreased water intake or loss of water through excessive sweating or diarrhea. |
| Potassium ($K^+$)<br>3.5–5.0 mEq/L | Potassium has a major role in cardiac electrophysiologic function.<br>*Hypokalemia:* Decreased potassium levels due to administration of potassium-excreting diuretics can cause many forms of dysrhythmias, including life-threatening ventricular tachycardia or ventricular fibrillation, and predispose patients taking digitalis preparations to digitalis toxicity.<br>*Hyperkalemia:* Increased potassium levels can result from an increased intake of potassium (eg, foods high in potassium or potassium supplements), decreased renal excretion of potassium, use of potassium-sparing diuretics (eg, spironolactone), or use of angiotensin-converting enzyme inhibitors (ACE inhibitors) that inhibit aldosterone function. Serious consequences of hyperkalemia include heart block, asystole, and life-threatening ventricular dysrhythmias. |
| Calcium ($Ca^{++}$)<br>8.6–10.2 mg/dL | Calcium is necessary for blood coagulability, neuromuscular activity, and automaticity of the nodal cells (sinus and atrioventricular nodes).<br>*Hypocalcemia:* Decreased calcium levels slow nodal function and impair myocardial contractility. The latter effect increases the risk for heart failure.<br>*Hypercalcemia:* Increased calcium levels can occur with the administration of thiazide diuretics because these medications reduce renal excretion of calcium. Hypercalcemia potentiates digitalis toxicity, causes increased myocardial contractility, and increases the risk for varying degrees of heart block and sudden death from ventricular fibrillation. |
| Magnesium ($Mg^{++}$)<br>1.3–2.3 mEq/L | Magnesium is necessary for the absorption of calcium, maintenance of potassium stores, and metabolism of adenosine triphosphate. It plays a major role in protein and carbohydrate synthesis and muscular contraction.<br>*Hypomagnesemia:* Decreased magnesium levels are due to enhanced renal excretion of magnesium from the use of diuretic or digitalis therapy. Low magnesium levels predispose patients to atrial or ventricular tachycardias.<br>*Hypermagnesemia:* Increased magnesium levels are commonly caused by the use of cathartics or antacids containing magnesium. Increased magnesium levels depress contractility and excitability of the myocardium, causing heart block and, if severe, asystole. |
| Blood urea nitrogen (BUN)<br>10–20 mg/dL | BUN and creatinine are end products of protein metabolism excreted by the kidneys.<br>Elevated BUN reflects reduced renal perfusion from decreased cardiac output or intravascular fluid volume deficit as a result of diuretic therapy or dehydration. |
| Creatinine<br>0.7–1.4 mg/dL | Both BUN and creatinine are used to assess renal function, although creatinine is a more sensitive measure. Renal impairment is detected by an increase in both BUN and creatinine. A normal creatinine level and an elevated BUN suggest an intravascular fluid volume deficit. |
| Glucose<br>Fasting:<br>60–110 mg/dL | Glucose levels are elevated in stressful situations, when mobilization of endogenous epinephrine results in conversion of liver glycogen to glucose. Serum glucose levels are drawn in a fasting state. |
| Glycohemoglobin (hemoglobin $A_{1c}$)<br>Nondiabetic: 4.4–6.4% | Glycohemoglobin (hemoglobin $A_{1C}$) is monitored in people with diabetes. It reflects the blood glucose levels over 2–3 mo. The glycemic goal is to maintain the hemoglobin $A_{1C}$ below 7% reflecting consistent near-normal blood glucose levels. |
| **Coagulation Studies** | Injury to a vessel wall or tissue initiates the formation of a thrombus. This injury activates the coagulation cascade, the complex interactions among phospholipids, calcium, and clotting factors that convert prothrombin to thrombin. The coagulation cascade has two pathways, the intrinsic and extrinsic pathways. Coagulation studies are routinely performed before invasive procedures, such as cardiac catheterization, electrophysiology testing, and cardiac surgery. |
| Partial thromboplastin time (PTT)<br>60–70 sec<br>Activated partial thromboplastin time (aPTT)<br>20–39 sec | PTT or aPTT measures the activity of the intrinsic pathway and is used to assess the effects of unfractionated heparin. A therapeutic range is 1.5–2.5 times baseline values. Adjustment of heparin dose is required for aPTT <50 sec (↑ dose) or >100 sec (↓ dose). |
| Prothrombin time (PT)<br>9.5–12 sec | PT measures the extrinsic pathway activity and is used to monitor the level of anticoagulation with warfarin (Coumadin). |
| International normalized ratio (INR) 1.0 | The INR, reported with the PT, provides a standard method for reporting PT levels and eliminates the variation of PT results from different laboratories. The INR, rather than the PT alone, is used to monitor the effectiveness of warfarin. The therapeutic range for INR is 2–3.5, although specific ranges vary based on diagnosis. |
| **Hematologic Studies** | |
| Complete blood count (CBC) | The CBC identifies the total number of white and red blood cells and platelets, and measures hemoglobin and hematocrit. The CBC is carefully monitored in patients with cardiovascular disease. |
| White blood cell (WBC) count<br>4500–11,000/$mm^3$ | WBC counts are monitored in immunocompromised patients, including patients with heart transplants or in situations where there is concern for infection (eg, after invasive procedures or surgery). |
| Hematocrit<br>Male: 42–52%<br>Female: 35–47%<br>Hemoglobin<br>Male: 13–18 g/dL<br>Female: 12–16 g/dL | The hematocrit represents the percentage of red blood cells found in 100 mL of whole blood. The red blood cells contain hemoglobin, which transports oxygen to the cells. Low hemoglobin and hematocrit levels have serious consequences for patients with cardiovascular disease, such as more frequent angina episodes or acute myocardial infarction. |
| Platelets<br>150,000–450,000/$mm^3$ | Platelets are the first line of protection against bleeding. Once activated by blood vessel wall injury or rupture of atherosclerotic plaque, platelets undergo chemical changes that form a thrombus. Several medications inhibit platelet function, including aspirin, clopidogrel (Plavix), and intravenous glycoprotein IIb/IIIa inhibitors (abciximab [ReoPro], eptifibatide [Integrilin], and tirofiban [Aggrastat]). When these medications are administered, it is essential to monitor for thrombocytopenia (low platelet counts). |

levels increase after meals and are affected by stress. Diabetes, alcohol use, and obesity can elevate triglyceride levels. These levels have a direct correlation with LDL and an inverse one with HDL.

### Brain (B-Type) Natriuretic Peptide

Brain (B-type) natriuretic peptide (BNP) is a neurohormone that helps regulate BP and fluid volume. It is primarily secreted from the ventricles in response to increased preload with resulting elevated ventricular pressure. The level of BNP in the blood increases as the ventricular walls expand from increased pressure, making it a helpful diagnostic, monitoring, and prognostic tool in the setting of HF. Because this serum laboratory test can be quickly obtained, BNP levels are useful for prompt diagnosis of HF in settings such as the emergency department. Elevations in BNP can occur from a number of other conditions such as pulmonary embolus, MI, and ventricular hypertrophy. Therefore, the clinician correlates BNP levels with abnormal physical assessment findings and other diagnostic tests before making a definitive diagnosis of HF. A BNP level greater than 100 pg/mL is suggestive of HF.

### C-Reactive Protein

High-sensitivity assay for C-reactive protein (hs-CRP) is a venous blood test that measures levels of CRP, a protein produced by the liver in response to systemic inflammation. Inflammation is thought to play a role in the development and progression of atherosclerosis. Therefore, hs-CRP is used as an adjunct to other tests to predict CVD risk, though its role as an independent risk factor for cardiovascular disease is controversial. People with high levels of hs-CRP (3.0 mg/dL or greater) may be at greatest risk for CVD compared to people with moderate (1.0 to 3.0 mg/dL) or low (less than 1.0 mg/dL) levels of hs-CRP. In addition, an elevated hs-CRP may place patients with ACS at risk for recurrent cardiac events, including unstable angina and acute MI, higher mortality, and increased risk of restenosis of coronary arteries after PCI (Koenig, 2005).

### Homocysteine

Determining the homocysteine level enhances the clinician's ability to assess the patient's risk for CVD. Homocysteine, an amino acid, is linked to the development of atherosclerosis because it can damage the endothelial lining of arteries and promote thrombus formation. Therefore, an elevated blood level of homocysteine is thought to indicate a high risk for CAD, stroke, and peripheral vascular disease, although it is not an independent predictor of CAD. Genetic factors and a diet low in folic acid, vitamin $B_6$, and vitamin $B_{12}$ are associated with elevated homocysteine levels. A 12-hour fast is necessary before drawing a blood sample for an accurate serum measurement. Test results are interpreted as optimal (less than 12 μmol/L), borderline (12 to 15 μmol/L), and high risk (greater than 15 μmol/L).

## Chest X-Ray and Fluoroscopy

A chest x-ray is obtained to determine the size, contour, and position of the heart. It reveals cardiac and pericardial calcifications and demonstrates physiologic alterations in the pulmonary circulation. Although it does not help diagnose acute MI, it can help diagnose some complications (eg, HF). Correct placement of pacemakers and pulmonary artery catheters is also confirmed by chest x-ray.

Fluoroscopy is an x-ray imaging technique that allows visualization of the heart on a screen. It shows cardiac and vascular pulsations and unusual cardiac contours. This technique uses a moveable x-ray source, which makes it a useful aid for positioning transvenous pacing electrodes and for guiding the insertion of arterial and venous catheters during cardiac catheterization and other cardiac procedures.

## Electrocardiography

The ECG is a graphic representation of the electrical currents of the heart. The ECG is obtained by placing disposable electrodes in standard positions on the skin of the chest wall and extremities (see Chapter 27 for electrode placement). Recordings of the electrical current flowing between two electrodes is made on graph paper or displayed on a monitor. Several different recordings can be obtained by using a variety of electrode combinations, called leads. Simply stated, a lead is a specific view of the electrical activity of heart. The standard ECG is composed of 12 leads or 12 different views, although it is possible to record 15 or 18 leads.

The 12-lead ECG is used to diagnose dysrhythmias, conduction abnormalities, chamber enlargement, and myocardial ischemia, injury, or infarction. It can also suggest cardiac effects of electrolyte disturbances (high or low calcium and potassium levels) and the effects of antiarrhythmic medications. A 15-lead ECG adds three additional chest leads across the right precordium and is used for early diagnosis of right ventricular and left posterior (ventricular) infarction. The 18-lead ECG adds three posterior leads to the 15-lead ECG and is useful for early detection of myocardial ischemia and injury. To enhance interpretation of the ECG, the patient's age, gender, BP, height, weight, symptoms, and medications (especially digitalis and antiarrhythmic agents) are noted on the ECG requisition. The details of electrocardiography are presented in Chapter 27.

### Continuous Electrocardiographic Monitoring

Continuous ECG monitoring is the standard of care for patients who are at high risk for dysrhythmias. This form of cardiac monitoring detects abnormalities in heart rate and rhythm. Many systems have the capacity to monitor for changes in ST segments, which are used to identify the presence of myocardial ischemia or injury (see Chapter 28). There are two types of continuous ECG monitoring techniques used in health care settings: hardwire cardiac monitoring, found in emergency departments, critical care units, and progressive care units; and telemetry, found in general nursing care units or outpatient cardiac rehabilitation programs. Hardwire cardiac monitoring and telemetry systems vary in sophistication; however, most systems have the following features in common:

- Monitor more than one lead simultaneously
- Monitor ST segments (ST-segment depression is a marker of myocardial ischemia; ST-segment elevation provides evidence of an evolving MI)
- Provide graded visual and audible alarms (based on priority, asystole merits the highest grade of alarm)
- Interpret and store alarms

- Trend data over time
- Print a copy of rhythms from one or more specific ECG leads over a set time (called a rhythm strip)

**NURSING ALERT**

**Patients placed on continuous ECG monitoring must be informed of its purpose and cautioned that it does not detect shortness of breath, chest pain, or other ACS symptoms. Thus, patients are instructed to report new or worsening symptoms immediately.**

### Hardwire Cardiac Monitoring

Hardwire cardiac monitoring is used to continuously observe the heart for dysrhythmias and conduction disorders using one or two ECG leads. A real-time ECG is displayed on a bedside monitor and at a central monitoring station. In critical care units, additional components can be added to the bedside monitor to continuously monitor hemodynamic parameters (noninvasive BP, arterial pressures, pulmonary artery pressures) and respiratory parameters (respiratory rate, oxygen saturation).

### Telemetry

In addition to hardwire cardiac monitoring, the ECG can be continuously observed by **telemetry,** the transmission of radiowaves from a battery-operated transmitter to a central bank of monitors. The primary benefit of using telemetry is that the system is wireless, which allows patients to ambulate while one or two ECG leads are monitored. The patient has electrodes placed on the chest with a lead cable that connects to the transmitter. The transmitter can be placed in a disposable pouch and worn around the neck, or simply secured to the patient's clothing. Most transmitter batteries are changed every 24 to 48 hours.

### Lead Systems

The number of electrodes needed for hardwire cardiac monitoring and telemetry is dictated by the lead system used in the clinical setting. Electrodes need to be securely and accurately placed on the chest wall. Chart 26-4 provides helpful hints on how to apply these electrodes. There are three-, four-, or five-lead systems available for ECG monitoring. With a three-lead system, the nurse has only three lead options, whereas a four-lead system provides six possibilities. Newer monitoring systems have a five-lead system, which provides up to seven different lead selections. The advantage of the latter system is that it can more comprehensively monitor the activity of the anterior wall of the left ventricle (see Fig. 26-9 for electrode placement).

The two ECG leads most often selected for continuous ECG monitoring are leads II and $V_1$. Lead II provides the best visualization of atrial depolarization (represented by the P wave). Lead $V_1$ best records ventricular depolarization and is most helpful when monitoring for certain dysrhythmias (eg, premature ventricular contractions, tachycardias, bundle branch blocks) (see Chapter 27).

The EASI monitoring system (Phillips Medical System) uses five electrodes, is capable of printing a 12-lead ECG, and allows that any 3 of 12 leads can be displayed simultaneously. However, since this system requires that electrodes be placed on the trunk rather than the extremities, it is not considered equivalent to the standard approach. Therefore, it is recommended that the EASI method should not be used for serial comparisons or used in place of a standard 12-lead ECG (Jahrsdoerfer, Giuliano & Stephens, 2005).

## Chart 26-4 • *Applying Electrodes*

The monitoring system requires an adequate electrical signal to analyze the patient's cardiac rhythm. When applying electrodes, the following recommendations should be followed to optimize skin adherence and conduction of the heart's electrical current:

- Débride the skin surface of dead cells with soap and water and dry well (or as recommended by the manufacturer).
- Clip (do not shave) hair from around the electrode site if needed.
- If the patient is diaphoretic (sweaty), apply a small amount of benzoin to the skin, avoiding the area under the center of the electrode.
- Connect the electrodes to the lead wires prior to placing them on the chest (connecting lead wires when electrodes are in place may be uncomfortable for some patients).
- Peel the backing off the electrode and check to make sure the center is moist with electrode gel.
- Locate the appropriate lead placement and apply the electrode to the skin, securing it in place with light pressure.
- Change the electrodes every 24 to 48 hours (or as recommended by the manufacturer), examine the skin for irritation, and apply the electrodes to different locations.
- If the patient is sensitive to the electrodes, use hypoallergenic electrodes.

### Ambulatory Electrocardiography

Ambulatory electrocardiography is a form of continuous ECG monitoring used for diagnostic purposes in the outpatient setting. Electrodes (number varies based on model used) are connected with lead wires to a cable that is inserted into a portable recorder (ie, Holter monitor) that records the ECG onto a digital memory device. The patient wears the Holter monitor for 24 hours to detect dysrhythmias or myocardial ischemia that may occur during waking hours or sleep. The patient keeps a diary, noting the time of any symptoms or performance of unusual activities. Data from the digital memory device are uploaded into a computer for analysis, and rhythms that need further evaluation by a clinician are identified. Ambulatory electrocardiography is used to identify the etiology of symptoms (eg, syncope, palpitations) that may be caused by dysrhythmias, to detect episodes of myocardial ischemia, and to evaluate effectiveness of cardiac medications (eg, antiarrhythmic medications, nitrates) or pacemaker function.

### Transtelephonic Monitoring

Another method of evaluating the ECG of a patient at home is by transtelephonic monitoring. The patient attaches

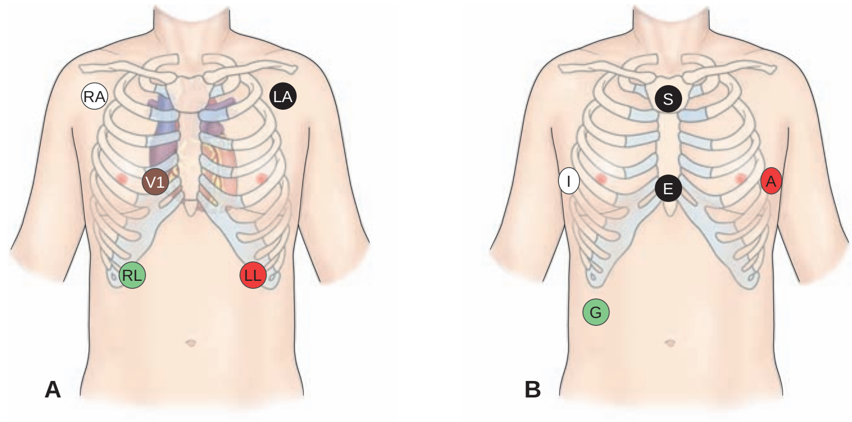



**Figure 26-9** Electrode placement used in continuous electrocardiographic monitoring for **(A)** three-lead system, placement on RA, LA, and LL; four-lead system, placement on RA, LA, RL, and LL; five-lead system, placement on RA, LA, RL, LL, and V1; and **(B)** EASI-derived 12-lead ECG system.

RA – Right arm (white)
LA – Left arm (black)
RL – Right leg (green)
LL – Left leg (red)
V1 – Chest or precordium (brown)

E – Lower sternum at 5th intercostal space ICS (black)
A – 5th ICS at left midclavicular line (red)
S – Upper sternum (black)
I – 5th ICS at right midclavicular line (white)
Ground – Any area (green)

a specific lead system for transmitting the signals and places a telephone mouthpiece over the transmitter box. The ECG is recorded and evaluated at a remote location, such as a physician's office or community agency. This method is often used for diagnosing dysrhythmias and to evaluate pacemaker function.

**Wireless Mobile Cardiac Monitoring Systems**

This emerging technology allows health care professionals to monitor and transmit the ECG of patients outside of the hospital or office setting continuously. The wireless method has a number of advantages when compared with Holter and transtelephonic monitoring. It is lightweight and can monitor the patient 24 hours a day 7 days a week. Patients wear a small sensing device that transmits each heartbeat to a small monitor. When a dysrhythmia is detected, the system automatically transmits the patient's ECG to a monitoring center through either the patient's telephone line when at home or through wireless communications systems when outside of the home. This system enhances detection and early treatment of dysrhythmias that might otherwise be diagnosed only after the patient develops serious symptoms.

## Cardiac Stress Testing

Normally, the coronary arteries dilate to four times their usual diameter in response to increased metabolic demands for oxygen and nutrients. However, coronary arteries affected by atherosclerosis dilate less, compromising blood flow to the myocardium and causing ischemia. Therefore, abnormalities in cardiovascular function are more likely to be detected during times of increased demand, or "stress." The **cardiac stress test** procedures—the exercise stress test, the pharmacologic stress test, and the mental or emotional stress test—are noninvasive ways to evaluate the response of the cardiovascular system to stress. The stress test helps determine the following: (1) presence of CAD, (2) cause of chest pain, (3) functional capacity of the heart after an MI or heart surgery, (4) effectiveness of antianginal or antiarrhythmic medications, (5) dysrhythmias that occur during physical exercise, and (6) specific goals for a physical fitness program. Contraindications to stress testing include severe aortic stenosis, acute myocarditis or pericarditis, severe hypertension, suspected left main CAD, HF, and unstable angina. Because complications of stress testing can be life-threatening (MI, cardiac arrest, HF, and severe dysrhythmias), testing facilities must have staff and equipment ready to provide treatment, including advanced cardiac life support.

Stress testing is often combined with echocardiography or radionuclide imaging (discussed later). These techniques are performed during the resting state and immediately after stress testing.

### *Exercise Stress Testing*

**Procedure**

During an exercise stress test, the patient walks on a treadmill (most common), pedals a stationary bicycle, or uses an arm crank. Exercise intensity progresses according to established protocols. The goal is to increase the heart rate to the "target heart rate," which is 80% to 90% of the maximum predicted heart rate based on the patient's age and gender. During the test, the following are monitored: two or more ECG leads for heart rate, rhythm, and ischemic changes; BP; skin temperature; physical appearance; perceived exertion; and symptoms, including chest pain, dyspnea, dizziness, leg cramping, and fatigue. The test is terminated when the target heart rate is achieved or when the patient experiences chest pain, extreme fatigue, a decrease in BP or pulse rate, serious dysrhythmias or ST-segment changes on the ECG, or other complications. When significant ECG abnormalities occur during the stress test (ST-segment depressions or elevations), the test result is reported as positive and further diagnostic testing such as a cardiac catheterization is required.

**Nursing Interventions**

In preparation for the exercise stress test, the patient is instructed to fast for 4 hours before the test and to avoid

stimulants such as tobacco and caffeine. Medications may be taken with sips of water. The physician may instruct the patient not to take certain cardiac medications, such as beta-adrenergic blocking agents, before the test. Clothes and sneakers or rubber-soled shoes suitable for exercising are to be worn. The nurse prepares the patient for the stress test by describing how the stress test is performed, the type of monitoring equipment used, the rationale for having an IV catheter inserted, and what symptoms to report. The exercise method is reviewed and patients are asked to put forth their best exercise effort. If the test is to be performed with echocardiography or radionuclide imaging (described in the following section), this information is reviewed as well. After the test, the patient is monitored for 10 to 15 minutes. Once stable, patients may resume their usual activities.

### *Pharmacologic Stress Testing*

#### Procedure

Patients who are physically disabled or deconditioned will not be able to achieve their target heart rate by exercising on a treadmill or bicycle. Two vasodilating agents, dipyridamole (Persantine) and adenosine (Adenocard), administered IV, are used to mimic the effects of exercise by maximally dilating the coronary arteries. The effects of dipyridamole last about 15 to 30 minutes. The side effects are related to its vasodilating action and include chest discomfort, dizziness, headache, flushing, and nausea. Adenosine has similar side effects, although patients report these symptoms as more severe. Adenosine has an extremely short half-life (less than 10 seconds), so any severe effects subside rapidly. Dipyridamole and adenosine are the agents of choice used in conjunction with radionuclide imaging techniques. Theophylline and other xanthines, such as caffeine, block the effects of dipyridamole and adenosine and must be avoided before these pharmacologic stress tests.

Dobutamine may also be used if the patient cannot exercise. Dobutamine, a synthetic sympathomimetic, increases heart rate, myocardial contractility, and BP, thereby increasing the metabolic demands of the heart. It is the agent of choice when echocardiography is used because of its effects on altering myocardial wall motion (due to enhanced contractility). Dobutamine is also used for patients who have bronchospasm or pulmonary disease and cannot tolerate having doses of theophylline withheld.

#### Nursing Interventions

In preparation for the pharmacologic stress test, the patient is instructed not to eat or drink anything for at least 4 hours before the test. This includes chocolate, caffeine, caffeine-free coffee, tea, carbonated beverages, or medications that contain caffeine (eg, Anacin, Darvon). If caffeine is ingested before a dipyridamole or adenosine stress test, the test will have to be rescheduled. Patients taking aminophylline, theophylline, or dipyridamole are instructed to stop taking these medications for 24 to 48 hours before the test (if tolerated). The patient is informed about the transient sensations that may occur during infusion of the vasodilating agent, such as flushing or nausea, which will disappear quickly. The patient is instructed to report the occurrence of any other symptoms during the test to the cardiologist or nurse. The stress test may take about 1 hour, or up to 3 hours if imaging is performed.

## Echocardiography

### *Traditional Echocardiography*

Echocardiography is a noninvasive ultrasound test that is used to measure the ejection fraction and examine the size, shape, and motion of cardiac structures. It is particularly useful for diagnosing pericardial effusions; determining chamber size and the etiology of heart murmurs; evaluating the function of heart valves, including prosthetic heart valves; and evaluating ventricular wall motion.

#### Procedure

Echocardiography involves transmission of high-frequency sound waves into the heart through the chest wall and recording of the return signals. The ultrasound is generated by a handheld transducer applied to the front of the chest. The transducer picks up the echoes, converts them to electrical impulses, and transmits them for display on an oscilloscope and recording on a videotape. An ECG is recorded simultaneously to assist with interpreting the echocardiogram.

Two-dimensional or cross-sectional echocardiography creates a sophisticated, spatially correct image of the heart. Other techniques, such as Doppler and color flow imaging echocardiography, show the direction and velocity of the blood flow through the heart.

Echocardiography may be performed with an exercise or pharmacologic stress test. Images are obtained at rest and then immediately after the target heart rate is reached. Myocardial ischemia from decreased perfusion during stress causes abnormalities in ventricular wall motion and is easily detected by echocardiography. A stress test using echocardiography is considered positive if abnormalities in ventricular wall motion are detected during stress but not during rest. These findings are highly suggestive of CAD and require further evaluation, such as a cardiac catheterization.

#### Nursing Interventions

Before echocardiography, the nurse informs the patient about the test, explaining that it is painless. Echocardiographic monitoring is performed while a transducer that emits sound waves is moved over the surface of the chest wall. Gel applied to the skin helps transmit the sound waves. Periodically, the patient is asked to turn onto the left side or hold a breath. The test takes about 30 to 45 minutes. If the patient is to undergo an exercise or pharmacologic stress test with echocardiography, information on stress testing is also reviewed with the patient.

### *Transesophageal Echocardiography*

#### Procedure

A significant limitation of traditional echocardiography is the poor quality of the images produced. Ultrasound loses its clarity as it passes through tissue, lung, and bone. An alternate technique involves threading a small transducer through the mouth and into the esophagus. This technique,

called transesophageal echocardiography (TEE), provides clearer images because ultrasound waves pass through less tissue. A topical anesthetic agent and moderate sedation are used during a TEE because of the discomfort associated with the positioning of the transducer in the esophagus (refer to Chapter 19 for further discussion of moderate sedation). Once the patient is comfortable, the transducer is inserted into the mouth and the patient is asked to swallow several times until it is positioned in the esophagus.

The high-quality imaging obtained during TEE makes this technique an important first-line diagnostic tool for evaluating patients with many types of CVD, including HF, valvular heart disease, dysrhythmias, and many other conditions that place the patient at risk for atrial or ventricular thrombi. Pharmacologic stress testing using dobutamine and TEE can also be performed. It is frequently used during cardiac surgery to continuously monitor the response of the heart to the surgical procedure (eg, valve replacement or coronary artery bypass). Complications are uncommon during TEE, but if they do occur, they are serious. These complications are caused by sedation and impaired swallowing resulting from the topical anesthesia (respiratory depression and aspiration) and by insertion and manipulation of the transducer into the esophagus and stomach (vasovagal response or esophageal perforation). The patient must be assessed before TEE for a history of dysphagia or radiation therapy to the chest, which increases the likelihood of complications.

#### Nursing Interventions

Prior to the test the nurse provides preprocedure education and ensures that the patient has a clear understanding of what the test entails and why it is being performed, instructs the patient not to eat or drink anything for 6 hours prior to the study, and checks to make sure that informed consent has been obtained. The nurse also inserts an IV line or assesses an existing IV for patency and asks the patient to remove full or partial dentures. During the test, the nurse provides emotional support and monitors level of consciousness, BP, ECG, respiration, and oxygen saturation ($SpO_2$). During the recovery period, the patient must maintain bed rest with the head of the bed elevated to 45 degrees. Following the moderate sedation policy of the agency, the nurse monitors the patient for dyspnea and assesses vital signs, $SpO_2$, level of consciousness, and gag reflex as recommended. Food and oral fluids are withheld until the patient is fully alert and the effects of the topical anesthetic agent are reversed, usually 2 hours after the procedure; if gag reflex is intact, the nurse begins feeding with sips of water, then advances to preprocedure diet. The patient is informed that a sore throat may be present for the next 24 hours; he or she is instructed to report the presence of a persistent sore throat, shortness of breath, or difficulty swallowing. If the procedure is performed in an outpatient setting, a family member or friend must be available to transport the patient home from the test site.

## Radionuclide Imaging

Radionuclide imaging studies involve the use of radioisotopes to noninvasively evaluate coronary artery perfusion, to detect myocardial ischemia and infarction, and to assess left ventricular function. **Radioisotopes** are unstable atoms. Thallium 201 ($Tl^{201}$) and technetium 99m ($Tc^{99m}$) are two radioisotopes used in cardiac nuclear medicine studies that give off small amounts of energy in the form of gamma rays as they decay. When these radioisotopes are injected into the bloodstream, the energy emitted can be detected by a gamma scintillation camera positioned over the body. Planar imaging, used with thallium, provides a one-dimensional view of the heart from three locations. Single photon emission computed tomography (SPECT) provides three-dimensional images. With SPECT, the patient is positioned supine with arms raised above the head, while the camera moves around the patient's chest in a 180- to 360-degree arc to more precisely identify the areas of decreased myocardial perfusion.

### *Myocardial Perfusion Imaging*

#### Procedure

The radioisotope $Tl^{201}$ crosses into the cells of healthy myocardium and is used to assess myocardial perfusion. It is taken up more slowly and in smaller amounts by myocardial cells that are ischemic from decreased blood flow. However, thallium does not cross into areas of the myocardium that have been scarred by MI.

Thallium is often used with stress testing to assess changes in myocardial perfusion immediately after exercise (or after injection of one of the medications used in stress testing) and at rest. One or two minutes before the end of the stress test, a dose of $Tl^{201}$ is injected into the IV line, allowing the radioisotope to be distributed into the myocardium. Images are taken immediately. Areas that do not show thallium uptake indicate areas of either MI or stress-induced myocardial ischemia. Resting images, taken 3 hours later, help differentiate infarction from ischemia. Infarcted tissue cannot take up thallium regardless of when the scan is taken; the defect remains the same size during exercise or rest. This is called a fixed defect, indicating that there is no perfusion in that area of the myocardium. Ischemic myocardium, on the other hand, recovers in a few hours. If perfusion is restored, thallium crosses into the myocardial cells, and the area of defect on the resting images is either smaller or completely reversed. These reversible defects constitute positive stress test findings. Typically, cardiac catheterization is recommended after a positive test result to determine whether a percutaneous coronary intervention or coronary artery bypass graft surgery is needed.

Another radioisotope used for cardiac imaging is $Tc^{99m}$. Technetium can be combined with various chemical compounds, giving it an affinity for different types of cells. For example, $Tc^{99m}$ sestamibi (Cardiolite) is distributed to myocardial cells in proportion to its perfusion, making this an excellent tracer for assessing perfusion to the myocardium. The procedure for cardiac imaging using $Tc^{99m}$ sestamibi with stress testing is similar to the procedure for using thallium, but patients receiving $Tc^{99m}$ sestamibi can have their resting images recorded before or after the exercise images.

#### Nursing Interventions

The patient undergoing nuclear imaging techniques with stress testing should be prepared for the type of stressor to be

used (exercise or drug) and the type of imaging technique (planar or SPECT). The patient may be concerned about receiving a radioactive substance and needs to be reassured that these tracers are safe—the radiation exposure is similar to that of other diagnostic x-ray studies. No postprocedure radiation precautions are necessary.

When providing teaching for a patient undergoing SPECT, the nurse instructs the patient that the arms will need to be positioned over the head for about 20 to 30 minutes. If the patient is physically unable to do this, thallium with planar imaging can be used.

### Test of Ventricular Function and Wall Motion

Equilibrium radionuclide angiocardiography (ERNA), also known as multiple-gated acquisition (MUGA) scanning, is a common noninvasive technique that uses a conventional scintillation camera interfaced with a computer to record images of the heart during several hundred heartbeats. The computer processes the data and allows for sequential viewing of the functioning heart. The sequential images are analyzed to evaluate left ventricular function, wall motion, and ejection fraction. MUGA scanning can also be used to assess the differences in left ventricular function during rest and exercise.

The patient is reassured that there is no known radiation danger and is instructed to remain motionless during the scan.

### Computed Tomography

#### Procedure

Computed tomography (CT), also called computerized axial tomographic (CAT) scanning or electron-beam computed tomography (EBCT), uses x-rays to provide cross-sectional images of the chest, including the heart and great vessels. These techniques are used to evaluate cardiac masses and diseases of the aorta and pericardium.

EBCT, also known as the ultrafast CT, is an x-ray scanning technique that results in much faster image acquisition with a higher degree of resolution than traditional x-ray or CT scanning provides. It is used to evaluate bypass graft patency, congenital heart lesions, left and right ventricular muscle mass, chamber volumes, cardiac output, and ejection fraction. For people without previous MI, PCI, or coronary artery bypass surgery, EBCT is used to determine the amount of calcium deposits in the coronary arteries and underlying atherosclerosis. From this scan, a calcium score is derived that predicts the likelihood of cardiac events, such as MI or the need for a revascularization procedure within the next 1 to 2 years.

EBCT is not widely used, but it does show great promise in the early detection of CAD that is not yet clinically significant and that would not be identified by traditional testing methods such as the exercise stress test.

#### Nursing Interventions

Patient preparation for these tests is the nursing role. The nurse explains to the patient that he or she will be positioned on a table during the scan while the scanner rotates around him or her. The procedure is noninvasive and painless. However, to obtain adequate images, the patient must lie perfectly still during the scanning process. An IV access line is necessary if contrast enhancement is to be used.

### Positron Emission Tomography

Positron emission tomography (PET) is a noninvasive scanning method that has been used primarily to study neurologic dysfunction. More recently, and with increasing frequency, PET has been used to diagnose cardiac dysfunction. PET provides more specific information about myocardial perfusion and viability than does TEE or thallium scanning. For cardiac patients, including those without symptoms, PET helps in planning treatment (eg, coronary artery bypass surgery, PCIs). PET also helps evaluate the patency of native and previously grafted vessels and the collateral circulation.

#### Procedure

During a PET scan, radioisotopes are administered by injection; one compound is used to determine blood flow in the myocardium, and another determines the metabolic function. The PET camera provides detailed three-dimensional images of the distributed compounds. The viability of the myocardium is determined by comparing the extent of glucose metabolism in the myocardium to the degree of blood flow. For example, ischemic but viable tissue will show decreased blood flow and elevated metabolism. For a patient with this finding, revascularization through surgery or angioplasty will probably be indicated to improve heart function. Restrictions of food intake before the test vary among institutions, but because PET evaluates glucose metabolism, the patient's blood glucose level should be within the normal range before testing.

#### Nursing Interventions

The nurse should instruct the patient to refrain from using tobacco and ingesting caffeine for 4 hours before the PET procedure. The patient should also be reassured that radiation exposure is at safe and acceptable levels, similar to those of other diagnostic x-ray studies.

### Magnetic Resonance Angiography

#### Procedure

Magnetic resonance angiography (MRA) is a noninvasive, painless technique that is used to examine both the physiologic and anatomic properties of the heart. MRA uses a powerful magnetic field and computer-generated pictures to image the heart and great vessels. It is valuable in diagnosing diseases of the aorta, heart muscle, and pericardium, as well as congenital heart lesions. The application of this technique to the evaluation of coronary artery anatomy is limited, however, because the quality of the images obtained during MRA is distorted by respirations, the beating heart, and certain implanted devices (stents and surgical clips). In addition, this technique cannot adequately visualize the small distal coronary arteries as well as conventional angiography that is performed during a cardiac catheterization. Therefore, the latter technique remains the "gold standard" for the diagnosis of CAD.

#### Nursing Interventions

Because of the magnetic field used during MRA, diagnostic centers where these procedures are performed carefully screen patients for contraindications, including the presence

of a pacemaker, metal plates, prosthetic joints, or other metallic implants that can become dislodged if exposed to MRA. Patients are instructed to remove any jewelry, watches, or other metal items. Transdermal patches that contain a heat-conducting aluminized layer (eg, NicoDerm, Androderm, Transderm Nitro, Transderm Scop, Catapres-TTS) must be removed before MRA to prevent burning of the skin. During an MRA, the patient is positioned supine on a table that is placed into an enclosed imager or tube containing the magnetic field. A patient who is claustrophobic may need to receive a mild sedative before undergoing an MRA. An intermittent clanking or thumping that can be annoying is generated by the magnetic coils, so the patient may be offered a headset to listen to music. The scanner is equipped with a microphone so that the patient can communicate with the staff. The patient is instructed to remain motionless during the scan.

## Cardiac Catheterization

**Cardiac catheterization** is an invasive diagnostic procedure in which radiopaque arterial and venous catheters are introduced into selected blood vessels of the right and left sides of the heart. Catheter advancement is guided by fluoroscopy. Most commonly, the catheters are inserted percutaneously through the blood vessels, or via a cutdown procedure if the patient has poor vascular access. Pressures and oxygen saturation levels in the four heart chambers are measured.

Cardiac catheterization is most frequently used to diagnose CAD, assess coronary artery patency, and determine the extent of atherosclerosis and determine whether revascularization procedures, including PCI or coronary artery bypass surgery, may be of benefit to the patient (see Chapter 28). Cardiac catheterization is also used to diagnose pulmonary arterial hypertension or to treat stenotic heart valves via percutaneous balloon valvuloplasty.

During cardiac catheterization, the patient has one or more IV lines in place for the administration of sedatives, fluids, heparin, and other medications. BP and ECG monitoring is necessary to observe for hemodynamic instability or dysrhythmias. The myocardium can become ischemic and trigger dysrhythmias as catheters are positioned in the coronary arteries or during injection of contrast agents. Resuscitation equipment must be readily available, and staff must be prepared to provide advanced cardiac life support measures as necessary.

Radiopaque contrast agents are used to visualize the coronary arteries. Some contrast agents contain iodine, and the patient is assessed before the procedure for previous reactions to contrast agents or allergies to iodine-containing substances (eg, seafood). If the patient has a suspected or known allergy to the substance, antihistamines or methylprednisolone (Solu-Medrol) may be administered before the procedure. In addition, the following blood tests are performed to identify abnormalities that may complicate recovery: blood urea nitrogen (BUN) and creatinine levels, international normalized ratio (INR) and prothrombin time (PT), activated thromboplastin time (aPTT), hematocrit and hemoglobin values, platelet count, and electrolyte levels.

Patients undergoing cardiac catheterization who have comorbid conditions—including diabetes, HF, preexisting renal disease, hypotension, or dehydration, or who are elderly—are at risk for contrast agent–induced nephropathy (defined as an increase in the baseline serum creatinine by 25% or more within 2 days of the procedure). Although this form of acute renal failure is usually reversible, temporary dialysis may be necessary. Preventive strategies for high-risk patients include preprocedure and postprocedure hydration with IV infusions of saline or sodium bicarbonate and the antioxidant acetylcysteine (Mucomyst) (Briguori, Airoldi, D'Andrea, et al., 2007).

Diagnostic cardiac catheterization is commonly performed on an outpatient basis and requires 2 to 6 hours of bed rest after the procedure before the patient is allowed to ambulate. Variations in time to ambulation are related to the size of the catheter used during the procedure, the site of catheter insertion (femoral or radial artery), the patient's anticoagulation status, and other variables (eg, advanced age, obesity, bleeding disorder). The use of smaller (4 or 6 Fr) catheters is associated with shorter recovery times. Several options to achieve arterial hemostasis after catheter removal, including manual pressure, mechanical compression devices such as the FemoStop (placed over puncture site for 30 minutes), and percutaneously deployed devices, are used. The latter devices are positioned at the femoral arterial puncture site after completion of the procedure. They deploy a saline-soaked gelatin sponge (QuickSeal), collagen (VasoSeal), sutures (Perclose, Techstar), or a combination of both collagen and sutures (Angio-Seal). Other newer products that expedite arterial hemostasis include external patches (Syvek Patch, Clo-Sur PAD). These products are placed over the puncture site as the catheter is removed and manual pressure is applied for 4 to 10 minutes. Once hemostasis is achieved, the patch is covered with a dressing that remains in place for 24 hours. A number of factors, such as the patient's condition, cost, institutional availability of these devices, and the physician's preference, determine which closure devices are used.

Major benefits of the percutaneously deployed vascular closure devices include reliable, immediate hemostasis and a shorter time on bed rest without a significant increase in bleeding or other complications. However, these devices are not without risk. Bleeding around the closure device, infection, and arterial obstruction due to embolization or local injury to the vessel during placement have all been reported, although they are rare complications (Kalapatapu, Ali, Masroor, et al., 2006).

Patients hospitalized for angina or acute MI who require cardiac catheterization usually return to their hospital rooms for recovery. In some cardiac catheterization laboratories, a PCI (discussed in Chapter 28) may be performed immediately during the catheterization if indicated.

### Angiography

Cardiac catheterization is usually performed with angiography, a technique in which a contrast agent is injected into the vascular system to outline the heart and blood vessels. When a specific heart chamber or blood vessel is singled out for study, the procedure is known as selective angiography. Angiography makes use of cineangiograms, a series of rapidly changing films on an intensified fluoroscopic screen that record the passage of the contrast agent through the vascular site or sites. Recording allows for comparison of data over time. Common sites for selective angiography are the aorta, the coronary arteries, and the right and left sides of the heart.

### Aortography

An aortogram is a form of angiography that outlines the lumen of the aorta and the major arteries arising from it. In thoracic aortography, a contrast agent is used to study the aortic arch and its major branches. The catheter may be introduced into the aorta using the translumbar or retrograde brachial or femoral artery approach.

### Coronary Arteriography

Coronary arteriography involves the introduction of a catheter into the right or left brachial or femoral artery, which is then passed into the ascending aorta and manipulated into the right and left coronary arteries. Angiographic techniques are used to evaluate the degree of atherosclerosis and to determine treatment. They are also used to study suspected congenital anomalies of the coronary arteries.

### Right Heart Catheterization

Right heart catheterization usually precedes left heart catheterization. It involves the passage of a catheter from an antecubital or femoral vein into the right atrium, right ventricle, pulmonary artery, and pulmonary arterioles. Pressures and oxygen saturation levels from each of these areas are obtained and recorded.

Although right heart catheterization is considered relatively safe, potential complications include cardiac dysrhythmias, venous spasm, infection of the insertion site, cardiac perforation, and, rarely, cardiac arrest.

### Left Heart Catheterization

Left heart catheterization is performed to evaluate the patency of the coronary arteries and the function of the left ventricle and the mitral and aortic valves. Potential complications include dysrhythmias, MI, perforation of the heart or great vessels, and systemic embolization. Left heart catheterization is performed by retrograde catheterization of the left ventricle. In this approach, the physician usually inserts the catheter into the right brachial artery or a femoral artery and advances it into the aorta and left ventricle.

After the procedure, the catheter is carefully withdrawn and arterial hemostasis is achieved using manual pressure or other techniques previously described. If the physician performed an arterial or venous cutdown, the site is sutured and a sterile dressing is applied.

#### *Nursing Interventions*

Nursing responsibilities before cardiac catheterization include the following:

- The patient is instructed to fast, usually for 8 to 12 hours, before the procedure. If catheterization is to be performed as an outpatient procedure, a friend, family member, or other responsible person must transport the patient home.
- The patient is informed of the expected duration of the procedure and advised that it will involve lying on a hard table for less than 2 hours.
- The patient is reassured that IV medications are given to maintain comfort.
- The patient is informed about sensations that will be experienced during the catheterization. Knowing what to expect can help the patient cope with the experience. The nurse explains that an occasional pounding sensation (palpitation) may be felt in the chest because of extra heartbeats that almost always occur, particularly when the catheter tip touches the endocardium. The patient may be asked to cough and to breathe deeply, especially after the injection of contrast agent. Coughing may help disrupt a dysrhythmia and clear the contrast agent from the arteries. Breathing deeply and holding the breath help lower the diaphragm for better visualization of heart structures. The injection of a contrast agent into either side of the heart may produce a flushed feeling throughout the body and a sensation similar to the need to void, which subsides in 1 minute or less.
- The patient is encouraged to express fears and anxieties. The nurse provides teaching and reassurance to reduce apprehension.

Nursing responsibilities after cardiac catheterization may include the following:

- The catheter access site is observed for bleeding or hematoma formation. Peripheral pulses are assessed in the affected extremity (dorsalis pedis and posterior tibial pulses in the lower extremity, radial pulse in the upper extremity) every 15 minutes for 1 hour, and then every 1 to 2 hours until the pulses are stable.
- Temperature, color, and capillary refill of the affected extremity are frequently evaluated, per local nursing standards. The patient is assessed for affected extremity pain, numbness, or tingling sensations that may indicate arterial insufficiency. Any changes are reported promptly.
- Dysrhythmias are carefully screened by observing the cardiac monitor or by assessing the apical and peripheral pulses for changes in rate and rhythm. A vasovagal reaction, consisting of bradycardia, hypotension, and nausea, can be precipitated by a distended bladder or by discomfort from manual pressure that is applied during removal of an arterial or venous catheter. The vasovagal response is reversed by promptly elevating the lower extremities above the level of the heart, infusing a bolus of IV fluid, and administering IV atropine to treat the bradycardia.
- Bed rest is maintained for 2 to 6 hours after the procedure. If manual or mechanical pressure is used, the patient must remain on bed rest for up to 6 hours with the affected leg straight and the head of the bed elevated no greater than 30 degrees. For comfort, the patient may be turned from side to side with the affected extremity straight. If the cardiologist deployed a percutaneous vascular closure device or patch, the nurse checks local nursing care standards and anticipates that the patient will have fewer activity restrictions. The patient may be permitted to ambulate within 2 hours. Analgesic medication is administered as prescribed for discomfort.
- The patient is instructed to report chest pain and bleeding or sudden discomfort from the catheter insertion sites promptly.
- The patient is monitored for contrast agent–induced nephropathy by observing for elevations in serum creatinine levels. Oral and IV hydration is used to increase urinary output and flush the contrast agent from

CHART 26-5

PATIENT EDUCATION

**Self-Management After Cardiac Catheterization**

After discharge from the hospital for cardiac catheterization, guidelines for self-care include the following:

- For the next 24 hours, do not bend at the waist (to lift anything), strain, or lift heavy objects.
- Avoid tub baths, but shower as desired.
- Talk with your physician about when you may return to work, drive, or resume strenuous activities.
- Call your physician if any of the following occur: bleeding, swelling, new bruising or pain from your procedure puncture site, temperature of 38.6°C (101.5°F) or more.
- If test results show that you have coronary artery disease, talk with your physician about options for treatment, including cardiac rehabilitation programs in your community.
- Talk with your physician and nurse about lifestyle changes to reduce your risk for further or future heart problems, such as quitting smoking, lowering your cholesterol level, initiating dietary changes, beginning an exercise program, or losing weight.
- Your physician may prescribe one or more new medications depending on your risk factors (medications to lower your blood pressure or cholesterol; aspirin or clopidogrel to prevent blood clots). Take all of your medications as instructed. If you feel that any of them are causing side effects, call your physician immediately. Do not stop taking any medications before talking to your doctor.

the urinary tract; accurate intake and output are recorded.

- Patient safety is ensured by instructing the patient to ask for help when getting out of bed the first time after the procedure. The patient is monitored for bleeding from the catheter access site and for orthostatic hypotension, indicated by complaints of dizziness or lightheadedness.

For patients being discharged from the hospital on the same day as the procedure, additional instructions are provided (Chart 26-5).

## Electrophysiologic Testing

The electrophysiology study (EPS) is an invasive procedure that plays a major role in the diagnosis and management of serious dysrhythmias. EPS may be indicated for patients with syncope, palpitations, or both, and for survivors of cardiac arrest from ventricular fibrillation (sudden cardiac death). EPS is used to distinguish atrial from ventricular tachycardias when the determination cannot be made from the 12-lead ECG, evaluate how readily a life-threatening dysrhythmia (eg, ventricular tachycardia, ventricular fibrillation) can be induced, evaluate AV node function, evaluate the effectiveness of antiarrhythmic medications in suppressing the dysrhythmia, or determine the need for other therapeutic interventions, such as a pacemaker, implantable cardioverter-defibrillator, or radiofrequency ablation. See Chapter 27 for a detailed discussion of EPS.

## Hemodynamic Monitoring

Critically ill patients require continuous assessment of their cardiovascular system to diagnose and manage their complex medical conditions. This type of assessment is achieved by the use of direct pressure monitoring systems, referred to as **hemodynamic monitoring**. Common forms include central venous pressure (CVP), pulmonary artery pressure, and intra-arterial BP monitoring. Patients requiring hemodynamic monitoring are typically cared for in critical care units. Some progressive care units also admit stable patients with CVP or intra-arterial BP monitoring. To perform hemodynamic monitoring, a CVP, pulmonary artery, or arterial catheter is introduced into the appropriate blood vessel or heart chamber. It is connected to a pressure monitoring system that has several components, including:

- A flush system composed of IV solution (which may include heparin), tubing, stopcocks, and a flush device, which provides continuous and manual flushing of the system
- A pressure bag placed around the flush solution that is maintained at 300 mm Hg of pressure; the pressurized flush system delivers 3 to 5 mL of solution per hour through the catheter to prevent clotting and backflow of blood into the pressure monitoring system
- A transducer to convert the pressure coming from the artery or heart chamber into an electrical signal
- An amplifier or monitor, which increases the size of the electrical signal for display on an oscilloscope

Nurses caring for patients who require hemodynamic monitoring receive training prior to using this sophisticated technology. The following guidelines help ensure safe and effective care:

- The nurse ensures that the system is set up and maintained properly. For example, the pressure monitoring system must be kept patent and free of air bubbles.
- Before the system is used to obtain pressure measurements, the nurse checks that the stopcock of the transducer is positioned at the level of the atrium. This landmark is referred to as the phlebostatic axis (Fig. 26-10). The nurse uses a marker to identify this level on the chest wall, which provides a stable reference point for subsequent pressure readings.
- The nurse establishes the zero reference point in order to ensure that the system is properly functioning at atmospheric pressure. This process is accomplished by placing the stopcock of the transducer at the phlebostatic axis, opening the transducer to air, and activating the zero function key on the bedside monitor. Measurements of CVP, BP, and pulmonary artery pressures can be made with the head of the bed elevated up to 60 degrees, but the system must be repositioned to the phlebostatic axis to ensure an accurate reading.

Complications from use of hemodynamic monitoring systems are uncommon and can include pneumothorax, infection, and air embolism. The nurse observes for signs of pneumothorax during the insertion of catheters using a

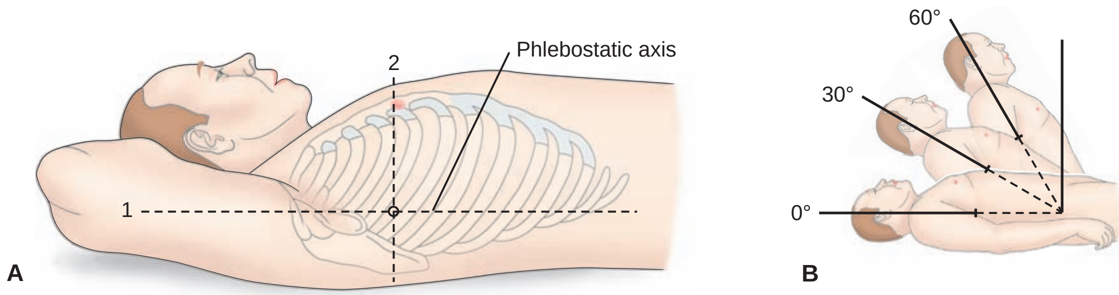



**Figure 26-10 A,** The phlebostatic axis is the reference point for the atrium when the patient is positioned supine. It is the intersection of two lines on the chest wall: (*1*) the midaxillary line drawn between the anterior and posterior surfaces of the chest and (*2*) the line drawn through the fourth intercostal space. Its location is identified with a skin marker. The stopcock of the transducer used in hemodynamic monitoring is "leveled" at this mark prior to taking pressure measurements. **B,** Measurements can be taken with the head of the bed (HOB) elevated up to 60 degrees. Note the phlebostatic axis changes as the HOB is elevated, so that the stopcock and transducer must be repositioned after each position change.

central venous approach (CVP and pulmonary artery catheters). The longer any of these catheters are left in place (after 72 to 96 hours), the greater the risk of infection. Air emboli can be introduced into the vascular system if the stopcocks attached to the pressure transducers are mishandled during blood drawing, administration of medications, or other procedures that require opening the system to air. Therefore, nurses handling this equipment must demonstrate competence prior to independently caring for a patient requiring hemodynamic monitoring.

### Central Venous Pressure Monitoring

CVP is a measurement of the pressure in the vena cava or right atrium. Since the pressure in the vena cava, right atrium, and right ventricle are equal at the end of diastole, the CVP also reflects the filling pressure of the right ventricle (preload). The normal CVP is 2 to 6 mm Hg. It is measured by positioning a catheter in the vena cava or right atrium and connecting it to a pressure monitoring system. The CVP is most valuable when it is monitored over time and correlated with the patient's clinical status. A CVP greater than 6 mm Hg indicates an elevated right ventricular preload. There are many problems that can cause an elevated CVP, but the most common is due to hypervolemia (excessive fluid circulating in the body) or right-sided HF. In contrast, a low CVP (less than 2 mm Hg) indicates reduced right ventricular preload, which is most often from hypovolemia. Dehydration, excessive blood loss, vomiting or diarrhea, and overdiuresis can result in hypovolemia and a low CVP. This diagnosis can be substantiated when a rapid IV infusion of fluid causes the CVP to increase.

Before insertion of a CVP catheter, the site is prepared by clipping excessive hair, if necessary, and by cleansing with an antiseptic solution. A local anesthetic agent is used. During this sterile procedure, the physician threads a single-lumen or multilumen catheter through the external jugular, antecubital, or femoral vein into the vena cava just above or within the right atrium.

#### Nursing Interventions

Once the CVP catheter is inserted, it is secured and a dry, sterile dressing is applied. Catheter placement is confirmed by a chest x-ray, and the site is inspected daily for signs of infection. The dressing and pressure monitoring system are changed according to hospital policy. In general, the dressing is kept dry and air occlusive. Dressing changes are performed using sterile technique. The frequency of CVP measurements is dictated by the patient's condition and the treatment plan. This catheter can also be used for infusing IV fluids, administering IV medications, and drawing blood specimens.

### Pulmonary Artery Pressure Monitoring

Pulmonary artery pressure monitoring is used in critical care for assessing left ventricular function, diagnosing the etiology of shock, and evaluating the patient's response to medical interventions (eg, fluid administration, vasoactive medications). A pulmonary artery catheter and a pressure monitoring system are used. A variety of catheters are available for cardiac pacing, oximetry, cardiac output measurement, or a combination of functions. Pulmonary artery catheters are balloon-tipped, flow-directed catheters that have distal and proximal lumens (Fig. 26-11). The distal lumen has a port that opens into the pulmonary artery. Once connected by its hub to the pressure monitoring system, it is used to measure continuous pulmonary artery pressures. The proximal lumen has a port that opens into the right atrium. It is used to administer IV medications and fluids or to monitor right atrial pressures (ie, CVP). Each catheter has a balloon inflation hub and valve. A syringe is connected to the hub, which is used to inflate or deflate the balloon with air (1.5-mL capacity). The valve opens and closes the balloon inflation lumen.

A pulmonary artery catheter with specialized capabilities has additional components. For example, the thermodilution catheter has three additional features that enable it to measure cardiac output: a thermistor connector attached to the cardiac output computer of the bedside monitor, a proximal injectate port used for injecting fluids when obtaining the cardiac output, and a thermistor (positioned near the distal port) (see Fig. 26-11).

The pulmonary artery catheter, covered with a sterile sleeve, is inserted into a large vein (subclavian, jugular, or femoral) through a sheath. The sheath is equipped with a side port for infusing IV fluids and medications. The

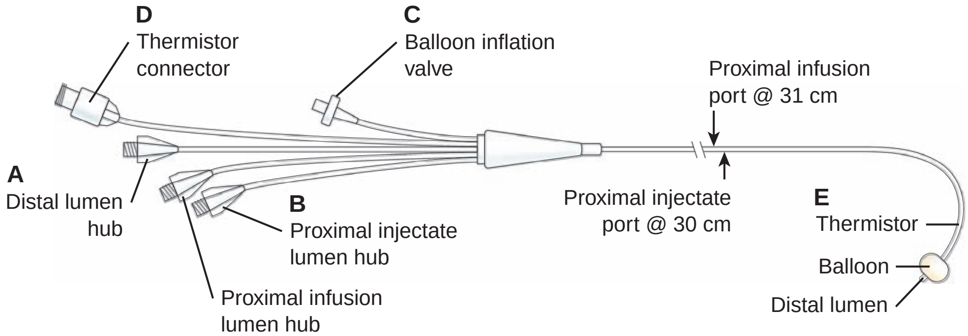



**Figure 26-11** The pulmonary artery catheter used for obtaining pressure measurements and cardiac output. **A,** The pressure monitoring system is connected to the distal lumen hub. **B,** Intravenous solutions are infused through the proximal infusion and injectate lumen hubs. **C,** An air-filled syringe connected to the balloon inflation valve is used for balloon inflation during catheter insertion and pulmonary artery wedge pressure measurements. **D,** To obtain cardiac output, the thermistor connector is inserted into the cardiac output component of the bedside cardiac monitor and 5 to 10 mL of normal saline is injected in 4 seconds into the proximal injectate port. **E,** The thermistor located near the balloon is used to calculate the cardiac output. Redrawn courtesy of Baxter Healthcare Corporation, Edwards Critical Care Division, Santa Ana, California.

catheter is then passed into the vena cava and right atrium. In the right atrium, the balloon tip is inflated, and the catheter is carried rapidly by the flow of blood through the tricuspid valve into the right ventricle, through the pulmonic valve, and into a branch of the pulmonary artery. When the catheter reaches the pulmonary artery, the balloon is deflated and the catheter is secured with sutures (Fig. 26-12). Fluoroscopy may be used during insertion to visualize the progression of the catheter through the right heart chambers to the pulmonary artery. This procedure can be performed in the operating room, in the cardiac catheterization laboratory, or at the bedside in the critical care unit. During insertion of the pulmonary artery catheter, the bedside monitor is observed for pressure and waveform changes, as well as dysrhythmias as the catheter progresses through the right heart to the pulmonary artery.

Once the catheter is in position, the following are measured: right atrial, pulmonary artery systolic, pulmonary artery diastolic, mean pulmonary artery, and pulmonary artery wedge pressures (see Fig. 26-2 for normal chamber pressures). Monitoring of the pulmonary artery diastolic and pulmonary artery wedge pressures is particularly important in critically ill patients because they are used to evaluate left ventricular filling pressures (ie, left ventricular preload).

It is important to note that the pulmonary artery wedge pressure is achieved by inflating the balloon tip, which causes it to float more distally into a smaller portion of the pulmonary artery until it is wedged into position. This is an occlusive maneuver that impedes blood flow through that segment of the pulmonary artery. Therefore, the wedge pressure is measured immediately and the balloon is deflated promptly to restore blood flow.

*NURSING ALERT*

**After measuring the pulmonary artery wedge pressure, the nurse ensures that the balloon is deflated and that the catheter has returned to its normal position. This important intervention is verified by evaluating the pulmonary artery pressure waveform displayed on the bedside monitor.**

#### Nursing Interventions

Catheter site care is essentially the same as for a CVP catheter. Similar to CVP measurement, the transducer must be positioned at the phlebostatic axis to ensure accurate readings (see Fig. 26-10). Serious complications include pulmonary artery rupture, pulmonary thromboembolism, pulmonary infarction, catheter kinking, dysrhythmias, and air embolism.

### *Intra-Arterial Blood Pressure Monitoring*

Intra-arterial BP monitoring is used to obtain direct and continuous BP measurements in critically ill patients who have severe hypertension or hypotension. Arterial catheters are also useful when arterial blood gas measurements and blood samples need to be obtained frequently.

Once an arterial site is selected, usually the radial artery, circulation to the involved extremity is assessed by the Allen test or an ultrasonic Doppler study because placing an arterial catheter can further impede perfusion to an area that has poor circulation. As a result, the tissue distal to the cannulated artery can become ischemic or necrotic. The Allen test is used to evaluate perfusion of the hand and fingers by the radial and ulnar arteries. To perform the Allen test, the hand is elevated and the patient is asked to make a fist for 30 seconds. The nurse compresses the radial and ulnar arteries simultaneously, causing the hand to blanch. After the patient opens the fist, the nurse releases the pressure on the ulnar artery. If blood flow is restored (hand turns pink) within 6 seconds, the circulation to the hand may be adequate enough to tolerate placement of a radial artery catheter. However, an ultrasonic Doppler is the most accurate method for assessing arterial perfusion of the hand.

#### Nursing Interventions

Site preparation and care are the same as for CVP catheters. The catheter flush solution is the same as for pulmonary artery catheters. A transducer is attached, and pressures are measured in mm Hg. The nurse monitors the patient for complications, which include local obstruction with distal ischemia, external hemorrhage, massive ecchymosis, dissection, air embolism, blood loss, pain, arteriospasm, and infection.

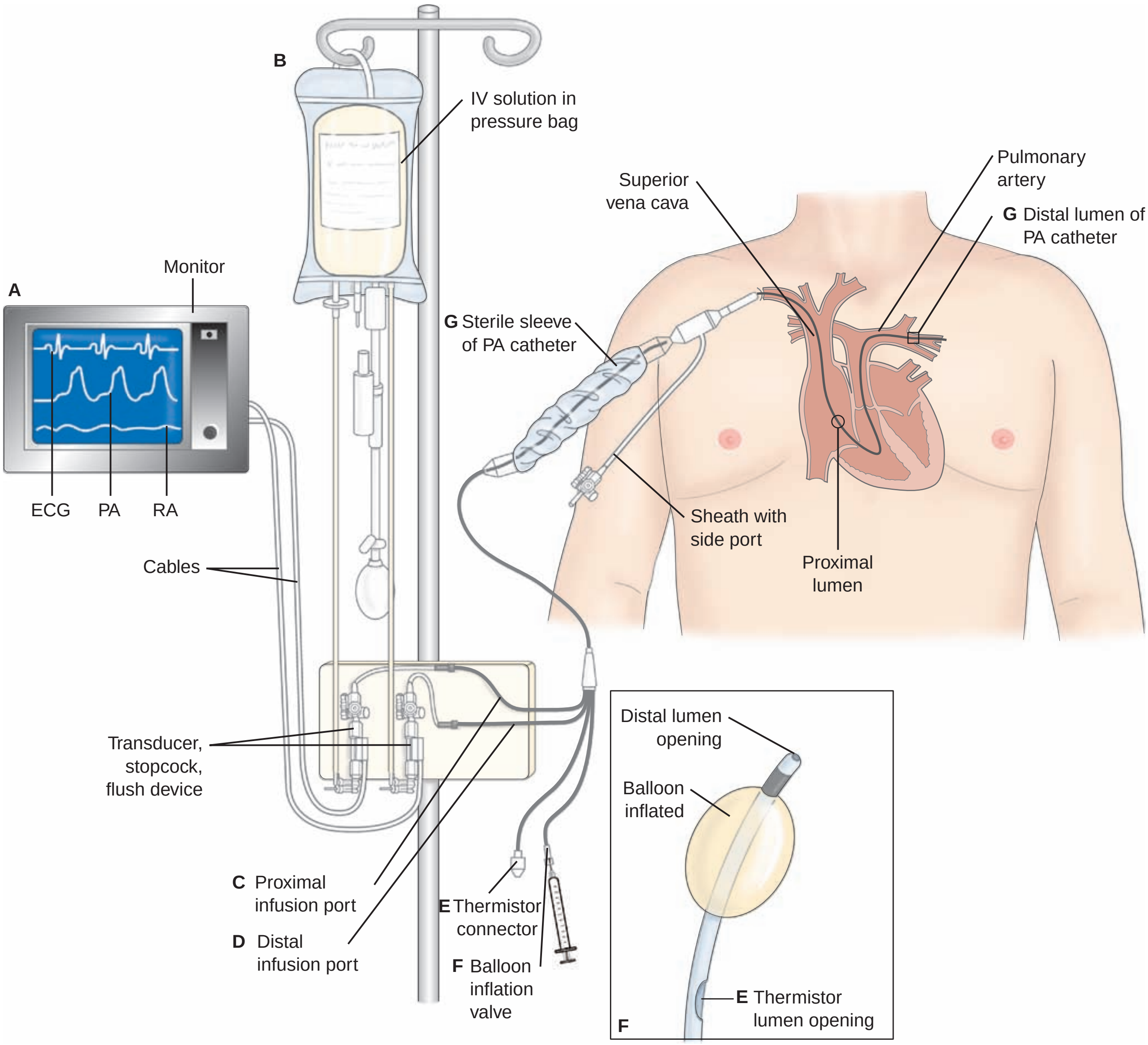



**Figure 26-12** Pulmonary artery (PA) catheter and pressure monitoring systems. **A,** Bedside monitor that connects with cables to **(B)** the pressure monitoring systems (includes intravenous [IV] solution in a pressure bag, IV tubing, and two transducers with stopcocks and flush devices). This system connects to **(C)** the proximal infusion port that opens in the right atria and is used to infuse fluids or medications and monitor central venous pressures and **(D)** the distal infusion port. This port opens in the PA and is used to monitor PA pressures. **E,** The thermistor connector is attached to the bedside cardiac monitor to obtain cardiac output. **F,** An air-filled syringe is attached to the balloon inflation valve during catheter insertion and measurement of PA wedge pressure. **G,** PA catheter positioned in the pulmonary artery. Note the sterile sleeve over the PA catheter. The PA catheter is threaded through the sheath until it reaches the desired position in the PA. The side port on the sheath is used to infuse medications or fluids. ECG, electrocardiogram; RA, right atrium.

## CRITICAL THINKING EXERCISES

**1** During change-of-shift report, the off-going nurse tells you that she heard abnormal sounds while obtaining apical pulses on an elderly female patient, who has had a long history of coronary artery disease and heart failure. She is recovering from a recent myocardial infarction and is being treated now for new-onset atrial fibrillation. Name five types of abnormal heart sounds and explain the pathophysiology of each sound. Describe the quality of these sounds and their timing in relation to the cardiac cycle. If you suspect a murmur, what six characteristics do you identify to determine the underlying cause? Given this patient's medical history, what do you think caused those abnormal heart sounds?

**2** While walking by the central monitoring station you hear an alarm. You notice that this alarm sounded several times within the last 30 minutes. The message "cannot

analyze" is flashing at the central station. Is hearing an alarm from a patient who has an order for continuous ECG monitoring a serious concern? What two common problems might be preventing the monitor from analyzing this patient's rhythm? What will you do to troubleshoot this situation?

EBP **3** Your patient was transferred today from the coronary intensive care unit after experiencing an ST-segment elevation myocardial infarction. As you are getting him settled in his room, he tells you that he had an asthma attack that was so severe he went to the emergency department. Upon further discussion, you discover that his only symptoms have been increasing episodes of shortness of breath with mild activity and more fatigue than usual. He attributes these symptoms to smoking and being out of shape. What additional information might you need to help explain why he did not experience chest symptoms during his MI? What additional questions might you ask this patient to get a better understanding of his illness perception? What is the strength of the evidence that supports the relationship between ACS symptoms and the symptoms your patient experienced? Why is it important for this patient to have a clear understanding of his diagnosis, symptoms, and health regimen prior to discharge from the hospital?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Heart Association, www.americanheart.org

New York Cardiac Center, http://nycardiaccenter.org

Medi-Smart Cardiovascular Nursing Resources http://www.medi-smart.com/cardiac.htm



chapter 27

# Management of Patients With Dysrhythmias and Conduction Problems

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Correlate the components of the normal electrocardiogram (ECG) with physiologic events of the heart.
2. Define the ECG as a waveform that represents the cardiac electrical event in relation to the lead (placement of electrodes).
3. Analyze elements of an ECG rhythm strip: ventricular and atrial rate, ventricular and atrial rhythm, QRS complex and shape, QRS duration, P wave and shape, PR interval, and P:QRS ratio.
4. Identify the ECG criteria, causes, and management of several dysrhythmias, including conduction disturbances.
5. Use the nursing process as a framework for care of patients with dysrhythmias.
6. Compare the different types of pacemakers, their uses, possible complications, and nursing implications.
7. Describe the nursing management of patients with implantable cardiac devices.
8. Describe the key points of using a defibrillator.
9. Describe the purpose of an implantable cardioverter defibrillator, the types available, and the nursing implications.
10. Describe invasive methods to diagnose and treat recurrent dysrhythmias and discuss the nursing implications.

## GLOSSARY

**ablation:** purposeful destruction of heart muscle cells, usually in an attempt to control a dysrhythmia

**antiarrhythmic medication:** a medication that suppresses or prevents a dysrhythmia

**automaticity:** ability of the cardiac cells to initiate an electrical impulse

**cardioversion:** electrical current administered in synchrony with the patient's own QRS complex to stop a dysrhythmia

**chronotropy:** rate of impulse formation

**conduction:** transmission of electrical impulses from one cell to another

**defibrillation:** electrical current administered to stop a dysrhythmia, not synchronized with the patient's QRS complex

**depolarization:** process by which cardiac muscle cells change from a more negatively charged to a more positively charged intracellular state

**dromotropy:** conduction velocity

## GLOSSARY *(Continued)*

**dysrhythmia:** disorder of the formation or conduction (or both) of the electrical impulse within the heart, altering the heart rate, heart rhythm, or both and potentially causing altered blood flow (also referred to as arrhythmia)

**elective replacement indicator (ERI):** a signal produced by a pacemaker when it is interrogated to indicate a near-depleted battery

**implantable cardioverter defibrillator (ICD):** a device implanted into the chest to treat dysrhythmias

**inhibited:** in reference to pacemakers, term used to describe the pacemaker withholding an impulse (not firing)

**inotropy:** force of myocardial contraction

**P wave:** the part of an electrocardiogram (ECG) that reflects conduction of an electrical impulse through the atrium; atrial depolarization

**paroxysmal dysrhythmia:** a dysrhythmia that has a sudden onset and/or termination and is usually of short duration

**PP interval:** the duration between the beginning of one P wave and the beginning of the next P wave; used to calculate atrial rate and rhythm

**PR interval:** the part of an ECG that reflects conduction of an electrical impulse from the sinoatrial (SA) node through the atrioventricular (AV) node

**proarrhythmic:** an agent (eg, a medication) that causes or exacerbates a dysrhythmia

**QRS complex:** the part of an ECG that reflects conduction of an electrical impulse through the ventricles; ventricular depolarization

**QT interval:** the part of an ECG that reflects the time from ventricular depolarization through repolarization

**repolarization:** process by which cardiac muscle cells return to a more negatively charged intracellular condition, their resting state

**RR interval:** the duration between the beginning of one QRS complex and the beginning of the next QRS complex; used to calculate ventricular rate and rhythm

**sensitivity:** the level that the intracardiac electrical activity must exceed in order to be sensed by a pacemaker

**sinus rhythm:** electrical activity of the heart initiated by the sinoatrial (SA) node

**ST segment:** the part of an ECG that reflects the end of the QRS complex to the beginning of the T wave

**supraventricular tachycardia (SVT):** a rhythm that originates in the conduction system above the ventricles

**T wave:** the part of an ECG that reflects repolarization of the ventricles

**TP interval:** the part of an ECG that reflects the time between the end of the T wave and the beginning of the next P wave; used to identify the isoelectric line

**triggered:** in reference to pacemakers, term used to describe the release of an impulse in response to some stimulus

**U wave:** the part of an ECG that may reflect Purkinje fiber repolarization; usually it is not seen unless a patient's serum potassium level is low

**ventricular tachycardia (VT):** a rhythm that originates in the ventricles

Without a regular rate and rhythm, the heart may not perform efficiently as a pump to circulate oxygenated blood and other life-sustaining nutrients to all of the body's tissues and organs (including the heart itself). With an irregular or erratic rhythm, the heart is considered to be dysrhythmic (sometimes called arrhythmic). This is a potentially dangerous condition.

# Dysrhythmias

**Dysrhythmias** are disorders of the formation or conduction (or both) of the electrical impulse within the heart. These disorders can cause disturbances of the heart rate, the heart rhythm, or both. Dysrhythmias may initially be evidenced by the hemodynamic effect they cause (eg, a change in conduction may change the pumping action of the heart and cause decreased blood pressure). Dysrhythmias are diagnosed by analyzing the electrocardiographic (ECG) waveform. Their treatment is based on frequency and severity of symptoms produced. Dysrhythmias are named according to the site of origin of the impulse and the mechanism of formation or conduction involved (Chart 27-1). For example, an impulse that originates in the sinoatrial (SA) node and at a slow rate is called sinus bradycardia.

## Normal Electrical Conduction

The electrical impulse that stimulates and paces the cardiac muscle normally originates in the SA node, an area located near the superior vena cava in the right atrium. Usually, the electrical impulse occurs at a rate of 60 to 100 times a minute in the adult. The electrical impulse quickly travels from the sinus node through the atria to the atrioventricular (AV) node (Fig. 27-1); this process is known as **conduction.** The electrical stimulation of the muscle cells of the atria causes them to contract. The structure of the AV node slows the electrical impulse, giving the atria time to contract and fill the ventricles with blood. This part of atrial contraction is frequently referred to as the "atrial kick" and accounts for nearly one third of the volume ejected during ventricular contraction. The electrical impulse then travels very quickly through the bundle of His to the right and left bundle branches and the Purkinje fibers, located in the ventricular muscle. The electrical stimulation of the muscle cells of the ventricles in turn causes the mechanical contraction of the ventricles (systole). The cells repolarize and the ventricles then relax (diastole). The electrical impulse causes the mechanical contraction of the heart muscle that follows.

The electrical stimulation is called **depolarization,** and the mechanical contraction is called systole. Electrical relaxation is called **repolarization,** and mechanical relaxation is called diastole. The process from sinus node electrical impulse generation through ventricular repolarization completes the electromechanical circuit, and the cycle begins again. See Chapter 26 for a more complete explanation of cardiac function.

### Influences on Heart Rate and Contractility

The heart rate is influenced by the autonomic nervous system, which consists of sympathetic and parasympathetic fibers. Sympathetic nerve fibers (also referred to as adrenergic fibers) are attached to the heart and arteries as well as several other areas in the body. Stimulation of the sympathetic system increases heart rate (positive **chronotropy**), conduction through the AV node (positive **dromotropy**), and the force of myocardial contraction (positive **inotropy**). Sympathetic stimulation also constricts peripheral blood vessels, therefore increasing blood pressure. Parasympathetic nerve fibers are also attached to the heart and arteries. Parasympathetic stimulation reduces the heart rate (negative chronotropy), AV conduction (negative dromotropy), and the force of atrial myocardial contraction. The decreased sympathetic stimulation results in dilation of arteries, thereby lowering blood pressure.

Manipulation of the autonomic nervous system may increase or decrease the incidence of dysrhythmias. Increased sympathetic stimulation (eg, caused by exercise, anxiety, fever, or administration of catecholamines, such as dopamine [Intropin], aminophylline, or dobutamine [Dobutrex]) may increase the incidence of dysrhythmias. Decreased sympathetic stimulation (eg, with rest, anxiety-reduction methods such as therapeutic communication or meditation, or administration of beta-adrenergic blocking agents) may decrease the incidence of dysrhythmias.

## The Electrocardiogram

The electrical impulse that travels through the heart can be viewed by means of electrocardiography, the end product of which is an ECG. Each phase of the cardiac cycle is reflected by specific waveforms on the screen of a cardiac monitor or on a strip of ECG graph paper.

An ECG is obtained by slightly abrading the skin with a clean dry gauze pad and placing electrodes on the body at specific areas. Electrodes come in various shapes and sizes, but they all have two components: (1) an adhesive substance that attaches to the skin to secure the electrode in place and (2) a substance that reduces the skin's electrical impedance and promotes detection of the electrical current.

The number and placement of the electrodes depend on the type of ECG needed. Most continuous monitors use two to five electrodes, usually placed on the limbs and the chest. These electrodes create an imaginary line, called a lead,

**Chart 27-1 • *Identifying Cardiac Rhythms***

**Sites of Origin**

Sinus (SA) node
Atria
Atrioventricular (AV) node or junction
Ventricles

**Mechanisms of Formation or Conduction**

Normal (idio) rhythm
Bradycardia
Tachycardia
Dysrhythmia
Flutter
Fibrillation
Premature complexes
Conduction blocks

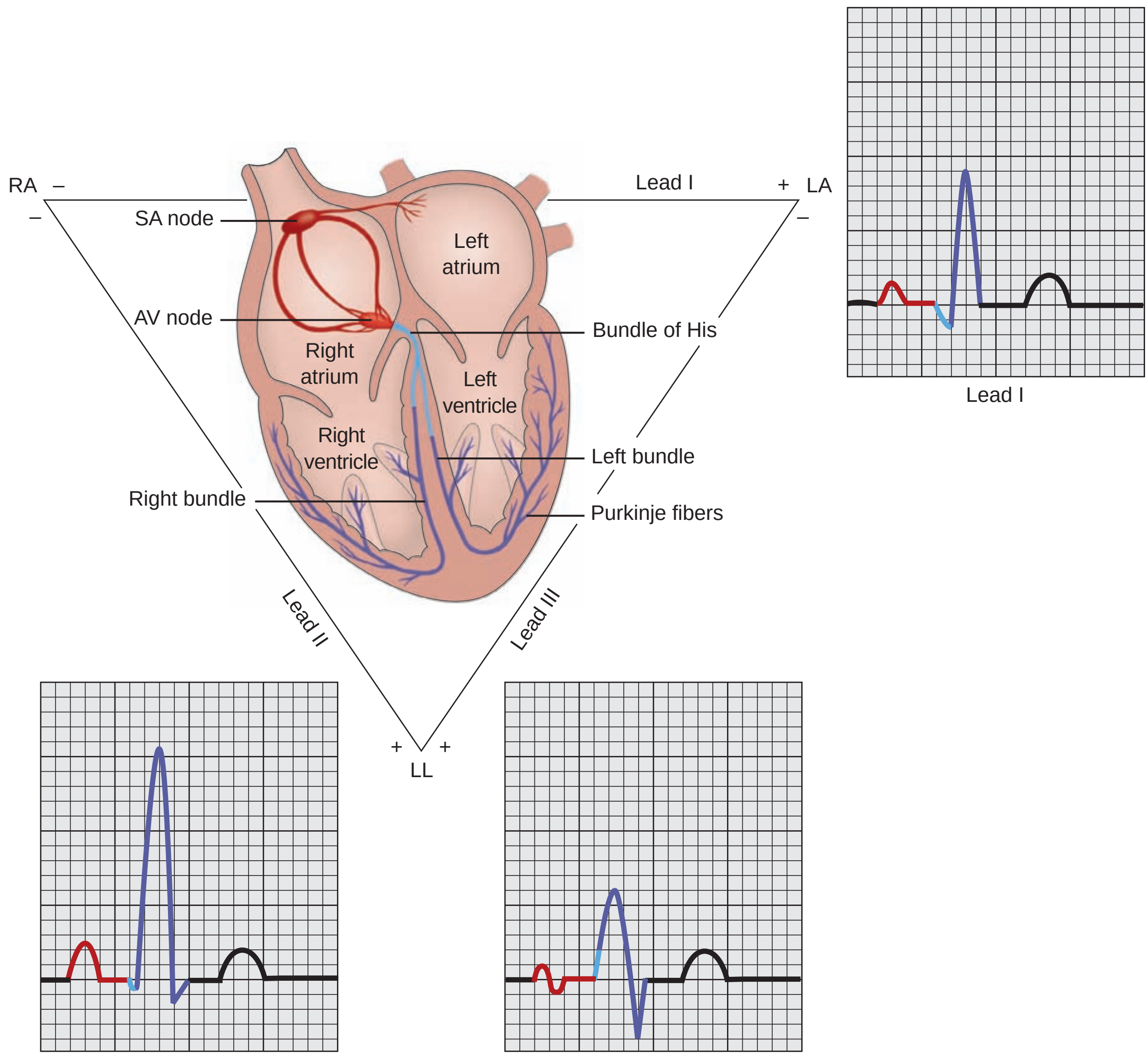



**Figure 27-1** Relationship of ECG complex, lead system, and electrical impulse. The heart conducts electrical activity, which the ECG measures and shows. The configurations of electrical activity displayed on the ECG vary depending on the lead (or view) of the ECG and on the rhythm of the heart. Therefore, the configuration of a normal rhythm tracing from lead I will differ from the configuration of a normal rhythm tracing from lead II, lead II will differ from lead III, and so on. The same is true for abnormal rhythms and cardiac disorders. To make an accurate assessment of the heart's electrical activity or to identify where, when, and what abnormalities occur, the ECG needs to be evaluated from every lead, not just from lead II. Here the different areas of electrical activity are identified by color. RA, right arm; LA, left arm; SA, sinoatrial; AV, atrioventricular; LL, left leg.

that serves as a reference point from which the electrical activity is viewed. A lead is like an eye of a camera: It has a narrow peripheral field of vision, looking only at the electrical activity directly in front of it. Therefore, the ECG waveforms that appear on the paper or cardiac monitor represent the electrical current in relation to the lead (see Fig. 27-1). A change in the waveform can be caused by a change in the electrical current (where it originates or how it is conducted) or by a change in the lead.

### Obtaining an Electrocardiogram

Electrodes are attached to cable wires, which are connected to one of the following:

- An ECG machine placed at the patient's side for an immediate recording (standard 12-lead ECG)
- A cardiac monitor at the patient's bedside for continuous reading; this kind of monitoring, usually called hardwire monitoring, is used in intensive care units
- A small box that the patient carries that continuously transmits the ECG information by radiowaves to a central monitor located elsewhere (called telemetry)
- A small, lightweight tape recorder–like machine (called ambulatory ECG monitoring or a Holter monitor) that the patient wears and that continuously records the ECG on a tape, which is later viewed and analyzed with a scanner

A patient may undergo an electrophysiology (EP) study in which electrodes are placed inside the heart in order to obtain an intracardiac ECG. This is used not only to diagnose the dysrhythmia, but also to determine the most effective

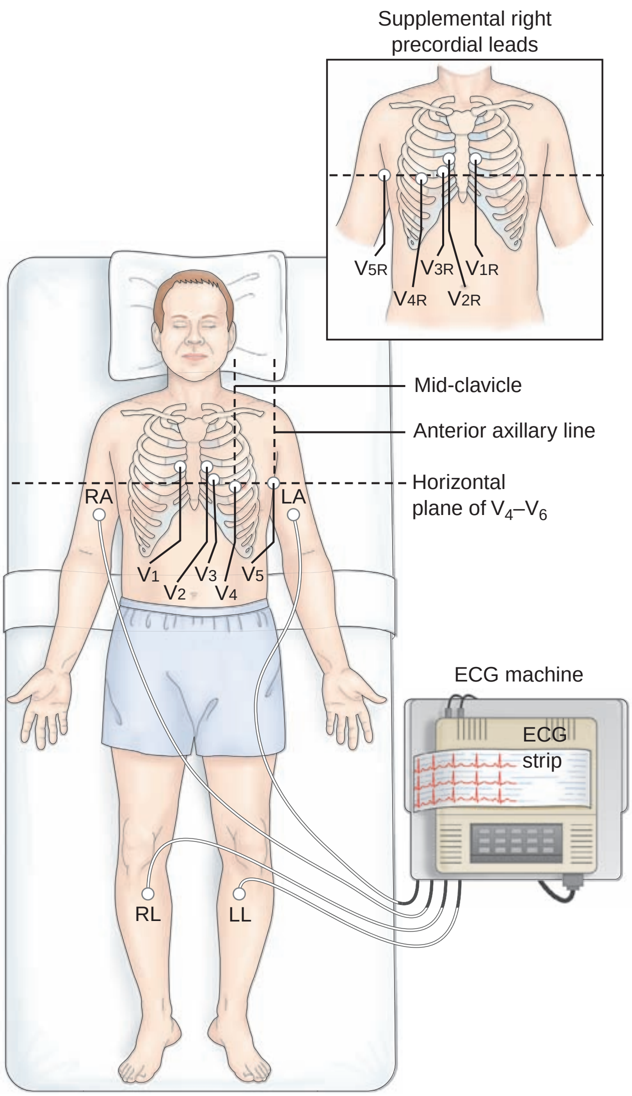



**Figure 27-2** ECG electrode placement. The standard left precordial leads are $V_1$—fourth intercostal space, right sternal border; $V_2$—fourth intercostal space, left sternal border; $V_3$—diagonally between $V_2$ and $V_4$; $V_4$—fifth intercostal space, left midclavicular line; $V_5$—same level as $V_4$, anterior axillary line; $V_6$ (not illustrated)—same level as $V_4$ and $V_5$, midaxillary line. The right precordial leads, placed across the right side of the chest, are the mirror opposite of the left leads. RA, right arm; LA, left arm; RL, right leg; LL, left leg. Adapted from Molle, E. A., Kronenberger, J., West-Stack, C., et al. (2005). *Lippincott Williams & Wilkins's pocket guide to medical assisting* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins.

treatment plan. However, because an EP study is invasive, it is performed in the hospital and may require that the patient be admitted. (A more in-depth discussion is found later in this chapter.)

The placement of electrodes for continuous monitoring, telemetry, or Holter monitoring varies with the type of technology, the purpose of monitoring, and the standards of the health care facility. For a standard 12-lead ECG, 10 electrodes (6 on the chest and 4 on the limbs) are placed on the body (Fig. 27-2). To prevent interference from the electrical activity of skeletal muscle, the limb electrodes are usually placed on areas that are not bony and that do not have significant movement. These limb electrodes provide the first six leads: leads I, II, III, aVR, aVL, and aVF. The six chest electrodes are applied to the chest at very specific areas. The chest electrodes provide the V or precordial leads, $V_1$ through $V_6$. To locate the fourth intercostal space and the placement of $V_1$, the sternal angle and then the sternal notch, which is about 1 or 2 inches below the sternal angle, are located. When the fingers are moved to the patient's immediate right, the second rib can be palpated. The second intercostal space is the indentation felt just below the second rib.

Locating the specific intercostal space is critical for correct chest electrode placement. Errors in diagnosis can occur if electrodes are incorrectly placed. Sometimes, when the patient is in the hospital and needs to be monitored closely for ECG changes, the chest electrodes are left in place to ensure the same placement for follow-up ECGs.

A standard 12-lead ECG reflects the electrical activity primarily in the left ventricle. Placement of additional electrodes for other leads may be needed to obtain more complete information. For example, in patients with suspected right-sided heart damage, right-sided precordial leads are required to evaluate the right ventricle (see Fig. 27-2).

### *Interpreting the Electrocardiogram*

The ECG waveform reflects the function of the heart's conduction system, which normally initiates and conducts the electrical activity, in relation to the lead. The ECG offers important information about the electrical activity of the heart. ECG waveforms are printed on graph paper that is divided by light and dark vertical and horizontal lines at standard intervals (Fig. 27-3). Time and rate are measured on the horizontal axis of the graph, and amplitude or voltage is measured on the vertical axis. When an ECG waveform moves toward the top of the paper, it is called a positive deflection. When it moves toward the bottom of the paper, it is called a negative deflection. When an ECG is reviewed, each waveform should be examined and compared with the others.

#### Waves, Complexes, and Intervals

The ECG is composed of waveforms (including the P wave, the QRS complex, the T wave, and possibly a U wave) and of segments and intervals (including the PR interval, the ST segment, and the QT interval) (see Fig. 27-3).

The **P wave** represents the electrical impulse starting in the sinus node and spreading through the atria. Therefore, the P wave represents atrial depolarization. It is normally 2.5 mm or less in height and 0.11 seconds or less in duration.

The **QRS complex** represents ventricular depolarization. Not all QRS complexes have all three waveforms. The Q wave is the first negative deflection after the P wave. The Q wave is normally less than 0.04 seconds in duration and less than 25% of the R-wave amplitude. The R wave is the first positive deflection after the P wave, and the S wave is the first negative deflection after the R wave. When a wave is less than 5 mm in height, small letters (q, r, s) are used; when a wave is taller than 5 mm, capital letters (Q, R, S) are used to label the waves. The QRS complex is normally less than 0.12 seconds in duration.

The **T wave** represents ventricular repolarization (when the cells regain a negative charge; also called the resting

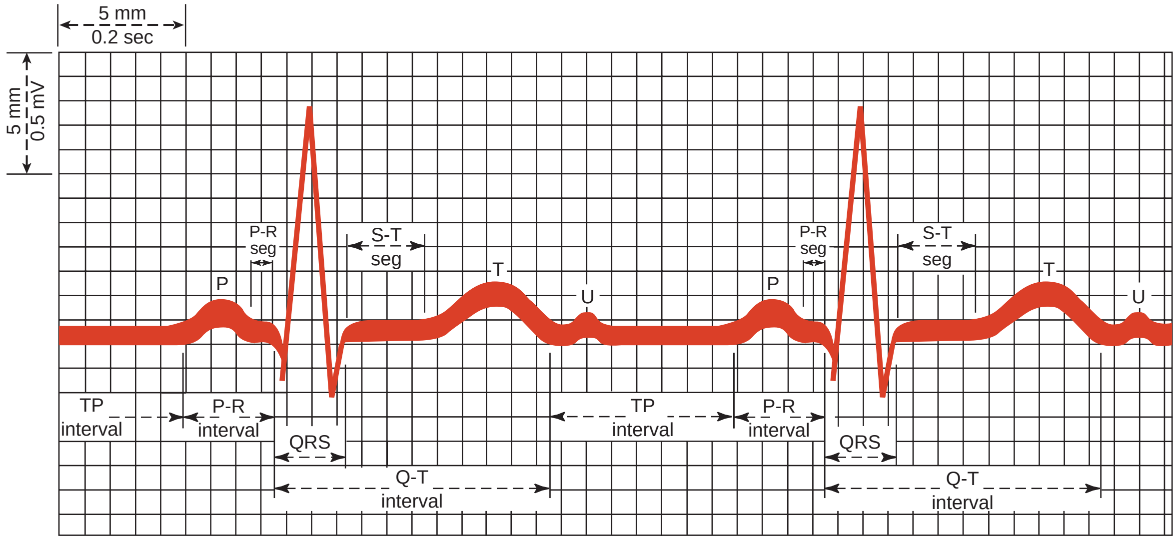



**Figure 27-3** ECG graph and commonly measured components. Each small box represents 0.04 seconds on the horizontal axis and 1 mm or 0.1 millivolt on the vertical axis. The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex; the QRS complex is measured from the beginning of the Q wave to the end of the S wave; the QT interval is measured from the beginning of the Q wave to the end of the T wave; and the TP interval is measured from the end of the T wave to the beginning of the next P wave.

state). It follows the QRS complex and is usually the same direction as the QRS complex. Atrial repolarization also occurs but is not visible on the ECG because it occurs at the same time as the QRS.

The **U wave** is thought to represent repolarization of the Purkinje fibers, but it sometimes is seen in patients with hypokalemia (low potassium levels), hypertension, or heart disease. If present, the U wave follows the T wave and is usually smaller than the P wave. If tall, it may be mistaken for an extra P wave.

The **PR interval** is measured from the beginning of the P wave to the beginning of the QRS complex and represents the time needed for sinus node stimulation, atrial depolarization, and conduction through the AV node before ventricular depolarization. In adults, the PR interval normally ranges from 0.12 to 0.20 seconds in duration.

The **ST segment,** which represents early ventricular repolarization, lasts from the end of the QRS complex to the beginning of the T wave. The beginning of the ST segment is usually identified by a change in the thickness or angle of the terminal portion of the QRS complex. The end of the ST segment may be more difficult to identify because it merges into the T wave. The ST segment is normally isoelectric (see discussion of TP interval). It is analyzed to identify whether it is above or below the isoelectric line, which may be, among other signs and symptoms, a sign of cardiac ischemia (see Chapter 28).

The **QT interval,** which represents the total time for ventricular depolarization and repolarization, is measured from the beginning of the QRS complex to the end of the T wave. The QT interval varies with heart rate, gender, and age, and the measured interval needs to be corrected for these variables through specific calculations. Several ECG interpretation books contain charts for these calculations. The QT interval is usually 0.32 to 0.40 seconds in duration if the heart rate is 65 to 95 bpm (beats per minute). If the QT interval becomes prolonged, the patient may be at risk for a lethal ventricular dysrhythmia called torsades de pointes.

The **TP interval** is measured from the end of the T wave to the beginning of the next P wave, an isoelectric period (see Fig. 27-3). When no electrical activity is detected, the line on the graph remains flat; this is called the isoelectric line. The ST segment is compared with the TP interval to detect changes from the line on the graph during the isoelectric period.

The **PP interval** is measured from the beginning of one P wave to the beginning of the next. The PP interval is used to determine atrial rhythm and atrial rate. The **RR interval** is measured from one QRS complex to the next QRS complex. The RR interval is used to determine ventricular rate and rhythm (Fig. 27-4).

### Determining Heart Rate From the Electrocardiogram

Heart rate can be obtained from the ECG strip by several methods. A 1-minute strip contains 300 large boxes and 1500 small boxes. Therefore, an easy and accurate method of determining heart rate with a regular rhythm is to count the number of small boxes within an RR interval and divide 1500 by that number. If, for example, there are 10 small boxes between two R waves, the heart rate is 1500/10, or 150; if there are 25 small boxes, the heart rate is 1500/25, or 60 (see Fig. 27-4A).

An alternative but less accurate method for estimating heart rate, which is usually used when the rhythm is irregular, is to count the number of RR intervals in 6 seconds and multiply that number by 10. The top of the ECG paper is usually marked at 3-second intervals, which is 15 large boxes horizontally (see Fig. 27-4B). The RR intervals are counted, rather than QRS complexes, because a computed heart rate based on the latter might be inaccurately high.

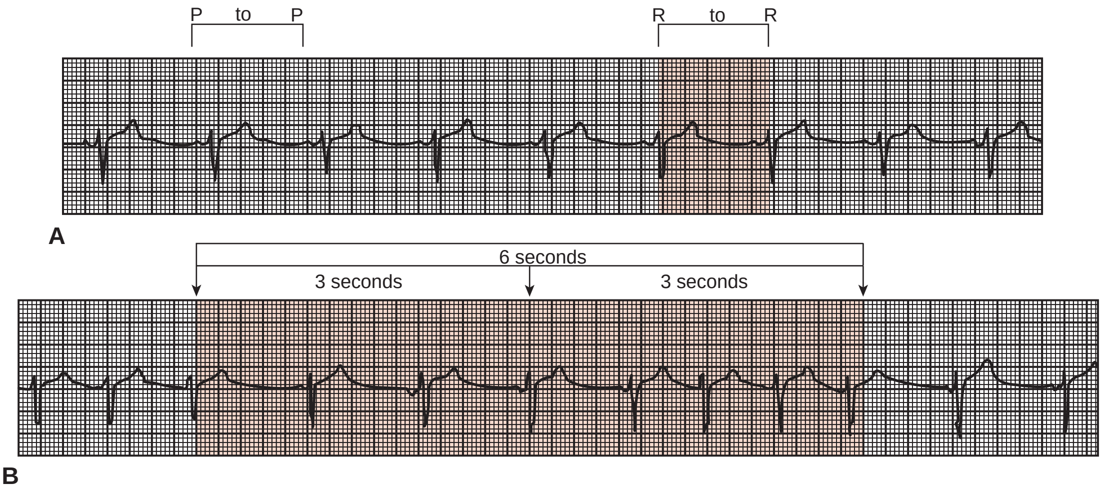



**Figure 27-4** **A,** Ventricular and atrial heart rate determination with a regular rhythm: 1500 divided by the number of small boxes between two P waves (atrial rate) or between two R waves (ventricular rate). In this example, there are 25 small boxes between both the R waves and the P waves, so the heart rate is 60 beats per minute. **B,** Heart rate determination if the rhythm is irregular. There are approximately seven RR intervals in 6 seconds, so there are about 70 RR intervals in 60 seconds ($7 \times 10 = 70$). The ventricular heart rate is 70 beats per minute.

The same methods may be used for determining atrial rate, using the PP interval instead of the RR interval.

**Determining Heart Rhythm From the Electrocardiogram**

The rhythm is often identified at the same time the rate is determined. The RR interval is used to determine ventricular rhythm and the PP interval is used to determine atrial rhythm. If the intervals are the same or if the difference between the intervals is less than 0.8 seconds throughout the strip, the rhythm is called regular. If the intervals are different, the rhythm is called irregular.

## Analyzing the Electrocardiogram Rhythm Strip

The ECG must be analyzed in a systematic manner to determine the patient's cardiac rhythm and to detect dysrhythmias and conduction disorders, as well as evidence of myocardial ischemia, injury, and infarction. Chart 27-2 is an example of a method that can be used to analyze the patient's rhythm.

Once the rhythm has been analyzed, the findings are compared with and matched to the ECG criteria for dysrhythmias to determine a diagnosis. It is important for the nurse to assess the patient to determine the physiologic effect of the dysrhythmia and to identify possible causes. Treatment of a dysrhythmia is based on clinical evaluation of the patient with identification of the dysrhythmia's etiology and effect, not on its presence alone.

### *Normal Sinus Rhythm*

Normal **sinus rhythm** occurs when the electrical impulse starts at a regular rate and rhythm in the sinus node and travels through the normal conduction pathway. Normal sinus rhythm has the following characteristics (Fig. 27-5):

*Ventricular and atrial rate:* 60 to 100 in the adult
*Ventricular and atrial rhythm:* Regular
*QRS shape and duration:* Usually normal, but may be regularly abnormal
*P wave:* Normal and consistent shape; always in front of the QRS
*PR interval:* Consistent interval between 0.12 and 0.20 seconds
*P:QRS ratio:* 1:1

### *Types of Dysrhythmias*

Dysrhythmias include sinus, atrial, junctional, and ventricular dysrhythmias and their various subcategories.

**Sinus Node Dysrhythmias**

***Sinus Bradycardia.*** Sinus bradycardia occurs when the sinus node creates an impulse at a slower-than-normal rate.

**Chart 27-2 • *Interpreting Dysrhythmias: Systematic Analysis of the Electrocardiogram***

When examining an ECG rhythm strip to learn more about a patient's dysrhythmia:

1. Determine the ventricular rate.
2. Determine the ventricular rhythm.
3. Determine QRS duration.
4. Determine whether the QRS duration is consistent throughout the strip. If not, identify other duration.
5. Identify QRS shape; if not consistent, then identify other shapes.
6. Identify P waves; is there a P in front of every QRS?
7. Identify P-wave shape; identify whether it is consistent or not.
8. Determine the atrial rate.
9. Determine the atrial rhythm.
10. Determine each PR interval.
11. Determine if the PR intervals are consistent, irregular but with a pattern to the irregularity, or just irregular.
12. Determine how many P waves for each QRS (P:QRS ratio).

In many cases, the nurse may use a checklist and document the findings next to the appropriate ECG criterion.

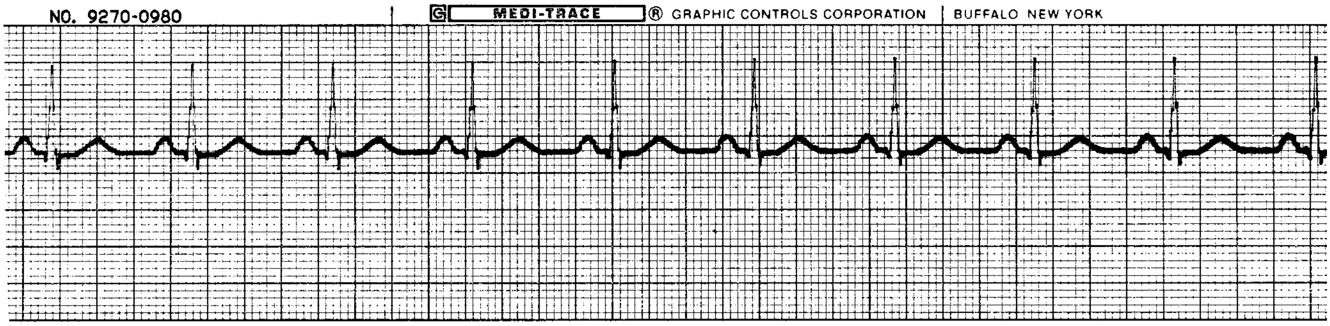



**Figure 27-5** Normal sinus rhythm in lead II.

Causes include lower metabolic needs (eg, sleep, athletic training, hypothyroidism), vagal stimulation (eg, from vomiting, suctioning, severe pain, extreme emotions), medications (eg, calcium channel blockers, amiodarone, beta-blockers), idiopathic sinus node dysfunction, increased intracranial pressure (ICP), and myocardial infarction (MI), especially of the inferior wall. Other possible contributing factors in clinically significant bradycardia include what are referred to as the H's and the T's: hypovolemia, hypoxia, hydrogen ion (acidosis), hypokalemia or hyperkalemia, hypoglycemia, and hypothermia; toxins, tamponade (cardiac), tension pneumothorax, thrombosis (coronary or pulmonary), and trauma (hypovolemia, increased ICP) (American Heart Association [AHA], 2005). Sinus bradycardia has the following characteristics (Fig. 27-6):

*Ventricular and atrial rate:* Less than 60 in the adult
*Ventricular and atrial rhythm:* Regular
*QRS shape and duration:* Usually normal, but may be regularly abnormal
*P wave:* Normal and consistent shape; always in front of the QRS
*PR interval:* Consistent interval between 0.12 and 0.20 seconds
*P:QRS ratio:* 1:1

All characteristics of sinus bradycardia are the same as those of normal sinus rhythm, except for the rate. The patient is assessed to determine the hemodynamic effect and the possible cause of the dysrhythmia. If the decrease in heart rate results from stimulation of the vagus nerve, such as with bearing down during defecation or vomiting, attempts are made to prevent further vagal stimulation. If the bradycardia is caused by a medication such as a beta-blocker, the medication may be withheld. If the slow heart rate causes significant hemodynamic changes resulting in shortness of breath, acute alteration of mental status, angina, hypotension, ST-segment changes, or premature ventricular complexes, treatment is directed toward increasing the heart rate. If the slow heart rate is due to sinus node dysfunction, which most often occurs in people older than 50 years of age, decreased exercise capacity, fatigue, unexplained confusion, or memory loss may result (Fuster, Walsh & O'Rourke, 2008).

Atropine, 0.5 mg given rapidly as an intravenous (IV) bolus every 3 to 5 minutes to a maximum total dose of 3 mg, is the medication of choice in treating symptomatic sinus bradycardia. It blocks vagal stimulation, thus allowing a normal rate to occur. Rarely, catecholamines and emergency transcutaneous pacing also are implemented.

***Sinus Tachycardia.*** Sinus tachycardia occurs when the sinus node creates an impulse at a faster-than-normal rate. Causes may include the following:

- Physiologic or psychological stress (eg, acute blood loss, anemia, shock, hypervolemia, hypovolemia, heart failure, pain, hypermetabolic states, fever, exercise, anxiety)
- Medications that stimulate the sympathetic response (eg, catecholamines, aminophylline, atropine), stimulants (eg, caffeine, alcohol, nicotine), and illicit drugs (eg, amphetamines, cocaine, Ecstasy)
- Enhanced automaticity of the SA node and/or excessive sympathetic tone with reduced parasympathetic tone, a condition called inappropriate sinus tachycardia (Blomström-Lundqvist, Scheinman, Aliot, et al., 2003)

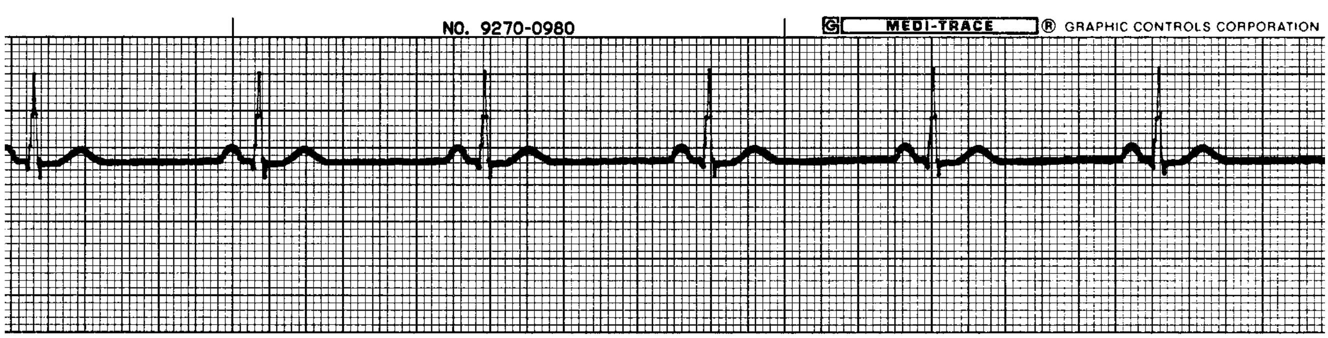



**Figure 27-6** Sinus bradycardia in lead II.

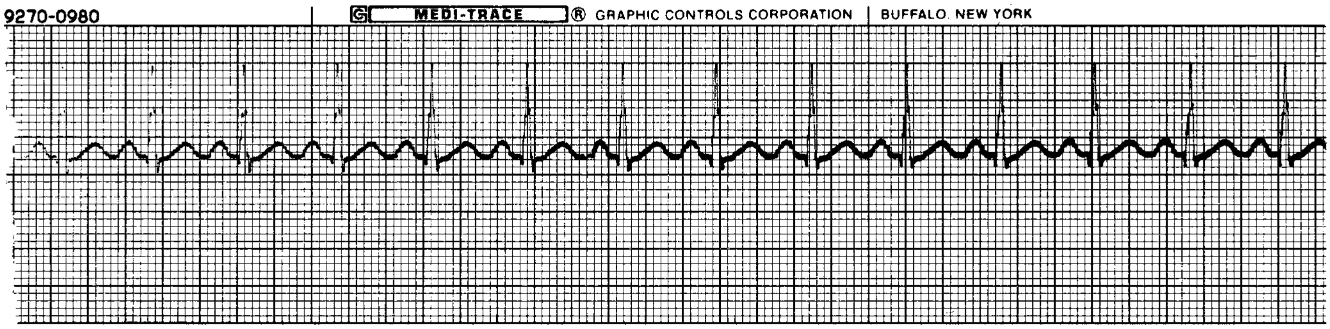



**Figure 27-7** Sinus tachycardia in lead II.

- Autonomic dysfunction, which results in a type of sinus tachycardia called postural orthostatic tachycardia syndrome (POTS). Patients with POTS have tachycardia without hypotension within 5 to 10 minutes of standing or with head-upright tilt testing.

Sinus tachycardia has the following characteristics (Fig. 27-7):

*Ventricular and atrial rate:* Greater than 100 in the adult, but usually less than 120
*Ventricular and atrial rhythm:* Regular
*QRS shape and duration:* Usually normal, but may be regularly abnormal
*P wave:* Normal and consistent shape; always in front of the QRS, but may be buried in the preceding T wave
*PR interval:* Consistent interval between 0.12 and 0.20 seconds
*P:QRS ratio:* 1:1

All aspects of sinus tachycardia are the same as those of normal sinus rhythm, except for the rate. Sinus tachycardia does not start or end suddenly (nonparoxysmal). As the heart rate increases, the diastolic filling time decreases, possibly resulting in reduced cardiac output and subsequent symptoms of syncope and low blood pressure. If the rapid rate persists and the heart cannot compensate for the decreased ventricular filling, the patient may develop acute pulmonary edema.

Treatment of sinus tachycardia is usually determined by the severity of symptoms and directed at identifying and abolishing its cause. Beta-blockers and calcium channel blockers (Table 27-1), although rarely used, may be administered to reduce the heart rate quickly. Catheter ablation (discussed later in this chapter) of the SA node may be used in cases of persistent inappropriate sinus tachycardia unresponsive to other treatments. Treatment for POTS may include increased fluid and sodium intake and use of anti-embolism stockings to prevent pooling of blood in the lower extremities.

***Sinus Arrhythmia.*** Sinus arrhythmia occurs when the sinus node creates an impulse at an irregular rhythm; the rate usually increases with inspiration and decreases with expiration. Nonrespiratory causes include heart disease and valvular disease, but these are rare. Sinus arrhythmia has the following characteristics (Fig. 27-8):

*Ventricular and atrial rate:* 60 to 100 in the adult
*Ventricular and atrial rhythm:* Irregular
*QRS shape and duration:* Usually normal, but may be regularly abnormal
*P wave:* Normal and consistent shape; always in front of the QRS
*PR interval:* Consistent interval between 0.12 and 0.20 seconds
*P:QRS ratio:* 1:1

Sinus arrhythmia does not cause any significant hemodynamic effect and usually is not treated.

### Atrial Dysrhythmias

***Premature Atrial Complex.*** A premature atrial complex (PAC) is a single ECG complex that occurs when an electrical impulse starts in the atrium before the next normal impulse of the sinus node. The PAC may be caused by caffeine, alcohol, nicotine, stretched atrial myocardium (eg, as in hypervolemia), anxiety, hypokalemia (low potassium level), hypermetabolic states (eg, with pregnancy), or atrial ischemia, injury, or infarction. PACs are often seen with sinus tachycardia. PACs have the following characteristics (Fig. 27-9):

*Ventricular and atrial rate:* Depends on the underlying rhythm (eg, sinus tachycardia)
*Ventricular and atrial rhythm:* Irregular due to early P waves, creating a PP interval that is shorter than the others. This is sometimes followed by a longer-than-normal PP interval, but one that is less than twice the normal PP interval. This type of interval is called a noncompensatory pause.
*QRS shape and duration:* The QRS that follows the early P wave is usually normal, but it may be abnormal (aberrantly conducted PAC). It may even be absent (blocked PAC).
*P wave:* An early and different P wave may be seen or may be hidden in the T wave; other P waves in the strip are consistent.
*PR interval:* The early P wave has a shorter-than-normal PR interval, but still between 0.12 and 0.20 seconds.
*P:QRS ratio:* usually 1:1

PACs are common in normal hearts. The patient may say, "My heart skipped a beat." A pulse deficit (a difference between the apical and radial pulse rate) may exist.

If PACs are infrequent, no treatment is necessary. If they are frequent (more than six per minute), this may herald a worsening disease state or the onset of more serious dysrhythmias, such as atrial fibrillation. Treatment is directed toward the cause.

***Atrial Flutter.*** Atrial flutter occurs because of a conduction defect in the atrium and causes a rapid, regular atrial rate, usually between 250 and 400 times per minute. Because the

**Table 27-1 SUMMARY OF ANTIARRHYTHMIC MEDICATIONS**

| Class[*] | Action | Drug Names | Side Effects | Nursing Interventions |
|---|---|---|---|---|
| IA | Moderate depression of depolarization; prolongs repolarization<br>Treats and prevents atrial and ventricular dysrhythmias | quinidine (Quinaglute, Quinidex, Cardioquin)<br>procainamide (Pronestyl, Procan SR)<br>disopyramide (Norpace) | Decreased cardiac contractility<br>Prolonged QRS, QT<br>Proarrhythmic<br>Hypotension with IV administration<br>Diarrhea with quinidine, constipation with disopyramide<br>Cinchonism with quinidine<br>Lupus-like syndrome with procainamide<br>Anticholinergic effects: dry mouth, urinary hesitancy with disopyramide | Observe for HF<br>Monitor BP with IV administration<br>Monitor QRS duration for increase >50% from baseline<br>Monitor for prolonged QT<br>Monitor *N*-acetyl procainamide (NAPA) laboratory values during procainamide therapy<br>If administered for atrial fibrillation, ensure patient has been pretreated with a medication to control AV conduction |
| IB | Minimal depression of depolarization; shortened repolarization<br>Treats ventricular dysrhythmias | lidocaine (Xylocaine)<br>mexiletine (Mexitil)<br>tocainide (Tonocard) | CNS changes (eg, confusion, lethargy)<br>Bradycardia<br>GI distress<br>Tremors | Monitor for CNS changes and tremors<br>Discuss with physician decreasing lidocaine dose in elderly patients and patients with cardiac/liver dysfunction |
| IC | Marked depression of depolarization; little effect on repolarization<br>Treats atrial and ventricular dysrhythmias | flecainide (Tambocor)<br>propafenone (Rythmol) | Proarrhythmic<br>HF<br>Dizziness, visual disturbances, dyspnea | Decreased dose with renal dysfunction, and strict vegetarian diets<br>Avoid use in patients with structural heart disease (eg, coronary artery disease and heart failure) |
| II | Decreases automaticity and conduction<br>Treats atrial and ventricular dysrhythmias | acebutolol (Sectrol)[†]<br>atenolol (Tenormin)<br>bisoprolol/HCTZ (Ziac, Zebeta)<br>esmolol (Brevibloc)[†]<br>labetalol (Trandate)<br>metoprolol (Lopressor, Toprol-XL)<br>nadolol (Corgard)<br>nebivolol (Bystolic)<br>propranolol (Inderal)[†]<br>sotalol (Betapace; Sorine; also has class III actions)[†] | Bradycardia, AV block<br>Decreased contractility<br>Bronchospasm<br>Nausea<br>Asymptomatic and symptomatic hypotension<br>Masks hypoglycemia and thyrotoxicosis<br>CNS disturbances (eg, confusion, dizziness, fatigue, depression) | Monitor heart rate, PR interval, signs and symptoms of HF, especially in those also taking calcium channel blockers<br>Monitor blood glucose level in patients with type 2 diabetes mellitus<br>Caution the patient about abrupt withdrawal to avoid tachycardia, hypertension, and myocardial ischemia |
| III | Prolongs repolarization<br>Amiodarone treats and prevents ventricular and atrial dysrhythmias, especially in patients with ventricular dysfunction<br>Dofetilide and ibutilide treat and prevent atrial dysrhythmias | amiodarone (Cordarone)<br>dofetilide (Tikosyn)<br>ibutilide (Corvert) | Pulmonary toxicity (amiodarone)<br>Corneal microdeposits (amiodarone)<br>Photosensitivity (amiodarone)<br>Bradycardia<br>Hypotension, especially with IV administration<br>Polymorphic ventricular dysrhythmias (rare with amiodarone)<br>Nausea and vomiting<br>Potentiates digoxin (amiodarone)<br>See beta-blockers (sotalol) | Make sure patient is sent for baseline pulmonary function tests (amiodarone)<br>Closely monitor patient<br>Assess for contraindications prior to administration<br>Monitor QT duration<br>Continuous ECG monitoring with initiation of dofetilide and ibutilide |
| IV | Blocks calcium channel<br>Treats and prevents paroxysmal atrial dysrhythmias[‡] | verapamil (Calan, Isoptin)<br>diltiazem (Cardizem, Dilacor, Tiazac, Diltia, Cartia) | Bradycardia, AV blocks<br>Hypotension with IV administration<br>HF, peripheral edema<br>Constipation, dizziness, headache, nausea | Monitor heart rate, PR interval<br>Monitor blood pressure closely with IV administration<br>Monitor for signs and symptoms of HF<br>Do not crush sustained-release medications |

[*]Based on Vaughn-Williams classification.
[†]Beta-blocker with labeled use for dysrhythmias.
[‡]There are other calcium channel blockers, but they are not approved or used for dysrhythmias.
AV, atrioventricular; BP, blood pressure; CNS, central nervous system; GI, gastrointestinal; HCTZ, hydrochlorothiazide; HF, heart failure; IV, intravenous.

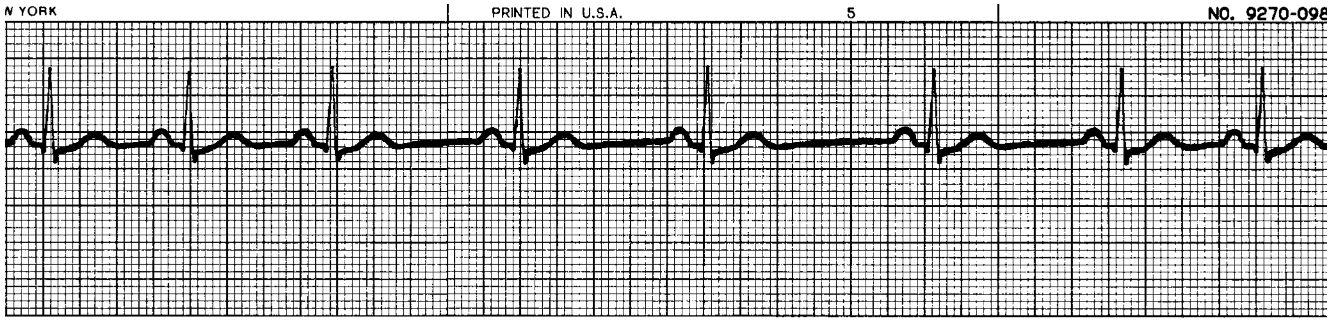



**Figure 27-8** Sinus arrhythmia in lead II. Note irregular RR and PP intervals.

atrial rate is faster than the AV node can conduct, not all atrial impulses are conducted into the ventricle, causing a therapeutic block at the AV node. This is an important feature of this dysrhythmia. If all atrial impulses were conducted to the ventricle, the ventricular rate would also be 250 to 400, which could result in ventricular fibrillation, a life-threatening dysrhythmia. Atrial flutter often occurs in patients with chronic obstructive pulmonary disease, valvular disease, and thyrotoxicosis, as well as following open heart surgery and repair of congenital cardiac defects (Fuster, et al., 2008).

Atrial flutter has the following characteristics (Fig. 27-10):

*Ventricular and atrial rate:* Atrial rate ranges between 250 and 400; ventricular rate usually ranges between 75 and 150

*Ventricular and atrial rhythm:* The atrial rhythm is regular; the ventricular rhythm is usually regular but may be irregular because of a change in the AV conduction

*QRS shape and duration:* Usually normal, but may be abnormal or may be absent

*P wave:* Saw-toothed shape; these waves are referred to as F waves

*PR interval:* Multiple F waves may make it difficult to determine the PR interval

*P:QRS ratio:* 2:1, 3:1, or 4:1

Vagal maneuvers or administration of adenosine (Adenocard, Adenoscan), which causes sympathetic block and slowing of conduction in the AV node, may allow better visualization of flutter waves. Adenosine should be rapidly administered intravenously, followed by a 20-mL saline flush and elevation of the arm with the IV line to promote rapid circulation of the medication.

Atrial flutter can cause serious signs and symptoms, such as chest pain, shortness of breath, and low blood pressure. Electrical cardioversion (discussed later) is often successful in converting the rhythm to sinus rhythm. If the dysrhythmia has lasted longer than 48 hours and a transesophageal echocardiogram has not confirmed the absence of atrial clots, then adequate anticoagulation, using the same criteria as for atrial fibrillation, may be indicated before cardioversion or ablation. Medications used to slow the ventricular response rate include beta-blockers, nondihydropyridine calcium channel blockers, and digitalis, alone or in combination (Fuster, et al., 2008) (see Table 27-1). Catheter ablation rather than antiarrhythmicmedications is now the long-term treatment of choice.

***Atrial Fibrillation.*** Atrial fibrillation is an uncoordinated atrial electrical activation that causes a rapid, disorganized, and uncoordinated twitching of atrial musculature. The ventricular rate response is dependent on the ability of the AV node to conduct the atrial impulses, the level of sympathetic and parasympathetic tone, presence of accessory

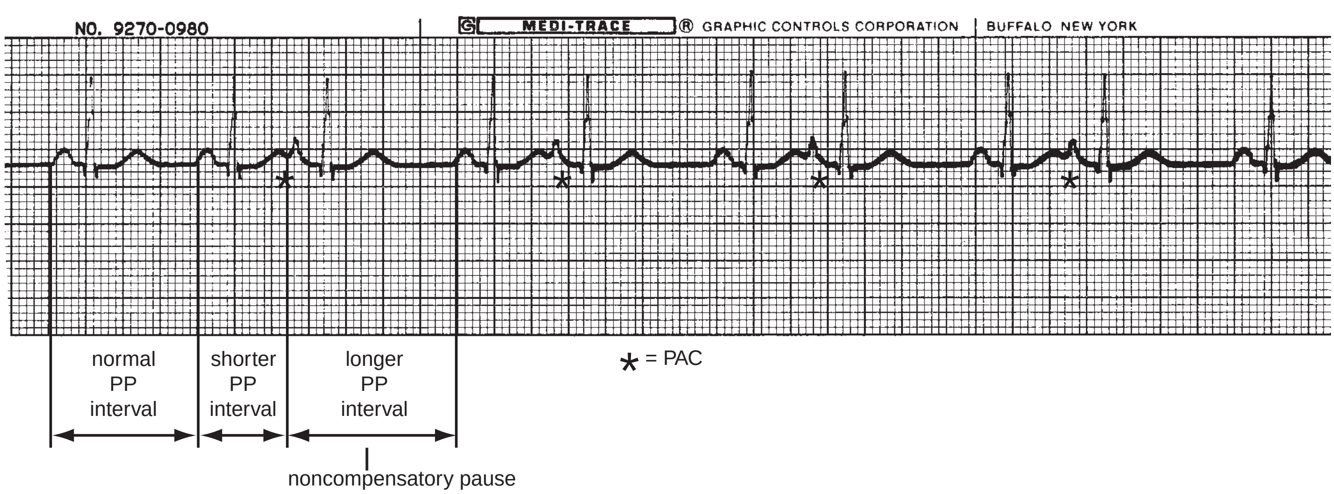



**Figure 27-9** Premature atrial complexes (PACs) in lead II. Note that the pause following the PAC is longer than the normal PP interval but shorter than twice the normal PP interval.

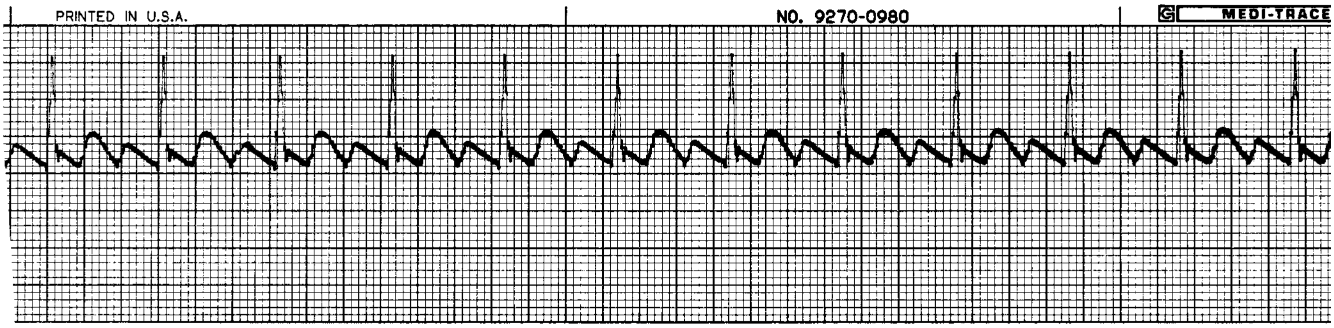



**Figure 27-10** Atrial flutter in lead II.

pathways, and effects of any medications (Fuster, Ryden, Cannom, et al., 2006). For example, regular RR intervals in atrial fibrillation may indicate the presence of complete AV block, junctional tachycardia, or ventricular tachycardia. Atrial fibrillation may be transient, starting and stopping suddenly and occurring for a very short time (**paroxysmal dysrhythmia**), or it may be persistent, requiring treatment to terminate the rhythm or to control the ventricular rate. The lack of consistency in describing the pattern of atrial fibrillation has led to use of numerous labels (eg, acute, chronic, paroxysmal, persistent, permanent) and difficulty in comparative assessment of treatments (Fuster, et al., 2006).

Atrial fibrillation usually occurs in people of advanced age with structural heart disease, such as valvular heart disease (most often mitral or tricuspid), inflammatory or infiltrative disease (pericarditis, myocarditis, amyloidosis), coronary artery disease, hypertension, congenital disorder (especially atrial septal defect), and heart failure (diastolic or systolic) (Fuster, et al., 2008). The dysrhythmia also may be found in people with diabetes, obesity, hyperthyroidism, pheochromocytoma, pulmonary hypertension and embolism, obstructive sleep apnea, and acute moderate to heavy ingestion of alcohol ("holiday heart" syndrome), as well as following pulmonary or open heart surgery (Fuster, et al., 2006; Mehra, Benjamin, Shahar, et al., 2006). Atrial fibrillation has been linked to increased risk of stroke and premature death, and it is considered a growing health problem in developed countries (Fuster, et al., 2008). Neurogenic atrial fibrillation that occurs with subarachnoid hemorrhage and nonhemorrhagic stroke is caused by increased vagal or sympathetic stimulation. Sometimes atrial fibrillation occurs in people with no underlying pathophysiology (called lone atrial fibrillation).

Occurrence of atrial fibrillation after coronary artery bypass, valvular replacements, and heart transplantation may prolong the duration and cost of the hospitalization (Fuster, et al., 2008). Hospital admissions for atrial fibrillation increased by 66% over the past 20 years, and occurrence of the dysrhythmia increases the length and cost of the hospital stay (Fuster, et al., 2006).

Atrial fibrillation has the following characteristics (Fig. 27-11):

*Ventricular and atrial rate:* Atrial rate is 300 to 600; ventricular rate is usually 120 to 200 in untreated atrial fibrillation

*Ventricular and atrial rhythm:* Highly irregular

*QRS shape and duration:* Usually normal, but may be abnormal

*P wave:* No discernible P waves; irregular undulating waves that vary in amplitude and shape are seen and are referred to as fibrillatory or f waves

*PR interval:* Cannot be measured

*P:QRS ratio:* Many:1

A rapid and irregular ventricular response reduces the time for ventricular filling, resulting in a smaller stroke volume. Because atrial fibrillation causes a loss in AV synchrony (the atria and ventricles contract at different times), the atrial kick (the last part of diastole and ventricular filling, which accounts for 25% to 30% of the cardiac output) is also lost. This may lead to irregular palpitations and symptoms of heart failure such as shortness of breath, fatigue, exercise intolerance, and malaise. Patients may be asymptomatic or experience significant hemodynamic collapse (hypotension,

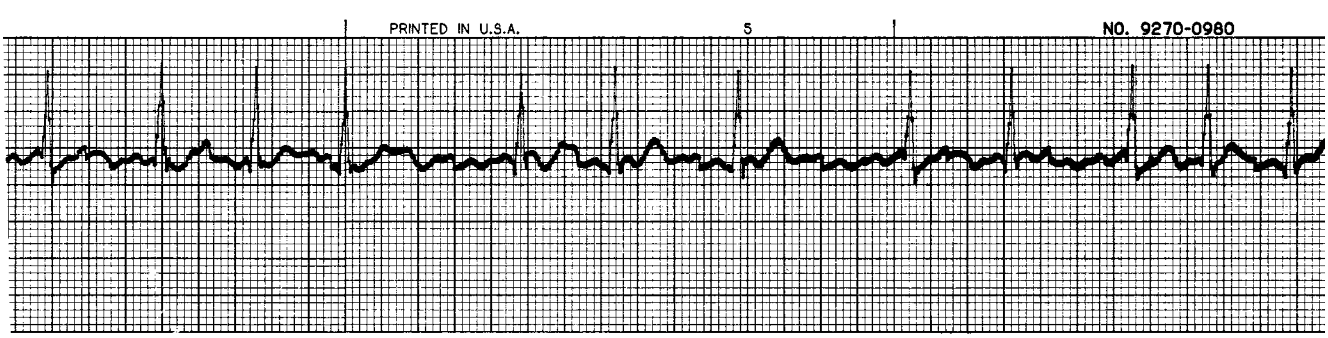



**Figure 27-11** Atrial fibrillation in lead II.

chest pain, pulmonary edema, and altered level of consciousness), especially if they also have hypertension, mitral stenosis, hypertrophic cardiomyopathy, or some form of restrictive heart failure. There is usually a pulse deficit, a numeric difference between apical and radial pulse rates. The shorter time in diastole reduces the time available for coronary artery perfusion, thereby increasing the risk of myocardial ischemia with the onset of chest discomfort. The erratic atrial contraction and the atrial myocardial dysfunction promote the formation of thrombi, especially within the atria, increasing the risk of an embolic event.

In addition, a high ventricular rate response during atrial fibrillation can lead to dilated ventricular cardiomyopathy. The rapid ventricular rate can also lead to mitral valve dysfunction, mitral regurgitation, and intraventricular conduction delay. Controlling the ventricular rate may prevent and correct these effects.

The clinical evaluation of atrial fibrillation should include a history and physical examination (to identify pattern of atrial fibrillation, associated symptoms, and any underlying conditions); 12-lead ECG (to identify presence of ventricular hypertrophy, preexcitation from accessory pathways, intraventricular conduction defects, and history of MI); echocardiogram (to assess cardiac chamber size, thickness, and function; to identify potential causes, such as cardiomyopathy or valvular dysfunction; and to identify the presence of a thrombus); and blood tests to assess thyroid, renal, and hepatic function (Fuster, et al., 2008). Additional tests may include a chest x-ray (to evaluate pulmonary vasculature), exercise test (to assess rate control as well as myocardial ischemia), Holter or event monitoring, and an EP study. The physical examination may reveal an irregular pulse, irregular jugular venous pulsations, and irregular $S_1$ heart sounds.

Treatment of atrial fibrillation depends on the cause, pattern, and duration of the dysrhythmia; the ventricular response rate; and the patient's symptoms, age, and comorbidities. In many patients, atrial fibrillation converts to sinus rhythm within 24 hours and without treatment. Hospitalization may not be necessary. Electrical cardioversion is indicated for patients with atrial fibrillation that is hemodynamically unstable unless they have digitalis toxicity or hypokalemia. Because of the high risk of embolization of atrial thrombi, cardioversion of atrial fibrillation that has lasted longer than 48 hours should be avoided unless the patient has received warfarin (Coumadin) for at least 3 to 4 weeks prior to cardioversion. Alternatively, the absence of a mural thrombus can be confirmed by transesophageal echocardiogram and heparin can be administered immediately prior to cardioversion. Because atrial function may be impaired for several weeks after cardioversion, warfarin is indicated for at least 4 weeks after the procedure. Patients may be given amiodarone (Cordarone), flecainide (Tambocor), ibutilide (Corvert), propafenone (Rythmol), or sotalol (Betapace) prior to cardioversion to prevent relapse of the atrial fibrillation (Fuster, et al., 2006).

Medications that may be administered to achieve cardioversion to sinus rhythm include flecainide, propafenone, or sotalol (Fuster, et al., 2008). Other choices include dofetilide (Tikosyn), amiodarone, and ibutilide. Because of the incidence of torsade de pointes, a ventricular tachycardia, the use of ibutilide warrants ECG monitoring for at least 4 hours after its administration.

If the QRS is wide and the ventricular rhythm is very fast and irregular, atrial fibrillation with an accessory pathway should be suspected. An accessory pathway is congenital tissue between the atria, His bundle, AV node, Purkinje fibers, or ventricular myocardium. This anomaly is known as Wolff-Parkinson-White or WPW syndrome. Electrical cardioversion is the treatment of choice for atrial fibrillation in the presence of WPW syndrome. Medications that block AV conduction (eg, digoxin [Digitek], diltiazem [Cardizem], and verapamil [Calan]) should be avoided. If the patient is hemodynamically stable, procainamide (Pronestyl), propafenone, flecainide, or ibutilide is recommended to restore sinus rhythm (Fuster, et al., 2008). Other medications that may be used include sotalol, quinidine (Quinaglute), disopyramide (Norpace), or amiodarone. Catheter ablation is performed for long-term management.

To control the heart rate in persistent atrial fibrillation, an IV beta-blocker or a nondihydropyridine calcium channel blocker (diltiazem and verapamil) is recommended (Fuster, et al., 2006). However, people with impaired ventricular function should not receive verapamil, those with bronchospasm should not receive a beta-blocker, and those with AV block should not receive any of these medications. IV digoxin or amiodarone may be used for rate control in patients with heart failure or left ventricular dysfunction but without an accessory pathway. IV procainamide or ibutilide is an alternative for rate control in patients with an accessory pathway. In pregnant women, digoxin, a beta-blocker, or a nondihydropyridine calcium channel blocker may be used for rate control. If medications fail to control the heart rate or cause significant side effects, catheter ablation may be indicated.

Persistent atrial fibrillation can cause sinus node dysfunction and alteration in the atrial musculature and contractile function (atrial remodeling), which may persist for days or weeks following conversion to sinus rhythm (Fuster, et al., 2006). This has implications for the length of recovery time and the duration of anticoagulation therapy needed after conversion.

If maintenance of sinus rhythm is necessary to maintain quality of life, flecainide, propafenone, or sotalol may be prescribed (Fuster, et al., 2006). Patients who have been observed in the hospital while being given a dose of either propafenone or flecainide to convert atrial fibrillation may be given the medication to self-administer outside the hospital if they have a recurrence, an approach called "pill in the pocket" (Fuster, et al., 2008). Several approaches are used to prevent the occurrence of postoperative atrial fibrillation; preoperative administration of a beta-blocker or amiodarone is the most successful (Fuster, et al., 2006). Pacemaker implantation, ablation, or surgery may be indicated for patients who do not respond to medications.

Although control of the rhythm had been the initial treatment of choice, recent studies have found that controlling the heart rate (resting heart rate less than 80) is equal to controlling the rhythm in terms of quality of life, frequency of hospitalization for heart failure, and incidence of stroke (AFFIRM Investigators, 2002; Fuster, et al., 2006). Antithrombotic therapy is indicated for all patients with

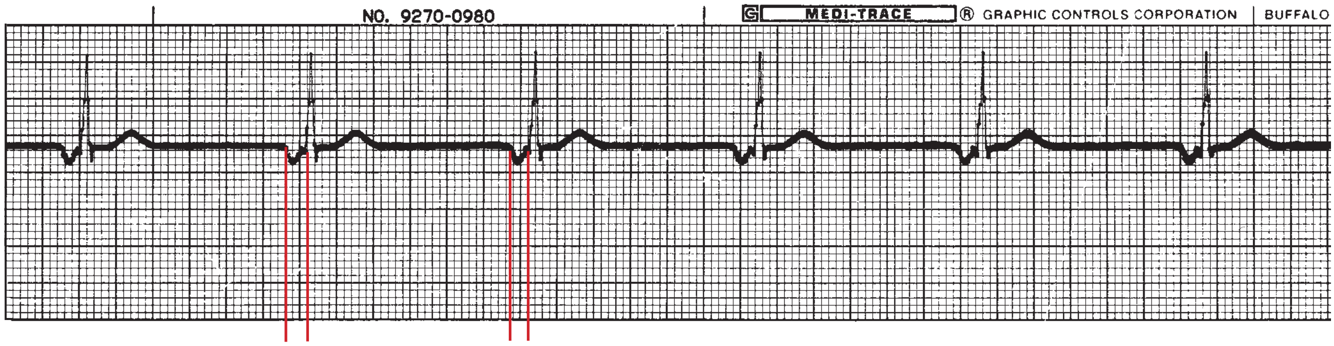



**Figure 27-12** Junctional rhythm in lead II; note short PR intervals.

atrial fibrillation. The type of therapy should be based on the risks of stroke and bleeding versus its benefits in a particular patient. Warfarin is indicated if the patient with atrial fibrillation is at high risk for stroke (ie, older than 75 years of age or has hypertension, diabetes, heart failure, or history of stroke) (Fuster, et al., 2008). If immediate anticoagulation is necessary, the patient may be placed on heparin until the warfarin level is therapeutic, usually defined as an international normalized ratio (INR) between 2 and 3. If a patient sustains an ischemic stroke or develops a systemic embolization during treatment, the antithrombotic therapy may be increased with the goal of increasing the INR to between 3.0 and 3.5 (Fuster, et al., 2006). Although aspirin may be substituted for warfarin in patients with contraindications to warfarin or those who are at a high risk of bleeding, warfarin is generally preferred (Fuster, et al., 2008). If a patient will be undergoing a procedure that carries a risk of bleeding, anticoagulation therapy may be withheld for up to a week. If more than a week is needed, heparin may be given, although its efficiency is unknown. Patients with atrial fibrillation who have a coronary artery stent implanted should receive clopidogrel (Plavix), an antiplatelet agent, plus warfarin for 1 to 12 months following the procedure (Fuster, et al., 2006).

### Junctional Dysrhythmias

***Premature Junctional Complex.*** A premature junctional complex is an impulse that starts in the AV nodal area before the next normal sinus impulse reaches the AV node. Premature junctional complexes are less common than PACs. Causes include digitalis toxicity, heart failure, and coronary artery disease. The ECG criteria for premature junctional complex are the same as for PACs, except for the P wave and the PR interval. The P wave may be absent, may follow the QRS, or may occur before the QRS but with a PR interval of less than 0.12 seconds. This dysrhythmia rarely produces significant symptoms. Treatment for frequent premature junctional complexes is the same as for frequent PACs.

***Junctional Rhythm.*** Junctional or idionodal rhythm occurs when the AV node, instead of the sinus node, becomes the pacemaker of the heart. When the sinus node slows (eg, from increased vagal tone) or when the impulse cannot be conducted through the AV node (eg, because of complete heart block), the AV node automatically discharges an impulse. Junctional rhythm not caused by complete heart block has the following characteristics (Fig. 27-12):

*Ventricular and atrial rate:* Ventricular rate 40 to 60; atrial rate also 40 to 60 if P waves are discernible

*Ventricular and atrial rhythm:* Regular

*QRS shape and duration:* Usually normal, but may be abnormal

*P wave:* May be absent, after the QRS complex, or before the QRS; may be inverted, especially in lead II

*PR interval:* If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds

*P:QRS ratio:* 1:1 or 0:1

Junctional rhythm may produce signs and symptoms of reduced cardiac output. If this occurs, the treatment is the same as for sinus bradycardia. Emergency pacing may be needed.

***Nonparoxysmal Junctional Tachycardia.*** Junctional tachycardia is caused by enhanced automaticity in the junctional area, resulting in a rhythm similar to junctional rhythm, except at a rate of 70 to 120. Although this rhythm generally does not have any detrimental hemodynamic effect, it may indicate a serious underlying condition, such as digitalis toxicity, myocardial ischemia, hypokalemia, or chronic obstructive pulmonary disease. Because junctional tachycardia is caused by increased automaticity, cardioversion is not an effective treatment; in fact, it causes an increase in the ventricular rate (AHA, 2005).

***Atrioventricular Nodal Reentry Tachycardia.*** Atrioventricular nodal reentry tachycardia (AVNRT) is a common dysrhythmia that occurs when an impulse is conducted to an area in the AV node that causes the impulse to be rerouted back into the same area over and over again at a very fast rate. Each time the impulse is conducted through this area, it is also conducted down into the ventricles, causing a fast ventricular rate. AVNRT that has an abrupt onset and an abrupt cessation with a QRS of normal duration has been termed paroxysmal atrial tachycardia (PAT). AVNRT also occurs when the duration of the QRS complex is 0.12 seconds or greater and a block in the bundle branch is known to be present. This dysrhythmia may last for seconds or several hours. Factors associated with the development of AVNRT include caffeine, nicotine, hypoxemia, and stress. Underlying pathologies include coronary artery disease and cardiomyopathy; however, it occurs more

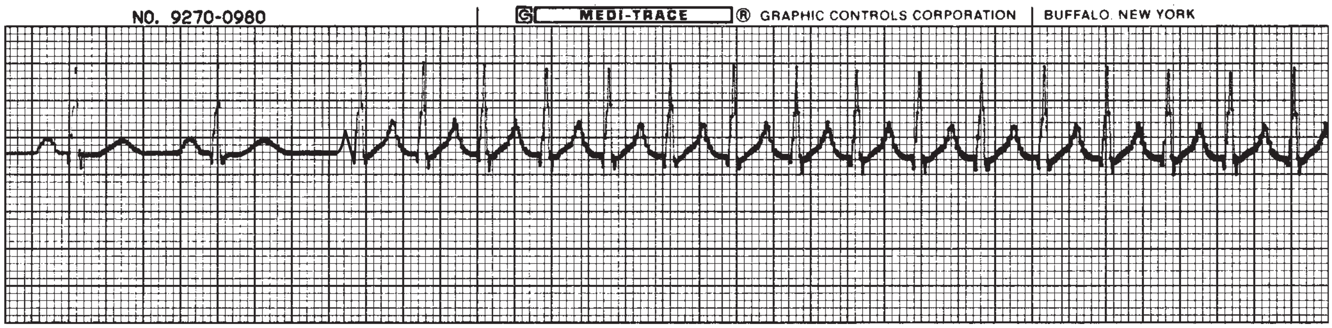



**Figure 27-13** AV nodal reentry tachycardia in lead II.

often in females and not in association with underlying structural heart disease (Blomström-Lundqvist, et al., 2003). AVNRT has the following characteristics (Fig. 27-13):

*Ventricular and atrial rate:* Atrial rate usually 150 to 250; ventricular rate usually 120 to 200

*Ventricular and atrial rhythm:* Regular; sudden onset and termination of the tachycardia

*QRS shape and duration:* Usually normal, but may be abnormal

*P wave:* Usually very difficult to discern

*PR interval:* If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds

*P:QRS ratio:* 1:1, 2:1

The clinical symptoms vary with the rate and duration of the tachycardia and the patient's underlying condition. The tachycardia usually is of short duration, resulting only in palpitations. A fast rate may also reduce cardiac output, resulting in significant signs and symptoms such as restlessness, chest pain, shortness of breath, pallor, hypotension, and loss of consciousness.

Because AVNRT is generally a benign dysrhythmia, the goal of treatment is to alleviate symptoms that affect quality of life. Patients who become significantly symptomatic and require emergency department visits to terminate the rhythm may want to initiate therapy immediately. However, those with minimum symptoms with an AVRNT that terminates spontaneously or with minimal treatment may choose just to be monitored.

The aim of therapy is to break the reentry of the impulse. Catheter ablation is the initial treatment of choice and is used to eliminate the area that permits the rerouting of the impulse that causes the tachycardia. Vagal maneuvers, such as carotid sinus massage (Fig. 27-14), gagging, breath holding, and immersing the face in ice water, may be used to interrupt AVNRT. These techniques increase parasympathetic stimulation, causing slower conduction through the AV node and blocking the reentry of the rerouted impulse. Some patients use some of these methods to terminate the episode on their own. Because of the risk of a cerebral embolic event, carotid sinus massage is contraindicated in patients with carotid bruits. If the vagal maneuvers are ineffective, the patient may then receive a bolus of adenosine to correct the rhythm; this is nearly 100% effective in terminating AVNRT (Fuster, et al., 2008). Patients who are also taking dipyridamole (Persantin) or who are cardiac transplant recipients are more sensitive to adenosine, and they should receive a lower initial dose (Fuster, et al., 2008). Because the effect of adenosine is so short, AVNRT may recur; the first dose may be followed with a larger dose or with a calcium channel blocker, such as verapamil, followed by one or two additional boluses. Digoxin is not indicated because of it slow onset. If the patient is unstable or does not respond to the medications, cardioversion is the treatment of choice. The unstable patient may be given adenosine while preparations for cardioversion are being made. For recurrent sustained AVNRT, treatment with calcium channel blockers such as verapamil and diltiazem, class 1a antiarrhythmic agents such as procainamide and disopyramide, class 1c antiarrhythmics such as flecainide and propafenone, and class 3 agents such as sotalol and amiodarone may prevent a recurrence. If the rhythm is infrequent and there is no underlying cardiac structural disorder, a single oral dose of flecainide or a combination of diltiazem and propranolol during an episode of tachycardia may be effective.

If P waves cannot be identified, the rhythm may be called **supraventricular tachycardia (SVT),** or paroxysmal supraventricular tachycardia (PSVT) if it has an abrupt onset, until the underlying rhythm and resulting diagnosis is determined. SVT and PSVT indicate only that the rhythm is not **ventricular tachycardia (VT).** SVT could be atrial fibrillation, atrial flutter, or AVNRT, among others. Vagal maneuvers and adenosine may be used to convert the rhythm or at least slow conduction in the AV node to allow visualization of the P waves. If the ECG does not assist in the differentiation of the dysrhythmia, invasive electrophysiology testing may be necessary to make the diagnosis.

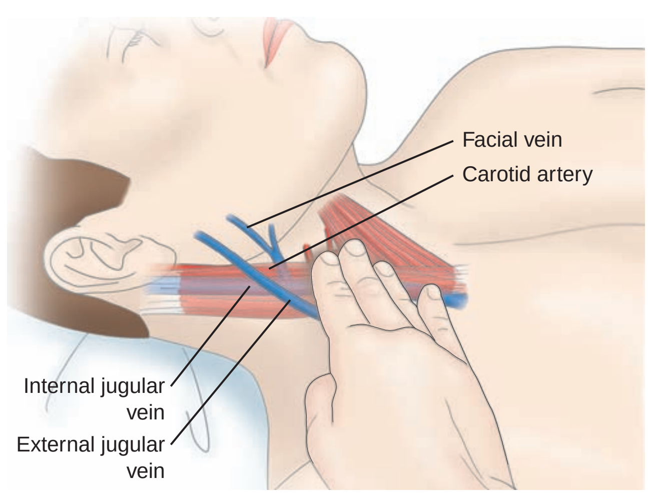



**Figure 27-14** Carotid sinus massage.

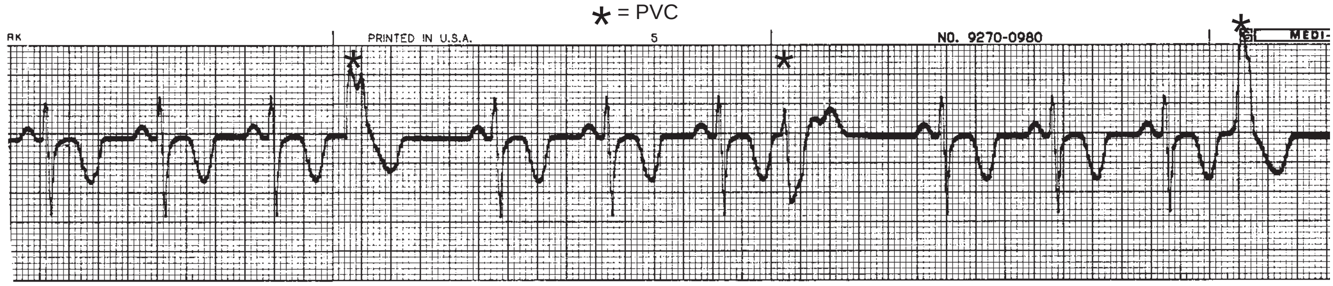



**Figure 27-15** Multifocal premature ventricular complexes (PVCs) in quadrigeminy in lead $V_1$. Note regular PP interval (P wave within PVC).

### Ventricular Dysrhythmias

***Premature Ventricular Complex.*** A premature ventricular complex (PVC) is an impulse that starts in a ventricle and is conducted through the ventricles before the next normal sinus impulse. PVCs can occur in healthy people, especially with intake of caffeine, nicotine, or alcohol. PVCs may be caused by cardiac ischemia or infarction, increased workload on the heart (eg, heart failure, and tachycardia), digitalis toxicity, hypoxia, acidosis, or electrolyte imbalances, especially hypokalemia. The Sleep Heart Health Study found that those people with sleep disordered breathing (eg, obstructive sleep apnea) had a significantly higher prevalence of complex ventricular ectopy and nonsustained ventricular tachycardia during sleep (Mehra, et al., 2006). The implication of the presence of PVCs during and after exercise is not clear and remains controversial (Fuster, et al., 2008).

In a rhythm called bigeminy, every other complex is a PVC. In trigeminy, every third complex is a PVC, and in quadrigeminy, every fourth complex is a PVC. PVCs have the following characteristics (Fig. 27-15):

*Ventricular and atrial rate:* Depends on the underlying rhythm (eg, sinus rhythm)
*Ventricular and atrial rhythm:* Irregular due to early QRS, creating one RR interval that is shorter than the others. PP interval may be regular, indicating that the PVC did not depolarize the sinus node.
*QRS shape and duration:* Duration is 0.12 seconds or longer; shape is bizarre and abnormal
*P wave:* Visibility of P wave depends on the timing of the PVC; may be absent (hidden in the QRS or T wave) or in front of the QRS. If the P wave follows the QRS, the shape of the P wave may be different.
*PR interval:* If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds
*P:QRS ratio:* 0:1; 1:1

The patient may feel nothing or may say that the heart "skipped a beat." The effect of a PVC depends on its timing in the cardiac cycle and how much blood was in the ventricles when they contracted. Initial treatment is aimed at correcting the cause.

In the absence of disease, PVCs usually are not serious. PVCs that are frequent and persistent may be treated with amiodarone or sotalol. Long-term pharmacotherapy for only PVCs is not indicated. In patients with acute MI, PVCs may warrant more aggressive therapy. Lidocaine (Xylocaine) may be used in the patient with acute MI. Patients with acute MI who did not receive thrombolytics and had more than 10 PVCs per hour and those who did receive thrombolytics and had more than 25 PVCS per hour were found to be at the greatest risk for sudden cardiac death (Fuster, et al., 2008). In the past, PVCs were considered to be indicative of an increased risk for ensuing VT. However, PVCs that (1) are more frequent than six per minute, (2) are multifocal or polymorphic (having different shapes and rhythms), (3) occur two in a row (pair), and (4) occur on the T wave (the vulnerable period of ventricular depolarization) have not been found to be precursors of VT in patients without structural heart disease (Cardiac Arrhythmia Suppression Trial Investigators, 1989). These PVCs are no longer considered as warning or complex PVCs.

***Ventricular Tachycardia.*** VT is defined as three or more PVCs in a row, occurring at a rate exceeding 100 bpm. The causes are similar to those of PVC. Patients with larger MIs and lower ejection fractions are at higher risk of lethal ventricular tachycardia (see Chapter 30). VT is an emergency because the patient is usually (although not always) unresponsive and pulseless. VT has the following characteristics (Fig. 27-16):

*Ventricular and atrial rate:* Ventricular rate is 100 to 200 bpm; atrial rate depends on the underlying rhythm (eg, sinus rhythm)

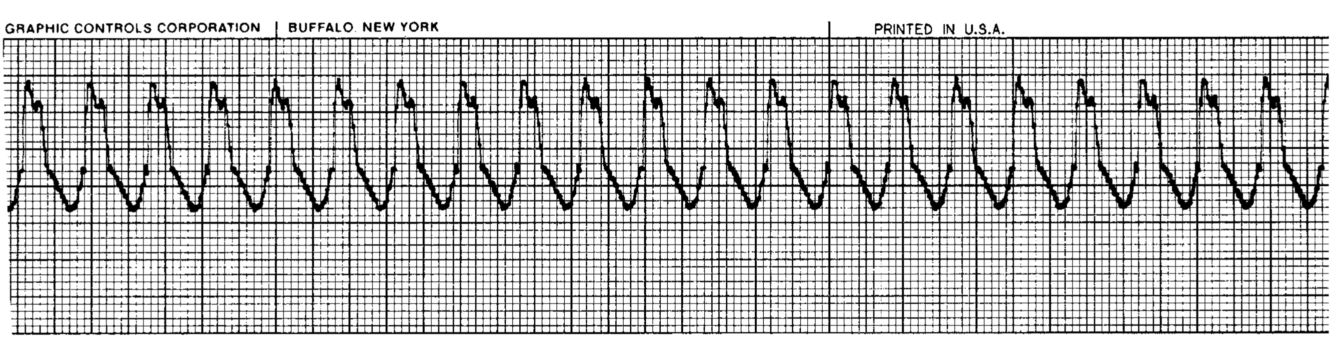



**Figure 27-16** Ventricular tachycardia in lead $V_1$.

*Ventricular and atrial rhythm:* Usually regular; atrial rhythm may also be regular

*QRS shape and duration:* Duration is 0.12 seconds or more; bizarre, abnormal shape

*P wave:* Very difficult to detect, so atrial rate and rhythm may be indeterminable

*PR interval:* Very irregular, if P waves are seen

*P:QRS ratio:* Difficult to determine, but if P waves are apparent, there are usually more QRS complexes than P waves

The patient's tolerance or lack of tolerance for this rapid rhythm depends on the ventricular rate and severity of ventricular dysfunction. However, hemodynamic stability does not predict mortality risk (Fuster, et al., 2008). Several factors determine the initial treatment, including the following: identifying the rhythm as monomorphic (having a consistent QRS shape and rate) or polymorphic (having varying QRS shapes and rhythms); determining the existence of a prolonged QT interval before the initiation of VT; and ascertaining the patient's heart function (normal or decreased). If the patient is stable, continuing the assessment, especially obtaining a 12-lead ECG, may be the only action necessary.

However, the patient may need antiarrhythmic medications, antitachycardia pacing, or direct cardioversion. IV procainamide is the antiarrhythmic medication of choice for a patient with stable acute MI with VT, whereas IV amiodarone is the medication of choice for a patient with unstable VT or impaired cardiac function. Sotalol may also be used. Although lidocaine has been the medication most commonly used for immediate, short-term therapy, especially for patients with impaired cardiac function, it has no proven short-term or long-term efficacy in cardiac arrest (AHA, 2005). Cardioversion is the treatment of choice for monophasic VT in a symptomatic patient. Defibrillation is the treatment of choice for pulseless VT. Any type of VT in a patient who is unconscious and without a pulse is treated in the same manner as ventricular fibrillation: immediate **defibrillation** is the action of choice. For long-term management, patients with an ejection fraction less than 35% should be considered for an implantable cardioverter defibrillator. Those with an ejection fraction greater than 35% may be managed with amiodarone. A small percentage of patients with VT have structurally normal hearts and respond well to medications and ablation, and they have an excellent prognosis (Fuster, et al., 2008). If the ventricular rate is above 200, then presence of an accessory pathway should be suspected. If the ventricular rhythm is irregular, atrial fibrillation should be suspected and treated appropriately (Fuster, et al., 2006).

Torsade de pointes is a polymorphic VT preceded by a prolonged QT interval. Common causes include central nervous system disease; certain medications; or low levels of potassium, calcium, or magnesium. Congenital QT prolongation is another cause. Because this rhythm is likely to cause the patient to deteriorate and become pulseless, immediate treatment is required: correction of any electrolyte imbalance, administration of isoproterenol (Isuprel) IV, or initiation of ventricular pacing. Magnesium has frequently been used to treat torsades, but its use has not been proved effective (AHA, 2005).

***Ventricular Fibrillation.*** The most common dysrhythmia in patients with cardiac arrest is ventricular fibrillation, which is a rapid, disorganized ventricular rhythm that causes ineffective quivering of the ventricles. No atrial activity is seen on the ECG. The most common cause of ventricular fibrillation is coronary artery disease and resulting acute MI. Other causes include untreated or unsuccessfully treated VT, cardiomyopathy, valvular heart disease, several **proarrhythmic** medications, acid-base and electrolyte abnormalities, and electrical shock. Another cause is Brugada syndrome, in which the patient (frequently of Asian descent) has a structurally normal heart, few or no risk factors for coronary artery disease, and a family history of sudden cardiac death. Ventricular fibrillation has the following characteristics (Fig. 27-17):

*Ventricular rate:* Greater than 300 per minute

*Ventricular rhythm:* Extremely irregular, without a specific pattern

*QRS shape and duration:* Irregular, undulating waves without recognizable QRS complexes

Ventricular fibrillation is always characterized by the absence of an audible heartbeat, a palpable pulse, and respirations. Because there is no coordinated cardiac activity, cardiac arrest and death are imminent if the dysrhythmia is not corrected. Early defibrillation is critical to survival, with administration of immediate bystander cardiopulmonary resuscitation (CPR) until defibrillation is available. The chance of survival decreases by 7% to 10% for every minute in delay of defibrillation (AHA, 2005). If the arrest was not witnessed or there was more than a 4-minute

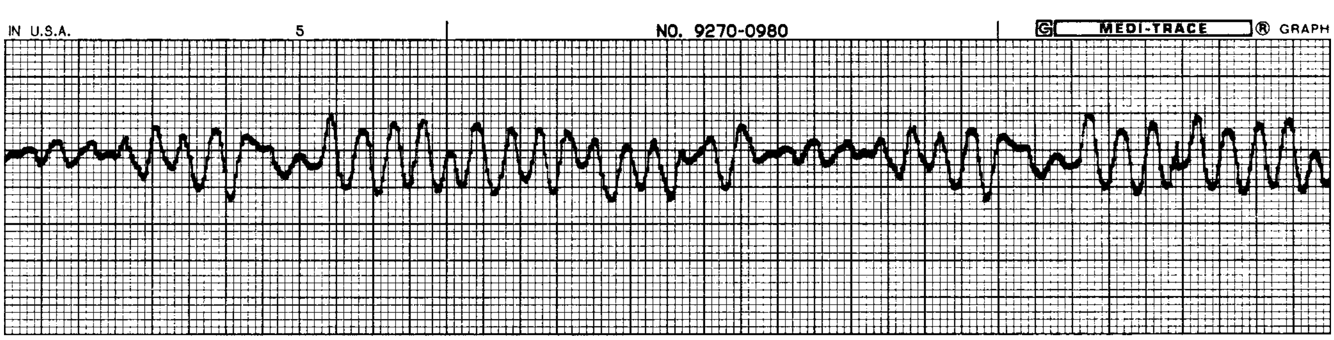



**Figure 27-17** Ventricular fibrillation in lead II.

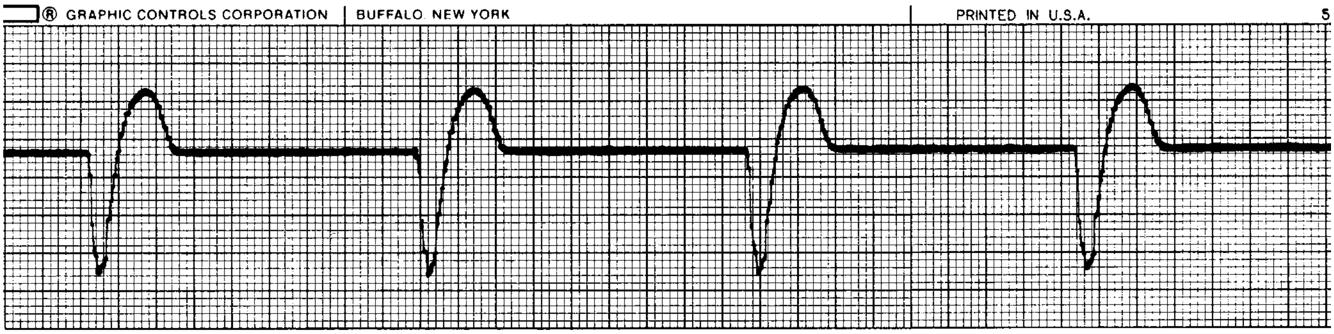



**Figure 27-18** Idioventricular rhythm in lead $V_1$.

delay in emergency services response, five cycles of CPR may be given prior to defibrillation (AHA, 2005). After the initial defibrillation, five additional cycles of CPR (about 2 minutes of continuous chest compressions in the intubated patient), beginning with chest compression and alternating with a rhythm check and defibrillation, are used to convert ventricular fibrillation to an electrical rhythm that produces a pulse. Cardiocerebral resuscitation for cardiac arrest with continuous chest compressions, interrupted only with defibrillation, and its de-emphasis on the use of positive-pressure ventilation continues to be explored as a better method for improving survival (Fuster, et al., 2008). Epinephrine should be administered as soon as possible after the second rhythm check (immediately before or after the second defibrillation) and then every 3 to 5 minutes. One dose of vasopressin (Pitressin) may be administered instead of epinephrine if the cardiac arrest persists. Other antiarrhythmic medications (amiodarone, lidocaine, or possibly magnesium) should be administered as soon as possible after the third rhythm check (immediately before or after the third defibrillation).

For refractory ventricular fibrillation, amiodarone may be the medication of choice. However, once the patient is intubated, CPR should be given continuously, not in cycles, and the rhythm check and medication administration occur every 2 minutes. In addition, underlying and contributing factors are identified and eliminated throughout the event (AHA, 2005).

Current AHA guidelines recommend inducing mild hypothermia in unconscious adults who experience cardiac arrest (including cardiac arrest due to ventricular fibrillation) and who receive CPR within 10 minutes. Hypothermia is defined as a core body temperature of 32°C to 34°C (89.6°F to 93.2°F). Induction should be started as soon as possible after circulation is restored, preferably within 60 minutes, and maintained for 12 to 24 hours. It is usually initiated by applying ice packs to the axilla and groin as well as administering iced saline gastric lavage until a cooling machine is obtained.

The nurse caring for a patient with hypothermia (passive or induced) needs to monitor for appropriate level of cooling, sedation, and neuromuscular paralysis to prevent seizures, myoclonus, and shivering. The nurse also needs to monitor for complications of hypothermia, which include electrolyte imbalance (especially due to the diuresis caused by hypothermia), hypotension, pneumonia, sepsis, hyperglycemia, dysrhythmias, and coagulopathy, especially if the temperature drops below the intended goal. Because of these numerous nursing interventions, patients receive care in intensive care units. Each patient should be assigned three nurses during the induction process and two nurses during the hypothermia state (Bader, Rovzar, Baumgartner, et al., 2007).

***Idioventricular Rhythm.*** Idioventricular rhythm, also called ventricular escape rhythm, occurs when the impulse starts in the conduction system below the AV node. When the sinus node fails to create an impulse (eg, from increased vagal tone) or when the impulse is created but cannot be conducted through the AV node (eg, due to complete AV block), the Purkinje fibers automatically discharge an impulse. When idioventricular rhythm is not caused by AV block, it has the following characteristics (Fig. 27-18):

*Ventricular rate:* 20 and 40; if the rate exceeds 40, the rhythm is known as accelerated idioventricular rhythm (AIVR)

*Ventricular rhythm:* Regular

*QRS shape and duration:* Bizarre, abnormal shape; duration is 0.12 seconds or more

Idioventricular rhythm commonly causes the patient to lose consciousness and experience other signs and symptoms of reduced cardiac output. In such cases, the treatment is the same as for asystole and pulseless electrical activity (PEA) if the patient is in cardiac arrest or for bradycardia if the patient is not in cardiac arrest. Interventions include identifying the underlying cause; administering IV epinephrine, atropine, and vasopressor medications; and initiating emergency transcutaneous pacing. In some cases, idioventricular rhythm may cause no symptoms of reduced cardiac output. However, bed rest is prescribed so as not to increase the cardiac workload.

***Ventricular Asystole.*** Commonly called flatline, ventricular asystole (Fig. 27-19) is characterized by absent QRS complexes confirmed in two different leads, although P waves may be apparent for a short duration. There is no heartbeat, no palpable pulse, and no respiration. Without immediate treatment, ventricular asystole is fatal.

Ventricular asystole is treated the same as PEA, focusing on high-quality CPR with minimal interruptions and identifying underlying and contributing factors. The guidelines for advanced cardiovascular life support (ACLS) (AHA, 2005) state that the key to successful treatment is rapid assessment to identify a possible cause, which may be hypoxia,

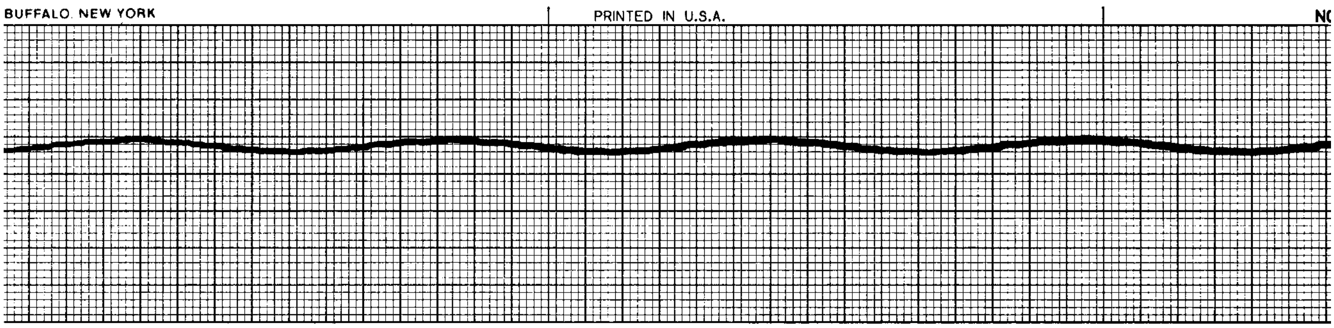



**Figure 27-19** Asystole. Always check two different leads to confirm rhythm.

acidosis, severe electrolyte imbalance, drug overdose, hypovolemia, cardiac tamponade, tension pneumothorax, coronary or pulmonary thrombosis, trauma, or hypothermia. After the initiation of CPR, intubation and establishment of IV access are the next recommended actions, with no or minimal interruptions in chest compressions. After 2 minutes or five cycles of CPR, a bolus of IV epinephrine is administered and repeated at 3- to 5-minute intervals. One dose of vasopressin may be administered for the first or second dose of epinephrine. A bolus of IV atropine may also be administered as soon as possible after the rhythm check (AHA, 2005). Because of the poor prognosis associated with asystole, if the patient does not respond to these actions and others aimed at correcting underlying causes, resuscitation efforts are usually ended ("the code is called") unless special circumstances (eg, hypothermia, transportation to a hospital is required) exist.

### Conduction Abnormalities

When assessing the rhythm strip, the underlying rhythm is first identified (eg, sinus rhythm, sinus arrhythmia). Then the PR interval is assessed for the possibility of an AV block. AV blocks occur when the conduction of the impulse through the AV nodal or His bundle area is decreased or stopped. These blocks can be caused by medications (eg, digitalis, calcium channel blockers, beta-blockers), Lyme disease, myocardial ischemia and infarction, valvular disorders, cardiomyopathy, endocarditis, or myocarditis. If the AV block is caused by increased vagal tone (eg, long-term athletic training, sleep, coughing, suctioning, pressure above the eyes or on large vessels, anal stimulation), it is commonly accompanied by sinus bradycardia. AV block may be temporary and resolve on its own, or it may be permanent and require permanent pacing.

The clinical signs and symptoms of a heart block vary with the resulting ventricular rate and the severity of any underlying disease processes. Whereas first-degree AV block rarely causes any hemodynamic effect, the other blocks may result in decreased heart rate, causing a decrease in perfusion to vital organs, such as the brain, heart, kidneys, lungs, and skin. A patient with third-degree AV block caused by digitalis toxicity may be stable; another patient with the same rhythm caused by acute MI may be unstable. Health care providers must always keep in mind the need to treat the patient, not the rhythm. The treatment is based on the hemodynamic effect of the rhythm.

***First-Degree Atrioventricular Block.*** First-degree AV block occurs when all the atrial impulses are conducted through the AV node into the ventricles at a rate slower than normal. This conduction disorder has the following characteristics (Fig. 27-20):

*Ventricular and atrial rate*: Depends on the underlying rhythm
*Ventricular and atrial rhythm:* Depends on the underlying rhythm
*QRS shape and duration:* Usually normal, but may be abnormal
*P wave:* In front of the QRS complex; shows sinus rhythm, regular shape
*PR interval:* Greater than 0.20 seconds; PR interval measurement is constant
*P:QRS ratio:* 1:1

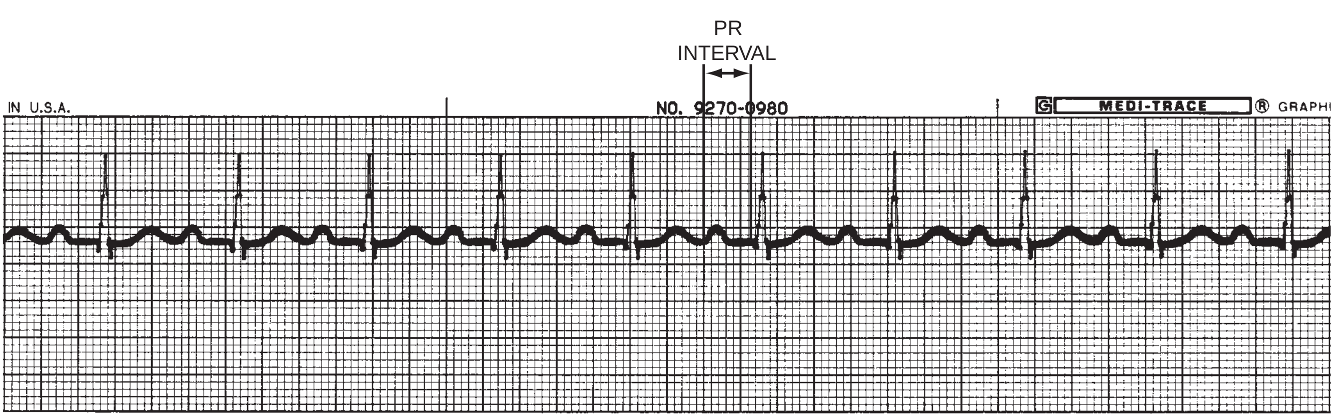



**Figure 27-20** Sinus rhythm with first-degree AV block in lead II. Note that PR is constant but greater than 0.20 seconds.

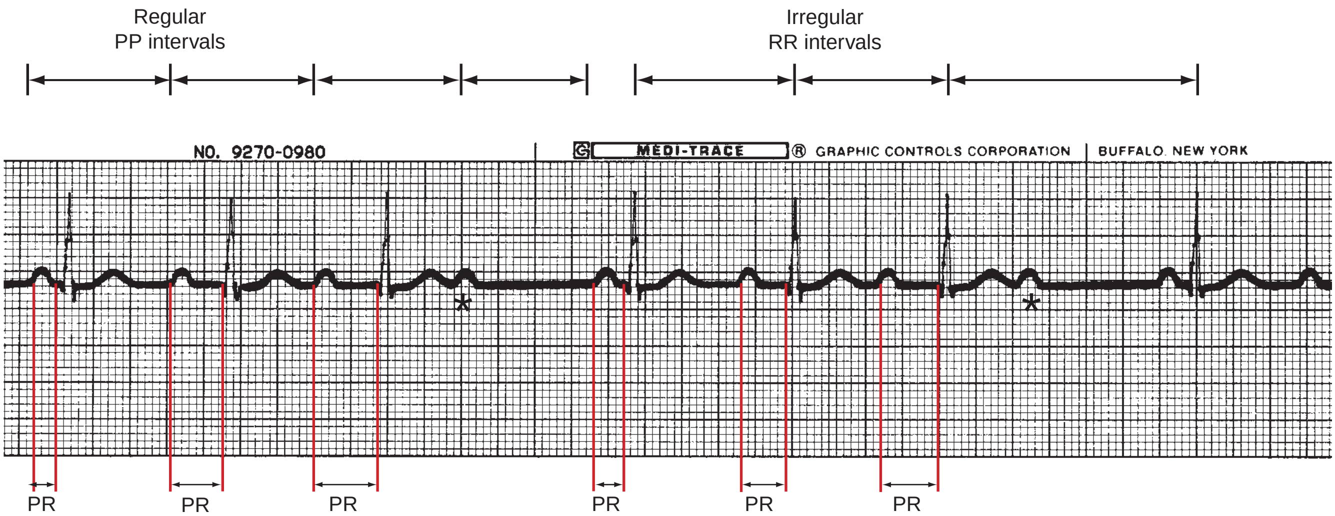



**Figure 27-21** Sinus rhythm with second-degree AV block, type I in lead II. Note progressively longer PR durations until there is a nonconducted P wave, indicated by the asterisk.

***Second-Degree Atrioventricular Block, Type I (Wenckebach).*** Second-degree AV block, type I, occurs when there is a repeating pattern in which all but one of a series of atrial impulses are conducted through the AV node into the ventricles (eg, every four of five atrial impulses are conducted). Each atrial impulse takes a longer time for conduction than the one before, until one impulse is fully blocked. Because the AV node is not depolarized by the blocked atrial impulse, the AV node has time to fully repolarize, so that the next atrial impulse can be conducted within the shortest amount of time. Second-degree AV block, type I, has the following characteristics (Fig. 27-21):

*Ventricular and atrial rate*: Depends on the underlying rhythm

*Ventricular and atrial rhythm:* The PP interval is regular if the patient has an underlying normal sinus rhythm; the RR interval characteristically reflects a pattern of change. Starting from the RR that is the longest, the RR interval gradually shortens until there is another long RR interval.

*QRS shape and duration:* Usually normal but may be abnormal

*P wave:* In front of the QRS complex; shape depends on underlying rhythm

*PR interval:* PR interval becomes longer with each succeeding ECG complex until there is a P wave not followed by a QRS. The changes in the PR interval are repeated between each "dropped" QRS, creating a pattern in the irregular PR interval measurements.

*P:QRS ratio:* 3:2, 4:3, 5:4, and so forth

***Second-Degree Atrioventricular Block, Type II.*** Second-degree AV block, type II, occurs when only some of the atrial impulses are conducted through the AV node into the ventricles. Second-degree AV block, type II, has the following characteristics (Fig. 27-22):

*Ventricular and atrial rate*: Depends on the underlying rhythm

*Ventricular and atrial rhythm:* The PP interval is regular if the patient has an underlying normal sinus rhythm.

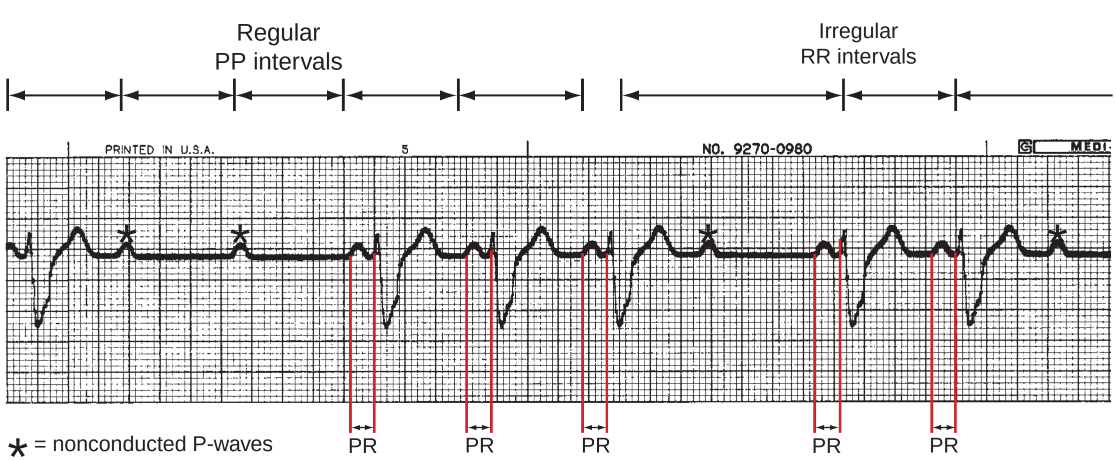



**Figure 27-22** Sinus rhythm with second-degree AV block, type II in lead $V_1$; note constant PR interval and presence of more P waves than QRS complexes.

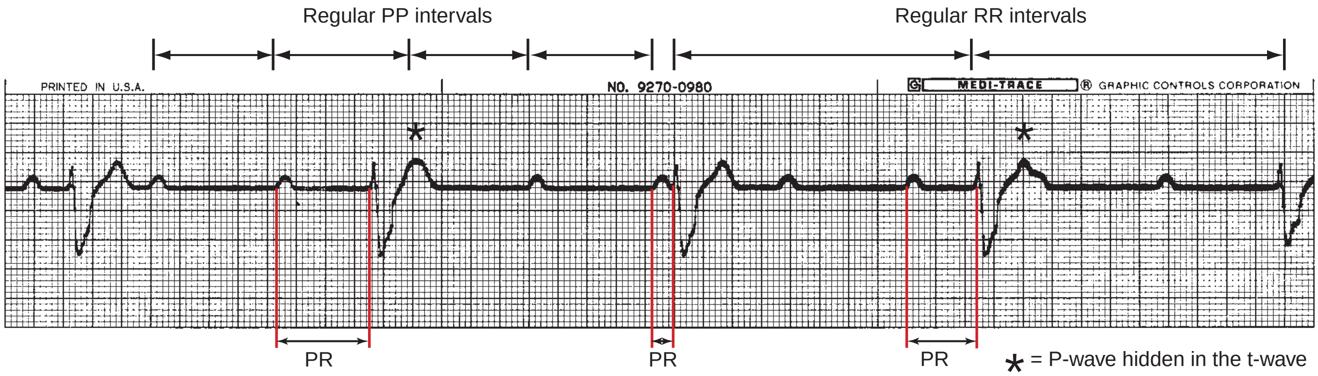



**Figure 27-23** Sinus rhythm with third-degree AV block and idioventricular rhythm in lead $V_1$; note irregular PR intervals.

The RR interval is usually regular but may be irregular, depending on the P:QRS ratio.

*QRS shape and duration:* Usually abnormal but may be normal

*P wave:* In front of the QRS complex; shape depends on underlying rhythm

*PR interval:* PR interval is constant for those P waves just before QRS complexes

*P:QRS ratio:* 2:1, 3:1, 4:1, 5:1, and so forth

***Third-Degree Atrioventricular Block.*** Third-degree AV block occurs when no atrial impulse is conducted through the AV node into the ventricles. In third-degree AV block, two impulses stimulate the heart: one stimulates the ventricles (eg, junctional or ventricular escape rhythm), represented by the QRS complex, and one stimulates the atria (eg, sinus rhythm or atrial fibrillation), represented by the P wave. P waves may be seen, but the atrial electrical activity is not conducted down into the ventricles to cause the QRS complex, the ventricular electrical activity. Having two impulses stimulate the heart results in a condition called AV dissociation, which may also occur during VT. Complete block (third-degree AV block) has the following characteristics (Fig. 27-23):

*Ventricular and atrial rate*: Depends on the escape rhythm and underlying atrial rhythm

*Ventricular and atrial rhythm:* The PP interval is regular and the RR interval is regular, but the PP interval is not equal to the RR interval

*QRS shape and duration:* Depends on the escape rhythm; with junctional rhythm, QRS shape and duration are usually normal; with idioventricular rhythm, QRS shape and duration are usually abnormal

*P wave:* Depends on underlying rhythm

*PR interval:* Very irregular

*P:QRS ratio:* More P waves than QRS complexes

***Medical Management of Conduction Abnormalities.*** Based on the cause of the AV block and the stability of the patient, treatment is directed toward increasing the heart rate to maintain a normal cardiac output. If the patient is stable and has no symptoms, no treatment may be indicated other than decreasing or eliminating the cause (eg, withholding the medication or treatment). If the causal medication is necessary for treating other conditions and no effective alternative is available, pacemaker implantation may be indicated. The initial treatment of choice is an IV bolus of atropine, although it is not effective in second-degree AV block, type II, or third-degree AV block. If the patient does not respond to atropine, has advanced AV block, or has had an acute MI, temporary transcutaneous pacing may be started. If the patient has no pulse, treatment is the same as for ventricular asystole. A permanent pacemaker may be necessary if the block persists.

# NURSING PROCESS

## The Patient With a Dysrhythmia

### Assessment

Major areas of assessment include possible causes of the dysrhythmia, contributing factors, and the dysrhythmia's effect on the heart's ability to pump an adequate blood volume. When cardiac output is reduced, the amount of oxygen reaching the tissues and vital organs is diminished. This diminished oxygenation produces the signs and symptoms associated with dysrhythmias. If these signs and symptoms are severe or if they occur frequently, the patient may experience significant distress and disruption of daily life.

A health history is obtained to identify any previous occurrences of decreased cardiac output, such as syncope (fainting), lightheadedness, dizziness, fatigue, chest discomfort, and palpitations. Coexisting conditions that could be possible causes of the dysrhythmia (eg, heart disease, chronic obstructive pulmonary disease) may also be identified. All medications, prescribed and over-the-counter (including herbs and nutritional supplements), as well as the route of administration, are reviewed. If a patient is taking an antiarrhythmic medication, assessment for side effects, adverse reactions, and potential contraindications is necessary. For example, some medications (eg, digoxin) can cause dysrhythmias. Laboratory results are reviewed to assess levels of medications as well as factors that could contribute to the dysrhythmia (eg, anemia). A thorough psychosocial assessment is performed to identify the possible effects of the dysrhythmia, the patient's perception and understanding of the dysrhythmia and its treatment, and whether anxiety is a significant contributing factor.

The nurse conducts a physical assessment to confirm the data obtained from the history and to observe for signs of

diminished cardiac output during the dysrhythmic event, especially changes in level of consciousness. The nurse assesses the patient's skin, which may be pale and cool. Signs of fluid retention, such as neck vein distention and crackles and wheezes auscultated in the lungs, may be detected. The rate and rhythm of apical and peripheral pulses are also assessed, and any pulse deficit is noted. The nurse auscultates for extra heart sounds (especially $S_3$ and $S_4$) and for heart murmurs, measures blood pressure, and determines pulse pressures. A declining pulse pressure indicates reduced cardiac output. Just one assessment may not disclose significant changes in cardiac output; therefore, the nurse compares multiple assessment findings over time, especially those that occur with and without the dysrhythmia.

## Diagnosis

### *Nursing Diagnoses*

Based on assessment data, major nursing diagnoses of the patient may include:

- Decreased cardiac output
- Anxiety related to fear of the unknown
- Deficient knowledge about the dysrhythmia and its treatment

### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following:

- Cardiac arrest (see Chapter 30)
- Heart failure (see Chapter 30)
- Thromboembolic event, especially with atrial fibrillation (see Chapter 30)

## Planning and Goals

The major goals for the patient may include eliminating or decreasing the occurrence of the dysrhythmia (by decreasing contributory factors) to maintain cardiac output, minimizing anxiety, and acquiring knowledge about the dysrhythmia, tests used to diagnose the problem, and its treatment.

## Nursing Interventions

### *Monitoring and Managing the Dysrhythmia*

The nurse regularly evaluates the patient's blood pressure, pulse rate and rhythm, rate and depth of respirations, and breath sounds to determine the dysrhythmia's hemodynamic effect. The nurse also asks the patient about episodes of lightheadedness, dizziness, or fainting as part of the ongoing assessment. If a patient with a dysrhythmia is hospitalized, the nurse may obtain a 12-lead ECG, continuously monitor the patient, and analyze rhythm strips to track the dysrhythmia.

Control of the occurrence or the effect of the dysrhythmia, or both, is often achieved with **antiarrhythmic medications.** The nurse assesses and observes for the benefits and adverse effects of each medication. The nurse, in collaboration with the physician, also manages medication administration carefully so that a constant serum level of the medication is maintained. The nurse may also conduct a 6-minute walk test as prescribed, which is used to identify the patient's ventricular rate in response to exercise. The patient is asked to walk for 6 minutes, covering as much distance as possible. The nurse monitors the patient for symptoms. At the end, the nurse records the distance covered and the preexercise and postexercise heart rate as well as the patient's response.

The nurse assesses for factors that contribute to the dysrhythmia (eg, oxygen deficits, acid-base and electrolyte imbalances, caffeine, or nonadherence to the medication regimen). The nurse also monitors for ECG changes (eg, widening of the QRS, prolongation of the QT interval, increased heart rate) that increase the risk of a dysrhythmic event.

### *Minimizing Anxiety*

When the patient experiences episodes of dysrhythmia, the nurse stays with the patient and provides assurance of safety and security while maintaining a calm and reassuring attitude. This assists in reducing anxiety (reducing the sympathetic response) and fosters a trusting relationship with the patient. The nurse seeks the patient's view of the events and discusses the emotional response to the dysrhythmia, encouraging verbalization of feelings and fears, providing supportive or empathetic statements, and assisting the patient to recognize feelings of anxiety, anger, or sadness. The nurse emphasizes successes with the patient to promote a sense of self-management of the dysrhythmia. For example, if a patient is experiencing episodes of dysrhythmia and a medication is administered that begins to reduce the incidence of the dysrhythmia, the nurse communicates that information to the patient. In addition, the nurse can help the patient develop a system to identify possible causative, influencing, and alleviating factors (eg, keeping a diary). The nursing goal is to maximize the patient's control and to make the episode less threatening.

### *Promoting Home and Community-Based Care*

TEACHING PATIENTS SELF-CARE. When teaching patients about dysrhythmias, the nurse first assesses the patient's understanding, clarifies misinformation, and then shares needed information in terms that are understandable and in a manner that is not frightening or threatening. The nurse clearly explains treatment options to the patient and family. If necessary, the nurse explains the importance of maintaining therapeutic serum levels of antiarrhythmic medications so that the patient understands why medications should be taken regularly each day and the importance of regular blood testing. If the medication has the potential to alter the heart rate, the patient should be taught how to take his or her pulse before each dose and to notify the health care provider if the pulse is abnormal. In addition, the relationship between a dysrhythmia and cardiac output is explained so that the patient recognizes symptoms of the dysrhythmia and the rationale for the treatment regimen. The patient and family need to know what measures to take to decrease the risk of recurrence of the dysrhythmia. If the patient has a potentially lethal dysrhythmia, it is also important to establish with the patient and family a plan of action to take in case of an emergency and, if appropriate, to encourage a family member to obtain CPR training.

The patient and family should also be taught about potential risks of the dysrhythmia and their signs and symptoms. For example, the patient with chronic atrial fibrillation should be taught about the possibility of an embolic event.

**CONTINUING CARE.** A referral for home care usually is not necessary for the patient with a dysrhythmia unless the patient is hemodynamically unstable and has significant symptoms of decreased cardiac output. Home care may be warranted if the patient has significant comorbidities, socioeconomic issues, or limited self-management skills that could increase the risk of nonadherence to the therapeutic regimen.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Maintains cardiac output
   a. Demonstrates heart rate, blood pressure, respiratory rate, and level of consciousness within normal ranges
   b. Demonstrates no or decreased episodes of dysrhythmia
2. Experiences reduced anxiety
   a. Expresses a positive attitude about living with the dysrhythmia
   b. Expresses confidence in ability to take appropriate actions in an emergency
3. Expresses understanding of the dysrhythmia and its treatment
   a. Explains the dysrhythmia and its effects
   b. Describes the medication regimen and its rationale
   c. Explains the need to maintain a therapeutic serum level of the medication
   d. Describes a plan to eliminate or limit factors that contribute to the dysrhythmia
   e. States actions to take in the event of an emergency

## Adjunctive Modalities and Management

Dysrhythmia treatments depend on whether the disorder is acute or chronic as well as on the cause of the dysrhythmia and its actual or potential hemodynamic effects.

Acute dysrhythmias may be treated with medications or with external electrical therapy (emergency defibrillation, cardioversion, or pacing). Many antiarrhythmic medications are used to treat atrial and ventricular tachydysrhythmias (see Table 27-1). The choice of medication depends on the specific dysrhythmia and its duration, the presence of structural heart disease, (eg, heart failure), and the patient's response to previous treatment. The nurse is responsible for monitoring and documenting the patient's responses to the medication and for ensuring that the patient has the knowledge and ability to manage the medication regimen.

If medications alone are ineffective in eliminating or decreasing the dysrhythmia, certain adjunctive mechanical therapies are available. The most common therapies are elective cardioversion and defibrillation for acute tachydysrhythmia, and implantable devices (pacemakers for bradycardias and internal cardiodefibrillators for chronic tachydysrhythmias). Surgical treatments, although less common, are also available. The nurse is responsible for assessing the patient's understanding of and response to mechanical therapy, as well as the patient's self-management abilities. The nurse explains that the purpose of the device is to help the patient lead a life that is as active and productive as possible.



Figure 27-24 Standard paddle placement for defibrillation.

### Cardioversion and Defibrillation

Cardioversion and defibrillation are used to treat tachydysrhythmias by delivering an electrical current that depolarizes a critical mass of myocardial cells. When the cells repolarize, the sinus node is usually able to recapture its role as the heart's pacemaker. One major difference between cardioversion and defibrillation is the timing of the delivery of electrical current. In cardioversion, the delivery of the electrical current is synchronized with the patient's electrical events; in defibrillation, the delivery of the current is immediate and unsynchronized.

The electrical current may be delivered externally through the skin with the use of paddles or with conductor pads. The paddles or pads may be placed on the front of the chest (Fig. 27-24) (standard placement), or one may be placed on the front of the chest and the other, using an adapter with a long handle if using paddles, placed under the patient's back just left of the spine (anteroposterior placement) (Fig. 27-25).

Defibrillator multifunction conductor pads (Fig. 27-26) contain a conductive medium and are connected to the defibrillator to allow for hands-off defibrillation. This method reduces the risk of touching the patient during the procedure and increases electrical safety. Automatic external

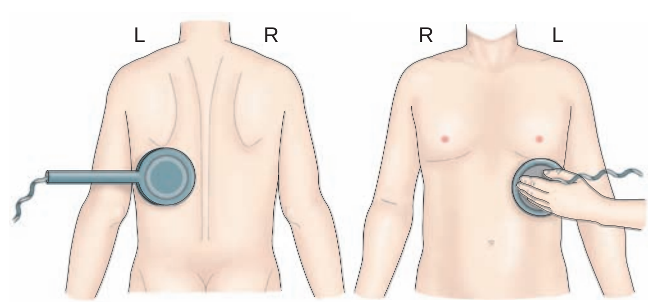



Figure 27-25 Anteroposterior paddle placement for defibrillation.

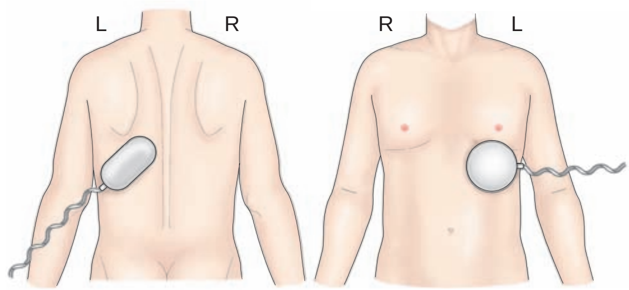



**Figure 27-26** Multifunction pads for defibrillation.

defibrillators (AEDs), which are now found in public areas such as airports and grocery stores, use this type of delivery for the electrical current.

> ***NURSING ALERT***
>
> **When using paddles, the appropriate conductant is applied between the paddles and the patient's skin. Any other type of conductant, such as ultrasound gel, should not be substituted.**

Whether using pads or paddles, the nurse must observe two safety measures. First, good contact must be maintained between the pads or paddles and the patient's skin (with a conductive medium between them) to prevent electrical current from leaking through the air (arcing) when the defibrillator is discharged. Second, no one is to be in contact with the patient or with anything that is touching the patient when the defibrillator is discharged, to minimize the chance that electrical current is conducted to anyone other than the patient.

When assisting with external defibrillation or cardioversion, the nurse should remember these key points:

- Use multifunction conductor pads or paddles with a conducting medium between the paddles and the skin (the conducting medium is available as a sheet, gel, or paste). Do not use gels or pastes with poor electrical conductivity (eg, ultrasound gel) (AHA, 2005).
- Place paddles or pads so that they do not touch the patient's clothing or bed linen and are not near medication patches or direct oxygen flow.
- During cardioversion, ensure that the monitor leads are attached to the patient and that the defibrillator is in the synchronized mode ("in sync"). If defibrillating, ensure that the defibrillator is *not* in the synchronized mode (most machines default to the "not-sync" mode).
- If using paddles, exert 20 to 25 pounds of pressure to ensure good skin contact.
- If using a manual discharge device, do not charge the device until ready to shock; then keep thumbs and fingers off the discharge buttons until paddles or pads are on the chest and ready to deliver the electrical charge.
- Before pressing the discharge button, call "Clear!" three times: As "Clear" is called the first time, ensure that you are not touching the patient, bed, or equipment; as "Clear" is called the second time, ensure that no one is touching the bed, the patient, or equipment, including the endotracheal tube or adjuncts; and as "Clear" is called the third time, perform a final visual check to ensure that you and everyone else are clear of the patient and anything touching the patient.
- Record the delivered energy.
- After the defibrillation, immediately resume CPR, starting with chest compressions.
- After five cycles (about 2 minutes) of CPR, check the cardiac rhythm and deliver another shock if indicated. Administer a vasoactive or antiarrhythmic medication as soon as possible after the rhythm check.
- After the event is complete, inspect the skin under the pads or paddles for burns; if any are detected, consult with the physician or a wound care nurse about treatment.

### *Electrical Cardioversion*

Electrical **cardioversion** involves the delivery of a "timed" electrical current to terminate a tachydysrhythmia. In cardioversion, the defibrillator is set to synchronize with the ECG on a cardiac monitor so that the electrical impulse discharges during ventricular depolarization (QRS complex). The synchronization prevents the discharge from occurring during the vulnerable period of repolarization (T wave), which could result in VT or ventricular fibrillation. The ECG monitor connected to the external defibrillator usually displays a mark or line that indicates sensing of a QRS complex. Sometimes the lead and the electrodes must be changed for the monitor to recognize the patient's QRS complex. When the synchronizer is on, no electrical current is delivered if the defibrillator does not discern a QRS complex. Therefore, it is important to ensure that the patient is connected to the monitor and to select a lead (not "paddles") that has the most appropriate sensing of the QRS. Because there may be a short delay until recognition of the QRS, the discharge buttons of an external manual defibrillator must be held down until the shock has been delivered. In most monitors, the synchronization mode must be reactivated if the initial cardioversion was ineffective and another cardioversion is needed (ie, the device defaults to unsynchronized defibrillation mode).

If the cardioversion is elective and the dysrhythmia has lasted longer than 48 hours, anticoagulation for a few weeks before cardioversion may be indicated. Digoxin is usually withheld for 48 hours before cardioversion to ensure the resumption of sinus rhythm with normal conduction. The patient is instructed not to eat or drink for at least 4 hours before the procedure. Gel-covered paddles or conductor pads are positioned front and back (anteroposteriorly) for cardioversion. Before cardioversion, the patient receives moderate sedation IV as well as an analgesic medication or anesthesia. Respiration is then supported with supplemental oxygen delivered by a bag-mask-valve device with suction equipment readily available. Although patients rarely require intubation, equipment is nearby in case it is needed. The amount of voltage used varies from 50 to 360 J, depending on the defibrillator's technology, the type and duration of the dysrhythmia, and the size and hemodynamic status of the patient. If ventricular fibrillation occurs after cardioversion, the defibrillator is used to defibrillate the patient (synchronization mode is *not* used).

Indications of a successful response are conversion to sinus rhythm, adequate peripheral pulses, and adequate blood pressure. Because of the sedation, airway patency must be maintained and the patient's state of consciousness assessed. Vital signs and oxygen saturation are monitored and recorded until the patient is stable and recovered from sedation and analgesic medications or anesthesia. ECG monitoring is required during and after cardioversion.

### Defibrillation

Defibrillation is used in emergency situations as the treatment of choice for ventricular fibrillation and pulseless VT, the most common cause of abrupt loss of cardiac function and sudden cardiac death. Defibrillation is not used for patients who are conscious or have a pulse. The sooner defibrillation is used, the better the survival rate: If it is used within 1 minute of the onset of VT or fibrillation, the survival rate is 90%; if it is delayed for 12 minutes, the survival rate is only 2% to 5%. Several studies have demonstrated that early defibrillation performed by lay people in a community setting can increase the survival rate. If immediate CPR is provided and defibrillation is performed within 5 minutes, more adults in ventricular fibrillation may survive with intact neurologic function (AHA, 2005). A large multisite study found that the availability of AEDs in public places and their use shortened the interval from collapse to rhythm recognition and defibrillation, which significantly increased the number of survivors (Hazinski, Idris, Kerber, et al., 2005). However, only a minority of prehospital arrests occur in public places, and prediction of the exact locations of future arrests is difficult. Therefore, although AEDs are clinically effective, money spent on AED equipment and training may be better spent on prevention interventions (Pell, Walker & Cobber, 2007).

Defibrillation depolarizes a critical mass of myocardial cells all at once; when they repolarize, the sinus node usually recaptures its role as the pacemaker. The electrical voltage required to defibrillate the heart is usually greater than that required for cardioversion and may cause more myocardial damage. Defibrillators are classified as monophasic or biphasic. Monophasic defibrillators deliver current in only one direction and require increased energy loads. Newer biphasic defibrillators deliver the electrical charge to the positive paddle, which then reverses back to the originating paddle. This system allows for lower, possibly nonprogressive energy levels (eg, 150 J with each defibrillation) with potentially less myocardial damage. If defibrillation was unsuccessful, CPR is immediately initiated and other advanced life support treatments are begun.

Epinephrine or vasopressin is administered after defibrillation to make it easier to convert the dysrhythmia to a normal rhythm with the next defibrillation. These medications may also increase cerebral and coronary artery blood flow. Antiarrhythmic medications such as amiodarone, lidocaine, or magnesium are administered if ventricular dysrhythmia persists (see Table 27-1). This treatment with continuous CPR, medication administration, and defibrillation continues until a stable rhythm resumes or until it is determined that the patient cannot be revived.

## Pacemaker Therapy

A pacemaker is an electronic device that provides electrical stimuli to the heart muscle. Pacemakers are usually used when a patient has a permanent or temporary slower-than-normal impulse formation, or a symptomatic AV or ventricular conduction disturbance. They may also be used to control some tachydysrhythmias that do not respond to medication. Biventricular (both ventricles) pacing, also called resynchronization therapy, may be used to treat advanced heart failure that does not respond to medication. Pacemaker technology also may be used in an implantable cardioverter defibrillator (eg, in patients with coronary artery disease and a reduced ejection fraction). (See Chapter 30 for further discussion of heart failure.)

Pacemakers can be permanent or temporary. Temporary pacemakers are used to support patients until they improve or receive a permanent pacemaker (eg, after acute MI or during open heart surgery). Temporary pacemakers are used only in hospital settings.

### Pacemaker Design and Types

Pacemakers consist of two components: an electronic pulse generator and pacemaker electrodes, which are located on leads or wires. The generator contains the circuitry and batteries that determine the rate (measured in beats per minute) and the strength or output (measured in milliamperes [mA]) of the electrical stimulus delivered to the heart. The generator also has circuitry that can detect the intracardiac electrical activity to cause an appropriate response; this component of pacing is called **sensitivity** and is measured in millivolts (mV). Sensitivity is set at the level that the intracardiac electrical activity must exceed to be sensed by the device. Leads, which carry the impulse created by the generator to the heart, can be threaded by fluoroscopy through a major vein into the heart, usually the right atrium and ventricle (endocardial leads), or they can be lightly sutured onto the outside of the heart and brought through the chest wall during open heart surgery (epicardial wires). The epicardial wires are always temporary and are removed by a gentle tug a few days after surgery. The endocardial leads may be temporarily placed with catheters through a vein (usually the femoral, subclavian, or internal jugular vein [transvenous wires]), usually guided by fluoroscopy. The leads may also be part of a specialized pulmonary artery catheter (see Chapter 30). However, obtaining a pulmonary artery wedge pressure may cause the leads to move out of pacing position. The endocardial and epicardial wires are connected to a temporary generator, which is about the size of a small paperback book. The energy source for a temporary generator is a common household battery. Monitoring for pacemaker malfunctioning and battery failure is a nursing responsibility.

The endocardial leads also may be placed permanently, passed into the heart through the subclavian, axillary, or cephalic vein, and connected to a permanent generator. Most current leads have a fixation mechanism (eg, a screw) at the end of the lead that allows precise positioning and avoidance of dislodgement. The permanent generator, which often weighs less than 1 oz and is the size of a thick credit card, is usually implanted in a subcutaneous pocket created in the pectoral region, below the clavicle, or behind the breast, especially in young women (Fig. 27-27). This

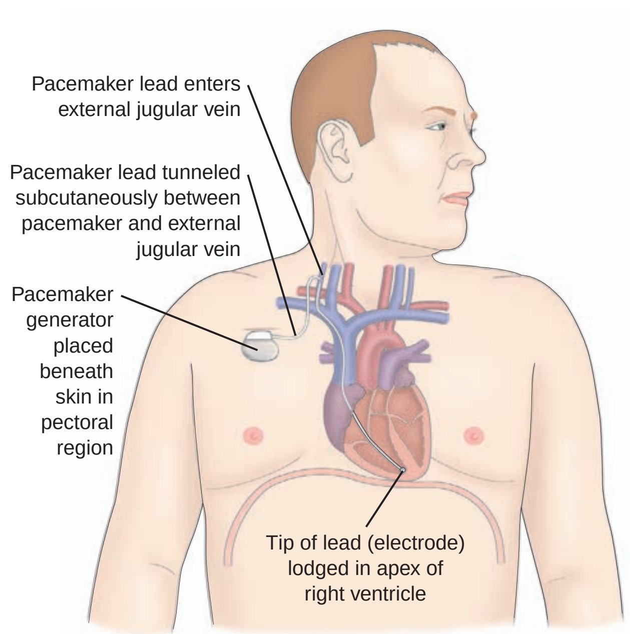



**Figure 27-27** Implanted transvenous pacing lead (with electrode) and pacemaker generator.

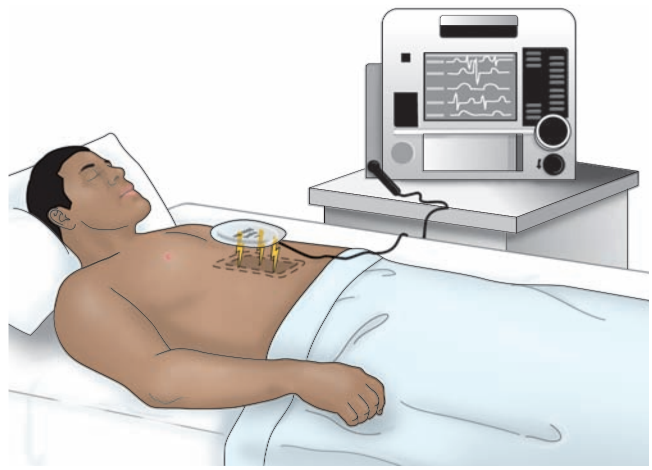


**Figure 27-28** Transcutaneous pacemaker with electrode pads connected to the anterior and posterior chest walls.

procedure usually takes about 1 hour, and it is performed in a cardiac catheterization laboratory using a local anesthetic and moderate sedation. Close monitoring of the respiratory status is needed until the patient is fully awake.

Permanent pacemaker generators are insulated to protect against body moisture and warmth and have filters that protect them from electrical interference from most household devices, motors, and appliances. Several different energy sources for permanent generators have been used and others have been investigated, but lithium cell units are most often used today. They last approximately 6 to 12 years, depending on the type of pacemaker, how it is programmed, and how often it is used. Most pacemakers have an **elective replacement indicator (ERI),** a signal that indicates when the battery is approaching depletion. The pacemaker continues to function for several months after the appearance of ERI to ensure that there is adequate time for a battery replacement. Although some batteries are rechargeable, most are not. Because the battery is permanently sealed in the pacemaker, the entire generator must be replaced. To replace a failing generator, the leads are disconnected, the old generator is removed, and a new generator is reconnected to the existing leads and reimplanted in the already existing subcutaneous pocket. Sometimes the leads are also replaced. Battery replacement is usually performed using a local anesthetic. Hospitalization is necessary for implantation or battery replacement; the patient usually can be discharged the next day.

If a patient suddenly develops a bradycardia, is symptomatic but has a pulse, and is unresponsive to atropine, emergency pacing may be started with transcutaneous pacing, which most defibrillators are now equipped to perform. AEDs are not yet able to do transcutaneous pacing. Large pacing ECG electrodes (sometimes the same conductive pads used for cardioversion and defibrillation) are placed on the patient's chest and back. The electrodes are connected to the defibrillator, which is the temporary pacemaker generator (Fig. 27-28). Because the impulse must travel through the patient's skin and tissue before reaching the heart, transcutaneous pacing can cause significant discomfort and is intended to be used only in emergencies. This type of pacing necessitates hospitalization. If the patient is alert, sedation and analgesia may be administered. Transcutaneous pacing is not indicated for pulseless bradycardia.

### Pacemaker Generator Functions

Because of the sophistication and wide use of pacemakers, a universal code has been adopted to provide a means of safe communication about their function. The coding is referred to as the NASPE-BPEG code because it is sanctioned by the North American Society of Pacing and Electrophysiology (now called the Heart Rhythm Society) and the British Pacing and Electrophysiology Group. The complete code consists of five letters and was revised in 2002 (Bernstein, Daubert, Fletcher, et al., 2002). The fourth and fifth letters are used only with permanent pacemakers.

- The first letter of the code identifies the chamber or chambers being paced (ie, the chamber containing a pacing electrode). The letter characters for this code are A (atrium), V (ventricle), or D (dual, meaning both A and V).
- The second letter identifies the chamber or chambers being sensed by the pacemaker generator. Information from the electrode within the chamber is sent to the generator for interpretation and action by the generator. The letter characters are A (atrium), V (ventricle), D (dual), and O (indicating that the sensing function is turned off).
- The third letter of the code describes the type of response that will be made by the pacemaker to what is sensed. The letter characters used to describe this response are I (**inhibited**), T (**triggered**), D (dual, inhibited and triggered), and O (none). Inhibited response means that the response of the pacemaker is controlled by the activity of the patient's heart; that is, when the patient's heart beats the pacemaker does not

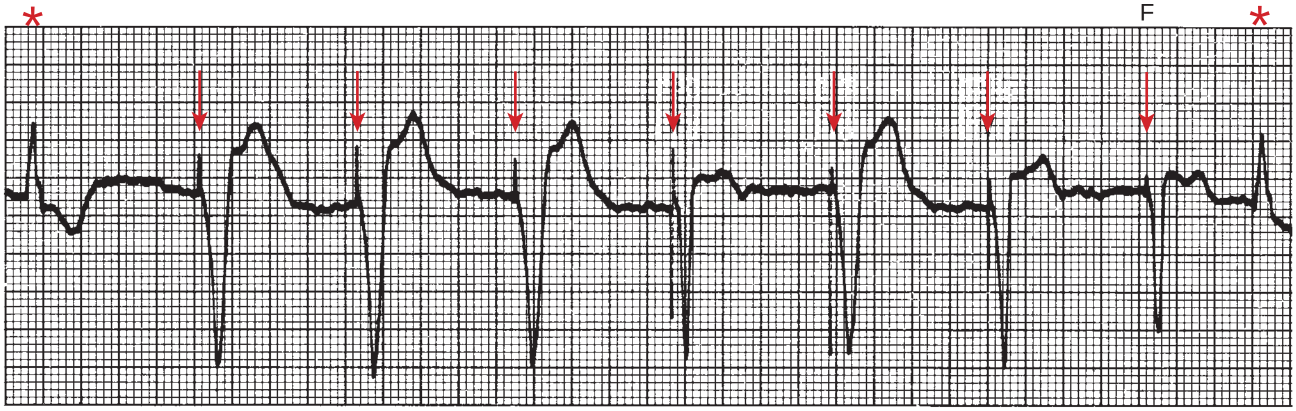



**Figure 27-29** Pacing with appropriate sensing (on-demand pacing) in lead $V_1$. Arrows denote pacing spike. Asterisk denotes intrinsic (patient's own) beats; therefore, no pacing. F denotes a fusion beat, which is a combination of an intrinsic beat and a paced beat occurring at the same time.

function, but when the heart does not beat, the pacemaker does function. In contrast, triggered response means that the pacemaker responds (paces the heart) when it senses intrinsic heart activity.

- The fourth letter of the code is related to a permanent generator's ability to vary the heart rate. This ability is available in most current pacemakers. The possible letters are O, indicating no rate responsiveness, or R, indicating that the generator has rate modulation (ie, the pacemaker has the ability to automatically adjust the pacing rate from moment to moment based on parameters such as QT interval, physical activity, acid-base changes, body temperature, rate and depth of respirations, or oxygen saturation). A pacemaker with rate-responsive ability is capable of improving cardiac output during times of increased cardiac demand, such as exercise, and decreasing the incidence of atrial fibrillation (Fuster, et al., 2008).
- The fifth letter of the code has two different indications: (1) that the permanent generator has multisite pacing capability with the letters A (atrium), V (ventricle), D (dual), and O (none); or (2) that the pacemaker has an antitachycardia function.

Commonly, only the first three letters are used for a pacing code. An example of a NASPE-BPEG code is DVI:

**D:** Both the atrium and the ventricle have a pacing electrode in place.

**V:** The pacemaker is sensing the activity of the ventricle only.

**I:** The pacemaker's stimulating effect is inhibited by ventricular activity—in other words, it does not create an impulse when the pacemaker senses that the patient's ventricle is active.

The pacemaker paces the atrium and then the ventricle when no ventricular activity is sensed for a period of time (the time is individually programmed into the pacemaker for each patient).

The type of generator and its selected settings depend on the patient's dysrhythmia, underlying cardiac function, and age. A straight vertical line usually can be seen on the ECG when pacing is initiated. The line that represents pacing is called a pacemaker spike. The appropriate ECG complex should immediately follow the pacing spike; therefore, a P wave should follow an atrial pacing spike and a QRS complex should follow a ventricular pacing spike. Because the impulse starts in a different place than the patient's normal rhythm, the QRS complex or P wave that responds to pacing looks different from the patient's normal ECG complex. *Capture* is a term used to denote that the appropriate complex followed the pacing spike.

Pacemakers are generally set to sense and respond to intrinsic activity, which is called on-demand pacing (Fig. 27-29). If the pacemaker is set to pace but not to sense, it is called a fixed or asynchronous pacemaker (Fig. 27-30); this is written in pacing code as AOO or VOO. The pacemaker paces at a constant rate, independent of the patient's intrinsic rhythm. Because AOO pacing stimulates only the atrium, it may be used in a patient who has undergone open

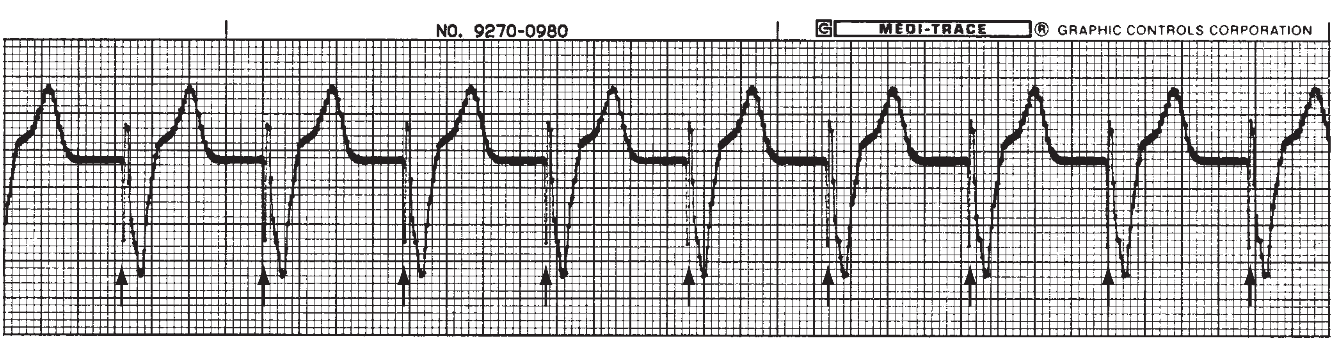



**Figure 27-30** Fixed pacing or total loss of sensing pacing in lead $V_1$; arrows denote pacing spikes.

heart surgery and develops sinus bradycardia. AOO pacing ensures synchrony between atrial stimulation and ventricular stimulation (and therefore contraction), as long as the patient has no conduction disturbances in the AV node. VOO pacing is rare because of the risk that the pacemaker may deliver an impulse during the vulnerable repolarization phase, leading to VT. The occurrence of this type of pacing may indicate battery failure.

VVI (V, paces the ventricle; V, senses ventricular activity; I, paces only if the ventricles do not depolarize) pacing causes loss of AV synchrony and atrial kick, which may cause a decrease in cardiac output and an increase in atrial distention and venous congestion. This can lead to pacemaker syndrome, causing symptoms such as chest discomfort, shortness of breath, fatigue, activity intolerance, and postural hypotension. In addition, atrial pacing and dual-chamber (right atrial and right ventricular) pacing have been found to reduce the incidence of atrial fibrillation; however, research has not yet shown that this reduction decreases the incidence of heart failure or mortality (Olshansky, Day, Moore, et al., 2007; Sweeney, Bank, Nsah, et al., 2007). Long-term right ventricular pacing and dual-chamber pacing allows AV synchrony but also induces left from right ventricular conduction and, therefore, ventricular dysfunction (Fuster, et al., 2008).

Synchronized biventricular pacing, also called cardiac resynchronized therapy (CRT), has been found to modify the intraventricular, interventricular, and atrial-ventricular conduction defects identified with symptomatic moderate to severe (New York Heart Association Functional Class III and IV) left ventricular dysfunction and heart failure. The generator for biventricular pacing has three leads: one for the right atrium; one for the right ventricle, as with most standard pacemaker generators; and one for the left ventricle, usually placed in the left lateral wall. This therapy improves cardiac function, resulting in decreased heart failure symptoms and an improved quality of life (Trupp, 2004). Biventricular pacing may be used with an implantable cardioverter defibrillator.

### Complications of Pacemaker Use

Complications associated with pacemakers relate to their presence within the body and improper functioning. The following complications may arise from a pacemaker:

- Local infection at the entry site of the leads for temporary pacing, or at the subcutaneous site for permanent generator placement. Prophylactic antibiotics and antibiotic irrigation of the subcutaneous pocket prior to generator placement has decreased the rate of infection to less than 2% (Fuster, et al., 2008).
- Pneumothorax. However, the current procedure and use of safe sheaths reduce this risk.
- Bleeding and hematoma at the lead entry sites for temporary pacing or at the subcutaneous site for permanent generator placement. This usually can be managed with cold compresses and discontinuation of antiplatelet and antithrombotic medications.
- Hemothorax from puncture of the subclavian vein or internal mammary artery.
- Ventricular ectopy and tachycardia from irritation of the ventricular wall by the endocardial electrode.
- Movement or dislocation of the lead placed transvenously (perforation of the myocardium).
- Phrenic nerve, diaphragmatic (hiccuping may be a sign), or skeletal muscle stimulation if the lead is dislocated or if the delivered energy (mA) is set high. The occurrence of this complication is avoided by testing during device implantation.
- Cardiac perforation resulting in pericardial effusion and rarely, cardiac tamponade, which may occur at the time of implantation or months later. This condition can be recognized by the change in QRS complex morphology, diaphragmatic stimulation, or hemodynamic instability.
- Twiddler syndrome may occur when the patient manipulates the generator, causing lead dislodgement or fracture of the lead.
- Pacemaker syndrome (hemodynamic instability caused by ventricular pacing and the loss of AV synchrony). This causes mild symptoms in more than 20% of ventricularly paced patients and severe symptoms in 5% to 7% of these patients (Fuster, et al., 2008).

In the initial hours after a temporary or permanent pacemaker is inserted, the most common complication is dislodgment of the pacing electrode. Minimizing patient activity can help prevent this complication. If a temporary electrode is in place, the extremity through which the catheter has been advanced is immobilized. With a permanent pacemaker, the patient is instructed initially to restrict activity on the side of the implantation.

The ECG is monitored very carefully to detect pacemaker malfunction. Improper pacemaker function, which can arise from failure in one or more components of the pacing system, is outlined in Table 27-2. The following data should be noted on the patient's record: model of pacemaker, type of generator, date and time of insertion, location of pulse generator, stimulation threshold, and pacer settings (eg, rate, energy output [mA], sensitivity [mV], and duration of interval between atrial and ventricular impulses [AV delay]). This information is important for identifying normal pacemaker function and diagnosing pacemaker malfunction.

A patient experiencing pacemaker malfunction may develop bradycardia as well as signs and symptoms of decreased cardiac output. The degree to which these symptoms become apparent depends on the severity of the malfunction, the patient's level of dependency on the pacemaker, and the patient's underlying condition. Pacemaker malfunction is diagnosed by analyzing the ECG. Manipulating the electrodes, changing the generator's settings, or replacing the pacemaker generator or leads (or both) may be necessary.

Inhibition of permanent pacemakers or reversion to asynchronous fixed rate pacing can occur with exposure to strong electromagnetic fields (electromagnetic interference [EMI]). However, recent pacemaker technology allows patients to safely use most household electronic appliances and devices (eg, microwave ovens, electric tools). Gas-powered engines should be turned off before working on them. Objects that contain magnets (eg, the earpiece of a phone; large stereo speakers; mattresses, jewelry, and wraps) should not be near the generator for longer than a few seconds. Patients are advised to place digital cellular phones at least 6 to 12 inches away from (or on the side opposite of)

**Table 27-2 ASSESSING PACEMAKER MALFUNCTION**

| Problem | Possible Cause | Intervention |
|---|---|---|
| Loss of capture–complex does *not* follow pacing spike | Inadequate stimulus<br>Lead dislodgement<br>Lead wire fracture<br>Catheter malposition<br>Battery depletion<br>Electronic insulation break<br>Medication change<br>Myocardial ischemia | Check security of all connections; increase milliamperage.<br>Reposition extremity; turn patient to left side.<br>Change battery.<br>Change generator. |
| Undersensing-pacing spike occurs at preset interval despite patient's intrinsic rhythm | Sensitivity too high<br>Electrical interference (eg, by a magnet)<br>Faulty generator | Decrease sensitivity.<br>Eliminate interference.<br>Replace generator. |
| Oversensing-loss of pacing artifact; pacing does not occur at preset interval despite lack of intrinsic rhythm | Sensitivity too low<br>Electrical interference<br>Battery depletion<br>Change in medication | Increase sensitivity.<br>Eliminate interference.<br>Change battery. |
| Loss of pacing-total absence of pacing spikes | Oversensing<br>Battery depletion<br>Loose or disconnected wires<br>Perforation | Change battery.<br>Check security of all connections.<br>Apply magnet over permanent generator.<br>Obtain 12-lead ECG and portable chest x-ray. Assess for murmur. Contact physician. |
| Change in pacing QRS shape | Septal perforation | Obtain 12-lead ECG and portable chest x-ray. Assess for murmur. Contact physician. |
| Rhythmic diaphragmatic or chest wall twitching or hiccuping | Output too high<br>Myocardial wall perforation | Decrease milliamperage.<br>Turn pacer off. Contact physician at once. Monitor closely for decreased cardiac output. |

the pacemaker generator and not to carry them in a shirt pocket. Large electromagnetic fields, such as those produced by magnetic resonance imaging, radio and television transmitter towers and lines, transmission power lines (not the distribution lines that bring electricity into a home), and electrical substations may cause EMI. Patients should be cautioned to avoid such situations or to simply move farther away from the area if they experience dizziness or a feeling of rapid or irregular heartbeats (palpitations). Welding and the use of a chain saw should be avoided. If such tools are used, precautionary steps such as limiting the welding current to a 60- to 130-ampere range or using electric rather than gasoline-powered chain saws are advised.

In addition, the metal of the pacemaker generator may trigger store and library antitheft devices as well as airport and building security alarms; however, these alarm systems generally do not interfere with the pacemaker function. Patients should walk through them quickly and avoid standing in or near these devices. The handheld screening devices used in airports may interfere with the pacemaker. Patients should be advised to ask security personnel to perform a hand search instead of using the handheld screening device. Patients also should be instructed to wear or carry medical identification to alert personnel to the presence of the pacemaker.

### *Pacemaker Surveillance*

Pacemaker clinics have been established to monitor patients and to test pulse generators for impending pacemaker battery failure. A computerized device is held over the generator to "interrogate" it with painless radio signals; it detects the generator's settings, battery status and the presence of ERI, pacing threshold, sensing function, lead integrity, pacing data (eg, number of pacing events), and other stored information. Several factors, such as lead fracture, muscle inhibition, and insulation disruption, also may be assessed depending on the type of pacemaker and the equipment available. If indicated, the pacemaker is turned off for a few seconds, using a magnet or a programmer, while the ECG is recorded to assess the patient's underlying cardiac rhythm. Transtelephonic transmission of the generator's information is another follow-up method. Special equipment is used to transmit information about the patient's pacemaker over the telephone to a receiving system at a pacemaker clinic. The information is converted into tones; equipment at the clinic converts these tones to an electronic signal and records them on an ECG strip. The pacemaker rate and other data concerning pacemaker function are obtained and evaluated by a cardiologist. This simplifies the diagnosis of a failing generator, reassures the patient, and improves management when the patient is physically remote from pacemaker testing facilities. The frequency of the pacemaker checks varies with the patient's age and underlying condition, the degree of pacemaker dependency, the age and type of the device, the results from previous pacemaker checks, and physician preference. A typical follow-up schedule is every 2 weeks during the first month, every 4 to 8 weeks for 3 years, and every 4 weeks thereafter.

## Implantable Cardioverter Defibrillator

The **implantable cardioverter defibrillator (ICD)** is an electronic device that detects and terminates life-threatening episodes of tachycardia or fibrillation, especially those that are ventricular in origin. Patients at high risk of VT or ventricular fibrillation are those who have survived sudden cardiac death syndrome, usually caused by ventricular fibrillation, or have experienced spontaneous, symptomatic VT (syncope secondary to VT) not due to a reversible cause. Other people at risk of sudden cardiac death include those with dilated cardiomyopathy, hypertrophic cardiomyopathy, arrhythmogenic right ventricular dysfunction, and idiopathic

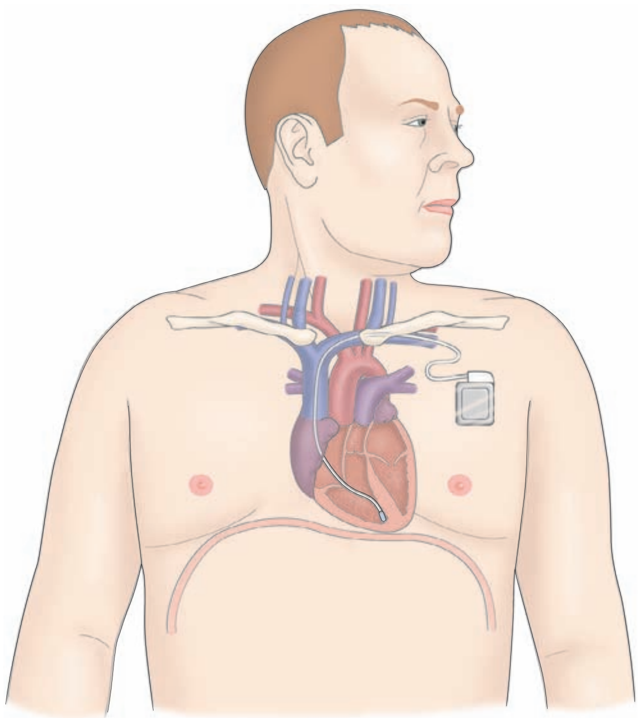


**Figure 27-31** The implantable cardioverter defibrillator (ICD) consists of a generator and a sensing/pacing/defibrillating electrode.

prolonged QT syndrome. In addition, patients with moderate to severe left ventricular dysfunction (ejection fraction of 40% or less), with or without nonsustained VT, with ischemic heart disease or nonischemic dilated cardiomyopathy, and a QRS duration of more than 150 milliseconds are at high risk for cardiac arrest; therefore, prophylactic implantation may be indicated (Fuster, et al., 2008). ICDs may also be implanted in patients with symptomatic, recurrent, medication-refractory atrial fibrillation.

An ICD has a generator about the size of a book of matches and at least a right ventricular lead that can sense intrinsic electrical activity and deliver an electrical impulse. The implantation procedure, postimplantation care, and length of hospitalization are much like those for insertion of a pacemaker (Fig. 27-31). ICDs are designed to respond to two criteria: a rate that exceeds a predetermined level and a change in the isoelectric line segments. When a dysrhythmia occurs, rate sensors require a set duration of time to sense the dysrhythmia. Then the device automatically charges, and, after a second "look" confirms the dysrhythmia, it delivers the programmed charge through the lead to the heart. The time from dysrhythmia detection to electrical discharge depends on the charging time, which depends on the programmed energy level (Fuster, et al., 2008). However, in an ICD that has the capability of providing atrial therapies, the device can be programmed to be activated by the patient, giving the patient time to activate the charge at a time and place of his or her choosing. The life of the lithium battery is about 9 years but varies depending on use of the ICD. ICD surveillance is similar to that of the pacemaker; however, it includes stored endocardial electrocardiograms and information about the number and frequency of shocks that have been delivered.

Antiarrhythmic medication usually is administered with this technology to minimize the occurrence of the tachydysrhythmia and to reduce the frequency of ICD discharge.

Several types of devices are available and may be programmed for multiple treatments (Fuster, et al., 2008). ICD, the generic name, is used as the abbreviation for these various devices. Each device offers a different delivery sequence, but all are capable of delivering high-energy (high-intensity) defibrillation to treat a tachycardia (atrial or ventricular). The device may deliver up to six shocks if necessary.

Some ICDs can respond with (1) antitachycardia pacing, in which the device delivers electrical impulses at a fast rate in an attempt to disrupt the tachycardia, (2) low-energy (low-intensity) cardioversion, or (3) defibrillation; others may use all three techniques (Fuster, et al., 2008). Antitachycardia pacing is used to terminate tachycardias caused by a conduction disturbance called reentry, which is repetitive restimulation of the heart by the same impulse. An impulse or a series of impulses is delivered to the heart by the device at a fast rate to collide with and stop the heart's reentry conduction impulses and therefore to stop the tachycardia. Some ICDs also have pacemaker capability if the patient develops bradycardia, which sometimes occurs after treatment of the tachycardia. Usually the mode is VVI (V, paces the ventricle; V, senses ventricular activity; I, paces only if the ventricles do not depolarize). Some ICDs also treat atrial fibrillation (Fuster, et al., 2008).

Which device is used and how it is programmed depend on the patient's dysrhythmia(s). The device may be programmed differently for different dysrhythmias (eg, ventricular fibrillation, ventricular tachycardia with a fast ventricular rate, and ventricular tachycardia with a slow ventricular rate). As with pacemakers, there is a NASPE-BPEG code for communicating the functions of the ICDs (Berstein, et al., 2002). The first letter represents the chamber or chambers shocked (O, none; A, atrium; V, ventricle; D, both atrium and ventricle). The second letter represents the chamber that can be antitachycardia paced (O, A, V, D, meaning the same as the first letter). The third letter indicates the method used by the generator to detect a tachycardia (E, electrogram; H, hemodynamics). The last letter represents the chambers that have antibradycardia pacing (O, A, V, D, meaning the same as the first and second letters of the ICD code).

One significant issue with ICDs is cost. Although ICDs reduce the number of sudden cardiac deaths, they are costly and should be used by people for whom the benefits are the most substantial. A large research trial showed that the cost-effectiveness of ICDs improved over time, especially for people who were 65 years of age or older with QRS duration of 0.12 seconds or longer (Zwanziger, Hall, Dick, et al., 2006).

Complications of ICD implantation are similar to those associated with pacemaker insertion. The primary complication is surgery-related infection; its risk increases with battery or lead replacement (Fuster, et al., 2008). A few complications are associated with the technical aspects of the equipment, like those of pacemakers, such as premature battery depletion and dislodged or fractured leads. Inappropriate delivery of ICD therapy, usually due to oversensing or atrial and sinus tachycardias with a rapid ventricular rate response, is the most frequent complication. This requires reprogramming of the device.

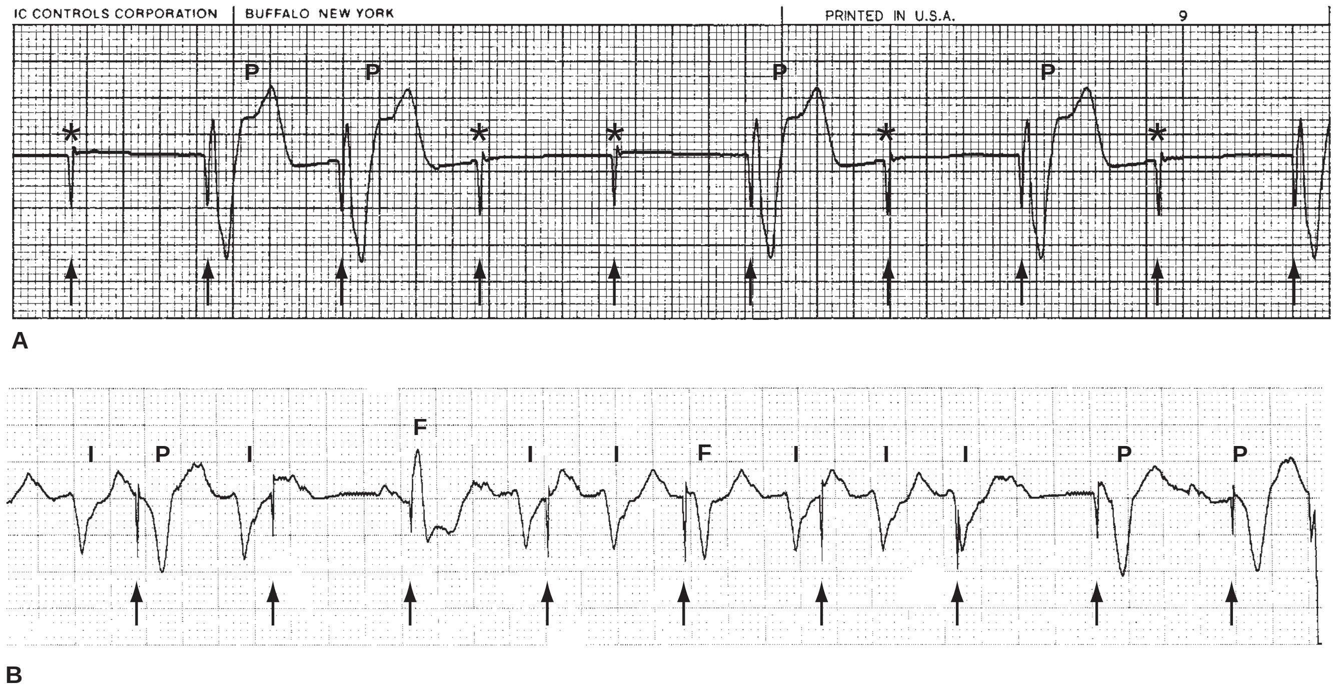



**Figure 27-32** **A,** Ventricular pacing with intermittent loss of capture (a pacing spike not followed by a QRS complex). **B,** Ventricular pacing with loss of sensing (a pacing spike occurring at an inappropriate time). ↑, pacing spike; *, loss of capture; P, pacemaker-induced QRS complex; I, patient's intrinsic QRS complex; F, fusion (a QRS complex formed by a merging of the patient's intrinsic QRS complex and the pacemaker-induced QRS complex). Both in lead $V_1$.

### *Nursing Management of the Patient With an Implantable Cardiac Device*

After a permanent electronic device (pacemaker or ICD) is inserted, the patient's heart rate and rhythm are monitored by ECG. The device's settings are noted and compared with the ECG recordings to assess the device's function. For example, pacemaker malfunction is detected by examining the pacemaker spike and its relationship to the surrounding ECG complexes (Fig. 27-32). In addition, cardiac output and hemodynamic stability are assessed to identify the patient's response to pacing and the adequacy of pacing. The appearance or increasing frequency of dysrhythmia is observed and reported to the physician. If the patient has an ICD implanted and develops VT or ventricular fibrillation, the ECG should be recorded to note the time between the onset of the dysrhythmia and the onset of the device's shock or antitachycardia pacing.

The incision site where the generator was implanted is observed for bleeding, hematoma formation, or infection, which may be evidenced by swelling, unusual tenderness, drainage, and increased warmth. The patient may complain of continuous throbbing or pain. These symptoms are reported to the physician.

A chest x-ray is usually taken after the procedure and prior to discharge to document the position of leads in addition to ensuring that the procedure did not cause a pneumothorax. It is necessary to assess the function of the device throughout its lifetime and especially after changes in the patient's medication regimen. For example, antiarrhythmics, beta-blockers, and diuretics may increase the pacing threshold, whereas corticosteroids and alpha adrenergics may decrease the pacing threshold; the opposite effect occurs when the patient is taken off these medications.

The patient is also assessed for anxiety, depression, or anger, which may be symptoms of ineffective coping with the implantation. In addition, the level of knowledge and learning needs of the patient and family and the history of adherence to the therapeutic regimen should be identified. It is especially important to include the family when providing education and support.

In the perioperative and postoperative phases, the nurse carefully observes the patient's responses to the device and provides the patient and family with further teaching as needed (Chart 27-3). The nurse also assists the patient and family in addressing concerns and in making decisions about self-care and lifestyle changes necessitated by the dysrhythmia and resulting device implantation.

#### Preventing Infection

The nurse changes the dressing as needed and inspects the insertion site for redness, swelling, soreness, or any unusual drainage. Any change in wound appearance, an increase in the patient's temperature, or an increase in the patient's white blood cell count should be reported to the physician.

#### Promoting Effective Coping

The patient treated with an electronic device experiences not only lifestyle and physical changes but also emotional changes. At different times during the healing process, the patient may feel angry, depressed, fearful, anxious, or a combination of these emotions. Although each patient uses individual coping strategies (eg, humor, prayer, communication

CHART 27-3

HOME CARE CHECKLIST

## *The Patient With an Implantable Cardiac Device*

| At the completion of home care instructions, the patient and significant other will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| **Avoid infection at the insertion site of the device.** | | |
| • Leave the incision uncovered and observe it daily for redness, increased swelling, and heat. | ✔ | ✔ |
| • Take temperature at same time each day; report any increase. | ✔ | ✔ |
| • Avoid wearing tight restrictive clothing that may cause friction over the insertion site. | ✔ | |
| • Initially avoid soaking in the tub and lotion, creams, or powders in the area of the device. | ✔ | |
| **Adhere to activity restrictions.** | | |
| • Restrict movement of arm until incision heals; do not raise arm above head for 2 weeks. | ✔ | ✔ |
| • Avoid heavy lifting for a few weeks. | ✔ | ✔ |
| • Discuss safety of activities (eg, driving) with physician. | ✔ | ✔ |
| • Avoid contact sports. | ✔ | |
| • Recognize that, although it may take up to 2 to 3 weeks to resume normal activities, physical activity does not usually have to be curtailed, with the exception of contact sports. | ✔ | ✔ |
| **Electromagnetic interference: Understand the importance of the following:** | | |
| • Avoid large magnetic fields such as those created by magnetic resonance imaging, large motors, arc welding, electrical substations, and so forth. Magnetic fields may deactivate the device, negating its effect on a dysrhythmia. | ✔ | |
| • At security gates at airports, government buildings, or other secured areas, show identification card and request a hand (not handheld device) search. Obtain and carry a physician's letter about this requirement. | ✔ | |
| • Some electrical and small motor devices, as well as products that contain magnets (eg, cellular phones), may interfere with the functioning of the cardiac device if the electrical device is placed very close to it. Avoid leaning directly over large electrical devices or motors, or ensure contact is of brief duration; place cellular phone on opposite side of cardiac device. | ✔ | |
| • Household appliances (eg, microwave ovens) should not cause any concern. | ✔ | ✔ |
| **Promote safety.** | | |
| • Describe what to do if symptoms occur and notify physician if any discharges seem unusual. | ✔ | ✔ |
| • Maintain a log that records discharges of an ICD. Record events that precipitate the sensation of shock. This provides important data for the physician to use in readjusting the medical regimen. | ✔ | ✔ |
| • Encourage family members to attend a CPR class. | | ✔ |
| • Call 911 for emergency assistance if feeling of dizziness occurs. | ✔ | ✔ |
| • Wear medical identification (eg, Medic-Alert) that includes physician information. | ✔ | |
| • Avoid frightening family or friends with unexpected shocks from an ICD, which will not harm them. Inform family and friends that in the event they are in contact with the patient when a shock is delivered, they may also feel the shock. It is especially important to warn sexual partners that this may occur. | ✔ | ✔ |
| • Carry medical identification with physician's name, type and model number of the device, manufacturer's name, and hospital where device was inserted. | ✔ | ✔ |
| **Follow-up care.** | | |
| • Discuss psychological responses to the device implantation, such as changes in self-image, depression due to loss of mobility secondary to driving restrictions, fear of shocks, increased anxiety, concerns that sexual activity may trigger the device, and changes in partner relationship. | ✔ | ✔ |
| • Adhere to appointments that are scheduled to monitor the electronic performance of the cardiac device. This is especially important during the first month after implantation and near the end of the battery life. Remember to take a log of ICD discharges to review with physician. | ✔ | ✔ |
| • For patients with pacemakers, check pulse daily. Report *immediately* any sudden slowing or increasing of the pulse rate. This may indicate pacemaker malfunction. | ✔ | ✔ |
| • Attend a cardiac device support group within the area. | ✔ | |
| • Hospitalization may be necessary periodically to change battery or replace pacemaker unit. | ✔ | ✔ |

with a significant other) to manage emotional distress, some strategies may work better than others. Signs that may indicate ineffective coping include social isolation, increased or prolonged irritability or depression, and difficulty in relationships.

To promote effective coping strategies, the nurse must recognize the patient's as well as the family's perceptions of the situation and their resulting emotional state and assist them to explore their reactions and feelings. Because of the unpredictable and possibly painful ICD discharge, patients with ICDs are most vulnerable to feelings of helplessness, leading to depression. The nurse can help the patient identify positive methods to deal with the actual or perceived limitations and manage any lifestyle changes needed. The nurse may help the patient identify changes (eg, loss of ability to participate in contact sports), the emotional responses to the change (eg, anger), and how the patient responds to that emotion (eg, quickly becomes angry when talking with spouse). The nurse reassures the patient that the responses are normal and helps the patient identify realistic goals (eg, develop interest in another activity) and develop a plan to attain these goals. The patient and family should be encouraged to talk about their experiences and emotions with each other and the health care team. The nurse may refer the patient and family to a hospital, community, or online support group. The nurse may also encourage the use of spiritual resources. The nurse also may teach the patient easy-to-use stress reduction techniques (eg, deep-breathing exercises) to facilitate coping. Instructing the patient about the ICD may help the patient to cope with changes that occur as a result of device implantation (see Chart 27-3).

**Promoting Home and Community-Based Care**

After device insertion, the patient's hospital stay may be 1 day or less, and follow-up in an outpatient clinic or office is common. The patient's anxiety and feelings of vulnerability may interfere with the ability to learn information provided. The nurse needs to include caregivers in the teaching and provide printed materials for use by the patient and caregiver. The nurse establishes priorities for learning with the patient and caregiver. Teaching may include the importance of periodic device monitoring, promoting safety, surgical site care, and avoiding EMI (see Chart 27-3). In addition, the educational plan should include information about activities that are safe and those that may be dangerous. The nurse discusses with the patient and family what they are to do when a shock is delivered. The nurse may facilitate CPR training for the family.

## Electrophysiologic Studies

An EP study is an invasive procedure used to evaluate and treat various dysrhythmias that have caused cardiac arrest or significant symptoms. It also is indicated for patients with symptoms that suggest a dysrhythmia that has gone undetected and undiagnosed by other methods. Because an EP study is invasive, it is performed in the hospital and may require that the patient be admitted. An EP study is used to do the following:

- Identify the impulse formation and propagation through the cardiac electrical conduction system
- Assess the function or dysfunction of the SA and AV nodal areas
- Identify the location (called mapping) and mechanism of dysrhythmogenic (the ability to cause dysrhythmias) foci
- Assess the effectiveness of antiarrhythmic medications and devices for the patient with a dysrhythmia
- Treat certain dysrhythmias through the destruction of the causative cells (**ablation**)

An EP procedure is a type of cardiac catheterization that is performed in a specially equipped cardiac catheterization laboratory by an electrophysiologist, who is a cardiologist with specialized training, assisted by other EP laboratory personnel. The patient is conscious but lightly sedated. Usually a catheter with multiple electrodes is inserted through a small incision in the femoral vein, threaded through the inferior vena cava, and advanced into the heart; however, depending on the type of study and the information needed, a second catheter may be inserted into the femoral artery. The electrodes are positioned within the heart at specific locations—for instance, in the right atrium near the sinus node, in the coronary sinus, near the tricuspid valve, and at the apex of the right ventricle. The number and placement of electrodes depend on the type of study being conducted. These electrodes allow the electrical signal to be recorded from within the heart (intracardiogram).

The electrodes also allow the clinician to introduce a pacing stimulus to the intracardiac area at a precisely timed interval and rate, thereby stimulating the area (programmed stimulation). An area of the heart may be paced at a rate much faster than the normal rate of **automaticity,** the rate at which impulses are spontaneously formed (eg, in the sinus node). This allows the pacemaker to become an artificial focus of automaticity and to assume control (overdrive suppression). Then the pacemaker is stopped suddenly, and the time it takes for the sinus node to resume control is assessed. A prolonged time indicates dysfunction of the sinus node.

One of the main purposes of programmed stimulation is to assess the ability of the area surrounding the electrode to cause a reentry dysrhythmia. One or a series of premature impulses is delivered to an area in an attempt to cause the tachydysrhythmia. Because the precise location of the suspected area and the specific timing of the pacing needed are unknown, the electrophysiologist uses several different techniques to cause the dysrhythmia during the study. If the dysrhythmia can be reproduced by programmed stimulation, it is called inducible. Once a dysrhythmia is induced, a treatment plan is determined and implemented. If, on the follow-up EP study, the tachydysrhythmia cannot be induced, then the treatment is determined to be effective. Different medications may be administered and combined with electrical devices (pacemaker, ICD) to determine the most effective treatment to suppress the dysrhythmia.

Patient care, patient teaching, and associated complications of an EP study are similar to those associated with cardiac catheterization (see Chapter 26). The study is usually about 2 hours in length; however, if the electrophysiologist conducts not only a diagnostic procedure but also treatment, the study can take up to 6 hours. During the procedure, patients benefit from a calm, reassuring approach.

Patients who are to undergo an EP study may be anxious about the procedure and its outcome. A detailed discussion

involving the patient, the family, and the electrophysiologist usually occurs to ensure that the patient can give informed consent and to reduce the patient's anxiety about the procedure. Before the procedure, the patient should receive instructions about the procedure and its usual duration, the environment where the procedure is performed, and what to expect. Although an EP study is not painful, it does cause discomfort and can be tiring. It may also cause feelings that were experienced when the dysrhythmia occurred in the past. In addition, patients are taught what will be expected of them (eg, lying very still during the procedure, reporting symptoms or concerns).

The patient should also know that the dysrhythmia may occur during the procedure. It often stops on its own; if it does not, treatment is given to restore the patient's normal rhythm. The dysrhythmia may have to be terminated using cardioversion or defibrillation, but this is performed under more controlled circumstances than if performed in an emergency.

Postprocedural care is similar to that for cardiac catheterization, including restriction of activity to promote hemostasis at the insertion site. To identify any complications and to ensure healing, the patient's vital signs and the appearance of the insertion site are assessed frequently. Because an artery is not always used, there is a lower incidence of vascular complications than with other catheterization procedures. Cardiac arrest may occur, but the incidence is low (less than 1%) (Fuster, et al., 2008).

## Cardiac Conduction Surgery

Atrial tachycardias and ventricular tachycardias that do not respond to medications and are not suitable for antitachycardia pacing may be treated by methods that include a maze procedure and ablation. Hospitalization is required for both procedures.

### Maze Procedure

The maze procedure is an open heart surgical procedure for refractory atrial fibrillation. Small transmural incisions are made throughout the atria. The resulting formation of scar tissue prevents reentry conduction of the electrical impulse. Because the procedure requires significant time and cardiopulmonary bypass, its use is reserved only for those patients undergoing cardiac surgery for other reason (eg, coronary artery bypass) (Fuster, et al., 2008). In addition, some patients need a permanent pacemaker after the surgery.

### Catheter Ablation Therapy

Catheter ablation destroys specific cells that are the cause or central conduction route of a tachydysrhythmia. It is performed with or after an EP study. Usual indications for ablation are AVNRT, a recurrent atrial dysrhythmia (especially atrial fibrillation), or VT unresponsive to previous therapy (or for which the therapy produced significant side effects).

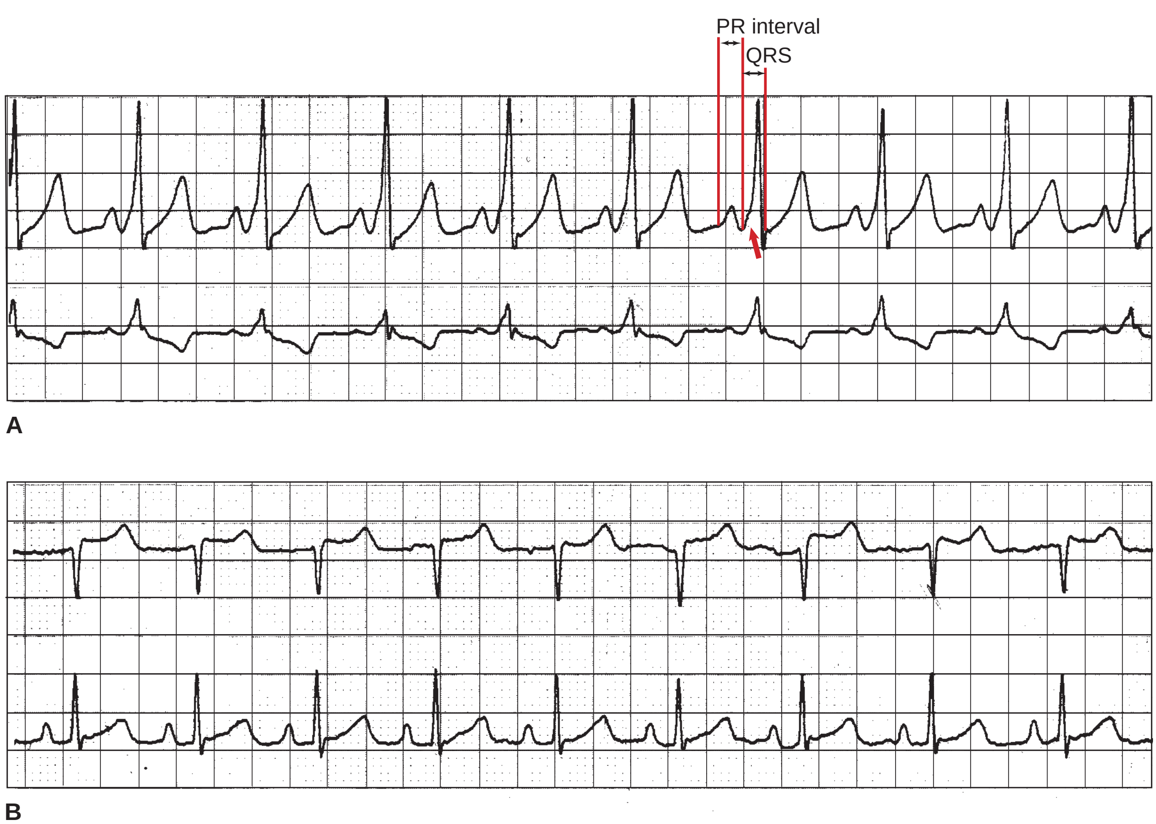



**Figure 27-33** Wolff-Parkinson-White syndrome. **A,** Sinus rhythm. Note the short PR interval, slurred initial upstroke of the QRS complex (delta wave, at the arrow), and prolonged QRS duration, upper lead II, lower lead $V_1$. **B,** Rhythm strip of same patient following ablation, upper lead $V_1$, lower lead II. ECG strips courtesy of Linda Ardini and Catherine Berkmeyer, Inova Fairfax Hospital, Falls Church, VA.

Ablation is also indicated to eliminate accessory AV pathways or bypass tracts that exist in the hearts of patients with preexcitation syndromes such as WPW syndrome. During normal embryonic development, all connections between the atria and ventricles disappear, except for that between the AV node and the bundle of His. In some people, embryonic connections of normal heart muscle between the atria and ventricles remain, providing an accessory pathway or a tract through which the electrical impulse can bypass the AV node. These pathways can be located in several different areas. If the patient develops atrial fibrillation, the impulse may be conducted into the ventricle at a rate of 300 times per minute or more, which can lead to ventricular fibrillation and sudden cardiac death. Preexcitation syndromes are identified by specific ECG findings. For example, in WPW syndrome there is a shortened PR interval, slurring (called a delta wave) of the initial QRS deflection, and prolonged QRS duration (Fig. 27-33).

Ablation is most often accomplished by using radiofrequency, which involves placing a special catheter at or near the origin of the dysrhythmia. High-frequency, low-energy sound waves are passed through the catheter, causing thermal injury and cellular changes that result in localized destruction and scarring. The tissue damage is more specific to the dysrhythmic tissue, with less trauma to the surrounding cardiac tissue than occurs with cryoablation (extreme cold) or electrical ablation. Although cryoablation has less risk of causing AV block and has been found to be less painful to the patient, the procedure takes longer and has lower acute and long-term efficacy rates (Fuster, et al., 2008).

During the ablation procedure, defibrillation pads, an automatic blood pressure cuff, and a pulse oximeter are used and an indwelling urinary catheter is inserted. The patient is usually given moderate sedation. An EP study is performed to induce the dysrhythmia. The ablation catheter is placed at the origin of the dysrhythmia, and the ablation procedure is performed. Multiple ablations may be necessary. Successful ablation is achieved when the dysrhythmia can no longer be induced. The patient is monitored for another 30 to 60 minutes and then retested to ensure that the dysrhythmia does not recur.

Postprocedural care on a step-down unit is similar to that for an EP study, except that the patient is monitored more closely, depending on the time needed for recovery from sedation. Major risks of catheter ablation include pericardial tamponade, phrenic nerve injury, stroke, pulmonary vein stenosis, and atrioesophageal fistulas (Fuster, et al., 2008).

## CRITICAL THINKING EXERCISES

EBP **1** You are caring for a 69-year-old woman who had an acute MI and received thrombolytic therapy. You notice that her pulse is irregular and your analysis of the ECG strip indicates that she has sinus rhythm and frequent PVCs. What are some of the possible causes of this dysrhythmia? Identify some of the key factors that would need to be included in your assessment to assist in identification of the cause of the dysrhythmia. What nursing interventions are needed? What is the evidence base that supports these nursing interventions? Discuss the strength of the evidence and the criteria used to evaluate the strength of the evidence.

EBP **2** You are caring for a 40-year-old man who recently had an AV sequential pacemaker inserted, with the rate set at 72 bpm. When taking his pulse, you note that his heart rate is 66 bpm. Describe the possible causes of this difference in heart rate and the nursing actions that are needed. The patient's wife tells you that her husband has informed her that now that he has a pacemaker, they must get rid of their microwave oven. What would you say to the wife and patient about this? What other education would you provide to them about safety in relation to the pacemaker? What is the evidence base that supports this education? Discuss the strength of the evidence and the criteria used to evaluate the strength of the evidence.

EBP **3** You are working as an occupational health nurse in a building that employs several people with significant cardiac risk factors. The organization's safety officer has asked you about purchasing and installing an AED. What other information would you need before you reply? Discuss the evidence that supports your answer.

**4** Your patient is an 89-year-old man with atrial fibrillation. He is complaining about all the pills that he is taking and the time-consuming monitoring of them. He tells you that he wants to stop taking his antithrombotic medication. What are his options? How would you discuss this issue with him? How would you explore his issue about medications?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Association of Critical Care Nurses, www.aacn.org
American Association of Heart Failure Nurses, http://aahfn.org
American College of Cardiology, www.acc.org
American Heart Association, National Center, www.americanheart.org
Heart Rhythm Society, www.hrsonline.org
National Heart, Lung, Blood Institute, Health Information Center, National Institutes of Health, www.nhlbi.nih.gov
National Institute on Aging, www.nia.nih.gov



chapter 28

# Management of Patients With Coronary Vascular Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the pathophysiology, clinical manifestations, and treatment of coronary atherosclerosis.
2. Describe the pathophysiology, clinical manifestations, and treatment of angina pectoris.
3. Use the nursing process as a framework for care of patients with angina pectoris.
4. Describe the pathophysiology, clinical manifestations, and treatment of myocardial infarction.
5. Use the nursing process as a framework for care of a patient with acute coronary syndrome.
6. Describe percutaneous coronary interventional and coronary artery revascularization procedures.
7. Describe the nursing care of a patient who has had a percutaneous coronary interventional procedure for treatment of coronary artery disease.
8. Describe the nursing care of a patient who has undergone cardiac surgery.

## GLOSSARY

**acute coronary syndrome (ACS):** signs and symptoms that indicate unstable angina or acute myocardial infarction

**angina pectoris:** chest pain brought about by myocardial ischemia

**atheroma:** fibrous cap composed of smooth muscle cells that forms over lipid deposits within arterial vessels and protrudes into the lumen of the vessel, narrowing the lumen and obstructing blood flow; also called plaque

**atherosclerosis:** abnormal accumulation of lipid deposits and fibrous tissue within arterial walls and the lumen

**contractility:** ability of the cardiac muscle to shorten in response to an electrical impulse

**coronary artery bypass graft (CABG):** a surgical procedure in which a blood vessel from another part of the body is grafted onto the occluded coronary artery below the occlusion in such a way that blood flow bypasses the blockage

**creatine kinase (CK):** an enzyme found in human tissues; one of the three types of CK is specific to heart muscle and may be used as an indicator of heart muscle injury

## GLOSSARY *(Continued)*

**high-density lipoprotein (HDL):** a protein-bound lipid that transports cholesterol to the liver for excretion in the bile; composed of a higher proportion of protein to lipid than low-density lipoprotein; exerts a beneficial effect on the arterial wall

**ischemia:** insufficient tissue oxygenation

**low-density lipoprotein (LDL):** a protein-bound lipid that transports cholesterol to tissues in the body; composed of a lower proportion of protein to lipid than high-density lipoprotein; exerts a harmful effect on the arterial wall

**metabolic syndrome:** a cluster of metabolic abnormalities including insulin resistance, obesity, dyslipidemia, and hypertension that increase the risk of cardiovascular disease

**myocardial infarction (MI):** death of heart tissue caused by lack of oxygenated blood flow

**percutaneous coronary intervention (PCI):** an invasive procedure in which a catheter is placed in a coronary artery, and one of several methods is employed to remove or reduce a blockage within the artery

**percutaneous transluminal coronary angioplasty (PTCA):** a type of percutaneous coronary intervention in which a balloon is inflated within a coronary artery to break an atheroma and open the vessel lumen, improving coronary artery blood flow

**stent:** a woven mesh that provides structural support to a coronary vessel, preventing its closure

**sudden cardiac death:** abrupt cessation of effective heart activity

**thrombolytic:** an agent or process that breaks down blood clots

**troponin:** myocardial protein; measurement is used to assess heart muscle injury

Cardiovascular disease is the leading cause of death in the United States for men and women of all racial and ethnic groups (American Heart Association [AHA], 2007). Research related to the identification and treatment of cardiovascular disease includes all segments of the population affected by cardiac conditions, including women, children, and people of diverse racial and ethnic backgrounds. This research aims to identify specific prevention and treatment strategies in these populations.

# CORONARY ARTERY DISEASE

Coronary artery disease (CAD) is the most prevalent type of cardiovascular disease in adults. For this reason, it is important for nurses to become familiar with various manifestations of coronary artery conditions and methods for assessing, preventing, and treating these disorders.

## *Coronary Atherosclerosis*

The most common cause of cardiovascular disease in the United States is **atherosclerosis,** an abnormal accumulation of lipid, or fatty substances, and fibrous tissue in the lining of arterial blood vessel walls. These substances block and narrow the coronary vessels in a way that reduces blood flow to the myocardium. Atherosclerosis involves a repetitious inflammatory response to injury of the artery wall and subsequent alteration in the structural and biochemical properties of the arterial walls. New information that relates to the development of atherosclerosis has increased the understanding of treatment and prevention of this progressive and potentially life-threatening process.

### Pathophysiology

Atherosclerosis is thought to begin as fatty streaks of lipids that are deposited in the intima of the arterial wall. These lesions commonly begin early in life, perhaps even in childhood. Not all fatty streaks later develop into advanced lesions. Genetics and environmental factors are involved in the progression of these lesions. The development of atherosclerosis over many years involves an inflammatory response, which begins with injury to the vascular endothelium (Futterman & Lemberg, 2006). The injury may be initiated by smoking, hypertension, and other factors. The presence of inflammation has multiple effects on the arterial wall, including the attraction of inflammatory cells, such as monocytes (macrophages). The macrophages ingest lipids, becoming "foam cells" that transport the lipids into the arterial wall. Activated macrophages also release biochemical substances that can further damage the endothelium, attracting platelets and initiating clotting (Carreiro-Lewandowski, 2006).

Smooth muscle cells within the vessel wall subsequently proliferate and form a fibrous cap over a core filled with lipid and inflammatory infiltrate. These deposits, called **atheromas** or plaques, protrude into the lumen of the vessel, narrowing it and obstructing blood flow (Fig. 28-1). Plaque may be stable or unstable, depending on the degree of inflammation and thickness of the fibrous cap. If the fibrous cap over the plaque is thick and the lipid pool remains relatively stable, it can resist the stress of blood flow and vessel movement. If the cap is thin and inflammation is ongoing, the lesion becomes what is called vulnerable plaque. At this point, the lipid core may grow, causing it to rupture and hemorrhage into the plaque. A ruptured plaque is a focus for thrombus formation. The thrombus may then obstruct blood flow, leading to **acute coronary syndrome (ACS),** which may result in an acute **myocardial infarction (MI)** if quick, decisive action is not taken. When an MI occurs, a portion of the heart muscle becomes necrotic.

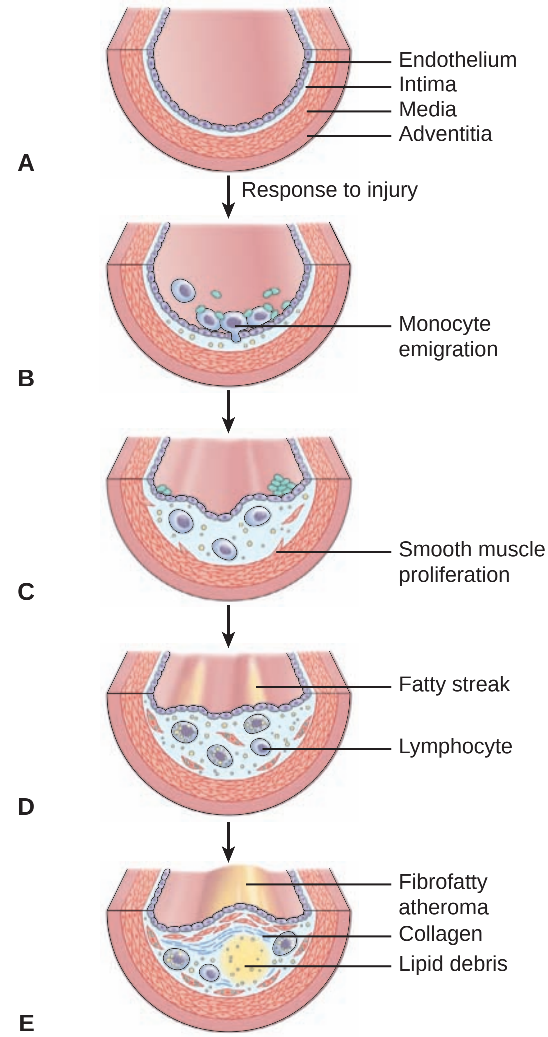



**Figure 28-1** **A, B,** Atherosclerosis begins as monocytes and lipids enter the intima of an injured vessel. Smooth muscle cells proliferate within the vessel wall, **C,** contributing to the development of fatty accumulations and atheroma, **D.** As the plaque enlarges, the vessel narrows and blood flow decreases, **E.** The plaque may rupture and a thrombus might form, obstructing blood flow.

The anatomic structure of the coronary arteries makes them particularly susceptible to the mechanisms of atherosclerosis. As Figure 28-2 shows, the three major coronary arteries have multiple branches. Atherosclerotic lesions most often form where the vessels branch, suggesting a hemodynamic component that favors their formation (Porth & Matfin, 2009). Although heart disease is most often caused by atherosclerosis of the coronary arteries, other phenomena

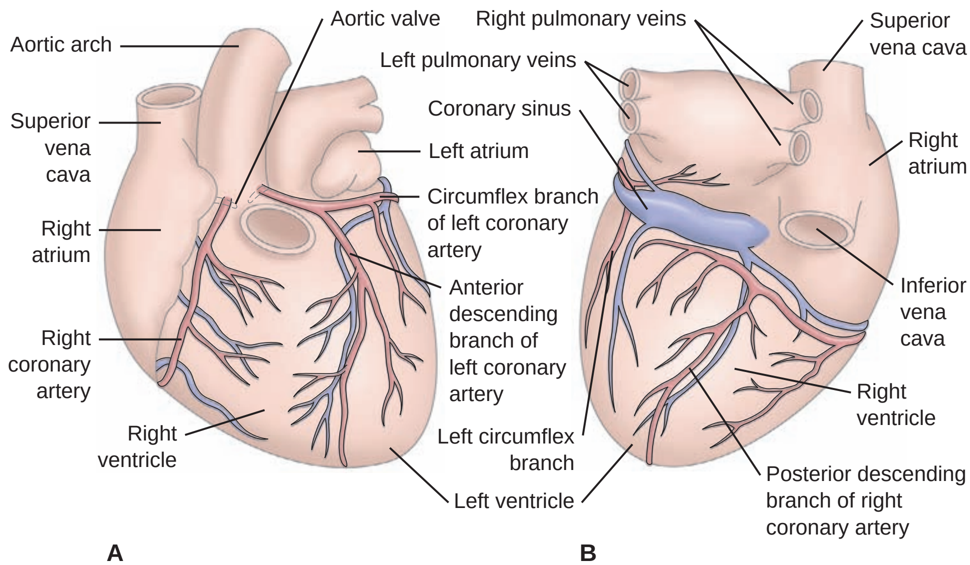



**Figure 28-2** The coronary arteries supply the heart muscle with oxygenated blood, adjusting the flow according to metabolic needs. **A,** Anterior view and, **B,** posterior view of heart.

may also decrease blood flow to the heart. Examples include vasospasm (sudden constriction or narrowing) of a coronary artery, myocardial trauma from internal or external forces, structural disease, congenital anomalies, decreased oxygen supply (eg, from acute blood loss, anemia, or low blood pressure), and increased oxygen demand (eg, from rapid heart rate, thyrotoxicosis, or use of cocaine).

## Clinical Manifestations

CAD produces symptoms and complications according to the location and degree of narrowing of the arterial lumen, thrombus formation, and obstruction of blood flow to the myocardium. This impediment to blood flow is usually progressive, causing an inadequate blood supply that deprives the cardiac muscle cells of oxygen needed for their survival. The condition is known as **ischemia. Angina pectoris** refers to chest pain that is brought about by myocardial ischemia. Angina pectoris usually is caused by significant coronary atherosclerosis. If the decrease in blood supply is great enough, of long enough duration, or both, irreversible damage and death of myocardial cells may result. Over time, irreversibly damaged myocardium undergoes degeneration and is replaced by scar tissue, causing various degrees of myocardial dysfunction. Significant myocardial damage may result in persistently low cardiac output and heart failure where the heart cannot support the body's needs for blood. A decrease in blood supply from CAD may even cause the heart to abruptly stop beating **(sudden cardiac death).**

The most common manifestation of myocardial ischemia is the onset of chest pain. However, the classic epidemiologic study of the people in Framingham, Massachusetts, showed that nearly 15% of men and women who had coronary events, which included unstable angina, MIs, or sudden cardiac death events, were totally asymptomatic prior to the coronary event (Kannel, 1986). Patients with myocardial ischemia may present to an emergency department or clinic with a variety of symptoms other than chest pain. Patients who are older or have a history of diabetes or heart failure may report symptoms such as shortness of breath. Many women have been found to have atypical symptoms, including dyspnea, nausea, and weakness (Canto, Goldberg, Hand, et al., 2007). Prodromal symptoms may occur (ie, angina a few hours to days before the acute episode), or a major cardiac event may be the first indication of coronary atherosclerosis.

## Risk Factors

Epidemiologic studies point to several factors that increase the probability that a person will develop heart disease. Major risk factors are listed in Chart 28-1. Some people do not have classic risk factors. Elevated **low-density lipoprotein (LDL)** cholesterol, also known as bad cholesterol, is the primary target of cholesterol-lowering therapy. People at highest risk for having a cardiac event within 10 years are those with known CAD or those with diabetes, peripheral arterial disease, abdominal aortic aneurysm, or carotid artery disease. The latter diseases are called CAD risk equivalents, because patients with these diseases have the same risk for a cardiac event as patients with CAD. The likelihood of having a cardiac event within 10 years is also affected by factors such as age, systolic blood pressure, smoking history, level of total cholesterol, level of LDL, and level of **high-density lipoprotein (HDL),** also known as good cholesterol.

In addition, a cluster of metabolic abnormalities known as **metabolic syndrome** has emerged as a major risk factor for cardiovascular disease (Porth & Matfin, 2009; Xu & Whitmer, 2006; Zacho, Tyboerg-Hanson, Jensen, et al., 2008). A diagnosis of this syndrome includes three of the following conditions:

- Insulin resistance (fasting plasma glucose more than 100 mg/dL or abnormal glucose tolerance test)
- Central obesity (waist circumference more than 35 inches in women, more than 40 inches in men)
- Dyslipidemia (triglycerides more than 150 mg/dL, HDL less than 50 mg/dL in women, less than 40 mg/dL in men)
- Blood pressure persistently greater than 130/85 mm Hg
- Proinflammatory state (high levels of C-reactive protein)
- Prothrombotic state (high fibrinogen level)

**CHART 28-1** ***Risk Factors for Coronary Artery Disease***

A modifiable risk factor is one over which a person may exercise control, such as by changing a lifestyle or personal habit or by using medication. A nonmodifiable risk factor is a circumstance over which a person has no control. A risk factor may operate independently or in tandem with other risk factors. The more risk factors a person has, the greater the likelihood of coronary artery disease (CAD). Those at risk are advised to seek regular medical examinations and to engage in "heart-healthy" behavior (a deliberate effort to reduce the number and extent of risks).

**Nonmodifiable Risk Factors**

Family history of CAD (first-degree relative with cardiovascular disease at 55 years of age or younger for men and at 65 years of age or younger for women)
Increasing age (more than 45 years for men; more than 55 years for women)
Gender (men develop CAD at an earlier age than women)
Race (higher incidence of heart disease in African Americans than in Caucasians)

**Modifiable Risk Factors**

Hyperlipidemia
Cigarette smoking, tobacco use
Hypertension
Diabetes mellitus
Metabolic syndrome
Obesity
Physical inactivity

**Physiology ■■■ Pathophysiology**

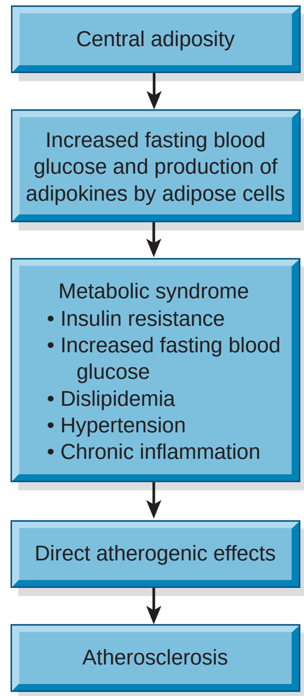



**Figure 28-3** Pathophysiology of cardiovascular disease in metabolic syndrome. Central adiposity plays a major role in the development of metabolic syndrome. Adipokines (such as leptin) and other hormones and metabolites are thought to contribute to the development of metabolic abnormalities. The eventual effect of these processes is the promotion of atherosclerosis.

Many people with type 2 diabetes mellitus fit this clinical picture. It is theorized that in obese patients, excessive adipose tissue may secrete mediators that lead to metabolic changes. Adipokines (adipose tissue cytokines), free fatty acids, and other substances are known to modify insulin action and contribute to atherogenic changes in the cardiovascular system (Fig. 28-3).

C-reactive protein (CRP) is known to be an inflammatory marker for cardiovascular risk, including acute coronary events and stroke. The liver produces CRP in response to a stimulus such as tissue injury, and high levels of this protein may occur in people with diabetes and those who are likely to have an acute coronary event (Xu & Whitmer, 2006; Zacho, et al., 2008). To determine overall cardiovascular risk, clinicians view high sensitivity (hs-CRP) test results together with other screening tools such as measurements of lipid levels.

## Prevention

Four modifiable risk factors—cholesterol abnormalities, tobacco use, hypertension, and diabetes mellitus—have been cited as major risk factors for CAD and its complications. As a result, they receive much attention in health promotion programs.

### *Controlling Cholesterol Abnormalities*

The Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (ATP III), published in 2001 and updated in 2006, lists the clinical guidelines for cholesterol testing and management (Institute for Clinical Systems Improvement [ICSI], 2006b). These guidelines address primary prevention (preventing the occurrence of CAD) and secondary prevention (preventing the progression of CAD). The association of a high blood cholesterol level with heart disease is well established. The metabolism of fats is an important contributor to the development of heart disease. Fats, which are insoluble in water, are encased in water-soluble lipoproteins that allow them to be transported within the circulatory system. The various lipoproteins are categorized by their protein content, which is measured in density. The density increases when more protein is present. Four elements of fat metabolism—total cholesterol, LDL, HDL, and triglycerides—are known to affect the development of heart disease. Cholesterol is processed by the gastrointestinal tract into lipoprotein globules called chylomicrons. These are reprocessed by the liver as lipoproteins (Fig. 28-4). This is a physiologic process necessary for the formation of lipoprotein-based cell membranes and other important metabolic processes. When an excess of LDL is produced, LDL particles adhere to vulnerable points in the arterial endothelium. Here macrophages ingest them, contributing to plaque formation.

All adults 20 years of age or older should have a fasting lipid profile (total cholesterol, LDL, HDL, and triglyceride) performed at least once every 5 years and more often if the profile is abnormal. Patients who have had an

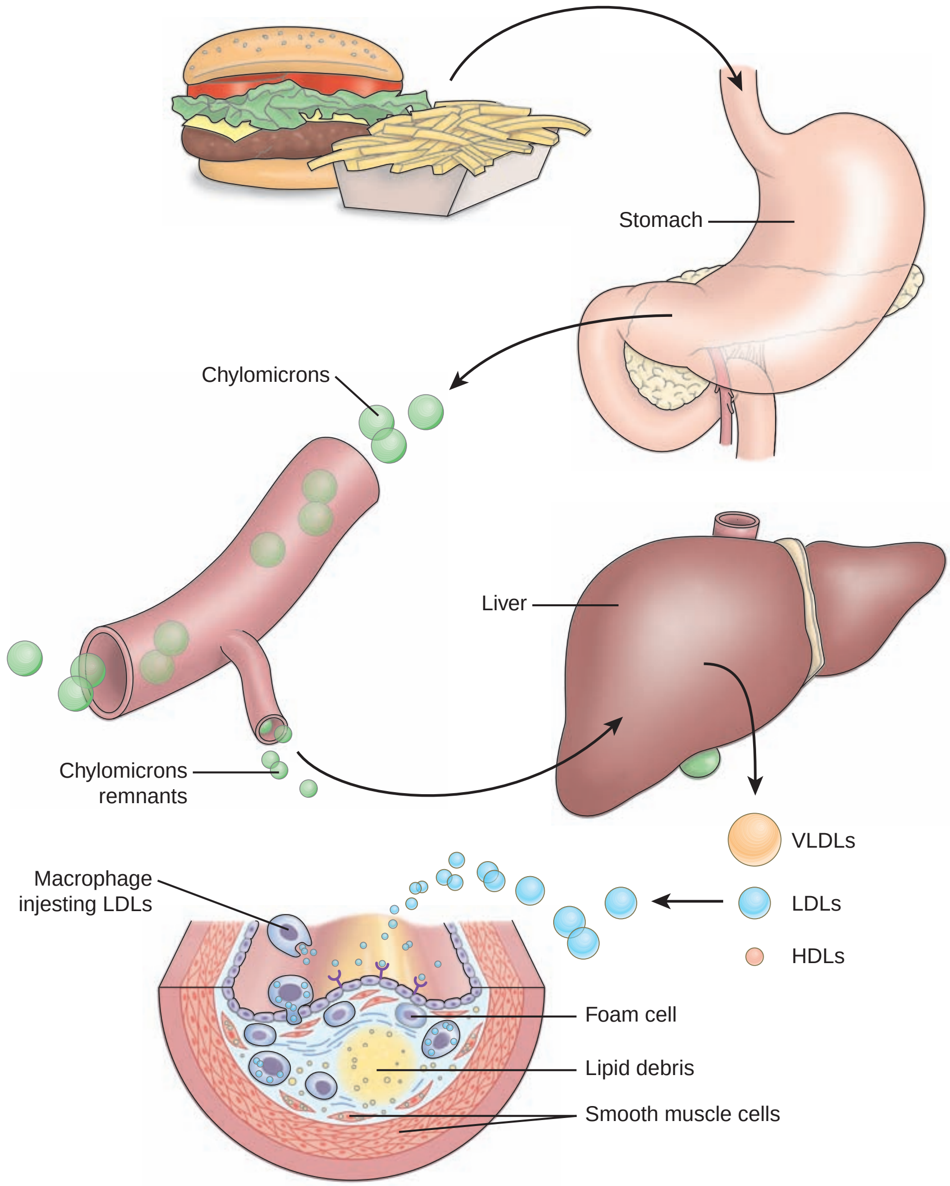



**Figure 28-4** Lipoproteins and the development of atherosclerosis. As dietary cholesterol and saturated fat are processed by the gastrointestinal tract, chylomicrons enter the blood. They are broken down into chylomicron remnants in the capillaries. The liver processes them into lipoproteins. When these are released into the circulation, excess low-density lipoproteins (LDLs) adhere to receptors on the intimal wall. Macrophages also ingest LDLs and transport them into the vessel wall, beginning the process of plaque formation. HDLs, high-density lipoproteins; VLDL, very low-density lipoprotein.

acute event (eg, MI), a **percutaneous coronary intervention (PCI),** or a **coronary artery bypass graft (CABG)** require assessment of their LDL cholesterol level within a few months of the event or procedure because LDL levels may be low immediately after the acute event or procedure. Subsequently, lipids should be monitored every 6 weeks until the desired level is achieved and then every 4 to 6 months. A fasting lipid profile should demonstrate the following values (Grundy, Cleeman, Daniels, et al., 2005):

- LDL cholesterol less than 100 mg/dL (less than 70 mg/dL for very high-risk patients)
- Total cholesterol less than 200 mg/dL
- HDL cholesterol greater than 60 mg/dL
- Triglyceride less than 150 mg/dL

LDL is the target of current therapy because of the known association with advancing CAD. The total cholesterol level is also a clear predictor of coronary events. HDL, as previously stated, is known as good cholesterol because it transports other lipoproteins such as LDL to the liver, where they can be degraded and excreted. Because of this, a high HDL level is a strong negative risk factor for heart disease (ie, it protects against heart disease).

Triglyceride is another fatty substance, made up of fatty acids, that is transported through the blood by a lipoprotein. Although an elevated triglyceride level (more than 200 mg/dL) may be genetic in origin, it also can be caused by obesity, physical inactivity, excessive alcohol intake, high-carbohydrate diets, diabetes mellitus, kidney disease, and certain medications, such as oral contraceptives and corticosteroids.

### Dietary Measures

Table 28-1 provides recommendations of the Therapeutic Lifestyle Changes (TLC) diet (Lichtenstein, Appel, Brands, et al., 2006). These general recommendations may need to

**Table 28-1 NUTRIENT CONTENT OF THE THERAPEUTIC LIFESTYLE CHANGES (TLC) DIET**

| Nutrient | Recommended Intake |
|---|---|
| Total calories* | Balance intake and expenditure to maintain desirable weight |
| Total fat | 25%–35% of total calories |
| Saturated fat† | Less than 7% of total calories |
| Polyunsaturated fat | Up to 10% of total calories |
| Monounsaturated fat | Up to 20% of total calories |
| Carbohydrate‡ | 50%–60% of total calories |
| Dietary fiber | 20–30 g/day |
| Protein | Approximately 15% of total calories |
| Cholesterol | Less than 200 mg/day |

*Daily energy expenditure should include at least moderate physical activity (contributing approximately 200 kcal per day).

†Trans-fatty acids are formed from the processing (manufacturing, hydrogenation) of vegetable oils into a more solid form. The effects of trans-fatty acids are similar to saturated fats (ie, raising low-density lipoprotein and lowering high-density lipoprotein). Intake of trans-fatty acids should be minimized.

‡Carbohydrates should be derived predominately from foods rich in complex carbohydrates, including grains, especially whole grains, fruits, and vegetables.

From Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. (ATP III). *Circulation, 106*(25), 3143–3421.

be adjusted for the individual patient who has other nutritional needs, such as the patient who has diabetes. To assist in following the appropriate TLC diet, the patient should be referred to a registered dietitian. Other TLC recommendations include weight loss, cessation of tobacco use, and increased physical activity.

The Mediterranean diet, another diet that promotes the ingestion of vegetables and fish and restricts red meat, is also reported to reduce mortality from cardiovascular disease (Mitrou, Kipnis, Thiebaut, et al., 2007). People who adopt strict vegetarian diets can significantly reduce blood lipids, blood glucose, body mass index, and blood pressure. However, very intensive dietary programs such as these may not be acceptable to all patients who need to modify risk factors.

In addition, soluble dietary fiber may help reduce cholesterol levels. Soluble fibers, which are found in fresh fruit, cereal grains, vegetables, and legumes, enhance the excretion of metabolized cholesterol. Intake of at least 25 g of fiber each day is recommended (Grundy, Cleeman, Merz, et al., 2004).

Many resources are available to assist people in controlling their cholesterol levels. The National Heart, Lung, and Blood Institute (NHLBI) and its National Cholesterol Education Program (NCEP), the AHA, and the American Diabetes Association (ADA), as well as CAD support groups and reliable Internet sources are a few examples of the available resources. Cookbooks and recipes that include the nutritional contents of foods can be included as resources for patients. Dietary control has been made easier because food manufacturers are required to provide nutritional data on product labels. The label information of interest to a person attempting to eat a heart-healthy diet is as follows: serving size (expressed in household measures), amount of total fat per serving, amount of saturated fat and trans fat per serving, amount of cholesterol per serving, and amount of fiber per serving.

#### Physical Activity

Management of an elevated triglyceride level focuses on weight reduction and increased physical activity. Regular, moderate physical activity increases HDL levels and reduces triglyceride levels, decreasing the incidence of coronary events and reducing overall mortality risk. The goal for most people is a total of 30 minutes of moderate exercise (such as brisk walking) on most days (Leitzmann, Park, Blair, et al., 2007). The nurse helps patients set realistic goals for physical activity. For example, inactive patients can start with activity that lasts 3 minutes, such as parking farther from a building to increase daily walking time. For sustained activity, patients should begin with a 5-minute warm-up period to stretch and prepare the body for exercise. They should end the exercise with a 5-minute cool-down period in which they gradually reduce the intensity of the activity to prevent a sudden decrease in cardiac output. Patients should be instructed to engage in an activity or variety of activities that interest them to maintain motivation. They should also be taught to exercise to an intensity that does not preclude their ability to talk; if they cannot have a conversation while exercising, they should slow down or switch to a less intensive activity. When the weather is hot and humid, patients should exercise during the early morning, or indoors, and wear loose-fitting clothing. When the weather is cold, they should layer clothing and wear a hat. The nurse can also suggest walking in large stores or shopping malls in inclement weather. Patients should stop any activity if chest pain, unusual shortness of breath, dizziness, lightheadedness, or nausea occurs.

#### Medications

If diet alone cannot normalize serum cholesterol levels, medications can have a synergistic effect with the prescribed diet and control cholesterol levels (Table 28-2). Lipid-lowering medications can reduce CAD mortality in patients with elevated lipid levels and in at-risk patients with normal lipid levels (ICSI, 2006b). The lipid-lowering agents affect the lipid components somewhat differently and can be grouped into six types: 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) (or statins), nicotinic acids, fibric acids (or fibrates), bile acid sequestrants (or resins), cholesterol absorption inhibitor, and omega-3 acid-ethyl esters.

### *Promoting Cessation of Tobacco Use*

Cigarette smoking contributes to the development and severity of CAD in the following three ways:

- The inhalation of smoke increases the blood carbon monoxide level. Hemoglobin, the oxygen-carrying component of blood, combines more readily with carbon monoxide than with oxygen. A decreased amount of available oxygen may decrease the heart's ability to pump.
- The nicotinic acid in tobacco triggers the release of catecholamines, which raise the heart rate and blood pressure. Nicotinic acid can also cause the coronary arteries to constrict. Smokers have an increased risk of CAD and sudden cardiac death (Porth & Matfin, 2009). The increase in catecholamines may be a factor in sudden cardiac death.
- Use of tobacco adversely affects the vascular endothelium, resulting in increased platelet adhesion and leading to a higher probability of thrombus formation.

A person at increased risk for heart disease is encouraged to stop tobacco use through any means possible: educational programs, counseling, consistent motivation and

**Table 28-2 MEDICATIONS AFFECTING LIPOPROTEIN METABOLISM**

| Medications | Therapeutic Effects | Considerations |
|---|---|---|
| **HMG-CoA Reductase Inhibitors (statins)**<br>Atorvastatin (Lipitor)<br>Fluvastatin (Lescol)<br>Lovastatin (Mevacor)<br>Pravastatin (Pravachol)<br>Rosuvastatin (Crestor)<br>Simvastatin (Zocor) | ↓ LDL<br>↑ HDL<br>↓ TG<br>Block cholesterol synthesis<br>Favorable effects on vascular endothelium, including anti-inflammatory and antithrombotic effects | Frequently given as initial therapy for significantly elevated cholesterol and LDL levels<br>Myopathy is an adverse effect<br>Monitor hepatic function<br>Contraindicated in liver disease<br>Check for drug interactions<br>Indication for use now includes ACS |
| **Nicotinic Acids**<br>Niacin-extended release (Niaspan)<br>Niacin-intermediate release (Niacor)<br>Niacin-sustained release (Slo-Niacin) | ↓ LDL<br>↑ HDL<br>↓ TG<br>↓ Lipoprotein synthesis | May be used for minimally elevated cholesterol and LDL levels or as an adjunct to a statin when the lipid goal has not been achieved and TG levels are elevated<br>Side effects include flushing, hyperglycemia, hyperuricemia (gout), upper GI distress, and hepatotoxicity<br>Monitor hepatic function<br>Contraindicated in gout and liver failure<br>Dose needs to be titrated weekly to achieve therapeutic dosage |
| **Fibric Acids (fibrates)**<br>Fenofibrate (TriCor)<br>Gemfibrozil (Lopid) | ↑ HDL<br>↓ TG<br>↓ Cholesterol synthesis | Adverse effects include dyspepsia, gallstones, and myopathy<br>Contraindicated in severe renal and liver disease<br>Have potential to ↑ LDL and may be used in patients with TG levels above 400 mL/dL<br>Use with caution in patients who are also taking a statin |
| **Bile Acid Sequestrants**<br>Cholestyramine (Questran)<br>Colestipol (Colestid) | ↓ LDL<br>Slight ↑ HDL<br>Bind cholesterol and ↑ its breakdown | Most often used as adjunct therapy when statins alone have not been effective in controlling lipid levels and TG levels less than 200 mg/dL<br>Side effects include GI distress, constipation, and decreased absorption of other drugs |
| **Cholesterol Absorption Inhibitor**<br>Ezetimibe (Zetia) | ↓ LDL<br>↑ HDL<br>↓ TG | Better tolerated than bile acid sequestrants<br>May be used in combination with other agents, such as statins<br>Side effects include back pain, arthralgia, and abdominal pain |
| **Omega-3-Acid-Ethyl Esters**<br>Fish oil capsules | ↓ TG | May be used alone or in combination with other agents<br>Side effects include GI distress, taste perversion, rash, flu syndrome, and back pain |

ACS, acute coronary syndrome; GI, gastrointestinal; HDL, high-density lipoprotein; HMG-CoA, 3-hydroxy-3-methylglutaryl coenzyme A; LDL, low-density lipoprotein; TG, triglycerides; ↓ decrease, ↑ increase.

From Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. (ATP III) (2002). *Circulation, 106*(25), 3143–3421.

reinforcement messages, support groups, and medications. Some people have found complementary therapies (eg, acupuncture, guided imagery, hypnosis) to be helpful. People who stop smoking reduce their risk of heart disease within the first year, and the risk continues to decline as long as they refrain from smoking (Lichtenstein, et al., 2006).

Use of medications such as the nicotine patch (NicoDerm CQ, Habitrol) or the antidepressant bupropion (Zyban) may assist with stopping use of tobacco (Fraker, Fihn, Gibbons, et al., 2007). Products containing nicotine have some of the same effects as smoking: catecholamine release (increasing heart rate and blood pressure) and increased platelet adhesion. These medications should be used for a short time and at the lowest effective doses.

Exposure to other smokers' smoke (passive or secondhand smoke) is believed to cause heart disease in nonsmokers (Office of the U.S. Surgeon General, 2006). Oral contraceptive use by women who smoke is inadvisable because these medications significantly increase the risk for CAD and sudden cardiac death.

### Managing Hypertension

Hypertension is defined as blood pressure measurements that repeatedly exceed 140/90 mm Hg. The risk of cardiovascular disease increases as blood pressure increases, and people with a blood pressure greater than 120/80 mm Hg are considered prehypertensive and at risk (Rosendorff, Black, Cannon, et al., 2007). Long-standing elevated blood pressure may result in increased stiffness of the vessel walls,

leading to vessel injury and a resulting inflammatory response within the intima. Inflammatory mediators then lead to the release of growth-promoting factors that cause vessel hypertrophy and hyperresponsiveness. These changes result in acceleration and aggravation of atherosclerosis. Hypertension also increases the work of the left ventricle, which must pump harder to eject blood into the arteries. Over time, the increased workload causes the heart to enlarge and thicken (ie, hypertrophy) and may eventually lead to heart failure.

Early detection of high blood pressure and adherence to a therapeutic regimen can prevent the serious consequences associated with untreated elevated blood pressure. Hypertension is discussed in detail in Chapter 32.

#### Controlling Diabetes Mellitus

Diabetes mellitus is known to accelerate the development of heart disease, and for 65% to 75% of patients with diabetes, cardiovascular disease is identified as the cause of death (Zipes, Libby, Bonow, et al., 2005). Hyperglycemia fosters dyslipidemia, increased platelet aggregation, and altered red blood cell function, which can lead to thrombus formation. It has been suggested that these metabolic alterations impair endothelial cell–dependent vasodilation and smooth muscle function, promoting the development of atherosclerosis. Treatment with insulin (eg, Humulin, Novolin) and metformin (Glucophage) and other therapeutic interventions that lower plasma glucose levels can lead to improved endothelial function and patient outcomes. Diabetes is discussed in detail in Chapter 41.

### Gender

Heart disease has long been recognized as a cause of morbidity and mortality in men, but it has not been as readily recognized and treated in women until recent years. Cardiovascular events in women occur an average of 10 years later in life than they do in men; in women older than 55 years of age, the incidence of CAD is approximately equal to that in men (AHA, 2007). Women also tend to have a higher incidence of complications from cardiovascular disease and a higher mortality. In addition, women tend to not recognize the symptoms of CAD as early as men, and they wait longer to report their symptoms and seek medical assistance. More likely to experience unstable angina than an MI, women may present with symptoms other than chest pain (Canto, et al., 2007).

The age difference between women and men newly diagnosed with CAD was traditionally thought to be related to estrogen. It is now recognized that menopause is a milestone in the aging process during which risk factors tend to accumulate. Cardiovascular disease may be well developed by the time of menopause, despite the supposed protective effects of estrogen (Mosca, Banka, Benjamin, et al., 2007). Although hormone therapy (HT) (formerly referred to as hormone replacement therapy) for menopausal women was once promoted as preventive therapy for CAD, research studies do not support HT as an effective means of prevention. HT decreases menopausal symptoms and the risk of osteoporosis-related bone fractures, but it also has been associated with an increased incidence of CAD, breast cancer, deep vein thrombosis, stroke, and pulmonary embolism. Current guidelines do not recommend HT for primary or secondary prevention of CAD. However, women do respond well to other preventive measures such as management of serum lipids (Mosca, et al., 2007).

In the past, women who possibly had coronary vascular events were less likely than men to be referred for coronary artery diagnostic procedures such as heart catheterization or treatment with invasive interventions (eg, PCI). However, as a result of better education of health care professionals and the general public, gender differences now have less influence on diagnosis and treatment. When compared with men, women continue to have poorer outcomes, with increased morbidity and mortality after MI, CABG, and PCI. They also have poorer results related to symptom relief. These differences may be due to older age, more comorbid conditions, smaller coronary arteries, and the distribution of plaque in the coronary arteries (Eastwood & Doering, 2005).

## Angina Pectoris

Angina pectoris is a clinical syndrome usually characterized by episodes or paroxysms of pain or pressure in the anterior chest. The cause is insufficient coronary blood flow, resulting in a decreased oxygen supply when there is increased myocardial demand for oxygen in response to physical exertion or emotional stress. In other words, the need for oxygen exceeds the supply. In general, the severity of the symptoms of angina is based on the magnitude of the precipitating activity and its effect on activities of daily living.

### Pathophysiology

Angina is usually caused by atherosclerotic disease. Almost invariably, angina is associated with a significant obstruction of at least one major coronary artery. Normally, the myocardium extracts a large amount of oxygen from the coronary circulation to meet its continuous demands. When there is an increase in demand, flow through the coronary arteries needs to be increased. When there is blockage in a coronary artery, flow cannot be increased, and ischemia results. The types of angina are listed in Chart 28-2. Several factors are associated with typical anginal pain:

**Chart 28-2 • *Types of Angina***

- **Stable angina:** predictable and consistent pain that occurs on exertion and is relieved by rest and/or nitroglycerin
- **Unstable angina** (also called preinfarction angina or crescendo angina): symptoms increase in frequency and severity; may not be relieved with rest or nitroglycerin
- **Intractable or refractory angina:** severe incapacitating chest pain
- **Variant angina** (also called Prinzmetal's angina): pain at rest with reversible ST-segment elevation; thought to be caused by coronary artery vasospasm
- **Silent ischemia:** objective evidence of ischemia (such as electrocardiographic changes with a stress test), but patient reports no pain

- Physical exertion, which can precipitate an attack by increasing myocardial oxygen demand
- Exposure to cold, which can cause vasoconstriction and elevated blood pressure, with increased oxygen demand
- Eating a heavy meal, which increases the blood flow to the mesenteric area for digestion, thereby reducing the blood supply available to the heart muscle; in a severely compromised heart, shunting of blood for digestion can be sufficient to induce anginal pain
- Stress or any emotion-provoking situation, causing the release of catecholamines, which increases blood pressure, heart rate, and myocardial workload

Unstable angina is not associated with these listed factors. It may occur at rest. See the later discussion of unstable angina in the section discussing ACS and MI.

## Clinical Manifestations

Ischemia of the heart muscle may produce pain or other symptoms, varying in severity from mild indigestion to a choking or heavy sensation in the upper chest that ranges from discomfort to agonizing pain accompanied by severe apprehension and a feeling of impending death. The pain is often felt deep in the chest behind the sternum (retrosternal area). Typically, the pain or discomfort is poorly localized and may radiate to the neck, jaw, shoulders, and inner aspects of the upper arms, usually the left arm. The patient often feels tightness or a heavy choking or strangling sensation that has a viselike, insistent quality. The patient with diabetes mellitus may not have severe pain with angina because diabetic neuropathy can blunt nociceptor transmission, dulling the perception of pain. Women may have different symptoms than men, possibly because coronary disease in women tends to be more diffuse and affects long segments of the artery rather than discrete segments.

A feeling of weakness or numbness in the arms, wrists, and hands, as well as shortness of breath, pallor, diaphoresis, dizziness or lightheadedness, and nausea and vomiting may accompany the pain. Anxiety may occur with angina. An important characteristic of angina is that it subsides with rest or administering nitroglycerin. In many patients, anginal symptoms follow a stable, predictable pattern.

Unstable angina is characterized by attacks that increase in frequency and severity and are not relieved by rest and administering nitroglycerin. Patients with unstable angina require medical intervention.

### Gerontologic Considerations

The elderly person with angina may not exhibit the typical pain profile because of the diminished responses of neurotransmitters that occur with aging. Often, the presenting symptom in the elderly is dyspnea. Sometimes there are no symptoms ("silent" CAD), making recognition and diagnosis a clinical challenge. Elderly patients should be encouraged to recognize their chest pain–like symptom (eg, weakness) as an indication that they should rest or take prescribed medications. Pharmacologic stress testing and cardiac catheterization may be used to diagnose CAD in elderly patients. Medications used to manage angina are administered cautiously in the elderly because they are associated with an increase risk of adverse reactions (Futterman & Lemberg, 2007). Invasive procedures (eg, PCI) that were once considered too risky in the elderly may be considered; the elderly can benefit from symptom relief and longer survival.

## Assessment and Diagnostic Findings

The diagnosis of angina begins with the patient's history related to the clinical manifestations of ischemia. A 12-lead electrocardiogram (ECG) may show changes indicative of ischemia such as T-wave inversion. Laboratory studies are performed; these may include CRP and cardiac biomarker values to rule out an ACS (refer to later discussion on ACS). The patient may undergo an exercise or pharmacologic stress test in which the heart is monitored by an ECG, echocardiogram, or both. The patient may also be referred for a nuclear scan or invasive procedure (eg, cardiac catheterization, coronary angiography).

## Medical Management

The objectives of the medical management of angina are to decrease the oxygen demand of the myocardium and to increase the oxygen supply. Medically, these objectives are met through pharmacologic therapy and control of risk factors. Alternatively, reperfusion procedures may be used to restore the blood supply to the myocardium. These include PCI procedures (eg, **percutaneous transluminal coronary angioplasty [PTCA],** intracoronary stents, and atherectomy) and CABG.

### Pharmacologic Therapy

Table 28-3 summarizes drug therapy.

#### Nitroglycerin

Nitrates are an important treatment for angina pectoris. A vasoactive agent, nitroglycerin is administered to reduce myocardial oxygen consumption, which decreases ischemia and relieves pain. Nitroglycerin dilates primarily the veins and, in higher doses, the arteries. Dilation of the veins causes venous pooling of blood throughout the body. As a result, less blood returns to the heart, and filling pressure (preload) is reduced. If the patient is hypovolemic (does not have adequate circulating blood volume), the decrease in filling pressure can cause a significant decrease in cardiac output and blood pressure.

Nitrates in higher doses also relax the systemic arteriolar bed, lowering blood pressure and decreasing afterload. These effects decrease myocardial oxygen requirements and increase oxygen supply, bringing about a more favorable balance between supply and demand.

Nitroglycerin may be given by several routes: sublingual tablet or spray, oral capsule, topical agent, and intravenous (IV) administration. Sublingual nitroglycerin is generally placed under the tongue or in the cheek (buccal pouch) and ideally alleviates the pain of ischemia within 3 minutes. Chart 28-3 provides more information on self-administration of sublingual nitroglycerin. Oral preparations and topical patches are used to provide sustained effects. The patches are often applied in the morning and removed at bedtime. This regimen allows for a nitrate-free period to prevent the development of tolerance.

A continuous or intermittent IV infusion of nitroglycerin may be administered to the hospitalized patient with

**Table 28-3 SUMMARY OF MEDICATIONS USED TO TREAT ANGINA**

| Medications | Major Indications |
|---|---|
| **Nitrates**<br>Nitroglycerin (Nitrostat, Nitro-Bid) | Short-term and long-term reduction of myocardial oxygen consumption through selective vasodilation |
| **Beta-Adrenergic Blocking Agents (beta-blockers)**<br>Metoprolol (Lopressor, Toprol)<br>Atenolol (Tenormin) | Reduction of myocardial oxygen consumption by blocking beta-adrenergic stimulation of the heart |
| **Calcium Ion Antagonists (calcium channel blockers)**<br>Amlodipine (Norvasc)<br>Diltiazem (Cardizem, Tiazac)<br>Felodipine (Plendil) | Negative inotropic effects; indicated in patients not responsive to beta-blockers; used as primary treatment for vasospasm |
| **Antiplatelet Medications**<br>Aspirin<br>Clopidogrel (Plavix)<br>Glycoprotein IIb/IIIa agents:<br>Abciximab (ReoPro)<br>Tirofiban (Aggrastat)<br>Eptifibatide (Integrilin) | Prevention of platelet aggregation |
| **Anticoagulants**<br>Heparin (unfractionated)<br>Low-molecular-weight heparins (LMWHs):<br>Enoxaparin (Lovenox)<br>Dalteparin (Fragmin) | Prevention of thrombus formation |

recurring signs and symptoms of ischemia or after a revascularization procedure. The dose of nitroglycerin administered is based on the patient's symptoms while avoiding side effects such as hypotension. It usually is not administered if the systolic blood pressure is 90 mm Hg or less. Generally, after the patient is symptom-free, the nitroglycerin may be switched to an oral or topical preparation within 24 hours.

### Beta-Adrenergic Blocking Agents

Beta-blockers such as metoprolol (Lopressor, Toprol) and atenolol (Tenormin) reduce myocardial oxygen consumption by blocking beta-adrenergic sympathetic stimulation to the heart. The result is a reduction in heart rate, slowed conduction of impulses through the conduction system, decreased blood pressure, and reduced myocardial **contractility** (force of contraction) to balance the myocardial oxygen needs (demands) and the amount of oxygen available (supply). This helps control chest pain and delays the onset of ischemia during work or exercise. Beta-blockers reduce the incidence of recurrent angina, infarction, and cardiac mortality. The dose can be titrated to achieve a resting heart rate of 50 to 60 bpm (beats per minute).

Cardiac side effects and possible contraindications include hypotension, bradycardia, advanced atrioventricular block, and acute heart failure. If a beta-blocker is given intravenously for an acute cardiac event, the ECG, blood pressure, and heart rate are monitored closely after the medication has been administered. Side effects include depression, fatigue,

CHART 28-3 PHARMACOLOGY

## *Self-Administration of Nitroglycerin*

Most patients with angina pectoris must self-administer nitroglycerin on an as-needed basis. A key nursing role in such cases is educating patients about the medication and how to take it. Sublingual nitroglycerin comes in tablet and spray forms.

- Instruct the patient to make sure the mouth is moist, the tongue is still, and saliva is not swallowed until the nitroglycerin tablet dissolves. If the pain is severe, the patient can crush the tablet between the teeth to hasten sublingual absorption.
- Advise the patient to carry the medication at all times as a precaution. However, because nitroglycerin is very unstable, it should be carried securely in its original container (eg, capped dark glass bottle); tablets should never be removed and stored in metal or plastic pillboxes.
- Explain that nitroglycerin is volatile and is inactivated by heat, moisture, air, light, and time. Instruct the patient to renew the nitroglycerin supply every 6 months.
- Inform the patient that the medication should be taken in anticipation of any activity that may produce pain. Because nitroglycerin increases tolerance for exercise and stress when taken prophylactically (ie, before angina-producing activity, such as exercise, stair-climbing, or sexual intercourse), it is best taken before pain develops.
- Recommend that the patient note how long it takes for the nitroglycerin to relieve the discomfort. Advise the patient that if pain persists after taking three sublingual tablets at 5-minute intervals, emergency medical services should be called.
- Discuss possible side effects of nitroglycerin, including flushing, throbbing headache, hypotension, and tachycardia.
- Advise the patient to sit down for a few minutes when taking nitroglycerin to avoid hypotension and syncope.

decreased libido, and masking of symptoms of hypoglycemia. Patients taking beta-blockers are cautioned not to stop taking them abruptly, because angina may worsen and MI may develop. Beta-blocker therapy should be decreased gradually over several days before being discontinued. Patients with diabetes who take beta-blockers are instructed to monitor their blood glucose levels often and to observe for signs and symptoms of hypoglycemia. Beta-blockers that are not cardioselective also affect the beta-adrenergic receptors in the bronchioles, causing bronchoconstriction, and therefore are contraindicated in patients with significant chronic pulmonary disorders, such as asthma.

### Calcium Channel Blocking Agents

Calcium channel blockers (calcium ion antagonists) have a variety of effects. These agents decrease sinoatrial node automaticity and atrioventricular node conduction, resulting in a slower heart rate and a decrease in the strength of myocardial contraction (negative inotropic effect). These effects decrease the workload of the heart. Calcium channel blockers also relax the blood vessels, causing a decrease in blood pressure and an increase in coronary artery perfusion. Calcium channel blockers increase myocardial oxygen supply by dilating the smooth muscle wall of the coronary arterioles; they decrease myocardial oxygen demand by reducing systemic arterial pressure and the workload of the left ventricle.

The calcium channel blockers most commonly used are amlodipine (Norvasc) and diltiazem (Cardizem, Tiazac). They may be used by patients who cannot take beta-blockers, who develop significant side effects from beta-blockers or nitrates, or who still have pain despite beta-blocker and nitroglycerin therapy. Calcium channel blockers are also used to prevent and treat vasospasm, which may occur after a PCI.

First-generation calcium channel blockers such as nifedipine (Procardia) should be avoided or used with caution in people with heart failure because they decrease myocardial contractility. Amlodipine and felodipine (Plendil) are the calcium channel blockers of choice for patients with heart failure. Hypotension may occur after the IV administration of any of the calcium channel blockers. Other side effects may include atrioventricular block, bradycardia, constipation, and gastric distress.

### Antiplatelet and Anticoagulant Medications

Antiplatelet medications are administered to prevent platelet aggregation and subsequent thrombosis, which impedes blood flow.

***Aspirin.*** Aspirin prevents platelet aggregation and reduces the incidence of MI and death in patients with CAD. A 160- to 325-mg dose of aspirin should be given to the patient with angina as soon as the diagnosis is made (eg, in the emergency department or physician's office) and then continued with 81 to 325 mg daily. Patients should be advised to continue aspirin even if they concurrently take other analgesics such as acetaminophen (Tylenol). Because aspirin may cause gastrointestinal upset and bleeding, the use of $H_2$-blockers (eg, famotidine [Pepcid]) or proton pump inhibitors (eg, omeprazole [Prilosec]) should be considered to allow continued aspirin therapy.

***Clopidogrel.*** Clopidogrel (Plavix) is given in addition to aspirin in patients at high risk for MI. Patients are given more than one platelet inhibitor because the medications act on different pathways to block platelet activation (Housholder-Hughes, 2006). Unlike aspirin, this medication takes a few days to achieve antiplatelet effects.

***Heparin.*** IV unfractionated heparin prevents the formation of new blood clots. Treating patients with unstable angina with heparin reduces the occurrence of MI. If the patient's signs and symptoms indicate a significant risk for a cardiac event, the patient is hospitalized and may be given an IV bolus of heparin and started on a continuous infusion. The amount of heparin administered is based on the results of the activated partial thromboplastin time (aPTT). Heparin therapy is usually considered therapeutic when the aPTT is 2 to 2.5 times the normal aPTT value.

A subcutaneous injection of low-molecular-weight heparin (LMWH; enoxaparin [Lovenox] or dalteparin [Fragmin]) may be used instead of IV unfractionated heparin to treat patients with unstable angina or non–ST-segment elevation MIs (Antman, Hand, Armstrong, et al., 2007). LMWHs provide effective and stable anticoagulation, potentially reducing the risk of rebound ischemic events, and eliminate the need to monitor aPTT results. LMWHs may be beneficial before and during PCIs and for ST-segment elevation MIs.

Because unfractionated heparin and LMWH increase the risk of bleeding, the patient is monitored for signs and symptoms of external and internal bleeding, such as low blood pressure, increased heart rate, and decreased serum hemoglobin and hematocrit. The patient receiving heparin is placed on bleeding precautions, which include:

- Applying pressure to the site of any needle puncture for a longer time than usual
- Avoiding intramuscular (IM) injections
- Avoiding tissue injury and bruising from trauma or use of constrictive devices (eg, continuous use of an automatic blood pressure cuff)

A decrease in platelet count or evidence of thrombosis may indicate heparin-induced thrombocytopenia (HIT), an antibody-mediated reaction to heparin that may result in thrombosis (Cooney, 2006). Patients who have received heparin within the past 3 months and those who have been receiving unfractionated heparin for 5 to 15 days are at high risk for HIT (see Chapter 33 for further discussion of HIT).

***Glycoprotein IIb/IIIa Agents.*** IV administration of glycoprotein (GP) IIb/IIIa agents (abciximab [ReoPro], tirofiban [Aggrastat], eptifibatide [Integrilin]) is indicated for hospitalized patients with unstable angina and as adjunct therapy for PCI. These agents prevent platelet aggregation by blocking the GP IIb/IIIa receptors on the platelets, preventing adhesion of fibrinogen and other factors that crosslink platelets to each other and thus form platelet clots. As with heparin, bleeding is the major side effect, and bleeding precautions should be initiated.

### Oxygen Administration

Oxygen therapy is usually initiated at the onset of chest pain in an attempt to increase the amount of oxygen delivered to the myocardium and to decrease pain. The therapeutic effectiveness of oxygen is determined by observing the rate

and rhythm of respirations. Blood oxygen saturation is monitored by pulse oximetry; the normal oxygen saturation ($SpO_2$) level is greater than 93%.

# NURSING PROCESS

## The Patient With Angina Pectoris

### Assessment

The nurse gathers information about the patient's symptoms and activities, especially those that precede and precipitate attacks of angina pectoris. Appropriate questions are listed in Chart 28-4. The answers to these questions form the basis for designing an effective program of treatment and prevention. In addition to assessing angina pectoris or its equivalent, the nurse also assesses the patient's risk factors for CAD, the patient's response to angina, the patient's and family's understanding of the diagnosis, and adherence to the current treatment plan.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include:

- Ineffective cardiac tissue perfusion secondary to CAD as evidenced by chest pain or other prodromal symptoms
- Death anxiety related to cardiac symptoms
- Deficient knowledge about the underlying disease and methods for avoiding complications
- Noncompliance, ineffective management of therapeutic regimen related to failure to accept necessary lifestyle changes

#### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following, which are discussed in the chapters indicated:

- ACS and/or MI (described later in this chapter)
- Dysrhythmias and cardiac arrest (see Chapters 27 and 30)
- Heart failure (see Chapter 30)
- Cardiogenic shock (see Chapter 15)

**CHART 28-4** *Assessing Angina*

Ask the following:

- "Where is the pain (or prodromal symptoms)? Can you point to it?"
- "Can you feel the pain anywhere else?"
- "How would you describe the pain?"
- "Is it like the pain you had before?"
- "Can you rate the pain on a 0 to 10 scale, with 10 being the most pain?"
- "When did the pain begin?"
- "How long does it last?"
- "What brings on the pain?"
- "What helps the pain to go away?"
- "Do you have any other symptoms with the pain?"

### Planning and Goals

Major patient goals include immediate and appropriate treatment when angina occurs, prevention of angina, reduction of anxiety, awareness of the disease process and understanding of the prescribed care, adherence to the self-care program, and absence of complications.

### Nursing Interventions

#### *Treating Angina*

If the patient reports pain (or the person's prodromal symptoms suggest anginal ischemia, which may include sensations of indigestion or nausea, choking, heaviness, weakness or numbness in the upper extremities, dyspnea, or dizziness), the nurse takes immediate action. When a patient experiences angina, the patient is directed to stop all activities and sit or rest in bed in a semi-Fowler's position to reduce the oxygen requirements of the ischemic myocardium. The nurse assesses the patient's angina, asking questions to determine whether the angina is the same as the patient typically experiences. A change may indicate a worsening of the disease or a different cause. The nurse then continues to assess the patient, measuring vital signs and observing for signs of respiratory distress. If the patient is in the hospital, a 12-lead ECG is usually obtained and scrutinized for ST-segment and T-wave changes. If the patient has been placed on cardiac monitoring with continuous ST-segment monitoring, the ST segment is assessed for changes.

Nitroglycerin is administered sublingually, and the patient's response is assessed (relief of chest pain and effect on blood pressure and heart rate). If the chest pain is unchanged or is lessened but still present, nitroglycerin administration is repeated up to three doses. Each time blood pressure, heart rate, and the ST segment (if the patient is on a monitor with ST-segment monitoring capability) are assessed. The nurse administers oxygen therapy if the patient's respiratory rate is increased or if the oxygen saturation level is decreased. Oxygen is usually administered at 2 L/min by nasal cannula, even without evidence of respiratory distress, although there is no documentation of its effect on outcome. If the pain is significant and continues after these interventions, the patient is further evaluated for acute MI and may be transferred to a higher-acuity nursing unit.

#### *Reducing Anxiety*

Patients with angina often fear loss of their roles within society and the family. They may also fear that the pain (or the prodromal symptoms) may lead to an MI or death. Exploring the implications that the diagnosis has for the patient and providing information about the illness, its treatment, and methods of preventing its progression are important nursing interventions. Various stress reduction methods, such as guided imagery or music therapy, should be explored with the patient. Addressing the spiritual needs of the patient and family may also assist in allaying anxieties and fears.

#### *Preventing Pain*

The nurse reviews the assessment findings, identifies the level of activity that causes the patient's pain or prodromal symptoms, and plans the patient's activities accordingly. If the patient has pain frequently or with minimal activity, the

nurse alternates the patient's activities with rest periods. Balancing activity and rest is an important aspect of the educational plan for the patient and family.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The teaching program for the patient with angina is designed so that the patient and family understand the illness, identify the symptoms of myocardial ischemia, state the actions to take when symptoms develop, and discuss methods to prevent chest pain and the advancement of CAD. The goals of education are to reduce the frequency and severity of anginal attacks, to delay the progress of the underlying disease if possible, and to prevent complications. The factors outlined in Chart 28-5 are important in educating the patient with angina pectoris.

The self-care program is prepared in collaboration with the patient and family or friends. Activities should be planned to minimize the occurrence of angina episodes. The patient needs to understand that any pain unrelieved within 15 minutes by the usual methods, including nitroglycerin (see Chart 28-3), should be treated at the closest emergency center; the patient should call 911 for assistance.

**CONTINUING CARE.** Arrangements are made for a home care nurse when appropriate. The home care nurse assists the patient with scheduling and keeping follow-up appointments. The patient may need reminders about follow-up monitoring, including periodic blood laboratory testing and ECGs. In addition, the home care nurse may monitor the patient's adherence to dietary restrictions and to prescribed antianginal medications, including nitroglycerin. If the patient has severe anginal symptoms, the nurse may assess the home environment and recommend modifications that diminish the occurrence of anginal episodes. For instance, if a patient cannot climb stairs without experiencing ischemia, the home care nurse may help the patient plan daily activities that minimize stair climbing. Some patients may benefit from moving the bedroom to a lower level in the home.

## Evaluation

### *Expected Patient Outcomes*

1. Reports that pain is relieved promptly
   a. Recognizes symptoms
   b. Takes immediate action
   c. Seeks medical assistance if pain persists or changes in quality
2. Reports decreased anxiety
   a. Expresses acceptance of diagnosis
   b. Expresses control over choices within medical regimen
   c. Does not exhibit signs and symptoms that indicate a high level of anxiety
3. Understands ways to avoid complications and is free of complications
   a. Describes the process of angina
   b. Explains reasons for measures to prevent complications

CHART 28-5 HOME CARE CHECKLIST
### *Managing Angina Pectoris*

| At the completion of home care instructions, the patient and significant other will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Reduce the probability of an episode of anginal pain by balancing rest with activity. | | |
| • Participate in a regular daily program of activities that do not produce chest discomfort, shortness of breath, or undue fatigue. | ✔ | |
| • Follow the prescribed exercise regimen. | ✔ | |
| • Recognize that temperature extremes (particularly cold) may induce anginal pain; therefore, avoid exercise in temperature extremes. | ✔ | |
| • Alternate activity with periods of rest. | ✔ | |
| • Use appropriate resources for support during emotionally stressful times (eg, counselor, nurse, clergy, physician). | ✔ | ✔ |
| • Avoid using medications or any over-the-counter substances (eg, diet pills, nasal decongestants) that can increase the heart rate and blood pressure without first discussing with a health care provider. | ✔ | ✔ |
| • Stop smoking and other forms of tobacco, and avoid secondhand smoke (because smoking increases the heart rate, blood pressure, and blood carbon monoxide levels). | ✔ | ✔ |
| • Follow a diet low in saturated fat, high in fiber, and if indicated, lower in calories. | ✔ | ✔ |
| • Achieve and maintain normal blood pressure. | ✔ | |
| • Achieve and maintain normal blood glucose levels. | ✔ | |
| • Take medications, especially aspirin and beta-blockers, as prescribed. | ✔ | |
| • Carry nitroglycerin at all times; state when and how to use it; identify its side effects. | ✔ | ✔ |
| • Make and keep follow-up appointments. | ✔ | ✔ |
| • Report increase in symptoms to health care provider. | ✔ | ✔ |

   c. Exhibits normal ECG and cardiac biomarkers
   d. Experiences no signs and symptoms of acute MI
4. Adheres to self-care program
   a. Takes medications as prescribed
   b. Keeps health care appointments
   c. Implements plan to reduce risk factors

## Acute Coronary Syndrome and Myocardial Infarction

ACS is an emergent situation characterized by an acute onset of myocardial ischemia that results in myocardial death (ie, MI) if definitive interventions do not occur promptly. (Although the terms coronary occlusion, heart attack, and MI are used synonymously, the preferred term is MI.) The spectrum of ACS includes unstable angina, non–ST-segment elevation MI (NSTEMI), and ST-segment elevation MI (STEMI).

### Pathophysiology

In unstable angina, there is reduced blood flow in a coronary artery, often due to rupture of an atherosclerotic plaque, but the artery is not completely occluded. This is an acute situation that is sometimes referred to as preinfarction angina because the patient will likely have an MI if prompt interventions do not occur.

In an MI, an area of the myocardium is permanently destroyed, typically because plaque rupture and subsequent thrombus formation result in complete occlusion of the artery. Vasospasm (sudden constriction or narrowing) of a coronary artery, decreased oxygen supply (eg, from acute blood loss, anemia, or low blood pressure), and increased demand for oxygen (eg, from a rapid heart rate, thyrotoxicosis, or ingestion of cocaine) are other causes of MI. In each case, a profound imbalance exists between myocardial oxygen supply and demand.

The area of infarction develops over minutes to hours. As the cells are deprived of oxygen, ischemia develops, cellular injury occurs, and the lack of oxygen results in infarction, or the death of cells. The expression “time is muscle” reflects the urgency of appropriate treatment to improve patient outcomes. Each year in the United States, nearly 1 million people have acute MIs; one fourth of these people die as a result (AHA, 2007). Half of those who die never reach a hospital.

Various descriptions are used to further identify an MI: the type (NSTEMI, STEMI), the location of the injury to the ventricular wall (anterior, inferior, posterior, or lateral wall), and the point in time within the process of infarction (acute, evolving, or old). The differences between NSTEMI and STEMI are diagnostic and are explained later in this chapter.

The ECG usually identifies the type and location of the MI, and other ECG indicators such as a Q wave and patient history identify the timing. Regardless of the location, the goals of medical therapy are to prevent or minimize myocardial tissue death and prevent complications. The pathophysiology of CAD and the risk factors involved were discussed earlier in this chapter.

### Clinical Manifestations

Chest pain that occurs suddenly and continues despite rest and medication is the presenting symptom in most patients with ACS. Some of these patients have prodromal symptoms or a previous diagnosis of CAD, but about half report no previous symptoms (AHA, 2007). Patients may present with a combination of symptoms, including chest pain, shortness of breath, indigestion, nausea, and anxiety. They may have cool, pale, and moist skin. Their heart rate and respiratory rate may be faster than normal. These signs and symptoms, which are caused by stimulation of the sympathetic nervous system, may be present for only a short time or may persist. In many cases, the signs and symptoms of MI cannot be distinguished from those of unstable angina; hence, the evolution of the term ACS.

### Assessment and Diagnostic Findings

The diagnosis of ACS is generally based on the presenting symptoms (Chart 28-6); the 12-lead ECG and laboratory tests (eg, serial cardiac biomarkers) are performed to clarify whether the patient has unstable angina, NSTEMI, or STEMI. The prognosis depends on the severity of coronary artery obstruction and the presence and extent of myocardial damage. Physical examination is always conducted, but the examination alone does not confirm the diagnosis.

#### *Patient History*

The patient history includes the description of the presenting symptom (eg, pain), the history of previous cardiac and other illnesses, and the family history of heart disease. The history should also include information about the patient’s risk factors for heart disease.

#### *Electrocardiogram*

The 12-lead ECG provides information that assists in ruling out or diagnosing an acute MI. It should be obtained within 10 minutes from the time a patient reports pain or arrives in the emergency department. By monitoring serial ECG changes over time, the location, evolution, and resolution of an MI can be identified and monitored.

The ECG changes that occur with an MI are seen in the leads that view the involved surface of the heart. The classic ECG changes are T-wave inversion, ST-segment elevation, and development of an abnormal Q wave (Fig. 28-5). Because infarction evolves over time, the ECG also changes over time. The first ECG signs of an acute MI occur as a result of myocardial ischemia and injury. Myocardial injury causes the T wave to become enlarged and symmetric. As the area of injury becomes ischemic, myocardial repolarization is altered and delayed, causing the T wave to invert. The ischemic region may remain depolarized while adjacent areas of the myocardium return to the resting state. Myocardial injury also causes ST-segment changes. The injured myocardial cells depolarize normally but repolarize more rapidly than normal cells, causing the ST segment to rise at least 1 mm above the isoelectric line (the area between the T wave and the next P wave is used as the reference for the isoelectric line) when measured 0.06 to 0.08 seconds after the end of the QRS, a point called the J point (Fig. 28-6). This elevation in the ST segment in two contiguous leads is a key diagnostic indicator for MI (ie, STEMI).

CHART 28-6

## *Assessing for Acute Coronary Syndrome (ACS) or Acute Myocardial Infarction (MI)*

Be alert for the following signs and symptoms:

**Cardiovascular**

- Chest pain or discomfort not relieved by rest or nitroglycerin palpitations. Heart sounds may include $S_3$, $S_4$, and new onset of a murmur.
- Increased jugular venous distention may be seen if the MI has caused heart failure.
- Blood pressure may be elevated because of sympathetic stimulation or decreased because of decreased contractility, impending cardiogenic shock, or medications.
- Irregular pulse may indicate atrial fibrillation.
- In addition to ST-segment and T-wave changes, ECG may show tachycardia, bradycardia, or other dysrhythmias.

**Respiratory**

Shortness of breath, dyspnea, tachypnea, and crackles if MI has caused pulmonary congestion. Pulmonary edema may be present.

**Gastrointestinal**

Nausea and vomiting.

**Genitourinary**

Decreased urinary output may indicate cardiogenic shock.

**Skin**

Cool, clammy, diaphoretic, and pale appearance due to sympathetic stimulation may indicate cardiogenic shock.

**Neurologic**

Anxiety, restlessness, and lightheadedness may indicate increased sympathetic stimulation or a decrease in contractility and cerebral oxygenation. The same symptoms may also herald cardiogenic shock.

**Psychological**

Fear with feeling of impending doom, or denial that anything is wrong.

The appearance of abnormal Q waves is another indication of MI. Q waves develop within 1 to 3 days because there is no depolarization current conducted from necrotic tissue. The lead system then views the flow of current from other parts of the heart. A new and significant Q wave is 0.04 seconds or longer and 25% of the R-wave depth (provided the R wave exceeds a depth of 5 mm). An acute MI may also cause a significant decrease in the height of the R wave. During an acute MI, injury and ischemic changes are usually present. An abnormal Q wave may be present without ST-segment and T-wave changes, which indicates an old, not acute, MI. For some patients, there are no persistent ECG changes, and the MI is diagnosed by blood levels of cardiac biomarkers.

Using the above information, patients are diagnosed with one of the following forms of ACS:

- Unstable angina: The patient has clinical manifestations of coronary ischemia, but ECG and cardiac biomarkers show no evidence of acute MI.
- STEMI: The patient has ECG evidence of acute MI with characteristic changes in two contiguous leads on a 12-lead ECG. In this type of MI, there is significant damage to the myocardium.
- NSTEMI: The patient has elevated cardiac biomarkers but no definite ECG evidence of acute MI.

During recovery from an MI, the ST segment often is the first ECG indicator to return to normal (1 to 6 weeks). The T

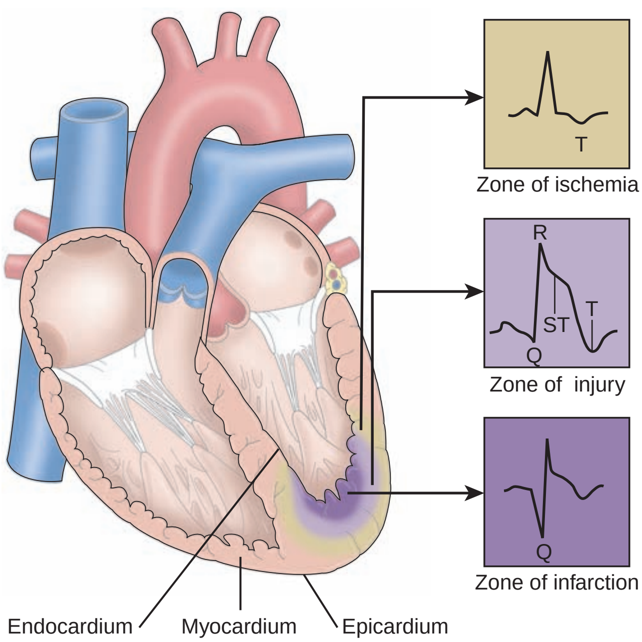



**Figure 28-5** Effects of ischemia, injury, and infarction on an electrocardiogram (ECG) recording. Ischemia causes inversion of the T wave because of altered repolarization. Cardiac muscle injury causes elevation of the ST segment. Later, Q waves develop because of the absence of depolarization current from the necrotic tissue and opposing currents from other parts of the heart.

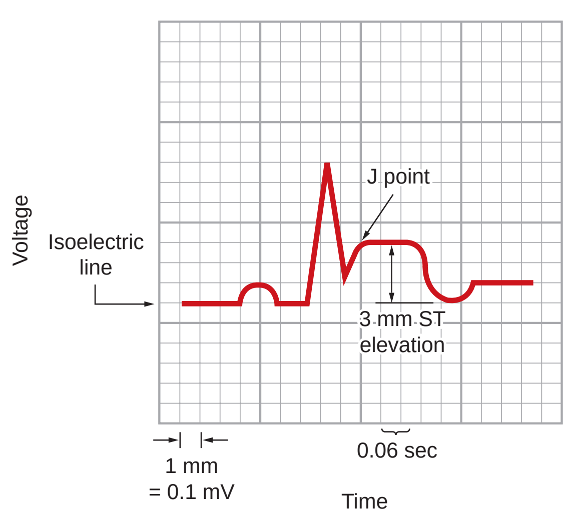



**Figure 28-6** Using the electrocardiogram (ECG) to diagnose acute myocardial infarction (MI). (ST-segment elevation is measured 0.06 to 0.08 seconds after the J point. An elevation of more than 1 mm in contiguous leads is indicative of acute MI.)

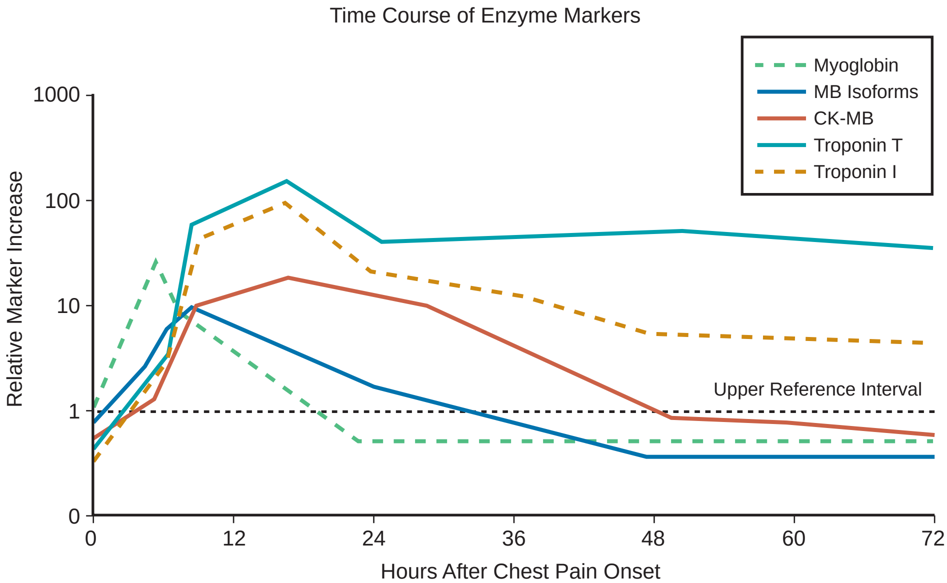



**Figure 28-7** Peak elevation and duration of serum enzymes and biomarkers after acute myocardial infarction. Illustration from Morton, P. G. & Fontaine, D. K. (2009). *Critical care nursing* (9th ed.). Philadelphia: Lippincott Williams & Wilkins.

wave becomes large and symmetric for 24 hours, and it then inverts within 1 to 3 days for 1 to 2 weeks. Q-wave alterations are usually permanent. An old STEMI is usually indicated by an abnormal Q wave or decreased height of the R wave without ST-segment and T-wave changes.

#### *Echocardiogram*

The echocardiogram is used to evaluate ventricular function. It may be used to assist in diagnosing an MI, especially when the ECG is nondiagnostic. The echocardiogram can detect hypokinetic and akinetic wall motion and can determine the ejection fraction (see Chapter 26).

#### *Laboratory Tests*

Cardiac enzymes and biomarkers are used to diagnose an acute MI. Cardiac biomarkers, which include myoglobin and troponin, can be analyzed rapidly, expediting an accurate diagnosis. These tests are based on the release of cellular contents into the circulation when myocardial cells die. Figure 28-7 shows the time courses of cardiac enzymes and biomarkers.

##### Creatine Kinase and Its Isoenzymes

There are three **creatine kinase (CK)** isoenzymes: CK-MM (skeletal muscle), CK-MB (heart muscle), and CK-BB (brain tissue). CK-MB is the cardiac-specific isoenzyme; it is found mainly in cardiac cells and therefore increases only when there has been damage to these cells. Elevated CK-MB assessed by mass assay is an indicator of acute MI; the level begins to increase within a few hours and peaks within 24 hours of an MI. If the area is reperfused (eg, due to thrombolytic therapy or PCI), it peaks earlier.

##### Myoglobin

Myoglobin is a heme protein that helps transport oxygen. Like CK-MB enzyme, myoglobin is found in cardiac and skeletal muscle. The myoglobin level starts to increase within 1 to 3 hours and peaks within 12 hours after the onset of symptoms. An increase in myoglobin is not very specific in indicating an acute cardiac event; however, negative results are an excellent parameter for ruling out an acute MI.

##### Troponin

**Troponin,** a protein found in the myocardium, regulates the myocardial contractile process. There are three isomers of troponin: C, I, and T. Troponins I and T are specific for cardiac muscle, and these biomarkers are currently recognized as reliable and critical markers of myocardial injury (Carreiro-Lewandowski, 2006). An increase in the level of troponin in the serum can be detected within a few hours during acute MI. It remains elevated for a long period, often as long as 3 weeks, and it therefore can be used to detect recent myocardial damage.

### Medical Management

The goals of medical management are to minimize myocardial damage, preserve myocardial function, and prevent complications. These goals are facilitated by the use of guidelines developed by the American College of Cardiology (ACC) and the AHA (Chart 28-7). These goals may be achieved by reperfusing the area with the emergency use of thrombolytic medications or by PCI. Minimizing myocardial damage is also accomplished by reducing myocardial oxygen demand and increasing oxygen supply with medications, oxygen administration, and bed rest. The resolution of pain and ECG changes indicate that demand and supply are in equilibrium; they may also indicate reperfusion. Visualization of blood flow through an open vessel in the catheterization laboratory is evidence of reperfusion.

#### *Pharmacologic Therapy*

The patient with suspected MI is given aspirin, nitroglycerin, morphine, an IV beta-blocker, and other medications as indicated while the diagnosis is being confirmed. Patients should continue the beta-blocker throughout hospitalization and after discharge because long-term therapy with beta-blockers can decrease the incidence of future cardiac events. Unfractionated heparin or an LMWH is prescribed along with platelet-inhibiting agents to prevent further clot formation. Nonsteroidal anti-inflammatory drugs (NSAIDS)

### Chart 28-7 • *Treatment Guidelines for Acute Myocardial Infarction*

- Use rapid transit to the hospital.
- Obtain 12-lead electrocardiogram (ECG) to be read within 10 minutes.
- Obtain laboratory blood specimens of cardiac biomarkers, including troponin.
- Obtain other diagnostics to clarify the diagnosis.
- Begin routine medical interventions:
  - Supplemental oxygen
  - Nitroglycerin
  - Morphine
  - Aspirin 162 to 325 mg
  - Beta-blocker
  - Angiotensin-converting enzyme inhibitor within 24 hours
  - Anticoagulation with heparin and platelet inhibitors
- Evaluate for indications for reperfusion therapy:
  - Percutaneous coronary intervention
  - Thrombolytic therapy
- Continue therapy as indicated:
  - Intravenous heparin, low-molecular-weight heparin, bivalirudin, or fondaparinux
  - Clopidogrel (Plavix)
  - Glycoprotein IIb/IIIa inhibitor
  - Bed rest for a minimum of 12 to 24 hours

Antman, E. M., Hand, M, Armstrong, P. W., et al. (2007). 2007 Focused update of the ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. *Circulation, 117*, 296–329. http://circ.ahajournals.org

may be discontinued because of their association with adverse cardiac events (Antman, et al., 2007).

#### Analgesics

The analgesic of choice for acute MI is morphine administered in IV boluses to reduce pain and anxiety. It also reduces preload and afterload, which decreases the workload of the heart and relaxes bronchioles to enhance oxygenation. The cardiovascular response to morphine is monitored carefully, particularly the blood pressure, which can decrease, and the respiratory rate, which can be depressed. Because morphine decreases the sensation of pain, ST-segment changes may be a better indicator of subsequent ischemia than reported pain.

#### Angiotensin-Converting Enzyme Inhibitors

Angiotensin-converting enzyme (ACE) inhibitors prevent the conversion of angiotensin I to angiotensin II. In the absence of angiotensin II, the blood pressure decreases and the kidneys excrete sodium and fluid (diuresis), decreasing the oxygen demand of the heart. Use of ACE inhibitors in patients after MI decreases mortality rates and prevents remodeling of myocardial cells that is associated with the onset of heart failure. It is important to ensure that a patient is not hypotensive, hyponatremic, hypovolemic, or hyperkalemic before administering ACE inhibitors. Blood pressure, urine output, and serum sodium, potassium, and creatinine levels need to be monitored closely.

#### Thrombolytics

**Thrombolytics** are used to treat some patients with acute MI. These agents are administered IV according to a specific protocol (Chart 28-8). The purpose of thrombolytics is to dissolve (ie, lyse) the thrombus in a coronary artery (thrombolysis), allowing blood to flow through the coronary artery again (reperfusion), minimizing the size of the infarction and preserving ventricular function. Thrombolytics can be used as first-line therapy in facilities that lack the resources to perform PCIs (Boden, Eagle & Granger, 2007). However, although thrombolytics may dissolve the thrombus, they do not affect the underlying atherosclerotic lesion. The patient may be referred for a cardiac catheterization and other invasive interventions.

Thrombolytics dissolve all clots, not just the one in the coronary artery. Thus, they should not be used if the patient has formed a protective clot elsewhere, such as after major surgery or hemorrhagic stroke. Because thrombolytics reduce the patient's ability to form a clot, the patient is at risk

### CHART 28-8 PHARMACOLOGY
### *Administration of Thrombolytic Therapy*

**Indications**

- Chest pain for longer than 20 minutes, unrelieved by nitroglycerin
- ST-segment elevation in at least two leads that face the same area of the heart
- Less than 6 hours from onset of pain

**Absolute Contraindications**

- Active bleeding
- Known bleeding disorder
- History of hemorrhagic stroke
- History of intracranial vessel malformation
- Recent major surgery or trauma
- Uncontrolled hypertension
- Pregnancy

**Nursing Considerations**

- Minimize the number of times the patient's skin is punctured
- Avoid intramuscular injections
- Draw blood for laboratory tests when starting the IV line
- Start IV lines before thrombolytic therapy; designate one line to use for blood draws
- Avoid continual use of noninvasive blood pressure cuff
- Monitor for acute dysrhythmias and hypotension
- Monitor for reperfusion: resolution of angina or acute ST-segment changes
- Check for signs and symptoms of bleeding: decrease in hematocrit and hemoglobin values, decrease in blood pressure, increase in heart rate, oozing or bulging at invasive procedure sites, back pain, muscle weakness, changes in level of consciousness, complaints of headache
- Treat major bleeding by discontinuing thrombolytic therapy and any anticoagulants; apply direct pressure and notify the physician immediately
- Treat minor bleeding by applying direct pressure if accessible and appropriate; continue to monitor

for bleeding. Thrombolytics should not be used if the patient is bleeding or has a bleeding disorder. All patients who receive thrombolytic therapy are placed on bleeding precautions to minimize the risk for bleeding. This means minimizing the number of punctures for inserting IV lines, avoiding IM injections, preventing tissue trauma, and applying pressure for longer than usual after any puncture.

To be effective, thrombolytics must be administered as early as possible after the onset of symptoms that indicate an acute MI, generally within 3 to 6 hours. They are given to patients with ECG evidence of acute MI. The selected thrombolytic agent should be initiated within 30 minutes of presentation to the hospital (ISCI, 2006a). This is called door-to-needle time, and hospitals monitor their ability to administer the thrombolytic agent within the recommended time period as an indicator of quality of care.

The thrombolytic agents used most often are alteplase (Activase) and reteplase (r-PA, TNKase). Alteplase is a tissue plasminogen activator (t-PA) that activates the plasminogen present on a blood clot. An IV bolus dose is given and followed by an infusion. Aspirin and unfractionated heparin or LMWH may be used with t-PA to prevent another clot from forming at the site of the lesion. Reteplase, a newer recombinant thrombolytic, is similar to alteplase and has similar effects. It is administered in two bolus doses, followed by a heparin infusion.

#### *Emergent Percutaneous Coronary Intervention*

The patient with STEMI may be taken directly to the cardiac catheterization laboratory for an immediate PCI. The procedure is used to open the occluded coronary artery and promote reperfusion to the area that has been deprived of oxygen. Superior outcomes have been reported with use of PCI compared to thrombolytics (Antman, et al., 2007). Early PCI has been shown to be effective in patients of all ages, including those older than 75 years (Chart 28-9). PCI may also be indicated in patients with unstable angina and NSTEMI who are at high risk due to persistent ischemia (King, Smith, Hirshfeld, et al., 2007). The procedure treats the underlying atherosclerotic lesion. Because the duration of oxygen deprivation is directly related to the number of myocardial cells that die, the time from the patient's arrival in the emergency department to the time PCI is performed should be less than 60 minutes. This is frequently referred to as door-to-balloon time. A cardiac catheterization laboratory and staff must be available if an emergent PCI is to be performed within this short time. The nursing care related to PCI is presented later in this chapter.

CHART 28-9 *Ethics and Related Issues*

**Should Aggressive Treatment Be Recommended for the Elderly With Acute Coronary Syndrome (ACS)?**

**Situation**

Many patients who present with acute coronary events are elderly. They often have chronic conditions such as diabetes or arthritis. Elderly patients have traditionally been managed conservatively with medications, but currently interventions such as cardiac catheterization may be recommended. These patients look to their family members for help with treatment decisions.

**Dilemma**

An 80-year-old woman is hospitalized with unstable angina. When discussing the situation with her two adult sons, the cardiologist recommends cardiac catheterization with possible percutaneous transluminal coronary angioplasty (PTCA) and stent placement. The patient is oriented but lethargic. She defers to her sons regarding treatment decisions. One son worries that she will be subjected to an invasive procedure that is potentially high risk, painful, expensive, and possibly futile. The second son feels that if there is hope of success, she should have the procedure.

**Discussion**

Research on the risks and benefits of treatment for ACS now includes the elderly as a subgroup. Studies suggest that elderly patients may benefit as much, if not more, than younger patients from coronary reperfusion procedures in terms of reduction of death or myocardial infarction (Futterman & Lemberg, 2007).

1. What information would you provide that supports or discourages aggressive treatment for ACS in the elderly?
2. What assistance can you offer to enhance the patient's and family's autonomy regarding decision making as well as their sense of justice regarding the allocation of resources?

## Cardiac Rehabilitation

After the patient with an MI is free of symptoms, an active rehabilitation program is initiated. Cardiac rehabilitation is an important continuing care program for patients with CAD that targets risk reduction by means of education, individual and group support, and physical activity. It is considered to be an important part of continuing care for patients with CAD (Thomas, King, Lui, et al., 2007). Most insurance programs, including Medicare, cover the cost of cardiac rehabilitation, although not all patients who are candidates for cardiac rehabilitation services participate in these programs.

The goals of rehabilitation for the patient who has had an MI are to extend life and improve the quality of life. The immediate objectives are to limit the effects and progression of atherosclerosis, return the patient to work and preillness lifestyle, enhance the psychosocial and vocational status of the patient, and prevent another cardiac event. These objectives are accomplished by encouraging physical activity and physical conditioning, educating the patient and family, and providing counseling and behavioral interventions.

Throughout all phases of rehabilitation, the goals of activity and exercise tolerance are achieved through gradual physical conditioning. Cardiac efficiency is achieved when work and activities of daily living can be performed at a lower heart rate and lower blood pressure, thereby reducing the heart's oxygen requirements and reducing cardiac workload. Physical conditioning is achieved gradually over time. It is not unusual for patients to "overdo it" in an attempt to achieve their goals too rapidly. Patients are observed for chest pain, dyspnea, weakness, fatigue, and palpitations and instructed to stop exercise if any of these occur. In a monitored program, they are also monitored for an increase in

heart rate above the target heart rate, an increase in systolic or diastolic blood pressure of more than 20 mm Hg, a decrease in systolic blood pressure, onset or worsening of dysrhythmias, or ST-segment changes on the ECG.

The target heart rate during hospitalization is an increase of less than 10% from the resting heart rate, or 120 bpm. Following discharge, the target heart rate is based on the patient's stress test results, medications, and overall condition. Oxygen saturation may also be assessed through pulse oximetry to ensure that it remains higher than 93%. If signs or symptoms occur, the patient is instructed to slow down or stop exercising. If the patient is exercising in an unmonitored program, he or she is cautioned to cease activity immediately if signs or symptoms occur and to seek appropriate medical attention.

Patients who are able to walk at 3 to 4 miles/h can usually resume sexual activities. They should be well rested and in a familiar setting, wait at least 1 hour after eating or drinking alcohol, and use a comfortable position. Sexual dysfunction or cardiac symptoms should be reported to the health care provider.

### Phases of Cardiac Rehabilitation

Cardiac rehabilitation programs are categorized in three phases.

Phase I begins with the diagnosis of atherosclerosis, which may occur when the patient is admitted to the hospital for ACS (eg, unstable angina or acute MI). Because of today's brief hospital stays, mobilization occurs earlier and patient teaching focuses on the essentials of self-care, rather than instituting behavioral changes for risk reduction. Research has shown that the low-level activities and initial education for the patient and family improve patient outcomes (Flynn, Cafarelli, Petrakos, et al., 2007). Priorities for in-hospital teaching include the signs and symptoms that indicate the need to call 911 (seek emergency assistance), the medication regimen, rest–activity balance, and follow-up appointments with the physician. The patient is reassured that although CAD is a lifelong disease and must be treated as such, most patients can resume a normal life after an MI. This positive approach while in the hospital helps motivate and teach the patient to continue the education and lifestyle changes that are usually needed after discharge. The amount of activity recommended at discharge depends on the age of the patient, his or her condition before the cardiac event, the extent of the disease, the course of the hospital stay, and the development of any complications.

Phase II occurs after the patient has been discharged. The patient attends sessions three times a week for 4 to 6 weeks but may continue for as long as 6 months. This outpatient program consists of supervised, often ECG-monitored, exercise training that is individualized based on the results of an exercise stress test. Support and guidance related to the treatment of the disease and teaching and counseling related to lifestyle modification for risk factor reduction are a part of this phase. Short-term and long-range goals are collaboratively determined based on the patient's needs. At each session, the patient is assessed for the effectiveness of and adherence to the treatment. To prevent complications and another hospitalization, the cardiac rehabilitation staff alerts the referring physician to any problems.

Outpatient cardiac rehabilitation programs are designed to encourage patients and families to support each other. Programs may offer support sessions for spouses and significant others while the patients exercise. The programs involve group educational sessions for both patients and families that are given by cardiologists, exercise physiologists, dietitians, nurses, and other health care professionals. These sessions may take place outside a traditional classroom setting. For instance, a dietitian may take a group of patients to a grocery store to examine labels and meat selections or to a restaurant to discuss menu offerings for a "heart-healthy" diet.

Phase III is a long-term outpatient program that focuses on maintaining cardiovascular stability and long-term conditioning. The patient is usually self-directed during this phase and does not require a supervised program, although it may be offered. The goals of each phase build on the accomplishments of the previous phase.

## NURSING PROCESS

## The Patient With Acute Coronary Syndrome

### Assessment

One of the most important aspects of care of the patient with ACS is the assessment. It establishes the baseline for the patient so that any deviations may be identified, systematically identifies the patient's needs, and helps determine the priority of those needs. Systematic assessment includes a careful history, particularly as it relates to symptoms: chest pain or discomfort, difficulty breathing (dyspnea), palpitations, unusual fatigue, faintness (syncope), or sweating (diaphoresis). Each symptom must be evaluated with regard to time, duration, and the factors that precipitate the symptom and relieve it and in comparison with previous symptoms. A precise and complete physical assessment is critical to detect complications and any change in patient status. Chart 28-6 identifies important assessments and possible findings.

IV sites are examined frequently. Two IV lines are typically placed for any patient with ACS to ensure that access is available for administering emergency medications. Medications are administered IV to achieve rapid onset and to allow for timely adjustment. After the patient's condition stabilizes, IV lines may be changed to a saline lock to maintain IV access.

### Diagnosis

#### *Nursing Diagnoses*

Based on the clinical manifestations, history, and diagnostic assessment data, major nursing diagnoses may include:

- Ineffective cardiac tissue perfusion related to reduced coronary blood flow
- Risk for imbalanced fluid volume
- Risk for ineffective peripheral tissue perfusion related to decreased cardiac output from left ventricular dysfunction
- Death anxiety related to cardiac event
- Deficient knowledge about post-ACS self-care

***Collaborative Problems/Potential Complications***

Based on the assessment data, potential complications that may develop include the following:

- Acute pulmonary edema (see Chapter 30)
- Heart failure (see Chapter 30)
- Cardiogenic shock (see Chapter 15)
- Dysrhythmias and cardiac arrest (see Chapters 27 and 30)
- Pericardial effusion and cardiac tamponade (see Chapter 30)

## Planning and Goals

The major goals for the patient include relief of pain or ischemic signs (eg, ST-segment changes) and symptoms, prevention of myocardial damage, absence of respiratory dysfunction, maintenance or attainment of adequate tissue perfusion, reduced anxiety, adherence to the self-care program, and absence or early recognition of complications. Care of the patient with ACS who has an uncomplicated MI is summarized in the Plan of Nursing Care (Chart 28-10).

## Nursing Interventions

***Relieving Pain and Other Signs and Symptoms of Ischemia***

Balancing myocardial oxygen supply with demand (eg, as evidenced by the relief of chest pain) is the top priority in the care of the patient with an ACS. Although administering medications as previously described is required to accomplish this goal, nursing interventions are also important. Collaboration among the patient, nurse, and physician is critical in assessing the patient's response to therapy and in altering the interventions accordingly.

Oxygen should be administered along with medication therapy to assist with relief of symptoms. Administration of oxygen, even in low doses, raises the circulating level of oxygen to reduce pain associated with low levels of myocardial oxygen. The route of administration, usually by nasal cannula, and the oxygen flow rate are documented. A flow rate of 2 to 4 L/min is usually adequate to maintain oxygen saturation levels of 96% to 100% unless chronic pulmonary disease is present.

Vital signs are assessed frequently as long as the patient is experiencing pain and other signs or symptoms of acute ischemia. Physical rest in bed with the backrest elevated or in a supportive chair helps decrease chest discomfort and dyspnea. Elevation of the head and torso is beneficial for the following reasons:

- Tidal volume improves because of reduced pressure from abdominal contents on the diaphragm and better lung expansion.
- Drainage of the upper lung lobes improves.
- Venous return to the heart (preload) decreases, reducing the work of the heart.

***Improving Respiratory Function***

Regular and careful assessment of respiratory function detects early signs of pulmonary complications. The nurse monitors fluid volume status to prevent overloading the heart and lungs and encourages the patient to breathe deeply and change position frequently to help keep fluid from pooling in the bases of the lungs. Pulse oximetry guides the use of oxygen therapy.

***Promoting Adequate Tissue Perfusion***

Bed or chair rest during the initial phase of treatment helps reduce myocardial oxygen consumption. This limitation on mobility should remain until the patient is pain free and hemodynamically stable. It is important to check skin temperature and peripheral pulses frequently to monitor tissue perfusion.

***Reducing Anxiety***

Alleviating anxiety and decreasing fear are important nursing functions that reduce the sympathetic stress response. Decreased sympathetic stimulation decreases the workload of the heart, which may relieve pain and other signs and symptoms of ischemia.

The development of a trusting and caring relationship with the patient is critical in reducing anxiety. Providing information to the patient and family in an honest and supportive manner encourages the patient to be a partner in care and greatly assists in developing a positive relationship. Other interventions that can be used to reduce anxiety include ensuring a quiet environment, preventing interruptions that disturb sleep, using a caring and appropriate touch, teaching relaxation techniques, using humor, and providing spiritual support consistent with the patient's beliefs. The nurse provides frequent opportunities for the patient to privately share concerns and fears. An atmosphere of acceptance helps the patient know that these concerns and fears are both realistic and normal. Music therapy and pet therapy can also relax the patient and reduce anxiety (Cole, 2007). Hospitals may have developed infection control and safety procedures pertaining to the animals, their handlers, and the patients eligible for pet therapy.

***Monitoring and Managing Potential Complications***

Complications that can occur after acute MI may be caused by the damage that occurs to the myocardium and to the conduction system from reduced coronary blood flow. Because these complications can be life-threatening, close monitoring for and early identification of their signs and symptoms are critical (see the Plan of Nursing Care in Chart 28-10).

The nurse monitors the patient closely for changes in cardiac rate and rhythm, heart sounds, blood pressure, chest pain, respiratory status, urinary output, skin color and temperature, sensorium, ECG changes, and laboratory values. It is necessary to report promptly any changes in the patient's condition to the physician and institute emergency measures when necessary.

***Promoting Home and Community-Based Care***

**TEACHING PATIENTS SELF-CARE.** The most effective way to increase the probability that the patient will implement a self-care regimen after discharge is to identify the patient's priorities, provide adequate education about heart-healthy living, and facilitate the patient's involvement in a cardiac rehabilitation program (Decker, Garavelia, Chen, et al., 2007). Patient participation in the development of an individualized

CHART 28-10

## PLAN OF NURSING CARE
### Care of the Patient With an Uncomplicated Myocardial Infarction

**NURSING DIAGNOSIS:** Ineffective cardiac tissue perfusion related to reduced coronary blood flow
**GOAL:** Relief of chest pain/discomfort

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Initially assess, document, and report to the physician the following: | 1. These data assist in determining the cause and effect of the chest discomfort and provide a baseline with which posttherapy symptoms can be compared. | • Reports beginning relief of chest discomfort and symptoms.<br>• Appears comfortable and is free of pain and other signs or symptoms.<br>• Respiratory rate, cardiac rate, and blood pressure return to prediscomfort level.<br>• Skin warm and dry.<br>• Adequate cardiac output as evidenced by:<br>Stable/improving ECG<br>Heart rate and rhythm<br>Blood pressure<br>Mentation<br>Urine output<br>Serum BUN and creatinine<br>Skin color and temperature<br>• No adverse effects from medications. |
| a. The patient's description of chest discomfort, including location, intensity, radiation, duration, and factors that affect it. Other symptoms such as nausea, diaphoresis, or complaints of unusual fatigue. | a. There are many conditions associated with chest discomfort. There are characteristic clinical findings of ischemic pain and symptoms. | |
| b. The effect of coronary ischemia on perfusion to the heart (eg, change in blood pressure, heart rhythm), to the brain (eg, changes in LOC), to the kidneys (eg, decrease in urine output), and to the skin (eg, color, temperature). | b. MI decreases myocardial contractility and ventricular compliance and may produce dysrhythmias. Cardiac output is reduced, resulting in reduced blood pressure and decreased organ perfusion. | |
| 2. Obtain a 12-lead ECG recording during symptomatic events, as prescribed, to assess for ongoing ischemia. | 2. An ECG during symptoms may be useful in the diagnosis of ongoing ischemia. | |
| 3. Administer oxygen as prescribed. | 3. Oxygen therapy increases the oxygen supply to the myocardium. | |
| 4. Administer medication therapy as prescribed and evaluate the patient's response continuously. | 4. Medication therapy (nitroglycerin, morphine, beta-blocker, aspirin) is the first line of defense in preserving myocardial tissue. | |
| 5. Ensure physical rest: backrest elevated to promote comfort; diet as tolerated; use of bedside commode; use of stool softener to prevent straining at stool. Provide a restful environment, and allay fears and anxiety by being calm and supportive. Individualize visitation, based on patient response. | 5. Physical rest reduces myocardial oxygen consumption. Fear and anxiety precipitate the stress response; this results in increased levels of endogenous catecholamines, which increase myocardial oxygen consumption. | |

**NURSING DIAGNOSIS:** Risk for impaired gas exchange related to left ventricular failure
**GOAL:** Absence of respiratory distress

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Initially, every 4 hours, and with chest discomfort or symptoms, assess, document, and report to the physician abnormal heart sounds ($S_3$ and $S_4$ gallop or new murmur), abnormal breath sounds (particularly crackles), decreased oxygenation, and activity intolerance. | 1. These data are useful in diagnosing left ventricular failure. Diastolic filling sounds ($S_3$ and $S_4$) result from decreased left ventricular compliance associated with MI. Papillary muscle dysfunction (from infarction of the papillary muscle) can result in mitral regurgitation and a reduction in stroke volume. The presence of crackles (usually at the lung bases) may indicate pulmonary congestion from increased left heart pressures. The association of symptoms and activity can be used as a guide for activity prescription and a basis for patient teaching. | • No shortness of breath, dyspnea on exertion, orthopnea, or paroxysmal nocturnal dyspnea.<br>• Respiratory rate less than 20 breaths/min with physical activity and 16 breaths/min with rest.<br>• Skin color and temperature normal.<br>• $SpO_2$, $PaO_2$, and $PaCO_2$ within normal limits.<br>• Heart rate less than 100 bpm and greater than 60 bpm, with blood pressure within patient's normal limits.<br>• Chest x-ray unchanged.<br>• Appears comfortable and rested. |

*Continued on following page*

CHART 28-10

**PLAN OF NURSING CARE**

***Care of the Patient With an Uncomplicated Myocardial Infarction*** *(Continued)*

**NURSING DIAGNOSIS:** Risk for ineffective peripheral tissue perfusion related to decreased cardiac output
**GOAL:** Maintenance/attainment of adequate tissue perfusion

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Initially, every 4 hours, and with chest discomfort, assess, document, and report to the physician the following:<br>a. Hypotension<br>b. Tachycardia and other dysrhythmia<br>c. Activity intolerance<br>d. Mentation changes (use family input)<br>e. Reduced urine output (less than 30 mL/h)<br>f. Cool, moist, cyanotic extremities, decreased peripheral pulses, prolonged capillary refill | 1. These data are useful in determining a low cardiac output state. | • Blood pressure within the patient's normal range.<br>• Ideally, normal sinus rhythm without dysrhythmia is maintained, or patient's baseline rhythm is maintained between 60 and 100 bpm without further dysrhythmia.<br>• Prescribed activity is well tolerated.<br>• Remains alert and oriented and without cognitive or behavioral change.<br>• Appears comfortable.<br>• Urine output greater than 30 mL/h.<br>• Extremities warm and dry with normal color. |

**NURSING DIAGNOSIS:** Anxiety related to cardiac event
**GOAL:** Reduction of anxiety

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess, document, and report to the physician the patient's and family's level of anxiety and coping mechanisms. | 1. These data provide information about psychological well-being. Causes of anxiety are variable and individual, and may include acute illness, hospitalization, pain, disruption of activities of daily living at home and at work, changes in role and self-image due to illness, and financial concerns. Because anxious family members can transmit anxiety to the patient, the nurse must also identify strategies to reduce the family's fear and anxiety. | • Reports less anxiety.<br>• Patient and family discuss their anxieties and fears about illness and death.<br>• Patient and family appear less anxious.<br>• Appears restful, respiratory rate less than 16 breaths/min, heart rate less than 100 bpm without ectopic beats, blood pressure within patient's normal limits, skin warm and dry.<br>• Participates actively in a progressive rehabilitation program.<br>• Practices stress reduction techniques. |
| 2. Assess the need for spiritual counseling and refer as appropriate. | 2. If a patient finds support in a religion, spiritual counseling may assist in reducing anxiety and fear. | |
| 3. Assess the need for social service referral. | 3. Social services can assist with posthospital care and financial concerns. | |

**NURSING DIAGNOSIS:** Deficient knowledge about post-MI self-care
**GOAL:** Adheres to the home health care program; chooses lifestyle consistent with heart-healthy recommendations (See Chart 28-11: Promoting Health After Myocardial Infarction and Other Acute Coronary Syndromes)

program enhances the potential for an effective treatment plan (Chart 28-11).

CONTINUING CARE. Depending on the patient's condition and the availability of family assistance, a home care referral may be indicated. The home care nurse assists the patient with scheduling and keeping follow-up appointments and with adhering to the prescribed cardiac rehabilitation regimen. The patient may need reminders about follow-up monitoring, including periodic laboratory testing and ECGs, as well as general health screening. In addition, the home care nurse monitors the patient's adherence to dietary restrictions and to prescribed medications. If the patient is receiving home oxygen, the nurse ensures that the patient is using the oxygen as prescribed and that appropriate home safety measures are maintained. If the patient has evidence of heart failure secondary to an MI, appropriate home care guidelines for the patient with heart failure are followed (see Chapter 30).

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Experiences relief of angina
2. Has stable cardiac and respiratory status
3. Maintains adequate tissue perfusion

CHART 28-11

HEALTH PROMOTION

### *Promoting Health After Myocardial Infarction and Other Acute Coronary Syndromes*

To extend and improve the quality of life, a patient who has had an MI must adjust his or her lifestyle to promote heart-healthy living. With this in mind, the nurse and patient develop a program to help the patient achieve desired outcomes.

**Lifestyle Recommendations During Convalescence and Healing**

Adaptation to an MI is an ongoing process and usually requires some modification of lifestyle. Instruct patients to make the following specific modifications:

- Avoid any activity that produces chest pain, extreme dyspnea, or undue fatigue
- Avoid extremes of heat and cold and walking against the wind
- Lose weight, if indicated
- Stop smoking and use of tobacco; avoid secondhand smoke
- Develop heart-healthy eating patterns and avoid large meals and hurrying while eating
- Modify meals to align with the Therapeutic Lifestyle Changes (TLC) or other recommended diet
- Adhere to medical regimen, especially in taking medications
- Follow recommendations that ensure blood pressure and blood glucose are in control
- Pursue activities that relieve and reduce stress

**Adoption of an Activity Program**

Additionally, the patient needs to undertake a structured program of activity and exercise for long-term rehabilitation. Advise patients to:

- Engage in a regimen of physical conditioning with a gradual increase in activity duration and then a gradual increase in activity intensity
- Walk daily, increasing distance and time as prescribed
- Monitor pulse rate during physical activity
- Avoid physical exercise immediately after a meal
- Alternate activity with rest periods (some fatigue is normal and expected during convalescence)
- Participate in a daily program of exercise that develops into a program of regular exercise for a lifetime

**Managing Symptoms**

The patient must learn to recognize and take appropriate action for recurrent symptoms. Make sure that patients know to do the following:

- Call 911 if chest pressure or pain (or prodromal symptoms) is not relieved in 15 minutes by nitroglycerin
- Contact the physician if any of the following occur: shortness of breath, fainting, slow or rapid heartbeat, swelling of feet and ankles

4. Exhibits decreased anxiety
5. Adheres to a self-care program
6. Has no complications

# INVASIVE CORONARY ARTERY PROCEDURES

## *Percutaneous Coronary Interventions*

### Types of Procedures

Invasive interventional procedures to treat CAD include PTCA, intracoronary stent implantation, atherectomy, and brachytherapy. All of these procedures are classified as PCIs.

#### *Percutaneous Transluminal Coronary Angioplasty*

In PTCA, a balloon-tipped catheter is used to open blocked coronary vessels and resolve ischemia. It is used in patients with angina and as an intervention for ACS. Catheter-based interventions can also be used to open blocked CABGs. The purpose of PTCA is to improve blood flow within a coronary artery by compressing and "cracking" the atheroma. The procedure is attempted when the interventional cardiologist believes that PTCA can improve blood flow to the myocardium.

PTCA is carried out in the cardiac catheterization laboratory. Hollow catheters called sheaths are inserted, usually in the femoral artery (and sometimes femoral vein), providing a conduit for other catheters. Catheters are then threaded through the femoral artery, up through the aorta, and into the coronary arteries. Angiography is performed using injected radiopaque contrast agents (commonly called dye) to identify the location and extent of the blockage. A balloon-tipped dilation catheter is passed through the sheath and positioned over the lesion. The physician determines the catheter position by examining markers on the balloon that can be seen with fluoroscopy. When the catheter is properly positioned, the balloon is inflated with high pressure for several seconds and then deflated. The pressure compresses and often "cracks" the atheroma (Fig. 28-8). The media and adventitia of the coronary artery are also stretched.

Several inflations and several balloon sizes may be required to achieve the goal, usually defined as an improvement in blood flow and a residual stenosis of less than 20% (Urden, Stacy & Lough, 2006). Other measures of the success of a PTCA are an increase in the artery's lumen and no clinically obvious arterial trauma. Because the blood supply to the coronary artery decreases while the balloon is inflated, the patient may complain of chest pain and the ECG may display ST-segment changes. Intracoronary stents are usually positioned in the intima of the vessel to maintain patency after the balloon is withdrawn.

#### *Coronary Artery Stent*

After PTCA, the area that has been treated may close off partially or completely, a process called restenosis. The intima of the coronary artery has been injured and responds by initiating an acute inflammatory process. This process may include release of mediators that leads to vasoconstriction, clotting, and scar tissue formation. A coronary artery stent may be placed to overcome these risks. A **stent** is a metal

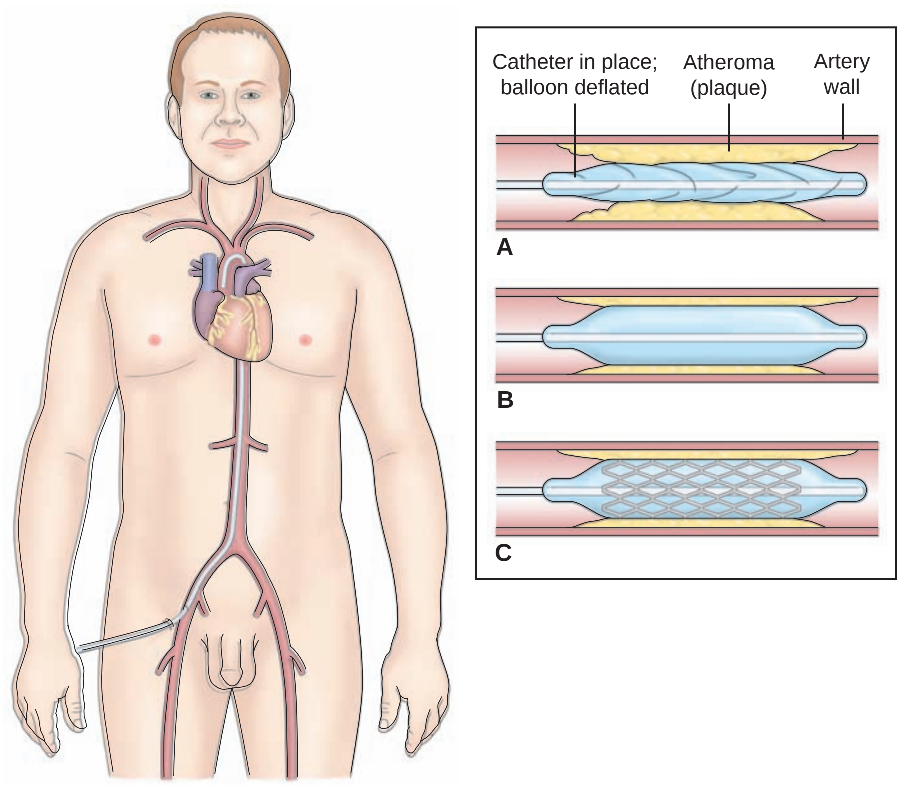



**Figure 28-8** Percutaneous transluminal coronary angioplasty. **A,** A balloon-tipped catheter is passed into the affected coronary artery and placed across the area of the atheroma (plaque). **B,** The balloon is then rapidly inflated and deflated with controlled pressure. **C,** A stent is placed to maintain patency of the artery, and the balloon is removed.

mesh that provides structural support to a vessel at risk of acute closure. The stent is positioned over the angioplasty balloon. When the balloon is inflated, the mesh expands and presses against the vessel wall, holding the artery open. The balloon is withdrawn, but the stent is left permanently in place within the artery (see Fig. 28-8). Eventually, endothelium covers the stent and it is incorporated into the vessel wall. Some stents are coated with medications, such as sirolimus (Rapamune) or paclitaxel (Taxol), which may minimize the formation of thrombi or scar tissue within the stent. These drug-eluting stents have increased the success of PCI (Fennessy & Borden, 2006). Because of the risk of thrombus formation within the stent, the patient receives antiplatelet medications, usually aspirin and clopidogrel. The clopidogrel is continued for at least a month following placement of a bare metal stent and for a year following drug-eluting stents (King, et al., 2007).

### *Atherectomy*

Atherectomy is an invasive interventional procedure that involves the removal of the atheroma, or plaque, from a coronary artery by cutting, shaving, or grinding (Urden, et al., 2006). It may be used in conjunction with PTCA. Directional coronary atherectomy and transluminal extraction catheter procedures involve the use of a catheter that removes the lesion and its fragments. Another procedure called rotational atherectomy uses a catheter with diamond chips impregnated on the tip (called a bur) that rotates like a dentist's drill at 130,000 to 180,000 rpm, pulverizing the lesion. Usually, several passes of these catheters are needed to achieve satisfactory results. Postprocedural patient care is the same as for a patient after PTCA.

### *Brachytherapy*

PTCA and stent implantation cause a cellular reaction in the coronary artery that promotes proliferation of the intima of the artery, increasing the possibility of arterial obstruction. Brachytherapy reduces the recurrence of obstruction, preventing vessel restenosis by inhibiting smooth muscle cell proliferation. Brachytherapy involves the delivery of gamma or beta radiation by placing a radioisotope close to the lesion. The radioisotope may be delivered by a catheter or implanted with the stent. However, drug-eluting stents are used more commonly to prevent restenosis, because they are typically more effective and less expensive than brachytherapy (Reynolds, et al., 2007).

## Complications

Complications that can occur during a PCI procedure include dissection, perforation, abrupt closure, or vasospasm of the coronary artery, acute MI, acute dysrhythmias (eg, ventricular tachycardia), and cardiac arrest. These may require emergency surgical treatment. Complications after the procedure may include abrupt closure of the coronary artery and vascular complications, such as bleeding at the insertion site, retroperitoneal bleeding, hematoma, and arterial occlusion, as well as acute renal failure (Table 28-4) (Lins, Guffey, VanRiper, et al., 2006).

## Postprocedure Care

Patient care is similar to that for a diagnostic cardiac catheterization (see Chapter 26). Patients who are not already hospitalized are admitted the day of the PCI. Those with no complications go home the next day. When the

**Table 28-4 COMPLICATIONS AFTER PERCUTANEOUS CORONARY INTERVENTIONS**

| Complication | Clinical Manifestations | Possible Causes | Nursing Actions |
|---|---|---|---|
| Myocardial ischemia | Chest pain<br>Ischemic changes on ECG<br>Dysrhythmias | Thrombosis<br>Restenosis of coronary artery | Administer oxygen and nitroglycerin<br>Obtain 12-lead ECG<br>Notify cardiologist |
| Bleeding and hematoma formation | Continuation of bleeding from vascular access site<br>Swelling at site<br>Formation of hard lump<br>Pain with leg movement<br>Possible hypotension and tachycardia | Anticoagulant therapy<br>Vascular trauma<br>Inadequate hemostasis<br>Leg movement | Keep patient on bedrest<br>Apply manual pressure over sheath insertion site<br>Outline hematoma with marking pen<br>Notify physician if bleeding continues |
| Retroperitoneal hematoma | Back, flank, or abdominal pain<br>Hypotension<br>Tachycardia<br>Restlessness, agitation | Arterial leak of blood into the retroperitoneal space | Notify physician<br>Stop anticoagulants<br>Administer IV fluids<br>Anticipate diagnostic testing (eg, computed tomography scan)<br>Prepare patient for intervention |
| Arterial occlusion | Lost/weakened pulse distal to sheath insertion site<br>Extremity cool, cyanotic, painful | Arterial thrombus or embolus | Notify physician<br>Anticipate intervention |
| Pseudoaneurysm formation | Swelling at vascular access site<br>Pulsatile mass, bruit | Vessel trauma during the procedure | Notify physician<br>Anticipate intervention |
| Arteriovenous fistula formation | Swelling at vascular access site<br>Pulsatile mass, bruit | Vessel trauma during the procedure | Notify physician<br>Anticipate intervention |
| Acute renal failure | Decreased urine output<br>Elevated blood urea nitrogen, serum creatinine | Nephrotoxic contrast agent | Monitor urine output, blood urea nitrogen, creatinine, electrolytes<br>Provide adequate hydration<br>Administer renal protective agents (acetylcysteine) before and after procedure as prescribed |

ECG, electrocardiogram; IV, intravenous.

PCI is performed emergently to treat ACS, patients usually go to a critical care unit and stay in the hospital for a few days. During the PCI, patients receive IV heparin or a thrombin inhibitor (eg, bivalirudin [Angiomax]) and are monitored closely for signs of bleeding (Levine, Berger, Cohen, et al., 2006). Patients may also receive a GP IIb/IIIa agent (eg, eptifibatide) for several hours following the PCI to prevent platelet aggregation and thrombus formation in the coronary artery. Hemostasis is achieved, and femoral sheaths may be removed at the end of the procedure by using a vascular closure device (eg, Angio-Seal, VasoSeal) or a device that sutures the vessels. Hemostasis after sheath removal may also be achieved by direct manual pressure, a mechanical compression device (eg, C-shaped clamp), or a pneumatic compression device (eg, FemoStop).

Patients may return to the nursing unit with the large peripheral vascular access sheaths in place. The sheaths are then removed after blood studies (eg, activated clotting time) indicate that the heparin is no longer active and the clotting time is within an acceptable range. This usually takes a few hours, depending on the amount of heparin given during the procedure. The patient must remain flat in bed and keep the affected leg straight until the sheaths are removed and then for a few hours afterward to maintain hemostasis. Because immobility and bed rest may cause discomfort, treatment may include analgesics and sedation. Sheath removal and the application of pressure on the vessel insertion site may cause the heart rate to slow and the blood pressure to decrease (vasovagal response). An IV bolus of atropine is usually given to treat this response.

Some patients with unstable lesions and at high risk for abrupt vessel closure are restarted on heparin after sheath removal, or they receive an IV infusion of a GP IIb/IIIa inhibitor. These patients are monitored closely and may have a delayed recovery period.

After hemostasis is achieved, a pressure dressing is applied to the site. Patients resume self-care and ambulate unassisted within a few hours of the procedure. The duration of immobilization depends on the size of the sheath inserted, the amount of anticoagulant administered, the method of hemostasis, the patient's underlying condition, and the physician's preference. On the day after the procedure, the site is inspected and the dressing removed. The patient is instructed to monitor the site for bleeding or development of a hard mass indicative of hematoma.

## Surgical Procedures: Coronary Artery Revascularization

Advances in diagnostics, medical management, surgical and anesthesia techniques, as well as the care provided in critical care and surgical units, home care, and rehabilitation programs have continued to make surgery an effective treatment option for patients with CAD. CAD has been treated by myocardial revascularization since the 1960s, and the most common CABG techniques have been performed for more than 35 years. CABG is a surgical procedure in which a blood vessel is grafted to an occluded coronary artery so that blood can flow beyond the occlusion; it is also called a bypass graft.

The major indications for CABG are:

- Alleviation of angina that cannot be controlled with medication or PCI
- Treatment of left main coronary artery stenosis or multivessel CAD
- Prevention and treatment of MI, dysrhythmias, or heart failure
- Treatment for complications from an unsuccessful PCI

CABG is performed less frequently in women. Compared with men, women referred for this surgery tend to be older and have more comorbidities. In addition, they have a higher risk of surgical complications such as MIs and strokes (Puskas, Kilgo, Kutner, et al., 2007). Furthermore, women have smaller coronary arteries, which makes the surgical procedure technically more difficult. Although some women have good outcomes following CABG, men generally have a better rate of graft patency and symptom relief (Eastwood & Doering, 2005).

The recommendation for CABG is determined by a number of factors, including the number of diseased coronary vessels, the degree of left ventricular dysfunction, the presence of other health problems, the patient's symptoms, and any previous treatment. Studies have shown that CABG may be the preferred treatment for high-risk patients such as those with severe triple-vessel CAD, ventricular dysfunction, and diabetes (Bravata, Gienger, McDonald, et al., 2007). Studies continue to compare clinical outcomes of CABG and PCI in patients with CAD.

For a patient to be considered for CABG, the coronary arteries to be bypassed must have approximately a 70% occlusion (60% if in the left main coronary artery). If significant blockage is not present, flow through the artery will compete with flow through the bypass, and circulation to the ischemic area of myocardium may not improve. It is also necessary that the artery be patent beyond the area of blockage or the flow through the bypass will be impeded.

A vessel commonly used for CABG is the greater saphenous vein, followed by the lesser saphenous vein (Fig. 28-9). Cephalic and basilic veins are also used. The vein is removed from the leg (or arm) and grafted to the ascending aorta and to the coronary artery distal to the lesion. Traditionally, a skin incision was made over the length of vein segment, but new techniques allow small incisions on the affected extremity. A common adverse effect of vein removal is edema in the extremity from which the vein was taken. The degree of edema varies and usually diminishes over time. Within 5 to 10 years, atherosclerotic changes often develop in saphenous vein grafts.

The right and left internal mammary arteries and occasionally the radial and gastroepiploic arteries are also used for CABG. Arterial grafts are preferred to venous grafts because they do not develop atherosclerotic changes as quickly and remain patent longer. The surgeon leaves the proximal end of the mammary artery intact and detaches the distal end of the artery from the chest wall. This end of the artery is then grafted to the coronary artery distal to the occlusion. The internal mammary arteries may not be long enough to use for multiple bypasses. Because of this, many CABG procedures are performed with a combination of venous and arterial grafts.

## Traditional Coronary Artery Bypass Graft

CABG procedures are performed with the patient under general anesthesia. In the traditional CABG procedure, the surgeon performs a median sternotomy and connects the patient to the cardiopulmonary bypass (CPB) machine. Next, a blood vessel from another part of the patient's body (eg, saphenous vein, left internal mammary artery) is grafted distal to the coronary artery lesion, bypassing the obstruction (Fig. 28-10). CPB is then discontinued, chest tubes and epicardial pacing wires are placed,

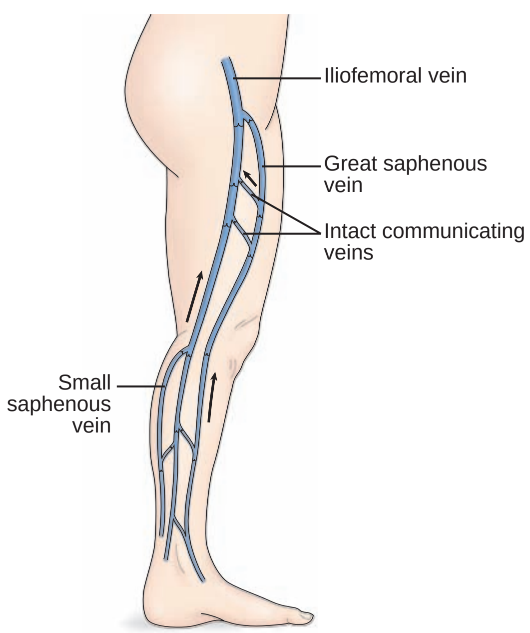



**Figure 28-9** The greater and lesser saphenous veins are commonly used in bypass graft procedures.

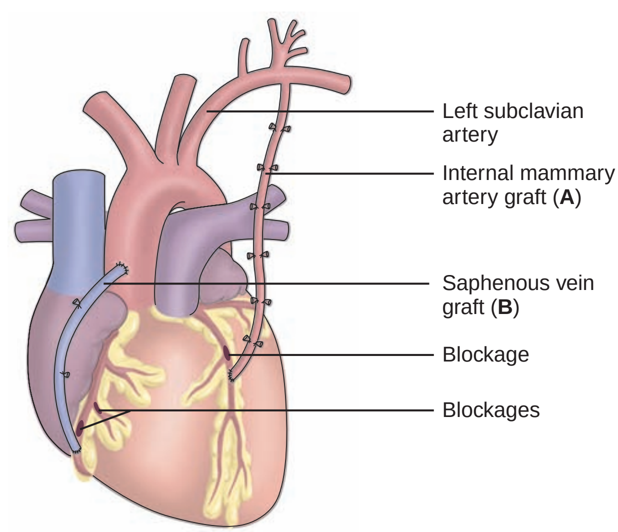



**Figure 28-10** Coronary artery bypass grafts. One or more procedures may be performed using various veins and arteries. **A,** Left internal mammary artery, used frequently because of its functional longevity. **B,** Saphenous vein, also used as bypass graft.

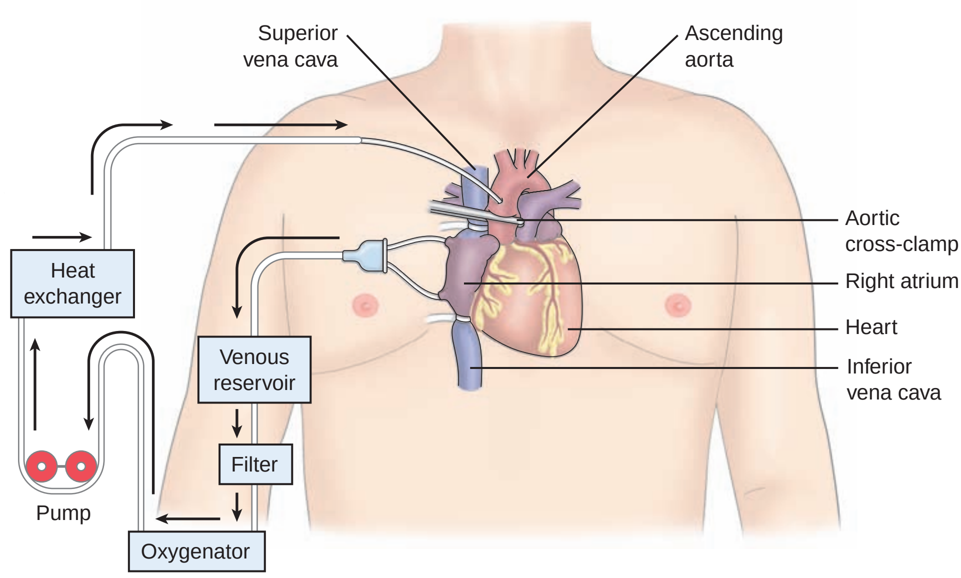



**Figure 28-11** The cardiopulmonary bypass (CPB) system in which cannulas are placed through the right atrium into the superior and inferior vena cavae to divert blood from the body and into the bypass system. The pump system creates a vacuum, pulling blood into the venous reservoir. The blood is cleared of air bubbles, clots, and particulates by the filter and then is passed through the oxygenator, releasing carbon dioxide and obtaining oxygen. Next, the blood is pulled to the pump and pushed out to the heat exchanger, where its temperature is regulated. The blood is then returned to the body via the ascending aorta.

and the incision is closed. The patient is then admitted to a critical care unit.

### *Cardiopulmonary Bypass*

Many cardiac surgical procedures are possible because of CPB (ie, extracorporeal circulation). The procedure mechanically circulates and oxygenates blood for the body while bypassing the heart and lungs. CPB maintains perfusion to body organs and tissues and allows the surgeon to complete the anastomoses in a motionless, bloodless surgical field.

CPB is accomplished by placing a cannula in the right atrium, vena cava, or femoral vein to withdraw blood from the body. The cannula is connected to tubing filled with an isotonic crystalloid solution. Venous blood removed from the body by the cannula is filtered, oxygenated, cooled or warmed by the machine, and then returned to the body. The cannula used to return the oxygenated blood is usually inserted in the ascending aorta, or it may be inserted in the femoral artery (Fig. 28-11). The heart is stopped by the injection of a potassium-rich cardioplegia solution into the coronary arteries. The patient receives heparin to prevent clotting and thrombus formation in the bypass circuit when blood comes in contact with the surfaces of the tubing. At the end of the procedure when the patient is disconnected from the bypass machine, protamine sulfate is administered to reverse the effects of heparin.

During the procedure, hypothermia is maintained, usually 28°C to 32°C (82.4°F to 89.6°F). The blood is cooled during CPB and returned to the body. The cooled blood slows the body's basal metabolic rate, thereby decreasing the demand for oxygen. Cooled blood usually has a higher viscosity, but the crystalloid solution used to prime the bypass tubing dilutes the blood. When the surgical procedure is completed, the blood is rewarmed as it passes through the CPB circuit. Urine output, arterial blood gases, electrolytes, and coagulation studies are monitored to assess the patient's status during CPB.

## Alternative Coronary Artery Bypass Graft Techniques

A number of alternative CABG techniques have been developed that may have fewer complications for some groups of patients. Off-pump CABG (OPCAB) surgery has been used successfully in many patients since the 1990s. OPCAB involves a standard median sternotomy incision, but the surgery is performed without CPB. A beta-adrenergic blocker may be used to slow the heart rate. The surgeon also uses a myocardial stabilization device to hold the site still for the anastomosis of the bypass graft into the coronary artery while the heart continues to beat (Fig. 28-12). The

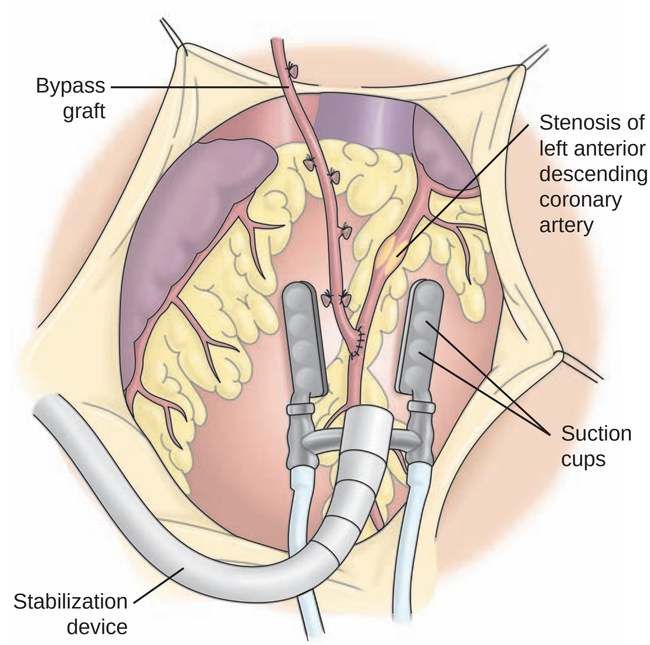



**Figure 28-12** Stabilizer device for off-pump coronary artery bypass surgery.

potential benefits of OPCAB include a decrease in the incidence of stroke and other neurologic complications, renal failure, and other postoperative complications (Lattouf, Puskas, Thourani, et al., 2007). Comparison of this technique with traditional CABG has been found to be favorable in some patient groups.

Minimally invasive surgical techniques that eliminate median sternotomy have also been developed. These endoscopic techniques use smaller incisions and a robotic system to place bypass grafts (Katz & Bonatti, 2007). The patient is placed on CPB via the femoral vessels. Patients who require multiple bypass grafts or grafts to arteries on the dorsum of the heart may not be candidates for this technique.

## Complications of Coronary Artery Bypass Graft

CABG may result in complications such as hemorrhage, dysrhythmias, and MI (Table 28-5). The patient may require interventions for more than one complication at a time. Collaboration among nurses, physicians, pharmacists, respiratory therapists, and dietitians is necessary to achieve the desired patient outcomes. Although most patients improve symptomatically following surgery, CABG is not a cure for CAD, and angina, exercise intolerance, or other symptoms experienced before CABG may recur. Medications required before surgery may need to be continued. Lifestyle modifications recommended before surgery remain important to treat the underlying CAD and for the continued viability of the newly implanted grafts.

## Nursing Management

Cardiac surgery patients have many of the same needs and require the same perioperative care as other surgical patients (see Chapters 18 through 20), plus some special needs.

### *Preoperative Management*

Preoperative teaching is important; patients and their families may be very anxious as the association of the heart with life and death intensifies their emotions. Before surgery, physical and psychological assessments establish a baseline for future reference. In addition, it is necessary to evaluate the patient's understanding of the surgical procedure, informed consent, and adherence to treatment protocols.

#### Assessing the Patient

Patients are frequently admitted to the hospital the day of the procedure. Therefore, most of the preoperative evaluation is completed in the physician's office and during preadmission testing.

Nursing and medical personnel perform a history and physical examination. Preoperative testing consists of a chest x-ray, ECG, laboratory tests, including coagulation studies, and blood typing and cross-matching. The health assessment focuses on obtaining baseline physiological, psychological, and social information. The patient's and family's learning needs are identified and addressed. Of particular importance are the patient's usual functional level, coping mechanisms, and available support systems. These affect the patient's postoperative course, discharge plans, and rehabilitation.

The preoperative history and health assessment should be thorough and well documented because they provide a basis for postoperative comparison. It is necessary to perform a systematic assessment of all systems, with emphasis on cardiovascular functioning. The nurse assesses the patient for disorders that could complicate or affect the postoperative course, such as diabetes, hypertension, and preexisting disabilities.

The status of the cardiovascular system is determined by reviewing the patient's symptoms, including past and present experiences with chest pain, palpitations, and breathing difficulty (dyspnea), leg pain that occurs with walking (intermittent claudication), and peripheral edema. The patient's history of major illnesses, previous surgeries, medication, use of illicit and over-the-counter drugs, herbal supplements, alcohol, and tobacco is also obtained. Particular attention is paid to blood glucose control in patients with diabetes because there is a higher incidence of postoperative complications when glycemic control is poor (Presutti & Millo, 2006).

A complete physical examination is performed, with a focused cardiovascular emphasis, as previously discussed in detail in Chapter 26.

The psychosocial assessment and the assessment of the patient's and family's learning needs are as important as the physical examination. Anticipation of cardiac surgery is a source of great stress to the patient and family, and patients with high anxiety levels have poorer outcomes (Gallagher & McKinley, 2007). However, some anxiety is expected, and the work of worrying can help patients identify priorities and find coping strategies that help them face the threat of surgery (Chart 28-12). Questions may be asked to obtain the following information:

- Knowledge and understanding of the surgical procedure, postoperative course, and recovery
- Meaning of the surgery to the patient and family
- Fears regarding the present and future
- Coping mechanisms that are being used
- Support systems in effect

#### Reducing Fear and Anxiety

The nurse gives the patient and family time and opportunity to express their fears. Topics of concern may be pain, changes in body image, fear of the unknown, and disability or death. It is often helpful to describe to the patient the sensations that he or she can expect. It is necessary to describe the preoperative sedation, the anesthetic, and the postoperative pain medications. The nurse reassures the patient that the fear of pain is normal, that some pain will be experienced, that medication to relieve pain will be provided, and that the patient will be closely monitored. In addition, the nurse suggests that the patient request analgesic medication before the pain becomes severe. If the patient has concerns about scarring from surgery, the nurse encourages him or her to discuss this issue and corrects any misconceptions. The patient and family may want to discuss their fear of the patient dying. After the fear is expressed, the nurse can assure the patient and family that this fear is normal and further explore their feelings.

For patients with extreme anxiety or fear and for whom emotional support and education are not successful, medication therapy may be helpful. The anxiolytic agents most

**Table 28-5 POTENTIAL COMPLICATIONS OF CARDIAC SURGERY**

| Complication | Cause | Assessment and Management |
|---|---|---|
| **Cardiac Complications** | | |
| **Decreased Cardiac Output** | | |
| Hypovolemia (most common cause of decreased cardiac output after cardiac surgery) | • Net loss of blood and intravascular volume.<br>• Surgical hypothermia (as the reduced body temperature rises after surgery, blood vessels dilate, and more volume is needed to fill the vessels).<br>• Intravenous fluid loss to the interstitial spaces because surgery and anesthesia increase capillary permeability. | • Arterial hypotension, tachycardia, low central venous pressure (CVP) and low pulmonary artery wedge pressure (PAWP) are often seen.<br>• Fluid replacement may be prescribed. Replacement fluids include colloid (albumin, hetastarch), packed red blood cells, or crystalloid solution (normal saline, lactated Ringer's solution). |
| Persistent bleeding | • Cardiopulmonary bypass causes platelet dysfunction, and hypothermia alters clotting mechanisms.<br>• Surgical trauma causes tissues and blood vessels to ooze bloody drainage.<br>• Intraoperative anticoagulant (heparin) therapy.<br>• Postoperative coagulopathy may also result from liver dysfunction and depletion of clotting components. | • Accurate measurement of wound bleeding and chest tube blood is essential. Drainage should not exceed 200 mL/h for the first 4 to 6 hours. Drainage should decrease and stop within a few days, while progressing from sanguinous to serosanguineous to serous.<br>• Serial hemoglobin, hematocrit, and coagulation studies are performed to guide therapy.<br>• Administration of fluids, colloids, and blood products: packed red blood cells, fresh frozen plasma, platelet concentrate.<br>• Protamine sulfate may be administered to neutralize unfractionated heparin.<br>• Administration of desmopressin acetate (DDAVP) to enhance platelet function.<br>• If bleeding persists, the patient may return to the operating room. |
| Cardiac tamponade | • Fluid and clots accumulate in the pericardial sac, which compress the heart, preventing blood from filling the ventricles. | • Signs and symptoms include arterial hypotension, tachycardia, muffled heart sounds, decreased urine output, and ↑ CVP. Arterial pressure waveform may show pulsus paradoxus (decrease of more than 10 mm Hg systolic blood pressure during inspiration).<br>• The chest drainage system is checked to eliminate possible kinks or obstructions in the tubing.<br>• Chest x-ray may show a widening mediastinum.<br>• Emergency medical management is required; may include return to surgery. |
| Fluid overload | • Intravenous (IV) fluids and blood products increase circulating volume. | • High CVP and pulmonary artery pressures as well as crackles indicate fluid overload.<br>• Diuretics are prescribed and the rate of IV fluid administration is reduced.<br>• Alternative treatments include continuous renal replacement therapy and dialysis. |
| Hypothermia | • Low body temperature leads to vasoconstriction, shivering, and arterial hypertension. | • Patient is rewarmed gradually after surgery, decreasing vasoconstriction. |
| Hypertension | • Results from postoperative vasoconstriction. It may stretch suture lines and cause postoperative bleeding. The condition is usually transient. | • Vasodilators (nitroglycerin [Tridil], nitroprusside [Nipride]) may be used to treat hypertension. Administer cautiously to avoid hypotension. |
| Tachydysrhythmias | • Increased heart rate is common with perioperative volume changes. Uncontrolled atrial fibrillation commonly occurs during the first few days postoperatively. | • If a tachydysrhythmia is the primary problem, the heart rhythm is assessed and medications (eg, amiodarone [Cordarone], diltiazem [Cardizem], may be prescribed. Antidysrhythmic agents may be given before coronary artery bypass graft (CABG) to minimize the risk of postoperative tachydysrhythmias.<br>• Carotid massage may be performed by a physician to assist with diagnosing or treating the dysrhythmia.<br>• Cardioversion and defibrillation are alternatives for symptomatic tachydysrhythmias. |
| Bradycardias | • Decreased heart rate due to surgical trauma and edema affecting the cardiac conduction system. | • Many postoperative patients have temporary pacer wires that can be attached to a pulse generator (pacemaker) to stimulate the heart to beat faster. Less commonly, atropine or other medications may be used to increase heart rate. |
| Cardiac failure | • Myocardial contractility may be decreased perioperatively. | • The nurse observes for and reports signs of heart failure including hypotension, ↑ CVP, ↑ PAWP, venous distention; labored respirations; and edema.<br>• Medical management includes diuretics, digoxin, and IV inotropic agents. |

*Continued on following page*

**Table 28-5 POTENTIAL COMPLICATIONS OF CARDIAC SURGERY (Continued)**

| Complication | Cause | Assessment and Management |
|---|---|---|
| Myocardial infarction (MI) (may occur intraoperatively or postoperatively) | • Portion of the cardiac muscle dies; therefore, contractility decreases. Impaired ventricular wall motion further decreases cardiac output. Symptoms may be masked by the postoperative surgical discomfort or the anesthesia–analgesia regimen. | • Careful assessment to determine the type of pain the patient is experiencing; MI suspected if the mean blood pressure is low with normal preload.<br>• Serial electrocardiograms (ECGs) and cardiac biomarkers assist in making the diagnosis (alterations may be due to the surgical intervention). |
| **Pulmonary Complications** | | |
| Impaired gas exchange | • During and after anesthesia, patients require mechanical assistance to breathe.<br>• Anesthetic agents stimulate production of mucus and chest incision pain may decrease the effectiveness of ventilation.<br>• Potential for postoperative atelectasis. | • Pulmonary complications are detected during assessment of breath sounds, oxygen saturation levels, arterial blood gases, and ventilator readings.<br>• Extended periods of mechanical ventilation may be required while complications are treated. |
| **Neurologic Complications** | | |
| Neurologic changes; stroke | • Thrombi and emboli may cause cerebral infarction and neurological signs may be evident when patients recover from anesthesia. | • Inability to follow simple commands within 6 hours of recovery from anesthetic; weakness on one side of body or other neurological changes may indicate stroke.<br>• Patients who are elderly or who have renal or hepatic failure may take longer to recover from anesthesia. |
| **Renal Failure and Electrolyte Imbalance** | | |
| Acute renal failure | • May result from hypoperfusion of the kidneys or from injury to the renal tubules by nephrotoxic drugs. | • May respond to diuretics or may require continuous renal replacement therapy (CRRT) or dialysis.<br>• Fluids, electrolytes, and urine output are monitored frequently.<br>• Renal failure may become chronic and require ongoing dialysis. |
| Electrolyte imbalance | • Postoperative imbalances in potassium, magnesium, sodium, calcium, and blood glucose are related to surgical losses, metabolic changes, and the administration of medications and IV fluids. | • Monitor electrolytes and basic metabolic studies frequently.<br>• Implement treatment to correct electrolyte imbalance promptly (see Chart 28-13). |
| **Other Complications** | | |
| Hepatic failure | • Surgery and anesthesia stress the liver. Most common in patients with cirrhosis, hepatitis, or prolonged right-sided heart failure. | • Use of medications metabolized by the liver must be minimized.<br>• Bilirubin, albumin, and amylase levels are monitored, and nutritional support is provided. |
| Infection | • Surgery and anesthesia alter the patient's immune system. Multiple invasive devices used to monitor and support the patient's recovery may serve as a source of infection. | • Monitor for signs of possible infection: body temperature, white blood cell and differential counts, incision and puncture sites, urine (clarity, color, and odor), bilateral breath sounds, sputum (color, odor, amount).<br>• Antibiotic therapy may be instituted or modified as necessary.<br>• Invasive devices are discontinued as soon as they are no longer required. Institutional protocols for maintaining and replacing invasive lines and devices are followed to minimize the risk of infection. |

commonly used before cardiac surgery are lorazepam (Ativan) and diazepam (Valium).

### Monitoring and Managing Potential Complications

Angina may occur because of increased stress and anxiety related to the forthcoming surgery. The patient who develops angina usually responds to typical angina therapy, most commonly nitroglycerin. Some patients require oxygen and IV nitroglycerin infusions. Physiologically unstable patients may require management in a critical care unit preoperatively.

### Providing Patient Teaching

Prior to surgery, patients and their families are given specific preoperative instructions. This includes information about the prescribed medications, including anticoagulants, antihypertensives, and medications that control diabetes. The patient is instructed to shower with an antiseptic solution.

Teaching also includes information about the hospitalization and surgery. The nurse informs the patient and family about the equipment, tubes, and lines that will be present after surgery and their purposes. They should expect monitors, several IV lines, chest tubes, and a urinary catheter. Explaining the purpose and the approximate time that these devices will be in place helps reassure the patient. Most patients remain intubated and on mechanical ventilation for 2 to 24 hours after surgery. It is important that patients realize that this will prevent them from talking, and the nurse should reassure them that the staff will be able to assist them with other means of communication.

CHART 28-12

NURSING RESEARCH PROFILE

## *Anxiety in Patients Undergoing Coronary Artery Bypass Graft*

Gallagher, R. & McKinley, S. (2007). Stressors and anxiety in patients undergoing coronary artery bypass surgery. *American Journal of Critical Care, 162*(3), 248–257.

### Purpose

Although a coronary artery bypass graft (CABG) is a commonly performed surgical procedure, it is known to be a stressful event for patients. The anxiety associated with surgery persists throughout the postoperative course and is associated with increased pain, continuing cardiac symptoms, and readmission to the hospital. The aim of this study was to describe the specific stressors facing patients and identify those associated with high levels of anxiety.

### Design

A convenience sample of adult, English-speaking patients scheduled for CABGs at two hospitals in Sydney, Australia, participated in this study. Investigators used parts of the Hospital Anxiety and Depression Scale and the Stressor Scale when they interviewed the participants. In addition to these instruments, open-ended questions about participants' most important concerns were also part of the evaluation. This assessment occurred at three times: before surgery ($n = 172$), before discharge ($n = 143$), and 10 days after discharge ($n = 138$).

### Findings

Although many participants reported low levels of anxiety, 40% experienced borderline or clinically significant levels of anxiety before surgery and after discharge. Women were particularly likely to express anxiety, and participants who were anxious before surgery were likely to continue to experience anxiety throughout recovery. The highest ranking stressors were as follows: waiting for surgery (preoperative period), being away from home or work (before discharge), and being in pain or discomfort (following discharge).

### Nursing Implications

Anxiety should be assessed before CABG in all patients. Interventions should address the stress of waiting for surgery, especially for patients who wait for a long period of time. Pain management protocols and resuming roles and lifestyle should also be addressed. Special efforts should be made to support patients with high anxiety levels.

The nurse takes care to answer the patient's questions about postoperative care and procedures. After the nurse explains deep breathing and coughing, use of the incentive spirometer, and foot exercises, the patient practices these procedures before surgery. It is important to discuss the benefit of early and frequent ambulation. The family's questions at this time usually focus on the length of the surgery, who will discuss the results of the procedure with them after surgery, where to wait during the surgery, the visiting procedures for the critical care unit, and how they can support the patient before surgery and in the critical care unit.

### *Intraoperative Management*

The perioperative nurse performs assessments and prepares the patient as described previously in Chapters 18 and 19. In addition to assisting with the surgical procedure, perioperative nurses are responsible for the comfort and safety of the patient.

Before the chest incision is closed, chest tubes are inserted to evacuate air and drainage from the mediastinum and the thorax. Temporary epicardial pacemaker electrodes may be implanted on the surface of the right atrium and the right ventricle. These epicardial electrodes can be connected to an external pacemaker if the patient has persistent bradycardia perioperatively. Possible intraoperative complications include low cardiac output, dysrhythmias, hemorrhage, MI, stroke, embolization, and organ failure from shock, embolus, or adverse drug reactions. Astute intraoperative nursing assessment is critical to prevent, detect, and initiate prompt intervention for these complications.

### *Postoperative Nursing Management*

Initial postoperative care focuses on achieving or maintaining hemodynamic stability and recovery from general anesthesia. Care may be provided in the postanesthesia care unit (PACU) or intensive care unit. The immediate postoperative period for the patient who has undergone cardiac surgery presents many challenges to the health care team. All efforts are made to facilitate the transition from the operating room to the critical care unit or PACU with minimal risk. Specific information about the surgical procedure and important factors about postoperative management are communicated by the surgical team and anesthesia personnel to the critical care or PACU nurse, who then assumes responsibility for the patient's care. Figure 28-13 presents an overview of the many aspects of postoperative care of the cardiac surgical patient.

Once the patient's cardiac status and respiratory status are stable, the patient is transferred to a surgical progressive care unit with telemetry. Care focuses on monitoring of cardiopulmonary status, pain management, wound care, progressive activity, and nutrition. Education about medications and risk factor modification is emphasized.

A typical plan of postoperative nursing care is presented in Chart 28-13.

#### Assessing the Patient

When the patient is admitted to the critical care unit or PACU, and hourly for at least every 8 hours thereafter, nursing and medical personnel perform a complete assessment of all systems. It is necessary to assess the following parameters:

*Neurologic status:* level of responsiveness, pupil size and reaction to light, reflexes, facial symmetry, movement of the extremities, and hand grip strength

*Cardiac status:* heart rate and rhythm, heart sounds, pacemaker status, arterial blood pressure, central venous pressure (CVP), and in selected patients, hemodynamic parameters: pulmonary artery pressure, pulmonary artery wedge pressure (PAWP), cardiac output and index, systemic and pulmonary vascular resistance, mixed venous oxygen saturation ($SvO_2$) (see Chapter 26 for a detailed description of hemodynamic monitoring)

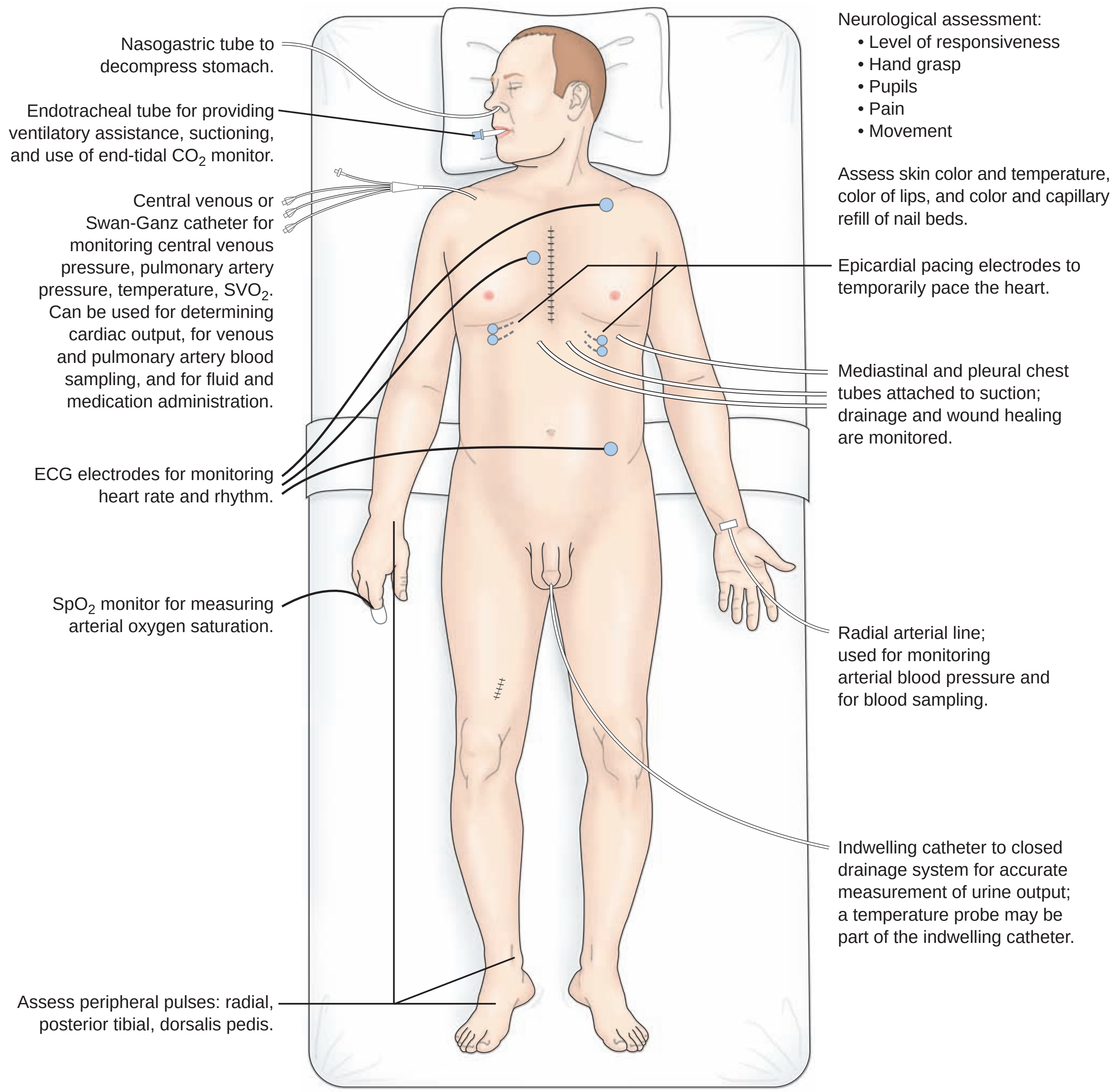



**Figure 28-13** Postoperative care of the cardiac surgical patient requires the nurse to be proficient in interpreting hemodynamics, correlating physical assessments with laboratory results, sequencing interventions, and evaluating progress toward desired outcomes.

*Respiratory status:* chest movement, breath sounds, ventilator settings (eg, rate, tidal volume, oxygen concentration, mode such as synchronized intermittent mandatory ventilation, positive end-expiratory pressure, pressure support), respiratory rate, peak inspiratory pressure, arterial oxygen saturation ($SaO_2$), percutaneous oxygen saturation ($SpO_2$), end-tidal $CO_2$, pleural chest tube drainage, arterial blood gases

*Peripheral vascular status:* peripheral pulses; color of skin, nail beds, mucosa, lips, and earlobes; skin temperature; edema; condition of dressings and invasive lines

*Renal function:* urinary output; urine specific gravity and osmolality

*Fluid and electrolyte status:* intake, output from all drainage tubes, all cardiac output parameters, and indications of electrolyte imbalance

*Pain:* nature, type, location, and duration; apprehension; response to analgesics

Assessment also includes checking all equipment and tubes to ensure that they are functioning properly: endotracheal tube, ventilator, end-tidal $CO_2$ monitor, $SpO_2$ monitor, pulmonary artery catheter, $SvO_2$ monitor, arterial and IV lines, IV infusion devices and tubing, cardiac monitor, pacemaker, chest tubes, and urinary drainage system.

As the patient regains consciousness and progresses through the postoperative period, the nurse also assesses

CHART 28-13

## PLAN OF NURSING CARE
### *Care of the Patient After Cardiac Surgery*

**NURSING DIAGNOSIS:** Decreased cardiac output related to blood loss and compromised myocardial function
**GOAL:** Restoration of cardiac output to maintain organ and tissue perfusion

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor cardiovascular status. Serial readings of blood pressure, other hemodynamic parameters, and cardiac rhythm and rate are obtained, recorded, and correlated with the patient's overall condition. | 1. Effectiveness of cardiac output is determined by continuous monitoring. | • The following parameters are within the patient's normal ranges:<br>Arterial pressure<br>CVP<br>Pulmonary artery pressures<br>PAWP<br>Heart sounds<br>Pulmonary and systemic vascular resistance<br>Cardiac output and cardiac index<br>Peripheral pulses<br>Cardiac rate and rhythm<br>Cardiac biomarkers<br>Urine output<br>Skin and mucosal color<br>Skin temperature |
| a. Assess arterial blood pressure every 15 minutes until stable; then arterial or cuff blood pressure every 1 to 4 hours × 24 hours; then every 8 to 12 hours until hospital discharge. | a. Blood pressure is one of the most important physiologic parameters to monitor; vasoconstriction after cardiopulmonary bypass may require treatment with an IV vasodilator. | |
| b. Auscultate for heart sounds and rhythm. | b. Auscultation provides evidence of cardiac tamponade (muffled distant heart sounds), pericarditis (precordial rub), dysrhythmias. | |
| c. Assess peripheral pulses (pedal, tibial, radial). | c. Presence or absence and quality of pulses provide data about cardiac output as well as obstructive lesions. | |
| d. Monitor hemodynamic parameters to assess cardiac output, volume status, and vascular tone. | d. Rising CVP and PAWP may indicate congestive heart failure or pulmonary edema. Low pressures may indicate need for volume replacement. | |
| e. Watch for trends in hemodynamics and note that mechanical ventilation may alter hemodynamics. | e. Trends are more important than isolated readings. Mechanical ventilation increases intrathoracic pressure. | |
| f. Monitor ECG pattern for cardiac dysrhythmias and ischemic changes. | f. Dysrhythmias may occur with coronary ischemia, hypoxia, bleeding, acid-base or electrolyte disturbances, digitalis toxicity, or cardiac failure. ST-segment changes may indicate myocardial ischemia. Pacemaker capture and antiarrhythmic medications are used to maintain heart rate and rhythm and to support blood pressure. | |
| g. Assess cardiac biomarker results. | g. Elevations may indicate myocardial infarction. | |
| h. Measure urine output every half hour to 1 hour at first, then with vital signs. | h. Urine output less than 30 mL/h indicates decreased renal perfusion and may reflect decreased cardiac output. | |
| i. Observe buccal mucosa, nail beds, lips, earlobes, and extremities. | i. Duskiness and cyanosis may indicate decreased cardiac output. | |
| j. Assess skin; note temperature and color. | j. Cool moist skin indicates vasoconstriction and decreased cardiac output. | |
| 2. Observe for persistent bleeding: excessive chest tube drainage of blood; hypotension; low CVP; tachycardia. Prepare to administer blood products, IV solutions. | 2. Bleeding can result from surgical trauma to tissues, anticoagulant medications, and clotting defects. | • Less than 200 mL/h of drainage through chest tubes during first 4 to 6 hours.<br>• Vital signs stable. |

*Continued on following page*

CHART 28-13

**PLAN OF NURSING CARE**

***Care of the Patient After Cardiac Surgery*** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Observe for cardiac tamponade: hypotension; rising CVP and PAWP, pulsus paradoxus; muffled heart sounds; weak, thready pulse; jugular vein distention; decreasing urinary output. Check for diminished amount of blood in chest drainage collection system. Prepare for reoperation. | 3. Cardiac tamponade results from bleeding into the pericardial sac or accumulation of fluid in the sac, which compresses the heart and prevents adequate filling of the ventricles. Decrease in chest drainage may indicate that fluid and clots are accumulating in the pericardial sac. | • CVP and other hemodynamic parameters within normal limits.<br>• Urinary output within normal limits.<br>• Skin color normal.<br>• Respirations unlabored, clear breath sounds.<br>• Pain limited to incision. |
| 4. Observe for signs of cardiac failure. Prepare to administer diuretics, digoxin, IV inotropic agents. | 4. Cardiac failure results from decreased pumping action of the heart; can cause deficient perfusion to vital organs. | |

**NURSING DIAGNOSIS:** Impaired gas exchange related to chest surgery
**GOAL:** Adequate gas exchange

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Maintain mechanical ventilation until the patient is able to breathe independently. | 1. Ventilatory support is used to decrease work of the heart, to maintain effective ventilation, and to provide an airway in the event of complications. | • Airway patent.<br>• ABGs within normal range.<br>• Endotracheal tube correctly placed, as evidenced by x-ray.<br>• Breath sounds clear bilaterally.<br>• Ventilator synchronous with respirations.<br>• Breath sounds clear after suctioning/coughing.<br>• Nail beds and mucous membranes pink.<br>• Mental acuity consistent with amount of sedatives and analgesics received.<br>• Oriented to person; able to respond yes and no appropriately.<br>• Able to be weaned successfully from ventilator. |
| 2. Monitor arterial blood gases, tidal volume, peak inspiratory pressure, and extubation parameters. | 2. ABGs and ventilator parameters indicate effectiveness of ventilator and changes that need to be made to improve gas exchange. | |
| 3. Auscultate chest for breath sounds. | 3. Crackles indicate pulmonary congestion; decreased or absent breath sounds may indicate pneumothorax, hemothorax, dislodgement of tube. | |
| 4. Sedate patient adequately, as prescribed, and monitor respiratory rate and depth. | 4. Sedation helps the patient to tolerate the endotracheal tube and to cope with ventilatory sensations. | |
| 5. Suction tracheobronchial secretions as needed, using strict aseptic technique. | 5. Retention of secretions leads to hypoxia and possible infection. | |
| 6. Assist in weaning and endotracheal tube removal. | 6. Extubation decreases risk of pulmonary infections and enhances ability of patient to communicate. | |
| 7. After extubation, promote deep breathing, coughing, and turning. Encourage use of the incentive spirometer and compliance with breathing treatments. Teach incisional splinting with a "cough pillow" to decrease discomfort. | 7. Aids in keeping airway patent, preventing atelectasis, and facilitating lung expansion. | |

**NURSING DIAGNOSIS:** Risk for imbalanced fluid volume and electrolyte imbalance related to alterations in blood volume
**GOAL:** Fluid and electrolyte balance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor fluid and electrolyte balance. | 1. Adequate circulating blood volume is necessary for optimal cellular activity; fluid and electrolyte imbalance can occur after surgery. | • Fluid intake and output balanced.<br>• Hemodynamic assessment parameters negative for fluid overload or hypovolemia. |
| a. Accurately document intake and output; record urine volume every half hour to 4 hours while in critical care unit; then every 8 to 12 hours while hospitalized. | a. Provides a method to determine positive or negative fluid balance and fluid requirements. | |

*Continued*

CHART 28-13

PLAN OF NURSING CARE

## *Care of the Patient After Cardiac Surgery* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| b. Assess blood pressure, hemodynamic parameters, weight, electrolytes, hematocrit, jugular venous pressure, breath sounds, urinary output, and nasogastric tube drainage. | b. Provides information about state of hydration. | • Normal blood pressure with position changes.<br>• Absence of dysrhythmia.<br>• Stable weight.<br>• Arterial blood pH 7.35 to 7.45.<br>• Serum potassium 3.5 to 5.0 mEq/L (3.5 to 5.0 mmol/L).<br>• Serum magnesium 1.3 to 2.3 mg/dL (0.62 to 0.95 mmol/L).<br>• Serum sodium 135 to 145 mEq/L (135 to 145 mmol/L).<br>• Serum calcium 8.6 to 10.2 mg/dL (2.15 to 2.55 mmol/L).<br>• Serum glucose less than 110 mg/dL. |
| c. Measure postoperative chest drainage; cessation of drainage may indicate kinked or blocked chest tube. Ensure patency and integrity of the drainage system. Maintain autotransfusion system if in use. | c. Excessive blood loss from chest cavity can cause hypovolemia. | |
| d. Weigh daily and correlate with intake and output. | d. Indicator of fluid balance. | |
| 2. Be alert to changes in serum electrolyte levels. | 2. A specific concentration of electrolytes is necessary in both extracellular and intracellular body fluids to sustain life. | |
| a. Hypokalemia (low potassium) *Effects:* dysrhythmias: PVCs, ventricular tachycardia. Observe for specific ECG changes. Administer IV potassium replacement as prescribed. | a. *Causes:* inadequate intake, diuretics, vomiting, excessive nasogastric drainage, stress from surgery. | |
| b. Hyperkalemia (high potassium) *Effects:* ECG changes, tall peaked T waves, wide QRS, brachycardia. Be prepared to administer diuretic or an ion-exchange resin (sodium polystyrene sulfonate [Kayexalate]); IV sodium bicarbonate, or IV insulin and glucose. | b. *Causes:* increased intake, hemolysis from cardiopulmonary bypass/mechanical assist devices, acidosis, renal insufficiency. The resin binds potassium and promotes intestinal excretion of it. IV sodium bicarbonate drives potassium into the cells from extracellular fluid. Insulin assists the cells with glucose and potassium absorption. | |
| c. Monitor serum magnesium, sodium and calcium. | c. Low levels of magnesium are associated with dysrhythmias, muscle spasm, and tetany. Low levels of sodium are associated with weakness and neurological symptoms. Low levels of calcium can lead to dysrhythmias and muscle spasm. | |
| d. Hyperglycemia (high blood glucose) *Effects:* increased urine output, thirst, metabolic acidosis Administer insulin as prescribed. | d. *Cause:* stress response to surgery. Affects both patients with diabetes and those without diabetes. | |

*Continued on following page*

CHART 28-13

## PLAN OF NURSING CARE
## *Care of the Patient After Cardiac Surgery (Continued)*

**NURSING DIAGNOSIS:** Disturbed sensory perception related to excessive environmental stimulation, sleep deprivation, physiological imbalance
**GOAL:** Reduction of symptoms of sensory perceptual imbalance; prevention of postcardiotomy delirium

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Use measures to prevent postcardiotomy delirium:<br>a. Explain all procedures and the need for patient cooperation.<br>b. Plan nursing care to provide for periods of uninterrupted sleep with patient's normal day–night pattern.<br>c. Promote continuity of care.<br>d. Orient to time and place frequently. Encourage family to visit.<br>e. Assess for medications that may contribute to delirium. | 1. Postcardiotomy delirium may result from anxiety, sleep deprivation, increased sensory input, disorientation to night and day. Normally, sleep cycles are at least 50 minutes long. The first cycle may be as long as 90 to 120 minutes and then shorten during successive cycles. Sleep deprivation results when the sleep cycles are interrupted or inadequate in number. | • Cooperates with procedures.<br>• Sleeps for long, uninterrupted intervals.<br>• Oriented to person, place, time.<br>• Experiences no perceptual distortions, hallucinations, disorientation, delusions. |
| 2. Observe for perceptual distortions, hallucinations, disorientation, and paranoid delusions. | 2. Delirium can indicate a serious medical condition such as hypoxia, acid-base imbalance, metabolic abnormalities, and cerebral infarction. | |

**NURSING DIAGNOSIS:** Acute pain related to surgical trauma and pleural irritation caused by chest tubes
**GOAL:** Relief of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Record nature, type, location, intensity, and duration of pain. | 1. Pain and anxiety increase pulse rate, oxygen consumption, and cardiac workload. | • States pain is decreasing in severity.<br>• Reports absence of pain.<br>• Restlessness decreased.<br>• Vital signs stable.<br>• Participates in deep-breathing and coughing exercises.<br>• Verbalizes fewer complaints of pain each day.<br>• Positions self; participates in care activities.<br>• Gradually increases activity. |
| 2. Encourage routine pain medication dosing for the first 24 to 72 hours and observe for side effects of lethargy, hypotension, tachycardia, respiratory depression. | 2. Analgesia promotes rest, decreases oxygen consumption caused by pain, and aids patient in performing deep-breathing and coughing exercises; pain medications is more effective when taken before pain is severe. | |

**NURSING DIAGNOSIS:** Ineffective renal tissue perfusion related to decreased cardiac output, hemolysis, or vasopressor drug therapy
**GOAL:** Maintenance of adequate renal perfusion

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess renal function: | 1. Renal injury can be caused by deficient perfusion, hemolysis, low cardiac output, and use of vasopressor agents to increase blood pressure. | • Urine output consistent with fluid intake; greater than 30 mL/h.<br>• Urine specific gravity 1.003 to 1.030.<br>• BUN, creatinine, electrolytes within normal limits. |
| a. Measure urine output every half hour to 4 hours in critical care then every 8 to 12 hours until hospital discharge. | a. Less than 30 mL/h indicates decreased renal function. | |
| b. Monitor and report lab results: BUN, serum creatinine, serum electrolytes. | b. Indicate kidneys' ability to excrete waste products. | |
| 2. Prepare to administer rapid-acting diuretics or inotropic drugs (eg, dobutamine). | 2. Promote renal function and increase cardiac output and renal blood flow. | |
| 3. Prepare patient for dialysis or continuous renal replacement therapy if indicated. | 3. Provides patient with the opportunity to ask questions and prepare for the procedure. | |

*Continued*

CHART 28-13 PLAN OF NURSING CARE
## *Care of the Patient After Cardiac Surgery* (Continued)

**NURSING DIAGNOSIS:** Ineffective thermoregulation related to infection or postpericardiotomy syndrome
**GOAL:** Maintenance of normal body temperature

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess temperature every hour. | 1. Fever can indicate infectious or inflammatory process. | • Normal body temperature.<br>• Incisions are free of infection and are healing.<br>• Absence of symptoms of postpericardiotomy syndrome: fever, malaise, pericardial effusion, pericardial friction rub, arthralgia. |
| 2. Use aseptic technique when changing dressings, suctioning endotracheal tube; maintain closed systems for all intravenous and arterial lines and for indwelling urinary catheter. | 2. Decreases risk of infection. | |
| 3. Observe for symptoms of postpericardiotomy syndrome. | 3. Occurs in approximately 10% of patients after cardiac surgery. | |
| 4. Obtain cultures and other lab work (CBC, ESR); administer antibiotics as prescribed. | 4. Antibiotics treat documented infection. | |
| 5. Administer anti-inflammatory agents as directed. | 5. Relieve symptoms of inflammation. | |

**NURSING DIAGNOSIS:** Deficient knowledge about self-care activities
**GOAL:** Ability to perform self-care activities

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Develop teaching plan for patient and family. Provide specific instructions for the following:<br>• Diet and daily weights<br>• Activity progression<br>• Exercise<br>• Deep breathing, coughing, lung expansion exercises<br>• Temperature monitoring<br>• Medication regimen<br>• Pulse taking<br>• Access to the emergency medical system | 1. Each patient will have unique learning needs. | • Patient and family members explain and comply with therapeutic regimen.<br>• Patient and family members identify necessary lifestyle changes.<br>• Has copy of discharge instructions (in the patient's primary language and at appropriate reading level; has an alternate format if indicated).<br>• Keeps follow-up appointments. |
| 2. Provide verbal and written instructions; provide several teaching sessions for reinforcement and answering questions. | 2. Repetition promotes learning by allowing for questions and clarification of misinformation. | |
| 3. Involve family in teaching sessions. | 3. Family members responsible for home care are usually anxious and require adequate time for learning. | |
| 4. Provide contact information for surgeon and cardiologist and instructions about follow-up visit with surgeon. | 4. Arrangements for contacts with health care personnel help to allay anxieties. | |
| 5. Make appropriate referrals: home care agency, cardiac rehabilitation program, community support groups. | 5. Learning, recovery and lifestyle changes continue after discharge from the hospital. | |

indicators of psychological and emotional status. The patient may exhibit behavior that reflects denial or depression or may experience postcardiotomy delirium. Characteristic signs of delirium include transient perceptual illusions, visual and auditory hallucinations, disorientation, and paranoid delusions (Pun, 2007).

It is also necessary to assess the family's needs. The nurse ascertains how family members are coping with the situation; determines their psychological, emotional, and spiritual needs; and finds out whether they are receiving adequate information about the patient's condition.

### Monitoring for Complications

The patient is continuously assessed for impending complications (see Table 28-5). The nurse and the surgeon function collaboratively to prevent complications, to identify early signs and symptoms of complications, and to institute measures to reverse their progression.

***Decreased Cardiac Output.*** A decrease in cardiac output is always a threat to the patient who has had cardiac surgery and it can have a variety of causes. Preload alterations occur when too little blood volume returns to the heart as a

result of hypovolemia, persistent bleeding, or cardiac tamponade. Excessive postoperative bleeding can lead to decreased intravascular volume, hypotension, and low cardiac output. Bleeding problems are common after cardiac surgery because of the effects of CPB, trauma from the surgery, and anticoagulation (Ferraris, Ferraris, Saha, et al., 2007). Preload can also be altered if too much volume returns to the heart, causing fluid overload.

Afterload alterations occur when the arteries are constricted as a result of postoperative hypertension or hypothermia, increasing the workload of the heart. Heart rate alterations from bradycardia, tachycardia, and dysrhythmias can lead to decreased cardiac output, and contractility can be altered in cardiac failure, MI, electrolyte imbalances, and hypoxia.

***Fluid Volume and Electrolyte Imbalance.*** Fluid and electrolyte imbalance may occur after cardiac surgery. Nursing assessment for these complications includes monitoring of intake and output, weight, hemodynamic parameters, hematocrit levels, distention of neck veins, edema, liver size, breath sounds (eg, fine crackles, wheezing), and electrolyte levels. The nurse reports changes in serum electrolytes promptly so that treatment can be instituted. Especially important are dangerously high or dangerously low levels of potassium, magnesium, sodium, and calcium. Elevated blood glucose levels are common in the postoperative period. Administration of IV insulin may be required in patients both with and without diabetes to achieve the glycemic control necessary to promote wound healing and recovery (Presutti & Millo, 2006).

***Impaired Gas Exchange.*** Impaired gas exchange is another possible complication after cardiac surgery. All body tissues require an adequate supply of oxygen for survival. To achieve this after surgery, an endotracheal tube with ventilator assistance may be used for 24 hours or more. The assisted ventilation is continued until the patient's blood gas values are acceptable and the patient demonstrates the ability to breathe independently. Patients who are stable after surgery may be extubated as early as 2 to 4 hours after surgery, which reduces their discomfort and anxiety and facilitates patient–nurse communication.

The patient is continuously assessed for signs of impaired gas exchange: restlessness, anxiety, cyanosis of mucous membranes and peripheral tissues, tachycardia, and fighting the ventilator. Breath sounds are assessed often to detect pulmonary congestion and monitor lung expansion. Arterial blood gases, $SpO_2$, and end-tidal $CO_2$ are assessed for decreased oxygen and increased carbon dioxide. Following extubation, aggressive pulmonary interventions, such as turning, coughing, deep breathing, and early ambulation are necessary to prevent atelectasis and pneumonia.

***Impaired Cerebral Circulation.*** Brain function depends on a continuous supply of oxygenated blood. The brain does not have the capacity to store oxygen and must rely on adequate continuous perfusion by the heart. It is important to observe the patient for signs and symptoms of hypoxia: restlessness, confusion, dyspnea, hypotension, and cyanosis. An assessment of the patient's neurologic status includes level of consciousness, response to verbal commands and painful stimuli, pupil size and reaction to light, facial symmetry, movement of the extremities, hand grip strength, presence of pedal and popliteal pulses, and temperature and color of extremities. The nurse documents any indication of a change in status and reports abnormal findings to the surgeon because they may signal the onset of a complication. Hypoperfusion or microemboli may produce central nervous system injury after cardiac surgery.

### Restoring Cardiac Output

To evaluate the patient's cardiac status, the nurse primarily determines the effectiveness of cardiac output through clinical observations and routine measurements: serial readings of blood pressure, heart rate, CVP, arterial pressure, and pulmonary artery pressures.

Renal function is related to cardiac function, as blood pressure and cardiac output drive glomerular filtration; therefore, urinary output is measured and recorded. Urine output of less than 30 mL/h may indicate a decrease in cardiac output or inadequate fluid volume.

Body tissues depend on adequate cardiac output to provide a continuous supply of oxygenated blood to meet the changing demands of the organs and body systems. Because the buccal mucosa, nail beds, lips, and earlobes are sites with rich capillary beds, they are observed for cyanosis or duskiness as possible signs of reduced cardiac output. Distention of the neck veins when the head of the bed is elevated to 30 degrees or more may signal right-sided heart failure. If cardiac output has decreased, the skin becomes cool, moist, and cyanotic or mottled.

Dysrhythmias may develop due to decreased perfusion to or irritation of the myocardium from surgery. The most common dysrhythmias encountered during the postoperative period are atrial fibrillation, bradycardias, tachycardias, and ectopic beats. Continuous observation of the cardiac monitor for dysrhythmias is essential.

The nurse reports any indications of decreased cardiac output promptly to the physician. The physician uses the assessment data to determine the cause of the problem. After a diagnosis has been made, the physician and the nurse work collaboratively to restore cardiac output and prevent further complications. When indicated, the physician prescribes blood components, fluids, antidysrhythmics, diuretics, vasodilators, or vasopressors. If additional surgery is necessary, the patient and family are prepared for the procedure.

### Promoting Adequate Gas Exchange

To ensure adequate gas exchange, the patency of the endotracheal tube is assessed and maintained. It must be secured to prevent it from slipping out or down into the right mainstem bronchus. Suctioning is necessary when crackles or coughing are present. Routinely, 100% oxygen is delivered to the patient from the ventilator or by a manual resuscitation bag (eg, Ambu-Bag) before and after suctioning to minimize the risk of hypoxia that can result from the suctioning procedure. Arterial blood gas determinations are compared with baseline data, and changes are reported to the physician promptly.

When the patient's condition stabilizes, body position is changed every 1 to 2 hours. Frequent changes of patient position provide for optimal pulmonary ventilation and perfusion by allowing the lungs to expand more fully.

Physical assessment and arterial blood gas results guide the process of weaning the patient from the ventilator. Before being extubated, the patient should have cough and gag reflexes and stable vital signs; be able to lift the head off the bed or have a firm hand grasp; have adequate vital capacity, negative inspiratory force, and minute volume appropriate for body size; and have acceptable arterial blood gas levels while breathing warmed humidified oxygen without the assistance of the ventilator.

The nurse assists with the weaning process and eventually with removal of the endotracheal tube. After extubation, the nurse encourages deep breathing and coughing at least every 1 to 2 hours to clear secretions, open the alveolar sacs, and promote effective ventilation.

#### Maintaining Fluid and Electrolyte Balance

To promote fluid and electrolyte balance, the nurse carefully assesses intake and output, using flow sheets to determine positive or negative fluid balance. It is necessary to record all fluid intake, including IV, nasogastric tube, and oral fluids, as well as all output, including urine, nasogastric drainage, and chest drainage.

Hemodynamic parameters (ie, blood pressure, CVP, PAWP) are correlated with intake, output, and weight to determine the adequacy of hydration and cardiac output. Serum electrolytes are monitored, and the patient is observed for signs of potassium, magnesium, sodium, or calcium imbalance.

Any indications of dehydration, fluid overload, or electrolyte imbalance are reported promptly, and the physician and nurse work collaboratively to restore fluid and electrolyte balance and monitor the patient's response to therapies.

#### Minimizing Sensory-Perception Imbalance

Some patients exhibit abnormal perceptions and behaviors that occur with varying intensity and duration. Clinical manifestations of postoperative delirium include restlessness, agitation, visual and auditory hallucinations, and paranoia. The delirium typically appears after a 2- to 5-day stay in an intensive care environment. In the early years of cardiac surgery, this phenomenon occurred more frequently than it does today. Advances in surgical techniques and in the delivery of anesthetic agents have significantly decreased the incidence of postoperative delirium. Presumed causes of postoperative delirium include anxiety, sleep deprivation, increased sensory input, medications, and physiologic problems such as hypoxemia and metabolic imbalance (Pun, 2007). The delirium typically resolves after the patient is transferred from the unit.

Basic comfort measures are used in conjunction with prescribed analgesics and sedatives to promote rest. Invasive lines and tubes are discontinued as soon as possible to promote comfort and safety. Patient care is coordinated to provide undisturbed periods of rest. As the patient's condition stabilizes and the patient is disturbed less frequently for monitoring and therapeutic procedures, rest periods can be extended. Uninterrupted sleep is provided as much as possible, especially during the patient's normal hours of sleep.

Careful explanations of all procedures and of the need for cooperation help keep the patient oriented throughout the postoperative course. Continuity of care is desirable; a familiar face and a nursing staff with a consistent approach help the patient feel safe. The patient's family should be welcomed at the bedside. A well-designed and individualized plan of nursing care can assist the nursing team in coordinating its efforts for the emotional well-being of the patient.

#### Relieving Pain

Patients who have had cardiac surgery may have pain in the peri-incisional area or throughout the chest, shoulders, and back. Pain is usually a result of trauma to the chest wall and irritation of the pleura by the chest tubes as well as incisional pain from peripheral vein or artery graft harvest sites.

The nurse assesses patients for verbal and nonverbal indicators of pain and accurately records the nature, type, location, and duration of the pain. To reduce the amount of pain, the nurse encourages the patient to use patient-controlled analgesia (PCA) or accept medication as often as it is prescribed. The addition of adjunctive pain relievers (anti-inflammatory agents, muscle relaxants) to opioids decreases the amount of opioids required for pain relief and increases patient comfort. Patients report the most pain during coughing, turning, and moving. Physical support of the incision with a folded bath blanket or small pillow during deep breathing and coughing helps minimize pain. The patient should then be able to participate in respiratory exercises and to progressively increase self-care. Patient comfort improves after removal of the chest tubes.

Pain produces tension, which may stimulate the central nervous system to release catecholamines, resulting in constriction of the arterioles and increased heart rate. This can cause increased afterload and decreased cardiac output. Opioids alleviate pain and induce sleep and feelings of euphoria, which reduces the metabolic rate and oxygen demands. After the administration of opioids, it is necessary to document observations indicating relief of apprehension and pain in the patient's record. The nurse observes the patient for any adverse effects of opioids, including respiratory depression, hypotension, constipation, ileus, or urinary retention. If serious side effects occur, an opioid antagonist (eg, naloxone [Narcan]) may be required.

#### Maintaining Adequate Tissue Perfusion

The nurse routinely palpates peripheral pulses (eg, pedal, tibial, femoral, radial, brachial) to assess for arterial obstruction. If a pulse is absent in any extremity, the cause may be prior catheterization of that extremity, chronic peripheral vascular disease, or a thromboembolic obstruction. The nurse immediately reports newly identified absence of any pulse to the physician.

Thromboembolic events can result from vascular injury, dislodgment of a clot from a damaged valve, loosening of mural thrombi, or coagulation problems. Air embolism can result from CPB or central venous cannulation. Symptoms of embolization vary according to site. The usual embolic sites are the lungs, coronary arteries, mesentery, spleen, extremities, kidneys, and brain. It is necessary to observe the patient for onset of the following:

- Chest pain and respiratory distress from pulmonary embolus or MI
- Abdominal or back pain from mesenteric emboli
- Pain, cessation of pulses, blanching, numbness, or coldness in an extremity

- One-sided weakness and pupillary changes, as occur in stroke

The nurse promptly reports any of these symptoms to the physician.

After surgery, it is important to prevent venous stasis, which can cause deep venous thrombosis and subsequent pulmonary embolism, by using the following measures:

- Apply sequential pneumatic compression wraps or anti-embolism stockings
- Discourage crossing of legs
- Avoid elevating the knees on the bed
- Omit pillows in the popliteal space
- Begin passive exercises followed by active exercises to promote circulation and prevent venous stasis

Inadequate renal perfusion can occur as a complication of cardiac surgery. One possible cause is low cardiac output. Trauma to blood cells during CPB can cause hemolysis of red blood cells, which then occlude the renal glomeruli. Use of vasopressor agents to increase blood pressure may constrict the renal arterioles and reduce blood flow to the kidneys.

Nursing management includes accurate measurement of urine output. An output of less than 30 mL/h may indicate hypovolemia or renal insufficiency. The physician may prescribe fluids to increase cardiac output and renal blood flow or IV diuretics may be administered to increase urine output. The nurse should be aware of the patient's blood urea nitrogen, serum creatinine, glomerular filtration rate, and serum electrolyte levels. The nurse should report abnormal levels promptly because it may be necessary to adjust fluids and the dose or type of medication administered. If efforts to maintain renal perfusion are ineffective, the patient may require continuous renal replacement therapy or dialysis (see Chapter 44).

#### Maintaining Normal Body Temperature

Patients are usually hypothermic when admitted to the critical care unit following the cardiac surgical procedure. The patient must be gradually warmed to a normal temperature. This is accomplished partially by the patient's own basal metabolic processes and often with the assistance of air or water blanket systems. While the patient is hypothermic, the clotting process is less efficient, the heart is prone to dysrhythmias, and oxygen does not readily transfer from the hemoglobin to the tissues. Because anesthesia and hypothermia suppress normal basal metabolism, oxygen supply usually meets the cellular demand.

After cardiac surgery, the patient is at risk for developing elevated body temperature as a result of tissue inflammation or infection. The inflammatory/immune response to surgery includes the release of cytokines that cause fever (Porth & Matfin, 2009). The resultant increase in metabolic rate increases tissue oxygen demands and increases cardiac workload. Antipyretics and other measures are used to lower body temperature.

Common sites of postoperative infection include the lungs, urinary tract, incisions, and intravascular catheters. Meticulous care is used to prevent contamination at the sites of catheter and tube insertions. Aseptic technique is used when changing dressings and when providing endotracheal tube and catheter care. Clearance of pulmonary secretions is accomplished by frequent repositioning of the patient, suctioning, and chest physical therapy, as well as teaching and encouraging the patient to breathe deeply and cough. Closed systems are used to maintain all IV and arterial lines. All invasive equipment is discontinued as soon as possible after surgery.

Postpericardiotomy syndrome may occur in patients who undergo cardiac surgery. The syndrome is characterized by fever, pericardial pain, pleural pain, dyspnea, pericardial effusion, pericardial friction rub, and arthralgia. These signs and symptoms may occur days to weeks after surgery, often after the patient has been discharged from the hospital.

It is necessary to differentiate postpericardiotomy syndrome from other postoperative complications (eg, infection, incisional pain, MI, pulmonary embolus, bacterial endocarditis, pneumonia, atelectasis). Treatment depends on the severity of the symptoms. Anti-inflammatory agents often produce a dramatic improvement in symptoms.

#### Promoting Home and Community-Based Care

***Teaching Patients Self-Care.*** Depending on the type of surgery and postoperative progress, the patient may be discharged from the hospital 3 to 5 days after surgery. Following recovery from the surgery, patients can expect fewer symptoms from CAD and an improved quality of life. CABG has been shown to increase the lifespan of high-risk patients, including those with left main artery blockages and left ventricular dysfunction with multivessel blockages (Bravata, et al., 2007).

Although the patient may be eager to return home, the patient and family usually are apprehensive about this transition. The family members often express the fear that they are not capable of caring for the patient at home. They often are concerned that complications will occur that they are unprepared to handle.

The nurse helps the patient and family set realistic, achievable goals. A teaching plan that meets the patient's individual needs is developed with the patient and family. Specific instructions are provided about incision care; signs and symptoms of infection; diet; activity progression and exercise; deep breathing, incentive spirometry, and smoking cessation; weight and temperature monitoring; the medication regimen; and follow-up visits with home care nurses, the rehabilitation personnel, the surgeon, and the cardiologist or internist.

Some patients have difficulty learning and retaining information after cardiac surgery. The patient may experience recent memory loss, short attention span, difficulty with simple math, poor handwriting, and visual disturbances. Patients with these difficulties often become frustrated when they try to resume normal activities. The patient and family are reassured that the difficulty is almost always temporary and will subside, usually in 6 to 8 weeks. In the meantime, instructions are given to the patient at a slower pace than normal, and a family member assumes responsibility for making sure that the prescribed regimen is followed.

***Continuing Care.*** Arrangements are made for a home care nurse when appropriate. Because the hospital stay is relatively short, it is particularly important for the nurse to assess the patient's and family's ability to manage care in the

home. The home care nurse continues the teaching process, monitors vital signs and incisions, assesses for signs and symptoms of complications, and provides support for the patient and family. Additional interventions may include dressing changes, diet counseling, and tobacco use cessation strategies. Women may experience a longer recovery and may require additional interventions to manage symptoms (Zimmerman, Barnason, Schulz, et al., 2007). They also have a higher risk of depression during the postoperative period (Doering, Cross, Magsarili, et al., 2007). Patients and families need to know that cardiac surgery did not cure the patient's underlying heart disease. Lifestyle changes for risk factor reduction are essential, and medications taken before surgery may still be necessary.

It is important to encourage the patient to contact the surgeon, cardiologist, or nurse with problems or questions. This provides the patient and family with reassurance that professional support is available. The patient is expected to have at least one follow-up visit with the surgeon.

Teaching does not end at the time of discharge from the hospital or home health care. Many patients and families benefit from supportive programs such as cardiac rehabilitation programs. These programs provide monitored exercise; instructions about diet and stress reduction; information about resuming work, driving, and sexual activity; assistance with tobacco use cessation; and support groups for patients and families. The AHA sponsors the Mended Hearts Club, which provides information as well as an opportunity for families to share experiences.

## CRITICAL THINKING EXERCISES

EBP **1** While working in the cardiology clinic, you receive a phone call from a patient with known coronary artery disease. She reports that she is experiencing some shortness of breath and mild back pain. What evidence base is there to suggest that symptoms of an MI may be different for women than men? Discuss the strength of this evidence and its significance in determining assessment criteria to be used for women and men. What questions would you ask this patient? What would you instruct her to do? Provide rationale for your instructions.

**2** A 72-year-old man is admitted to the surgical intensive care unit following four-vessel CABG surgery. Initially, his blood pressure is high at 164/88, but it drops to 92/60 mm Hg, his ECG shows sinus tachycardia, and his cardiac output is decreased. What are the most likely reasons for the drop in blood pressure? What other parameters should be assessed? Describe your interventions for this postoperative CABG patient with hypotension and low cardiac output. Identify your expected outcomes for these interventions.

**3** You are caring for a patient who has been hospitalized with a diagnosis of unstable angina. His condition is stable and he will be discharged later in the day. He is anxious to go home, but agrees to an educational session with you prior to discharge. The patient is obese and has a history of hypertension and cigarette smoking. Knowing that multiple lifestyle changes are recommended, how will you prioritize your teaching strategies? What type of follow-up care is available to assist this patient following discharge?

EBP **4** Your neighbor is a 60-year-old woman who was discharged from the hospital last month with ACS treated with thrombolytics. She asks you if she really needs to keep taking her beta-blocker indefinitely. She tells you that her husband read in a news magazine that care for women with heart disease has been traditionally based on treatment of men with heart disease. What is the strength of the evidence that supports maintaining women post-ACS on beta-blockers?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Heart Association, www.americanheart.org

Healthy People 2010, www.healthypeople.gov

Heartmates, P.O. Box 16202, Minneapolis, MN 55416; 612-558-3331, www.heartmates.com

National Heart, Lung, and Blood Institute, National Institutes of Health, www.nhlbi.nih.gov



chapter 29

# Management of Patients With Structural, Infectious, and Inflammatory Cardiac Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Define valvular disorders of the heart and describe the pathophysiology, clinical manifestations, and management of patients with mitral and aortic disorders.
2. Describe types of cardiac valve repair and replacement procedures used to treat valvular problems and the care needed by patients who undergo these procedures.
3. Describe the pathophysiology, clinical manifestations, and management of patients with intracardiac septal defects.
4. Describe the pathophysiology, clinical manifestations, and management of patients with cardiomyopathies.
5. Describe the pathophysiology, clinical manifestations, and management of patients with infections of the heart.

## GLOSSARY

**allograft:** heart valve replacement made from a human heart valve (synonym: homograft)
**annuloplasty:** repair of a cardiac valve's outer ring
**aortic valve:** semilunar valve located between the left ventricle and the aorta
**autograft:** heart valve replacement made from the patient's own heart valve (eg, the pulmonic valve is excised and used as an aortic valve)
**cardiomyopathy:** disease of the heart muscle
**chordae tendineae:** nondistensible fibrous strands connecting papillary muscles to atrioventricular (mitral, tricuspid) valve leaflets
**chordoplasty:** repair of the chordae tendineae
**commissurotomy:** splitting or separating fused cardiac valve leaflets
**heterograft:** heart valve replacement made of tissue from an animal heart valve (synonym: xenograft)
**homograft:** heart valve replacement made from a human heart valve (synonym: allograft)
**leaflet repair:** repair of a cardiac valve's movable "flaps" (leaflets)
**mitral valve:** atrioventricular valve located between the left atrium and left ventricle
**orthotopic transplantation:** the recipient's heart is removed and a donor heart is grafted into the same site; the patient has one heart
**prolapse (of a valve):** stretching of an atrioventricular heart valve leaflet into the atrium during systole
**pulmonic valve:** semilunar valve located between the right ventricle and the pulmonary artery
**regurgitation:** backward flow of blood through a heart valve
**stenosis:** narrowing or obstruction of a cardiac valve's orifice
**total artificial heart:** mechanical device used to aid a failing heart, assisting the right and left ventricles
**tricuspid valve:** atrioventricular valve located between the right atrium and right ventricle
**valve replacement:** insertion of a device at the site of a malfunctioning heart valve to restore blood flow in one direction through the heart
**valvuloplasty:** repair of a stenosed or regurgitant cardiac valve by commissurotomy, annuloplasty, leaflet repair, or chordoplasty (or a combination of procedures)
**ventricular assist device:** mechanical device used to aid a failing right or left ventricle
**xenograft:** heart valve replacement made of tissue from an animal heart valve (synonym: heterograft)

Structural, infectious, and inflammatory disorders of the heart present many challenges for the patient, family, and health care team. Problems with the heart valves, holes in the intracardiac septum, cardiomyopathies, and infectious diseases of the heart muscle alter cardiac output. Treatments for these disorders may be noninvasive, such as medication therapy and activity and dietary modification. Invasive treatments also may be used, such as valve repair or replacement, septal repair, ventricular assist devices, total artificial hearts, cardiac transplantation, and other procedures. Nurses have an integral role in the care of patients with structural, infectious, and inflammatory cardiac conditions.

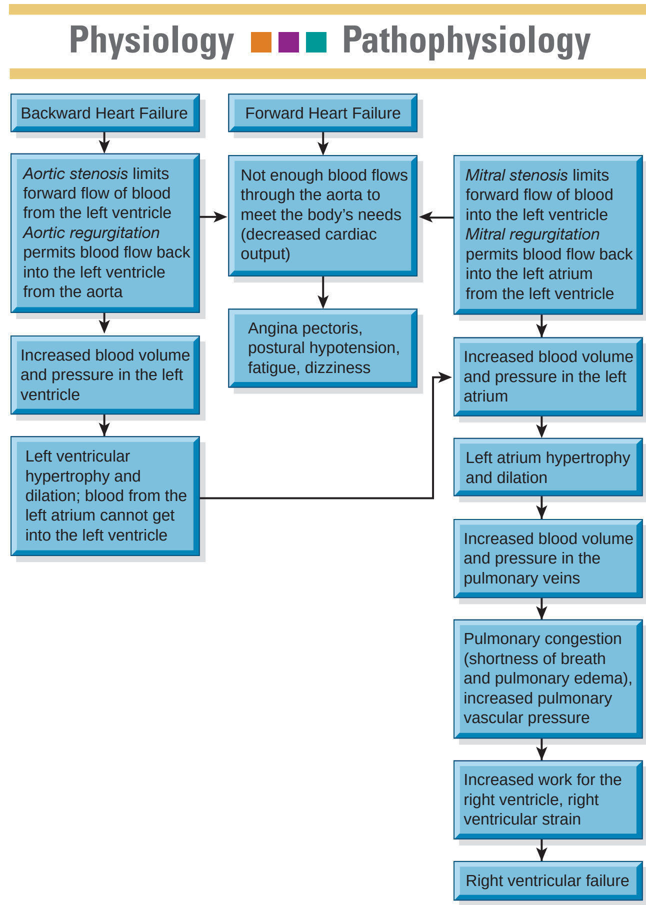



**Figure 29-2** Pathophysiology: left-sided heart failure as a result of aortic and mitral valvular heart disease and the development of right ventricular failure.

## VALVULAR DISORDERS

The valves of the heart control the flow of blood through the heart into the pulmonary artery and aorta by opening and closing in response to the blood pressure changes as the heart contracts and relaxes through the cardiac cycle.

The atrioventricular valves separate the atria from the ventricles and include the **tricuspid valve,** which separates the right atrium from the right ventricle, and the **mitral valve,** which separates the left atrium from the left ventricle. The tricuspid valve has three leaflets; the mitral valve has two. Both valves have **chordae tendineae** that anchor the valve leaflets to the papillary muscles of the ventricles.

The semilunar valves are located between the ventricles and their corresponding arteries. The **pulmonic valve** lies between the right ventricle and the pulmonary artery; the **aortic valve** lies between the left ventricle and the aorta. Figure 29-1 shows valves in the closed position.

When any of the heart valves do not close or open properly, blood flow is affected. When valves do not close completely, blood flows backward through the valve, a condition called **regurgitation.** When valves do not open completely, a condition called **stenosis,** the flow of blood through the valve is reduced.

Disorders of the mitral valve fall into the following categories: mitral valve **prolapse** (ie, stretching of the valve leaflet into the atrium during systole), mitral regurgitation, and mitral stenosis. Disorders of the aortic valve are categorized as aortic regurgitation and aortic stenosis. These valvular disorders may require surgical repair or replacement of the valve to correct the problem, depending on severity of symptoms (Fig. 29-2). Tricuspid and pulmonic valve disorders also occur, usually with fewer symptoms and complications. Regurgitation and stenosis may occur at the same time in the same or different valves.

### *Mitral Valve Prolapse*

Mitral valve prolapse is a deformity that usually produces no symptoms. Rarely, it progresses and can result in sudden death. This condition occurs more frequently in women

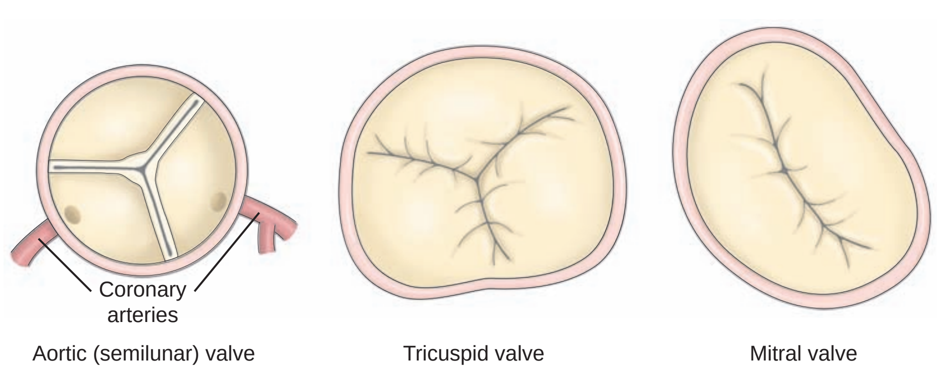



**Figure 29-1** The valves of the heart (aortic or semilunar, tricuspid, and mitral) in the closed position.

than in men and is being diagnosed more frequently than it once was, probably because of improved diagnostic methods. The cause is usually an inherited connective tissue disorder resulting in enlargement of one or both of the mitral valve leaflets. The annulus often dilates. The chordae tendineae and papillary muscles may elongate.

### Pathophysiology

In mitral valve prolapse, a portion of one or both mitral valve leaflets balloons back into the atrium during systole. Rarely, the ballooning stretches the leaflet to the point that the valve does not remain closed during systole (ie, ventricular contraction). Blood then regurgitates from the left ventricle back into the left atrium. About 15% of patients who develop murmurs eventually experience heart enlargement, atrial fibrillation, pulmonary hypertension, or heart failure (Libby, Bonow, Mann, et al., 2008).

### Clinical Manifestations

Most people who have mitral valve prolapse never have symptoms. A few have symptoms of fatigue, shortness of breath, lightheadedness, dizziness, syncope, palpitations, chest pain, and anxiety (Fuster, O'Rourke, Walsh, et al., 2008; Libby, et al., 2008). Fatigue may occur regardless of activity level and amount of rest or sleep. Shortness of breath is not correlated with activity levels or pulmonary function. Atrial or ventricular dysrhythmias may produce the sensation of palpitations, but palpitations have been reported while the heart has been beating normally. Chest pain, which is often localized to the chest, is not correlated with activity and may last for days. Anxiety may be a response to the symptoms; however, some patients report anxiety as the only symptom. Some clinicians speculate that the symptoms may be explained by dysautonomia (a dysfunction of the autonomic nervous system that results in increased excretion of catecholamines). No consensus exists about the cause of the symptoms experienced by some patients (Libby, et al., 2008).

### Assessment and Diagnostic Findings

Often the first and only sign of mitral valve prolapse is identified when a physical examination of the heart reveals an extra heart sound, referred to as a mitral click. A systolic click is an early sign that a valve leaflet is ballooning into the left atrium. In addition to the mitral click, a murmur of mitral regurgitation may be heard if progressive valve leaflet stretching and regurgitation have occurred. A few patients experience signs and symptoms of heart failure if mitral regurgitation exists. Doppler echocardiography may be used to diagnose and monitor the progression of mitral valve prolapse.

### Medical Management

Medical management is directed at controlling symptoms. If dysrhythmias are documented and cause symptoms, the patient is advised to eliminate caffeine and alcohol from the diet and to stop smoking. Most patients do not require any medications; prophylactic antibiotics are no longer recommended prior to dental or invasive procedures (Wilson, Taubert, Gewitz, et al., 2007), although antiarrhythmic medications may be prescribed.

Chest pain that does not respond to nitrates may respond to calcium channel blockers or beta-blockers. Heart failure is treated the same as it would be for any other case of heart failure (see Chapter 30). In advanced stages of disease, mitral valve repair or replacement may be necessary (discussed later in this chapter).

### Nursing Management

The nurse educates the patient about the diagnosis and the possibility that the condition is hereditary. First-degree relatives (eg, parents, siblings) may be advised to have echocardiograms. Patients with mitral valve prolapse may be at risk for infectious endocarditis that results from bacteria entering the bloodstream and adhering to the abnormal valve structures. The nurse teaches the patient how to minimize this risk: practicing good oral hygiene, obtaining routine dental care, avoiding body piercing and body branding, and not using toothpicks or other sharp objects in the oral cavity.

Because most patients with mitral valve prolapse are asymptomatic, the nurse explains the need to inform the health care provider about any symptoms that may develop. To minimize symptoms, the nurse teaches the patient to avoid caffeine and alcohol. The nurse encourages the patient to read product labels, particularly on over-the-counter products such as cough medicine, because these products may contain alcohol, caffeine, ephedrine, and epinephrine, which may produce dysrhythmias and other symptoms. In addition, the nurse also explores possible diet, activity, sleep, and other lifestyle factors that may correlate with symptoms. Treatment of dysrhythmias, chest pain, heart failure, or other complications of mitral valve prolapse is described in Chapter 30. Women diagnosed with mitral valve prolapse without mitral regurgitation or other complications may complete pregnancies and have vaginal deliveries.

## *Mitral Regurgitation*

Mitral regurgitation involves blood flowing back from the left ventricle into the left atrium during systole. Often the edges of the mitral valve leaflets do not close during systole. The leaflets cannot close completely because the leaflets and chordae tendineae have thickened and fibrosed, resulting in their contraction. The most common causes of mitral valve regurgitation in developed countries are degenerative changes of the mitral valve (eg, mitral valve prolapse) and ischemia of the left ventricle (Bonow, Carabello, Chatterjee, et al., 2008). The most common causes in developing countries are rheumatic heart disease and its sequelae (Sidebotham, McKee, Gillham, et al., 2007).

Other conditions that lead to mitral regurgitation include myxomatous changes, which enlarge and stretch the left atrium and ventricle, causing leaflets and chordae tendineae to stretch or rupture. Infective endocarditis may cause perforation of a leaflet, or the scarring following the infection may cause retraction of the leaflets or chordae tendineae. Collagen-vascular diseases (eg, systemic lupus erythematosus), cardiomyopathy, and ischemic heart disease may also result in changes in the left ventricle, causing the papillary muscles, chordae tendineae, or leaflets to stretch, shorten, or rupture.

### Pathophysiology

Mitral regurgitation may result from problems with one or more of the leaflets, the chordae tendineae, the annulus, or the papillary muscles. As previously stated, a mitral valve leaflet may shorten or tear, and the chordae tendineae may elongate, shorten, or tear. The annulus may be stretched by heart enlargement or deformed by calcification. The papillary muscle may rupture, stretch, or be pulled out of position by changes in the ventricular wall (eg, scar from a myocardial infarction or ventricular dilation). The papillary muscles may be unable to contract because of ischemia. Regardless of the cause, blood regurgitates into the atrium during systole.

With each beat of the left ventricle, some of the blood is forced back into the left atrium, adding to the blood flowing in from the lungs. This causes the left atrium to stretch and eventually hypertrophy and dilate. The backward flow of blood from the ventricle diminishes the volume of blood flowing into the atrium from the lungs. As a result, the lungs become congested, eventually adding extra strain on the right ventricle.

### Clinical Manifestations

Chronic mitral regurgitation is often asymptomatic, but acute mitral regurgitation (eg, that resulting from a myocardial infarction) usually manifests as severe congestive heart failure. Dyspnea, fatigue, and weakness are the most common symptoms. Palpitations, shortness of breath on exertion, and cough from pulmonary congestion also occur.

### Assessment and Diagnostic Findings

A systolic murmur is heard as a high-pitched, blowing sound at the apex. The pulse may be regular and of good volume, or it may be irregular as a result of extrasystolic beats or atrial fibrillation. Doppler echocardiography is used to diagnose and monitor the progression of mitral regurgitation. Transesophageal echocardiography (TEE) provides the best images of the mitral valve.

### Medical Management

Management of mitral regurgitation is the same as that for heart failure (see Chapter 30). Patients with mitral regurgitation and heart failure benefit from afterload reduction (arterial dilation) by treatment with angiotensin-converting enzyme (ACE) inhibitors, such as captopril (Capoten), enalapril (Vasotec), lisinopril (Prinivil, Zestril), ramipril (Altace), or hydralazine (Apresoline); angiotensin receptor blockers (ARBs), such as losartan (Cozar) or valsartan (Diovan); and beta-blockers, such as carvedilol (Coreg). Once symptoms of heart failure develop, the patient needs to restrict his or her activity level to minimize symptoms. Surgical intervention consists of mitral valvuloplasty (ie, surgical repair of the valve) or valve replacement (discussed later).

## Mitral Stenosis

Mitral stenosis is an obstruction of blood flowing from the left atrium into the left ventricle. It is most often caused by rheumatic endocarditis, which progressively thickens the mitral valve leaflets and chordae tendineae. The leaflets often fuse together. Eventually, the mitral valve orifice narrows and progressively obstructs blood flow into the ventricle.

### Pathophysiology

Normally, the mitral valve opening is as wide as the diameter of three fingers. In cases of marked stenosis, the opening narrows to the width of a pencil. The left atrium has great difficulty moving blood into the ventricle because of the increased resistance of the narrowed orifice. Poor left ventricular filling can cause decreased cardiac output. The increased blood volume in the left atrium causes it to dilate and hypertrophy. Because there is no valve to protect the pulmonary veins from the backward flow of blood from the atrium, the pulmonary circulation becomes congested. As a result, the right ventricle must contract against an abnormally high pulmonary arterial pressure and is subjected to excessive strain. Eventually, the right ventricle fails.

### Clinical Manifestations

The first symptom of mitral stenosis is often dyspnea on exertion as a result of pulmonary venous hypertension. Symptoms usually develop after the valve opening is reduced by one-third to one-half its usual size. Patients are likely to show progressive fatigue as a result of low cardiac output. The enlarged left atrium may create pressure on the left bronchial tree, resulting in a dry cough or wheezing. Patients may expectorate blood (ie, hemoptysis) or experience palpitations, orthopnea, paroxysmal nocturnal dyspnea (PND), and repeated respiratory infections.

### Assessment and Diagnostic Findings

The pulse is weak and often irregular because of atrial fibrillation (caused by the strain on the atrium). A low-pitched, rumbling, diastolic murmur is heard at the apex. As a result of the increased blood volume and pressure, the atrium dilates, hypertrophies, and becomes electrically unstable, and patients experience atrial dysrhythmias. Doppler echocardiography is used to diagnose mitral stenosis. Electrocardiography (ECG) and cardiac catheterization with angiography may be used to help determine the severity of the mitral stenosis.

### Medical Management

Congestive heart failure is treated as described in Chapter 30. Patients with mitral stenosis may benefit from anticoagulants to decrease the risk for developing atrial thrombus and may also require treatment for anemia. Patients with mitral stenosis are advised to avoid strenuous activities and competitive sports, both of which increase the heart rate. Mitral stenosis decreases the amount of blood that can flow from the left atrium to the left ventricle during diastole. When the heart rate increases, diastole is shortened, and thus the amount of time for the forward flow of blood is less. Therefore, as the heart rate increases, cardiac output decreases and pulmonary pressures increase with the backup of blood from the left atrium into the pulmonary veins. Surgical intervention consists of valvuloplasty, usually a commissurotomy to open or rupture the fused commissures of the mitral valve. Percutaneous transluminal valvuloplasty or mitral valve replacement may be performed.

## Aortic Regurgitation

Aortic regurgitation is the flow of blood back into the left ventricle from the aorta during diastole. It may be caused by inflammatory lesions that deform the leaflets of the aortic valve, preventing them from completely closing the aortic valve orifice. This valvular defect also may result from infective or rheumatic endocarditis, congenital abnormalities, diseases such as syphilis, a dissecting aneurysm that causes dilation or tearing of the ascending aorta, blunt chest trauma, or deterioration of an aortic valve replacement. In many cases, the cause is unknown and is classified as idiopathic.

### Pathophysiology

Blood from the aorta returns to the left ventricle during diastole, in addition to the blood normally delivered by the left atrium. The left ventricle dilates in an attempt to accommodate the increased volume of blood. It also hypertrophies in an attempt to increase muscle strength to expel more blood with above-normal force, thus increasing systolic blood pressure. The arteries attempt to compensate for the higher pressures by reflex vasodilation; the peripheral arterioles relax, reducing peripheral resistance and diastolic blood pressure.

### Clinical Manifestations

Aortic insufficiency develops without symptoms in most patients. Some patients are aware of a forceful heartbeat, especially in the head or neck. Marked arterial pulsations that are visible or palpable at the carotid or temporal arteries may be present as a result of the increased force and volume of the blood ejected from the hypertrophied left ventricle. Exertional dyspnea and fatigue follow. Signs and symptoms of progressive left ventricular failure include breathing difficulties (eg, orthopnea, PND).

### Assessment and Diagnostic Findings

A diastolic murmur is heard as a high-pitched, blowing sound at the third or fourth intercostal space at the left sternal border. The pulse pressure (ie, difference between systolic and diastolic pressures) is considerably widened in patients with aortic regurgitation. One characteristic sign of the disease is the water-hammer (Corrigan's) pulse, in which the pulse strikes the palpating finger with a quick, sharp stroke and then suddenly collapses. The diagnosis may be confirmed by Doppler echocardiography (preferably transesophageal), radionuclide imaging, ECG, magnetic resonance imaging (MRI), and cardiac catheterization. Patients with symptoms usually have echocardiograms every 4 to 6 months, and those without symptoms have echocardiograms every 2 to 3 years.

### Medical Management

The patient is advised to avoid physical exertion, competitive sports, and isometric exercise. Dysrhythmias and heart failure are treated as described in Chapters 27 and 30. The medications usually prescribed first for patients with symptoms of aortic regurgitation are vasodilators such as calcium channel blockers (eg, nifedipine [Adalat, Procardia]) and ACE inhibitors (eg, captopril, enalapril, lisinopril, ramipril), or hydralazine. The treatment of choice is aortic valvuloplasty or valve replacement, preferably performed before left ventricular failure occurs. Surgery is recommended for any patient with left ventricular hypertrophy, regardless of the presence or absence of symptoms.

## Aortic Stenosis

Aortic valve stenosis is narrowing of the orifice between the left ventricle and the aorta. In adults, the stenosis is often a result of degenerative calcifications. Calcifications may be caused by inflammatory changes that occur in response to years of normal mechanical stress. Diabetes mellitus, hypercholesterolemia, hypertension, and low levels of high-density lipoprotein cholesterol may be risk factors for degenerative changes of the valve. Congenital leaflet malformations or an abnormal number of leaflets (ie, one or two rather than three) may be involved. Rarely rheumatic endocarditis may cause adhesions or fusion of the commissures and valve ring, stiffening of the cusps, and calcific nodules on the cusps. However, the cause of cusp calcification may be unknown.

### Pathophysiology

Progressive narrowing of the valve orifice occurs, usually over several years to several decades. The left ventricle overcomes the obstruction to circulation by contracting more slowly but with greater energy than normal, forcibly squeezing the blood through the smaller orifice. The obstruction to left ventricular outflow increases pressure on the left ventricle, and the ventricular wall thickens, or hypertrophies. When these compensatory mechanisms of the heart begin to fail, clinical signs and symptoms develop.

### Clinical Manifestations

Many patients with aortic stenosis are asymptomatic. When symptoms develop, patients usually first have exertional dyspnea, caused by increased pulmonary venous pressure due to left ventricular failure. Orthopnea, PND, and pulmonary edema may also occur, along with dizziness and syncope because of reduced blood flow to the brain. Angina pectoris is a frequent symptom; it results from the increased oxygen demands of the hypertrophied left ventricle, the decreased time in diastole for myocardial perfusion, and the decreased blood flow into the coronary arteries. Blood pressure is usually normal but may be low. Pulse pressure may be low (30 mm Hg or less) because of diminished blood flow.

### Assessment and Diagnostic Findings

On physical examination, a loud, rough systolic murmur may be heard over the aortic area. The sound to listen for is a systolic crescendo–decrescendo murmur, which may radiate into the carotid arteries and to the apex of the left ventricle. The murmur is low-pitched, rough, rasping, and vibrating. An $S_4$ sound may be heard. If the examiner rests a hand over the base of the heart (second intercostal space next to the sternum and above the suprasternal notch up along the carotid arteries), a vibration may be felt. The vibration is caused by turbulent blood flow across the

narrowed valve orifice. By having the patient lean forward during auscultation and palpation, especially during exhalation, it is possible to accentuate the signs of aortic stenosis.

Doppler echocardiography is used to diagnose and monitor the progression of aortic stenosis. Patients with symptoms usually have echocardiograms every 6 to 12 months, and those without symptoms have echocardiograms every 2 to 5 years. Evidence of left ventricular hypertrophy may be seen on a 12-lead ECG and an echocardiogram. After stenosis progresses to the point that surgical intervention is considered, left-sided heart catheterization is necessary to measure the severity of the valvular abnormality and to evaluate the coronary arteries. Pressure tracings are taken from the left ventricle and from the base of the aorta. The systolic pressure in the left ventricle is considerably higher than that in the aorta during systole. Graded exercise studies (stress tests) are not usually prescribed for patients with aortic stenosis because of the high risk of precipitating ventricular tachycardia or fibrillation.

### Medical Management

Medications are prescribed to treat dysrhythmia or left ventricular failure (see Chapters 27 and 30). Definitive treatment for aortic stenosis is surgical replacement of the aortic valve. Patients who are symptomatic and are not surgical candidates may benefit from one-balloon or two-balloon percutaneous valvuloplasty procedures.

## *Nursing Management: Valvular Heart Disorders*

The nurse teaches the patient with valvular heart disease about the diagnosis, the progressive nature of valvular heart disease, and the treatment plan. The patient is taught to report new symptoms or changes in symptoms to the health care provider. The nurse also teaches the patient that the infectious agent, usually a bacterium, is able to adhere to the diseased heart valve more readily than to a normal valve. Once attached to the valve, the infectious agent multiplies, resulting in endocarditis and further damage to the valve. In addition, the nurse teaches the patient how to minimize the risk of developing infectious endocarditis.

The nurse measures the patient's heart rate, blood pressure, and respiratory rate, compares these results with previous data, and notes any changes. Heart and lung sounds are auscultated and peripheral pulses palpated. The nurse assesses the patient with valvular heart disease for the following conditions:

- Signs and symptoms of heart failure, such as fatigue, dyspnea on exertion, an increase in coughing, hemoptysis, multiple respiratory infections, orthopnea, and PND (see Chapter 30)
- Dysrhythmias, by palpating the patient's pulse for strength and rhythm (ie, regular or irregular) and asking whether the patient has experienced palpitations or felt forceful heartbeats (see Chapter 27)
- Symptoms such as dizziness, syncope, increased weakness, or angina pectoris (see Chapter 28)

The nurse collaborates with the patient to develop a medication schedule and teaches about the name, dosage, actions, adverse effects, and any drug–drug or drug–food interactions of the prescribed medications for heart failure, dysrhythmias, angina pectoris, or other symptoms. Specific precautions are emphasized, such as the risk to patients with aortic stenosis who experience angina pectoris and take nitroglycerin. The venous dilation that results from nitroglycerin decreases blood return to the heart, thus decreasing cardiac output and increasing the risk of syncope and decreased coronary artery blood flow. The nurse teaches the patient about the importance of attempting to relieve the symptoms of angina with rest and relaxation before taking nitroglycerin and to anticipate the potential adverse effects.

In addition, the nurse teaches the patient to weigh daily and report gains of 2 pounds in 1 day or 5 pounds in 1 week to the health care provider. The nurse may assist the patient with planning activity and rest periods to achieve an acceptable lifestyle. The patient may need to be advised to rest and sleep sitting in a chair or bed with the head elevated when experiencing symptoms of pulmonary congestion. Care of patients treated with valvuloplasty or surgical valve replacement is described later in this chapter.

## VALVE REPAIR AND REPLACEMENT PROCEDURES

### *Valvuloplasty*

The repair, rather than replacement, of a cardiac valve is referred to as **valvuloplasty.** In general, valves that undergo valvuloplasty function longer than prosthetic valve replacements, and patients do not require continuous anticoagulation. The type of valvuloplasty depends on the cause and type of valve dysfunction. Repair may be made to the commissures between the leaflets in a procedure known as **commissurotomy,** to the annulus of the valve by annuloplasty, to the leaflets, or to the chordae by chordoplasty. TEE is usually performed at the conclusion of a valvuloplasty to evaluate the effectiveness of the procedure.

Most valvuloplasty procedures require general anesthesia and often require cardiopulmonary bypass. However, some procedures can be performed in the cardiac catheterization laboratory and do not always require general anesthesia or cardiopulmonary bypass. Percutaneous partial cardiopulmonary bypass is used in some cardiac catheterization laboratories. Cardiopulmonary bypass is achieved by inserting a large catheter (ie, cannula) into two peripheral blood vessels, usually a femoral vein and an artery. Blood is diverted from the body through the venous catheter to the cardiopulmonary bypass machine (see Chapter 28) and returned to the patient through the arterial catheter.

#### Commissurotomy

The most common valvuloplasty procedure is commissurotomy. Each valve has leaflets; the site where the leaflets meet is called the commissure. The leaflets may adhere to one another and close the commissure (ie, stenosis). Less commonly, the leaflets fuse in such a way that in addition to stenosis, the leaflets are also prevented from closing completely, resulting in a backward flow of blood (ie, regurgita-

tion). A commissurotomy is the procedure performed to separate the fused leaflets.

### Closed Commissurotomy/Balloon Valvuloplasty

Closed commissurotomies do not require cardiopulmonary bypass. The valve is not directly visualized. Closed commissurotomies, in which a surgical technique is used, are performed in the operating room with the patient under general anesthesia; a midsternal incision is made, a small hole is cut into the heart, and the surgeon's finger or a dilator is used to open the commissure.

Percutaneous balloon valvuloplasty is the technique most commonly performed in the United States for closed commissurotomy. Balloon valvuloplasty is beneficial for mitral valve stenosis in younger patients, for aortic valve stenosis in elderly patients, and for patients with complex medical conditions that place them at high risk for the complications of more extensive surgical procedures. Most often used for mitral and aortic valve stenosis, balloon valvuloplasty also has been used for tricuspid and pulmonic valve stenosis. The procedure is contraindicated for patients with left atrial or ventricular thrombus, severe aortic root dilation, significant mitral valve regurgitation, thoracolumbar scoliosis, rotation of the great vessels, and other cardiac conditions that require open heart surgery.

Balloon valvuloplasty (Fig. 29-3) is performed in the cardiac catheterization laboratory. The patient may receive light or moderate sedation or just a local anesthetic. Mitral balloon valvuloplasty involves advancing one or two catheters into the right atrium, through the atrial septum into the left atrium, across the mitral valve into the left ventricle, and out into the aorta. A guidewire is placed through each catheter, and the original catheter is removed. A large balloon catheter is then placed over the guidewire and positioned with the balloon across the mitral valve. The balloon is then inflated with a dilute angiographic solution. When two balloons are used, they are inflated simultaneously. The advantage of two balloons is that they are each smaller than the one large balloon often used, making smaller atrial septal defects. As the balloons are inflated, they usually do not completely occlude the mitral valve, thereby permitting some forward flow of blood during the inflation period. The balloons are usually inflated for 10 to 30 seconds. Multiple inflations are usually required to achieve the desired results.

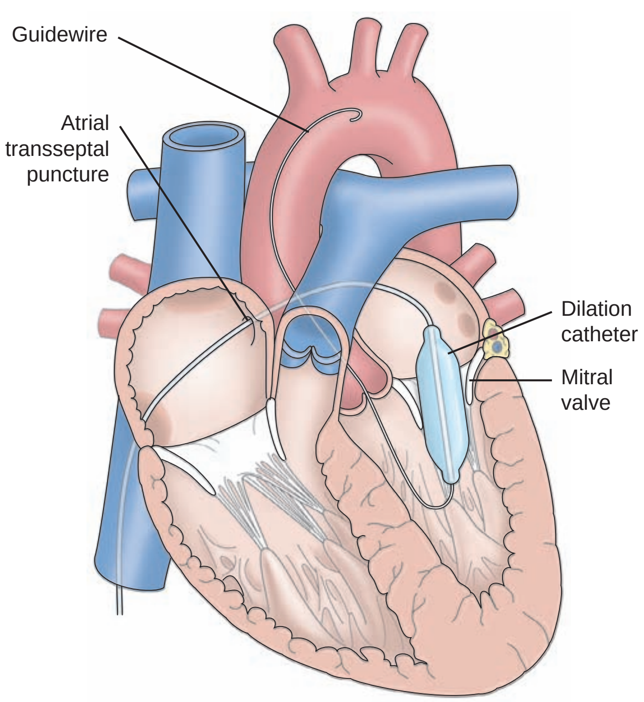



**Figure 29-3** Balloon valvuloplasty: cross-section of heart illustrating the guidewire and dilation catheter placed through an atrial transseptal puncture and across the mitral valve. The guidewire is extended out from the aortic valve into the aorta for catheter support.

All patients have some degree of mitral regurgitation after the procedure. Other possible complications include bleeding from the catheter insertion sites, emboli resulting in complications such as strokes, and rarely, left-to-right atrial shunts through an atrial septal defect caused by the procedure.

Aortic balloon valvuloplasty is performed most commonly by introducing a catheter through the aorta, across the aortic valve, and into the left ventricle, although it also may be performed by passing the balloon or balloons through the atrial septum. The one-balloon or the two-balloon technique can be used for treating aortic stenosis. Balloons are inflated for 15 to 60 seconds, and inflation is usually repeated multiple times. The aortic valve procedure is not as effective as the mitral valve procedure, and the rate of restenosis is 36% to 80% in the first 12 months after the procedure (Libby, et al., 2008). Possible complications include aortic regurgitation, emboli, ventricular perforation, rupture of the aortic valve annulus, ventricular dysrhythmia, mitral valve damage, and bleeding from the catheter insertion sites.

### Open Commissurotomy

Open commissurotomies are performed with direct visualization of the valve. The patient is under general anesthesia. A midsternal or left thoracic incision is made. Cardiopulmonary bypass is initiated and an incision is made into the heart. The valve is exposed and the surgeon uses a scalpel, finger, balloon, or dilator to open the commissures.

An added advantage of direct visualization of the valve is that thrombus and calcifications may be identified and removed. If the valve has chordae or papillary muscles, they may be inspected and surgically repaired as necessary.

## Annuloplasty

**Annuloplasty** is the repair of the valve annulus (ie, junction of the valve leaflets and the muscular heart wall). General anesthesia and cardiopulmonary bypass are required for all annuloplasties. The procedure narrows the diameter of the valve's orifice and is useful for the treatment of valvular regurgitation.

There are two annuloplasty techniques. One technique uses an annuloplasty ring (Fig. 29-4), which may be preshaped (rigid/semirigid) or flexible. The leaflets of the valve are sutured to a ring, creating an annulus of the desired size. When the ring is in place, the tension created by the moving

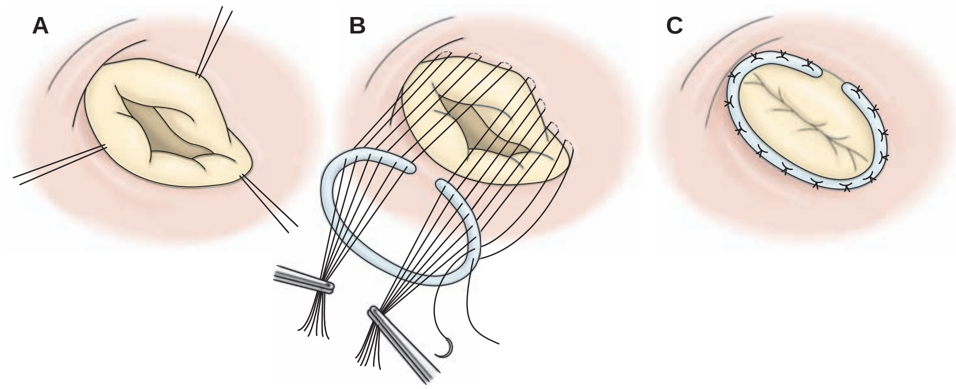



**Figure 29-4** Annuloplasty ring insertion. **A,** Mitral valve regurgitation; leaflets do not close. **B,** Insertion of an annuloplasty ring. **C,** Completed valvuloplasty; leaflets close.

blood and contracting heart is borne by the ring rather than by the valve or a suture line. Progressive regurgitation is prevented by the repair. The second technique involves tacking the valve leaflets to the atrium with sutures or taking tucks to tighten the annulus. Because the valve's leaflets and the suture lines are subjected to the direct forces of the blood and heart muscle movement, the repair may degenerate more quickly than one using an annuloplasty ring.

### Leaflet Repair

Damage to cardiac valve leaflets may result from stretching, shortening, or tearing. **Leaflet repair** for elongated, ballooning, or other excess tissue leaflets is removal of the extra tissue. The elongated tissue may be folded over onto itself (ie, tucked) and sutured (ie, leaflet plication). A wedge of tissue may be cut from the middle of the leaflet and the gap sutured closed (ie, leaflet resection) (Fig. 29-5). Short leaflets are most often repaired by chordoplasty. After the short chordae are released, the leaflets often unfurl and can resume their normal function (closing the valve during systole). A leaflet may be extended by suturing a piece of pericardium to it. A pericardial or synthetic patch may be used to repair holes in the leaflets.

### Chordoplasty

**Chordoplasty** is repair of the chordae tendineae. The mitral valve is involved with chordoplasty (because it has chordae tendineae); the tricuspid valve seldom requires chordoplasty. Stretched, torn, or shortened chordae tendineae may cause regurgitation. Stretched chordae tendineae can be shortened, transposed to the other leaflet, or replaced with synthetic chordae. Torn chordae can be reattached to the leaflet and shortened chordae can be elongated. Stretched papillary muscles, which may also cause regurgitation, can be shortened as well.

## Valve Replacement

When valvuloplasty is not a viable alternative (eg, when the annulus or leaflets of the valve are immobilized by calcifications, severe fibrosis or fusion of the chordate tendineae, papillary muscles, and leaflets below the valve), **valve replacement** is performed. General anesthesia and cardiopulmonary bypass are used for valve replacements. Most procedures are performed through a median sternotomy (ie, incision through the sternum), although the mitral valve may be approached through a right thoracotomy incision. Mitral, and more rarely aortic, valve replacements may be performed with minimally invasive techniques that do not involve cutting through the length of the sternum. Instead, incisions are made in only the upper or lower half of the sternum or between ribs; these incisions are only 2 to 4 inches long. Some of these minimally invasive procedures are robot assisted; the surgical instruments are connected to a robot, and the surgeon, watching a video display, uses a joystick to control the robot and surgical instruments. With these procedures, patients have less bleeding, pain, risk of infection, and scarring. Hospital stays average 3 days, and recovery may be as short as 3 weeks.

After the valve is visualized, the leaflets of the aortic or pulmonic valve are removed, but some or all of the mitral valve structures (leaflets, chordae, and papillary muscles) are left in place to help maintain the shape and function of

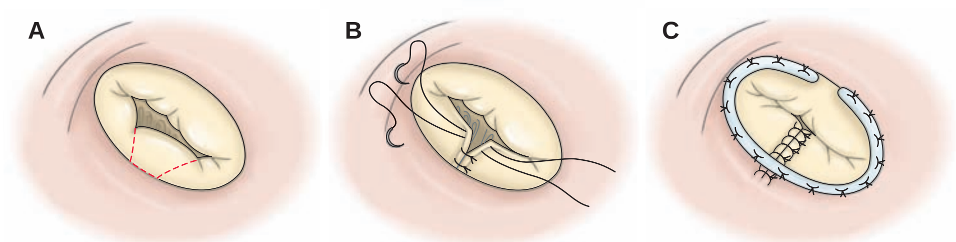



**Figure 29-5** Valve leaflet resection and repair with a ring annuloplasty. **A,** Mitral valve regurgitation; the section indicated by dashed lines is excised. **B,** Approximation of edges and suturing. **C,** Completed valvuloplasty, leaflet repair, and annuloplasty ring.

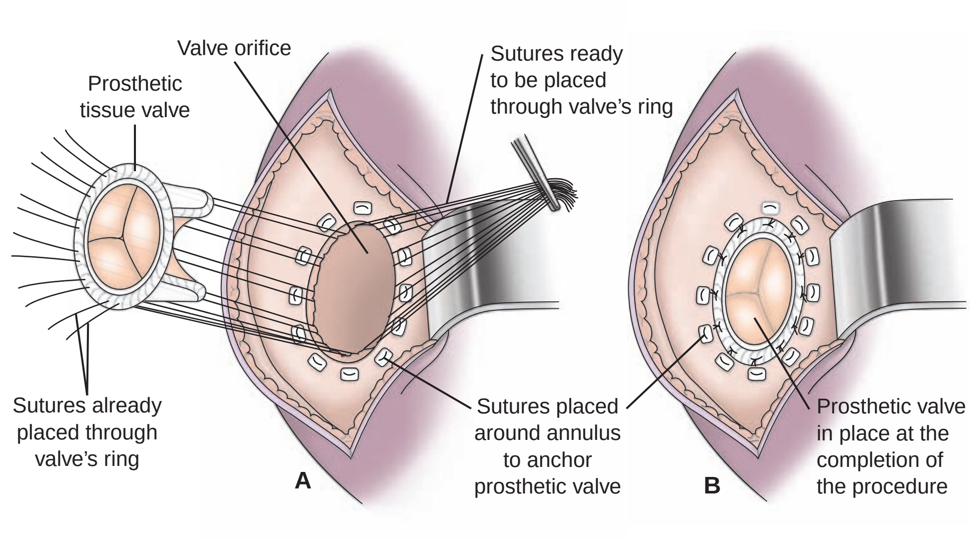



**Figure 29-6** Valve replacement. **A,** The native valve is trimmed, and the prosthetic valve is sutured in place. **B,** Once all sutures are placed through the ring, the surgeon slides the prosthetic valve down the sutures and into the natural orifice. The sutures are then tied off and trimmed.

the left ventricle after mitral valve replacement. Sutures are placed around the annulus and then through the valve prosthesis. The replacement valve is slid down the suture into position and tied into place (Fig. 29-6). The incision is closed, and the surgeon evaluates the function of the heart and the quality of the prosthetic repair. The patient is weaned from cardiopulmonary bypass, the surgical repair is often assessed with color flow Doppler TEE, and the surgery is completed.

Before surgery, the heart gradually adjusted to the pathology; but the surgery abruptly "corrects" the way blood flows through the heart. Complications unique to valve replacement are related to the sudden changes in intracardiac blood pressures. All prosthetic valve replacements create a degree of stenosis when they are implanted in the heart. Usually the stenosis is mild and does not affect heart function. If valve replacement was for a stenotic valve, blood flow through the heart is often improved. The signs and symptoms of the backward heart failure resolve in a few hours or days. If valve replacement was for a regurgitant valve, it may take months for the chamber into which blood had been regurgitating to achieve its optimal postoperative function. The signs and symptoms of heart failure resolve gradually as the heart function improves. Patients are at risk for many postoperative complications, such as bleeding, thromboembolism, infection, heart failure, hypertension, dysrhythmias, hemolysis, and mechanical obstruction of the valve.

Two types of valve prostheses may be used: mechanical and tissue (ie, biologic) valves (Fig. 29-7).

## Mechanical Valves

Mechanical valves are of the bileaflet, ball-and-cage, or tilting-disk design and are thought to be more durable than tissue prosthetic valves; therefore, they are often used for younger patients. These valves are used for patients with renal failure, hypercalcemia, endocarditis, or sepsis who require valve replacement. The mechanical valves do not deteriorate or become infected as easily as the tissue valves used for patients with these conditions. Significant complications associated with mechanical valves are thromboemboli requiring long-term use of anticoagulants. Some amount of hemolysis also occurs with these valves; usually it is not clinically significant.

## Tissue (Biologic) Valves

Tissue (ie, biologic) valves are of three types: xenografts, homografts, and autografts. Tissue valves are less likely to generate thromboemboli, and long-term anticoagulation is not required. Tissue valves are not as durable as mechanical valves and require replacement more frequently.

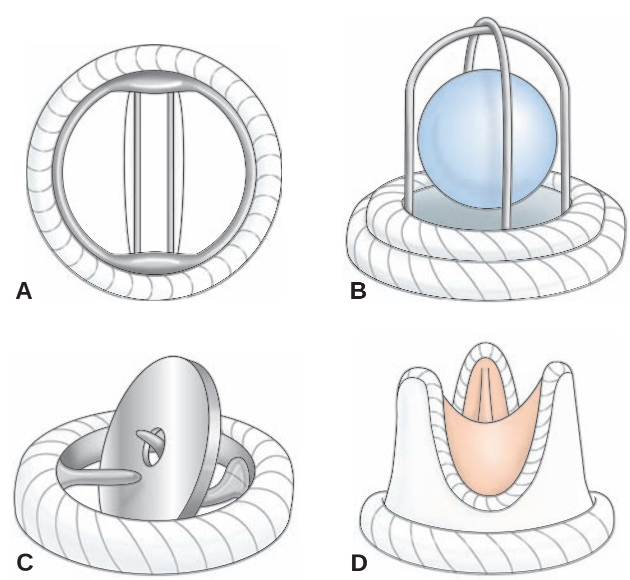



**Figure 29-7** Common mechanical and tissue valve replacements. **A,** Bileaflet (St. Jude, mechanical). **B,** Caged ball valve (Starr-Edwards, mechanical). **C,** Tilting-disk valve (Medtronic-Hall, mechanical). **D,** Porcine heterograft valve (Carpenter-Edwards, tissue).

### Xenografts

**Xenografts** are tissue valves (eg, bioprostheses, **heterografts**) that are used for tricuspid valve replacements. They are not thrombogenic, so patients do not need long-term anticoagulation therapy. They are used for women of childbearing age because the potential complications of long-term anticoagulation associated with menses, placental transfer to a fetus, and delivery of a child are avoided. They also are used for patients older than 70 years of age, patients with a history of peptic ulcer disease, and others who cannot tolerate long-term anticoagulation. Most xenografts come from pigs (porcine), but some come from cows (bovine). Viability is 7 to 10 years.

### Homografts

**Homografts,** or **allografts** (ie, human valves), are obtained from cadaver tissue donations and are used for aortic and pulmonic valve replacement. The aortic valve and a portion of the aorta or the pulmonic valve and a portion of the pulmonary artery are harvested and stored cryogenically. Homografts are not always available and are very expensive. They last for about 10 to 15 years, somewhat longer than xenografts. They are resistant to infectious endocarditis.

### Autografts

**Autografts** (ie, autologous valves) are obtained by excising the patient's own pulmonic valve and a portion of the pulmonary artery for use as the aortic valve. Anticoagulation is unnecessary because the valve is the patient's own tissue and is not thrombogenic. The autograft is an alternative for children (it may grow as the child grows), women of childbearing age, young adults, patients with a history of peptic ulcer disease, and people who cannot tolerate anticoagulation. Aortic valve autografts have remained viable for more than 20 years.

Most aortic valve autograft procedures are double valve–replacement procedures; a homograft can also be performed for pulmonic valve replacement. If pulmonary vascular pressures are normal, some surgeons elect not to replace the pulmonic valve. Patients can recover without a valve between the right ventricle and the pulmonary artery.

## Nursing Management: Valvuloplasty and Replacement

The nurse assists the patient and family to prepare for the procedure, reinforces and supplements explanations provided by the physician, and provides psychosocial support. Care of the surgical patient is described in Chapters 18 through 20.

Patients who have undergone percutaneous balloon valvuloplasty procedures may be admitted to a telemetry or intensive care unit. The nurse assesses for signs and symptoms of heart failure and emboli (see Chapter 30), listens for any changes in heart sounds at least every 4 hours, and provides the patient with the same care as for postprocedure cardiac catheterization or percutaneous transluminal coronary angioplasty (PTCA) (see Chapter 28). After undergoing percutaneous balloon valvuloplasty, the patient usually remains in the hospital for 24 to 48 hours.

Patients who have undergone surgical valvuloplasty or valve replacements are admitted to the intensive care unit. Care focuses on recovery from anesthesia and hemodynamic stability. Vital signs are assessed every 5 to 15 minutes and as needed until the patient recovers from anesthesia or sedation, and then are assessed every 2 to 4 hours and as needed. Intravenous (IV) medications to increase or decrease blood pressure and to treat dysrhythmias or altered heart rates are administered and their effects monitored. The medications are gradually decreased until they are no longer required or the patient can take the needed medication by another route (eg, oral, topical). Patient assessments are conducted every 1 to 4 hours and as needed, with particular attention to neurologic, respiratory, and cardiovascular systems. (See Chapter 28, Chart 28-13, which presents a plan of nursing care for a patient recovering from cardiac surgery.)

After the patient has recovered from anesthesia and sedation, is hemodynamically stable without IV medications, and has stable physical assessment parameters, he or she is usually transferred to a telemetry unit, typically within 24 to 72 hours of surgery. Nursing care continues as for most postoperative patients, including wound care and patient teaching regarding diet, activity, medications, and self-care. The patient is usually discharged from the hospital in 3 to 7 days.

The nurse educates the patient about anticoagulant therapy, explaining the need for frequent follow-up appointments and blood laboratory studies. Patients who take warfarin (Coumadin) usually have individualized target international normalized ratios (INRs) between 2.0 and 3.5. Patients who have been treated with an annuloplasty ring or a tissue valve replacement usually require anticoagulation for only 3 months, unless there are other risk factors such as atrial fibrillation or a history of thromboembolism. Aspirin may be prescribed with warfarin for some patients. The nurse provides teaching about all prescribed medications: the name of the medication, dosage, its actions, prescribed schedule, potential adverse effects, and any drug–drug or drug–food interactions.

Patients with a mechanical valve prosthesis (including annuloplasty rings and other prosthetic materials used in valvuloplasty) require education to prevent infective endocarditis. Patients may be at risk for infectious endocarditis that results from bacteria entering the bloodstream and adhering to the abnormal valve structures or prosthetic devices. The nurse teaches the patient how to minimize the risk of developing infectious endocarditis. Antibiotic prophylaxis is necessary before dental procedures involving manipulation of gingival tissue, the periapical area of the teeth, or perforation of the oral mucosa (not including routine anesthetic injections, placement of orthodontic brackets, or loss of deciduous teeth). Antibiotic therapy should also be used before invasive procedures involving the respiratory tract (eg, biopsy of respiratory mucosa, tonsillectomy, and adenectomy).

Home care and office or clinic nurses reinforce all new information and self-care instructions with patients and families for 4 to 8 weeks after the procedure. Doppler echocardiograms are often performed 3 to 4 weeks after discharge from the hospital to further evaluate the effects and results of the surgery. The echocardiogram also provides a

baseline for future comparison if cardiac symptoms or complications develop. Doppler echocardiograms are usually repeated every 1 to 2 years.

## Septal Defects

The atrial or ventricular septum may have an abnormal opening between the right and left sides of the heart (ie, septal defect). Most septal defects are congenital and are usually identified and repaired during infancy or childhood. Adults may not have undergone early repair or may develop septal defects as a result of myocardial infarction or trauma. In general, pressures in the left atria and ventricle are higher than those on the right, so blood initially flows from the left heart chamber into the right—a left-to-right shunt.

With an atrial septal defect (ASD), ultimately the right atrial pressures become greater than the left atrial pressures, and blood begins to flow from the right atrium into the left atrium—a right-to-left shunt. With a ventricular septal defect (VSD), the extra blood volume causes the right ventricle to dilate, as well as pulmonary vascular congestion and hypertension.

Patients with septal defects may not experience any symptoms, gradually develop symptoms, or rapidly develop heart failure. Patients with ASDs who gradually develop symptoms usually describe decreased exercise tolerance, dyspnea on exertion, palpitations, syncope, and symptoms of right ventricular or congestive heart failure. Cyanosis may result, or strokes (cerebrovascular accidents, brain attacks) may occur. Patients with VSDs who gradually develop symptoms describe shortness of breath, syncope, chest pain, and symptoms of left ventricular failure.

### Medical Management

Treatment is individualized to the patient's symptoms. Heart failure is treated as described in Chapter 30. Vasodilators are often prescribed first to decrease resistance to ventricular ejection and minimize the left-to-right shunting.

Many septal defects can be repaired percutaneously in a cardiac catheterization laboratory. A guidewire is advanced through a vein into the right side of the heart and through the septal defect. A special catheter is placed over the guidewire and positioned across the septal defect. Two connected mesh disks (one on each side of the septum) are then used to close the septal defect.

Surgical repair of some septal defects requires general anesthesia and cardiopulmonary bypass. ASD repairs without mitral or tricuspid valve involvement have low morbidity and mortality rates. Generally, VSD repairs are uncomplicated, but close proximity of the defect to the intraventricular conduction system and the valves may make this repair more complex.

### Nursing Management

Care for a patient recovering from a percutaneous septal defect repair is the same care as for postprocedure cardiac catheterization or PTCA (see Chapter 28). After undergoing percutaneous septal repair, the patient usually remains in the hospital for 24 to 48 hours. Care for a patient recovering from a surgical septal defect repair is the same as other cardiac surgeries (see Chapter 28, Chart 28-13).

## Cardiomyopathy

**Cardiomyopathy** is a heart muscle disease associated with cardiac dysfunction. It is classified according to the structural and functional abnormalities of the heart muscle: dilated cardiomyopathy (DCM), hypertrophic cardiomyopathy (HCM), restrictive or constrictive cardiomyopathy (RCM), arrhythmogenic right ventricular cardiomyopathy (ARVC), and unclassified cardiomyopathy (Libby, et al., 2008). A patient may have pathology representing more than one of these classifications, such as a patient with HCM developing dilation and symptoms of DCM. Ischemic cardiomyopathy is a term frequently used to describe an enlarged heart caused by coronary artery disease, which is usually accompanied by heart failure (see Chapter 30).

### Pathophysiology

The pathophysiology of all cardiomyopathies is a series of events that culminate in impaired cardiac output. Decreased stroke volume stimulates the sympathetic nervous system and the renin–angiotensin–aldosterone response, resulting in increased systemic vascular resistance and increased sodium and fluid retention, which places an increased workload on the heart. These alterations can lead to heart failure (see Chapter 30).

#### *Dilated Cardiomyopathy*

DCM is the most common form of cardiomyopathy, with an incidence of 5 to 8 cases per 100,000 people per year (Libby, et al., 2008). DCM is distinguished by significant dilation of the ventricles without simultaneous hypertrophy (ie, increased muscle wall thickness) and systolic dysfunction (Fig. 29-8). The ventricles have elevated systolic and diastolic volumes but a decreased ejection fraction.

More than 75 conditions and diseases may cause DCM, including pregnancy, heavy alcohol intake, viral infection (eg, influenza), chemotherapeutic medications (eg, daunorubicin [Cerubidine], doxorubicin [Adriamycin]), and Chagas disease. When the causative factor cannot be identified, the diagnosis is idiopathic DCM, which accounts for approximately 25% of all heart failure cases. Because genetic factors may be involved, echocardiography and ECG should be used to screen all first-degree blood relatives (eg, parents, siblings, children) for DCM (Libby, et al., 2008).

Microscopic examination of the muscle tissue shows diminished contractile elements (actin and myosin filaments) of the muscle fibers and diffuse necrosis of myocardial cells. The result is poor systolic function. The structural changes decrease the amount of blood ejected from the ventricle with systole, increasing the amount of blood remaining in the ventricle after contraction. Less blood is then able to enter the ventricle during diastole, increasing end-diastolic pressure and eventually increasing pulmonary and systemic venous pressures. Altered valve function, usually regurgitation, can result from an enlarged stretched ventricle. Poor blood flow through the ventricle may also cause ventricular

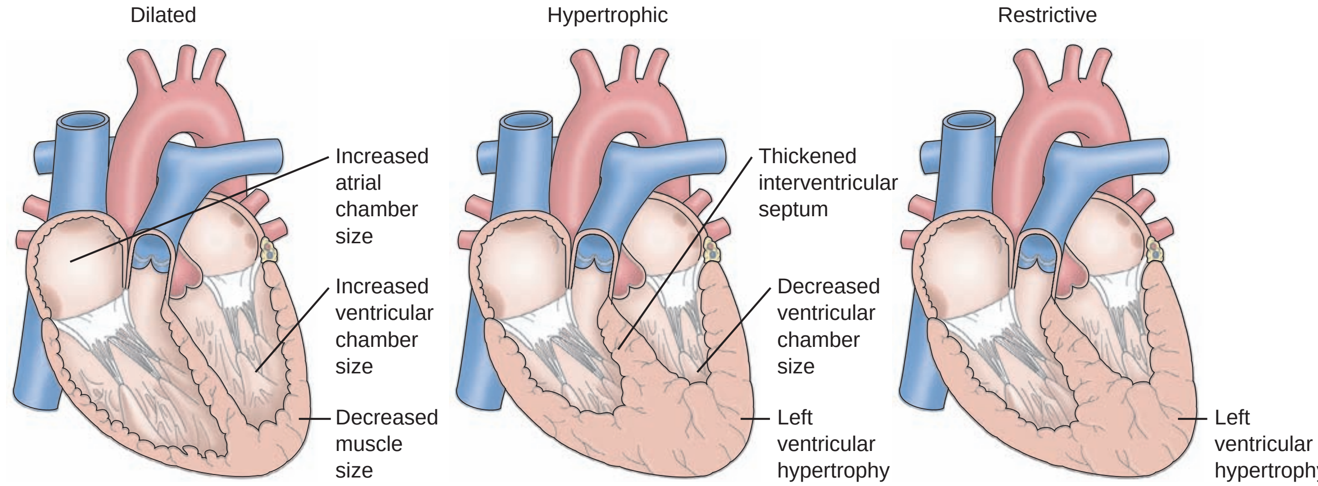



**Figure 29-8** Cardiomyopathies that lead to congestive heart failure. Redrawn from Anatomical Chart Company. (2006). *Atlas of pathophysiology* (2nd ed.). Ambler, PA: Lippincott Williams & Wilkins.

or atrial thrombi, which may embolize to other locations in the body. Early diagnosis and treatment can prevent or delay significant symptoms and sudden death from DCM.

### Hypertrophic Cardiomyopathy

HCM is a rare autosomal dominant condition, occurring in men, women, and children (often detected after puberty) with an estimated prevalence rate of 0.05% to 0.2% of the population in the United States (Zevitz, 2006). Echocardiograms may be performed every year from 12 to 18 years of age and then every 5 years from 18 to 70 years of age in susceptible individuals. Doppler echocardiography may also be used to detect the HCM and blood flow alterations (Libby, et al., 2008). HCM also may be idiopathic (ie, no known cause).

In HCM, the heart muscle asymmetrically increases in size and mass, especially along the septum (see Fig. 29-8). HCM often affects nonadjacent areas of the ventricle. The increased thickness of the heart muscle reduces the size of the ventricular cavities and causes the ventricles to take a longer time to relax after systole. During the first part of diastole it is more difficult for the ventricles to fill with blood. The atrial contraction at the end of diastole becomes critical for ventricular filling and systolic contraction.

Cardiac muscle cells normally lie parallel to and end-to-end with each other. The hypertrophied cardiac muscle cells are disorganized, oblique, and perpendicular to each other, decreasing the effectiveness of contractions and possibly increasing the risk of dysrhythmias such as ventricular tachycardia and ventricular fibrillation. In HCM the coronary arteriole walls are thickened, which decreases the internal diameter of the arterioles. The narrow arterioles restrict the blood supply to the myocardium, causing numerous small areas of ischemia and necrosis. The necrotic areas of the myocardium ultimately fibrose and scar, further impeding ventricular contraction.

### Restrictive Cardiomyopathy

RCM is characterized by diastolic dysfunction caused by rigid ventricular walls that impair diastolic filling and ventricular stretch (see Fig. 29-8). Systolic function is usually normal. RCM may be associated with amyloidosis (amyloid, a protein substance, is deposited within cells) and other such infiltrative diseases. However, the cause is unknown (ie, idiopathic) in most cases. Signs and symptoms are similar to constrictive pericarditis: dyspnea, nonproductive cough, and chest pain. Echocardiography, as well as measurement of pulmonary artery systolic (PAS) pressure, pulmonary artery wedge pressure (PAWP), and central venous pressure (CVP) are used to differentiate the two conditions.

### Arrhythmogenic Right Ventricular Cardiomyopathy

ARVC occurs when the myocardium of the right ventricle is progressively infiltrated and replaced by fibrous scar and adipose tissue. Initially, only localized areas of the right ventricle are affected, but as the disease progresses, the entire heart is affected. Eventually, the right ventricle dilates and develops poor contractility, right ventricular wall abnormalities, and dysrhythmias. The prevalence of ARVC is unknown because many cases are not recognized. Palpitations or syncope may develop between 15 and 40 years of age. ARVC should be considered in patients with ventricular tachycardia originating in the right ventricle (ie, a left bundle branch block configuration on ECG) or sudden death, especially among young athletes (Libby, et al., 2008). ARVC is genetic (ie, autosomal dominant) (Sen-Chowdhry, Syrris & Mckenna, 2005). First-degree blood relatives (eg, parents, siblings, children) should be screened for the disease with a 12-lead ECG, Holter monitor, and echocardiography.

### Unclassified Cardiomyopathies

Unclassified cardiomyopathies are different from or have characteristics of more than one of the previously described types. Examples of unclassified cardiomyopathies include fibroelastosis, noncompacted myocardium, systolic dysfunction with minimal dilation, and mitochondrial involvement (Libby, et al., 2008).

## Clinical Manifestations

Patients with cardiomyopathy may remain stable and without symptoms for many years. As the disease progresses, so do the symptoms. Frequently, dilated or restrictive cardiomyopathy is first diagnosed when the patient presents with signs and symptoms of heart failure (eg, dyspnea on exertion, fatigue). Patients with cardiomyopathy may also report PND, cough (especially with exertion), and orthopnea, which may lead to a misdiagnosis of bronchitis or pneumonia. Other symptoms include fluid retention, peripheral edema, and nausea, which is caused by poor perfusion of the gastrointestinal system. The patient also may experience chest pain, palpitations, dizziness, nausea, and syncope with exertion. However, with HCM, cardiac arrest (ie, sudden cardiac death) may be the initial manifestation in young people, including athletes (Libby, et al., 2008; Zevitz, 2006).

Regardless of type and cause, cardiomyopathy may lead to severe heart failure, lethal dysrhythmias, and death. The mortality rate is highest for African Americans and the elderly.

## Assessment and Diagnostic Findings

Physical examination at early stages may reveal tachycardia and extra heart sounds (eg, $S_3$, $S_4$). Patients with DCM may have diastolic murmurs, and patients with DCM and HCM may have systolic murmurs. With disease progression, examination also reveals signs and symptoms of heart failure (eg, crackles on pulmonary auscultation, jugular vein distention, pitting edema of dependent body parts, enlarged liver).

Diagnosis is usually made from findings disclosed by the patient history and by ruling out other causes of heart failure such as myocardial infarction. The echocardiogram is one of the most helpful diagnostic tools because the structure and function of the ventricles can be observed easily. Cardiac MRI may also be used, particularly to assist with the diagnosis of HCM (Rickers, Wilke, Jerosch-Herold, et al., 2005). ECG demonstrates dysrhythmias (atrial fibrillation, ventricular dysrhythmias) and changes consistent with left ventricular hypertrophy (left axis deviation, wide QRS, ST changes, inverted T waves). In ARVC, there often is a small deflection, an epsilon wave, at the end of the QRS. The chest x-ray reveals heart enlargement and possibly pulmonary congestion. Cardiac catheterization is sometimes used to rule out coronary artery disease as a causative factor. Endomyocardial biopsy may be performed to analyze myocardial cells.

## Medical Management

Medical management is directed toward identifying and managing possible underlying or precipitating causes; correcting the heart failure with medications, a low-sodium diet, and an exercise/rest regimen (see Chapter 30); and controlling dysrhythmias with antiarrhythmic medications and possibly with an implanted electronic device, such as an implantable cardioverter defibrillator (see Chapter 27). Systemic anticoagulation to prevent thromboembolic events is usually recommended. If the patient has signs and symptoms of congestion, fluid intake may be limited to 2 L each day. Patients with HCM should avoid dehydration and may need beta-blockers (atenolol [Tenormin], metoprolol [Lopressor], nadolol [Corgard], propranolol [Inderal]) to maintain cardiac output and minimize the risk of left ventricular outflow tract obstruction during systole. Patients with HCM or RCM may need to limit physical activity to avoid a life-threatening dysrhythmia.

A pacemaker may be implanted to alter the electrical stimulation of the muscle and prevent the forceful hyperdynamic contractions that occur with HCM. Atrial-ventricular and biventricular pacing have been used to decrease symptoms and obstruction of the left ventricular outflow tract. For some patients with DCM and HCM, biventricular pacing increases the ejection fraction and reverses some of the structural changes in the myocardium.

Nonsurgical septal reduction therapy, also called alcohol septal ablation, has been used to treat obstructive HCM. In the cardiac catheterization laboratory, a percutaneous catheter is positioned in one or more of the septal coronary arteries. Once the position is verified, 1 to 5 mL of 96% to 98% ethanol (ethyl alcohol) is injected at a rate of about 1 mL/min to destroy the myocardial cells; it is believed that the ethanol causes dehydration of the cardiac cells (Libby, et al., 2008; Zevitz, 2006). The slow rate of injection minimizes the risk of heart block and premature ventricular contractions. The procedure produces a septal myocardial infarction. The resulting scar is thinner than the living myocardium had been, so the obstruction is decreased. The patient may develop a left anterior hemibranch block or left bundle branch block. If the patient experiences pain, hydrocodone/acetaminophen (Vicodin) is usually administered. Nitrates and morphine are not used because coronary artery dilation is contraindicated.

## Surgical Management

When heart failure progresses and medical treatment is no longer effective, surgical intervention, including heart transplantation, is considered. However, because of the limited number of organ donors, many patients die waiting for transplantation. In some cases, a left ventricular assist device is implanted to support the failing heart until a suitable donor heart becomes available.

### *Left Ventricular Outflow Tract Surgery*

When patients with HCM become symptomatic despite medical therapy and a difference in pressure of 50 mm Hg or more exists between the left ventricle and the aorta, surgery is considered. The most common procedure is a myectomy (sometimes referred to as a myotomy-myectomy), in which some of the heart tissue is excised. Septal tissue approximately 1-cm wide and deep is cut from the enlarged septum below the aortic valve. The length of septum removed depends on the degree of obstruction caused by the hypertrophied muscle.

Instead of a septal myectomy, the surgeon may open the left ventricular outflow tract to the aortic valve by mitral valvuloplasty involving the leaflets, chordae, or papillary muscles, or the patient's mitral valve may be replaced with a low-profile disk valve. The space taken up by the mitral valve is substantially reduced by the valvuloplasty or prosthetic valve, allowing blood to move around the enlarged

septum to the aortic valve through the area the mitral valve once occupied. The primary complication of all the procedures is dysrhythmia. Additional complications include postoperative surgical complications such as pain, ineffective airway clearance, deep vein thrombosis, risk of infection, and delayed surgical recovery.

### Latissimus Dorsi Muscle Wrap

DCM may be treated with a latissimus dorsi muscle wrap, also called dynamic cardiomyoplasty (Libby, et al., 2008; Woods, Froelicher, Motzer, et al., 2005). The left latissimus dorsi muscle is dissected from the lateral side and back of the chest, leaving the medial end of the muscle and the blood supply intact, and the lateral end of the muscle is pulled through the pleural space into the pericardium. The latissimus dorsi muscle flap is then wrapped around the ventricles and sutured in place. Pacemaker leads are implanted into the muscle flap, and a pacemaker generator is implanted in the chest wall. For at least 2 weeks following surgery, the pacemaker remains turned off to facilitate the development of adhesions between the muscle wrap and the ventricles. Eventually, the pacemaker is turned on and used to stimulate latissimus dorsi muscle contraction. Several weeks of training, or conditioning, are necessary before this skeletal muscle functions effectively. The ultimate goal is for the latissimus dorsi muscle wrap to augment ventricular contraction and increase cardiac output. This skeletal muscle loses its contractility over time, and the patient may be evaluated for heart transplantation.

### Heart Transplantation

Because of advances in surgical techniques and immunosuppressive therapies, heart transplantation is now a therapeutic option for patients with end-stage heart disease. Cyclosporine (Gengraf, Neoral, Sandimmune) is an immunosuppressant that greatly decreases the body's rejection of foreign proteins, such as transplanted organs. Unfortunately, cyclosporine also decreases the body's ability to resist infections, and a satisfactory balance must be achieved between suppressing rejection and avoiding infection.

Cardiomyopathy, ischemic heart disease, valvular disease, rejection of previously transplanted hearts, and congenital heart disease are the most common indications for transplantation (Fuster, et al., 2008; Libby, et al., 2008; Moser & Riegel, 2008). Typical candidates have severe symptoms uncontrolled by medical therapy, no other surgical options, and a prognosis of less than 2 years to live. A multidisciplinary team screens the candidate before recommending the transplantation procedure (Chart 29-1). The person's age, pulmonary status, other chronic health conditions, psychosocial status, family support, infections, history of other transplantations, compliance, and current health status are considered.

CHART 29-1 NURSING RESEARCH PROFILE

## *Patient and Family Needs While Awaiting Heart Transplantation*

Haugh, K. H. & Salyer, J. (2007). Needs of patients and families during the wait for a donor heart. *Heart & Lung, 36*(5), 319–329.

#### Purpose

The purpose of this study of patients accepted for heart transplantation and their families was to identify interventions used during the wait for a donor heart, the perceived effectiveness of the interventions, and interventions not being used that may be helpful.

#### Design

This qualitative study used the focus group technique. The sample consisted of eight patients (four pretransplant, four posttransplant) and three family members from two heart transplant programs; the patients in the study spent an average of more than 300 days on the waiting list for a heart transplant. Researchers conducted a 2-hour videotaped focus group interview at each of two academic health care centers. The focus group moderator asked a series of eight open-ended questions to which the participants responded. The moderator encouraged participants to express themselves, reassured them that their contributions were important, and encouraged specific details in the responses. One researcher took notes during the focus group and summarized the discussion and sought verification from the participants at the end of each interview. After reviewing the videotape for both verbal content and nonverbal behaviors, the researchers identified themes, patterns, and similarities among the data from both the notes and videotape. They then mailed a written summary to each participant so that each person had an opportunity to provide additional feedback.

#### Findings

The central theme identified by the participants regarding their perceptions about the time spent waiting for transplant was that of tolerating uncertainty. Interventions reported as helpful were sharing of information, being sensitive to the needs of the family during hospitalization, maintaining respect and dignity, doing the "extra little things," and helping facilitate coping.

#### Nursing Implications

Patients and their families find nursing interventions helpful in tolerating the uncertainty of waiting for a donor heart. Nurses need to share information with patients and their families, but they must be sensitive to psychological needs and individualize the pace, amount, and depth of the information to each patient's preferences. Patients and families appreciate warm, receptive, friendly nurses. Nurses need to provide patients with as much control over their lives as possible and always treat patients with respect and dignity. Nurses must identify issues important to the patient's quality of life and try to address them whenever possible; for example, coordinating a visit between a hospitalized patient and his or her pet(s) may prove beneficial. Providing patients with control over their routine and tasks are important so that patients can "feel normal." Facilitating coping is another important nursing intervention. Patients appreciate spirituality, humor, peer support, and honesty to help them cope.

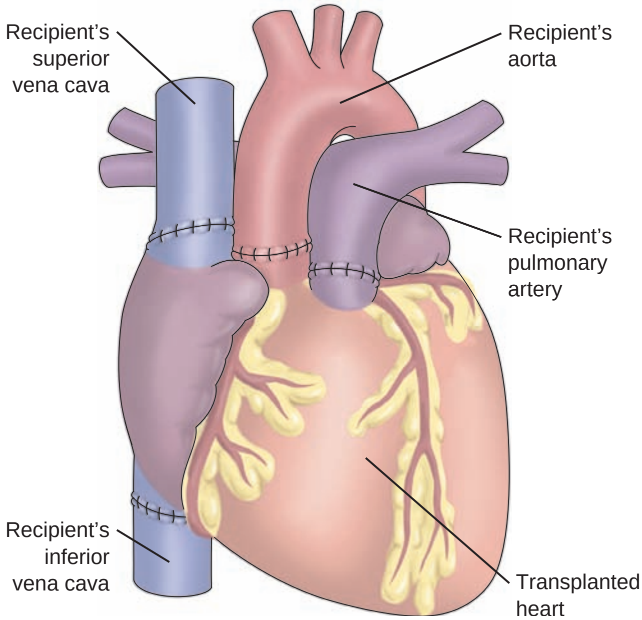



**Figure 29-9** Orthotopic method of heart transplantation.

When a donor heart becomes available, a computer generates a list of potential recipients on the basis of ABO blood group compatibility, the body sizes of the donor and the potential recipient, age, severity of illness, length of time on the waiting list, and the geographic locations of the donor and potential recipient. Distance is a factor because postoperative function depends on the heart being implanted within 4 hours of harvest from the donor. Some patients are candidates for more than one organ transplant (eg, heart–lung, heart–kidney, heart–liver).

**Orthotopic transplantation** is the most common surgical procedure for cardiac transplantation (Fig. 29-9). The recipient's heart is removed, and the donor heart is implanted at the vena cava and pulmonary veins. Some surgeons prefer to remove the recipient's heart, leaving a portion of the recipient's atria (with the vena cava and pulmonary veins) in place. The donor heart, which usually has been preserved in ice, is prepared for implant by cutting away a small section of the atria that corresponds with the sections of the recipient's heart that were left in place. The donor heart is implanted by suturing the donor atria to the residual atrial tissue of the recipient's heart. After the venous or atrial anastomoses are complete, the recipient's pulmonary artery and aorta are sutured to those of the donor heart.

Patients who have had heart transplants are constantly balancing the risk of rejection with the risk of infection. They must adhere to a complex regimen of diet, medications, activity, follow-up laboratory studies, biopsies of the transplanted heart (to diagnose rejection), and clinic visits. Most commonly, patients receive tacrolimus (Prograf) or cyclosporine, mycophenolate mofetil (CellCept) or azathioprine (Imuran), and corticosteroids (eg, prednisone) to minimize rejection.

The transplanted heart has no nerve connections (ie, denervated heart) to the recipient's body, so the sympathetic and vagus nerves do not affect the transplanted heart. The resting rate of the transplanted heart is approximately 70 to 90 bpm (beats per minute), but it increases gradually if catecholamines are in the circulation. Patients must gradually increase and decrease their exercise (ie, extended warm-up and cool-down periods), because 20 to 30 minutes may be required to achieve the desired heart rate. Atropine does not increase the heart rate of transplanted hearts.

In addition to rejection and infection, complications may include accelerated atherosclerosis of the coronary arteries (ie, cardiac allograft vasculopathy, accelerated graft atherosclerosis, transplant coronary artery disease). Both immunologic and nonimmunologic factors cause arterial injury and inflammation of the coronary arteries. The arterial smooth muscle proliferates and there is hyperplasia of the coronary artery intima, accelerating atherosclerosis along the entire length of the coronary arteries (Libby, et al., 2008; Woods, et al., 2005). Hypertension may occur in patients taking cyclosporine or tacrolimus; the cause has not been identified. Osteoporosis is a frequent side effect of the antirejection medications as well as pretransplantation dietary insufficiency and medications. Patients with a long-term sedentary lifestyle are at greater risk for osteoporosis. Posttransplantation lymphoproliferative disease and cancer of the skin and lips are the most common malignancies after transplantation, possibly caused by immunosuppression. Weight gain; obesity; diabetes; dyslipidemias (eg, hypercholesterolemia); hypotension; renal failure; and central nervous system, respiratory, and gastrointestinal disturbances may be adverse effects of the corticosteroids or other immunosuppressants. Toxicity from immunosuppressant medications may occur. The 1-year survival rate for patients with transplanted hearts is approximately 81% to 95%, and the 10-year survival rate is approximately 50% to 70% (Fuster, et al., 2008; Libby, et al., 2008; Moser & Reigel, 2008).

In the first year after transplant, patients respond to the psychosocial stresses imposed by organ transplantation in various ways. Most report a better quality of life after transplantation. Some experience guilt that someone had to die for them to be able to live, have anxiety about the new heart, experience depression or fear about rejection, or have difficulty with family role changes before and after transplantation (Fuster, et al., 2008; Kaba, Thompson, Burnard, et al., 2005; Moser & Reigel, 2008). After the first year, many patients believe that their lives have purpose, they are connected to a force greater than themselves, and look forward to the future (Flattery, Salyer, Maltby, et al., 2006).

### *Mechanical Assist Devices and Total Artificial Hearts*

The use of cardiopulmonary bypass in cardiovascular surgery and the possibility of performing heart transplantation in patients with end-stage cardiac disease, as well as the desire for a treatment option for patients with such disease who are not transplant candidates, have increased the need for mechanical assist devices. Patients who cannot be weaned from cardiopulmonary bypass and patients in cardiogenic shock may benefit from a period of mechanical heart assistance. The most commonly used device is the intra-aortic balloon pump (see Chapter 30). This pump decreases the work of the heart during contraction but does not perform the actual work of the heart.

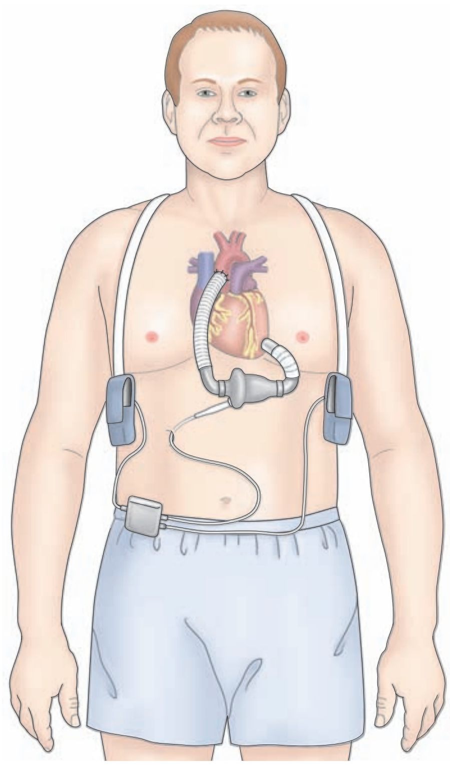


**Figure 29-10** Left ventricular assist device.

### Ventricular Assist Devices

More complex devices that actually perform some or all of the pumping function for the heart also are being used. These more sophisticated **ventricular assist devices** (VADs) can circulate as much blood per minute as the heart, if not more (Fig. 29-10). Each VAD is used to support one ventricle. Some VADs can be combined with an oxygenator; the combination is called extracorporeal membrane oxygenation (ECMO). The oxygenator–VAD combination is used for the patient whose heart cannot pump adequate blood through the lungs or the body.

VADs may be used as (1) a "bridge to recovery" for patients who require temporary assistance for reversible ventricular failure, (2) a "bridge to transplant" for patients with end-stage heart failure until a donor organ becomes available for transplant (most common), and (3) "destination therapy" for patients with end-stage heart failure who are not candidates for or decline heart transplantation. When VADs are used as destination therapy, patients are discharged from the hospital with the devices in place (Fuster, et al., 2008; Libby, et al., 2008; Moser & Reigel, 2008).

VADs may be external, internal (ie, implanted) with an external power source, or completely internal, and they may generate a pulsatile or continuous blood flow. There are three types of VADs: pneumatic, electric or electromagnetic, and axial flow. Pneumatic VADs are external or implanted pulsatile devices with a flexible reservoir housed in a rigid exterior. The reservoir usually fills with blood drained from the atrium or ventricle. The device then forces pressurized air into the rigid housing, compressing the reservoir and returning the blood to the circulation, usually into the aorta. Electric or electromagnetic VADs are similar to the pneumatic VADs, but instead of using pressurized air to return the blood to the circulation, one or more flat metal plates are pushed against the reservoir. Axial flow VADs use a rotary mechanism (an impeller) to create a nonpulsatile blood flow. The impeller spins rapidly within the VAD, creating a vacuum that pulls blood into the VAD and then pushes the blood out into the systemic circulation—the process is similar to a fan spinning in a tunnel, pulling air in one end of the tunnel and pushing it out the other.

### Total Artificial Hearts

**Total artificial hearts** are designed to replace both ventricles. Some require the removal of the patient's heart to implant the total artificial heart and others do not. One total artificial heart has been approved for use in the United States. Although there has been some short-term success, the long-term results have been disappointing. Researchers hope to develop a device that can be permanently implanted and that will eliminate the need for donated human heart transplantation for end-stage cardiac disease (Libby, et al., 2008; Moser & Reigel, 2008).

Complications of VADs and total artificial hearts include bleeding disorders, hemorrhage, thrombus, emboli, hemolysis, infection, renal failure, right-sided heart failure, multisystem failure, and mechanical failure (Libby, et al., 2008; Moser & Reigel, 2008). Nursing care of patients with these mechanical assist devices focuses on assessment for and minimization of these complications as well as providing emotional support and education about the device as well as the underlying cardiac disease.

## NURSING PROCESS

## The Patient With Cardiomyopathy

### Assessment

Nursing assessment for the patient with cardiomyopathy begins with a detailed history of the presenting signs and symptoms. The nurse identifies possible etiologic factors, such as heavy alcohol intake, recent illness or pregnancy, or history of the disease in immediate family members. If the patient reports chest pain, a thorough review of the pain, including its precipitating factors, is warranted. The review of systems includes the presence of orthopnea, PND, and syncope or dyspnea with exertion. The number of pillows needed to sleep, usual weight, any weight change, and limitations on activities of daily living are assessed. The New York Heart Association Classification for heart failure is determined (see Table 30-1). The patient's usual diet is evaluated to determine the need to reduce sodium intake, optimize nutrition, or supplement with vitamins.

Because of the chronicity of cardiomyopathy, the nurse conducts a careful psychosocial history, exploring the impact of the disease on the patient's role within the family and community. Identification of perceived stressors helps the patient and the health care team to implement activities to relieve anxiety related to changes in health status.

Very early on, the patient's support systems are identified, and members are encouraged to become involved in the patient's care and therapeutic regimen. The assessment addresses the effect the diagnosis has had on the patient and members of his or her support system and the patient's emotional status. Depression is common in a patient with cardiomyopathy who has developed heart failure.

The physical assessment focuses on signs and symptoms of heart failure. The baseline assessment includes such key components as:

- Vital signs
- Calculation of pulse pressure and identification of pulsus paradoxus
- Current weight and any weight gain or loss
- Detection by palpation of the point of maximal impulse, often shifted to the left
- Cardiac auscultation for a systolic murmur and $S_3$ and $S_4$ heart sounds
- Pulmonary auscultation for crackles
- Measurement of jugular vein distention
- Assessment of edema and its severity

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include:

- Decreased cardiac output related to structural disorders caused by cardiomyopathy or to dysrhythmia from the disease process and medical treatments
- Ineffective cardiopulmonary, cerebral, peripheral, and renal tissue perfusion related to decreased peripheral blood flow (resulting from decreased cardiac output)
- Impaired gas exchange related to pulmonary congestion caused by myocardial failure (resulting from decreased cardiac output)
- Activity intolerance related to decreased cardiac output or excessive fluid volume, or both
- Anxiety related to the change in health status and in role functioning
- Powerlessness related to disease process
- Noncompliance with medication and diet therapies

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications include:

- Heart failure
- Ventricular dysrhythmias
- Atrial dysrhythmias
- Cardiac conduction defects
- Pulmonary or cerebral embolism
- Valvular dysfunction

These complications are discussed earlier in this chapter and in Chapters 27 and 30.

## Planning and Goals

The major goals for patients include improvement or maintenance of cardiac output, increased activity tolerance, reduction of anxiety, adherence to the self-care program, increased sense of power with decision making, and absence of complications.

## Nursing Interventions

### *Improving Cardiac Output*

During a symptomatic episode, rest is indicated. Many patients with DCM find that sitting up with their legs down is more comfortable than lying down in a bed. This position is helpful in pooling venous blood in the periphery and reducing preload. Assessing the patient's oxygen saturation at rest and during activity may assist with determining a need for supplemental oxygen. Oxygen is usually administered through a nasal cannula when indicated.

Ensuring that medications are taken as prescribed is important to preserving adequate cardiac output. The nurse may assist the patient with planning a schedule for taking medications and identifying methods to remember to follow it, such as associating the time to take a medication with an activity (eg, eating a meal, brushing teeth). It is important to ensure that patients with DCM avoid verapamil (Calan, Isoptin), patients with HCM avoid diuretics, and patients with RCM avoid nifedipine to maintain contractility. In patients with HCM, the inotropic action of digoxin may create or worsen left ventricular outflow track obstruction. Patients with RCM have increased sensitivity to digoxin, and the nurse must anticipate that low doses will be prescribed and assess for digoxin toxicity.

It is also important to ensure that the patient receives or chooses food selections that are appropriate for a low-sodium diet. One way to monitor a patient's response to treatment is to determine the patient's weight every day and identify any significant change. Another indication of the effect of treatment involves assessment of shortness of breath after activity and comparison to before treatment. Patients with low cardiac output may need assistance keeping warm and frequently changing position to stimulate circulation and reduce the possibility of skin breakdown. Patients with HCM must be taught to avoid dehydration. One guideline for patients to use for self-assessment is to anticipate the urge to void at least every 4 hours while awake; if the urge to void is not present or the urine is a deep yellow color, more fluid intake is necessary.

### *Increasing Activity Tolerance*

The nurse plans the patient's activities so that they occur in cycles, alternating rest with activity periods. This benefits the patient's physiologic status, and it helps teach the patient about the need for planned cycles of rest and activity. For example, after taking a bath or shower, the patient should plan to sit and read a newspaper or engage in other relaxing activities. Suggesting that the patient sit while chopping vegetables, drying his or her hair, or shaving helps the patient learn to balance rest with activity. The nurse also makes sure that the patient recognizes the symptoms indicating the need for rest and actions to take when the symptoms occur. Patients with HCM or RCM must avoid strenuous activity, isometric exercises, and competitive sports.

### *Reducing Anxiety*

Spiritual, psychological, and emotional support may be indicated for patients, families, and significant others. Interventions are directed toward eradicating or alleviating

perceived stressors. Patients receive appropriate information about cardiomyopathy and self-management activities. It is important to provide an atmosphere in which patients feel free to verbalize concerns and receive assurance that their concerns are legitimate. If the patient is awaiting transplantation or facing death, it is necessary to allow time to discuss these issues. Providing the patient with realistic hope helps reduce anxiety while he or she awaits a donor heart. The nurse helps the patient, family, and significant others with anticipatory grieving.

#### *Decreasing the Sense of Powerlessness*

Patients often go through a grieving process when cardiomyopathy is diagnosed. The patient is assisted in identifying the things in life that he or she has lost (eg, foods that the patient enjoyed eating but are high in sodium, the ability to engage in an active lifestyle, the ability to play sports, the ability to lift grandchildren) and his or her emotional responses to the loss (eg, anger, depression). The nurse assists the patient in identifying the amount of control that he or she still has over life, such as making food choices, managing medications, and working with health care providers to achieve the best possible outcomes. A diary in which the patient records food selections and weight may help with understanding the relationship between sodium intake and weight gain. Some patients can manage a self-titrating diuretic regimen in which they adjust the dose of diuretic to their symptoms.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** A key part of the plan of nursing care involves teaching patients about the medication regimen, symptom monitoring, and symptom management. The nurse plays an integral role as the patient learns to balance lifestyle and work while accomplishing therapeutic activities. Helping patients cope with their disease status helps them adjust their lifestyles and implement a self-care program at home. Attainment of a goal, no matter how small, also promotes the patient's sense of well-being.

**CONTINUING CARE.** The nurse reinforces previous teaching and performs ongoing assessment of the patient's symptoms and progress. The nurse also assists the patient and family to adjust to lifestyle changes. Patients are taught to read nutrition labels, to maintain a record of daily weights and symptoms, and to organize daily activities to increase activity tolerance. In addition, the nurse assesses the patient's response to recommendations about diet and fluid intake and to the medication regimen and stresses the signs and symptoms that should be reported to the physician. Because of the risk of dysrhythmia, it may be necessary to teach the patient's family cardiopulmonary resuscitation. Women are often advised to avoid pregnancy, but each case is assessed individually. The nurse assesses the psychosocial needs of the patient and family on an ongoing basis. There may be concerns and fears about the prognosis, changes in lifestyle, effects of medications, and the possibility of others in the family having the same condition; these often increase the patient's anxiety and interfere with effective coping strategies. Establishing trust is vital to the nurse's relationship with these chronically ill patients and their families. This is particularly significant when the nurse is involved with a patient and family in discussions about end-of-life decisions. Patients who have significant symptoms of heart failure or other complications of cardiomyopathy may benefit from a home care referral.

### Evaluation

#### *Expected Patient Outcomes*

1. Maintains or improves cardiac function
   a. Exhibits heart and respiratory rates within normal limits
   b. Reports decreased dyspnea and increased comfort; maintains or improves gas exchange
   c. Reports no weight gain; appropriate weight for height
   d. Maintains or improves peripheral blood flow
2. Maintains or increases activity tolerance
   a. Carries out activities of daily living (eg, brushes teeth, feeds self)
   b. Reports increased tolerance to activity
3. Is less anxious
   a. Discusses prognosis freely
   b. Verbalizes fears and concerns
   c. Participates in support groups if appropriate
4. Decreases sense of powerlessness
   a. Identifies emotional response to diagnosis
   b. Discusses control that he or she has
5. Adheres to self-care program
   a. Takes medications according to prescribed schedule
   b. Modifies diet to accommodate sodium and fluid recommendations
   c. Modifies lifestyle to accommodate activity and rest behavior recommendations
   d. Identifies signs and symptoms to be reported to health care professionals

# INFECTIOUS DISEASES OF THE HEART

Any of the heart's three layers may be affected by an infectious process. The infections are named for the layer of the heart most involved in the infectious process: infective endocarditis (endocardium), myocarditis (myocardium), and pericarditis (pericardium). Rheumatic endocarditis is a unique infective endocarditis syndrome. The diagnosis of infection is made primarily on the basis of the patient's symptoms and echocardiography. The ideal management for all infectious diseases is prevention. IV antibiotics are usually necessary once an infection has developed in the heart.

## *Rheumatic Endocarditis*

Acute rheumatic fever, which occurs most often in school-age children, may develop after an episode of group A beta-hemolytic streptococcal pharyngitis (Chart 29-2). Patients with rheumatic fever may develop rheumatic heart disease

**Chart 29-2 • *Rheumatic Fever***

Rheumatic fever is a preventable disease. Diagnosing and treating streptococcal pharyngitis can prevent rheumatic fever and, therefore, rheumatic heart disease. Signs and symptoms of streptococcal pharyngitis include:

- Fever (38.9°C to 40°C [101°F to 104°F])
- Chills
- Sore throat (sudden in onset)
- Diffuse redness of throat with exudate on oropharynx (may not appear until after the first day)
- Enlarged and tender lymph nodes
- Abdominal pain (more common in children)
- Acute sinusitis and acute otitis media (may cause or result from streptococcal pharyngitis)

If signs and symptoms of streptococcal pharyngitis are present, a throat culture is necessary to make an accurate diagnosis. All patients with throat cultures positive for streptococcal pharyngitis must adhere to the prescribed antibiotic treatment. Penicillin is the most common antibiotic prescribed. Completing the course of prescribed antibiotics minimizes the risk of developing rheumatic fever (and subsequent rheumatic heart disease).

**CHART 29-3 *Risk Factors for Infective Endocarditis***

- Prosthetic cardiac valves or prosthetic material used for cardiac valve repair
- History of bacterial endocarditis (even without heart disease)
- Congenital heart disease
- Unrepaired cyanotic congenital heart disease, including patients with palliative shunts and conduits
- Repaired congenital heart disease with prosthetic material or device either by surgery or catheter intervention during the first 6 months after the procedure
- Repaired congenital heart disease with residual defects at the site or adjacent to the site of a prosthetic patch or device
- Cardiac transplant recipients with valvulopathy

Adapted from Wilson, W., Taubert, K. A., Gewitz, M., et al. (2007). The American Heart Association guideline: Prevention of infective endocarditis. *Circulation, 116*(15), 1736–1754.

as evidenced by a new heart murmur, cardiomegaly, pericarditis, and heart failure. Prompt treatment of "strep" throat with antibiotics can prevent the development of rheumatic fever. The streptococcus is spread by direct contact with oral or respiratory secretions. Although the bacteria are the causative agents, malnutrition, overcrowding, poor hygiene, and lower socioeconomic status may predispose individuals to rheumatic fever (Lutwick & Ravishankar, 2006; Moser & Reigel, 2008). The incidence of rheumatic fever in the United States and other developed countries generally has decreased, but the exact incidence is difficult to determine because the infection may go unrecognized, and people may not seek treatment (Lutwick & Ravishankar, 2006; Libby, et al., 2008). Clinical diagnostic criteria are not standardized, and autopsies are not routinely performed. Further information about rheumatic fever and rheumatic endocarditis can be found in pediatric nursing books.

## Infective Endocarditis

Infective endocarditis is a microbial infection of the endothelial surface of the heart. It usually develops in people with prosthetic heart valves or structural cardiac defects (eg, valve disorders, HCM) (Chart 29-3). It is more common in older people, who are more likely to have degenerative or calcific valve lesions, reduced immunologic response to infection, and the metabolic alterations associated with aging. Staphylococcal endocarditis infections of the valves in the right side of the heart are common among IV injection drug users (Libby, et al., 2008; Moser & Reigel, 2008). Hospital-acquired infective endocarditis occurs most often in patients with debilitating disease or indwelling catheters and in patients who are receiving hemodialysis or prolonged IV fluid or antibiotic therapy. Patients taking immunosuppressive medications or corticosteroids are more susceptible to fungal endocarditis.

Invasive procedures, particularly those involving mucosal surfaces, can cause a bacteremia, which rarely lasts for more than 15 minutes. However, if a patient has any anatomic cardiac defects, bacteremia can cause bacterial endocarditis. From 1950 to the mid-1980s, the incidence of infective endocarditis remained steady at about 3.6 cases per 100,000 patients. The incidence then increased, partially attributed to increased IV injection drug abuse and body piercing, especially oral, nasal, and nipple piercings (Libby, et al., 2008; Moser & Reigel, 2008).

### Pathophysiology

A deformity or injury of the endocardium leads to accumulation on the endocardium of fibrin and platelets (clot formation). Infectious organisms, usually staphylococci, streptococci, enterococci, pneumococci, or chlamydia, invade the clot and endocardial lesion. Other causative micro-organisms include fungi (eg, *Candida, Aspergillus*) and Rickettsiae. The infection most frequently results in platelets, fibrin, blood cells, and microorganisms that cluster as vegetations on the endocardium. The vegetations may embolize to other tissues throughout the body. As the clot on the endocardium continues to expand, the infecting organism is covered by the new clot and concealed from the body's normal defenses. The infection may erode through the endocardium into the underlying structures (eg, valve leaflets), causing tears or other deformities of valve leaflets, dehiscence of prosthetic valves, deformity of the chordae tendineae, or mural abscesses.

Usually the onset of infective endocarditis is insidious. The signs and symptoms develop from the toxic effect of the infection, from destruction of the heart valves, and from embolization of fragments of vegetative growths on the heart. Systemic emboli occur with left-sided heart infective endocarditis; pulmonary emboli occur with right-sided heart infective endocarditis (Libby, et al., 2008; Moser & Reigel, 2008).

## Clinical Manifestations

The primary presenting symptoms of infective endocarditis are fever and a heart murmur. The fever may be intermittent or absent, especially in patients who are receiving antibiotics or corticosteroids, in those who are elderly, or those who have heart failure or renal failure. A heart murmur may be absent initially but develops in almost all patients. Murmurs that worsen over time indicate progressive damage from vegetations or perforation of the valve or the chordae tendineae.

In addition to the fever and heart murmur, clusters of petechiae may be found on the body. Small, painful nodules (Osler nodes) may be present in the pads of fingers or toes. Irregular, red or purple, painless, flat macules (Janeway lesions) may be present on the palms, fingers, hands, soles, and toes. Hemorrhages with pale centers (Roth spots) caused by emboli may be observed in the fundi of the eyes. Splinter hemorrhages (ie, reddish-brown lines and streaks) may be seen under the fingernails and toenails, and petechiae may appear in the conjunctiva and mucous membranes. Cardiomegaly, heart failure, tachycardia, or splenomegaly may occur.

Central nervous system manifestations of infective endocarditis include headache; temporary or transient cerebral ischemia; and strokes, which may be caused by emboli to the cerebral arteries. Embolization may be a presenting symptom, and it may occur at any time and may involve other organ systems. Embolic phenomena may occur, as discussed in the previous section on rheumatic endocarditis.

Heart failure, which may result from perforation of a valve leaflet, rupture of chordae, blood flow obstruction due to vegetations, or intracardiac shunts from dehiscence of prosthetic valves, indicates a poor prognosis with medical therapy alone and a higher surgical risk (Libby, et al., 2008). Valvular stenosis or regurgitation, myocardial damage, and mycotic (fungal) aneurysms are potential cardiac complications. First-degree, second-degree, and third-degree atrioventricular blocks may occur and are often a sign of a valve ring abscess. Emboli, immunologic responses, abscess of the spleen, mycotic aneurysms, cerebritis, and hemodynamic deterioration may cause complications in other organs.

## Assessment and Diagnostic Findings

Although the previously described characteristics may indicate infective endocarditis, the signs and symptoms may indicate other diseases as well. Vague complaints of malaise, anorexia, weight loss, cough, and back and joint pain may be mistaken for influenza. The virulence of the causative organism usually correlates with the speed and degree of symptom development. A definitive diagnosis is made when a micro-organism is found in two separate blood cultures, in a vegetation, or in an abscess. Three sets of blood cultures (with each set including one aerobic and one anaerobic culture) drawn over a 24-hour period (or every 30 minutes if the patient's condition is unstable) should be obtained before administration of any antimicrobial agents. Negative blood cultures do not definitely rule out infective endocarditis. Patients may have elevated white blood cell (WBC) counts. In addition, patients may be anemic and have a positive rheumatoid factor and an elevated erythrocyte sedimentation rate (ESR) or C-reactive protein. Microscopic hematuria may be present on urinalysis.

Doppler echocardiography may assist in the diagnosis by demonstrating a mass on the valve, prosthetic valve, or supporting structures and by identifying vegetations, abscesses, new prosthetic valve dehiscence, or new regurgitation (Fuster, et al., 2008; Libby, et al., 2008; Moser & Reigel, 2008). The echocardiogram may reveal the development of heart failure. TEE may provide better data than transthoracic imaging.

## Prevention

Although rare, bacterial endocarditis may be life-threatening. A key strategy is primary prevention in high-risk patients (eg, those with previous infective endocarditis, prosthetic heart valves). Antibiotic prophylaxis is recommended for high-risk patients immediately before and sometimes after the following procedures (Nishimura, Carabello, Faxon, et al., 2008; Wilson, et al., 2007):

- Dental procedures that involve manipulation of gingival tissue or the periapical area of the teeth or perforation of the oral mucosa (except routine anesthetic injections through noninfected tissue, placement of orthodontic brackets, loss of deciduous teeth, bleeding from trauma to the lips or oral mucosa, dental x-rays, adjustment of orthodontic appliances, and placement of removable prosthodontic or orthodontic appliances)
- Tonsillectomy or adenoidectomy
- Surgical procedures that involve respiratory mucosa
- Bronchoscopy with biopsy or incision of respiratory tract mucosa
- Cystoscopy or urinary tract manipulation for patients with enterococcal urinary tract infections or colonization
- Surgery involving infected skin or musculoskeletal tissue

The type of antibiotic used for prophylaxis varies with the type of procedure and the degree of risk. Patients are usually instructed to take 2 g of amoxicillin (Amoxil) orally 1 hour before the procedure. If patients are allergic to penicillin, clindamycin (Cleocin), cephalexin (Keflex), cefazolin (Ancef, Kefzol), ceftriaxone (Rocephin), azithromycin (Zithromax), or clarithromycin (Biaxin) may be used.

Equally important is ongoing good oral hygiene. Poor dental hygiene can lead to bacteremia, particularly in the setting of a dental procedure. The severity of oral inflammation and infection is a significant factor in the incidence and degree of bacteremia. Regular professional oral care combined with personal oral care may reduce the risk of bacteremia. Personal oral care includes using a soft toothbrush and toothpaste to brush the teeth, gums, tongue, and oral mucosa at least twice a day, as well as rinsing the mouth with an antiseptic mouthwash for 30 seconds intermittently between tooth brushing. Patients must be advised to avoid nail biting and to minimize outbreaks of acne and psoriasis. Female patients are advised not to use intrauterine devices (IUDs) and to avoid body piercing and branding.

Increased vigilance is also required in patients with IV catheters and during invasive procedures. To minimize the risk of infection, nurses must ensure meticulous hand hygiene, site preparation, and aseptic technique during insertion and maintenance procedures. All catheters, tubes,

drains, and other devices are removed as soon as they are no longer needed or no longer function.

## Medical Management

The objective of treatment is to eradicate the invading organism through adequate doses of an appropriate antimicrobial agent. Antibiotic therapy is usually administered parenterally in a continuous IV infusion for 2 to 6 weeks. Parenteral therapy is administered in doses that produce a high serum concentration for a significant period to ensure eradication of the dormant bacteria within the dense vegetations. This therapy is often delivered in the patient's home and is monitored by a home care nurse. Serum levels of the antibiotic are monitored. If there is insufficient bactericidal activity, increased dosages of the antibiotic are prescribed or a different antibiotic is used. Numerous antimicrobial regimens are in use, but penicillin is usually the medication of choice. Blood cultures are taken periodically to monitor the effect of therapy. In fungal endocarditis, an antifungal agent, such as amphotericin B (eg, Abelcet, Amphocin, Fungizone), is the usual treatment.

In addition, the patient's temperature is monitored at regular intervals because the course of the fever is one indication of the effectiveness of treatment. However, febrile reactions also may occur as a result of medication. After adequate antimicrobial therapy is initiated, the infective organism is usually eliminated. The patient should begin to feel better, regain an appetite, and have less fatigue. During this time, patients require psychosocial support because although they feel well, they may find themselves confined to the hospital or home with restrictive IV therapy.

## Surgical Management

Surgical intervention may be required if the infection does not respond to medications, the patient has a prosthetic heart valve endocarditis, has a vegetation larger than 1 cm, or develops complications such as a septal perforation. Surgical interventions include valve débridement or excision, débridement of vegetations, débridement and closure of an abscess, and closure of a fistula. Aortic or mitral valve débridement, excision, or replacement is required in patients who:

- Develop congestive heart failure despite adequate medical treatment
- Have more than one serious systemic embolic episode
- Develop a valve obstruction
- Develop a periannular (heart valve), myocardial, or aortic abscess
- Have uncontrolled infection, persistent or recurrent infection, or fungal endocarditis

Surgical valve replacement greatly improves the prognosis for patients with severe symptoms from damaged heart valves. The aortic valve may be best treated with an autograft, as previously described. Most patients who have prosthetic valve endocarditis (ie, infected valve replacements) require valve replacement.

## Nursing Management

The nurse monitors the patient's temperature. The patient may have a fever for weeks. Heart sounds are assessed. A new or worsening murmur may indicate dehiscence of a prosthetic valve, rupture of an abscess, or injury to valve leaflets or chordae tendineae. The nurse monitors for signs and symptoms of systemic embolization, or, for patients with right-sided heart endocarditis, for signs and symptoms of pulmonary infarction and infiltrates. In addition, the nurse assesses signs and symptoms of organ damage such as stroke (ie, cerebrovascular accident or brain attack), meningitis, heart failure, myocardial infarction, glomerulonephritis, and splenomegaly.

Patient care is directed toward management of infection. Long-term IV antimicrobial therapy is often necessary; therefore, many patients have peripherally inserted central catheters or other long-term IV access. All invasive lines and wounds must be assessed daily for redness, tenderness, warmth, swelling, drainage, or other signs of infection. The patient and family are instructed about activity restrictions, medications, and signs and symptoms of infection. Patients with infective endocarditis are at high risk for another episode of infectious endocarditis. The nurse emphasizes the antibiotic prophylaxis previously described. If the patient has undergone surgical treatment, the nurse provides postoperative care and instructions.

As appropriate, the home care nurse supervises and monitors IV antibiotic therapy delivered in the home setting and educates the patient and family about prevention and health promotion. The nurse provides the patient and family with emotional support and facilitates coping strategies during the prolonged course of the infection and antibiotic treatment.

# *Myocarditis*

Myocarditis, an inflammatory process involving the myocardium, can cause heart dilation, thrombi on the heart wall (mural thrombi), infiltration of circulating blood cells around the coronary vessels and between the muscle fibers, and degeneration of the muscle fibers themselves. Mortality varies with the severity of symptoms. Most patients with mild symptoms recover completely, but some patients develop cardiomyopathy and heart failure.

## Pathophysiology

Myocarditis usually results from viral (eg, coxsackievirus A and B, human immunodeficiency virus [HIV], influenza A), bacterial, rickettsial, fungal, parasitic, metazoal, protozoal (eg, Chagas disease), or spirochetal infection. It also may be immune related, occurring after acute systemic infections such as rheumatic fever. It may develop in patients receiving immunosuppressive therapy or those with infective endocarditis, Crohn disease, or systemic lupus erythematosus.

Myocarditis may result from an inflammatory reaction to toxins such as pharmacologic agents used in the treatment of other diseases (eg, anthracyclines for cancer therapy), ethanol, or radiation (especially to the left chest or upper back). It may begin in one small area of the myocardium and then spread throughout the myocardium. The degree of myocardial inflammation and necrosis determines the degree of interstitial collagen and elastin destruction. The greater the destruction, the greater the hemodynamic effect and resulting signs and symptoms. It is theorized that DCM

and HCM are latent manifestations of myocarditis (Ellis & Di Salvo, 2007; Libby, et al., 2008).

### Clinical Manifestations

The symptoms of acute myocarditis depend on the type of infection, the degree of myocardial damage, and the capacity of the myocardium to recover. Patients may be asymptomatic, with an infection that resolves on its own. However, they may develop mild to moderate symptoms and seek medical attention, often reporting fatigue and dyspnea, palpitations, and occasional discomfort in the chest and upper abdomen. The most common symptoms are flulike. Patients may also sustain sudden cardiac death or quickly develop severe congestive heart failure.

### Assessment and Diagnostic Findings

Assessment of the patient may reveal no detectable abnormalities; as a result, the entire illness can go undiagnosed. Patients may be tachycardic or may report chest pain (with a subsequent cardiac catheterization demonstrating normal coronary arteries). Cardiac MRI with contrast may be diagnostic and can guide clinicians to sites for endocardial biopsies, which may be diagnostic for an organism or its genome, immune process, or a radiation reaction causing the myocarditis. Patients without any abnormal heart structure (at least initially) may suddenly develop dysrhythmias or ST–T-wave changes. If the patient has structural heart abnormalities (eg, systolic dysfunction), a clinical assessment may disclose cardiac enlargement, faint heart sounds (especially $S_1$), a gallop rhythm, or a systolic murmur. The WBC count and ESR may be elevated.

### Prevention

Prevention of infectious diseases by means of appropriate immunizations (eg, influenza, hepatitis) and early treatment appears to be important in decreasing the incidence of myocarditis (Libby, et al., 2008).

### Medical Management

Patients are given specific treatment for the underlying cause if it is known (eg, penicillin for hemolytic streptococci) and are placed on bed rest to decrease cardiac workload. Bed rest also helps decrease myocardial damage and the complications of myocarditis. In young patients with myocarditis, activities, especially athletics, should be limited for a 6-month period or at least until heart size and function have returned to normal. Physical activity is increased slowly, and the patient is instructed to report any symptoms that occur with increasing activity, such as a rapidly beating heart. If heart failure or dysrhythmia develops, management is essentially the same as for all causes of heart failure and dysrhythmias (see Chapters 27 and 30), except that beta-blockers are avoided because they decrease the strength of ventricular contraction (have a negative inotropic effect).

### Nursing Management

The nurse assesses for resolution of tachycardia, fever, and any other clinical manifestations. The cardiovascular assessment focuses on signs and symptoms of heart failure and dysrhythmias. Patients with dysrhythmias should have continuous cardiac monitoring with personnel and equipment readily available to treat life-threatening dysrhythmias.

*NURSING ALERT*

**Patients with myocarditis are sensitive to digitalis. Nurses must closely monitor these patients for digitalis toxicity, which is evidenced by dysrhythmia, anorexia, nausea, vomiting, headache, and malaise.**

Anti-embolism stockings and passive and active exercises should be used because embolization from venous thrombosis and mural thrombi can occur, especially in patients on bed rest.

## Pericarditis

Pericarditis refers to an inflammation of the pericardium, the membranous sac enveloping the heart. It may be a primary illness or it may develop during various medical and surgical disorders. For example, pericarditis may occur after pericardectomy (opening of the pericardium) following cardiac surgery. Pericarditis also may occur 10 days to 2 months after acute myocardial infarction (Dressler syndrome). Pericarditis may be subacute, acute, or chronic. It is classified either as adhesive (constrictive), because the layers of the pericardium become attached to each other and restrict ventricular filling, or by what accumulates in the pericardial sac: serous (serum), purulent (pus), calcific (calcium deposits), fibrinous (clotting proteins), or sanguinous (blood). Pericarditis also may be described as exudative or noneffusive.

### Pathophysiology

Causes underlying or associated with pericarditis are listed in Chart 29-4. The inflammatory process of pericarditis may lead to an accumulation of fluid in the pericardial sac (pericardial

**Chart 29-4 • *Causes of Pericarditis***

- Idiopathic or nonspecific causes
- Infection: usually viral (eg, human immunodeficiency virus, coxsackievirus, influenza); rarely bacterial (eg, streptococci, staphylococci, meningococci, gonococci, gram-negative rods); and mycotic (fungal)
- Disorders of connective tissue: systemic lupus erythematosus, rheumatic fever, rheumatoid arthritis, polyarteritis, scleroderma
- Hypersensitivity states: immune reactions, medication reactions, serum sickness
- Disorders of adjacent structures: myocardial infarction, dissecting aneurysm, pleural and pulmonary disease (pneumonia)
- Neoplastic disease: caused by metastasis from lung cancer or breast cancer, leukemia, and primary (mesothelioma) neoplasms
- Radiation therapy of chest and upper torso (peak occurrence 5–9 months after treatment)
- Trauma: chest injury, cardiac surgery, cardiac catheterization, implantation of pacemaker or implantable cardioverter defibrillator (ICD)
- Renal failure and uremia
- Tuberculosis

effusion) and increased pressure on the heart, leading to cardiac tamponade (see Chapter 30). Frequent or prolonged episodes of pericarditis may also lead to thickening and decreased elasticity of the pericardium, or scarring may fuse the visceral and parietal pericardium. These conditions restrict the heart's ability to fill with blood (constrictive pericarditis). The pericardium may become calcified, further restricting ventricular expansion during ventricular filling (diastole). With less filling, the ventricles pump less blood, leading to decreased cardiac output and signs and symptoms of heart failure. Restricted diastolic filling may result in increased systemic venous pressure, causing peripheral edema and hepatic failure.

## Clinical Manifestations

Pericarditis may be asymptomatic. The most characteristic symptom of pericarditis is chest pain, although pain also may be located beneath the clavicle, in the neck, or in the left trapezius (scapula) region. The pain or discomfort usually remains fairly constant, but it may worsen with deep inspiration and when lying down or turning. It may be relieved with a forward-leaning or sitting position. The most characteristic sign of pericarditis is a creaky or scratchy friction rub heard most clearly at the left lower sternal border. Other signs may include a mild fever, increased WBC count, anemia, and an elevated ESR or C-reactive protein level. Patients may have a nonproductive cough or hiccough. Dyspnea and other signs and symptoms of heart failure may occur as the result of pericardial compression due to constrictive pericarditis or cardiac tamponade.

## Assessment and Diagnostic Findings

The diagnosis is most often made on the basis of the history, signs, and symptoms. An echocardiogram may detect inflammation, pericardial effusion or tamponade, and heart failure. It may help confirm the diagnosis and may be used to guide pericardiocentesis (needle or catheter drainage of the pericardium). TEE may be useful in diagnosis but may underestimate the extent of pericardial effusions. Computed tomography (CT) may be the best diagnostic tool for determining the size, shape, and location of pericardial effusions and may be used to guide pericardiocentesis. MRI may assist with detection of inflammation and adhesions. Occasionally a video-assisted pericardioscope-guided biopsy of the pericardium or epicardium is performed to obtain tissue samples for culture and microscopic examination. Because the pericardial sac surrounds the heart, a 12-lead ECG may show concave ST elevations in many, if not all, leads (with no reciprocal changes) and may show depressed PR segments or atrial dysrhythmias.

## Medical Management

The objectives of management of pericarditis are to determine the cause, administer therapy for treatment and symptom relief, and detect signs and symptoms of cardiac tamponade. When cardiac output is impaired, the patient is placed on bed rest until the fever, chest pain, and friction rub have subsided.

Analgesics and nonsteroidal anti-inflammatory drugs (NSAIDs) such as aspirin or ibuprofen (Motrin) may be prescribed for pain relief during the acute phase. These agents also hasten the reabsorption of fluid in patients with rheumatic pericarditis. Indomethacin (Indocin) is contraindicated because it may decrease coronary blood flow. Corticosteroids (eg, prednisone) may be prescribed if the pericarditis is severe or if the patient does not respond to NSAIDs. Colchicine may also be used as alternative therapy.

Pericardiocentesis, a procedure in which some of the pericardial fluid is removed, is rarely necessary. It may be performed to assist in the identification of the cause or relieve symptoms, especially if there are signs and symptoms of heart failure or tamponade. Pericardial fluid is cultured if bacterial, tubercular, or fungal disease is suspected, and a sample is sent for cytology if neoplastic disease is suspected. A pericardial window, a small opening made in the pericardium, may be performed to allow continuous drainage into the chest cavity. Surgical removal of the tough encasing pericardium (pericardiectomy) may be necessary to release both ventricles from the constrictive and restrictive inflammation and scarring.

## Nursing Management

Patients with acute pericarditis require pain management with analgesics, positioning, and psychological support. Patients with chest pain often benefit from education and reassurance that the pain is not due to a heart attack. To minimize complications, the nurse helps the patient with activity restrictions until the pain and fever subside. As the patient's condition improves, the nurse encourages gradual increases of activity. However, if pain, fever, or friction rub reappear, activity restrictions must be resumed. The nurse educates the patient and family about a healthy lifestyle to enhance the patient's immune system.

Nurses caring for patients with pericarditis must be alert to cardiac tamponade (see Chapter 30). The nurse monitors the patient for heart failure. Patients with hemodynamic instability or pulmonary congestion are treated as they would be if they had heart failure (see Chapter 30).

## NURSING PROCESS

### The Patient With Pericarditis

#### Assessment

The primary symptom of the patient with pericarditis is pain, which is assessed by evaluating the patient in various positions. The nurse tries to identify whether the pain is influenced by respiratory movements, while holding an inhaled breath or holding an exhaled breath; by flexion, extension, or rotation of the spine, including the neck; by movements of the shoulders and arms; by coughing; or by swallowing. Recognizing the events that precipitate or intensify pain may help establish a diagnosis and differentiate the pain of pericarditis from the pain of myocardial infarction.

A pericardial friction rub occurs when the pericardial surfaces lose their lubricating fluid because of inflammation. The rub is audible on auscultation and is synchronous with

the heartbeat. However, it may be elusive and difficult to detect.

**NURSING ALERT**

**A pericardial friction rub is diagnostic of pericarditis. It has a creaky or scratchy sound and is louder at the end of exhalation. Nurses should monitor for the pericardial friction rub by placing the diaphragm of the stethoscope tightly against the thorax and auscultating the left sternal edge in the fourth intercostal space, the site where the pericardium comes into contact with the left chest wall. The rub may be heard best when a patient is sitting and leaning forward.**

If there is difficulty in distinguishing a pericardial friction rub from a pleural friction rub, the patient is asked to hold his or her breath; a pericardial friction rub will continue.

The patient's temperature is monitored frequently. Pericarditis may cause an abrupt onset of fever in a patient who has been afebrile.

## Diagnosis

### *Nursing Diagnosis*

Based on the assessment data, the major nursing diagnosis may be acute pain related to inflammation of the pericardium.

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include:

- Pericardial effusion
- Cardiac tamponade

## Planning and Goals

The patient's major goals may include relief of pain and absence of complications.

## Nursing Interventions

### *Relieving Pain*

Relief of pain is achieved by rest. Because sitting upright and leaning forward is the posture that tends to relieve pain, chair rest may be more comfortable. It is important to instruct the patient to restrict activity until the pain subsides. As the chest pain and friction rub abate, activities of daily living may be resumed gradually. If the patient is taking analgesics, antibiotics, or corticosteroids for the pericarditis, his or her responses are monitored and recorded. Patients taking NSAIDs are assessed for gastrointestinal adverse effects. If chest pain and friction rub recur, bed rest or chair rest is resumed.

### *Monitoring and Managing Potential Complications*

PERICARDIAL EFFUSION. Fluid may accumulate between the pericardial linings (ie, in the pericardial sac), a condition called pericardial effusion (see Chapter 30). Most patients have no effects or symptoms. However, enough fluid can accumulate to constrict the myocardium, impairing ventricular filling and the myocardium's ability to pump, a condition known as cardiac tamponade (discussed below). Failure to identify and treat this problem can lead to death.

CARDIAC TAMPONADE. The signs and symptoms of cardiac tamponade may begin with the patient reporting shortness of breath, chest tightness, or dizziness. The nurse may observe that the patient is becoming progressively more restless. Assessment of blood pressure may reveal a decrease of 10 mm Hg or more in the systolic blood pressure during inspiration (pulsus paradoxus). Usually, the systolic pressure decreases and the diastolic pressure remains stable; hence, the pulse pressure narrows. The patient usually has tachycardia, and the ECG voltage may be decreased or the QRS complexes may alternate in height (electrical alternans). Heart sounds may progress from distant to imperceptible. Blood continues to return to the heart from the periphery but cannot flow into the heart to be pumped back into the circulation. The patient develops neck vein distention and other signs of rising central venous pressure.

In such situations, the nurse notifies the physician immediately and prepares to assist with diagnostic echocardiography and pericardiocentesis (see Chapter 30). The nurse stays with the patient and continues to assess and record signs and symptoms while intervening to decrease patient anxiety.

### *Promoting Home and Community-Based Care*

Because patients, their family members, and their health care providers tend to focus on the most obvious needs and issues related to pericarditis, the nurse reminds them about the importance of continuing health promotion and screening practices. The nurse educates patients who have not been involved in these practices in the past about their importance and refers them to appropriate health care providers.

## Evaluation

### *Expected Patient Outcomes*

1. Freedom from pain
   a. Performs activities of daily living without pain, fatigue, or shortness of breath
   b. Temperature returns to normal range
   c. Exhibits no pericardial friction rub
2. Absence of complications
   a. Sustains blood pressure in normal range
   b. Has heart sounds that are strong and can be auscultated
   c. Shows absence of neck vein distention

## CRITICAL THINKING EXERCISES

EBP **1** A 70-year-old woman experiences exertional dyspnea while training for the senior Olympics. She has been diagnosed with aortic stenosis, and a cardiologist has recommended an aortic valve replacement. However, the woman is reluctant to "go under the knife." Based on your knowledge of aortic stenosis, what would you discuss with the patient? What patient teaching would you provide?

On what evidence do you base your response? What is the strength of that evidence?

EBP **2** A 19-year-old man with dilated cardiomyopathy experiences ventricular dysrhythmias, for which he is hospitalized. A cardiologist has inserted an implantable cardioverter defibrillator (ICD) and has prescribed an ACE inhibitor. The patient tells you that he will not take any medications after he leaves the hospital because he believes that he is cured and that "drugs are bad for you." The cardiologist has also recommended consultation with a transplant physician for consideration of a heart transplant. The patient tells you that he "might consider it. It will depend on how bad the shocks are, assuming this thing ever gives me a shock." Based on your knowledge of the antidrug campaign in the United States, dilated cardiomyopathy, and the developmental tasks of 19-year-olds, how would you respond? On what evidence do you base your response? What is the strength of that evidence?

**3** A 35-year-old woman with atrial fibrillation is recovering from a mitral valvuloplasty for mitral regurgitation. The cardiologist prescribes warfarin (Coumadin). What are this patient's teaching and discharge planning needs? As you care for the patient, you learn that she is interested in having another child. What information would you provide to the patient regarding mitral valve repair, warfarin treatment, and pregnancy?

**4** You are caring for a 55-year-old man with infective endocarditis. The clinical assistant who has just obtained the patient's vital signs reports that he has both tachycardia and tachypnea. As you enter the room, you find a very anxious, restless patient. Describe the actions you would take and explain why. Which actions would take priority over other ones?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Heart Association, National Center, www.americanheart.org
Cardiomyopathy Association, www.cardiomyopathy.org
Heartmates, www.heartmates.com
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov



chapter 30

# Management of Patients With Complications From Heart Disease

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Describe the management of patients with heart failure (HF).

**2** Use the nursing process as a framework for care of patients with HF.

**3** Develop a teaching plan for patients with HF.

**4** Describe the management of patients with pulmonary edema.

**5** Describe the management of patients with thromboembolism, pericardial effusion, and sudden cardiac death.

## GLOSSARY

**acute decompensated heart failure:** acute exacerbation of heart failure, with signs and symptoms resulting in markedly lower systemic perfusion

**afterload:** the resistance to ejection of blood from a ventricle

**anuria:** urine output of less than 50 mL/24 h

**ascites:** an accumulation of serous fluid in the peritoneal cavity

**cardiac output (CO):** the amount of blood pumped out of the heart in 1 minute

**cardiac resynchronization therapy (CRT):** a treatment for heart failure in which a device paces both ventricles to synchronize contractions

**compliance:** the elasticity or amount of "give" when blood enters the ventricle

**congestive heart failure (CHF):** a fluid overload condition (congestion) associated with heart failure

**contractility:** the force of ventricular contraction; related to the number and state of myocardial cells

**diastolic heart failure:** the inability of the heart to pump sufficiently because of an alteration in the ability of the heart to fill; current term used to describe a type of heart failure

## GLOSSARY *(Continued)*

**ejection fraction (EF):** percentage of blood volume in the ventricles at the end of diastole that is ejected during systole; a measurement of contractility

**heart failure (HF):** the inability of the heart to pump sufficient blood to meet the needs of the tissues for oxygen and nutrients; signs and symptoms of pulmonary and systemic congestion may or may not be present

**left-sided heart failure (left ventricular failure):** inability of the left ventricle to fill or pump (empty) sufficient blood to meet the needs of the tissues for oxygen and nutrients; traditional term used to describe patient's symptoms of heart failure

**oliguria:** diminished urine output; less than 500 mL/24 h

**orthopnea:** shortness of breath when laying flat

**paroxysmal nocturnal dyspnea (PND):** shortness of breath that occurs suddenly during sleep

**pericardiocentesis:** procedure that involves aspiration of fluid from the pericardial sac

**pericardiotomy:** surgically created opening of the pericardium

**preload:** the amount of myocardial stretch just before systole caused by the volume of blood presented to the ventricle

**pulmonary edema:** abnormal accumulation of fluid in the interstitial spaces and alveoli of the lungs

**pulseless electrical activity (PEA):** condition in which electrical activity is present but there is not an adequate pulse or blood pressure

**pulsus paradoxus:** systolic blood pressure that is more than 10 mm Hg higher during exhalation than during inspiration; difference is normally less than 10 mm Hg

**right-sided heart failure (right ventricular failure):** inability of the right ventricle to fill or pump (empty) sufficient blood to the pulmonary circulation

**stroke volume (SV):** amount of blood pumped out of the ventricle with each contraction

**systolic heart failure:** inability of the heart to pump sufficiently because of an alteration in the ability of the heart to contract; current term used to describe a type of heart failure.

Today it is possible to help the patient with heart disease live longer and achieve a high quality of life. Advances in diagnostic procedures, treatments, technologies, and pharmacotherapies allow earlier and more accurate diagnoses and treatment that can begin well before significant debilitation occurs. However, heart disease remains a chronic and often progressive condition, and complications may develop. This chapter presents the complications most often resulting from heart diseases and the collaborative treatment options for these complications.

## Cardiac Hemodynamics

The basic function of the heart is to pump blood. The heart's ability to pump is measured by **cardiac output (CO),** the amount of blood pumped per minute. CO is determined by measuring the heart rate (HR) and multiplying it by the **stroke volume (SV),** the amount of blood pumped out of the ventricle with each contraction. CO usually is calculated using the equation CO = HR × SV.

The HR is primarily controlled by the autonomic nervous system. When SV decreases, the nervous system is stimulated to increase HR and thereby maintain adequate CO. SV depends on three factors: preload, afterload, and contractility (Fig. 30-1). Precise measurement of these factors requires hemodynamic monitoring.

**Preload** is the amount of blood presented to the ventricle just before systole. It increases pressure in the ventricle, which stretches the ventricular wall. Like a piece of elastic, the ventricular muscle fibers need to be stretched (by blood volume) to produce optimal recoil and forceful ejection of blood. Too little or too much muscle fiber stretch decreases the volume of blood ejected. The major factor that determines preload is venous return of blood to the heart, which creates the volume of blood that enters the ventricle during diastole. Another factor that determines preload is ventricular **compliance,** the elasticity or amount of "give" when blood enters the ventricle. Elasticity is decreased when the muscle thickens, as in hypertrophic cardiomyopathy (see Chapter 29) or when there is increased fibrotic tissue within the ventricle. Fibrotic tissue replaces dead myocardial cells, such as after a myocardial infarction (MI) (see Chapter 28). Fibrotic tissue has little compliance, making the ventricle stiff. Given the same volume of blood, a noncompliant ventricle has a higher intraventricular pressure than a compliant one. Higher pressure increases the workload of the heart and can lead to **heart failure (HF)** if it is sustained.

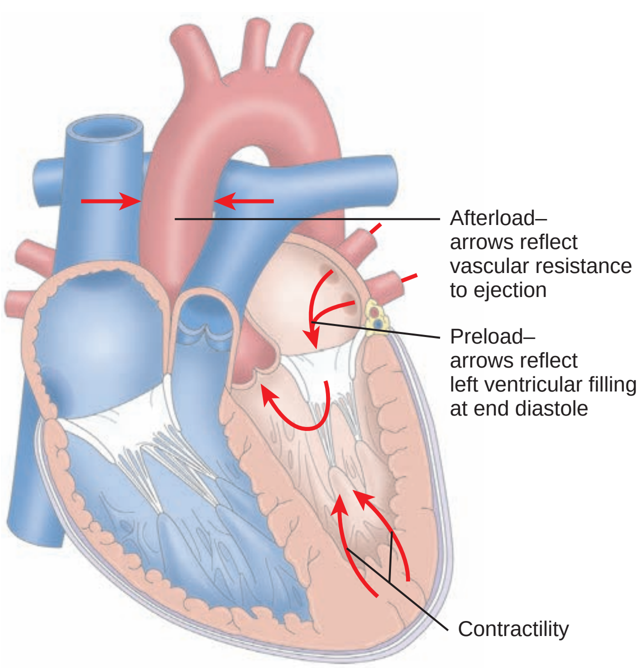



**Figure 30-1** The determinants of stroke volume (SV). The SV is determined by the amount of preload presented to the ventricle, the amount of afterload or resistance to ventricular ejection, and the strength of cardiac contractility. The cardiac output is the product of SV and heart rate. Redrawn from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

**Afterload** refers to the amount of resistance to the ejection of blood from the ventricle. To eject blood, the ventricle must overcome the resistance caused by tension in the aorta and systemic vessels. Afterload is inversely related to SV, and an increase in afterload causes the ventricle to work harder and may decrease the amount of blood ejected. The major factors that determine afterload are the diameter and distensibility of the great vessels (aorta and pulmonary artery) and the opening and competence of the semilunar valves (pulmonic and aortic valves). When the valves open easily, resistance is lower. If the patient has significant vasoconstriction, hypertension, or a narrowed valvular opening from stenosis, resistance (afterload) increases. When afterload increases, the workload of the heart must increase to overcome the resistance and eject blood.

**Contractility,** the force of contraction, is related to the status of the myocardium. Catecholamines, released by sympathetic stimulation during exercise or from administration of positive inotropic medications, can increase contractility and SV. MI causes necrosis and subsequent fibrosis of some myocardial cells, shifting the workload to the remaining cells. Significant loss of myocardial cells can decrease contractility and cause HF. Afterload can be reduced by medications to match the lower contractility and maintain adequate CO.

### Noninvasive Assessment of Cardiac Hemodynamics

There are several noninvasive assessment parameters that estimate preload, afterload, and contractility. Right ventricular preload may be estimated by measuring jugular venous distention (JVD). Mean arterial blood pressure is an approximate indicator of left ventricular afterload. Activity tolerance may be used as an indicator of overall cardiac functioning. Noninvasive assessments are described in more detail later in this chapter and in Chapter 26.

### Invasive Assessment of Cardiac Hemodynamics

A number of types of central venous catheters can be used to obtain more precise hemodynamic information. One important tool for evaluating the components of SV is the

pulmonary artery catheter, which is used to obtain the hemodynamic data essential for diagnosis and treatment (see Chapter 26). Measurements of intracardiac pressures, pulmonary artery pressures, and cardiac output are made at intervals. Therapy, especially intravenous (IV) medication, is adjusted based on the hemodynamic data. The patient with an invasive hemodynamic catheter is usually managed in an intensive care environment because of the need for frequent nursing assessments and interventions.

# HEART FAILURE

HF is the inability of the heart to pump sufficient blood to meet the needs of the tissues for oxygen and nutrients. In the past, HF was often referred to as **congestive heart failure (CHF),** because many patients experience pulmonary or peripheral congestion. Currently HF is recognized as a clinical syndrome characterized by signs and symptoms of fluid overload or of inadequate tissue perfusion. Fluid overload and decreased tissue perfusion result when the heart cannot generate a CO sufficient to meet the body's demands. The term HF indicates myocardial disease in which there is a problem with contraction of the heart (systolic dysfunction) or filling of the heart (diastolic dysfunction) that may or may not cause pulmonary or systemic congestion. Some cases of HF are reversible, depending on the cause. Most often, HF is a progressive, life-long condition that is managed with lifestyle changes and medications to prevent episodes of **acute decompensated heart failure**. These episodes are characterized by an increase in symptoms, decreased CO, and low perfusion (Varughese, 2007). They are associated with increased hospitalizations, increased health care costs, and decreased quality of life.

## *Chronic Heart Failure*

As with coronary artery disease, the incidence of HF increases with age. More than 5 million people in the United States have HF, and 550,000 new cases are diagnosed each year (American Heart Association [AHA], 2007). Although HF can affect people of all ages, it is most common in people older than 75 years of age; as the U.S. population ages, HF has become an epidemic that challenges the country's health care resources. HF is the most common reason for hospitalization of people older than 65 years of age and is the second most common reason for visits to a physician's office. The rate of emergency department visits and hospital readmissions for this condition remains very high. The estimated economic burden caused by HF is more than $33 billion annually in direct and indirect costs and is expected to increase (AHA, 2007).

The increase in the incidence of HF reflects not only the increased number of elderly people but also improvements in treatment of cardiac diseases such as MI, resulting in increased survival rates. Many hospitalizations for HF can be prevented by appropriate outpatient care. Prevention and early intervention to arrest the progression of HF are major health initiatives in the United States.

Two major types of HF are identified by assessment of left ventricular functioning, usually by echocardiogram. The more common type is an alteration in ventricular contraction called **systolic heart failure,** which is characterized by a weakened heart muscle. The less common type is **diastolic heart failure,** which is characterized by a stiff and noncompliant heart muscle, making it difficult for the ventricle to fill. An assessment of the **ejection fraction (EF)** is performed to assist in determining the type of HF. EF is calculated by subtracting the amount of blood present in the left ventricle at the end of systole from the amount present at the end of diastole and calculating the percentage of blood that is ejected. A normal EF is 55% to 65% of the ventricular volume; the ventricle does not completely empty between contractions. The EF is normal in diastolic HF but severely reduced in systolic HF.

Although a low EF is a hallmark of systolic HF, which is the most common type of HF, the severity of HF is frequently classified according to the patient's symptoms. The New York Heart Association (NYHA) Classification is described in Table 30-1. The American College of Cardiology and the American Heart Association (ACC/AHA) have developed another a HF classification system (Hunt, Abraham, Chin, et al., 2005). This system, described in Table 30-2, takes into consideration the natural history and progressive nature of HF. Treatment guidelines have been developed for each stage.

### Pathophysiology

HF results from a variety of cardiovascular conditions, including chronic hypertension, coronary artery disease, and valvular disease. These conditions can result in systolic failure, diastolic failure, or both. Significant myocardial dysfunction usually occurs before the patient experiences signs and symptoms of HF such as shortness of breath, edema, or fatigue.

**Table 30-1 NEW YORK HEART ASSOCIATION (NYHA) CLASSIFICATION OF HEART FAILURE**

| Classification | Signs and Symptoms | Prognosis |
|---|---|---|
| I | Ordinary physical activity does not cause undue fatigue, dyspnea, palpitations, or chest pain<br>No pulmonary congestion or peripheral hypotension<br>Patient is considered asymptomatic<br>Usually no limitations of activities of daily living (ADLs) | Good |
| II | Slight limitation on ADLs<br>Patient reports no symptoms at rest but increased physical activity will cause symptoms<br>Basilar crackles and $S_3$ murmur may be detected | Good |
| III | Marked limitation on ADL<br>Patient feels comfortable at rest but less than ordinary activity will cause symptoms | Fair |
| IV | Symptoms of cardiac insufficiency at rest | Poor |

**Table 30-2 AMERICAN COLLEGE OF CARDIOLOGY AND AMERICAN HEART ASSOCIATION (ACC/AHA) CLASSIFICATION OF HEART FAILURE**

| Classification | Criteria |
|---|---|
| Stage A | Patients at high risk for developing left ventricular dysfunction but without structural heart disease or symptoms of heart failure |
| Stage B | Patients with left ventricular dysfunction or structural heart disease who have not developed symptoms of heart failure |
| Stage C | Patients with left ventricular dysfunction or structural heart disease with current or prior symptoms of heart failure |
| Stage D | Patients with refractory end-stage heart failure requiring specialized interventions |

As HF develops, the body activates neurohormonal compensatory mechanisms. These mechanisms represent the body's attempt to cope with the HF and are responsible for the signs and symptoms that eventually develop. Understanding these mechanisms is important because the treatment of HF is aimed at opposing them and relieving symptoms.

Systolic HF results in decreased blood volume being ejected from the ventricle. The decreased ventricular stretch is sensed by baroreceptors in the aortic and carotid bodies. The sympathetic nervous system is then stimulated to release epinephrine and norepinephrine (Fig. 30-2) . The purpose of this initial response is to increase heart rate and contractility and support the failing myocardium, but the

## Physiology ■■■ Pathophysiology

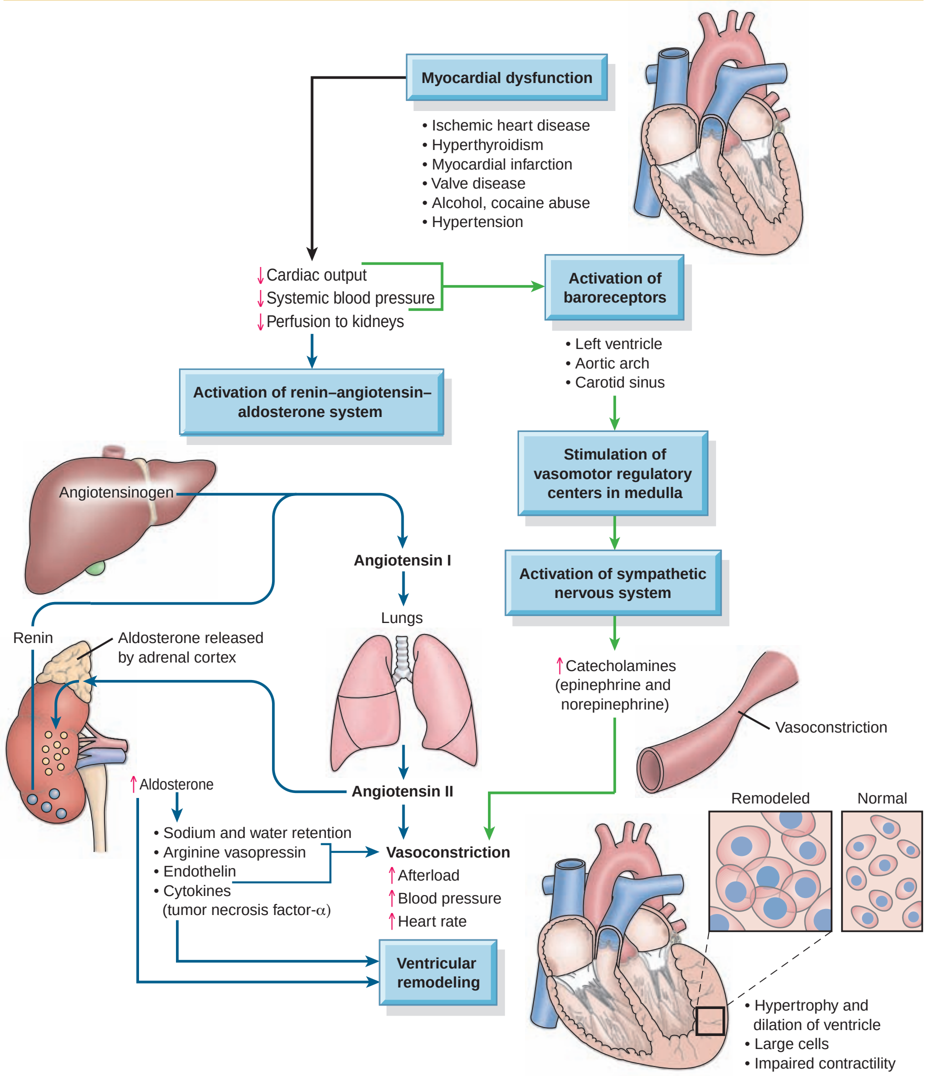



**Figure 30-2** The pathophysiology of heart failure. A decrease in cardiac output activates multiple neurohormonal mechanisms that ultimately result in the signs and symptoms of heart failure.

continued response has multiple negative effects. Sympathetic stimulation causes vasoconstriction in the skin, gastrointestinal tract, and kidneys. A decrease in renal perfusion due to low CO and vasoconstriction then causes the release of renin by the kidneys. Renin promotes the formation of angiotensin I, a benign, inactive substance. Angiotensin-converting enzyme (ACE) in the lumen of pulmonary blood vessels converts angiotensin I to angiotensin II, a potent vasoconstrictor, which then increases the blood pressure and afterload. Angiotensin II also stimulates the release of aldosterone from the adrenal cortex, resulting in sodium and fluid retention by the renal tubules and stimulation of antidiuretic hormone. These mechanisms lead to the fluid volume overload commonly seen in HF. Angiotensin, aldosterone, and other neurohormones (eg, endothelin, prostacyclin) lead to an increase in preload and afterload, which increases stress on the ventricular wall, causing an increase in the workload of the heart. A counterregulatory mechanism is attempted through the release of natriuretic peptides. Atrial natriuretic peptide (ANP) and B-type (ie, brain type) natriuretic peptide (BNP) are released from the overdistended cardiac chambers. These substances promote vasodilation and diuresis. However, their effect is usually not strong enough to overcome the negative effects of the other mechanisms.

As the heart's workload increases, contractility of the myocardial muscle fibers decreases. Decreased contractility results in an increase in end-diastolic blood volume in the ventricle, stretching the myocardial muscle fibers and increasing the size of the ventricle (ventricular dilation). The increased size of the ventricle further increases the stress on the ventricular wall, adding to the workload of the heart. One way the heart compensates for the increased workload is to increase the thickness of the heart muscle (ventricular hypertrophy). However, hypertrophy results in an abnormal proliferation of myocardial cells, a process known as ventricular remodeling. Under the influence of neurohormones (eg, angiotensin II), large myocardial cells are produced that are dysfunctional and die early, leaving the other normal myocardial cells to struggle to maintain CO. The compensatory mechanisms of HF have been called the "vicious cycle of HF" because the heart does not pump sufficient blood to the body, which causes the body to stimulate the heart to work harder; thus, the heart cannot respond and failure becomes worse.

Diastolic HF develops because of continued increased workload on the heart, which responds by increasing the number and size of myocardial cells (ie, ventricular hypertrophy and altered cellular functioning). These responses cause resistance to ventricular filling, which increases ventricular filling pressures despite a normal or reduced blood volume. Less blood in the ventricles causes decreased CO. The low CO and high ventricular filling pressures can cause the same neurohormonal responses as described for systolic HF.

## Etiology

Myocardial dysfunction is most often caused by coronary artery disease, cardiomyopathy, hypertension, or valvular disorders. Patients with diabetes mellitus are also at high risk for HF. Atherosclerosis of the coronary arteries is the primary cause of HF, and coronary artery disease is found in more than 60% of the patients with HF (Zipes, Libby & Bonow, 2005). Ischemia causes myocardial dysfunction because it deprives heart cells of oxygen and leads to acidosis from the accumulation of lactic acid. MI causes focal heart muscle necrosis, the death of myocardial cells, and a loss of contractility; the extent of the infarction correlates with the severity of HF. Revascularization of the coronary artery by a percutaneous coronary intervention (PCI) or by coronary artery bypass surgery (CABG) may improve myocardial oxygenation and ventricular function.

Cardiomyopathy is a disease of the myocardium. There are three types: dilated, hypertrophic, and restrictive (see Chapter 29). Dilated cardiomyopathy, the most common type of cardiomyopathy, causes diffuse cellular necrosis and fibrosis, leading to decreased contractility (systolic failure). Dilated cardiomyopathy can be idiopathic (unknown cause) or it can result from an inflammatory process, such as myocarditis, or from a cytotoxic agent, such as alcohol or doxorubicin (Adriamycin). Hypertrophic cardiomyopathy and restrictive cardiomyopathy lead to decreased distensibility and ventricular filling (diastolic failure). Usually, HF due to cardiomyopathy becomes chronic and progressive. However, cardiomyopathy and HF may resolve following removal of the causative agent, such as with the cessation of alcohol ingestion.

Systemic or pulmonary hypertension increases afterload (resistance to ejection), which increases the workload of the heart and leads to hypertrophy of myocardial muscle fibers. This can be considered a compensatory mechanism because it increases contractility. However, the hypertrophy may impair the heart's ability to fill properly during diastole, and the hypertrophied ventricle may eventually dilate and fail.

Valvular heart disease is also a cause of HF. The valves ensure that blood flows in one direction. With valvular dysfunction, blood has increasing difficulty moving forward, increasing pressure within the heart and increasing cardiac workload, leading to HF. Chapter 29 discusses the effects of valvular heart disease.

Several systemic conditions, including progressive renal failure and uncontrolled hypertension, contribute to the development and severity of HF (Varughese, 2007). Acute illness such as pneumonia with fever and hypoxia increase the metabolic rate and may precipitate HF. All of these conditions require an increase in CO to satisfy the systemic oxygen demand, and they stress the compromised myocardium. Cardiac dysrhythmias may cause HF or may be a result of HF; either way, the altered electrical stimulation impairs myocardial contraction and decreases the overall efficiency of myocardial function. Other factors, such as acidosis (respiratory or metabolic), electrolyte abnormalities, and antiarrhythmic medications, can worsen myocardial function.

## Clinical Manifestations

The clinical manifestations produced by the different types of HF (systolic, diastolic, or both) are similar (Chart 30-1) and therefore do not assist in differentiating the types of HF. The signs and symptoms of HF can be related to which ventricle is affected. **Left-sided heart failure (left ventricular failure)** causes different manifestations than **right-sided**

CHART 30-1

### *Assessing for Heart Failure*

Be alert for the following signs and symptoms:

**General**

- Fatigue
- Decreased activity tolerance
- Dependent edema
- Weight gain

**Cardiovascular**

- Third heart sound ($S_3$)
- Apical impulse enlarged with left lateral displacement
- Pallor and cyanosis
- Jugular venous distention (JVD)

**Respiratory**

- Dyspnea on exertion
- Pulmonary crackles that do not clear with cough
- Orthopnea
- Paroxysmal nocturnal dyspnea (PND)
- Cough on exertion or when supine

**Cerebrovascular**

- Unexplained confusion or altered mental status
- Lightheadedness

**Renal**

- Oliguria and decreased frequency during the day
- Nocturia

**Gastrointestinal**

- Anorexia and nausea
- Enlarged liver
- Ascites
- Hepatojugular reflux

**heart failure (right ventricular failure).** In chronic HF, patients may have signs and symptoms of both left and right ventricular failure.

### *Left-Sided Heart Failure*

Pulmonary congestion occurs when the left ventricle cannot effectively pump blood out of the ventricle into the aorta and the systemic circulation. The increased left ventricular end-diastolic blood volume increases the left ventricular end-diastolic pressure, which decreases blood flow from the left atrium into the left ventricle during diastole. The blood volume and pressure in the left atrium increases, which decreases blood flow from the pulmonary vessels. Pulmonary venous blood volume and pressure increase, forcing fluid from the pulmonary capillaries into the pulmonary tissues and alveoli, causing pulmonary interstitial edema and impaired gas exchange. The clinical manifestations of pulmonary congestion include dyspnea, cough, pulmonary crackles, and low oxygen saturation levels. An extra heart sound, the $S_3$, or "ventricular gallop," may be detected on auscultation. It is caused by a large volume of fluid entering the ventricle at the beginning of diastole.

Dyspnea, or shortness of breath, may be precipitated by minimal to moderate activity (dyspnea on exertion [DOE]); dyspnea also can occur at rest. The patient may report **orthopnea,** difficulty breathing when lying flat. Patients with orthopnea usually prefer not to lie flat. They may need pillows to prop themselves up in bed, or they may sit in a chair and even sleep sitting up. Some patients have sudden attacks of dyspnea at night, a condition known as **paroxysmal nocturnal dyspnea (PND).** Fluid that accumulates in the dependent extremities during the day may be reabsorbed into the circulating blood volume when the patient lies down. Because the impaired left ventricle cannot eject the increased circulating blood volume, the pressure in the pulmonary circulation increases, shifting fluid into the alveoli. The fluid-filled alveoli cannot exchange oxygen and carbon dioxide. Without sufficient oxygen, the patient experiences dyspnea and has difficulty sleeping.

The cough associated with left ventricular failure is initially dry and nonproductive. Most often, patients complain of a dry hacking cough that may be mislabeled as asthma or chronic obstructive pulmonary disease (COPD). The cough may become moist over time. Large quantities of frothy sputum, which is sometimes pink (blood-tinged), may be produced, usually indicating severe pulmonary congestion (pulmonary edema).

Adventitious breath sounds may be heard in various areas of the lungs. Usually, bibasilar crackles that do not clear with coughing are detected in the early phase of left ventricular failure. As the failure worsens and pulmonary congestion increases, crackles may be auscultated throughout all lung fields. At this point, oxygen saturation may decrease.

In addition to increased pulmonary pressures that cause decreased oxygenation, the amount of blood ejected from the left ventricle decreases. The dominant feature in HF is inadequate tissue perfusion. The diminished CO has widespread manifestations because not enough blood reaches all the tissues and organs (low perfusion) to provide the necessary oxygen. The decrease in SV can also lead to stimulation of the sympathetic nervous system, which further impedes perfusion to many organs.

A reduction in CO decreases blood flow to the kidneys, reducing urine output (**oliguria**). Renal perfusion pressure falls, which results in the release of renin from the kidney. Release of renin leads to aldosterone secretion and increased intravascular volume. However, when the patient is sleeping, the cardiac workload is decreased, improving renal perfusion, which in some patients leads to frequent urination at night (nocturia).

As HF progresses, decreased CO may cause other symptoms. Decreased gastrointestinal perfusion causes altered digestion. Decreased brain perfusion causes dizziness, lightheadedness, confusion, restlessness, and anxiety due to decreased oxygenation and blood flow. As anxiety increases, so does dyspnea, increasing anxiety and creating a vicious cycle. Stimulation of the sympathetic system also causes the peripheral blood vessels to constrict, so the skin appears pale or ashen and feels cool and clammy.

A decrease in SV causes the sympathetic nervous system to increase the HR (tachycardia), often causing the patient to complain of palpitations. The pulses become weak and thready. Without adequate CO, the body cannot respond to increased energy demands, and the patient becomes easily

fatigued and has decreased activity tolerance. Fatigue also results from the increased energy expended in breathing and the insomnia that results from respiratory distress, coughing, and nocturia.

### Right-Sided Heart Failure

When the right ventricle fails, congestion in the peripheral tissues and the viscera predominates. This occurs because the right side of the heart cannot eject blood and cannot accommodate all the blood that normally returns to it from the venous circulation. Increased venous pressure leads to JVD and increased capillary hydrostatic pressure throughout the venous system.

The systemic clinical manifestations include edema of the lower extremities (dependent edema), hepatomegaly (enlargement of the liver), **ascites** (accumulation of fluid in the peritoneal cavity), anorexia and nausea, and weakness and weight gain due to retention of fluid.

Edema usually affects the feet and ankles and worsens when the patient stands or sits for a long period. The edema decreases when the patient elevates the legs. The edema can gradually progress up the legs and thighs and eventually into the external genitalia and lower trunk. Edema in the abdomen, as evidenced by increased abdominal girth, may be the only edema present. Sacral edema is common in patients who are on bed rest, because the sacral area is dependent. Pitting edema, in which indentations in the skin remain after even slight compression with the fingertips (Fig. 30-3), is obvious only after retention of at least 4.5 kg (10 lb) of fluid (4.5 L).

Hepatomegaly and tenderness in the right upper quadrant of the abdomen result from venous engorgement of the liver. The increased pressure may interfere with the liver's ability to function (secondary liver dysfunction). As hepatic dysfunction progresses, increased pressure within the portal vessels may force fluid into the abdominal cavity, causing ascites. Ascites may increase pressure on the stomach and intestines and cause gastrointestinal distress. Hepatomegaly may also increase pressure on the diaphragm, causing respiratory distress.

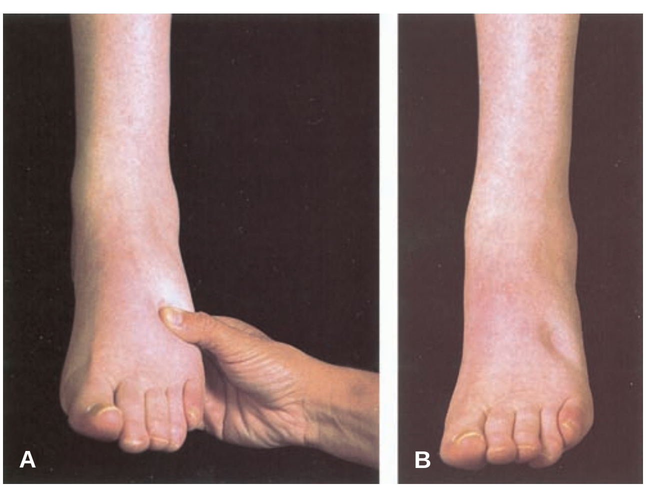



**Figure 30-3** Example of pitting edema. **A,** The nurse applies finger pressure to an area near the ankle. **B,** When the pressure is released, an indentation remains in the edematous tissue. From Bickley, L. S. (2007). *Bates' guide to physical examination and history taking* (9th ed.). Philadelphia: Lippincott Williams & Wilkins.

Anorexia (loss of appetite) and nausea or abdominal pain result from the venous engorgement and venous stasis within the abdominal organs. The weakness that accompanies right-sided HF results from reduced CO, impaired circulation, and inadequate removal of catabolic waste products from the tissues.

## Assessment and Diagnostic Findings

HF may go undetected until the patient presents with signs and symptoms of pulmonary and peripheral edema. However, the physical signs that suggest HF may also occur with other diseases, such as renal failure and COPD. Assessment of ventricular function is an essential part of the initial diagnostic workup.

An echocardiogram is usually performed to confirm the diagnosis of HF, identify the underlying cause, and determine the EF, which helps identify the type and severity of HF. This information may also be obtained noninvasively by radionuclide ventriculography or invasively by ventriculography as part of a cardiac catheterization procedure. A chest x-ray and an electrocardiogram (ECG) are obtained to assist in the diagnosis. Laboratory studies usually performed during the initial workup include serum electrolytes, blood urea nitrogen (BUN), creatinine, thyroid-stimulating hormone, complete blood cell count, BNP, and routine urinalysis. The BNP level is a key diagnostic indicator of HF; high levels are a sign of high cardiac filling pressure and can aid in the diagnosis of HF (Heart Failure Society of America [HFSA], 2006). The results of these laboratory studies assist in determining the underlying cause and can also be used to establish a baseline to assess effects of treatment. Cardiac stress testing or cardiac catheterization may be performed to determine whether coronary artery disease and cardiac ischemia are causing the HF.

## Medical Management

The overall goals of management of HF are to relieve patient symptoms, to improve functional status and quality of life, and to extend survival. Medical management is based on the type, severity, and cause of HF. Specific objectives of medical management include the following:

- Eliminate or reduce any etiologic contributory factors, such as uncontrolled hypertension or atrial fibrillation with a rapid ventricular response
- Optimize pharmacologic and other therapeutic regimens
- Reduce the workload on the heart by reducing preload and afterload
- Promote a lifestyle conducive to cardiac health
- Prevent episodes of acute decompensated HF

Treatment options vary according to the severity of the patient's condition and may include oral and IV medications, major lifestyle changes, supplemental oxygen, implantation of assistive devices, and surgical approaches, including cardiac transplantation.

Managing the patient with HF includes providing comprehensive education and counseling to the patient and family. It is important that the patient and family understand the nature of HF and the importance of their participation

in the treatment regimen. Lifestyle recommendations include restriction of dietary sodium; avoidance of excessive fluid intake, alcohol, and smoking; weight reduction when indicated; and regular exercise. The patient must know how to recognize signs and symptoms that need to be reported to a health care professional.

### Pharmacologic Therapy

Several medications are routinely prescribed for systolic HF, including ACE inhibitors, beta-blockers, diuretics, and digitalis (Table 30-3). Target doses for these medications are identified in the AHA/ACC guidelines, and nurses and physicians work collaboratively toward achieving effective dosing of these medications (Albert, 2006).

#### Angiotensin-Converting Enzyme Inhibitors

ACE inhibitors play a pivotal role in the management of systolic HF. They have been found to relieve the signs and symptoms of HF and significantly decrease mortality and morbidity. ACE inhibitors (eg, lisinopril [Prinivil, Zestril]) slow the progression of HF, improve exercise tolerance, and decrease the number of hospitalizations for HF (Institute for Clinical Systems Improvement [ICSI], 2006). Available as oral and IV medications, ACE inhibitors promote vasodilation and diuresis by decreasing afterload and preload. By doing so, they decrease the workload of the heart. Vasodilation reduces resistance to left ventricular ejection of blood, diminishing the heart's workload and improving ventricular emptying. In promoting diuresis, ACE inhibitors decrease the secretion of aldosterone, a hormone that causes the kidneys to retain sodium and water. ACE inhibitors stimulate the kidneys to excrete sodium and fluid (while retaining potassium), thereby reducing left ventricular filling pressure and decreasing pulmonary congestion. ACE inhibitors may be the first medication prescribed for patients in mild failure—patients with fatigue or DOE but without signs of fluid overload and pulmonary congestion. These agents are also recommended for prevention of heart failure in patients who are at risk (Hunt, et al., 2005).

ACE inhibitors are started at a low dose that is increased every 2 weeks until the optimal dose is achieved and the patient is hemodynamically stable. The final maintenance

**Table 30-3 MEDICATIONS USED TO TREAT HEART FAILURE**

| Medication | Therapeutic Effects | Key Nursing Considerations |
|---|---|---|
| **Angiotensin-Converting Enzyme (ACE) Inhibitors** | | |
| Lisinopril (Prinivil, Zestril)<br>Benazepril (Lotensin)<br>Captopril (Capoten)<br>Enalapril/enalaprilat (Vasotec)<br>Fosinopril (Monopril)<br>Moexipril (Univasc)<br>Perindopril (Aceon)<br>Quinapril (Accupril)<br>Ramipril (Altace)<br>Trandolapril (Mavik) | ↓ BP and ↓ afterload<br>Relieves signs and symptoms of HF<br>Prevents progression of HF | Observe for symptomatic hypotension, increased serum $K^+$, cough, and worsening renal function. |
| **Angiotensin Receptor Blockers (ARBs)** | | |
| Valsartan (Diovan)<br>Candesartan (Atacand)<br>Eprosartan (Teveten)<br>Irbesartan (Avapro)<br>Telmisartan (Micardis)<br>Losartan (Cozaar) | ↓ BP and ↓ afterload<br>Relieves signs and symptoms of HF<br>Prevents progression of HF | Observe for symptomatic hypotension, increased serum $K^+$, and worsening renal function. |
| **Beta-adrenergic Blocking Agents (beta-blockers)** | | |
| Metoprolol (Lopressor, Toprol)<br>Atenolol (Tenormin)<br>Carvedilol (Coreg) | Dilates blood vessels and ↓ afterload<br>↓ signs and symptoms of HF<br>Improves exercise capacity | Observe for decreased heart rate, symptomatic hypotension, and fatigue. |
| **Diuretics** | | |
| *Loop diuretic:*<br>Furosemide (Lasix)<br>*Thiazide diuretic:*<br>Metolazone (Zaroxolyn)<br>Hydrochlorothiazide (HCTZ)<br>*Aldosterone antagonist:*<br>Spironolactone (Aldactone) | ↓ fluid volume overload<br>↓ signs and symptoms of HF | Observe for electrolyte abnormalities, renal dysfunction, diuretic resistance, and decreased BP. Carefully monitor I&O and daily weight (see Chart 30-2). |
| **Digitalis** | | |
| Digoxin (Lanoxin) | Improves contractility<br>↓ signs and symptoms of HF | Observe for bradycardia and digitalis toxicity (see Chart 30-3). |
| **Calcium Channel Blockers** | | |
| *Dihydropyridines:*<br>Amlodipine (Norvasc)<br>Felodipine (Plendil) | Vasodilation and reduction of systemic vascular resistance | Observe for symptomatic hypotension, drowsiness, or dizziness. |

BP, blood pressure; HF, heart failure; I&O, input and output; ↓, decreases

dose depends on the patient's blood pressure, fluid status, and renal status, as well as the severity of the HF.

Patients receiving ACE inhibitors are monitored for hypotension, hypovolemia, hyperkalemia, and alterations in renal function, especially if they are also receiving diuretics. Hypotension is most likely to develop from ACE inhibitor therapy in patients older than 75 years of age and in those with a systolic blood pressure of 100 mm Hg or less, a serum sodium level of lower than 135 mEq/L, or severe HF. Adjusting the dose or type of diuretic in response to the patient's blood pressure and renal function may result in continued increases in the dosage of ACE inhibitors.

Because ACE inhibitors cause the kidneys to retain potassium, the patient who is also receiving a diuretic may not need to take oral potassium supplements. However, patients receiving potassium-sparing diuretics (which do not cause potassium loss with diuresis) must be carefully monitored for hyperkalemia, an increased level of potassium in the blood. Before the initiation of the ACE inhibitor, hyperkalemic and hypovolemic states must be corrected. ACE inhibitors may be discontinued if the potassium level remains greater than 5.5 mEq/L or if the serum creatinine rises.

Other side effects of ACE inhibitors include a dry, persistent cough that may not respond to cough suppressants. However, cough can also indicate a worsening of ventricular function and failure. Rarely, the cough indicates angioedema. If angioedema affects the oropharyngeal area and impairs breathing, the ACE inhibitor must be stopped immediately.

If the patient cannot continue taking an ACE inhibitor because of development of cough, an elevated creatinine level, or hyperkalemia, an angiotensin II receptor blocker (ARB) or a combination of hydralazine and isosorbide dinitrate is prescribed.

#### Angiotensin II Receptor Blockers

Although the action of ARBs is different from that of ACE inhibitors, ARBs (eg, valsartan [Diovan]) have similar hemodynamic effects: decreased blood pressure, decreased systemic vascular resistance, and improved cardiac output (ICSI, 2006). Whereas ACE inhibitors block the conversion of angiotensin I to angiotensin II, ARBs block the effects of angiotensin II at the angiotensin II receptor. ACE inhibitors and ARBs also have similar side effects: hyperkalemia, hypotension, and renal dysfunction. ARBs are prescribed as an alternative to ACE inhibitors, especially when patients cannot tolerate ACE inhibitors because of cough.

#### Hydralazine and Isosorbide Dinitrate

A combination of hydralazine and isosorbide dinitrate may be another alternative for patients who cannot take ACE inhibitors (Hunt, et al., 2005). Nitrates (eg, isosorbide dinitrate) cause venous dilation, which reduces the amount of blood return to the heart and lowers preload. Hydralazine lowers systemic vascular resistance and left ventricular afterload. This combination of medications is also recommended in heart failure guidelines.

#### Beta-Blockers

Beta-blockers, such as carvedilol (Coreg) and metoprolol (Lopressor, Toprol), have been found to reduce mortality and morbidity in patients with HF by reducing the adverse effects from the constant stimulation of the sympathetic nervous system. Beta-blockers are routinely prescribed in addition to ACE inhibitors, diuretics, and digitalis (ICSI, 2006). In addition, they have been recommended for patients with asymptomatic systolic dysfunction, such as those with a decreased EF, to prevent the onset of symptoms of HF.

Beta-blockers may produce a number of side effects and may potentially exacerbate symptoms of HF. Side effects are most common in the initial few weeks of treatment. The most frequent side effects are dizziness, hypotension, and bradycardia. Because of these side effects, beta-blockers are started at a low dose and only after the patient is stabilized and euvolemic (ie, state of normal volume). The dose is titrated slowly (every 2 weeks), with close monitoring after each dosage increase. If symptoms of HF increase during the titration phase, treatment options include increasing the dose of the diuretic, reducing the dose of the ACE inhibitor, or decreasing the dose of the beta-blocker.

An important nursing role during titration is educating the patient about the potential worsening of symptoms during the early phase of treatment and stressing that improvement may take several weeks. It is very important for nurses to provide support to patients going through this symptom-provoking phase of treatment. Because beta-blockade can cause bronchiole constriction, a beta-1–selective beta-blocker (ie, one that primarily blocks the beta-adrenergic receptor sites in the heart), such as metoprolol, is recommended for patients with well-controlled, mild to moderate asthma. Patients need to be monitored closely for increased asthma symptoms nonetheless, because even cardioselective beta-blockers retain some modest beta-2 effects. Any type of beta-blocker is contraindicated in patients with severe or uncontrolled asthma.

#### Diuretics

Diuretics are prescribed to remove excess extracellular fluid by increasing the rate of urine produced in patients with signs and symptoms of fluid overload. Of the types of diuretics prescribed for patients with edema from HF, three are most common: loop, thiazide, and aldosterone blocking (potassium-sparing) diuretics. These medications are classified according to their site of action in the kidney and their effects on renal electrolyte excretion and reabsorption.

Loop diuretics, such as furosemide (Lasix), inhibit sodium and chloride reabsorption mainly in the ascending loop of Henle. Patients are generally treated with a loop diuretic first (HFSA, 2006). Thiazide diuretics, such as metolazone (Zaroxolyn), inhibit sodium and chloride reabsorption in the early distal tubules. Both of these classes of diuretics increase the excretion of potassium; therefore, patients treated with these medications must have their serum potassium levels closely scrutinized. A medication from each of these classes may be used for patients in severe HF who are unresponsive to a single diuretic. Diuretics may be most effective if the patient assumes a supine position for 1 or 2 hours after taking them. The need for diuretics can be decreased if the patient avoids excessive fluid intake (eg, more than 2 qt/day) and adheres to a low-sodium diet (eg, less than 2 g/day).

Spironolactone (Aldactone) is a potassium-sparing diuretic that blocks the effects of aldosterone in the late distal tubule and collecting duct. It has been found to be effective in reducing mortality and morbidity in patients with moderate to severe HF (ICSI, 2006). Serum creatinine and potassium levels are monitored frequently (eg, within the first week and then every 4 weeks) when this medication is first administered.

Side effects of diuretics include electrolyte imbalances, symptomatic hypotension (especially with overdiuresis), hyperuricemia (causing gout), and ototoxicity. The type and dose of diuretic prescribed depend on clinical signs and symptoms and renal function. Careful patient monitoring and dose adjustments are necessary to balance the effectiveness of these medications with the side effects (Chart 30-2). Diuretics are administered IV for exacerbations of HF when rapid diuresis is necessary. Diuretics improve the patient's symptoms, provided that renal function is adequate (ICSI, 2006). As HF progresses, there may be a decline in renal function known as cardiorenal syndrome. Patients with this syndrome are resistant to diuretics and may require other interventions to deal with congestive signs and symptoms (Varughese, 2007).

### Digitalis

The most commonly prescribed form of digitalis for patients with HF is digoxin (Lanoxin). Until recently, this medication was considered an essential agent for the treatment of HF, but with the advent of new medications, it may or may not be prescribed. Digoxin increases the force of myocardial contraction and slows conduction through the atrioventricular node. It improves contractility, increasing left ventricular output, which also enhances diuresis. Although the use of digitalis does not result in decreased mortality rates among patients with HF, it is effective in decreasing the symptoms of systolic HF and may help prevent hospitalization (ICSI, 2006).

A key concern associated with digitalis therapy is digitalis toxicity. Chart 30-3 summarizes the actions and uses of digoxin along with the nursing surveillance required when it is administered. The patient is observed for indications that digitalis therapy is effective: lessening dyspnea and orthopnea, decrease in pulmonary crackles on auscultation, relief of peripheral edema, weight loss, and increase in activity tolerance. The serum potassium level is measured at intervals because the effect of digoxin is enhanced in the presence of hypokalemia and digoxin toxicity may occur. A serum digoxin level is obtained if there have been changes in the patient's renal function or symptoms.

### Calcium Channel Blockers

First-generation calcium channel blockers, such as verapamil (Calan), nifedipine (Procardia), and diltiazem (Cardizem), are contraindicated in patients with systolic HF, although they may be used in patients with diastolic HF (ICSI, 2006). Amlodipine (Norvasc) and felodipine (Plendil), which are dihydropyridine calcium channel blockers, cause vasodilation, reducing systemic vascular resistance. They may be used to improve symptoms, especially in patients with nonischemic cardiomyopathy.

### Intravenous Infusions

***Nesiritide.*** Nesiritide (Natrecor), a BNP that is made using recombinant technology, is indicated for patients with acute decompensated HF. BNPs are produced by the failing myocardium to mount a compensatory response in the presence of the myocardial demands, including increased ventricular end-diastolic pressure, myocardial wall stress, and increased release of neurohormones (eg, norepinephrine, renin, aldosterone) that occur with HF. Specifically, BNP binds to vascular smooth muscle and endothelial cells, causing dilation of arteries and veins. It also suppresses the neurohormones responsible for fluid retention, thus promoting diuresis. The result is reduced preload and afterload and increased SV (Fontana, 2006).

Nesiritide causes rapid improvement in the symptoms of HF. It may be used to treat hospitalized patients with acute exacerbations or to prevent exacerbations in outpatients when given as a series of intermittent IV infusions. The most common side effect is dose-related hypotension.

CHART 30-2 PHARMACOLOGY

#### *Administering and Monitoring Diuretic Therapy*

When nursing care involves diuretic therapy for conditions such as heart failure, the nurse needs to administer the medication and monitor the patient's response carefully, as follows:

- Administer the diuretic at a time conducive to the patient's lifestyle; for example, early in the day to avoid nocturia.
- Give supplementary potassium with thiazide and loop diuretics as prescribed to replace potassium loss.
- Check laboratory results for electrolyte depletion, especially potassium, magnesium, and sodium; and for electrolyte elevation, especially potassium with potassium-sparing agents.
- Monitor daily weights, intake, and output to assess response. Monitor serum blood urea nitrogen and creatinine for increasing levels, which indicate renal dysfunction.
- Assess lung sounds, jugular vein distention, daily weight, and peripheral, abdominal, or sacral edema to identify response to therapy.
- Monitor for adverse reactions, such as nausea and gastrointestinal distress, vomiting, diarrhea, weakness, headache, fatigue, anxiety or agitation, and cardiac dysrhythmias.
- Assess for signs of volume depletion, such as postural hypotension, dizziness, and balance problems.
- Monitor for glucose intolerance in patients with and without diabetes mellitus who are receiving thiazide diuretics.
- Monitor for potential ototoxicity in patients, especially those with renal failure, who are receiving a loop diuretic.
- Advise patients to avoid prolonged exposure to the sun because of the risk of photosensitivity.
- Monitor for elevated serum uric acid levels and the development of gout.
- Implement nursing actions to facilitate effect of medication, such as positioning patient supine after dose is taken.

CHART 30-3

PHARMACOLOGY

## Digoxin Use and Toxicity in Heart Failure

The therapeutic level of digoxin is usually 0.5 to 2.0 mg/mL. Blood samples are usually obtained and analyzed to determine digitalis concentration at least 6 to 10 hours after the last dose. Toxicity may occur despite normal serum levels, and recommended dosages vary considerably.

### Preparations

**Digoxin**

- Tablets: 0.125, 0.25, 0.5 mg (Lanoxin)
- Capsules: 0.05, 0.1, 0.2 mg (Lanoxicaps)
- Elixir: 0.05 mg/mL (Lanoxin Pediatric elixir)
- Injection: 0.25 mg/mL, 0.1 mg/mL (Lanoxin)

**Digoxin Toxicity**

A serious complication of digoxin therapy is toxicity. Diagnosis of digoxin toxicity is based on the patient's clinical symptoms, which include the following:

- Anorexia, nausea, vomiting, fatigue, depression, and malaise (early effects of digitalis toxicity)
- Changes in heart rate or rhythm; onset of irregular rhythm
- ECG changes indicating SA or AV block; new onset of irregular rhythm indicating ventricular dysrhythmias; and atrial tachycardia with block, junctional tachycardia, and ventricular tachycardia

**Reversal of Toxicity**

Digoxin toxicity is treated by holding the medication while monitoring the patient's symptoms and serum digoxin level. If the toxicity is severe, digoxin immune FAB (Digibind) may be prescribed. Digibind binds with digoxin and makes it unavailable for use. The Digibind dosage is based on the digoxin level and the patient's weight. Serum digoxin values are not accurate for several days after administration of Digibind because they do not differentiate between bound and unbound digoxin. Because Digibind quickly decreases the amount of available digoxin, an increase in ventricular rate due to atrial fibrillation and worsening of symptoms of HF may ensue shortly after its administration.

### Nursing Considerations and Actions

1. Assess the patient's clinical response to digoxin therapy by evaluating relief of symptoms such as dyspnea, orthopnea, crackles, hepatomegaly, and peripheral edema.
2. Monitor the patient for factors that increase the risk of toxicity:
   - Decreased potassium level (hypokalemia), which may be caused by diuretics. Hypokalemia increases the action of digoxin and predisposes patients to digoxin toxicity and dysrhythmias.
   - Use of medications that enhance the effects of digoxin, including oral antibiotics and cardiac drugs that slow AV conduction and can further decrease heart rate.
   - Impaired renal function, particularly in patients age 65 and older. Because digoxin is eliminated by the kidneys, renal function (serum creatinine) is monitored and doses of digoxin are adjusted accordingly.
3. Before administering digoxin, it is standard nursing practice to assess apical heart rate. When the patient's rhythm is atrial fibrillation and the heart rate is less than 60 bpm, or the rhythm becomes regular, the nurse may withhold the medication and notify the physician, because these signs indicate the development of AV conduction block. Although withholding digoxin is a common practice, the medication does not need to be withheld for a heart rate of less than 60 bpm if the patient is in sinus rhythm because digoxin does not affect SA node automaticity. Measuring the PR interval for a patient with cardiac monitoring is more important than the apical pulse in determining whether digoxin should be held.
4. Monitor for gastrointestinal side effects: anorexia, nausea, vomiting, abdominal pain, and distention.
5. Monitor for neurologic side effects: headache, malaise, nightmares, forgetfulness, social withdrawal, depression, agitation, confusion, paranoia, hallucinations, decreased visual acuity, yellow or green halo around objects (especially lights), or "snowy" vision.

AV, atrioventricular; bpm, beats per minute; ECG, electrocardiogram; HF, heart failure; SA, sinoatrial.

***Milrinone.*** Milrinone (Primacor) is a phosphodiesterase inhibitor that delays the release of calcium from intracellular reservoirs and prevents the uptake of extracellular calcium by the cells. This promotes vasodilation, resulting in decreased preload and afterload and reduced cardiac workload. Milrinone is administered intravenously if the patient has not responded to other therapies. The major side effects are hypotension, gastrointestinal dysfunction, increased ventricular dysrhythmias, and, rarely, decreased platelet counts. Blood pressure is monitored closely during and following infusions of milrinone.

***Dobutamine.*** Dobutamine (Dobutrex) is an IV medication administered to patients with significant left ventricular dysfunction and hypoperfusion. A catecholamine, dobutamine stimulates the beta-1–adrenergic receptors. Its major action is to increase cardiac contractility. However, at high doses, it also increases the heart rate and can precipitate ectopic beats and tachydysrhythmias. Because it also increases atrioventricular conduction, care must be taken in patients who have underlying atrial fibrillation.

IV inotropes such as dobutamine and milrinone are reserved for patients with severe ventricular dysfunction, who must be monitored continuously via ECG. Some patients require admission to the intensive care unit and hemodynamic monitoring with a pulmonary artery catheter or impedance cardiography. A form of noninvasive monitoring, impedance cardiography uses external electrodes placed on the chest that generate a small current between the electrodes to assess fluid status and cardiac output (Folan & Funk, 2008). Hemodynamic data guide therapy and assess patient response (Varughese, 2007).

### Medications for Diastolic Dysfunction

Patients with predominant diastolic HF may be treated with different medications than indicated for patients with systolic HF. After contributing causes such as hypertension and

ischemic heart disease are evaluated and treated, patients may be started on beta-blockers and other HF medications. An effort is made to restore normal sinus rhythm in patients with concomitant atrial fibrillation (Hunt, et al., 2005).

#### Other Medications for Heart Failure

Anticoagulants may be prescribed, especially if the patient has a history of atrial fibrillation or a thromboembolic event. Medications that manage hyperlipidemia (eg, statins) are also routinely prescribed for the HF population (Albert, 2006). Nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen (Motrin) should be avoided because they decrease renal perfusion, especially in the elderly.

### Nutritional Therapy

A low-sodium (2 to 3 g/day) diet and avoidance of drinking excessive amounts of fluid are usually recommended. Dietary restriction of sodium reduces fluid retention and the symptoms of peripheral and pulmonary congestion. The purpose of sodium restriction is to decrease the amount of circulating blood volume, which decreases myocardial work. A balance needs to be achieved between the ability of the patient to comply with the diet and the recommended dietary restriction. Any change in diet needs to be made with consideration of good nutrition as well as the patient's likes, dislikes, and cultural food patterns. Patient compliance is important because dietary indiscretions may result in severe exacerbations of HF requiring hospitalization (Albert, 2005). However, behavioral changes in this area are difficult for many patients.

### Additional Therapy

#### Supplemental Oxygen

Oxygen therapy may become necessary as HF progresses. The need is based on the degree of pulmonary congestion and resulting hypoxia. Some patients require supplemental oxygen only during periods of activity.

#### Other Interventions

A number of procedures and surgical approaches may benefit patients with HF. If the patient has underlying coronary artery disease, coronary artery revascularization with percutaneous coronary intervention or coronary artery bypass surgery (see Chapter 28) may be considered. Ventricular function may improve in some patients when coronary flow is increased.

Patients with HF are at high risk for dysrhythmias. Sudden cardiac death is a common cause of death among patients with advanced HF (Jensen, Galvin, Thompson, et al., 2007). In patients with severe left ventricular dysfunction and the possibility of life-threatening dysrhythmias, placement of an implantable cardioverter defibrillator (ICD) can prevent sudden cardiac death and extend survival (Ezekowitz, Rowe, Dryden, et al., 2007).

In the patient with HF who does not improve with standard therapy, **cardiac resynchronization therapy (CRT)** is another treatment that may be beneficial. CRT involves the use of a biventricular pacemaker to treat electrical conduction defects. Left bundle branch block, a type of delayed conduction that is frequently seen in patients with HF, results in dyssynchronous conduction and contraction of the right and left ventricles, which can further decrease EF (Jensen, et al., 2007). Use of a pacing device with leads placed in the right atrium, right ventricle, and left ventricular cardiac vein can synchronize the contractions of the right and left ventricles. This intervention has been shown to improve cardiac output, optimize myocardial energy consumption, reduce mitral regurgitation, and slow the ventricular remodeling process. For selected patients, this results in fewer symptoms and increased functional status (Saul, 2007). Combination devices are available for patients who require CRT and an ICD.

Ultrafiltration is an alternative intervention for patients with severe fluid overload. A dual-lumen central IV catheter is used, which could be a peripherally inserted central catheter or a midline or central catheter, and the patient's blood is circulated through a small bedside machine. Liters of excess fluid and plasma are removed slowly from the patient's intravascular circulating volume over a number of hours. This fluid is then discarded, and the filtered blood products are returned to the patient (Constanzo, Saltzberg, O'Sullivan, et al., 2005; Soat, 2008; Walsh & Wagemester, 2007).

For some patients with end-stage HF, cardiac transplantation is the only option for long-term survival. Some of these patients require mechanical circulatory assistance with an implanted ventricular assist device as a bridge therapy to cardiac transplantation (see Chapter 29).

### Gerontologic Considerations

Several normal age-related changes increase the frequency of HF: increased systolic blood pressure, increased ventricular wall thickness, and increased myocardial fibrosis. Elderly people may present with atypical signs and symptoms: fatigue, weakness, and somnolence. Decreased renal function makes the elderly patient resistant to diuretics and more sensitive to changes in volume. The administration of diuretics to elderly men requires nursing surveillance for bladder distention caused by urethral obstruction from an enlarged prostate gland. The bladder may be assessed with an ultrasound scanner or the suprapubic area palpated for an oval mass and percussed for dullness, indicative of bladder fullness. Urinary frequency and urgency may be particularly stressful to the elderly patient.

## NURSING PROCESS

### The Patient With Heart Failure

Despite advances in treatment of HF, morbidity and mortality remains high. Nurses have a major impact on outcomes for patients with HF.

#### Assessment

The nursing assessment for the patient with HF focuses on observing for effectiveness of therapy and for the patient's ability to understand and implement self-management strategies. Signs and symptoms of pulmonary and systemic fluid overload are recorded and reported immediately so that adjustments can be made in therapy. The nurse also

explores the patient's emotional response to the diagnosis of HF because it is a chronic and often progressive condition.

#### Health History

The health history focuses on the signs and symptoms of HF, such as dyspnea, shortness of breath, fatigue, and edema. Sleep disturbances, particularly sleep suddenly interrupted by shortness of breath, may be reported. Patients are asked about the number of pillows needed for sleep, edema, abdominal symptoms, altered mental status, activities of daily living, and the activities that cause fatigue. The nurse explores each patient's understanding of HF, self-management strategies, and the ability and willingness to adhere to those strategies. Patients are asked to identify the impact that HF has had on their quality of life and successful coping skills that they have used. Family and significant others are often included in these discussions.

#### Physical Examination

The lungs are auscultated to detect crackles and wheezes. Crackles are produced by the sudden opening of edematous small airways and alveoli. They may be heard at the end of inspiration and are not cleared with coughing. Wheezing may also be heard in some patients. The rate and depth of respirations are also documented.

The heart is auscultated for an $S_3$ heart sound, a sign that the heart is beginning to fail and that increased blood volume fills the ventricle with each beat. HR and rhythm are also documented. When the heart rate is rapid, the SV decreases because the ventricle has less time to fill. This in turn produces increased pressure in the atria and eventually in the pulmonary vascular bed.

JVD is also assessed; distention greater than 3 cm above the sternal angle is considered abnormal. This is an estimate, not a precise measurement, of central venous pressure.

Sensorium and level of consciousness must be evaluated. As the volume of blood ejected by the heart decreases, so does the amount of oxygen transported to the brain.

The nurse assesses dependent parts of the patient's body for perfusion and edema. With significant decreases in SV, there is a decrease in perfusion to the periphery, causing the skin to feel cool and appear pale or cyanotic. The feet and lower legs are examined for edema; if the patient is supine in bed, the sacrum and back are also assessed for edema. Fingers and hands may also become edematous.

The liver is assessed for hepatojugular reflux. The patient is asked to breathe normally while manual pressure is applied over the right upper quadrant of the abdomen for 30 to 60 seconds. If neck vein distention increases more than 1 cm, the finding is positive for increased venous pressure.

If the patient is hospitalized, the nurse measures urinary output carefully to establish a baseline against which to assess the effectiveness of diuretic therapy. Intake and output records are rigorously maintained. It is important to know whether the patient has ingested more fluid than he or she has excreted (positive fluid balance), which is then compared with any gain in weight. The patient must be monitored for oliguria (diminished urine output, less than 500 mL/24 h) or **anuria** (urine output less than 50 mL/24 h).

The patient is weighed daily in the hospital or at home, at the same time of day, with the same type of clothing, and on the same scale. If there is a significant change in weight (ie, 2- to 3-lb increase in a day or 5-lb increase in a week), the physician is notified and medications are adjusted (eg, the diuretic dose is increased).

### Diagnosis

#### Nursing Diagnoses

Based on the assessment data, major nursing diagnoses for the patient with HF may include the following:

- Activity intolerance and fatigue related to decreased CO
- Excess fluid volume related to the HF syndrome
- Anxiety related to breathlessness from inadequate oxygenation
- Powerlessness related to chronic illness and hospitalizations
- Ineffective therapeutic regimen management related to lack of knowledge

#### Collaborative Problems/Potential Complications

Based on the assessment data, potential complications that may develop include the following:

- Hypotension, poor perfusion, and cardiogenic shock (see Chapter 15)
- Dysrhythmias (see Chapter 27)
- Thromboembolism (see Chapter 31)
- Pericardial effusion and cardiac tamponade (see Chapter 29)

### Planning and Goals

Major goals for the patient may include promoting activity and reducing fatigue, relieving fluid overload symptoms, decreasing anxiety or increasing the patient's ability to manage anxiety, encouraging the patient to verbalize his or her ability to make decisions and influence outcomes, and teaching the patient about the self-care program.

### Nursing Interventions

#### Promoting Activity Tolerance

Reduced physical activity caused by HF symptoms leads to physical deconditioning that worsens the patient's symptoms and exercise tolerance. Prolonged bed rest, which may be self-imposed, should be avoided because of its deconditioning effects and risks such as pressure ulcers (especially in edematous patients), venous thrombosis, and pulmonary embolism. An acute illness that exacerbates HF symptoms or that requires hospitalization may be an indication for temporary bed rest. Otherwise, a total of 30 minutes of physical activity every day should be encouraged (HFSA, 2006). Exercise training has many favorable effects for HF, including increasing functional capacity and decreasing dyspnea. The exercise regimen should include 5 minutes of warm-up activities followed by about 30 minutes of exercise at the prescribed intensity level. A typical program for a patient with HF might include a daily walking regimen, with duration increased over a 6-week period. The physician, nurse, and patient collaborate to develop a schedule that promotes pacing and prioritization of activities. The schedule should alternate activities with periods of rest and avoid having two significant energy-consuming activities occur on the same day or in immediate succession.

Before undertaking physical activity, the patient should be given the following safety guidelines:

- Begin with a few minutes of warm-up activities.
- Avoid performing physical activities outside in extreme hot, cold, or humid weather.
- Ensure that you are able to talk during the physical activity; if you cannot do so, decrease the intensity of activity.
- Wait 2 hours after eating a meal before performing the physical activity.
- Stop the activity if severe shortness of breath, pain, or dizziness develops.
- End with cool-down activities and a cool-down period.

Because some patients may be severely debilitated, they may need to limit physical activities to only 3 to 5 minutes at a time, one to four times per day. The patient should increase the duration of the activity, then the frequency, before increasing the intensity of the activity.

Barriers to performing other activities are identified, and methods of adjusting an activity are discussed. For example, vegetables can be chopped or peeled while sitting at the kitchen table rather than standing at the kitchen counter. Small, frequent meals decrease the amount of energy needed for digestion while providing adequate nutrition. The nurse helps the patient identify peak and low periods of energy, planning energy-consuming activities for peak periods. For example, the patient may prepare the meals for the entire day in the morning. Pacing and prioritizing activities help maintain the patient's energy to allow participation in regular physical activity.

The patient's response to activities needs to be monitored. If the patient is hospitalized, vital signs and oxygen saturation level are monitored before, during, and immediately after an activity to identify whether they are within the desired range. HR should return to baseline within 3 minutes following the activity. If the patient is at home, the degree of fatigue felt after the activity can be used to assess the response. If the patient tolerates the activity, short-term and long-term goals can be developed to gradually increase the intensity, duration, and frequency of activity.

Adherence to exercise training is essential if the patient is to benefit from it, but it may be difficult for patients with other conditions (eg, arthritis) and longer duration of heart failure. Referral to a cardiac rehabilitation program may be needed, especially for HF patients with recent myocardial infarction, recent open heart surgery, or increased anxiety. A supervised program may also benefit those who need a structured environment, significant educational support, regular encouragement, and interpersonal contact.

### *Managing Fluid Volume*

Patients with severe HF may receive IV diuretic therapy, but patients with less severe symptoms may receive oral diuretic medication. Oral diuretics should be administered early in the morning so that diuresis does not interfere with the patient's nighttime rest. Discussing the timing of medication administration is especially important for elderly patients who may have urinary urgency or incontinence. A single dose of a diuretic may cause the patient to excrete a large volume of fluid shortly after its administration.

The patient's fluid status is monitored closely, auscultating the lungs, monitoring daily body weight, and assisting the patient to adhere to a low-sodium diet by reading food labels and avoiding high-sodium foods such as canned, processed, and convenience foods (Chart 30-4). If the diet

CHART 30-4

## HEALTH PROMOTION
## *Facts About Dietary Sodium*

Although the major source of sodium in the average American diet is salt, many types of natural foods contain varying amounts of sodium. Even if no salt is added in cooking and if salty foods are avoided, the daily diet will still contain about 2000 mg of sodium. Fresh fruits and vegetables are low in sodium and should be encouraged.

### Additives in Food

In general, food prepared at home is lower in sodium than restaurant or processed foods. Added food substances (additives), such as sodium alginate, which improves food texture; sodium benzoate, which acts as a preservative; and disodium phosphate, which improves cooking quality in certain foods, increase the sodium intake when included in the daily diet. Therefore, patients on low-sodium diets should be advised to check labels carefully for such words as "salt" or "sodium," especially on canned foods. For example, without looking at the sodium content per serving found on the nutrition labels, when given a choice between a serving of potato chips and a cup of canned cream of mushroom soup, most would think that soup is lower in sodium. However, when the labels are examined, the lower sodium choice is found to be the chips. Although potato chips are *not* recommended in a low sodium diet, this example illustrates that it is important to read food labels to determine both sodium content and serving size.

### Nonfood Sodium Sources

Sodium is also contained in municipal water. Water softeners also increase the sodium content of drinking water. Patients on sodium-restricted diets should be cautioned against using nonprescription medications such as antacids, cough syrups, and laxatives. Salt substitutes may be allowed, but it is recognized that they are high in potassium. Over-the-counter medications should not be used without first consulting the physician.

### Promoting Dietary Adherence

If patients find food unpalatable because of the dietary sodium restrictions and/or the taste disturbances caused by the medications, they may refuse to eat or to comply with the dietary regimen. For this reason, severe sodium restrictions should be avoided and the amount of medication should be balanced with the patient's ability to restrict dietary sodium. A variety of flavorings, such as lemon juice, vinegar, and herbs, may be used to improve the taste of the food and facilitate acceptance of the diet. The patient's food preferences should be taken into account—diet counseling and educational handouts can be geared to individual and ethnic preferences. It is very important to involve the family in the dietary teaching.

includes fluid restriction, the nurse can assist the patient to plan fluid intake throughout the day while respecting the patient's dietary preferences. If the patient is receiving IV fluids, the amount of fluid needs to be monitored closely, and the physician or pharmacist can be consulted about the possibility of maximizing the amount of medication in the same volume of IV fluid (eg, double concentrating to decrease the fluid volume administered).

The patient is positioned or taught how to assume a position that facilitates breathing. The number of pillows may be increased, the head of the bed may be elevated, or the patient may sit in a comfortable armchair. In these positions, the venous return to the heart (preload) is reduced, pulmonary congestion is alleviated, and pressure on the diaphragm is minimized. The lower arms are supported with pillows to eliminate the fatigue caused by the pull of the patient's weight on the shoulder muscles.

Because decreased circulation in edematous areas increases the risk of pressure ulcers, the nurse assesses for skin breakdown and institutes preventive measures. Frequent changes of position, positioning to avoid pressure, and leg exercises may help prevent pressure ulcers.

#### *Controlling Anxiety*

Because patients with HF have difficulty maintaining adequate oxygenation, they are likely to be restless and anxious and feel overwhelmed by breathlessness. These symptoms tend to intensify at night and may interfere with sleep. Emotional stress stimulates the sympathetic nervous system, which causes vasoconstriction, elevated arterial pressure, and increased heart rate. This sympathetic response increases the cardiac workload. By decreasing anxiety, the patient's cardiac workload also is decreased. Oxygen may be administered during an acute event to diminish the work of breathing and to increase the patient's comfort.

When the patient exhibits anxiety, the nurse takes steps to promote physical comfort and provide psychological support. In many cases, a family member's presence provides reassurance. Pet visitation or animal-assisted therapy can also be beneficial (Cole, 2007).

Along with reassurance, the nurse can begin teaching the patient ways to control anxiety and avoid anxiety-provoking situations. The patient learns how to identify factors that contribute to anxiety and how to use relaxation techniques to control anxious feelings. As the patient's anxiety decreases, cardiac function may improve and symptoms of HF may decrease.

> *NURSING ALERT*
>
> **In cases of confusion and anxiety reactions that affect the patient's safety, the use of restraints should be avoided. Restraints are likely to be resisted, and resistance inevitably increases the cardiac workload.**

The patient who insists on getting out of bed at night can be seated comfortably in an armchair. As cerebral and systemic circulation improves, the degree of anxiety decreases and the quality of sleep improves.

In addition to anxiety, patients with HF have a high incidence of depression; depression is associated with increased morbidity and mortality in patients with HF (Jiang, Kuchibhatia, Clary, et al., 2007). Patients with HF should be screened for this condition.

#### *Minimizing Powerlessness*

Patients need to recognize that they are not helpless and that they can influence the direction of their lives and the outcomes of treatment. The patient is assessed for factors that contribute to a sense of powerlessness. Contributing factors may include lack of knowledge and lack of opportunities to make decisions, particularly if health care providers and family members behave in controlling ways. If the patient is hospitalized, hospital policies may limit the patient's ability to make decisions (eg, what time to have meals or to take medications).

Taking time to listen actively to patients encourages them to express their concerns and ask questions. Other strategies include providing the patient with decision-making opportunities, such as when activities are to occur or encouraging food and fluid choices consistent with the dietary restrictions. Encouragement is provided, progress is identified, and the patient is assisted to differentiate between factors that can and cannot be controlled.

#### *Monitoring and Managing Potential Complications*

Many potential problems associated with HF therapy relate to the use of diuretics:

- Excessive and repeated diuresis can lead to hypokalemia (ie, potassium depletion). Signs include ventricular dysrhythmias, hypotension, muscle weakness, and generalized weakness. Hypokalemia poses problems for the patient with HF because it markedly weakens cardiac contractions. In patients receiving digoxin, hypokalemia can lead to digitalis toxicity. Digitalis toxicity and hypokalemia increase the likelihood of dangerous dysrhythmias (see Chart 30-3). Patients with HF may also develop low levels of magnesium, which can add to the risk of dysrhythmias.
- Hyperkalemia may occur, especially with the use of ACE inhibitors, ARBs, or spironolactone.
- Prolonged diuretic therapy may produce hyponatremia (deficiency of sodium in the blood), which results in disorientation, apprehension, weakness, fatigue, malaise, and muscle cramps.
- Volume depletion from excessive fluid loss may lead to dehydration and hypotension. ACE inhibitors and beta-blockers may contribute to the hypotension.
- Other problems associated with diuretics include increased serum creatinine and hyperuricemia (excessive uric acid in the blood), which leads to gout.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The nurse provides patient education and involves the patient in the therapeutic regimen to promote understanding and adherence to the plan. When the patient recognizes that the diagnosis of HF can be successfully managed with lifestyle changes and medications, recurrences of acute HF lessen, unnecessary hospitalizations decrease, and life expectancy increases. The Joint Commission and other agencies have established standards pertaining to the education of patients with HF.

Nurses teach patients and their families about medication management, low-sodium diets, activity and exercise recommendations, smoking cessation, learning to recognize the signs and symptoms of worsening HF, and when to contact a health care provider (Albert, 2006; Varughese, 2007). Although noncompliance is not well understood, interventions that may promote compliance include teaching to ensure accurate understanding. A basic home teaching plan for the patient with HF is presented in Chart 30-5.

The patient and family members are supported and encouraged to ask questions so that information can be clarified and understanding enhanced. It is important to be aware of cultural factors and adapt the teaching plan accordingly. Patients and their families need to be informed that the progression of the disease is influenced in part by choices made about health care and the decisions about following the treatment plan. They also need to be informed that health care providers are available to assist them in reaching their health care goals. Patients and family members need to make the decisions about the treatment plan and need to understand the possible outcomes of those decisions. The treatment plan is based on the patient's goals rather than on what health care providers think is needed.

**CONTINUING CARE.** Success in management of HF requires a complex medical regimen and multiple lifestyle changes. Assistance may be provided through home health care, an HF clinic, or telehealth management.

Depending on the patient's physical status and the availability of family assistance, a home care referral may be indicated for a patient who has been hospitalized. Elderly patients and those who have long-standing heart disease with compromised physical stamina often require assistance with the transition to home after hospitalization for an acute episode of HF. The home care nurse assesses the physical environment of the home and makes suggestions for adapting the home environment to meet the patient's activity limitations. If stairs are a concern, the patient can plan the day's activities so that stair climbing is minimized; for some patients, a temporary bedroom may be set up on the main level of the home. The home care nurse works with the patient and family to maximize the benefits of these changes.

The home care nurse also reinforces and clarifies information about dietary changes and fluid restrictions, the

CHART 30-5

HOME CARE CHECKLIST

### *The Patient With Heart Failure*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Identify heart failure as a chronic disease that can be managed with medications and specific self-management behaviors. | ✔ | ✔ |
| • Take or administer medications daily, exactly as prescribed. | ✔ | ✔ |
| • Monitor effects of medication such as changes in breathing and edema. | ✔ | ✔ |
| • Know signs and symptoms of orthostatic hypotension and how to prevent it. | ✔ | ✔ |
| • Weigh self daily at the same time with same clothes. | ✔ | |
| • Restrict sodium intake to 2000–3000 mg daily: adapt diet by examining nutrition labels to check sodium content per serving; avoid canned or processed foods; eat fresh or frozen foods; consult the written diet plan and the list of permitted and restricted foods; avoid salt use; and avoid excesses in eating and drinking. | ✔ | ✔ |
| • Review activity program.<br>• Participate in a daily exercise program.<br>• Increase walking and other activities gradually, provided they do not cause unusual fatigue or dyspnea.<br>• Conserve energy by balancing activity with rest periods.<br>• Avoid activity in extremes of heat and cold, which increase the work of the heart.<br>• Recognize that air conditioning may be essential in a hot, humid environment. | ✔ | |
| • Develop methods to manage and prevent stress.<br>• Avoid tobacco.<br>• Avoid alcohol.<br>• Engage in diversional activities, meditation, guided imagery, or music therapy. | ✔ | |
| • Keep regular appointments with physician or clinic. | ✔ | ✔ |
| • Be alert for symptoms that may indicate recurring heart failure.<br>• Know how to contact health care provider. | ✔ | ✔ |
| • Report immediately to the physician or clinic any of the following:<br>• Gain in weight of 2–3 lb (0.9–1.4 kg) in 1 day, or 5 lb (2.3 kg) in 1 week.<br>• Loss of appetite.<br>• Unusual shortness of breath with activity.<br>• Swelling of ankles, feet, or abdomen.<br>• Persistent cough.<br>• Development of restless sleep; increase in number of pillows needed to sleep. | ✔ | ✔ |

need to monitor symptoms and daily body weights, and the importance of obtaining follow-up health care. Assistance may be given in scheduling and keeping appointments as well. The patient is encouraged to gradually increase his or her self-care and responsibility for carrying out the therapeutic regimen. Assistance from home health nurses can result in fewer exacerbations of HF, lower costs, and improved quality of life (Anderson, 2007).

Disease management programs are important components in the successful management of HF (HFSA, 2006). HF clinics offer individualized disease management strategies. Referral to an HF clinic gives the patient access to education, professional staff, and timely adjustments to treatment regimens. Research has shown that patients managed through HF clinics have fewer exacerbations of HF, fewer hospitalizations, decreased costs of medical care, and increased quality of life (HFSA, 2006).

Telehealth management can provide the frequent contact necessary to manage HF without requiring frequent visits to health care providers. A variety of techniques ranging from simple telephone monitoring to sophisticated computer and video connections that monitor daily weight, vital signs, and symptoms may be used. Telehealth management can also decrease costs and hospitalizations for exacerbations of HF.

**END-OF-LIFE CONSIDERATIONS.** Because HF is a chronic and often progressive condition, patients and families need to consider issues related to the end of life. Although the prognosis in HF patients may be uncertain, issues often arise sooner or later related to the patient's thoughts and possible concerns about the use of complex treatment options (eg, ultrafiltration for fluid overload, implantation of a ventricular assist device). Discussions concerning the use of technology, preferences for end-of-life care, and advance directives should take place while the patient is able to participate and express preferences (Dougherty, Pyper, Au, et al., 2007).

### Evaluation

#### *Expected Patient Outcomes*

1. Demonstrates tolerance for increased activity
   a. Describes adaptive methods for usual activities
   b. Schedules activities to conserve energy and reduce fatigue and dyspnea
   c. Maintains heart rate, blood pressure, respiratory rate, and pulse oximetry within the targeted range
2. Maintains fluid balance
   a. Exhibits decreased peripheral and sacral edema
   b. Demonstrates methods for preventing edema
3. Is less anxious
   a. Avoids situations that produce stress
   b. Sleeps comfortably at night
   c. Reports decreased stress and anxiety
   d. Denies symptoms of depression
4. Makes sound decisions regarding care and treatment
   a. Demonstrates ability to influence outcomes
5. Adheres to self-care regimen
   a. Performs and records daily weights
   b. Ensures dietary intake includes no more than 2 to 3 g of sodium per day
   c. Takes medications as prescribed
   d. Reports any unusual symptoms or side effects

## Pulmonary Edema

**Pulmonary edema** is the abnormal accumulation of fluid in the interstitial spaces of the lungs that diffuses into the alveoli.

### Pathophysiology

Pulmonary edema is an acute event that results from left ventricular failure. It can occur acutely, such as with MI, or it can occur as an exacerbation of chronic HF. Myocardial scarring can limit the distensibility of the ventricle and render it vulnerable to a sudden increase in workload. With increased resistance to left ventricular filling, blood backs up into the pulmonary circulation. The patient quickly develops pulmonary edema, sometimes called "flash pulmonary edema," from the blood volume overload in the lungs. Pulmonary edema can also be caused by noncardiac disorders, such as renal failure, and other conditions that cause the body to retain fluid. The pathophysiology is similar to that seen in HF, in that the left ventricle cannot handle the volume overload and blood volume and pressure buildup in the left atrium. The rapid increase in atrial pressure results in an acute increase in pulmonary venous pressure, which produces an increase in hydrostatic pressure that forces fluid out of the pulmonary capillaries into the interstitial spaces and alveoli. Lymphatic drainage of the excess fluid is ineffective.

The fluid within the alveoli mixes with air, producing the classic symptom of pulmonary edema—frothy pink (blood-tinged) sputum. The fluid within the alveoli creates a diffusion block that severely impairs gas exchange. The result is hypoxemia, which is often severe. The onset may be preceded by premonitory symptoms of pulmonary congestion, but the condition also may develop quickly in the patient with a ventricle that has little reserve to meet increased oxygen needs.

### Clinical Manifestations

As a result of decreased cerebral oxygenation, the patient becomes increasingly restless and anxious. Along with a sudden onset of breathlessness and a sense of suffocation, the patient's hands become cold and moist, the nail beds become cyanotic (bluish), and the skin turns ashen (gray). The pulse is weak and rapid, and the neck veins are distended. Incessant coughing may occur, producing increasing quantities of foamy sputum. As pulmonary edema progresses, the patient's anxiety and restlessness increase; the patient becomes confused, then stuporous. Breathing is rapid, noisy, and moist sounding. The patient's oxygen saturation is significantly decreased. The patient, nearly suffocated by the blood-tinged, frothy fluid filling the alveoli, is literally drowning in secretions. The situation demands emergent action.

### Assessment and Diagnostic Findings

The diagnosis is made by evaluating the clinical manifestations resulting from pulmonary congestion. A chest x-ray may be obtained to confirm the extent of pulmonary vessel and tissue engorgement. Abrupt onset of signs of left-sided HF (eg, crackles on auscultation of the lungs) may occur without evidence of right-sided HF (eg, no JVD, no dependent edema).

## Prevention

Like many emergent conditions, pulmonary edema is easier to prevent than to treat. To recognize it in its early stages, the nurse assesses the degree of dyspnea, auscultates the lung fields and heart sounds, and assesses the degree of peripheral edema. A hacking cough, fatigue, weight gain, development or worsening of edema, and decreased activity tolerance may be early indicators of developing pulmonary edema.

In its early stage, pulmonary edema may be alleviated by placing the patient in an upright position with the feet and legs dependent, eliminating overexertion, and minimizing emotional stress to reduce the left ventricular load. The treatment regimen and the patient's understanding of and adherence to it are assessed. The long-range approach to preventing pulmonary edema must be directed at identifying its precipitating factors.

## Medical Management

Clinical management of a patient with acute pulmonary edema due to left ventricular failure is directed toward reducing volume overload, improving ventricular function, and increasing respiratory exchange (ICSI, 2006). These goals are accomplished through a combination of oxygen and ventilatory support, IV medications, and nursing interventions.

### Oxygen Therapy

Oxygen is administered in concentrations adequate to relieve hypoxemia and dyspnea. A face mask is used initially. If respiratory failure is severe or persists, continuous positive airway pressure may be tried (see Chapter 25 for further discussion). For some patients, endotracheal intubation and mechanical ventilation are required. The ventilator can provide positive end-expiratory pressure, which is effective in reducing venous return, decreasing fluid movement from the pulmonary capillaries to the alveoli, and improving oxygenation. Oxygenation is monitored by pulse oximetry and by measurement of arterial blood gases.

### Morphine

Morphine is titrated intravenously in small doses (2 to 5 mg) to reduce peripheral resistance and venous return so that blood can be redistributed from the pulmonary circulation to other parts of the body. This decreases pressure in the pulmonary capillaries and diffusion of fluid into the lung tissue. In addition, morphine reduces anxiety, which is also beneficial.

### Diuretics

Diuretics promote the excretion of sodium and water by the kidneys. For example, furosemide is administered by IV push or as a continuous infusion to produce a rapid diuretic effect. Furosemide also causes vasodilation and pooling of blood in peripheral blood vessels, which reduces the amount of blood returned to the heart. Other diuretics such as metolazone may be administered as second-line therapy (ICSI, 2006).

### Intravenous Infusions

Vasodilators such as IV nitroglycerin or nitroprusside (Nipride) may enhance symptom relief in pulmonary edema (HFSA, 2006). As described earlier in this chapter, a continuous infusion of nesiritide may also be prescribed for the patient with acute decompensated heart failure.

## Nursing Management

### Positioning the Patient to Promote Circulation

Proper positioning can help reduce venous return to the heart. The patient is positioned upright, preferably with the legs dangling over the side of the bed. This has the immediate effect of decreasing venous return, decreasing right ventricular stroke volume, and decreasing lung congestion.

### Providing Psychological Support

As the ability to breathe decreases, the patient's fear and anxiety rise proportionately, making the condition more severe. Reassuring the patient and providing skillful anticipatory nursing care are integral parts of the therapy. Because the patient has an unstable condition, the nurse must remain with the patient. The nurse gives the patient simple, concise information in a reassuring voice about what is being done to treat the condition and the expected results.

### Monitoring Medications

The patient receiving morphine is observed for respiratory depression, hypotension, and vomiting; a morphine antagonist, such as naloxone hydrochloride (Narcan), is kept available and given to the patient who exhibits serious respiratory depression.

The patient receiving diuretic therapy may excrete a large volume of urine within minutes after a potent diuretic is administered. A bedside commode may be used to decrease the energy required by the patient and to reduce the resultant increase in cardiac workload induced by getting on and off a bedpan. If necessary, an indwelling urinary catheter may be inserted.

The patient receiving continuous IV infusions of vasoactive medications requires ECG monitoring and frequent measurement of vital signs.

# OTHER COMPLICATIONS

## Cardiogenic Shock

Cardiogenic shock occurs when decreased CO leads to inadequate tissue perfusion and initiation of the shock syndrome. Cardiogenic shock may occur following MI when a large area of myocardium becomes ischemic and hypokinetic. It also can occur as a result of end-stage HF, cardiac tamponade, pulmonary embolism, cardiomyopathy, and dysrhythmias. Cardiogenic shock is a life-threatening condition with a high mortality rate. Chapter 15 provides detailed information about the pathophysiology and assessment of cardiogenic shock.

## Medical Management

Goals in the treatment of cardiogenic shock include correcting the underlying problem, reducing any further demand on the heart, improving oxygenation, and restoring tissue perfusion. Chapter 15 discusses medical and pharmacologic management of cardiogenic shock; mechanical circulatory assistive devices are discussed below.

### Mechanical Circulatory Assistive Devices

Therapeutic modalities for cardiogenic shock include the use of circulatory assist devices, such as the intra-aortic balloon pump (IABP). The IABP is a catheter with an inflatable balloon at the end. The catheter is usually inserted through the femoral artery, and the balloon is positioned in the descending thoracic aorta (Fig. 30-4). The IABP uses internal counterpulsation through the regular inflation and deflation of the balloon to augment the pumping action of the heart. It inflates during diastole, increasing the pressure in the aorta during diastole and therefore increasing blood flow through the coronary and peripheral arteries. It deflates just before systole, lessening the pressure within the aorta before left ventricular contraction, decreasing the amount of resistance the heart has to overcome to eject blood and therefore decreasing the amount of work the heart must put forth to eject blood. The device is connected to a console that synchronizes the inflation and deflation of the balloon with the ECG or the arterial pressure (as indicators for systole and diastole). Hemodynamic monitoring is often used to determine the patient's response to the IABP.

Other ventricular assist devices for long-term support of the failing heart are described in Chapter 29.

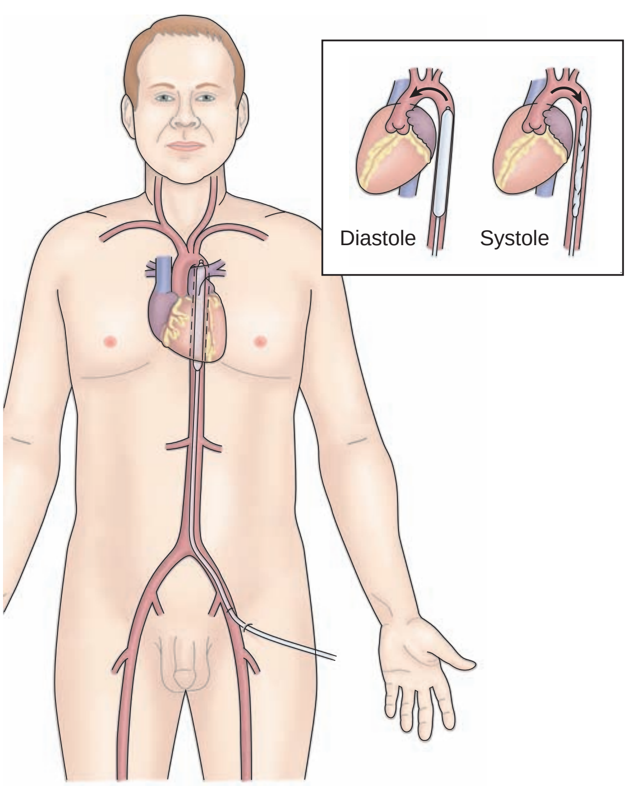



**Figure 30-4** The intra-aortic balloon pump inflates at the beginning of diastole, which results in increased perfusion of the coronary and peripheral arteries. It deflates just before systole, which results in a decrease in afterload (resistance to ejection) and in the left ventricular workload.

## Nursing Management

The patient in cardiogenic shock requires constant monitoring. Because of the frequency of nursing interventions and the technology required for effective patient management, the patient is treated in an intensive care unit. The critical care nurse must carefully assess the patient, observe the cardiac rhythm, monitor hemodynamic parameters, monitor fluid status, and adjust medications and therapies based on the assessment data. The patient is continuously evaluated for responses to the medical interventions and for the development of complications, so that problems can be addressed immediately.

# Thromboembolism

The decreased mobility of the patient with cardiac disease and the impaired circulation that accompany these disorders contribute to the development of intracardiac and intravascular thrombosis. Intracardiac thrombi are especially common in patients with atrial fibrillation, because the atria do not contract forcefully and blood flows slowly and turbulently, increasing the likelihood of thrombus formation. Intracardiac thrombi are detected by an echocardiogram and treated with anticoagulants, such as heparin and warfarin (Coumadin). Adverse effects of thromboemboli are discussed in detail in Chapter 31.

### Pulmonary Embolism

Pulmonary embolism is the most common thromboembolic problem among patients with HF. It poses a particular threat to people with cardiovascular disease (ICSI, 2006). Blood clots may form in the deep veins of the legs and embolize to the pulmonary vasculature, causing a life-threatening embolic event. Emboli mechanically obstruct the pulmonary vessels, cutting off the blood supply to sections of the lung (Fig. 30-5).

Clinical indicators of pulmonary embolism can vary but typically include dyspnea, tachypnea, chest pain, hemoptysis, tachycardia, and symptoms of deep venous thrombosis. Diagnostic tests often include a chest x-ray, ventilation–perfusion lung scan, or high-resolution helical computed tomography. A blood D-dimer assay is helpful to determine whether fibrinolysis of clots is taking place somewhere in the body.

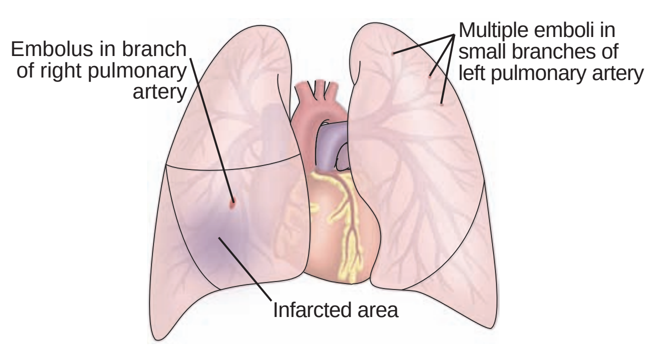



**Figure 30-5** Pulmonary emboli may be single or multiple.

Patient management begins with cardiopulmonary assessment and intervention. Emboli can cause hypoxic vasoconstriction and the release of inflammatory mediators in the pulmonary vessels, which can ultimately lead to right heart failure and respiratory failure (Shaughnessy, 2007). Anticoagulant therapy with unfractionated heparin, low-molecular-weight heparin, or fondaparinux (Arixtra) is started when pulmonary embolism is suspected (Piazza & Goldhaber, 2006b). Thrombolytic therapy may be used in patients with massive pulmonary emboli accompanied by hypotension and shock. Following initial therapy, patients are placed on warfarin for at least 6 months. Prevention of deep vein thrombosis and pulmonary emboli is an important aspect of patient management. Both pharmacologic and mechanical means (eg, pneumatic compression devices) have proven effective in at-risk patients. Care for patients with pulmonary embolism is further discussed in Chapter 23.

## Pericardial Effusion and Cardiac Tamponade

### Pathophysiology

Pericardial effusion (accumulation of fluid in the pericardial sac) may accompany advanced HF, pericarditis, metastatic carcinoma, cardiac surgery, or trauma. Normally, the pericardial sac contains about 20 mL of fluid, which is needed to decrease friction for the beating heart. An increase in pericardial fluid raises the pressure within the pericardial sac and compresses the heart. This has the following effects:

- Elevated pressure in all cardiac chambers
- Decreased venous return due to atrial compression
- Inability of the ventricles to distend and fill adequately

Pericardial fluid may accumulate slowly without causing noticeable symptoms until a large amount accumulates. However, a rapidly developing effusion can stretch the pericardium to its maximum size and, because of increased pericardial pressure, reduce venous return to the heart and decrease CO. The result is cardiac tamponade (eg, compression of the heart).

### Clinical Manifestations

The patient may report a feeling of fullness within the chest or may have substantial or ill-defined pain. The feeling of pressure in the chest may result from stretching of the pericardial sac. Because of increased pressure within the pericardium, venous pressure tends to increase, as evidenced by engorged neck veins. Other signs include shortness of breath and labile or low blood pressure (Humphreys, 2006). Systolic blood pressure that is markedly lower during inhalation is called **pulsus paradoxus.** Pulsus paradoxus is characterized by an abnormal difference of at least 10 mm Hg in systolic pressure between the point that it is heard during exhalation and the point that it is heard during inhalation. The cardinal signs of cardiac tamponade are falling systolic blood pressure, narrowing pulse pressure, rising venous pressure (increased JVD), and distant (muffled) heart sounds (Fig. 30-6).

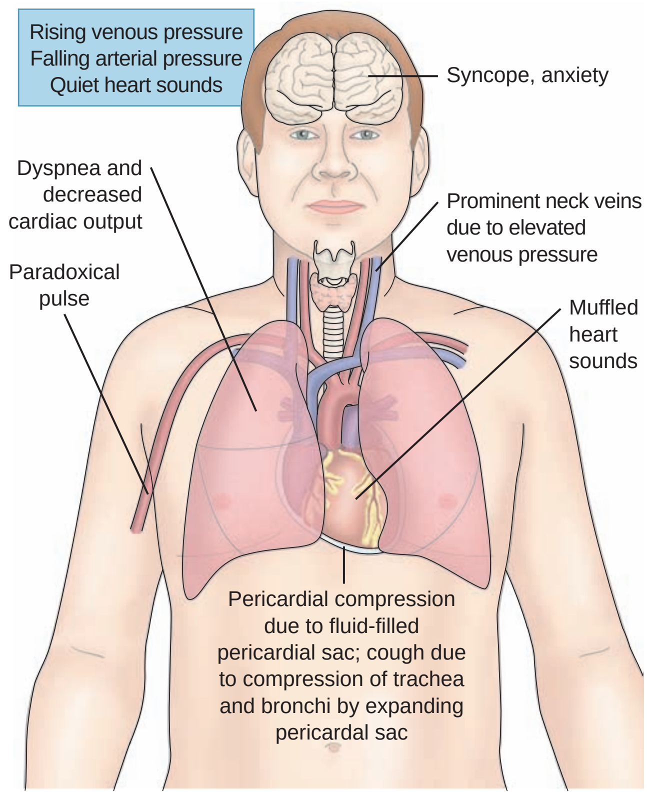



**Figure 30-6** Assessment findings in cardiac tamponade resulting from pericardial effusion include feelings of faintness, shortness of breath, and anxiety from decreased cardiac output, cough from pressure created in the trachea from swelling of the pericardial sac, distended neck veins from rising venous pressure, paradoxical pulse, and muffled or distant heart sounds.

### Assessment and Diagnostic Findings

An echocardiogram is performed to confirm the diagnosis and quantify the amount of pericardial fluid. A chest x-ray may also show a large pericardial effusion.

### Medical Management

#### *Pericardiocentesis*

If cardiac function becomes seriously impaired, **pericardiocentesis** (puncture of the pericardial sac to aspirate pericardial fluid) is performed to remove fluid from the pericardial sac. During this procedure, the patient is monitored by continuous ECG and frequent vital signs. Emergency resuscitation equipment should be readily available. The head of the bed is elevated to 45 to 60 degrees, placing the heart in proximity to the chest wall so that the needle can be directly inserted into the pericardial sac. If a peripheral IV line is not already in place, one is inserted, and a slow IV infusion is started in case it becomes necessary to administer emergency medications or blood products.

The pericardial aspiration needle is attached to a 50-mL syringe by a three-way stopcock. Several possible sites are used for pericardial aspiration. Typically, ultrasound imaging is used to guide placement of the needle into the pericardial space. The needle is advanced slowly until it has entered the pericardium and fluid is obtained.

A resulting decrease in central venous pressure and an associated increase in blood pressure after withdrawal of

pericardial fluid indicate that the cardiac tamponade has been relieved. The patient almost always feels immediate relief. If there is a substantial amount of pericardial fluid, a small catheter may be left in place to drain recurrent accumulation of blood or fluid. Pericardial fluid is sent to the laboratory for examination for tumor cells, bacterial culture, chemical and serologic analysis, and differential blood cell count.

Complications of pericardiocentesis include coronary artery puncture, myocardial trauma, dysrhythmias, pleural laceration, and gastric puncture. After pericardiocentesis, the patient's heart rhythm, blood pressure, venous pressure, and heart sounds are monitored to detect possible recurrence of cardiac tamponade. If it recurs, repeated aspiration is necessary. Cardiac tamponade may require treatment by open pericardial drainage (pericardiotomy).

#### *Pericardiotomy*

Recurrent pericardial effusions, usually associated with neoplastic disease, may be treated by a **pericardiotomy** (pericardial window). Under general anesthesia, a portion of the pericardium is excised to permit the exudative pericardial fluid to drain into the lymphatic system. The nursing care is the same as that for other cardiac surgery (see Chapter 28).

## *Cardiac Arrest*

Cardiac arrest occurs when the heart ceases to produce an effective pulse and circulate blood. It may be caused by a cardiac electrical event (ie, dysrhythmia) such as ventricular fibrillation, progressive profound bradycardia, or when there is no heart rhythm at all (asystole). Cardiac arrest may follow respiratory arrest; it may also occur when electrical activity is present but there is ineffective cardiac contraction or circulating volume, which is called **pulseless electrical activity (PEA).** PEA can be caused by hypovolemia (eg, with excessive bleeding), hypoxia, hypothermia, hyperkalemia, massive pulmonary embolism, myocardial infarction, and medication overdose (eg, beta-blockers, calcium channel blockers).

### Clinical Manifestations

In cardiac arrest, consciousness, pulse, and blood pressure are lost immediately. Ineffective respiratory gasping may occur. The pupils of the eyes begin dilating within 45 seconds. Seizures may or may not occur.

The risk of irreversible brain damage and death increases with every minute from the time that circulation ceases. The interval varies with the age and underlying condition of the patient. During this period, the diagnosis of cardiac arrest must be made and measures must be taken immediately to restore circulation.

### Emergency Management: Cardiopulmonary Resuscitation

Cardiopulmonary resuscitation (CPR) provides blood flow to vital organs until effective circulation can be reestablished. Following recognition of unresponsiveness, lack of pulse and respiration, the protocol for basic life support is initiated. Once loss of consciousness has been established, the resuscitation priority for the adult in most cases is placing a phone call to activate the code team or the emergency medical system (EMS). Exceptions to this include near drowning, drug or medication overdose, and respiratory arrest situations, for which 2 minutes of CPR should be performed before activating the EMS. Selected medications (Table 30-4) may be used during and after resuscitation.

**Table 30-4 MEDICATIONS USED IN CARDIOPULMONARY RESUSCITATION**

| Agent and Action | Indications | Nursing Considerations |
|---|---|---|
| Oxygen—improves tissue oxygenation and corrects hypoxemia | Administered to all patients with acute cardiac ischemia or suspected hypoxemia, including those with COPD | • Use 100% $FiO_2$ during resuscitation.<br>• Recognize that lung damage is unlikely when used for short time.<br>• Monitor dose by pulse oximeter. |
| Epinephrine—increases systemic vascular resistance and BP; improves coronary and cerebral perfusion and myocardial contractility | Given to patients in cardiac arrest, especially caused by asystole or pulseless electrical activity; may be given if caused by ventricular tachycardia or ventricular fibrillation | • Administer 1 mg every 3–5 minutes by IV push or through endotracheal tube.<br>• Avoid adding to IV lines that contain alkaline solution (eg, bicarbonate). |
| Vasopressin (Pitressin)—increases systemic vascular resistance and BP | An alternative to epinephrine | • Give 40 U IV one time only. |
| Atropine—blocks parasympathetic action; increases SA node automaticity and AV conduction | Given to patients with symptomatic bradycardia (hemodynamically unstable, frequent premature ventricular contractions, and symptoms of ischemia) | • Give rapidly as 0.5 mg IV push; may repeat to dose of 3 mg.<br>• Be aware that less than 0.5 mg in adult can cause heart rate to decrease to a worse bradycardia.<br>• Monitor patient for reflexive tachycardia. |
| Sodium bicarbonate ($NaHCO_3$)—corrects metabolic acidosis | Given to correct metabolic acidosis that is refractory to standard advanced cardiac life-support interventions (cardiopulmonary resuscitation, intubation, and respiratory management) | • Administer initial dose of 1 mEq/kg IV; then administer dose based on base deficit calculated from arterial blood gas values.<br>• Recognize that to prevent development of rebound metabolic alkalosis, complete correction of acidosis is not indicated. |
| Magnesium—promotes adequate functioning of cellular sodium–potassium pump | Given to patients with torsade de pointes | • May give 1–2 g diluted in 10 mL $D_5W$ over 5–20 minutes.<br>• Monitor for hypotension, asystole, bradycardia, and respiratory paralysis. |

AV, atrioventricular; BP, blood pressure; COPD, chronic obstructive pulmonary disease; $D_5W$, dextrose 5% in water; $FiO_2$, fraction of inspired oxygen; IV, intravenous; SA, sinoatrial.

Assessment and intervention for the patient with cardiac arrest includes utilization of the ABCD protocol. The ABCDs of basic CPR include *a*irway, *b*reathing, *c*irculation, and *d*efibrillation (AHA, 2006):

1. Airway: opening and maintaining an airway
2. Breathing: providing artificial ventilation by rescue breathing if spontaneous respirations are absent or inadequate
3. Circulation: promoting artificial circulation by external cardiac compression when there is no pulse; administering medications (eg, epinephrine for asystole)
4. Defibrillation with standard defibrillator or automatic external defibrillator (AED) for ventricular tachycardia and ventricular fibrillation

If the patient is already being monitored or is immediately placed on the monitor using the multifunction pads (found on most defibrillators) and the ECG shows ventricular fibrillation or the patient is unresponsive with ventricular tachycardia, immediate defibrillation rather than CPR is the treatment of choice. In this scenario, CPR is performed initially only if the defibrillator is not immediately available. The survival rate decreases for every minute that defibrillation is delayed (AHA, 2006). If the patient has not been defibrillated within 10 minutes, there is little chance of survival. Survival after cardiac arrest has been improved by extensive education of health care providers and by the use of semiautomatic defibrillators (Peters & Boyde, 2007). More information on defibrillation can be found in Chapter 27. Chart 30-6 provides information related to family presence during CPR.

### Maintaining Airway and Breathing

The first step in CPR is to establish an open airway. Any obvious material in the mouth or throat should be removed. The airway should be opened using a head-tilt chin-lift maneuver. The rescuer looks, listens, and feels for air movement. An oropharyngeal airway is inserted if available. Two rescue ventilations are provided using a bag-mask or mouth-mask device. An obstructed airway should be suspected when the rescuer cannot give the initial ventilations, and the Heimlich maneuver or abdominal thrusts should be administered to relieve the obstruction (see Chapter 25, Chart 25-6).

If the first rescue ventilations meet little or no resistance, the patient is ventilated every 5 to 6 seconds. Each breath is delivered over 1 second. If the patient is in the hospital, endotracheal intubation is frequently performed by a physician, nurse anesthetist, or respiratory therapist during a resuscitation procedure (also called a code) to ensure an adequate airway and ventilation. The resuscitation bag device is then connected directly to the endotracheal tube (ET).

Because of the risk of unrecognized esophageal intubation or dislodgement of the ET, tracheal intubation must be confirmed by two different methods: a primary method (visualization of the ET through the vocal cords, auscultation of breath sounds in five areas on the chest, or bilateral chest expansion) and a secondary method (carbon dioxide detector). A chest x-ray, which is frequently obtained after ET placement, is helpful in determining whether the ET is too high or too low in the trachea. However, a chest x-ray cannot definitively confirm placement of an ET: an ET in the esophagus or the trachea may produce the same appearance on the x-ray. Arterial blood gas levels are measured to guide ventilation therapy.

### Restoring Circulation

After performing ventilation, the carotid pulse is assessed, and external cardiac compressions are provided if no pulse is detected. If a defibrillator is not yet available but a process has been put into place to obtain one, chest compressions

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CHART 30-6 NURSING RESEARCH PROFILE

## *Family Presence During Invasive Procedures and Cardiopulmonary Resuscitation*

Duran, C. R., Oman, K. S., Abel, J. J., et al. (2007). Attitudes toward and beliefs about family presence: A survey of healthcare providers, patients' families, and patients. *American Journal of Critical Care, 16*(3), 270–279.

#### Purpose

The presence of family members during invasive procedures and resuscitation is becoming accepted practice as the emphasis on family-centered care increases. Resistance to this change in practice has been expressed by some clinicians who identify concerns regarding issues such as family interference with care or increased performance anxiety in health care providers. The purpose of this study was to compare the attitudes and beliefs of clinicians, patients' families, and patients regarding the option of family presence during invasive procedures and cardiopulmonary resuscitation.

#### Design

Surveys were distributed to clinicians (nurses, physicians, and respiratory therapists), patients' family members, and patients in the emergency department and various intensive care units of a large academic hospital. The surveys were completed by 202 clinicians, 72 family members, and 62 patients.

#### Findings

Health care providers had an overall positive attitude about family presence. Nurses were more open to family presence when compared to physicians. Residents, interns, and fellows were more open to the concept when compared with attending physicians, probably reflecting recent trends in exposure to family-centered care. Family members and patients had positive attitudes about family presence and found it beneficial. Some believed the family had a right to be present.

#### Nursing Implications

The results of this study confirm that family presence during invasive procedures and cardiopulmonary resuscitation is beneficial to patients and families. As this option becomes more accepted in practice, nurses and other providers need to plan for and accommodate families at the bedside.



**Figure 30-7** Chest compressions in cardiopulmonary resuscitation (CPR) are performed by placing the heel of one hand in the center of the chest between the nipples and the other hand on top of the first hand. Elbows are kept straight and body weight is used to apply forceful compressions to the lower sternum. For the most effective hand placement and outcome, the patient's chest should be bare.

are initiated. Compressions are performed with the patient on a firm surface, such as the floor or a cardiac board. The rescuer (facing the patient's side) places the heel of one hand in the center of the chest between the nipples and positions the other hand on top of the first hand (Fig. 30-7). The fingers should not touch the chest wall (AHA, 2006).

Using the force of body weight while keeping the elbows straight, the rescuer presses quickly downward from the shoulder area to deliver a forceful compression to the victim's lower sternum about 3.8 to 5 cm (1.5 to 2 in) toward the spine. The chest compression rate is approximately 100 times per minute. A compression to ventilation ratio of 30 to 2 is recommended without pause for ventilations.

When the code team or emergency medical personnel arrive, the patient is quickly assessed to determine cardiac rhythm and respiratory status as well as possible causes of the arrest. The specific subsequent advanced life support interventions depend on the assessment results. For example, after the patient is placed on a cardiac monitor and ventricular fibrillation is detected, the patient is defibrillated, and then CPR is resumed. However, if asystole is detected on the monitor, CPR is resumed immediately while epinephrine is administered and an attempt is made to identify the underlying cause, such as hypovolemia, hypothermia, or hypoxia. CPR may be stopped when the patient responds and begins to breathe, rescuers are too exhausted or at risk (eg, a building is at risk of collapsing) to continue CPR, or signs of death are obvious. If the patient does not respond to therapies given during the arrest, the resuscitation effort may be stopped or "called" by the physician. Many factors are usually considered in the decision: the initiating dysrhythmia and potential etiologies, environmental causes (eg, water drowning, hypothermia, or electrocution), whether the arrest is witnessed, the presence of bystanders to initiate resuscitation efforts, the length of time for initiation of advanced life support, and the patient's response to treatment. AHA guidelines state that resuscitation efforts should continue until death is inevitable (AHA, 2005).

### Follow-Up Monitoring and Care

Once resuscitated, the patient is transferred to an intensive care unit for close monitoring. Continuous ECG monitoring and frequent blood pressure assessments are essential until hemodynamic stability is reestablished. Etiologic factors that precipitated the arrest, such as metabolic or rhythm abnormalities, must be identified and treated. Possible contributing factors, such as electrolyte or acid–base imbalances, need to be identified and corrected. Comatose patients may benefit from therapeutic hypothermia, which induces a drop in core body temperature to 32°C to 34°C (89.6°F to 93.2°F) for 12 to 24 hours postresuscitation, although the best method to induce hypothermia has yet to be determined through research (Neumar, Nolan, Adrie, et al., 2008).

## CRITICAL THINKING EXERCISES

**1** A 79-year-old woman is admitted to the cardiac care unit with a diagnosis of HF. As you start to fill out the admission database, the woman tells you that she is feeling very anxious and cannot catch her breath. What questions do you ask her? What are your assessment priorities? What interventions might need to occur immediately, and how should you act to provide these?

EBP **2** On an inpatient progressive care unit, you are assigned to care for a 60-year-old man who has been readmitted for the third time in the past 6 months with severe HF and generalized edema. According to the patient's chart, he has a history of noncompliance with diet and medications. What are your immediate priorities and short-term goals for this patient? What medical interventions are indicated for this patient at this point in time? Develop an evidence-based plan of care for this patient's transition from hospital to home. Describe your planned interaction with the patient (ie, communication technique, behaviors) that would encourage the patient to participate in the plan and comply with the plan.

EBP **3** A 62-year-old woman is recovering from an acute MI on the telemetry unit. During your assessment, she complains of mild chest pressure. Her vital signs are as follows: blood pressure 86/60 mm Hg, heart rate 104 bpm (beats per minute), respiratory rate 28 breaths/min, and $SpO_2$ 92%. What other parameters should be assessed? Describe your immediate interventions and communication with other key members of the multidisciplinary health care team. Identify the evidence that supports your interventions and expected outcomes. What complications might this patient be experiencing? What should you tell the patient and family about possible pending interventions that might be indicated?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource,http://thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Heart Association, www.americanheart.org
Heart Failure Society of America, www.hfsa.org
Heartmates, Inc., www.heartmates.com
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov



chapter 31

# Assessment and Management of Patients With Vascular Disorders and Problems of Peripheral Circulation

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify anatomic and physiologic factors that affect peripheral blood flow and tissue oxygenation.
2. Use appropriate parameters for assessment of peripheral circulation.
3. Use the nursing process as a framework of care for patients with vascular insufficiency of the extremities.
4. Compare the various diseases of the arteries and their causes, pathophysiologic changes, clinical manifestations, management, and prevention.
5. Describe the prevention and management of venous thromboembolism.
6. Compare strategies to prevent venous insufficiency, leg ulcers, and varicose veins.
7. Use the nursing process as a framework of care for patients with leg ulcers.
8. Describe the relationship between lymphangitis and lymphedema.

## GLOSSARY

**anastomosis:** junction of two vessels

**aneurysm:** a localized sac or dilation of an artery formed at a weak point in the vessel wall

**angioplasty:** an invasive procedure that uses a balloon-tipped catheter to dilate a stenotic area of a blood vessel

**ankle-brachial index (ABI) or ankle-arm index (AAI):** ratio of the ankle systolic pressure to the arm systolic pressure; an objective measurement of arterial disease that provides quantification of the degree of stenosis

**arteriosclerosis:** diffuse process whereby the muscle fibers and the endothelial lining of the walls of small arteries and arterioles thicken

**atherosclerosis:** inflammatory process involving the accumulation of lipids, calcium, blood components, carbohydrates, and fibrous tissue on the intimal layer of a large or medium-sized artery

**bruit:** sound produced by turbulent blood flow through an irregular, tortuous, stenotic, or dilated vessel

**dissection:** separation of the weakened elastic and fibromuscular elements in the medial layer of an artery

**duplex ultrasonography:** combines B-mode gray-scale imaging of tissue, organs, and blood vessels with capabilities of estimating velocity changes by use of a pulsed Doppler

**intermittent claudication:** a muscular, cramplike pain in the extremities consistently reproduced with the same degree of exercise or activity and relieved by rest

**ischemia:** deficient blood supply

**rest pain:** persistent pain in the foot or digits when the patient is resting, indicating a severe degree of arterial insufficiency

**rubor:** reddish blue discoloration of the extremities; indicative of severe peripheral arterial damage in vessels that remain dilated and unable to constrict

**stenosis:** narrowing or constriction of a vessel

Conditions of the vascular system include arterial disorders, venous disorders, lymphatic disorders, and cellulitis. Nursing management depends on an understanding of the vascular system.

# ASSESSMENT OF VASCULAR FUNCTION

Adequate perfusion ensures oxygenation and nourishment of body tissues, and it depends in part on a properly functioning cardiovascular system. Adequate blood flow depends on the efficiency of the heart as a pump, the patency and responsiveness of the blood vessels, and the adequacy of circulating blood volume. Nervous system activity, blood viscosity, and the metabolic needs of tissues influence the rate and adequacy of blood flow.

## Anatomic and Physiologic Overview

The vascular system consists of two interdependent systems. The right side of the heart pumps blood through the lungs to the pulmonary circulation, and the left side of the heart pumps blood to all other body tissues through the systemic circulation. The blood vessels in both systems channel the blood from the heart to the tissues and back to the heart (Fig. 31-1). Contraction of the ventricles is the driving force that moves blood through the vascular system.

Arteries distribute oxygenated blood from the left side of the heart to the tissues, whereas the veins carry deoxygenated blood from the tissues to the right side of the heart. Capillary vessels located within the tissues connect the arterial and venous systems. These vessels permit the exchange of nutrients and metabolic wastes between the circulatory system and the tissues. Arterioles and venules immediately adjacent to the capillaries, together with the capillaries, make up the microcirculation.

The lymphatic system complements the function of the circulatory system. Lymphatic vessels transport lymph (a fluid similar to plasma) and tissue fluids (containing proteins, cells, and cellular debris) from the interstitial space to systemic veins.

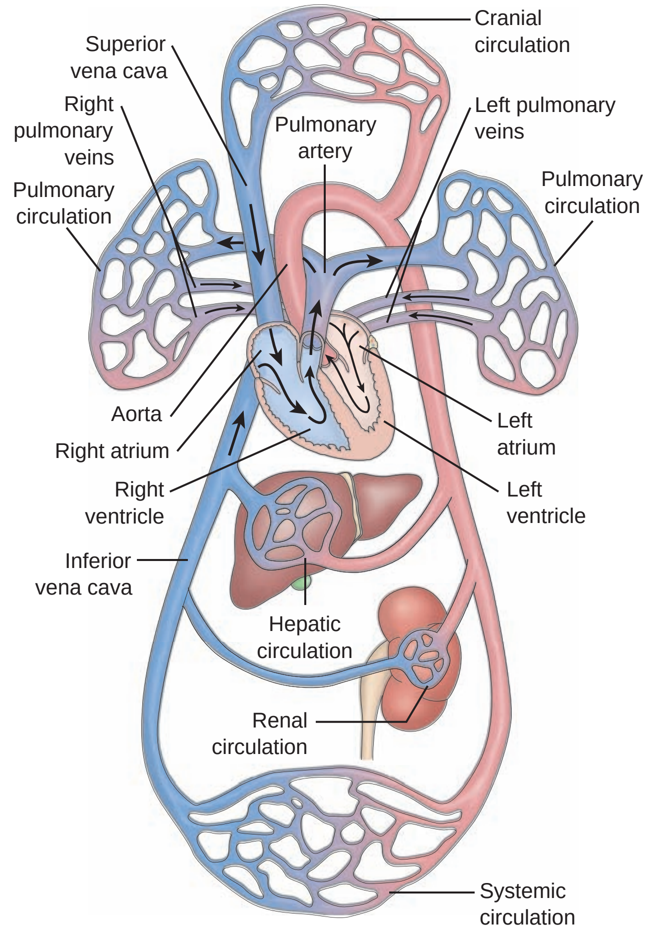



**Figure 31-1** Systemic and pulmonary circulation. Oxygen-rich blood from the pulmonary circulation is pumped from the left heart into the aorta and the systemic arteries to the capillaries, where the exchange of nutrients and waste products takes place. The deoxygenated blood returns to the right heart by way of the systemic veins and is pumped into the pulmonary circulation.

### Anatomy of the Vascular System

#### *Arteries and Arterioles*

Arteries are thick-walled structures that carry blood from the heart to the tissues. The aorta, which has a diameter of approximately 25 mm (1 inch) in the average-sized adult, gives rise to numerous branches, which continue to divide into progressively smaller arteries that are 4 mm (0.16 inch) in diameter. The vessels divide further, diminishing in size to approximately 30 μm in diameter. These smallest arteries, called the arterioles, are generally embedded within the tissues.

The walls of the arteries and arterioles are composed of three layers: the intima, an inner endothelial cell layer; the media, a middle layer of smooth muscle and elastic tissue; and the adventitia, an outer layer of connective tissue. The intima, a very thin layer, provides a smooth surface for contact with the flowing blood. The media makes up most of the vessel wall in the aorta and other large arteries of the body. This layer is composed chiefly of elastic and connective tissue fibers that give the vessels considerable strength and allow them to constrict and dilate to accommodate the blood ejected from the heart during each cardiac cycle (stroke volume) and maintain an even, steady flow of blood. The adventitia is a layer of connective tissue that anchors the vessel to its surroundings. There is much less elastic tissue in the smaller arteries and arterioles, and the media in these vessels is composed primarily of smooth muscle (Porth & Matfin, 2009). Smooth muscle controls the diameter of the vessels by contracting and relaxing. Chemical, hormonal, and neuronal factors influence the activity of smooth muscle. Because arterioles offer resistance to blood flow by altering their diameter, they are often referred to as *resistance vessels*. Arterioles regulate the volume and pressure in the arterial system and the rate of blood flow to the capillaries. Because of the large amount of smooth muscle in the media, the walls of the arteries are relatively thick, accounting for approximately 25% of the total diameter of the artery.

The intima and the inner third of the smooth muscle layer of the media are in such close contact with the blood that the blood vessels receive their nourishment by direct diffusion. The adventitia and the outer media layers have a limited vascular system for nourishment and require their own blood supply to meet metabolic needs.

### Capillaries

The walls of the capillaries, which lack smooth muscle and adventitia, are composed of a single layer of endothelial cells. This thin-walled structure permits rapid and efficient transport of nutrients to the cells and removal of metabolic wastes. The diameter of capillaries ranges from 5 to 10 μm; this means that red blood cells must alter their shape to pass through these vessels. Changes in a capillary's diameter are passive and are influenced by contractile changes in the blood vessels that carry blood to and from a capillary. The capillary's diameter also changes in response to chemical stimuli. In some tissues, a cuff of smooth muscle, called the precapillary sphincter, is located at the arteriolar end of the capillary and is responsible, along with the arteriole, for controlling capillary blood flow (Porth & Matfin, 2009).

Some capillary beds, such as those in the fingertips, contain arteriovenous anastomoses, through which blood passes directly from the arterial to the venous system. These vessels are believed to regulate heat exchange between the body and the external environment.

The distribution of capillaries varies with the type of tissue. For example, skeletal tissue, which has high metabolic requirements, has a denser capillary network than cartilage, which has low metabolic needs.

### Veins and Venules

Capillaries join to form larger vessels called venules, which join to form veins. The venous system is therefore structurally analogous to the arterial system; venules correspond to arterioles, veins to arteries, and the vena cava to the aorta. Analogous types of vessels in the arterial and venous systems have approximately the same diameters (see Fig. 31-1).

The walls of the veins, in contrast to those of the arteries, are thinner and considerably less muscular. In most veins, the wall makes up only 10% of the diameter, in contrast to 25% in most arteries. In veins, the walls are composed of three layers, like those of arteries, although in veins, these layers are not as well defined.

The thin, less muscular structure of the vein wall allows these vessels to distend more than arteries. Greater distensibility and compliance permit large volumes of blood to remain in the veins under low pressure. For this reason, veins are referred to as *capacitance vessels*. Approximately 75% of total blood volume is contained in the veins. The sympathetic nervous system, which innervates the vein musculature, can stimulate the veins to constrict (venoconstriction), thereby reducing venous volume and increasing the volume of blood in the general circulation. Contraction of skeletal muscles in the extremities creates the primary pumping action to facilitate venous blood flow back to the heart (Porth & Matfin, 2009).

Some veins, unlike arteries, are equipped with valves. In general, veins that transport blood against the force of gravity, as in the lower extremities, have one-way bicuspid valves that prevent blood from seeping backward as it is propelled toward the heart. Valves are composed of endothelial leaflets, the competency of which depends on the integrity of the vein wall.

### Lymphatic Vessels

The lymphatic vessels are a complex network of thin-walled vessels similar to the blood capillaries. This network collects lymphatic fluid from tissues and organs and transports the fluid to the venous circulation. The lymphatic vessels converge into two main structures: the thoracic duct and the right lymphatic duct. These ducts empty into the junction of the subclavian and the internal jugular veins. The right lymphatic duct conveys lymph primarily from the right side of the head, neck, thorax, and upper arms. The thoracic duct conveys lymph from the remainder of the body. Peripheral lymphatic vessels join larger lymph vessels and pass through regional lymph nodes before entering the venous circulation. The lymph nodes play an important role in filtering foreign particles.

The lymphatic vessels are permeable to large molecules and provide the only means by which interstitial proteins can return to the venous system. With muscular contraction, lymph vessels become distorted to create spaces between the endothelial cells, allowing protein and particles to enter. Muscular contraction of the lymphatic walls and surrounding tissues aids in propelling the lymph toward the venous drainage points (Porth & Matfin, 2009).

## Function of the Vascular System

### Circulatory Needs of Tissues

The amount of blood flow needed by body tissues constantly changes. The percentage of blood flow received by individual organs or tissues is determined by the rate of tissue metabolism, the availability of oxygen, and the function of the tissues. When metabolic requirements increase, blood vessels dilate to increase the flow of oxygen and nutrients to the tissues. When metabolic needs decrease, vessels constrict and blood flow to the tissues decreases. Metabolic demands of tissues increase with physical activity or exercise, local heat application, fever, and infection. Reduced metabolic requirements of tissues accompany rest or decreased physical activity, local cold application, and cooling of the body. If the blood vessels fail to dilate in response to the need for increased blood flow, tissue **ischemia** (deficient blood supply to a body part) results. The mechanism by which blood vessels dilate and constrict to adjust for metabolic changes ensures that normal arterial pressure is maintained (Porth & Matfin, 2009).

As blood passes through tissue capillaries, oxygen is removed and carbon dioxide is added. The amount of oxygen extracted by each tissue differs. For example, the myocardium tends to extract about 50% of the oxygen from arterial blood in one pass through its capillary bed, whereas the kidneys extract only about 7% of the oxygen from the blood that passes through them. The average amount of oxygen removed collectively by all of the body tissues is about 25%. This means that the blood in the vena cava contains about 25% less oxygen than aortic blood. This is known as the *systemic arteriovenous oxygen difference* (Porth

& Matfin, 2009). This difference becomes greater when less oxygen is delivered to the tissues than they need.

### Blood Flow

Blood flow through the cardiovascular system always proceeds in the same direction: left side of the heart to the aorta, arteries, arterioles, capillaries, venules, veins, vena cava, and right side of the heart. This unidirectional flow is caused by a pressure difference that exists between the arterial and venous systems. Because arterial pressure (approximately 100 mm Hg) is greater than venous pressure (approximately 40 mm Hg) and fluid always flows from an area of higher pressure to an area of lower pressure, blood flows from the arterial to the venous system.

The pressure difference ($\Delta P$) between the two ends of the vessel propels the blood. Impediments to blood flow offer the opposing force, which is known as resistance (R). The rate of blood flow is determined by dividing the pressure difference by the resistance:

$$\text{Flow rate} = \Delta P/R$$

This equation clearly shows that when resistance increases, a greater driving pressure is required to maintain the same degree of flow (Porth & Matfin, 2009). In the body, an increase in driving pressure is accomplished by an increase in the force of contraction of the heart. If arterial resistance is chronically elevated, the myocardium hypertrophies (enlarges) to sustain the greater contractile force.

In most long smooth blood vessels, flow is laminar or streamlined, with blood in the center of the vessel moving slightly faster than the blood near the vessel walls. Laminar flow becomes turbulent when the blood flow rate increases, when blood viscosity increases, when the diameter of the vessel becomes greater than normal, or when segments of the vessel are narrowed or constricted (Porth & Matfin, 2009). Turbulent blood flow creates a sound, called a **bruit,** that can be heard with a stethoscope.

### Blood Pressure

Chapter 32 provides more information on the physiology and measurement of blood pressure.

### Capillary Filtration and Reabsorption

Fluid exchange across the capillary wall is continuous. This fluid, which has the same composition as plasma without the proteins, forms the interstitial fluid. The equilibrium between hydrostatic and osmotic forces of the blood and interstitium, as well as capillary permeability, determines the amount and direction of fluid movement across the capillary. Hydrostatic force is a driving pressure that is generated by the blood pressure. Osmotic pressure is the pulling force created by plasma proteins. Normally, the hydrostatic pressure at the arterial end of the capillary is relatively high compared with that at the venous end. This high pressure at the arterial end of the capillaries tends to drive fluid out of the capillary and into the tissue space. Osmotic pressure tends to pull fluid back into the capillary from the tissue space, but this osmotic force cannot overcome the high hydrostatic pressure at the arterial end of the capillary. However, at the venous end of the capillary, the osmotic force predominates over the low hydrostatic pressure, and there is a net reabsorption of fluid from the tissue space back into the capillary (Porth & Matfin, 2009).

Except for a very small amount, fluid that is filtered out at the arterial end of the capillary bed is reabsorbed at the venous end. The excess filtered fluid enters the lymphatic circulation. These processes of filtration, reabsorption, and lymph formation aid in maintaining tissue fluid volume and removing tissue waste and debris. Under normal conditions, capillary permeability remains constant.

Under certain abnormal conditions, the fluid filtered out of the capillaries may greatly exceed the amounts reabsorbed and carried away by the lymphatic vessels. This imbalance can result from damage to capillary walls and subsequent increased permeability, obstruction of lymphatic drainage, elevation of venous pressure, or a decrease in plasma protein osmotic force. Accumulation of excess interstitial fluid that results from these processes is known as *edema.*

### Hemodynamic Resistance

The most important factor that determines resistance in the vascular system is the vessel radius. Small changes in vessel radius lead to large changes in resistance. The predominant sites of change in the caliber or width of blood vessels, and therefore in resistance, are the arterioles and the precapillary sphincter. Peripheral vascular resistance is the opposition to blood flow provided by the blood vessels. This resistance is proportional to the viscosity or thickness of the blood and the length of the vessel and is influenced by the diameter of the vessels. Under normal conditions, blood viscosity and vessel length do not change significantly, and these factors do not usually play an important role in blood flow. However, a large increase in hematocrit may increase blood viscosity and reduce capillary blood flow.

### Peripheral Vascular Regulating Mechanisms

Even at rest, the metabolic needs of body tissues are continuously changing. Therefore, an integrated and coordinated regulatory system is necessary so that blood flow to individual tissues is maintained in proportion to the needs of those tissues. This regulatory mechanism is complex and consists of central nervous system influences, circulating hormones and chemicals, and independent activity of the arterial wall itself.

Sympathetic (adrenergic) nervous system activity, mediated by the hypothalamus, is the most important factor in regulating the caliber and therefore the blood flow of peripheral blood vessels. All vessels are innervated by the sympathetic nervous system except the capillary and precapillary sphincters. Stimulation of the sympathetic nervous system causes vasoconstriction. The neurotransmitter responsible for sympathetic vasoconstriction is norepinephrine (Porth & Matfin, 2009). Sympathetic activation occurs in response to physiologic and psychological stressors. Diminution of sympathetic activity by medications or sympathectomy results in vasodilation.

Other hormones affect peripheral vascular resistance. Epinephrine, released from the adrenal medulla, acts like norepinephrine in constricting peripheral blood vessels in most tissue beds. However, in low concentrations, epinephrine

causes vasodilation in skeletal muscles, the heart, and the brain. Angiotensin I, which is formed from the interaction of renin (synthesized by the kidney) and angiotensinogen, a circulating serum protein, is then converted to angiotensin II by an enzyme secreted by the pulmonary vasculature, called angiotensin-converting enzyme (ACE). Angiotensin II is a potent vasoconstrictor, particularly of the arterioles. Although the amount of angiotensin II concentrated in the blood is usually small, its profound vasoconstrictive effects are important in certain abnormal states, such as heart failure and hypovolemia (Porth & Matfin, 2009).

Alterations in local blood flow are influenced by various circulating substances that have vasoactive properties. Potent vasodilators include nitric oxide, prostacyclin, histamine, bradykinin, prostaglandin, and certain muscle metabolites. A reduction in available oxygen and nutrients and changes in local pH also affect local blood flow. Thromboxane $A_2$ and serotonin are substances liberated from platelets that aggregate at the site of damaged vessels, causing arteriolar vasoconstriction and continued platelet aggregation at the site of injury (Mullenix, Anderson & Starnes, 2005).

## Pathophysiology of the Vascular System

Reduced blood flow through peripheral blood vessels characterizes all peripheral vascular diseases. The physiologic effects of altered blood flow depend on the extent to which tissue demands exceed the supply of oxygen and nutrients available. If tissue needs are high, even modestly reduced blood flow may be inadequate to maintain tissue integrity. Tissues then fall prey to ischemia, become malnourished, and ultimately die unless adequate blood flow is restored.

### Pump Failure

Inadequate peripheral blood flow occurs when the heart's pumping action becomes inefficient. Left-sided heart failure (left ventricular failure) causes an accumulation of blood in the lungs and a reduction in forward flow or cardiac output, which results in inadequate arterial blood flow to the tissues. Right-sided heart failure (right ventricular failure) causes systemic venous congestion and a reduction in forward flow (see Chapter 30).

### Alterations in Blood and Lymphatic Vessels

Intact, patent, and responsive blood vessels are necessary to deliver adequate amounts of oxygen to tissues and to remove metabolic wastes. Arteries can become damaged or obstructed as a result of atherosclerotic plaque, thromboemboli, chemical or mechanical trauma, infections or inflammatory processes, vasospastic disorders, and congenital malformations. A sudden arterial occlusion causes profound and often irreversible tissue ischemia and tissue death. When arterial occlusions develop gradually, there is less risk of sudden tissue death because collateral circulation may develop, giving that tissue the opportunity to adapt to gradually decreased blood flow.

Venous blood flow can be reduced by a thromboembolus obstructing the vein, by incompetent venous valves, or by a reduction in the effectiveness of the pumping action of surrounding muscles. Decreased venous blood flow results in increased venous pressure, a subsequent increase in capillary hydrostatic pressure, net filtration of fluid out of the capillaries into the interstitial space, and subsequent edema. Edematous tissues cannot receive adequate nutrition from the blood and consequently are more susceptible to breakdown, injury, and infection. Obstruction of lymphatic vessels also results in edema. Lymphatic vessels can become obstructed by a tumor or by damage from mechanical trauma or inflammatory processes.

### Circulatory Insufficiency of the Extremities

Although many types of peripheral vascular diseases exist, most result in ischemia and produce some of the same symptoms: pain, skin changes, diminished pulse, and possible edema. The type and severity of symptoms depend in part on the type, stage, and extent of the disease process and on the speed with which the disorder develops. Table 31-1 highlights the distinguishing features of arterial and venous insufficiency. In this chapter, peripheral vascular disease is categorized as arterial, venous, or lymphatic.

**Table 31-1 CHARACTERISTICS OF ARTERIAL AND VENOUS INSUFFICIENCY AND RESULTING ULCERS**

| Characteristic | Arterial | Venous |
|---|---|---|
| **General Characteristics** | | |
| Pain | Intermittent claudication to sharp, unrelenting, constant | Aching, cramping |
| Pulses | Diminished or absent | Present, but may be difficult to palpate through edema |
| Skin characteristics | Dependent rubor—elevation pallor of foot; dry, shiny skin; cool-to-cold temperature; loss of hair over toes and dorsum of foot; nails thickened and ridged | Pigmentation in gaiter area (area of medial and lateral malleolus), skin thickened and tough, may be reddish blue, frequently with associated dermatitis |
| **Ulcer Characteristics** | | |
| Location | Tip of toes, toe webs, heel or other pressure areas if confined to bed | Medial malleolus; infrequently lateral malleolus or anterior tibial area |
| Pain | Very painful | Minimal pain if superficial or may be very painful |
| Depth of ulcer | Deep, often involving joint space | Superficial |
| Shape | Circular | Irregular border |
| Ulcer base | Pale to black and dry gangrene | Granulation tissue—beefy red to yellow fibrinous in chronic long-term ulcer |
| Leg edema | Minimal unless extremity kept in dependent position constantly to relieve pain | Moderate to severe |

### Gerontologic Considerations

Aging produces changes in the walls of the blood vessels that affect the transport of oxygen and nutrients to the tissues. The intima thickens as a result of cellular proliferation and fibrosis. Elastin fibers of the media become calcified, thin, and fragmented, and collagen accumulates in the intima and the media. These changes cause the vessels to stiffen, which results in increased peripheral resistance, impaired blood flow, and increased left ventricular workload.

## Assessment

### Health History

The nurse obtains an in-depth description from the patient of any pain and its precipitating factors. A muscular, cramp-type pain in the extremities consistently reproduced with the same degree of exercise or activity and relieved by rest is experienced by patients with peripheral arterial insufficiency. Referred to as **intermittent claudication,** this pain is caused by the inability of the arterial system to provide adequate blood flow to the tissues in the face of increased demands for nutrients and oxygen during exercise. As the tissues are forced to complete the energy cycle without adequate nutrients and oxygen, muscle metabolites and lactic acid are produced. Pain is experienced as the metabolites aggravate the nerve endings of the surrounding tissue. Typically, about 50% of the arterial lumen or 75% of the cross-sectional area must be obstructed before intermittent claudication is experienced. When the patient rests and thereby decreases the metabolic needs of the muscles, the pain subsides. The progression of the arterial disease can be monitored by documenting the amount of exercise or the distance the patient can walk before pain is produced. Persistent pain in the forefoot (ie, the anterior portion of the foot) when the patient is resting indicates a severe degree of arterial insufficiency and a critical state of ischemia. Known as **rest pain,** this discomfort is often worse at night and may interfere with sleep. This pain frequently requires that the extremity be lowered to a dependent position to improve perfusion to the distal tissues.

The site of arterial disease can be deduced from the location of claudication, because pain occurs in muscle groups distal to the diseased vessel. Calf pain may accompany reduced blood flow through the superficial femoral or popliteal artery, whereas pain in the hip or buttock may result from reduced blood flow in the abdominal aorta or the common iliac or hypogastric arteries.

### Physical Assessment

A thorough assessment of the patient's skin color and temperature and the character of the peripheral pulses is important in the diagnosis of arterial disorders.

#### *Inspection of the Skin*

Adequate blood flow warms the extremities and gives them a rosy coloring. Inadequate blood flow results in cool and pale extremities. Further reduction of blood flow to these tissues, which occurs when the extremity is elevated, for example, results in an even whiter or more blanched appearance (eg, pallor). **Rubor,** a reddish-blue discoloration of the extremities, may be observed within 20 seconds to 2 minutes after the extremity is placed in the dependent position. Rubor suggests severe peripheral arterial damage in which vessels that cannot constrict remain dilated. Even with rubor, the extremity begins to turn pale with elevation. Cyanosis, a bluish tint of the skin, is manifested when the amount of oxygenated hemoglobin contained in the blood is reduced.

Additional changes resulting from a chronically reduced nutrient supply include loss of hair, brittle nails, dry or scaling skin, atrophy, and ulcerations. Edema may be apparent bilaterally or unilaterally and is related to the affected extremity's chronically dependent position because of severe rest pain. Gangrenous changes appear after prolonged, severe ischemia and represent tissue necrosis.

#### *Palpation of Pulses*

Determining the presence or absence, as well as the quality, of peripheral pulses is important in assessing the status of peripheral arterial circulation (Fig. 31-2). Palpation of pulses is subjective, and the examiner may mistake his or her own pulse for that of the patient. To prevent this, the examiner should use light touch and avoid using only the index finger for palpation because this finger has the strongest arterial pulsation of all the fingers. The thumb should not be used for the same reason. Absence of a pulse may indicate that the site of **stenosis** (narrowing or constriction) is proximal to that location. Occlusive arterial disease impairs blood flow and can reduce or obliterate palpable pulsations in the extremities. Pulses should be palpated bilaterally and simultaneously, comparing both sides for symmetry in rate, rhythm, and quality.

### Gerontologic Considerations

In elderly people, symptoms of peripheral arterial disease may be more pronounced than in younger people. In elderly patients who are inactive, gangrene may be the first sign of disease. These patients may have adjusted their lifestyle to accommodate the limitations imposed by the disease and may not walk far enough to develop symptoms of claudication. Circulation is decreased, but this is not apparent to the patient until trauma occurs. At this point, gangrene develops when minimal arterial flow is impaired further by edema formation resulting from the traumatic event.

Intermittent claudication may occur after walking only one-half to one block or after walking up a slight incline. Any prolonged pressure on the foot can cause pressure areas that become ulcerated, infected, and gangrenous. The outcomes of arterial insufficiency can include reduced mobility and activity as well as a loss of independence. Older people with reduced mobility are less likely to remain in the community setting, have higher rates of hospitalizations, and experience a poorer quality of life (McDermott, Guralnik, Tian, et al., 2007).

## Diagnostic Evaluation

Various tests may be performed to identify and diagnose abnormalities that can affect the vascular structures (arteries, veins, and lymphatics).

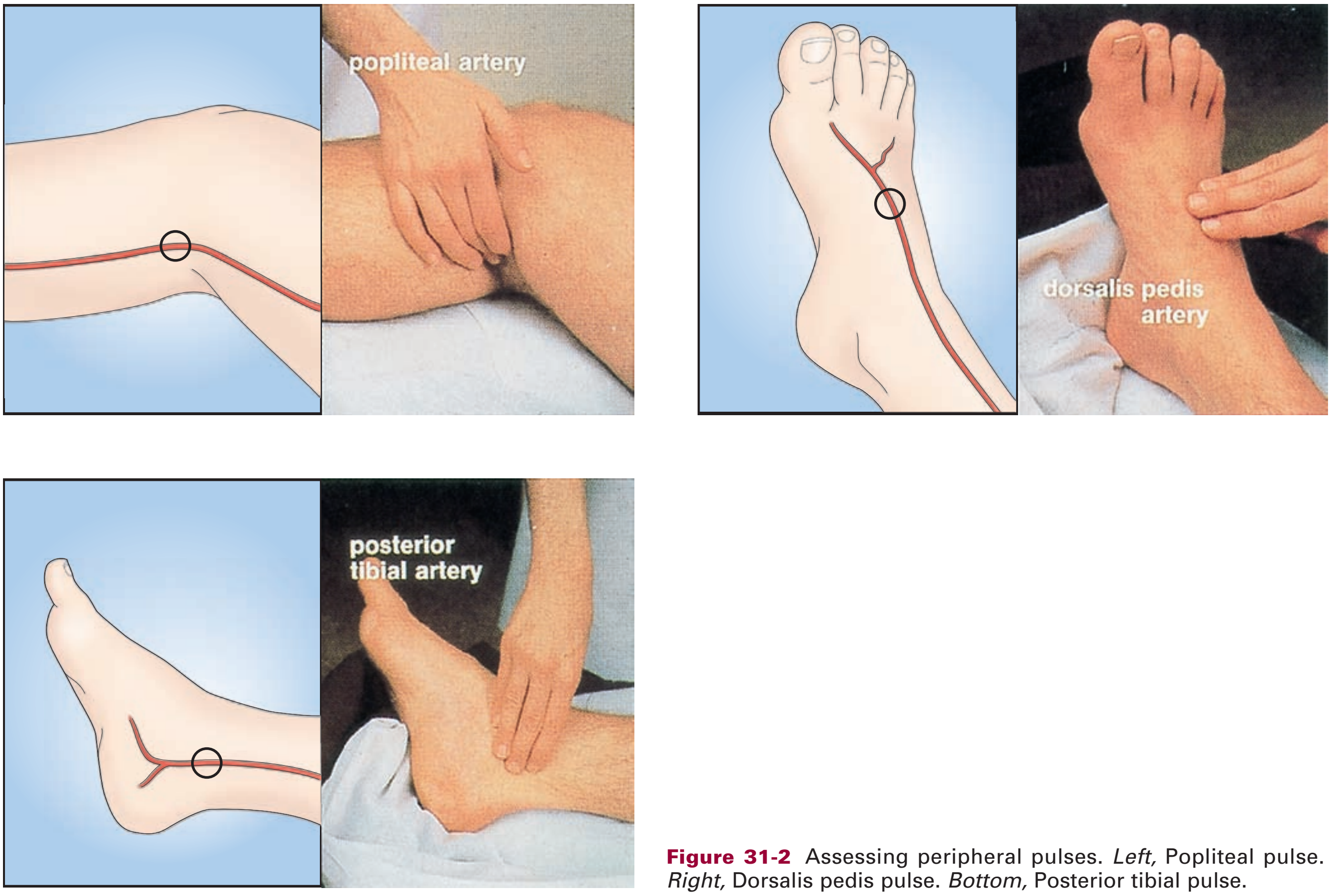



**Figure 31-2** Assessing peripheral pulses. *Left,* Popliteal pulse. *Right,* Dorsalis pedis pulse. *Bottom,* Posterior tibial pulse.

## Doppler Ultrasound Flow Studies

When pulses cannot be reliably palpated, a handheld continuous wave (CW) Doppler ultrasound device may be used to hear (insonate) the blood flow in vessels. This handheld device emits a continuous signal through the patient's tissues. The signals are reflected by ("echo off") the moving blood cells and are received by the device. The filtered-output Doppler signal is then transmitted to a loudspeaker or headphones, where it can be heard for interpretation. Because CW Doppler emits a continuous signal, all vascular structures in the path of the sound beam are insonated, and differentiating arterial from venous flow and detecting the site of a stenosis may be difficult. The depth at which blood flow can be detected by Doppler is determined by the frequency (in megahertz [MHz]) it generates. The lower the frequency, the deeper the tissue penetration; a 5- to 10-MHz probe may be used to evaluate the peripheral arteries.

To evaluate the lower extremities, the patient is placed in the supine position with the head of the bed elevated 20 to 30 degrees; the legs are externally rotated, if possible, to permit adequate access to the medial malleolus. Acoustic gel is applied to the patient's skin to permit uniform transmission of the ultrasound wave. The tip of the Doppler transducer is positioned at a 45- to 60-degree angle over the expected location of the artery and angled slowly to identify arterial blood flow. Excessive pressure is avoided because severely diseased arteries can collapse with even minimal pressure.

Because the transducer can detect blood flow in advanced arterial disease states, especially if collateral circulation has developed, identifying a signal documents only the presence of blood flow. The patient's provider must be notified of the absence of a signal if one had been detected previously.

CW Doppler is more useful as a clinical tool when combined with ankle blood pressures, which are used to determine the **ankle-brachial index (ABI),** also called the **ankle-arm index (AAI)** (Fig. 31-3). The ABI is the ratio of the systolic blood pressure in the ankle to the systolic blood pressure in the arm. It is an objective indicator of arterial disease that allows the examiner to quantify the degree of stenosis. With increasing degrees of arterial narrowing, there is a progressive decrease in systolic pressure distal to the involved sites.

The first step in determining the ABI is to have the patient rest in a supine position (not seated) for approximately 5 minutes. An appropriate-sized blood pressure cuff (typically, a 10-cm cuff) is applied to the patient's ankle above the malleolus. After identifying an arterial signal at the posterior tibial and dorsalis pedis arteries, the systolic pressures are obtained in both ankles. Diastolic pressures in the ankles cannot be measured with a Doppler. If pressure in these arteries cannot be measured, pressure can be measured in the peroneal artery, which can also be assessed at the ankle (Fig. 31-4).

Doppler ultrasonography is used to measure brachial pressures in both arms. Both arms are evaluated because the



**Figure 31-3** Continuous-wave (CW) Doppler ultrasound detects blood flow in peripheral vessels. Combined with computation of ankle or arm pressures, this diagnostic technique helps health care providers characterize the nature of peripheral vascular disease. Photograph reprinted with permission from Cantwell-Gab, K. (1996). Identifying chronic PAD. *American Journal of Nursing, 96*(7), 40–46.

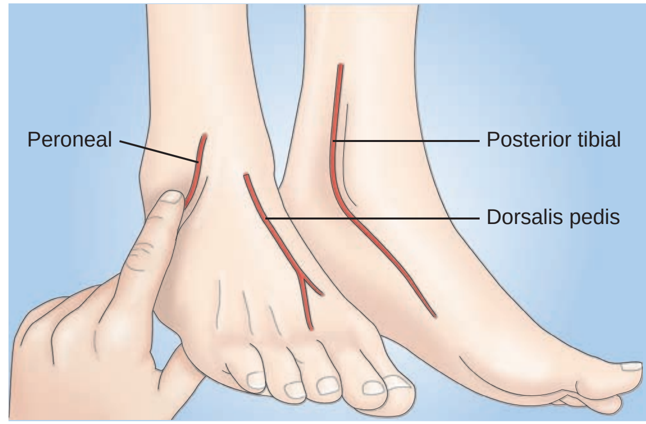



**Figure 31-4** Location of peroneal artery; lateral malleolus.

patient may have an asymptomatic stenosis in the subclavian artery, causing brachial pressure on the affected side to be 20 mm Hg or more lower than systemic pressure. The abnormally low pressure should not be used for assessment.

To calculate ABI, the ankle systolic pressure for each foot is divided by the higher of the two brachial systolic pressures (Chart 31-1). The ABI can be computed for a patient with the following systolic pressures:

*Right brachial:* 160 mm Hg
*Left brachial:* 120 mm Hg
*Right posterior tibial:* 80 mm Hg
*Right dorsalis pedis:* 60 mm Hg
*Left posterior tibial:* 100 mm Hg
*Left dorsalis pedis:* 120 mm Hg

The highest systolic pressure for each ankle (80 mm Hg for the right, 120 mm Hg for the left) would be divided by the highest brachial pressure (160 mm Hg):

*Right:* 80/160 mm Hg = 0.50 ABI
*Left:* 120/160 mm Hg = 0.75 ABI

In general, systolic pressure in the ankle of a healthy person is the same or slightly higher than the brachial systolic pressure, resulting in an ABI of about 1.0 (no arterial insufficiency). Patients with claudication usually have an ABI of 0.95 to 0.50 (mild to moderate insufficiency); patients with ischemic rest pain have an ABI of less than 0.50; and patients with severe ischemia or tissue loss have an ABI of 0.25 or less.

## Exercise Testing

Exercise testing is used to determine how long a patient can walk and to measure the ankle systolic blood pressure in response to walking. The patient walks on a treadmill at 1.5 mph with a 10% incline for a maximum of 5 minutes. Most patients can complete the test unless they have severe cardiac, pulmonary, or orthopedic problems or a physical disability. A normal response to the test is little or no drop in ankle systolic pressure after exercise. However, in a patient with true vascular claudication, the ankle pressure drops. Combining this hemodynamic information with the

### Chart 31-1 • *Avoiding Common Errors in Calculating Ankle-Brachial Index (ABI)*

Take the following precautions to ensure an accurate ABI calculation:

- *Use the correctly sized blood pressure (BP) cuffs.* To obtain accurate BP measurements, use a cuff with a bladder width at least 40% and length at least 80% of the limb circumference.
- *On the nursing plan of care, document the BP cuff sizes used* (eg, "12-cm BP cuff used for brachial pressures; 10-cm BP cuff used for ankle pressures"). This minimizes the risk of shift-to-shift discrepancies in ABIs.
- *Use sufficient BP cuff inflation.* To ensure complete closure of the artery and the most accurate measurements, inflate cuffs 20 to 30 mm Hg beyond the point at which the last arterial signal is detected.
- *Do not deflate BP cuffs too rapidly.* Try to maintain a deflation rate of 2 to 4 mm Hg/sec for patients without dysrhythmias and 2 mm Hg/sec or slower for patients with dysrhythmias. Deflating the cuff more rapidly may miss the patient's highest pressure and result in recording an erroneous (low) BP measurement.
- *Be suspicious of arterial pressures recorded at less than 40 mm Hg.* This may mean the venous signal has been mistaken for the arterial signal. If the arterial pressure, which is normally 120 mm Hg, is measured at less than 40 mm Hg, ask a colleague to double-check the findings before recording this as an arterial pressure.
- *Suspect medial calcific sclerosis anytime an ABI is 1.3 or greater or ankle pressure is more than 300 mm Hg.* Medial calcific sclerosis is associated with diabetes mellitus, chronic renal failure, and hyperparathyroidism. It produces falsely elevated ankle pressures by hardening the media of the arteries, making the vessels noncompressible.

From Cantwell-Gab, K. (1996). Identifying chronic PAD. *American Journal of Nursing, 96*(1) 40–46, with permission.

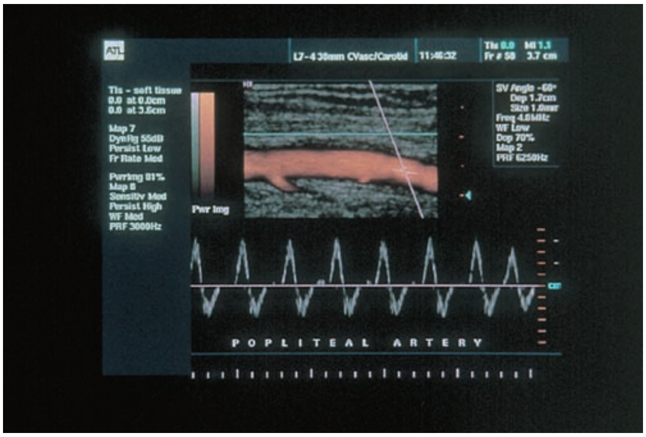



**Figure 31-5** Color flow duplex image of popliteal artery with normal triphasic Doppler flow.

walking time helps the clinician determine whether intervention is necessary.

## Duplex Ultrasonography

**Duplex ultrasonography** involves B-mode gray-scale imaging of the tissue, organs, and blood vessels (arterial and venous) and permits estimation of velocity changes by use of a pulsed Doppler (Fig. 31-5). Color flow techniques, which can identify vessels, may be used to shorten the examination time. The procedure primarily helps determine the level and extent of venous disease. The technique makes it possible to image and assess blood flow, evaluate flow of the distal vessels, locate the disease (stenosis versus occlusion), and determine anatomic morphology and the hemodynamic significance of plaque causing stenosis. Duplex ultrasound findings help in planning therapy and monitoring its outcomes. The test is noninvasive and usually requires no patient preparation. The equipment is portable, making it useful anywhere for initial diagnosis, screening, or follow-up evaluations.

## Computed Tomography

Computed tomography (CT) provides cross-sectional images of soft tissue and visualizes the area of volume changes to an extremity and the compartment where changes take place. CT of a lymphedematous arm or leg, for example, demonstrates a characteristic honeycomb pattern in the subcutaneous tissue.

In spiral (also called helical) CT, the scan head moves circumferentially around the patient as the patient passes through the scanner, creating a series of overlapping images that are connected to one another in a continuous spiral. Currently, 64-"slice" scanners, which have 64 visual pictures per rotation, are available in most imaging centers; these provide improved volume coverage speed and/or longitudinal spatial resolution, resulting in improved images (Hallett & Fleischmann, 2006). Scan times are short. However, the patient is exposed to x-rays, and a contrast agent is usually injected to visualize the blood vessels. Using computer software, the slicelike images are reconstructed into three-dimensional images that can be rotated and viewed from multiple angles.

## Computed Tomography Angiography

In computed tomography angiography (CTA), a spiral CT scanner and rapid intravenous (IV) infusion of contrast agent are used to image very thin sections of the target area, and the results are configured in three dimensions so that the image closely resembles an angiogram. A CTA of the thoracic or abdominal vasculature may be performed using 1.0- to 1.5-mm slices. However, thinner, 0.4- to 0.6-mm slices may be needed to evaluate small vessels such as those in the brain, kidney, upper extremity, or below-knee lower extremity. Achieving this increased resolution requires a higher radiation dose; therefore, this test is justified only if there is a potentially significant diagnostic gain (Hallett & Fleischmann, 2007). The high volume of contrast agent injected into a peripheral vein limits the usefulness of CTA in children and patients with significantly impaired renal function.

## Angiography

An arteriogram produced by angiography may be used to confirm the diagnosis of occlusive arterial disease when surgery or other interventions are considered. It involves injecting a radiopaque contrast agent directly into the arterial system to visualize the vessels. The location of a vascular obstruction or an **aneurysm** (abnormal dilation of a blood vessel) and the collateral circulation can be demonstrated. Typically, the patient experiences a temporary sensation of warmth as the contrast agent is injected, and local irritation may occur at the injection site. Infrequently, a patient may have an immediate or delayed allergic reaction to the iodine contained in the contrast agent. Manifestations include dyspnea, nausea and vomiting, sweating, tachycardia, and numbness of the extremities. Any such reaction must be reported to the interventionalist at once; treatment may include the administration of epinephrine, antihistamines, or corticosteroids. Additional risks include vessel injury, acute arterial occlusion, bleeding, or contrast nephropathy.

## Magnetic Resonance Angiography

Magnetic resonance angiography (MRA) is performed with a standard magnetic resonance imaging (MRI) scanner and special software programmed to isolate the blood vessels. The resulting images resemble a standard angiogram, but the images can be rotated and viewed from multiple angles.

## Air Plethysmography

Air plethysmography is used to quantify venous reflux and calf muscle pump ejection. Changes in leg volumes are measured with the patient's legs elevated, with the patient supine and standing, and after the patient performs toe-ups (the patient extends the ankle while standing; stands on his or her toes) by an air-filled device wrapped around the feet and legs. Air plethysmography provides information about venous filling time, functional venous volume, ejected volume, and residual volume. It is useful in evaluating patients with suspected valvular incompetence or chronic venous insufficiency but is not used for diagnosis of deep vein thrombosis.

## Contrast Phlebography (Venography)

Also known as venography, contrast phlebography involves injecting a radiopaque contrast agent into the venous system. If a thrombus exists, the x-ray image reveals an unfilled segment of vein in an otherwise completely filled vein. Injection of the contrast agent may cause brief but painful inflammation of the vein. The test is generally performed if the patient is to undergo thrombolytic therapy, but duplex ultrasonography is considered the standard for diagnosing lower extremity venous thrombosis.

## Lymphangiography

Lymphangiography provides a way of detecting lymph node involvement resulting from metastatic carcinoma, lymphoma, or infection in sites that are otherwise inaccessible to the examiner except by surgery. In this test, a lymphatic vessel in each foot (or hand) is injected with contrast agent. A series of x-rays is taken at the conclusion of the injection, 24 hours later, and periodically thereafter, as indicated. The failure to identify subcutaneous lymphatic collection of contrast agent and the persistence of contrast agent in the tissue for days afterward help confirm a diagnosis of lymphedema.

## Lymphoscintigraphy

Lymphoscintigraphy is a reliable alternative to lymphangiography. A radioactively labeled colloid is injected subcutaneously in the second interdigital space. The extremity is then exercised to facilitate the uptake of the colloid by the lymphatic system, and serial images are obtained at preset intervals.

# ARTERIAL DISORDERS

## *Arteriosclerosis and Atherosclerosis*

**Arteriosclerosis** is the most common disease of the arteries; the term means “hardening of the arteries.” It is a diffuse process whereby the muscle fibers and the endothelial lining of the walls of small arteries and arterioles become thickened. **Atherosclerosis** involves a different process, affecting the intima of the large and medium-sized arteries. These changes consist of the accumulation of lipids, calcium, blood components, carbohydrates, and fibrous tissue on the intimal layer of the artery. These accumulations are referred to as atheromas or plaques.

Although the pathologic processes of arteriosclerosis and atherosclerosis differ, rarely does one occur without the other, and the terms are often used interchangeably. Atherosclerosis is a generalized disease of the arteries, and when it is present in the extremities, it is usually present elsewhere in the body.

### Pathophysiology

The most common direct results of atherosclerosis in arteries include narrowing (stenosis) of the lumen, obstruction by thrombosis, aneurysm, ulceration, and rupture. Its indirect results are malnutrition and the subsequent fibrosis of the organs that the sclerotic arteries supply with blood. All actively functioning tissue cells require an abundant supply of nutrients and oxygen and are sensitive to any reduction in the supply of these nutrients. If such reductions are severe and permanent, the cells undergo ischemic necrosis (death of cells due to deficient blood flow) and are replaced by fibrous tissue, which requires much less blood flow.

Atherosclerosis can develop at any point in the body, but certain sites are more vulnerable, such as regions where arteries bifurcate or branch into smaller vessels. In the proximal lower extremity, these include the distal abdominal aorta, the common iliac arteries, the orifice of the superficial femoral and profunda femoris arteries, and the superficial femoral artery in the adductor canal, which is particularly narrow. Distal to the knee, atherosclerosis can occur anywhere along the artery.

Although many theories exist about the development of atherosclerosis, no single theory explains the pathogenesis completely; however, tenets of several theories are incorporated into the reaction-to-injury theory. According to this theory, vascular endothelial cell injury results from prolonged hemodynamic forces, such as shearing stresses and turbulent flow, irradiation, chemical exposure, or chronic hyperlipidemia. Injury to the endothelium increases the aggregation of platelets and monocytes at the site of the injury. Smooth muscle cells migrate and proliferate, allowing a matrix of collagen and elastic fibers to form (Guzman, 2007).

Atherosclerotic lesions are of two types: fatty streaks and fibrous plaque:

- Fatty streaks are yellow and smooth, protrude slightly into the lumen of the artery, and are composed of lipids and elongated smooth muscle cells. These lesions have been found in the arteries of people of all age groups, including infants. It is not clear whether fatty streaks predispose a person to the formation of fibrous plaques or whether they are reversible. They do not usually cause clinical symptoms.
- Fibrous plaques are composed of smooth muscle cells, collagen fibers, plasma components, and lipids. They are white to white-yellow and protrude in various degrees into the arterial lumen, sometimes completely obstructing it. These plaques are found predominantly in the abdominal aorta and the coronary, popliteal, and internal carotid arteries, and they are believed to be progressive lesions (Fig. 31-6).

Gradual narrowing of the arterial lumen stimulates the development of collateral circulation (Fig. 31-7). Collateral circulation arises from preexisting vessels that enlarge to reroute blood flow around a hemodynamically significant stenosis or occlusion. Collateral flow allows continued perfusion to the tissues, but it is often inadequate to meet increased metabolic demand, and ischemia results.

### Risk Factors

Many risk factors are associated with atherosclerosis (Chart 31-2). Although it is not entirely clear whether modification of these risk factors prevents the development of cardiovascular disease, evidence indicates that it may slow the disease process (Ostchega, Dillon, Hughes, et al., 2007).

The use of tobacco products may be one of the most important risk factors in the development of atherosclerotic lesions. Nicotine in tobacco decreases blood flow to the extremities and increases heart rate and blood pressure by

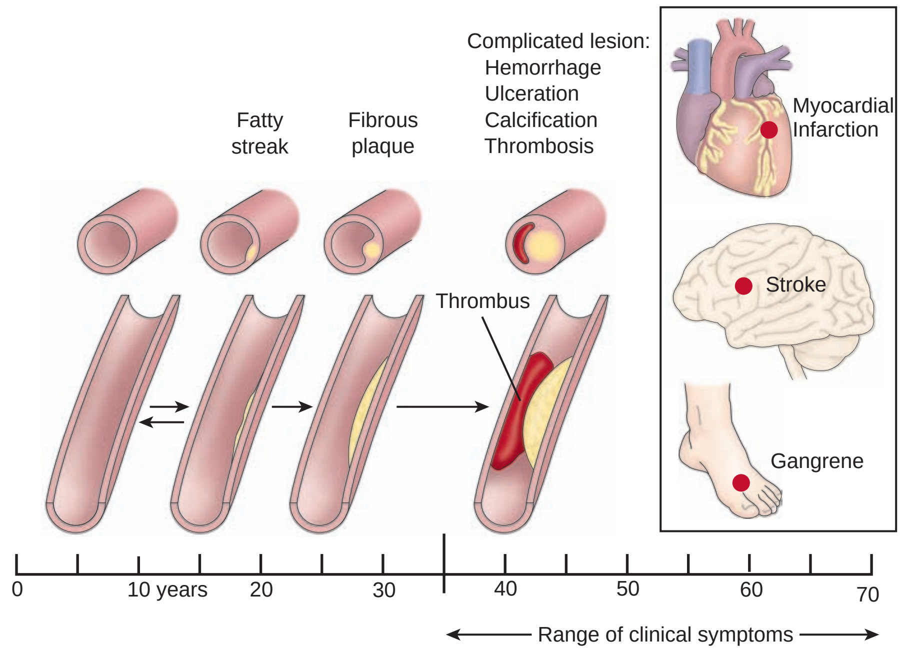



**Figure 31-6** Schematic concept of the progression of atherosclerosis. Fatty streaks constitute one of the earliest lesions of atherosclerosis. Many fatty streaks regress, whereas others progress to fibrous plaques and eventually to atheroma, which may be complicated by hemorrhage, ulceration, calcification, or thrombosis and may produce myocardial infarction, stroke, or gangrene.

stimulating the sympathetic nervous system, causing vasoconstriction. It also increases the risk of clot formation by increasing the aggregation of platelets. Carbon monoxide, a toxin produced by burning tobacco, combines more readily with hemoglobin than oxygen, depriving the tissues of oxygen. The amount of tobacco used, inhaled or chewed, is directly related to the extent of the disease, and cessation of tobacco use reduces the risks. Many other factors, such as obesity, stress, and lack of exercise, have been identified as contributing to the disease process (Bakhru & Erlinger, 2005).

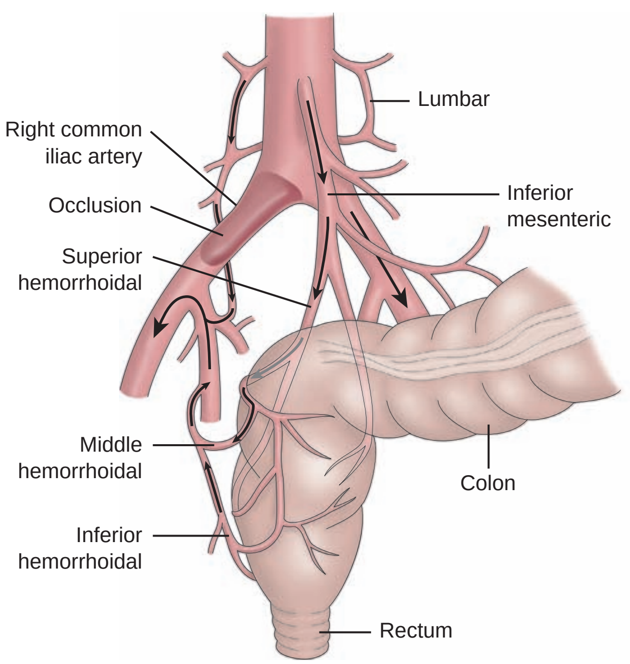



**Figure 31-7** Development of channels for collateral blood flow in response to occlusion of the right common iliac artery and the terminal aortic bifurcation.

C-reactive protein (CRP) is a sensitive marker of cardiovascular inflammation, both systemically and locally. Slight increases in serum CRP levels are associated with an increased risk of damage in the vasculature, especially if these increases are accompanied by other risk factors, including increasing age, female gender, hypertension, hypercholesterolemia, obesity, elevated blood glucose levels, smoking, or a positive family history of cardiovascular disease (Shankar, Li, Nieto, et al., 2007). There is also a positive association between peripheral arterial disease and the hemostatic or inflammatory markers fibrinogen and D-dimer (Reich, Heiss, Boland, et al., 2007).

Hyperhomocysteinemia has been positively correlated with the risk of peripheral, cerebrovascular, and coronary artery disease. Homocysteine is a protein that promotes coagulation by increasing factor V and factor XI activity

CHART 31-2

## *Risk Factors for Atherosclerosis and Peripheral Arterial Disease*

### Modifiable Risk Factors

- Nicotine use (ie, tobacco smoking or chewing)
- Diet (contributing to hyperlipidemia)
- Hypertension
- Diabetes mellitus (speeds the atherosclerotic process by thickening the basement membranes of both large and small vessels)
- Obesity
- Stress
- Sedentary lifestyle
- Elevated C-reactive protein
- Hyperhomocysteinemia

### Nonmodifiable Risk Factors

- Age
- Gender
- Familial predisposition/genetics

while depressing protein C activation and increasing the binding of lipoprotein (a) in fibrin. These processes increase thrombin formation and the propensity for thrombosis. Folate therapy for hyperhomocysteinemia has not been shown to improve cardiovascular endpoints. However, National Cholesterol Education Program (NCEP) guidelines suggest that folic acid supplements of 0.5 to 1.0 mg daily be reserved for patients with a strong history of atherosclerosis that cannot be explained by their lipid profile (Rice & Lumsden, 2006).

## Prevention

Intermittent claudication is a symptom of generalized atherosclerosis and may be a marker of occult coronary artery disease. Because it is suspected that a high-fat diet contributes to atherosclerosis, it is reasonable to measure serum cholesterol and to begin disease prevention efforts that include diet modification. The American Heart Association recommends reducing the amount of fat ingested in a healthy diet, substituting unsaturated fats for saturated fats, and decreasing cholesterol intake to reduce the risk of cardiovascular disease.

Certain medications that supplement dietary modification and exercise are used to reduce blood lipid levels. The NCEP has established guidelines for treating hyperlipidemia, with the primary goal of low-density lipoprotein (LDL) levels of less than 100 mg/dL. LDL levels of less than 70 mg/dL are recommended for patients with a history of diabetes, cigarette smoking, atherosclerosis, or hypertension (Federman, Ranani, Kirsner, et al., 2005). Secondary goals include achieving total cholesterol levels of less than 200 mg/dL and triglyceride levels less than 150 mg/dL. Medications classified as HMG-CoA reductase inhibitors or "statins," including but not limited to atorvastatin (Lipitor), lovastatin (Mevacor), pravastatin (Pravachol), simvastatin (Zocor), fluvastatin (Lescol), and rosuvastatin (Crestor), are currently first-line treatment because they reduce the incidence of major cardiovascular events (Hankey, Norman & Eikelboom, 2006). Several other classes of medications used to reduce lipid levels include bile acid sequestrants (cholestyramine [Questran], colesevelam [WelChol], colestipol [Colestid]), nicotinic acid (niacin [Niacor, Niaspan]), fibric acid inhibitors (gemfibrozil [Lopid], fenofibrate [Tricor]), and cholesterol absorption inhibitors (ezetimibe [Zetia]). Patients receiving long-term therapy with these medications require close monitoring.

Hypertension, which may accelerate the rate at which atherosclerotic lesions form in high-pressure vessels, can lead to a cerebrovascular accident (CVA, brain attack, stroke), ischemic renal disease, severe peripheral arterial disease (PAD), or coronary artery disease. Hypertension is a major risk factor for the development of PAD, resulting in a twofold risk of development of claudication (Steg, Bhatt, Wilson, et al., 2007). All patients with PAD should achieve blood pressure control consistent with the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7) guidelines (systolic blood pressure less than 130 mm Hg; diastolic blood pressure less than 90 mm Hg) (Ostchega, et al., 2007).

Although no single risk factor has been identified as the primary contributor to the development of atherosclerotic cardiovascular disease, it is clear that the greater the number of risk factors, the greater the risk of atherosclerosis. Elimination of all controllable risk factors, particularly the use of nicotine products, is strongly recommended.

## Clinical Manifestations

The clinical signs and symptoms resulting from atherosclerosis depend on the organ or tissue affected. Coronary atherosclerosis (heart disease), angina, and acute myocardial infarction are discussed in Chapter 28. Cerebrovascular diseases, including transient cerebral ischemic attacks and stroke, are discussed in Chapter 62. Atherosclerosis of the aorta, including aneurysm, and atherosclerotic lesions of the extremities are discussed later in this chapter. Renovascular disease (renal artery stenosis and end-stage renal disease) is discussed in Chapter 45.

## Medical Management

The management of atherosclerosis involves modification of risk factors, a controlled exercise program to improve circulation and its functioning capacity, medication therapy, and interventional or surgical graft procedures.

### *Surgical Management*

Vascular surgical procedures are divided into two groups: inflow procedures, which improve blood supply from the aorta into the femoral artery, and outflow procedures, which provide blood supply to vessels below the femoral artery. Inflow surgical procedures are described with diseases of the aorta and outflow procedures with peripheral arterial occlusive disease.

### *Radiologic Interventions*

Several interventional radiologic techniques are important adjunctive therapies to surgical procedures. If an isolated lesion or lesions are identified during the arteriogram, **angioplasty,** also called percutaneous transluminal angioplasty (PTA), may be performed. After the patient receives a local anesthetic agent, a balloon-tipped catheter is maneuvered across the area of stenosis. Although some clinicians theorize that PTA improves blood flow by overstretching (and thereby dilating) the elastic fibers of the nondiseased arterial segment, most believe that the procedure widens the arterial lumen by "cracking" and flattening the plaque against the vessel wall (see Chapter 28). Complications from PTA include hematoma formation, embolus, **dissection** (separation of the intima) of the vessel, acute arterial occlusion, and bleeding. To decrease the risk of reocclusion, stents (small, mesh tubes made of nitinol, titanium, or stainless steel) may be inserted to support the walls of blood vessels and prevent collapse immediately after balloon inflation (Fig. 31-8). A variety of stents and stent-grafts may be used for short-segment stenoses. Complications associated with stent or stent-graft use include distal embolization, intimal damage (dissection), and dislodgment. The advantage of angioplasty, stents, and stent-grafts is the decreased length of hospital stay required for the treatment; many of the procedures are performed on an outpatient basis.

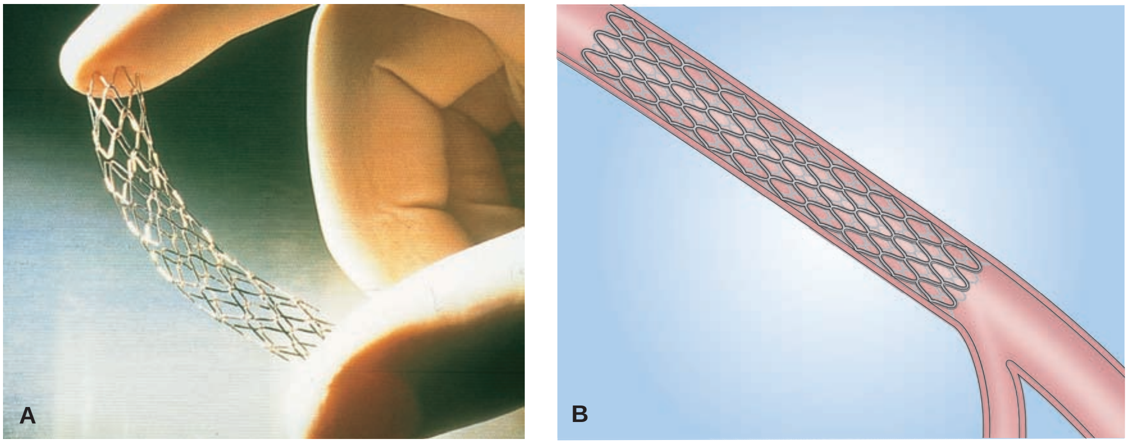



**Figure 31-8** **A,** Flexible stent. Courtesy of Medtronics, Peripheral Division, Santa Rosa, California. **B,** Representation of a common iliac artery with a Wallstent.

## Nursing Management of the Patient With Peripheral Arterial Insufficiency of the Extremities

An overview of the care of a patient with peripheral arterial problems is provided in the Plan of Nursing Care: The Patient With Peripheral Vascular Problems (Chart 31-3).

### *Improving Peripheral Arterial Circulation*

Arterial blood supply to a body part can be enhanced by positioning the part below the level of the heart. For the lower extremities, this is accomplished by elevating the head of the patient's bed or by having the patient use a reclining chair or sit with the feet resting on the floor.

The nurse can assist the patient with walking or other moderate or graded isometric exercises that may be prescribed to promote blood flow and encourage the development of collateral circulation. The nurse instructs the patient to walk to the point of pain, rest until the pain subsides, and then resume walking so that endurance can be increased as collateral circulation develops. Pain can serve as a guide in determining the appropriate amount of exercise. The onset of pain indicates that the tissues are not receiving adequate oxygen, signaling the patient to rest before continuing activity. A regular exercise program can result in increased walking distance before the onset of claudication. The amount of exercise a patient can tolerate before the onset of pain is determined to provide a baseline for evaluation.

Not all patients with peripheral vascular disease should exercise. Before recommending any exercise program, the patient's primary health care provider should be consulted. Conditions that worsen with exercise include leg ulcers, cellulitis, gangrene, or acute thrombotic occlusions.

### *Promoting Vasodilation and Preventing Vascular Compression*

Arterial dilation promotes increased blood flow to the extremities and is therefore a goal for patients with PAD. However, if the arteries are severely sclerosed, inelastic, or damaged, dilation is not possible. For this reason, measures to promote vasodilation, such as medications or surgery, may be only minimally effective.

Nursing interventions may involve applications of warmth to promote arterial flow and instructions to the patient to avoid exposure to cold temperatures, which causes vasoconstriction. Adequate clothing and warm temperatures protect the patient from chilling. If chilling occurs, a warm bath or drink is helpful. A hot water bottle or heating pad may be applied to the patient's abdomen, causing vasodilation throughout the lower extremities.

*NURSING ALERT*

**Patients are instructed to test the temperature of bath water and to avoid using hot water bottles and heating pads on the extremities. It is safer to apply a hot water bottle or a heating pad to the abdomen; this can cause reflex vasodilation in the extremities.**

In patients with vasospastic disorders (eg, Raynaud's disease), heat may be applied directly to ischemic extremities using a warmed or electric blanket; however, the temperature of the heat source must not exceed body temperature. Even at low temperatures, trauma to the tissues can occur in ischemic extremities.

*NURSING ALERT*

**Excess heat may increase the metabolic rate of the extremities and increase the need for oxygen beyond that provided by the reduced arterial flow through the diseased artery. Heat must be used with great caution!**

Nicotine from tobacco products causes vasospasm and can thereby dramatically reduce circulation to the extremities. Tobacco smoke also impairs transport and cellular use of oxygen and increases blood viscosity. Patients with arterial insufficiency who smoke or chew tobacco must be fully informed of the effects of nicotine on circulation and encouraged to stop.

Emotional upsets stimulate the sympathetic nervous system, resulting in peripheral vasoconstriction. Emotional stress can be minimized to some degree by avoiding stressful situations when possible or by consistently following a stress

CHART 31-3

## PLAN OF NURSING CARE
### *The Patient With Peripheral Vascular Problems*

**NURSING DIAGNOSIS:** Ineffective peripheral tissue perfusion related to compromised circulation
**GOAL:** Increased arterial blood supply to extremities

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Lower the extremities below the level of the heart (if condition is arterial in nature). | 1. Dependency of lower extremities enhances arterial blood supply. | • Has extremities warm to touch<br>• Has extremities with improved color<br>• Experiences decreased muscle pain with exercise |
| 2. Encourage moderate amount of walking or graded extremity exercises if no contraindications exist. | 2. Muscular exercise promotes blood flow and the development of collateral circulation. | |

**GOAL:** Decrease in venous congestion

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Elevate extremities above heart level (if condition is venous in nature). | 1. Elevation of extremities counteracts gravity, promotes venous return, and prevents venous stasis. | • Elevates lower extremities as prescribed<br>• Has decreased edema of extremities<br>• Avoids prolonged standing still or sitting<br>• Gradually increases walking time daily |
| 2. Discourage standing still or sitting for prolonged periods. | 2. Prolonged standing still or sitting promotes venous stasis. | |
| 3. Encourage walking. | 3. Walking promotes venous return by activating the "muscle pump." | |

**GOAL:** Promotion of vasodilation and prevention of vascular compression

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Maintain warm temperature and avoid chilling. | 1. Warmth promotes arterial flow by preventing the vasoconstriction effects of chilling. | • Protects extremities from exposure to cold<br>• Avoids all tobacco products<br>• Uses stress management program to minimize emotional upset<br>• Avoids constricting clothing and accessories<br>• Avoids crossing legs<br>• Takes medication as prescribed |
| 2. Discourage use of tobacco products. | 2. Nicotine in all tobacco products causes vasospasm, which impedes peripheral circulation. | |
| 3. Counsel in ways to avoid emotional upsets; stress management. | 3. Emotional stress causes peripheral vasoconstriction by stimulating the sympathetic nervous system. | |
| 4. Encourage avoidance of constrictive clothing and accessories. | 4. Constrictive clothing and accessories impede circulation and promote venous stasis. | |
| 5. Encourage avoidance of crossing the legs. | 5. Crossing the legs causes compression of vessels with subsequent impediment of circulation, resulting in venous stasis. | |
| 6. Administer vasodilator medications and adrenergic blocking agents as prescribed, with appropriate nursing considerations. | 6. Vasodilators relax smooth muscle; adrenergic blocking agents block the response to sympathetic nerve impulses or circulating catecholamines. | |

**NURSING DIAGNOSIS:** Chronic pain related to impaired ability of peripheral vessels to supply tissues with oxygen
**GOAL:** Relief of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Promote increased circulation. | 1. Enhancement of peripheral circulation increases the oxygen supplied to the muscle and decreases the accumulation of metabolites that cause muscle spasms. | • Uses measures to increase arterial blood supply to extremities<br>• Uses analgesic agents as prescribed |
| 2. Administer analgesic agents as prescribed, with appropriate nursing considerations. | 2. Analgesic agents help reduce pain and allow the patient to participate in activities and exercises that promote circulation. | |

*Continued*

CHART 31-3

## PLAN OF NURSING CARE
## *The Patient With Peripheral Vascular Problems* (Continued)

**NURSING DIAGNOSIS:** Risk for impaired skin integrity related to compromised circulation
**GOAL:** Attainment/maintenance of tissue integrity

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Instruct in ways to avoid trauma to extremities. | 1. Poorly nourished tissues are susceptible to trauma and bacterial invasion; healing of wounds is delayed or inhibited due to poor tissue perfusion. | • Inspects skin daily for evidence of injury or ulceration<br>• Avoids trauma and irritation to skin<br>• Wears protective shoes<br>• Adheres to meticulous hygiene regimen<br>• Eats a healthy diet that contains adequate protein and vitamins A and C |
| 2. Encourage wearing protective shoes and padding for pressure areas; wear new shoes for short period of time and inspect feet for signs of injury. | 2. Protective shoes and padding prevent foot injuries and blisters. | |
| 3. Encourage meticulous hygiene: bathing with neutral soaps, applying lotions, and carefully trimming nails. | 3. Neutral soaps and lotions prevent drying and cracking of skin; avoid lotion between toes as the increased moisture can lead to maceration of tissue. | |
| 4. Caution to avoid scratching or vigorous rubbing. | 4. Scratching and rubbing can cause skin abrasions and bacterial invasion. | |
| 5. Promote good nutrition; adequate intake of vitamins A and C, protein, and zinc; and control of obesity. | 5. Good nutrition promotes healing and prevents tissue breakdown. | |

**NURSING DIAGNOSIS:** Deficient knowledge regarding self-care activities
**GOAL:** Adherence to the self-care program

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Include family/significant others in teaching program. | 1. Adherence to the self-care program is enhanced when the patient receives support from family and from appropriate self-help groups and agencies. | • Practices frequent position changes as prescribed<br>• Practices postural exercises as prescribed<br>• Takes medications as prescribed<br>• Avoids vasoconstrictors<br>• Uses measures to prevent trauma<br>• Uses stress management program<br>• Accepts condition as chronic but amenable to therapies that will decrease symptoms |
| 2. Provide written instructions about foot care, leg care, and exercise program. | 2. Written instructions serve as reminder and reinforcement of information. | |
| 3. Assist to obtain properly fitting clothing, shoes, and stockings. | 3. Constrictive clothing and accessories impede circulation and promote venous stasis. | |
| 4. Refer to self-help groups as indicated, such as smoking cessation clinics or stress management, weight management, and exercise program. | 4. Reducing risk factors may reduce symptoms or slow disease progression. | |

management program. Counseling services or relaxation training may be indicated for people who cannot cope effectively with situational stressors.

Constrictive clothing and accessories such as tight socks or shoelaces may impede circulation to the extremities and promote venous stasis and therefore should be avoided. Crossing the legs for more than 15 minutes at a time should be discouraged because it compresses vessels in the legs.

### *Relieving Pain*

Frequently, the pain associated with peripheral arterial insufficiency is chronic, continuous, and disabling. It limits activities, affects work and responsibilities, disturbs sleep, and alters the patient's sense of well-being. Patients are often depressed, irritable, and unable to exert the energy necessary to execute prescribed therapies, making pain relief even more difficult. Analgesic agents such as hydrocodone plus acetaminophen (Vicodin), oxycodone plus acetylsalicylic acid (Percodan), or oxycodone plus acetaminophen (Percocet) may be helpful in reducing pain so that the patient can participate in therapies that can increase circulation and ultimately relieve pain more effectively.

### *Maintaining Tissue Integrity*

Poorly perfused tissues are susceptible to damage and infection. When lesions develop, healing may be delayed or inhibited because of the poor blood supply to the area. Infected, nonhealing ulcerations of the extremities can be debilitating and may require prolonged and often expensive treatments. Amputation of an ischemic limb may eventually be necessary. Measures to prevent these complications must be a high priority and vigorously implemented.

Trauma to the extremities must be avoided. Advising the patient to wear sturdy, well-fitting shoes or slippers to prevent foot injury and blisters may be helpful, and recommending neutral soaps and body lotions may prevent drying and cracking of skin. However, it is important to instruct the patient not to apply lotion between the toes because the increased moisture can lead to maceration of tissue. Scratching and vigorous rubbing can abrade skin and create sites for bacterial invasion; therefore, feet should be patted dry. Stockings should be clean and dry. Fingernails and toenails should be carefully trimmed straight across and sharp corners filed to follow the contour of the nail. If the nails cannot be trimmed safely, it is necessary to consult a podiatrist, who can also remove corns and calluses. Special shoe inserts may be needed to prevent calluses from recurring. All signs of blisters, ingrown toenails, infection, or other problems should be reported to health care professionals for treatment and follow-up. Patients with diminished vision and those with disabilities that limit mobility of the arms or legs may require assistance in periodically examining the lower extremities for trauma or evidence of inflammation or infection.

Good nutrition promotes healing and prevents tissue breakdown and is therefore included in the overall therapeutic program for patients with peripheral vascular disease. Eating a diet that contains adequate protein and vitamins is necessary for patients with arterial insufficiency. Key nutrients play specific roles in wound healing. Vitamin C is essential for collagen synthesis and capillary development. Vitamin A enhances epithelialization. Zinc is necessary for cell mitosis and cell proliferation. Obesity strains the heart, increases venous congestion, and reduces circulation; therefore, a weight reduction plan may be necessary for some patients. A diet low in lipids may be indicated for patients with atherosclerosis.

### *Promoting Home and Community-Based Care*

The self-care program is planned with the patient so that activities that promote arterial and venous circulation, relieve pain, and promote tissue integrity are acceptable. The patient and family are helped to understand the reasons for each aspect of the program, the possible consequences of nonadherence, and the importance of keeping follow-up appointments. Long-term care of the feet and legs is of prime importance in the prevention of trauma, ulceration, and gangrene. Chart 31-4 provides detailed patient instructions for foot and leg care.

CHART 31-4 HOME CARE CHECKLIST

**Foot and Leg Care in Peripheral Vascular Disease**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate daily foot bathing: Wash between toes with mild soap and lukewarm water, then rinse thoroughly and pat rather than rub dry. | ✔ | ✔ |
| • Recognize the dangers of thermal injury:<br>• Wear clean, loose, soft cotton socks (they are comfortable, allow air to circulate, and absorb moisture)<br>• In cold weather, wear extra socks in extra-large shoes.<br>• Avoid heating pads, whirlpools, and hot tubs.<br>• Avoid sunburn. | ✔ | |
| • Identify safety concerns:<br>• Inspect feet daily with a mirror for redness, dryness, cuts, blisters, etc.<br>• Always wear soft shoes or slippers when out of bed.<br>• Trim nails straight across after showering.<br>• Consult podiatrist to trim nails if vision is decreased; also for care of corns, blisters, ingrown nails.<br>• Clear pathways in house to prevent injury.<br>• Avoid wearing thong sandals.<br>• Use lamb's wool between toes if they overlap or rub each other. | ✔ | ✔ |
| • Demonstrate use of comfort measures:<br>• Wear leather shoes with an extra-depth toebox. Synthetic shoes do not allow air to circulate.<br>• If feet become dry and scaly, use cream with lanolin. Never put cream between toes.<br>• If feet perspire, especially between toes, use powder daily and/or lamb's wool between toes to promote drying. | ✔ | |
| • Demonstrate strategies to decrease risk of constricting blood vessels:<br>• Avoid circular compression around feet or knees—for example, by applying knee-high stockings or tight socks.<br>• Do not cross legs at knees.<br>• Stop using all tobacco products (ie, smoking or chewing) because nicotine causes vasoconstriction and vasospasm.<br>• Avoid applying tight, constricting bandages.<br>• Participate in a regular walking exercise program to stimulate circulation. | ✔ | |
| • Recognize when to seek medical attention:<br>• Contact health care provider at the onset of skin breakdown such as abrasions, blisters, fungus infection (athlete's foot), or pain.<br>• Do not use any medication on feet or legs unless prescribed.<br>• Avoid using iodine, alcohol, corn-/wart-removing compound, or adhesive products before checking with health care provider. | ✔ | ✔ |

## Peripheral Arterial Occlusive Disease

Arterial insufficiency of the extremities occurs most often in men and is a common cause of disability. The legs are most frequently affected; however, the upper extremities may be involved. The age of onset and the severity are influenced by the type and number of atherosclerotic risk factors (see Chart 31-2). In PAD, obstructive lesions are predominantly confined to segments of the arterial system extending from the aorta below the renal arteries to the popliteal artery (Fig. 31-9). Distal occlusive disease is frequently seen in patients with diabetes mellitus and in elderly patients (Chart 31-5).

### Clinical Manifestations

The hallmark symptom is intermittent claudication. This pain may be described as aching, cramping, or inducing fatigue or weakness that occurs with the same degree of exercise or activity and is relieved with rest. The pain commonly occurs in muscle groups distal to the area of stenosis or occlusion. As the disease progresses, the patient may have a decreased ability to walk the same distance as previously or may notice increased pain with ambulation. When the arterial insufficiency becomes severe, the patient has rest pain. This pain is associated with critical ischemia of the distal extremity and is persistent, aching, or boring; it may be so excruciating that it is unrelieved by opioids and is disabling. Ischemic rest pain is usually worse at night and often wakes the patient. Elevating the extremity or placing it in a horizontal position increases the pain, whereas placing the extremity in a dependent position reduces the pain. Some patients sleep with the affected leg hanging over the side of the bed. Some patients sleep in a reclining chair in an attempt to prevent or relieve the pain.

### Assessment and Diagnostic Findings

A sensation of coldness or numbness in the extremities may accompany intermittent claudication and is a result of reduced arterial flow. The extremity is cool and pale when elevated or ruddy and cyanotic when placed in a dependent position. Skin and nail changes, ulcerations, gangrene, and muscle atrophy may be evident. Bruits may be auscultated with a stethoscope. Peripheral pulses may be diminished or absent.

Examination of the peripheral pulses is an important part of assessing arterial occlusive disease. Unequal pulses between extremities or the absence of a normally palpable pulse is a sign of PAD.

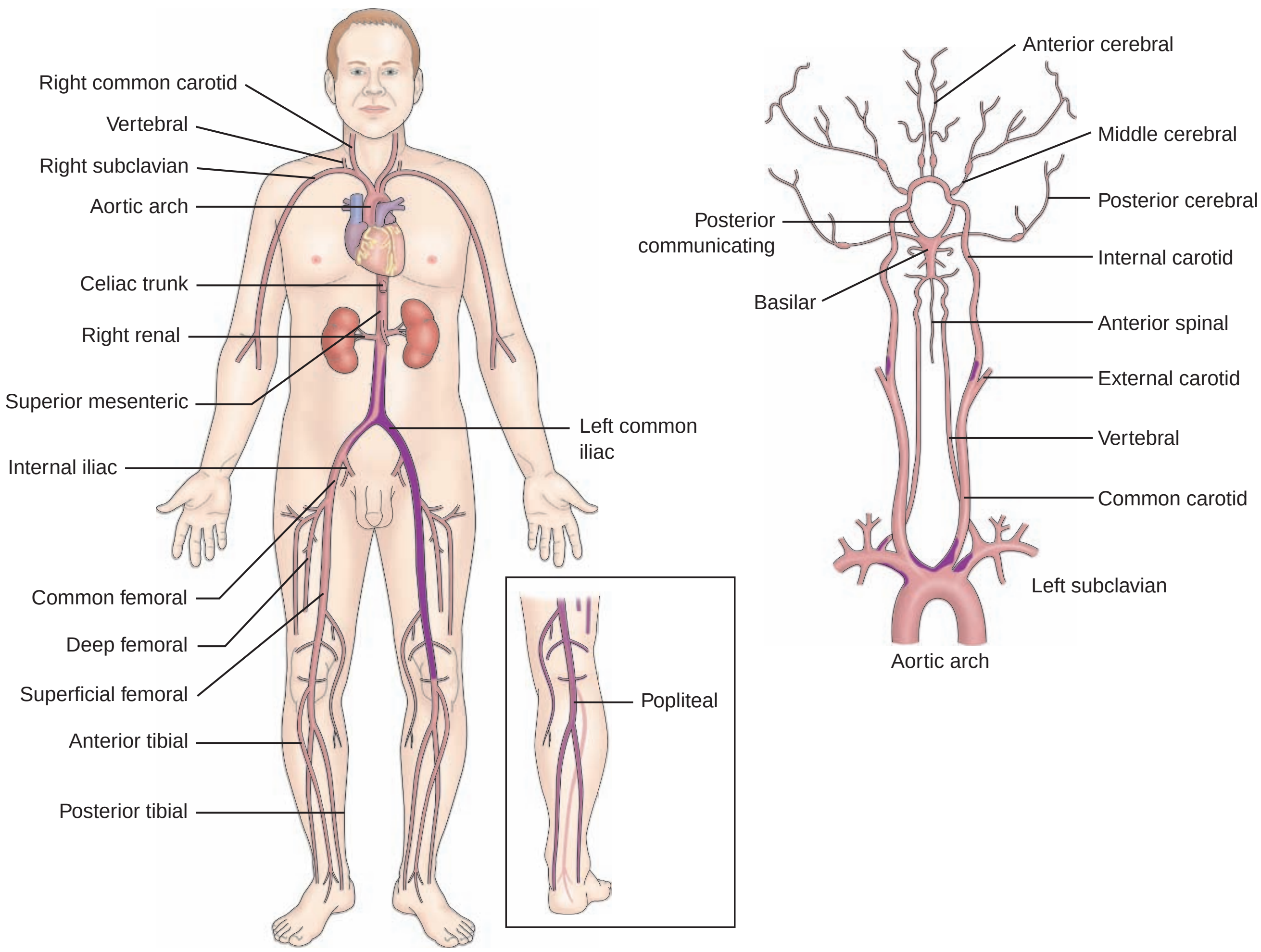



**Figure 31-9** Common sites of atherosclerotic obstruction in major arteries.

CHART 31-5

NURSING RESEARCH PROFILE

## *Long-Term Outcomes of Peripheral Arterial Disease in Patients With Diabetes in a Primary Care Setting*

Khattab, D., Ali, I. S. & Rawlings, B. (2005). Peripheral arterial disease in diabetic patients selected from a primary care setting: Implications for nursing practice. *Journal of Vascular Nursing, 23*(4), 139–148.

**Purpose**

Patients diagnosed with diabetes have higher rates of peripheral arterial disease (PAD) than patients without diabetes. Few epidemiologic studies have examined long-term glycemic control and its association with PAD. Most of the care given to patients diagnosed with diabetes occurs in outpatient settings, yet there is limited information on the prevalence of diabetes and long-term progression of asymptomatic PAD in patients with PAD in primary care settings. The aims of this study were to investigate the prevalence and the progression of PAD in patients with diabetes compared to the progression of PAD in patients without diabetes over a 7-year period.

**Design**

This study included male and female patients ($n = 146$) with diabetes selected from a family practice clinic serving a population of 13,500 in southern England. They ranged in age from 17 to 94 years. The two endpoints were progression of PAD and death. The researchers compared mortality data from these patients with those of a control group of 113 patients without diabetes with similar demographics. They investigated the cohort group with diabetes in years 1, 3, and 7, obtaining a complete health history, body mass index (BMI) calculation, plasma glucose levels (fasting and 2 hours postprandial), $Hb_{A1C}$, and total cholesterol and triglyceride levels. In addition, researchers obtained Doppler pressures on the posterior tibial, dorsalis pedis, and peroneal arteries bilaterally and calculated individual ankle-brachial indices (ABIs) for each tibial artery. They noted the cause of death for patients from both cohorts who died during the 7-year course of the study.

**Findings**

The prevalence of PAD in the cohort group with diabetes by the seventh year of the study was 57.1% in males and 51.4% in females; PAD tended to affect both legs symmetrically. By the end of the 7-year study period, PAD had progressed in 50% of the 70 patients with diabetes who remained enrolled in the study. During these 7 years, 10 of these patients developed claudication, 13 developed rest pain, and 3 developed critical ischemia.

A comparison of risk factors between those who did and did not show progression of PAD found that increasing age, duration of diabetes, smoking, and BMI were not statistically significant risk factors. Multiple regression analysis at year 7 revealed a significant ($p \leq 0.05$) independent association between hyperglycemia measured by $Hb_{A1C}$ and progression of PAD in the cohort with diabetes.

The overall mortality during the 7-year follow-up was 34.25% of the cohort group and 13.2% of the control group. This indicates a relative risk of mortality in the people with diabetes of 2.6-fold compared with controls.

**Nursing Implications**

Findings from this study are consistent with prevalence data concerning noninvasively diagnosed PAD in patients with diabetes. The prevalence of PAD among these participants with diabetes was higher than that in general population studies. Nurses in primary care settings need to know that identification of patients at high risk for death, followed by an aggressive approach to the correction of their atherosclerotic risk factors, may improve the survival in those with PAD. The findings of this study suggest that a low ABI value is strongly associated with increased mortality rate. Nurses may use Dopplers and obtain ABIs on patients at risk (ie, with diabetes) and, when appropriate, counsel and advise their patients about optimizing their health status. This may result in earlier detection of patients at risk for developing macrovascular complications.

The presence, location, and extent of arterial occlusive disease are determined by a careful history of the symptoms and by physical examination. The color and temperature of the extremity are noted and the pulses palpated. The nails may be thickened and opaque, and the skin may be shiny, atrophic, and dry, with sparse hair growth. The assessment includes comparison of the right and left extremities.

The diagnosis of peripheral arterial occlusive disease may be made using CW Doppler and ABIs, treadmill testing for claudication, duplex ultrasonography, or other imaging studies previously described.

## Medical Management

Generally, patients feel better with some type of exercise program. Exercise therapy that centers around walking to a point that causes pain three times weekly has shown to increase maximal walking time (minutes) and results in an overall improvement in walking ability of approximately 150% (Leng, Fowler & Ernst, 2005). If this walking program is combined with weight reduction and cessation of tobacco use, patients often can improve their activity tolerance. Patients should not be promised that their symptoms will be relieved if they stop tobacco use, because claudication may persist, and they may lose their motivation to stop using tobacco.

### *Pharmacologic Therapy*

Pentoxifylline (Trental) and cilostazol (Pletal) are approved for the treatment of symptomatic claudication. However, studies have found no consistent improvement with pentoxifylline compared to placebo (Robless, Mikhailidis & Stansby, 2008). Pentoxifylline increases erythrocyte flexibility, lowers blood fibrinogen concentrations, and has antiplatelet effects. Cilostazol, a phosphodiesterase III inhibitor, is a vasodilator that inhibits platelet aggregation. This agent is contraindicated in patients with a history of congestive heart failure (Rice & Lumsden, 2006).

Antiplatelet agents such as aspirin or clopidogrel (Plavix) prevent the formation of thromboemboli, which can lead to myocardial infarction and stroke. Aspirin has been shown to reduce the risk of cardiovascular events (eg, myocardial infarction, stroke, and cardiovascular death) in patients

with vascular disease; however, adverse events associated with aspirin use include gastrointestinal upset or bleeding. In a study conducted with a large, international registry of outpatients with known PAD, the 1-year rate for a cardiovascular event was high. The rate depended on whether the patient had risk factors (2.2%) alone or also symptomatic coronary or cerebrovascular disease (9.2%), suggesting that atherothrombosis is a type of global arterial disease (Steg, et al., 2007).

Statin therapy reduces the incidence of new intermittent claudication symptoms in patients with prior myocardial infarctions or anginal symptoms and improves pain-free walking time in patients with PAD. These medications also have beneficial effects on vascular inflammation, plaque stabilization, endothelial dysfunction, and thrombosis (Rice & Lumsden, 2006).

### Surgical Management

Surgery is reserved for treatment of severe and disabling claudication or when the limb is at risk for amputation because of tissue necrosis. The choice of the surgical procedure depends on the degree and location of the stenosis or occlusion. Other important considerations are the overall health of the patient and the length of the procedure that can be tolerated. For patients whose overall health is so compromised that they cannot tolerate an extensive vascular surgical procedure, it is sometimes necessary to provide the palliative therapy of primary amputation rather than arterial bypass. If endarterectomy is performed, an incision is made into the artery and the atheromatous obstruction is removed (Fig. 31-10).

Bypass grafts are performed to reroute the blood flow around the stenosis or occlusion. Before bypass grafting, the surgeon determines where the distal **anastomosis** (site where the vessels are surgically joined) will be placed. The distal outflow vessel must be at least 50% patent for the graft to remain patent. If the atherosclerotic occlusion is below the inguinal ligament in the superficial femoral artery, the surgical procedure of choice is the femoral-to-popliteal graft. This procedure is further classified as above-knee and below-knee grafts, referring to the location of the distal anastomosis.

Lower leg or ankle vessels with occlusions may also require grafts. Occasionally, the popliteal artery is completely occluded and only collateral vessels maintain perfusion. The distal anastomosis may be made onto any of the tibial arteries (posterior tibial, anterior tibial, or peroneal arteries) or the dorsalis pedis or plantar artery. The distal anastomosis site is determined by the ease of exposure of the vessel in surgery and by which vessel provides the best flow to the distal limb. These grafts require the use of native vein (ie, autologous; the patient's own vein) to ensure patency. The greater or lesser saphenous vein or a combination of one of the saphenous veins and an upper extremity vein such as the cephalic vein is used to provide the required length.

How long the graft remains patent is determined by several factors, including the size of the graft, graft location, and development of intimal hyperplasia at anastomosis sites. Bypass grafts may be synthetic or use autologous vein. Several synthetic materials are available for use as a peripheral bypass graft: woven or knitted Dacron or expanded polytetrafluoroethylene (ePTFE, such as Gore-Tex or Impra). Cryopreserved saphenous veins and umbilical veins are also available. Infection can be a problem that threatens survival of the graft and almost always requires its removal.

If a vein graft is the surgical choice, care must be taken in the operating room not to damage the vein after harvesting (removing the vein from the patient's body). The vein is occluded at one end and inflated with a heparinized solution to check for leakage and competency. The graft is then placed in a heparinized solution to keep it from becoming dry and brittle.

## Nursing Management

### Maintaining Circulation

The primary objective in the postoperative period is to maintain adequate circulation through the arterial repair. Pulses, Doppler assessment, color and temperature, capillary refill, and sensory and motor function of the affected extremity are checked and compared with those of the other extremity; these values are recorded initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. Doppler evaluation of the vessels distal to the bypass graft should be performed for all postoperative vascular patients because it is more sensitive than palpation for pulses. The ABI is monitored at least once every 8 hours for the first 24 hours and then once each day until discharge (not usually assessed with pedal artery bypasses). An adequate circulating blood volume should be

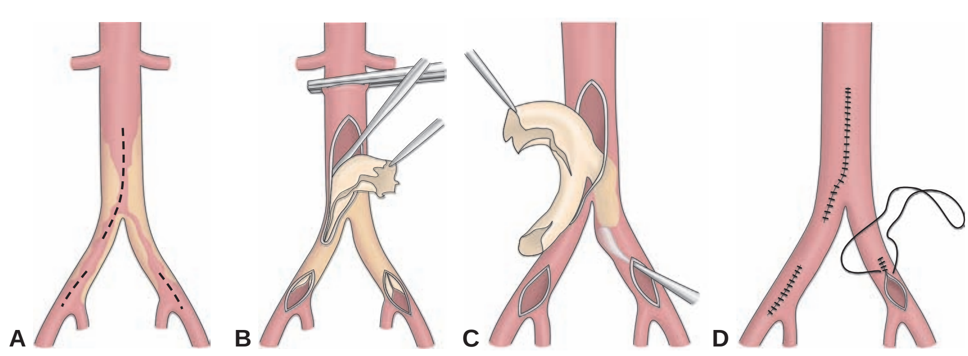



**Figure 31-10** In an aortoiliac endarterectomy, the vascular surgeon **(A)** identifies the diseased area, **(B)** clamps off the blood supply to the vessel, **(C)** removes the plaque, and **(D)** sutures the vessel shut, after which blood flow is restored. Adapted with permission from Rutherford, R. B. (2005). *Vascular surgery* (6th ed., Vols. I and II). Philadelphia: Elsevier.

established and maintained. Disappearance of a pulse that was present may indicate thrombotic occlusion of the graft; the surgeon is immediately notified.

#### *Monitoring and Managing Potential Complications*

Continuous monitoring of urine output, central venous pressure, mental status, and pulse rate and volume permits early recognition and treatment of fluid imbalances. Bleeding can result from the heparin administered during surgery or from an anastomotic leak. A hematoma may form as well.

Leg crossing and prolonged extremity dependency are avoided to prevent thrombosis. Edema is a normal postoperative finding; however, elevating the extremities and encouraging the patient to exercise the extremities while in bed reduces edema. Graduated compression or anti-embolism stockings may be prescribed for some patients, but care must be taken to avoid compressing distal vessel bypass grafts. Severe edema of the extremity, pain, and decreased sensation of toes or fingers can be an indication of compartment syndrome (see Chapter 69).

#### *Promoting Home and Community-Based Care*

Discharge planning includes assessing the patient's ability to manage activities of daily living (ADLs) independently. The nurse determines whether the patient has a network of family and friends to assist with ADLs. The patient is encouraged to make the lifestyle changes necessitated by the onset of a chronic disease, including pain management and modifications in diet, activity, and hygiene (skin care). The nurse ensures that the patient has the knowledge and ability to assess for any postoperative complications such as infection, occlusion of the artery or graft, and decreased blood flow. The nurse assists the patient in developing and implementing a plan to stop using tobacco.

Nursing care for patients with peripheral vascular disease is reviewed in Chart 31-3.

## *Upper Extremity Arterial Occlusive Disease*

Arterial occlusions occur less frequently in the upper extremities (arms) than in the legs and cause less severe symptoms because the collateral circulation is significantly better in the arms. The arms also have less muscle mass and are not subjected to the workload of the legs.

### Clinical Manifestations

Stenosis and occlusions in the upper extremity result from atherosclerosis or trauma. The stenosis usually occurs at the origin of the vessel proximal to the vertebral artery, setting up the vertebral artery as the major contributor of flow. The patient typically complains of arm fatigue and pain with exercise (forearm claudication), inability to hold or grasp objects (eg, combing hair, placing objects on shelves above the head), and occasionally difficulty driving.

The patient may develop a "subclavian steal" syndrome characterized by reverse flow in the vertebral and basilar artery to provide blood flow to the arm. This syndrome may cause vertebrobasilar (cerebral) symptoms, including vertigo, ataxia, syncope, or bilateral visual changes.

### Assessment and Diagnostic Findings

Assessment findings include coolness and pallor of the affected extremity, decreased capillary refill, and a difference in arm blood pressures of more than 20 mm Hg. Noninvasive studies performed to evaluate for upper extremity arterial occlusions include upper and forearm blood pressure determinations and duplex ultrasonography to identify the anatomic location of the lesion and to evaluate the hemodynamics of the blood flow. Transcranial Doppler evaluation is performed to evaluate the intracranial circulation and to detect any siphoning of blood flow from the posterior circulation to provide blood flow to the affected arm. If a surgical or interventional procedure is planned, a diagnostic arteriogram may be necessary.

### Medical Management

If a short, focal lesion is identified in an upper extremity artery, a PTA with possible stent or stent-graft placement may be performed. If the lesion involves the subclavian artery with documented siphoning of blood flow from the intracranial circulation and an interventional radiologic procedure is not possible, a surgical bypass may be performed.

### Nursing Management

Nursing assessment involves bilateral comparison of upper arm blood pressures (obtained by stethoscope and Doppler); radial, ulnar, and brachial pulses; motor and sensory function; temperature; color changes; and capillary refill every 2 hours. Disappearance of a pulse or Doppler flow that had been present may indicate an acute occlusion of the vessel, and the physician is notified immediately.

After surgery, the arm is kept at heart level or elevated, with the fingers at the highest level. Pulses are monitored with Doppler assessment of the arterial flow every hour for 4 hours and then every shift. Blood pressure (obtained by stethoscope and Doppler) is also assessed every hour for 4 hours and then every shift. Motor and sensory function, warmth, color, and capillary refill are monitored with each arterial flow (pulse) assessment.

*NURSING ALERT*

**Before and for 24 hours after surgery, the patient's arm is kept at heart level and protected from cold, venipunctures or arterial sticks, tape, and constrictive dressings.**

Discharge planning is similar to that for the patient with peripheral arterial occlusive disease. Chart 31-3 describes nursing care for patients with peripheral vascular disease.

## *Thromboangiitis Obliterans (Buerger's Disease)*

Buerger's disease is characterized by recurring inflammation of the intermediate and small arteries and veins of the lower and upper extremities. It results in thrombus formation and segmental occlusion of the vessels. It is differentiated from other vessel diseases by its microscopic appearance. In contrast

to atherosclerosis, Buerger's disease is believed to be an autoimmune vasculitis that results in occlusion of distal vessels.

Buerger's disease occurs most often in men between 20 and 35 years of age, and it has been reported in all races and in many areas of the world. There is considerable evidence that heavy smoking or chewing of tobacco is a causative or an aggravating factor (Puechal & Fiessinger, 2007).

### Clinical Manifestations

Pain is the outstanding symptom of Buerger's disease, which is generally bilateral and symmetric with focal lesions. Superficial thrombophlebitis may be present. The patient complains of foot cramps, especially of the arch (instep claudication), after exercise. The pain is relieved by rest; often, a burning pain is aggravated by emotional disturbances, nicotine, or chilling. Cold sensitivity of the Raynaud type is found in half the patients and is frequently confined to the hands. Digital rest pain is constant, and the characteristics of the pain do not change between activity and rest.

Physical signs include intense rubor (reddish-blue discoloration) of the foot and absence of the pedal pulse, but with normal femoral and popliteal pulses. If the upper extremities are involved, the radial and ulnar artery pulses are absent or diminished. Various types of paresthesias may develop.

As the disease progresses, definite redness or cyanosis of the part appears when the extremity is in a dependent position. Involvement is generally bilateral, but color changes may affect only one extremity or only certain digits. Color changes may progress to ulceration, and ulceration with gangrene eventually occurs.

### Assessment and Diagnostic Findings

Segmental limb blood pressures are taken to demonstrate the distal location of the lesions or occlusions. Duplex ultrasonography is used to document patency of the proximal vessels and to visualize the extent of distal disease. Contrast angiography is used to identify the diseased portion of the anatomy.

Although Buerger's disease is different from atherosclerosis, it may be accompanied by atherosclerosis of the larger vessels. The patient's ability to walk may be severely limited. Patients are at higher risk for nonhealing wounds because of impaired circulation.

### Medical Management

The treatment of Buerger's disease is essentially the same as that for atherosclerotic PAD. The main objectives are to improve circulation to the extremities, prevent the progression of the disease, and protect the extremities from trauma and infection. Treatment of ulceration and gangrene is directed toward minimizing infection and conservative débridement of necrotic tissue. Tobacco use is highly detrimental, and patients are strongly advised to completely stop using tobacco. Symptoms are often relieved by cessation of tobacco use.

Vasodilators are rarely prescribed because these medications cause dilation of only healthy vessels; vasodilators may divert blood away from the partially occluded vessels, thus exacerbating the manifestations of the disease. A regional sympathetic block or ganglionectomy may be useful in some instances to produce vasodilation and increase blood flow.

If gangrene of a toe develops as a result of arterial occlusive disease in the leg, it is unlikely that toe amputation or even transmetatarsal amputation will be sufficient; often, a below-knee amputation or occasionally an above-knee amputation is necessary. The indications for amputation include gangrene, especially if the infected area is moist; severe rest pain; or severe sepsis.

### Nursing Management

The patient is assisted in developing and implementing a plan to stop using tobacco and to manage pain. The patient may need to be encouraged to make the lifestyle changes necessary to adequately manage a chronic disease, including modifications in diet, activity, and hygiene (skin care). The nurse determines whether the patient has a network of family and friends to assist with ADLs. The nurse ensures that the patient has the knowledge and ability to assess for any postoperative complications such as infection and decreased blood flow. Chart 31-3 describes nursing care for patients with peripheral vascular disease. Nursing management during the immediate postoperative phase after amputation and through the rehabilitation phase is described in Chapter 69.

## Aortoiliac Disease

If collateral circulation has developed, patients with a stenosis or occlusion of the aortoiliac segment may be asymptomatic, or they may complain of buttock or low back discomfort associated with walking. Men may experience impotence. These patients may have decreased or absent femoral pulses.

### Medical Management

The treatment of aortoiliac disease is essentially the same as that for atherosclerotic peripheral arterial occlusive disease. The surgical procedure of choice is the aortoiliac graft. If possible, the distal graft is anastomosed to the iliac artery, and the entire surgical procedure is performed within the abdomen. If the iliac vessels are diseased, the distal anastomosis is made to the femoral arteries (aortobifemoral graft). Bifurcated woven or knitted Dacron grafts are preferred for this surgical procedure.

### Nursing Management

Preoperative assessment, in addition to the standard parameters (see Chapter 18), includes evaluating the brachial, radial, ulnar, femoral, posterior tibial, and dorsalis pedis pulses to establish a baseline for follow-up after arterial lines are placed and postoperatively. Patient teaching includes an overview of the procedure to be performed, the preparation for surgery, and the anticipated postoperative plan of care. Sights, sounds, and sensations that the patient may experience are discussed.

Postoperative care includes monitoring for signs of thrombosis in arteries distal to the surgical site. The nurse assesses color and temperature of the extremity, capillary refill time, sensory and motor function, and pulses by palpation and Doppler initially every 15 minutes and then at progressively

longer intervals if the patient's status remains stable. Any dusky or bluish discoloration, coldness, decrease in sensory or motor function, or decrease in pulse quality is reported immediately to the physician.

Postoperative care also includes monitoring urine output and ensuring that output is at least 30 mL/h. Renal function may be impaired as a result of hypoperfusion from hypotension, ischemia to the renal arteries during the surgical procedure, hypovolemia, or embolization of the renal artery or renal parenchyma. Vital signs, pain, and intake and output are monitored with the pulse and extremity assessments. Results of laboratory tests are monitored and reported to the physician. Abdominal assessment for bowel sounds and paralytic ileus is performed at least every 8 hours. Bowel sounds may not return before the third postoperative day. The absence of bowel sounds, absence of flatus, and abdominal distention are indications of paralytic ileus. Manual manipulation of the bowel during surgery may have caused bruising, resulting in decreased peristalsis. Nasogastric suction may be necessary to decompress the bowel until peristalsis returns. A liquid bowel movement before the third postoperative day may indicate bowel ischemia, which may occur when the mesenteric blood supply (celiac, superior mesenteric, or inferior mesenteric arteries) is occluded. Ischemic bowel usually causes increased pain and a markedly elevated white blood cell count (20,000 to 30,000 cells/mm$^3$).

## Aneurysms

An aneurysm is a localized sac or dilation formed at a weak point in the wall of the artery (Fig. 31-11). It may be classified by its shape or form. The most common forms of aneurysms are saccular and fusiform. A saccular aneurysm projects from only one side of the vessel. If an entire arterial segment becomes dilated, a fusiform aneurysm develops. Very small aneurysms due to localized infection are called mycotic aneurysms.

Historically, the cause of abdominal aortic aneurysm, the most common type of degenerative aneurysm, has been attributed to atherosclerotic changes in the aorta. Other causes of aneurysm formation are listed in Chart 31-6. Aneurysms are serious because they can rupture, leading to hemorrhage and death.

### Chart 31-6 • *Etiologic Classification of Arterial Aneurysms*

**Congenital:** Primary connective tissue disorders (Marfan's syndrome, Ehlers-Danlos syndrome) and other diseases (focal medial agenesis, tuberous sclerosis, Turner's syndrome, Menkes' syndrome)
**Mechanical (hemodynamic):** Poststenotic and arteriovenous fistula and amputation related
**Traumatic (pseudoaneurysms):** Penetrating arterial injuries, blunt arterial injuries, pseudoaneurysms
**Inflammatory (noninfectious):** Associated with arteritis (Takayasu's disease, giant cell arteritis, systemic lupus erythematosus, Behçet's syndrome, Kawasaki's disease) and periarterial inflammation (ie, pancreatitis)
**Infectious (mycotic):** Bacterial, fungal, spirochetal infections
**Pregnancy-related degenerative:** Nonspecific, inflammatory variant
**Anastomotic (postarteriotomy) and graft aneurysms:** Infection, arterial wall failure, suture failure, graft failure

Adapted with permission from Rutherford, R. B. (2005). *Vascular surgery* (6th ed., Vols. 1 and 2). Philadelphia: W. B. Saunders.

## THORACIC AORTIC ANEURYSM

Approximately 85% of all cases of thoracic aortic aneurysm are caused by atherosclerosis. They occur most frequently in men between the ages of 40 and 70 years. The thoracic area is the most common site for a dissecting aneurysm. About one third of patients with thoracic aneurysms die of rupture of the aneurysm (Rutherford, 2005).

### Clinical Manifestations

Symptoms are variable and depend on how rapidly the aneurysm dilates and how the pulsating mass affects surrounding intrathoracic structures. Some patients are asymptomatic. In most cases, pain is the most prominent symptom. The pain is usually constant and boring but may occur only when the person is supine. Other conspicuous symptoms are dyspnea, the result of pressure of the aneurysm sac against the trachea, a main bronchus, or the lung itself; cough, frequently paroxysmal and with a brassy quality; hoarseness, stridor, or weakness or complete loss of the

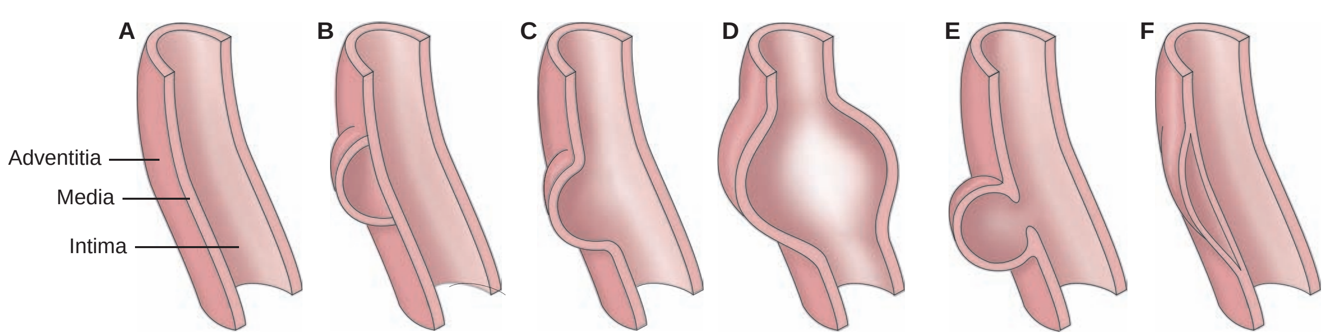



**Figure 31-11** Characteristics of arterial aneurysm. **A,** Normal artery. **B,** False aneurysm—actually a pulsating hematoma. The clot and connective tissue are outside the arterial wall. **C,** True aneurysm. One, two, or all three layers of the artery may be involved. **D,** Fusiform aneurysm—symmetric, spindle-shaped expansion of entire circumference of involved vessel. **E,** Saccular aneurysm—a bulbous protrusion of one side of the arterial wall. **F,** Dissecting aneurysm—this usually is a hematoma that splits the layers of the arterial wall.

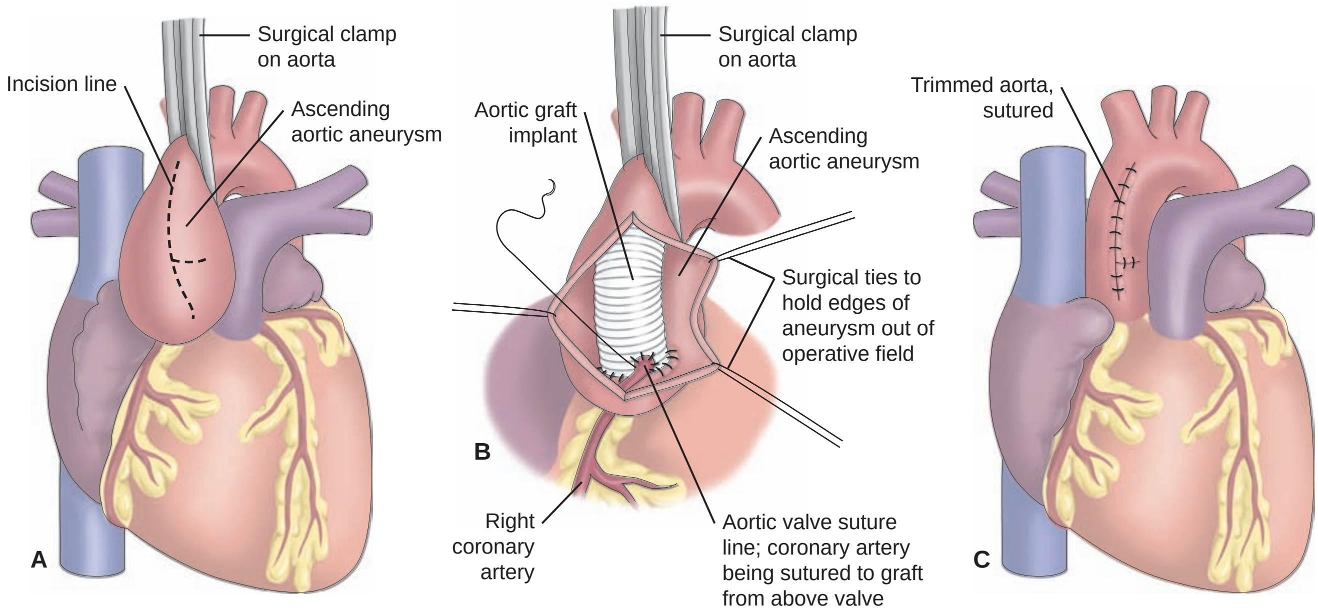



**Figure 31-12** Repair of an ascending aortic aneurysm and aortic valve replacement. **A,** Incision into aortic aneurysm. **B,** Aortic valve replacement with aortic graft implant to repair ascending aortic aneurysm. **C,** Aortic aneurysm trimmed and closed over graft.

voice (aphonia), resulting from pressure against the laryngeal nerve; and dysphagia (difficulty in swallowing) due to impingement on the esophagus by the aneurysm.

## Assessment and Diagnostic Findings

When large veins in the chest are compressed by the aneurysm, the superficial veins of the chest, neck, or arms become dilated, and edematous areas on the chest wall and cyanosis are often evident. Pressure against the cervical sympathetic chain can result in unequal pupils. Diagnosis of a thoracic aortic aneurysm is principally made by chest x-ray, CTA, and transesophageal echocardiography (TEE).

## Medical Management

Treatment is based on whether the aneurysm is symptomatic, is expanding in size, is caused by an iatrogenic injury, contains a dissection, and involves branch vessels. General measures such as controlling blood pressure and correcting risk factors may be helpful. It is important to control blood pressure in patients with dissecting aneurysms. Preoperatively, the systolic pressure is maintained at approximately 100 to 120 mm Hg with a beta-blocker such as esmolol (Brevibloc) or metoprolol (Lopressor). Occasionally, antihypertensives such as hydralazine (Apresoline) are used for this purpose. Sodium nitroprusside (Nipride) may be used by continuous IV drip to emergently lower the blood pressure. The goal of surgery is to repair the aneurysm and restore vascular continuity with a vascular graft (Fig. 31-12). Intensive monitoring is usually required after this type of surgery, and the patient is cared for in the critical care unit. The morbidity and mortality rate with open surgical repair of thoracic aneurysms is 20%, and patients have a 4% chance of developing paraplegia (Rodriguez, Olsen, Shtutman, et al., 2007).

Repair of thoracic aneurysms using endovascular grafts placed percutaneously in an interventional suite (eg, interventional radiology, cardiac catheterization laboratory) or an operating room may decrease postoperative recovery time and decrease complications compared with traditional surgical techniques. Thoracic endografts are made of similar materials as aortic endografts, such as Gore-Tex or PTFE material reinforced with nitinol or titanium stents. These endovascular grafts are inserted into the thoracic aorta via various vascular access routes, usually the brachial or femoral artery. Because a large surgical incision is not necessary to gain vascular access, the overall patient recovery time tends to be shorter than with open surgical repair. There is a 2.2% chance of perioperative paraplegia and a 2.7% chance of an intracranial CVA (Buth, Harris, Hobo, et al., 2007). To decrease the chances of paraplegia, spinal drains are usually placed in patients undergoing an endovascular repair of thoracic aortic aneurysms. Cerebral spinal drainage is performed to decrease the arterial to cerebral spinal fluid gradient, thereby improving spinal perfusion. What appears to be most important in preventing neurologic deficit is to maintain the blood pressure 20 mm Hg above baseline and to keep the mean arterial pressure greater than 90 mm Hg for the first 48 hours postoperatively (Sullivan & Sundt, 2006).

# ABDOMINAL AORTIC ANEURYSM

The most common cause of abdominal aortic aneurysm is atherosclerosis. The condition, which is more common among Caucasians, affects men four times more often than women and is most prevalent in elderly patients (Rutherford, 2005). Most of these aneurysms occur below the renal arteries (infrarenal aneurysms). Untreated, the eventual outcome may be rupture and death.

## Pathophysiology

All aneurysms involve a damaged media layer of the vessel. This may be caused by congenital weakness, trauma, or disease. After an aneurysm develops, it tends to enlarge.

Risk factors include genetic predisposition, tobacco use, and hypertension; more than half of patients with aneurysms have hypertension.

## Clinical Manifestations

Only about 40% of patients with abdominal aortic aneurysms have symptoms. Some patients complain that they can feel their heart beating in their abdomen when lying down, or they may say they feel an abdominal mass or abdominal throbbing. If the abdominal aortic aneurysm is associated with thrombus, a major vessel may be occluded or smaller distal occlusions may result from emboli. Small cholesterol, platelet, or fibrin emboli may lodge in the interosseous or digital arteries, causing cyanosis and mottling of the toes.

## Assessment and Diagnostic Findings

The most important diagnostic indication of an abdominal aortic aneurysm is a pulsatile mass in the middle and upper abdomen. About 80% of these aneurysms can be palpated. A systolic bruit may be heard over the mass. Duplex ultrasonography or CTA is used to determine the size, length, and location of the aneurysm. When the aneurysm is small, ultrasonography is conducted at 6-month intervals until the aneurysm reaches a size so that surgery to prevent rupture is of more benefit than the possible complications of a surgical procedure. Some aneurysms remain stable over many years of monitoring.

## Gerontologic Considerations

Most abdominal aortic aneurysms occur in patients between 60 and 90 years of age. Rupture is likely with coexisting hypertension and with aneurysms more than 6 cm wide. In most cases at this point, the chances of rupture are greater than the chance of death during surgical repair. If the elderly patient is considered at moderate risk of complications related to surgery or anesthesia, the aneurysm is not repaired until it is at least 5.5 cm (2 inches) wide.

## Medical Management

### Pharmacologic Therapy

If the aneurysm is stable in size based on serial duplex ultrasound scans, the blood pressure is closely monitored over time, because there is an association between increased diastolic blood pressure (above 100 mm Hg) and aneurysm rupture (Rutherford, 2005). Antihypertensive agents, including diuretics, beta-blockers, ACE inhibitors, angiotensin II receptor antagonists, and calcium channel blockers, are frequently prescribed to maintain the patient's blood pressure within acceptable limits (see Chapter 32).

### Surgical Management

An expanding or enlarging abdominal aortic aneurysm is likely to rupture. Surgery is the treatment of choice for abdominal aortic aneurysms more than 5.5 cm (2 inches) wide or those that are enlarging; the standard treatment has been open surgical repair of the aneurysm by resecting the vessel and sewing a bypass graft in place. The mortality rate associated with elective aneurysm repair, a major surgical procedure, is reported to be 1% to 4%. The prognosis for a patient with a ruptured aneurysm is poor, and surgery is performed immediately (Rutherford, 2005).

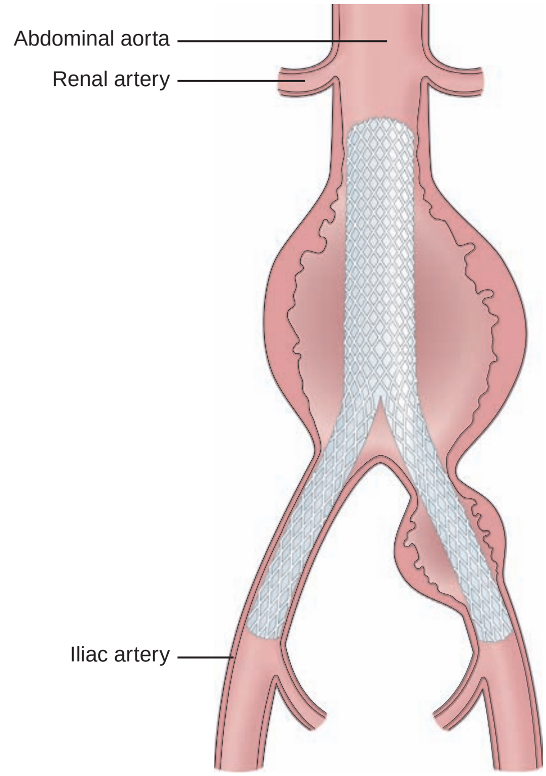



**Figure 31-13** AneuRx Endograft repair of an abdominal aortic aneurysm (Medtronic).

An alternative for treating an infrarenal abdominal aortic aneurysm is endovascular grafting, which involves the transluminal placement and attachment of a sutureless aortic graft prosthesis across an aneurysm (Fig. 31-13). This procedure can be performed under local or regional anesthesia. Endovascular grafting of abdominal aortic aneurysms may be performed if the patient's abdominal aorta and iliac arteries are not extremely tortuous, small, calcified, or filled with thrombi. Results from studies suggest comparable mortality rates between patients with aneurysms treated by endovascular grafting and those treated with surgical repair (O'Donnell, Sun, Winder, et al., 2007; Semmens, Lawrence-Brown, Hartley, et al., 2006). Potential complications include bleeding, hematoma, or wound infection at the arterial insertion site; distal ischemia or embolization; dissection or perforation of the aorta; graft thrombosis or infection; break of the attachment system; graft migration; proximal or distal graft leaks; delayed rupture; and bowel ischemia.

## Nursing Management

Before surgery, nursing assessment is guided by anticipating a rupture and by recognizing that the patient may have cardiovascular, cerebral, pulmonary, and renal impairment from atherosclerosis. The functional capacity of all organ systems should be assessed. Medical therapies designed to stabilize physiologic function should be promptly implemented.

Signs of impending rupture include severe back or abdominal pain, which may be persistent or intermittent. Abdominal

pain is often localized in the middle or lower abdomen to the left of the midline. Low back pain may be present because of pressure of the aneurysm on the lumbar nerves. Indications of a rupturing abdominal aortic aneurysm include constant, intense back pain; falling blood pressure; and decreasing hematocrit. Rupture into the peritoneal cavity is rapidly fatal. A retroperitoneal rupture of an aneurysm may result in hematomas in the scrotum, perineum, flank, or penis. Signs of heart failure or a loud bruit may suggest a rupture into the vena cava. If the aneurysm adheres to the adjacent vena cava, the vena cava may become damaged when rupture or leak of the aneurysm occurs. Rupture into the vena cava results in higher-pressure arterial blood entering the lower-pressure venous system and causing turbulence, which is heard as a bruit. The high blood pressure and increased blood volume returning to the right side of the heart from the vena cava may cause right-sided heart failure.

Postoperative care requires frequent monitoring of pulmonary, cardiovascular, renal, and neurologic status. Possible complications of surgery include arterial occlusion, hemorrhage, infection, ischemic bowel, renal failure, and impotence.

## Other Aneurysms

Aneurysms may also arise in the peripheral vessels, most often as a result of atherosclerosis. These may involve such vessels as the subclavian artery, renal artery, femoral artery, or (most frequently) popliteal artery. Between 50% and 60% of popliteal aneurysms are bilateral and may be associated with abdominal aortic aneurysms.

The aneurysm produces a pulsating mass and disturbs peripheral circulation distal to it. Pain and swelling develop because of pressure on adjacent nerves and veins. Diagnosis is made by duplex ultrasonography and CTA to determine the size, length, and extent of the aneurysm. Arteriography may be performed to evaluate the level of proximal and distal involvement.

### Medical Management

Surgical repair is performed with replacement grafts or endovascular repair using a stent-graft or wall graft, which is a Dacron or PTFE graft with external structures made from a variety of materials (eg, nitinol, titanium, stainless steel) for additional support.

### Nursing Management

The patient who has had an endovascular repair must lie supine for 6 hours; the head of the bed may be elevated up to 45 degrees after 2 hours. The patient needs to use a bedpan or urinal while on bed rest, or an indwelling urinary catheter may be used. Vital signs and Doppler assessment of peripheral pulses are performed initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. The access site (usually the femoral or iliac artery) is assessed when vital signs and pulses are monitored. The nurse assesses for bleeding, pulsation, swelling, pain, and hematoma formation. Skin changes of the lower extremity, lumbar area, or buttocks that might indicate signs of embolization, such as extremely tender, irregularly shaped, cyanotic areas, as well as any changes in vital signs, pulse quality, bleeding, swelling, pain, or hematoma, are immediately reported to the physician.

The patient's temperature should be monitored every 4 hours, and any signs of postimplantation syndrome should be reported. Postimplantation syndrome typically begins within 24 hours of stent-graft placement and consists of a spontaneously occurring fever, leukocytosis, and, occasionally, transient thrombocytopenia. This condition has been attributed to complex immunologic changes, although the exact etiology is unknown. The symptoms are thought to be related to the activation of cytokines (Akowuah, Wilde, Angelini, et al., 2007). They can be managed with mild analgesic or anti-inflammatory agents, such as acetaminophen (Tylenol) or ibuprofen (Motrin) and usually subside within a week.

Because of the increased risk of hemorrhage, the physician is also notified of persistent coughing, sneezing, vomiting, or systolic blood pressure greater than 180 mm Hg. Most patients can resume their preprocedure diet and are encouraged to drink fluids. An IV infusion may be continued until the patient can drink normally. Fluids are important to maintain blood flow through the arterial repair site and to assist the kidneys with excreting IV contrast agent and other medications used during the procedure. Six hours after the procedure, the patient may be able to roll from side to side and may be able to ambulate with assistance to the bathroom. Once the patient can take adequate fluids orally, the IV infusion may be discontinued and the IV access converted to a saline lock.

## Dissecting Aorta

Occasionally, in an aorta diseased by arteriosclerosis, a tear develops in the intima or the media degenerates, resulting in a dissection (see Fig. 31-11). Arterial dissections are three times more common in men than in women and occur most commonly in the 50- to 70-year-old age group (Rutherford, 2005).

### Pathophysiology

Arterial dissections (separations) are commonly associated with poorly controlled hypertension, blunt chest trauma, and cocaine use. The profound increase in sympathetic response caused by cocaine use creates an increase in the force of left ventricular contraction that causes heightened shear forces upon the aortic wall (Rutherford, 2005). Dissection is caused by rupture in the intimal layer. A rupture may occur through adventitia or into the lumen through the intima, allowing blood to reenter the main channel and resulting in chronic dissection (eg, pseudoaneurysm) or occlusion of branches of the aorta.

As the separation progresses, the arteries branching from the involved area of the aorta shear and occlude. The tear occurs most commonly in the region of the aortic arch, with the highest mortality rate associated with ascending aortic dissection. The dissection of the aorta may progress backward in the direction of the heart, obstructing the openings to the coronary arteries or producing hemopericardium (effusion of blood into the pericardial sac) or aortic insufficiency, or it may extend in the opposite direction, causing occlusion

of the arteries supplying the gastrointestinal tract, kidneys, spinal cord, and legs.

### Clinical Manifestations

Onset of symptoms is usually sudden. Severe and persistent pain, described as tearing or ripping, may be reported. The pain is in the anterior chest or back and extends to the shoulders, epigastric area, or abdomen. Aortic dissection may be mistaken for an acute myocardial infarction, which could confuse the clinical picture and initial treatment. Cardiovascular, neurologic, and gastrointestinal symptoms are responsible for other clinical manifestations, depending on the location and extent of the dissection. The patient may appear pale. Sweating and tachycardia may be detected. Blood pressure may be elevated or markedly different from one arm to the other if dissection involves the orifice of the subclavian artery on one side. Because of the variable clinical picture associated with this condition, early diagnosis is usually difficult.

### Assessment and Diagnostic Findings

Arteriography, CTA, transesophageal echocardiography, duplex ultrasonography, and MRA aid in the diagnosis.

### Medical Management

The medical or surgical treatment of a dissecting aorta depends on the type of dissection present and follows the general principles outlined for the treatment of thoracic aortic aneurysms.

### Nursing Management

A patient with a dissecting aorta requires the same nursing care as a patient with an aortic aneurysm requiring surgical intervention, as described earlier in this chapter. Interventions described in Chart 31-3 are also appropriate.

## Arterial Embolism and Arterial Thrombosis

Acute vascular occlusion may be caused by an embolus or acute thrombosis. Acute arterial occlusions may result from iatrogenic injury, which can occur during insertion of invasive catheters such as those used for arteriography, PTA or stent placement, or an intra-aortic balloon pump, or it may occur as a result of IV drug abuse. Other causes include trauma from a fracture, crush injury, and penetrating wounds that disrupt the arterial intima. The accurate diagnosis of an arterial occlusion as embolic or thrombotic in origin is necessary to initiate appropriate treatment.

### Pathophysiology

Arterial emboli arise most commonly from thrombi that develop in the chambers of the heart as a result of atrial fibrillation, myocardial infarction, infective endocarditis, or chronic heart failure. These thrombi become detached and are carried from the left side of the heart into the arterial system, where they lodge in and obstruct an artery that is smaller than the embolus. Emboli may also develop in advanced aortic atherosclerosis because the atheromatous plaques ulcerate or become rough. Acute thrombosis frequently occurs in patients with preexisting ischemic symptoms.

### Clinical Manifestations

The symptoms of arterial emboli depend primarily on the size of the embolus, the organ involved, and the state of the collateral vessels. The immediate effect is cessation of distal blood flow. The blockage can progress distal and proximal to the site of the obstruction. Secondary vasospasm can contribute to the ischemia. The embolus can fragment or break apart, resulting in occlusion of distal vessels. Emboli tend to lodge at arterial bifurcations and areas narrowed by atherosclerosis. Cerebral, mesenteric, renal, and coronary arteries are often involved in addition to the large arteries of the extremities.

The symptoms of acute arterial embolism in extremities with poor collateral flow are acute, severe pain and a gradual loss of sensory and motor function. The six *P*s associated with acute arterial embolism are *p*ain, *p*allor, *p*ulselessness, *p*aresthesia, *p*oikilothermia (coldness), and *p*aralysis. Eventually, superficial veins may collapse because of decreased blood flow to the extremity. Because of ischemia, the part of the extremity distal to the occlusion is markedly colder and paler than the part proximal to the occlusion.

Arterial thrombosis can also acutely occlude an artery. A thrombosis is a slowly developing clot that usually occurs where the arterial wall has become damaged, generally as a result of atherosclerosis. Thrombi may also develop in an arterial aneurysm. The manifestations of an acute thrombotic arterial occlusion are similar to those described for embolic occlusion. However, treatment is more difficult with a thrombus because the arterial occlusion has occurred in a degenerated vessel and requires more extensive reconstructive surgery to restore flow than is required with an embolic event.

### Assessment and Diagnostic Findings

An arterial embolus is usually diagnosed on the basis of the sudden nature of the onset of symptoms and an apparent source for the embolus. Two-dimensional transthoracic echocardiography or TEE, chest x-ray, and electrocardiography (ECG) may reveal underlying cardiac disease. Noninvasive duplex and Doppler ultrasonography can determine the presence and extent of underlying atherosclerosis, and arteriography may be performed.

### Medical Management

Management of arterial thrombosis depends on its cause. Management of acute embolic occlusion usually requires surgery because time is of the essence. Because the onset of the event is acute, collateral circulation has not developed, and the patient quickly moves through the list of six *P*s to paralysis, the most advanced stage. Heparin therapy is initiated immediately to prevent further development of emboli and to prevent the extension of existing thrombi. Typically, an initial IV bolus of 5000 units or 60 units/kg body weight is administered, followed by a continuous infusion of 12 units/kg/h until the patient undergoes surgery.

#### Surgical Management

Emergency embolectomy is the procedure of choice if the involved extremity is viable (Fig. 31-14). Arterial emboli are usually treated by insertion of an embolectomy catheter. The

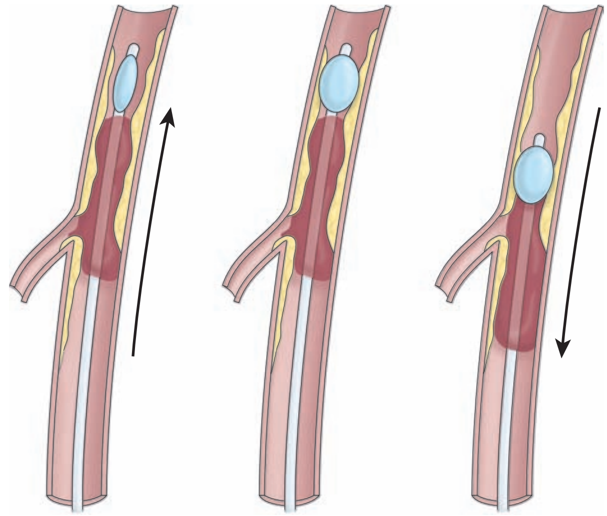


**Figure 31-14** Extraction of an embolus by balloon-tipped embolectomy catheter. The deflated balloon-tipped catheter is advanced past the embolus, inflated, and then gently withdrawn, carrying the embolic material with it. Adapted with permission from Rutherford, R. B. (2005). *Vascular surgery* (6th ed., Vols. I and II). Philadelphia: Elsevier.

catheter is passed through a groin incision into the affected artery and advanced past the occlusion. The catheter balloon is inflated with sterile saline solution, and the thrombus is extracted as the catheter is withdrawn. This procedure involves incising the vessel and removing the clot.

### Endovascular Management

Percutaneous mechanical thrombectomy devices may also be used for the treatment of an acute thrombosis. All endovascular devices necessitate obtaining access to the patient's arterial system and inserting a catheter into the patient's artery to obtain access to the thrombus. The approach is similar to that used for angiograms in that it is made through the groin to the femoral artery. Some devices require that a small incision be made into the patient's artery. These devices may use (1) a jet of fluid to disrupt the thrombus and then aspirate the particles; (2) a rotating, sinusoidal-shaped wire that mixes a thrombolytic agent that simultaneously dissolves the clot; or (3) high-frequency, low-energy ultrasound to dissolve an occlusive thrombus. Complications arising from the use of any of the endovascular devices may include arterial dissection or distal artery embolization.

### Pharmacologic Therapy

When the patient has collateral circulation, treatment may include IV anticoagulation with heparin, which can prevent the thrombus from spreading and reduce muscle necrosis. Intra-arterial thrombolytic medications are used to dissolve the embolus. Fibrin-specific thrombolytic medications (eg, tissue plasminogen activator [t-PA, alteplase, Activase] and single-chain urokinase-type plasminogen activator [scu-PA, prourokinase]) do not deplete circulating fibrinogen and plasminogen, which prevents the development of systemic fibrinolysis. Other thrombolytic medications are reteplase (r-PA, Retavase), tenecteplase (TNKase), and staphylokinase (Moore, 2006). Although these agents differ in their pharmacokinetics, they are administered in a similar manner: A catheter is advanced under x-ray visualization to the clot, and the thrombolytic agent is infused.

Thrombolytic therapy should not be used when there are known contraindications to therapy or when the extremity cannot tolerate the several additional hours of ischemia that it takes for the agent to lyse (disintegrate) the clot. Contraindications to peripheral thrombolytic therapy include active internal bleeding, cerebrovascular hemorrhage, recent major surgery, uncontrolled hypertension, and pregnancy.

## Nursing Management

Before surgery, the patient remains on bed rest with the affected extremity level or slightly dependent (15 degrees). The affected part is kept at room temperature and protected from trauma. Heating and cooling pads are contraindicated because ischemic extremities are easily traumatized by alterations in temperature. If possible, tape and ECG electrodes should not be used on the extremity; sheepskin and foot cradles are used to protect an affected leg from mechanical trauma.

If the patient is treated with thrombolytic therapy, the dose is based on the patient's weight. The patient is admitted to a critical care unit for continuous monitoring. Vital signs are taken initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. The patient is closely monitored for bleeding. The nurse minimizes the number of punctures for inserting IV lines and obtaining blood samples, avoids intramuscular injections, prevents any possible tissue trauma, and applies pressure at least twice as long as usual after any puncture is performed. If t-PA is used for the treatment, heparin is usually administered to prevent another thrombus from forming at the site of the lesion. The t-PA activates plasminogen on the thrombus, but it does not decrease the clotting factors as much as other thrombolytic therapies, so patients receiving t-PA can make new thrombi more readily than if they receive other thrombolytics.

During the postoperative period, the nurse collaborates with the surgeon about the patient's appropriate activity level based on the patient's condition. Generally, every effort is made to encourage the patient to move the extremity to stimulate circulation and prevent stasis. Anticoagulant therapy may be continued after surgery to prevent thrombosis of the affected artery and to diminish the development of subsequent thrombi at the initiating site. The nurse assesses for evidence of local and systemic hemorrhage, including mental status changes, which can occur when anticoagulants are administered. Pulses, Doppler signals, ABI, and motor and sensory function are assessed every hour for the first 24 hours, because significant changes may indicate reocclusion. Metabolic abnormalities, renal failure, and compartment syndrome may be complications after an acute arterial occlusion.

# Raynaud's Phenomenon

Raynaud's phenomenon is a form of intermittent arteriolar vasoconstriction that results in coldness, pain, and pallor of the fingertips or toes. There are two forms of this disorder.

Primary or idiopathic Raynaud's (Raynaud's disease) occurs in the absence of an underlying disease. Secondary Raynaud's (Raynaud's syndrome) occurs in association with an underlying disease, usually a connective tissue disorder, such as systemic lupus erythematosus, rheumatoid arthritis, or scleroderma; trauma; or obstructive arterial lesions. Symptoms may result from a defect in basal heat production that eventually decreases the ability of cutaneous vessels to dilate. Episodes may be triggered by emotional factors or by unusual sensitivity to cold. Raynaud's phenomenon is most common in women between 16 and 40 years of age, and it occurs more frequently in cold climates and during the winter (Pope, 2007).

The prognosis for patients with Raynaud's phenomenon varies; some slowly improve, some become progressively worse, and others show no change. Raynaud's symptoms may be mild so that treatment is not required. However, secondary Raynaud's is characterized by vasospasm and fixed blood vessel obstructions that may lead to ischemia, ulceration, and gangrene.

### Clinical Manifestations

The classic clinical picture reveals pallor brought on by sudden vasoconstriction. The skin then becomes bluish (cyanotic) because of pooling of deoxygenated blood during vasospasm. As a result of exaggerated reflow (hyperemia) due to vasodilation, a red color (rubor) is produced when oxygenated blood returns to the digits after the vasospasm stops. The characteristic sequence of color change of Raynaud's phenomenon is described as white, blue, and red. Numbness, tingling, and burning pain occur as the color changes. The manifestations tend to be bilateral and symmetric and may involve toes and fingers.

### Medical Management

Avoiding the particular stimuli (eg, cold, tobacco) that provoke vasoconstriction is a primary factor in controlling Raynaud's phenomenon. Calcium channel blockers (nifedipine [Procardia], amlodipine [Norvasc]) may be effective in relieving symptoms. Sympathectomy (interrupting the sympathetic nerves by removing the sympathetic ganglia or dividing their branches) may help some patients.

### Nursing Management

The nurse teaches the patient to avoid situations that may be stressful or unsafe. Stress management classes may be helpful. Exposure to cold must be minimized, and in areas where the fall and winter months are cold, the patient should wear layers of clothing when outdoors. Hats and mittens or gloves should be worn at all times when outside. Fabrics specially designed for cold climates (eg, Thinsulate) are recommended. Patients should warm up their vehicles before getting in so that they can avoid touching a cold steering wheel or door handle, which could elicit an attack. During summer, a sweater should be available when entering air-conditioned rooms.

Patients are often concerned about serious complications, such as gangrene and amputation, but these complications are uncommon unless the patient has another underlying disease causing arterial occlusions. Patients should avoid all forms of nicotine; nicotine gum or patches used to help people quit smoking may induce attacks.

Patients should be cautioned to handle sharp objects carefully to avoid injuring their fingers. Patients should be informed about the postural hypotension that may result from medications, such as calcium channel blockers, used to treat Raynaud's phenomenon.

# VENOUS DISORDERS

## *Venous Thromboembolism*

Deep vein thrombosis (DVT) and pulmonary embolism (PE) collectively make up the condition known as venous thromboembolism (VTE). The incidence of VTE is 10% to 20% in general medical patients, 20% to 50% in patients who have had a stroke, and up to 80% in critically ill patients (Morrison, 2006). The extent of the problem is underestimated, possibly because DVT and PE are often clinically silent. It is estimated that as many as 30% of patients hospitalized with VTE develop long-term postthrombotic complications. Hospital stays are shorter, which means that the majority of symptomatic thromboembolic complications in surgical patients occur after hospital discharge.

### Pathophysiology

Superficial veins, such as the greater saphenous, lesser saphenous, cephalic, basilic, and external jugular veins, are thick-walled muscular structures that lie just under the skin. Deep veins are thin walled and have less muscle in the media. They run parallel to arteries and bear the same names as the arteries. Deep and superficial veins have valves that permit unidirectional flow back to the heart. The valves lie at the base of a segment of the vein that is expanded into a sinus. This arrangement permits the valves to open without coming into contact with the wall of the vein, permitting rapid closure when the blood starts to flow backward. Other kinds of veins are known as perforating veins. These vessels have valves that allow one-way blood flow from the superficial system to the deep system.

Although the exact cause of VTE remains unclear, three factors, known as Virchow's triad, are believed to play a significant role in its development: stasis of blood (venous stasis), vessel wall injury, and altered blood coagulation (Chart 31-7). Venous stasis occurs when blood flow is reduced, as in heart failure or shock; when veins are dilated, as with some medication therapies; and when skeletal muscle contraction is reduced, as in immobility, paralysis of the extremities, or anesthesia. Moreover, bed rest reduces blood flow in the legs by at least 50% (Porth & Matfin, 2009). Damage to the intimal lining of blood vessels creates a site for clot formation. Direct trauma to the vessels, as with fractures or dislocation, diseases of the veins, and chemical irritation of the vein from IV medications or solutions, can damage veins. Increased blood coagulability occurs most commonly in patients for whom anticoagulant medications have been abruptly withdrawn. Oral contraceptive use and several blood dyscrasias (abnormalities) also can lead to hypercoagulability (Yang, 2005). In addition, normal pregnancy is accompanied by an increase in clotting factors that may not return to baseline until longer than 8 weeks postpartum, increasing the risk of thrombosis (James, 2007).

**CHART 31-7** *Risk Factors for Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)*

**Endothelial Damage**

- Trauma
- Surgery
- Pacing wires
- Central venous catheters
- Dialysis access catheters
- Local vein damage
- Repetitive motion injury

**Venous Stasis**

- Bed rest or immobilization
- Obesity
- History of varicosities
- Spinal cord injury
- Age (greater than 65 years)

**Altered Coagulation**

- Cancer
- Pregnancy
- Oral contraceptive use
- Protein C deficiency
- Protein S deficiency
- Antiphospholipid antibody syndrome
- Factor V Leiden defect
- Prothrombin 20210A defect
- Hyperhomocysteinemia
- Elevated factors II, VIII, IX, XI
- Antithrombin III deficiency
- Polycythemia
- Septicemia

Formation of a thrombus frequently accompanies phlebitis, which is an inflammation of the vein walls. When a thrombus develops initially in the veins as a result of stasis or hypercoagulability but without inflammation, the process is referred to as phlebothrombosis. Venous thrombosis can occur in any vein, but it occurs more often in the veins of the lower extremities. The superficial and deep veins of the extremities may be affected.

Upper extremity venous thrombosis is not as common as lower extremity thrombosis. Upper extremity venous thrombosis is more common in patients with IV catheters or in patients with an underlying disease that causes hypercoagulability. Internal trauma to the vessels may result from pacemaker leads, chemotherapy ports, dialysis catheters, or parenteral nutrition lines. The lumen of the vein may be decreased as a result of the catheter or from external compression, such as by neoplasms or an extra cervical rib. Effort thrombosis of the upper extremity is caused by repetitive motion (eg, in competitive swimmers, tennis players, and construction workers) that irritates the vessel wall, causing inflammation and subsequent thrombosis.

Venous thrombi are aggregates of platelets attached to the vein wall that have a tail-like appendage containing fibrin, white blood cells, and many red blood cells. The "tail" can grow or can propagate in the direction of blood flow as successive layers of the thrombus form. A propagating venous thrombosis is dangerous because parts of the thrombus can break off and occlude the pulmonary blood vessels. Fragmentation of the thrombus can occur spontaneously as it dissolves naturally, or it can occur with an elevated venous pressure, such as when a person stands suddenly or engages in muscular activity after prolonged inactivity. After an episode of acute DVT, recanalization (ie, reestablishment of the lumen of the vessel) typically occurs. The time required for complete recanalization is an important determinant of venous valvular incompetence, which is one complication of venous thrombosis (Labropoulos, Patel, Tiongson, et al., 2007). Other complications of venous thrombosis are listed in Chart 31-8.

## Clinical Manifestations

A major problem associated with recognizing DVT is that the signs and symptoms are nonspecific. The exception is phlegmasia cerulea dolens (massive iliofemoral venous thrombosis), in which the entire extremity becomes massively swollen, tense, painful, and cool to the touch.

### *Deep Veins*

With obstruction of the deep veins comes edema and swelling of the extremity because the outflow of venous blood is inhibited. The amount of swelling can be determined by measuring the circumference of the affected extremity at various levels with a tape measure and comparing one extremity with the other at the same level to determine size differences. If both extremities are swollen, a size difference may be difficult to detect. The affected extremity may feel warmer than the unaffected extremity, and the superficial veins may appear more prominent.

Tenderness, which usually occurs later, is produced by inflammation of the vein wall and can be detected by gently palpating the affected extremity. Homans' sign (pain in the calf after the foot is sharply dorsiflexed) is *not* a reliable sign

**Chart 31-8 •** *Complications of Venous Thrombosis*

**Chronic venous occlusion**
**Pulmonary emboli from dislodged thrombi**
**Valvular destruction**

- Chronic venous insufficiency
- Increased venous pressure
- Varicosities
- Venous ulcers

**Venous obstruction**

- Increased distal pressure
- Fluid stasis
- Edema
- Venous gangrene

for DVT because it can be elicited in any painful condition of the calf and has no clinical value in assessment for DVT. In some cases, signs and symptoms of a pulmonary embolus are the first indication of DVT.

### *Superficial Veins*

Thrombosis of superficial veins produces pain or tenderness, redness, and warmth in the involved area. The risk of the superficial venous thrombi becoming dislodged or fragmenting into emboli is very low because most of them dissolve spontaneously. This condition can be treated at home with bed rest, elevation of the leg, analgesic agents, and possibly anti-inflammatory medication.

## Assessment and Diagnostic Findings

Careful assessment is invaluable in detecting early signs of venous disorders of the lower extremities. Patients with a history of varicose veins, hypercoagulation, neoplastic disease, cardiovascular disease, or recent major surgery or injury are at high risk. Other patients at high risk include those who are obese or elderly and women taking oral contraceptives.

When performing the nursing assessment, key concerns include limb pain, a feeling of heaviness, functional impairment, ankle engorgement, and edema; differences in leg circumference bilaterally from thigh to ankle; increase in the surface temperature of the leg, particularly the calf or ankle; and areas of tenderness or superficial thrombosis (ie, cordlike venous segment).

## Prevention

VTE can be prevented, especially if patients who are considered at high risk are identified and preventive measures are instituted without delay. Preventive measures include the application of graduated compression stockings, the use of intermittent pneumatic compression devices, and encouragement of early mobilization and leg exercises. An additional method to prevent venous thrombosis in surgical patients is administration of subcutaneous unfractionated or low-molecular-weight heparin (LMWH). Patients should be advised to make lifestyle changes as appropriate, which may include weight loss, smoking cessation, and regular exercise.

## Medical Management

The objectives of treatment for DVT are to prevent the thrombus from growing and fragmenting (thus risking PE), recurrent thromboemboli, and postthrombotic syndrome (discussed later in the chapter) (Yang, 2005). Anticoagulant therapy (administration of a medication to delay the clotting time of blood, prevent the formation of a thrombus in postoperative patients, and forestall the extension of a thrombus after it has formed) can meet these objectives. However, anticoagulants cannot dissolve a thrombus that has already formed. Combining anticoagulation therapy with thrombolytic therapy may eliminate venous obstruction, maintain venous patency, and prevent postthrombotic syndrome caused by early removal of the thrombus (Vedantham, Millward, Cardella, et al., 2006).

### *Pharmacologic Therapy*

Measures for preventing or reducing blood clotting within the vascular system are indicated in patients with thrombophlebitis, recurrent embolus formation, and persistent leg edema from heart failure (Table 31-2). They are also indicated in elderly patients with a hip fracture that may result in lengthy immobilization. Contraindications for anticoagulant therapy are noted in Chart 31-9.

#### Unfractionated Heparin

Unfractionated heparin is administered subcutaneously to prevent development of DVT, or by intermittent or

**Table 31-2 SUMMARY OF ANTICOAGULANTS AND THROMBOLYTICS USED TO TREAT VENOUS THROMBOEMBOLI**

| Medication | Major Indications |
|---|---|
| **Unfractionated Heparin**<br>Heparin | Anticoagulation in patients with current VTE or VTE prophylaxis in patients at risk |
| **Low-Molecular-Weight Heparin (LMWH)**<br>Dalteparin (Fragmin)<br>Enoxaparin (Lovenox) | Prophylaxis in patients at risk for VTE or at risk for extension of current VTE |
| **Oral Anticoagulant**<br>Warfarin (Coumadin) | Anticoagulation in patients with current VTE or VTE prophylaxis in patients at risk |
| **Factor Xa Inhibitor**<br>Fondaparinux (Arixtra) | Prophylaxis in surgical patients at risk for VTE |
| **Thrombolytic**<br>Alteplase (Activase, t-PA)<br>Reteplase (Retavase)<br>Tenecteplase (TNKase)<br>Urokinase (Abbokinase)<br>Streptokinase (Streptase) | Fibrinolysis/dissolution of existing VTE |
| **Direct Thrombin Inhibitor**<br>Lepirudin (Refludan)<br>Argatroban (Novastan) | Treatment of heparin-induced thrombocytopenia |

VTE, venous thromboembolism.

CHART 31-9 **PHARMACOLOGY**

***Contraindications to Anticoagulant Therapy***

- Lack of patient cooperation
- Bleeding from the following systems:
    - Gastrointestinal
    - Genitourinary
    - Respiratory
    - Reproductive
- Hemorrhagic blood dyscrasias
- Aneurysms
- Severe trauma
- Alcoholism
- Recent or impending surgery of the eye, spinal cord, or brain
- Severe hepatic or renal disease
- Recent cerebrovascular hemorrhage
- Infections
- Open ulcerative wounds
- Occupations that involve a significant hazard for injury
- Recent childbirth

continuous IV infusion for 5 days to prevent the extension of a thrombus and the development of new thrombi. Oral anticoagulants, such as warfarin, are administered with heparin therapy. Medication dosage is regulated by monitoring the activated partial thromboplastin time (aPTT), the international normalized ratio (INR), and the platelet count.

**Low-Molecular-Weight Heparin**

Subcutaneous LMWHs that may include medications such as dalteparin and enoxaparin are effective treatments for some cases of DVT. These agents have longer half-lives than unfractionated heparin, so doses can be given in one or two subcutaneous injections each day. Doses are adjusted according to weight. LMWHs prevent the extension of a thrombus and development of new thrombi, and they are associated with fewer bleeding complications and lower risks of heparin-induced thrombocytopenia (HIT) than unfractionated heparin. Because there are several preparations, the dosing schedule must be based on the product used and the protocol at each institution. The cost of LMWH is higher than that of unfractionated heparin; however, LMWH may be used safely in pregnant women, and patients who take it may be more mobile and have an improved quality of life.

**Oral Anticoagulants**

Warfarin is a vitamin K antagonist that is indicated for extended anticoagulant therapy. Routine coagulation monitoring is essential to ensure that a therapeutic response is obtained and maintained over time. Interactions with a range of other medications can reduce or enhance the anticoagulant effects of warfarin, as can variable intake of foods containing vitamin K (see Chart 33-15). Warfarin has a narrow therapeutic window, and there is a slow onset of action. Treatment is initially supported with concomitant parenteral anticoagulation with heparin until the warfarin demonstrates anticoagulant effectiveness.

**Factor Xa Inhibitor**

Fondaparinux selectively inhibits factor Xa. This agent is given daily subcutaneously at a fixed dose, has a half-life of 17 hours, and is excreted unchanged via the kidneys (and therefore must be used with caution in patients with renal insufficiency). It has no effect on routine tests of coagulation, such as the aPTT or activated clotting time (ACT), so routine coagulation monitoring is unnecessary. Fondaparinux is approved for prophylaxis during major orthopedic surgery, such as hip or knee arthroplasties. Recent data suggest that fondaparinux, in conjunction with warfarin, is also effective for treatment of VTE (Nutescu, Wittkowsky, Dobesh, et al., 2006).

**Thrombolytic Therapy**

Unlike the heparins, catheter-directed thrombolytic (fibrinolytic) therapy lyses and dissolves thrombi in at least 50% of patients. Thrombolytic therapy (eg, alteplase) is given within the first 3 days after acute thrombosis. Therapy initiated beyond 14 days after the onset of symptoms is significantly less effective. The advantages of thrombolytic therapy include less long-term damage to the venous valves and a reduced incidence of postthrombotic syndrome and chronic venous insufficiency. However, thrombolytic therapy results in a threefold greater incidence of bleeding than heparin. If bleeding occurs and cannot be stopped, the thrombolytic agent is discontinued (Vedantham, et al., 2006).

### *Endovascular Management*

Endovascular management is necessary for DVT when anticoagulant or thrombolytic therapy is contraindicated (see Chart 31-9), the danger of pulmonary embolism is extreme, or venous drainage is so severely compromised that permanent damage to the extremity is likely. A thrombectomy may be necessary. This mechanical method of clot removal may involve using intraluminal catheters with a balloon or other devices. Some of these spin to break the clot, and others use oscillation to break up the clot to facilitate removal. A vena cava filter may be placed at the time of the thrombectomy; this filter traps large emboli and prevents pulmonary emboli (see Chapter 23). Some retrievable caval filters can be left in place and then retrieved for up to several months. In patients with chronic iliac vein compression, balloon angioplasty with stent placement may successfully treat the patient's chronic leg symptoms (Shebel & Whalen, 2005).

## Nursing Management

If the patient is receiving anticoagulant therapy, the nurse must frequently monitor the aPTT, prothrombin time (PT), INR, ACT, hemoglobin and hematocrit values, platelet count, and fibrinogen level, depending on which medication is being given. Close observation is also required to

detect bleeding; if bleeding occurs, it must be reported immediately and anticoagulant therapy discontinued.

### Assessing and Monitoring Anticoagulant Therapy

To prevent inadvertent infusion of large volumes of unfractionated heparin, which could cause hemorrhage, unfractionated heparin is administered by continuous IV infusion using an electronic infusion device. Dosage calculations are based on the patient's weight, and any possible bleeding tendencies are detected by a pretreatment clotting profile. If renal insufficiency exists, lower doses of heparin are required. Periodic coagulation tests and hematocrit levels are obtained. Heparin is in the effective, or therapeutic, range when the aPTT is 1.5 times the control.

Oral anticoagulants, such as warfarin, are monitored by the PT or the INR. Because the full anticoagulant effect of warfarin is delayed for 3 to 5 days, it is usually administered concurrently with heparin until desired anticoagulation has been achieved (ie, when the PT is 1.5 to 2 times normal or the INR is 2.0 to 3.0).

### Monitoring and Managing Potential Complications

#### Bleeding

The principal complication of anticoagulant therapy is spontaneous bleeding. Bleeding from the kidneys is detected by microscopic examination of the urine and is often the first sign of excessive dosage. Bruises, nosebleeds, and bleeding gums are also early signs. To promptly reverse the effects of heparin, IV injections of protamine sulfate may be administered. Risks of protamine administration include bradycardia and hypotension, which can be minimized by slow administration. Protamine sulfate can be used to reverse the effects of LMWH, but it is less effective with LMWH than with unfractionated heparin. Reversing the anticoagulation effects of warfarin is more difficult, but effective measures that may be prescribed include administration of vitamin K and/or infusion of fresh-frozen plasma or prothrombin concentrate. Oral and low-dose IV vitamin K significantly reduces the INR within 24 hours.

#### Thrombocytopenia

A complication of heparin therapy may be heparin-induced thrombocytopenia (HIT), which is defined as a sudden decrease in the platelet count by at least 30% of baseline levels. Patients at greatest risk are those who receive unfractionated heparin for a long period of time (ie, several days or weeks). Therefore, it is preferable not to use unfractionated heparin over the long term. The administration of LMWH is less frequently associated with HIT. Beginning warfarin concomitantly with unfractionated heparin can provide a stable INR or PT by day 5 of heparin treatment, at which time the heparin may be discontinued.

The thrombocytopenia associated with HIT is thought to result from an autoimmune mechanism that causes destruction of platelets. If the process is not arrested, platelets may aggregate, initiating inappropriate clotting, and thrombosis may occur. This serious complication results in thromboembolic manifestations known as HIT with thrombosis (HITT), and the prognosis is extremely guarded.

Prevention of thrombocytopenia depends on regular monitoring of platelet counts. Early signs include a decreasing platelet count, the need for increasing doses of heparin to maintain the therapeutic level, and thromboembolic or hemorrhagic complications (appearance of skin necrosis, either at the site of injection or at distal sites where thromboses occur; skin discoloration consisting of large hemorrhagic areas; hematomas; purpura; and blistering) (Arepally & Ortel, 2006). If thrombocytopenia does occur, platelet aggregation studies are performed, the heparin is discontinued, and alternate anticoagulant therapy is rapidly initiated because the continued prothrombotic state poses an ongoing threat of continuous clot development.

Lepirudin (Refludan) and argatroban (Novastan) are direct thrombin inhibitors approved for treatment of HIT. Lepirudin has a half-life of 1.3 hours, is excreted by the kidneys, and can be monitored using the aPTT. An initial IV bolus infusion followed by a continuous infusion with subsequent adjustments to maintain the aPTT between 1.5 and 2.5 times baseline is recommended. Strict dosage adjustment in renal failure is required, because the clearance of lepirudin is proportional to the patient's creatinine clearance. Argatroban has a half-life of 30 to 45 minutes, is metabolized by the liver, and is unaffected by renal function. The anticoagulant effect of argatroban is predictable, with low variability between patients, but it is dose dependent and requires monitoring with either the aPTT or ACT.

There is no safe, rapidly acting antidote if the patient develops bleeding complications from direct thrombin inhibitors. Recombinant factor VIIa may reverse the anticoagulant effects of direct thrombin inhibitors but may not be available in all hospitals, and it is costly (Nutescu, et al., 2006).

#### Drug Interactions

Because oral anticoagulants (ie, warfarin) interact with many other medications and herbal and nutritional supplements, close monitoring of the patient's medication schedule is necessary. Many medications and supplements potentiate or inhibit oral anticoagulants; it is always wise to check to see if any medications or supplements are contraindicated with warfarin (see Chart 33-15). Contraindications to anticoagulant therapy are summarized in Chart 31-9.

### Providing Comfort

Elevation of the affected extremity, graduated compression stockings, and analgesic agents for pain relief are adjuncts to therapy. They help improve circulation and increase comfort. Warm, moist packs applied to the affected extremity reduce the discomfort associated with DVT. The patient is encouraged to walk once anticoagulation therapy has been initiated. The nurse should instruct the patient that walking is better than standing or sitting for long periods. Bed exercises, such as repetitive dorsiflexion of the foot, are also recommended.

### Compression Therapy

#### Stockings

Graduated compression stockings usually are prescribed for patients with venous insufficiency. The amount of pressure gradient is determined by the amount and severity of

venous disease. For example, a 20- to 30-mm Hg pressure gradient is prescribed for patients with asymptomatic varicose veins, whereas at least a 40-mm Hg pressure gradient is prescribed for patients with venous stasis ulceration. These stockings should not be confused with antiembolism stockings (ie, TED stockings) that provide less compression (12 to 20 mm Hg). Graduated compression stockings are designed to apply 100% of the prescribed pressure gradient at the ankle and pressure that decreases as the stocking approaches the thigh, reducing the caliber of the superficial veins in the leg and increasing flow in the deep veins. These stockings may be knee high, thigh high, or pantyhose.

*NURSING ALERT*

**Any type of stocking can inadvertently become a tourniquet if applied incorrectly (ie, rolled tightly at the top). In such instances, the stockings produce rather than prevent stasis. For ambulatory patients, graduated compression stockings are removed at night and reapplied before the legs are lowered from the bed to the floor in the morning.**

When the stockings are off, the skin is inspected for signs of irritation, and the calves are examined for tenderness. Any skin changes or signs of tenderness are reported. Stockings are contraindicated in patients with severe pitting edema because they can produce severe pitting at the knee.

***Gerontologic Considerations.*** Because of decreased strength and manual dexterity, elderly patients may be unable to apply graduated compression stockings properly. If this is the case, a family member or friend should be taught to assist the patient to apply the stockings so that they do not cause undue pressure on any part of the feet or legs. Frames have been designed to assist patients with applying stockings, and if there is any concern regarding patients' physical abilities, they should be referred to a stocking vendor that can provide examples and training of stocking assistance devices.

#### External Compression Devices and Wraps

Short stretch elastic wraps may be applied from the toes to the knee in a 50% spiral overlap. These wraps are available in a two-layer system, which includes an inner layer of soft padding. These wraps are rectangular and become squares on stretching, indicating the appropriate degree of stretch and reducing the possibility of wrapping a leg too loosely or too tightly. Three- and four-layer systems are also available (eg, Profore, Dyna-Care), but these may be used only once compared with the two-layer system, which can be used multiple times.

Other types of compression are available. The Unna boot, which consists of a paste bandage impregnated with zinc oxide, glycerin, gelatin, and sometimes calamine, is applied without tension in a circular fashion from the base of the toes to the tibial tuberosity with a 50% spiral overlap. It is important to keep the foot dorsiflexed at a 90-degree angle to the leg, thus avoiding excess pressure or trauma to the anterior ankle area. Once the bandage dries, it provides a constant and consistent compression of the venous system. This type of compression may remain in place for as long as 1 week, although it may be too heavy for debilitated patients to handle.

The CircAid, a nonelastic leg wrap with a series of overlapping, interlocking Velcro straps, augments the effect of muscle while the patient is walking. The CircAid is usually worn during the day. Patients may find the CircAid easier to apply and wear than the Unna boot because it is lighter; they can remove it to shower, and it is adjustable. This readily adjustable feature may also be problematic; patients may be tempted to loosen the straps, and the compression achieved may not be adequate.

#### Intermittent Pneumatic Compression Devices

These devices can be used with elastic or graduated compression stockings to prevent DVT. They consist of an electric controller that is attached by air hoses to plastic knee-high or thigh-high sleeves. The leg sleeves are divided into compartments, which sequentially fill to apply pressure to the ankle, calf, and thigh at 35 to 55 mm Hg of pressure. These devices can increase blood velocity beyond that produced by the stockings. Nursing measures include ensuring that prescribed pressures are not exceeded, assessing for patient comfort, and ensuring compliance to therapy.

### *Positioning the Body and Encouraging Exercise*

When the patient is on bed rest, the feet and lower legs should be elevated periodically above the level of the heart. This position allows the superficial and tibial veins to empty rapidly and to remain collapsed. Active and passive leg exercises, particularly those involving calf muscles, should be performed to increase venous flow. Early ambulation is most effective in preventing venous stasis. Deep-breathing exercises are beneficial because they produce increased negative pressure in the thorax, which assists in emptying the large veins. Once ambulatory, the patient is instructed to avoid sitting for more than an hour at a time. The goal is to walk at least 10 minutes every 1 to 2 hours. The patient is also instructed to perform active and passive leg exercises as frequently as necessary when he or she cannot ambulate, such as during long car, bus, train, and plane trips.

### *Promoting Home and Community-Based Care*

In addition to teaching the patient how to apply graduated compression stockings and explaining the importance of elevating the legs and exercising adequately, the nurse teaches about the prescribed anticoagulant, its purpose, and the need to take the correct amount at the specific times prescribed (Chart 31-10). The patient should also be aware that periodic blood tests are necessary to determine if a change in medication or dosage is required. If the patient fails to adhere to the therapeutic regimen, continuation of the medication therapy should be questioned. A person who refuses to discontinue the use of alcohol should not receive anticoagulants because chronic alcohol use decreases their effectiveness. In patients with liver disease, the potential for bleeding may be exacerbated by anticoagulant therapy.

CHART 31-10 PATIENT EDUCATION
**Taking Anticoagulant Medications**

- Take the anticoagulant medication at the same time each day, usually between 8:00 and 9:00 am.
- Wear or carry identification indicating the anticoagulant medication being taken.
- Keep all appointments for blood tests.
- Because other medications affect the action of the anticoagulant medication do not take any of the following medications or supplements without consulting with the primary health care provider: vitamins, cold medicines, antibiotics, aspirin, mineral oil, and anti-inflammatory agents, such as ibuprofen (Motrin) and similar medications or herbal or nutritional supplements. The primary health care provider should be contacted before taking any over-the-counter drugs.
- Avoid alcohol, because it may change the body's response to an anticoagulant medication.
- Avoid food fads, crash diets, or marked changes in eating habits.
- Do not take warfarin (Coumadin) unless directed.
- Do not stop taking warfarin (when prescribed) unless directed.
- When seeking treatment from a physician, dentist, podiatrist, or another health care provider, be sure to inform the caregiver that you are taking an anticoagulant medication.
- Contact your primary health care provider before having dental work or elective surgery.
- If any of the following signs appear, report them immediately to the primary health care provider:
  - Faintness, dizziness, or increased weakness
  - Severe headaches or abdominal pain
  - Reddish or brownish urine
  - Any bleeding—for example, cuts that do not stop bleeding
  - Bruises that enlarge, nosebleeds, or unusual bleeding from any part of the body
  - Red or black bowel movements
  - Rash
- Avoid injury that can cause bleeding.
- For women: Notify the primary health care provider if you suspect pregnancy.

## Chronic Venous Insufficiency/ Postthrombotic Syndrome

Venous insufficiency results from obstruction of the venous valves in the legs or a reflux of blood through the valves. Superficial and deep leg veins can be involved. Resultant venous hypertension can occur whenever there has been a prolonged increase in venous pressure, such as occurs with DVT. Because the walls of veins are thinner and more elastic than the walls of arteries, they distend readily when venous pressure is consistently elevated. In this state, leaflets of the venous valves are stretched and prevented from closing completely, causing a backflow or reflux of blood in the veins. Duplex ultrasonography confirms the obstruction and identifies the level of valvular incompetence. From 20% to 50% of patients who are post-DVT when the valves in the deep veins become incompetent suffer from postthrombotic syndrome (Fig. 31-15) (Marr, 2006).

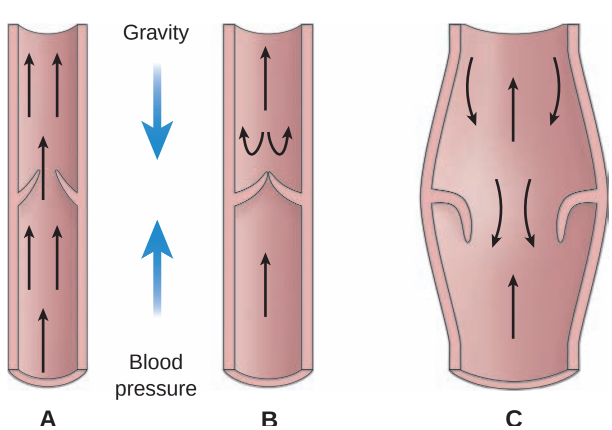



**Figure 31-15** Competent valves showing blood flow patterns when the valve is open **(A)** and closed **(B),** allowing blood to flow against gravity. **C,** With faulty or incompetent valves, the blood cannot move toward the heart.

### Clinical Manifestations

Postthrombotic syndrome is characterized by chronic venous stasis, resulting in edema, altered pigmentation, pain, and stasis dermatitis. The patient may notice the symptoms less in the morning and more in the evening. Obstruction or poor calf muscle pumping in addition to valvular reflux must be present for the development of severe postthrombotic syndrome and stasis ulcers. Superficial veins may be dilated. The disorder is long-standing, difficult to treat, and often disabling (Gohel, Barwell, Taylor, et al., 2007).

Stasis ulcers develop as a result of the rupture of small skin veins and subsequent ulcerations. When these vessels rupture, red blood cells escape into surrounding tissues and then degenerate, leaving a brownish discoloration of the tissues. The pigmentation and ulcerations usually occur in the lower part of the extremity, in the area of the medial malleolus of the ankle. The skin becomes dry, cracks, and itches; subcutaneous tissues fibrose and atrophy. The risk of injury and infection of the extremities is increased.

### Complications

Venous ulceration is the most serious complication of chronic venous insufficiency and can be associated with other conditions affecting the circulation of the lower extremities. Cellulitis or dermatitis may complicate the care of chronic venous insufficiency and venous ulcerations.

### Management

Management of the patient with venous insufficiency is directed at reducing venous stasis and preventing ulcerations. Measures that increase venous blood flow are antigravity activities, such as elevating the leg, and compression of superficial veins with graduated compression stockings.

Elevating the legs decreases edema, promotes venous return, and provides symptomatic relief. The legs should be elevated frequently throughout the day (at least 15 to 30 minutes every 2 hours). At night, the patient should sleep

with the foot of the bed elevated about 15 cm (6 inches). Prolonged sitting or standing in one position is detrimental; walking should be encouraged. When sitting, the patient should avoid placing pressure on the popliteal spaces, as occurs when crossing the legs or sitting with the legs dangling over the side of the bed. Constricting garments, especially socks that are too tight at the top or that leave marks on the skin, should be avoided.

Compression of the legs with graduated compression stockings reduces the pooling of venous blood, enhances venous return to the heart, and is recommended for people with venous insufficiency. It is recommended that stockings with 30 to 40 mm Hg pressure be used during the first year post-DVT (Marr, 2006). Each stocking should fit so that pressure is greater at the foot and ankle and then gradually declines to a lesser pressure at the knee or groin. If the top of the stocking is too tight or becomes twisted, a tourniquet effect is created, which worsens venous pooling. Stockings should be applied after the legs have been elevated for a period, when the amount of blood in the leg veins is at its lowest.

Extremities with venous insufficiency must be carefully protected from trauma; the skin is kept clean, dry, and soft. Signs of ulceration are immediately reported to the health care provider for treatment and follow-up.



**Figure 31-16** **A,** Ulcers resulting from arterial emboli. **B,** Gangrene of the toes resulting from severe arterial ischemia. **C,** Ulcer from venous stasis.

## Leg Ulcers

A leg ulcer is an excavation of the skin surface that occurs when inflamed necrotic tissue sloughs off. About 75% of all leg ulcers result from chronic venous insufficiency. Lesions due to arterial insufficiency account for approximately 20%; the remaining 5% are caused by burns, sickle cell anemia, and other factors (Humphreys, Stewart, Gohel, et al., 2007).

### Pathophysiology

Inadequate exchange of oxygen and other nutrients in the tissue is the metabolic abnormality that underlies the development of leg ulcers. When cellular metabolism cannot maintain energy balance, cell death (necrosis) results. Alterations in blood vessels at the arterial, capillary, and venous levels may affect cellular processes and lead to the formation of ulcers.

### Clinical Manifestations

The characteristics of leg ulcers are determined by the cause of the ulcer. Most ulcers, especially in elderly patients, have more than one cause. The symptoms depend on whether the problem is arterial or venous in origin (see Table 31-1). The severity of the symptoms depends on the extent and duration of the vascular insufficiency. The ulcer itself appears as an open, inflamed sore. The area may be draining or covered by eschar (dark, hard crust).

#### Arterial Ulcers

Chronic arterial disease is characterized by intermittent claudication, which is pain caused by activity and relieved after a few minutes of rest. The patient may also complain of digital or forefoot pain at rest. If the onset of arterial occlusion is acute, ischemic pain is unrelenting and rarely relieved even with opioids. Typically, arterial ulcers are small, circular, deep ulcerations on the tips of toes or in the web spaces between the toes. Ulcers often occur on the medial side of the hallux or lateral fifth toe and may be caused by a combination of ischemia and pressure (Fig. 31-16).

Arterial insufficiency may result in gangrene of the toe (digital gangrene), which usually is caused by trauma. The toe is stubbed and then turns black (see Fig. 31-16). Usually, patients with this problem are elderly people without adequate circulation to provide revascularization. Débridement is contraindicated in these instances. Although the toe is gangrenous, it is dry. Managing dry gangrene is preferable to débriding the toe and causing an open wound that will not heal because of insufficient circulation. If the toe were to be amputated, the lack of adequate circulation would prevent healing and might make further amputation necessary—a below-knee or an above-knee amputation. A higher-level amputation in an elderly person could result in a loss of independence and possibly the need for institutional care. Dry gangrene of the toe in an elderly person with poor circulation is usually left undisturbed. The nurse keeps the toe clean and dry until it separates (without creating an open wound).

#### Venous Ulcers

Chronic venous insufficiency is characterized by pain described as aching or heavy. The foot and ankle may be edematous. Ulcerations are in the area of the medial or lateral

malleolus (gaiter area) and are typically large, superficial, and highly exudative. Venous hypertension causes extravasation of blood, which discolors the area (see Fig. 31-16). Patients with neuropathy frequently have ulcerations on the side of the foot over the metatarsal heads. These ulcers are painless and are described in further detail in Chapter 41.

## Assessment and Diagnostic Findings

Because ulcers have many causes, the cause of each ulcer needs to be identified so appropriate therapy can be prescribed. The history of the condition is important in determining venous or arterial insufficiency. The pulses of the lower extremities (femoral, popliteal, posterior tibial, and dorsalis pedis) are carefully examined. More conclusive diagnostic aids are Doppler and duplex ultrasound studies, arteriography, and venography. Cultures of the ulcer bed may be necessary to determine whether an infecting agent is the primary cause of the ulcer.

## Medical Management

Patients with ulcers can be effectively managed by advanced practice nurses or wound-ostomy-continence nurses in collaboration with physicians. All ulcers have the potential to become infected.

### *Pharmacologic Therapy*

Antibiotic therapy is prescribed when the ulcer is infected; the specific antibiotic agent is based on culture and sensitivity test results. Oral antibiotics usually are prescribed because topical antibiotics have not proven to be effective for leg ulcers.

### *Compression Therapy*

Adequate compression therapy involves the application of external or counter pressure to the lower extremity to facilitate venous return to the heart. The pressure should be applied in a gradient or graduated fashion with the pressure being somewhat higher at the ankle. Graduated compression stockings are one option; some of these are custom-made to the patient's anatomic specifications. The patient should be instructed to wear the stockings at all times except at night and to reapply the stockings in the morning before getting out of bed. Short stretch elastic wraps, Unna boots, and CircAids may be other effective options. (See Venous Thromboembolism, Compression Therapy.)

### *Débridement*

To promote healing, the wound is kept clean of drainage and necrotic tissue. The usual method is to flush the area with normal saline solution or clean it with a noncytotoxic wound-cleansing agent (Saf-Clens, Biolex, Restore). If this is unsuccessful, débridement may be necessary. Débridement is the removal of nonviable tissue from wounds. Removing the dead tissue is important, particularly in instances of infection. Débridement can be accomplished by several different methods:

- Surgical débridement is the fastest method and can be performed by a physician, skilled advanced practice nurse, or wound-ostomy-continence nurse in collaboration with the physician.
- Nonselective débridement can be accomplished by applying isotonic saline dressings of fine-mesh gauze to the ulcer. When the dressing dries, it is removed (dry), along with the debris adhering to the gauze. Pain management is usually necessary.
- Enzymatic débridement with the application of enzyme ointments may be prescribed to treat the ulcer. The ointment is applied to the lesion but not to normal surrounding skin. Most enzymatic ointments are covered with saline-soaked gauze that has been thoroughly wrung out. A dry gauze dressing and a loose bandage are then applied. The enzymatic ointment is discontinued when the necrotic tissue has been débrided, and an appropriate wound dressing is applied.
- Calcium alginate dressings (eg, Kaltostat, Sorbsan, Aquacel Hydrofiber) may be used for débridement when absorption of exudate is needed. These dressings are changed when the exudate seeps through the cover dressing or at least every 7 days. The dressing can also be used on areas that are bleeding, because the material helps stop the bleeding. As the dry fibers absorb exudate, they become a gel that can be painlessly removed from the ulcer bed. Calcium alginate dressings should not be used on dry or nonexudative wounds.
- Foam dressings (eg, Lyofoam, Allevyn, Cavicare) may be an option for exudative wounds because they absorb exudate into the foam, keeping the wound moist.

### *Topical Therapy*

A variety of topical agents can be used in conjunction with cleansing and débridement therapies to promote healing of leg ulcers. The goals of treatment are to remove devitalized tissue and to keep the ulcer clean and moist while healing takes place. The treatment should not destroy developing tissue. For topical treatments to be successful, adequate nutritional therapy must be maintained.

### *Wound Dressing*

After the circulatory status has been assessed and determined to be adequate for healing (ABI of more than 0.5), surgical dressings can be used to promote a moist environment. Semiocclusive or occlusive wound dressings prevent evaporative water loss from the wound and retain warmth; these factors favor healing. When determining the appropriate dressing to apply, the following should be considered: simplicity of application, frequency of required dressing changes, ability to absorb wound drainage, expense, and patient comfort. Available options that promote the growth of granulation tissue and re-epithelialization include the hydrocolloids (eg, Comfeel, DuoDERM CGF, Restore, Tegasorb). These materials also provide a barrier for protection because they adhere to the wound bed and surrounding tissue. Semipermeable film dressings (eg, Bioclusive, OpSite, Tegaderm) may be selected because they keep the wound moist and are impervious to bacteria while allowing some gas exchange. However, they may not be effective treatment for deep wounds and infected wounds.

Growth factor dressings (eg, OASIS, becaplermin [Regranex], keratinocyte lysate) may directly provide a growth factor or they may stimulate important growth substances within the wound. Some studies of these dressings have

shown a statistically significant improvement in the number of ulcers healed and a reduced time to wound closure (O'Donnell & Lau, 2006).

Knowledge deficit, frustration, fear, and depression can decrease the patient's and family's compliance with the prescribed therapy; therefore, patient and family education is necessary before beginning and throughout the wound care program.

#### *Stimulated Healing*

Tissue-engineered human skin equivalent (eg, Apligraf [Graftskin]) is a skin product cultured from human dermal fibroblasts and keratinocytes used in combination with therapeutic compression. When applied, it interacts with the patient's cells within the wound to stimulate the production of growth factors. Application is not difficult, no suturing is involved, and the procedure is painless.

#### *Hyperbaric Oxygenation*

Hyperbaric oxygenation (HBO) may be beneficial as an adjunct treatment in patients with diabetes with no signs of wound healing after 30 days of standard wound treatment. HBO is accomplished by placing the patient into a chamber that increases barometric pressure while the patient is breathing 100% oxygen. The process by which HBO is thought to work involves several factors. The edema in the wound area is decreased because high oxygen tension facilitates vasoconstriction and enhances the ability of leukocytes to phagocytize and kill bacteria. In addition, HBO is thought to increase diffusion of oxygen to the hypoxic wound, thereby enhancing epithelial migration and improving collagen production. The two most common adverse effects of HBO are middle ear barotrauma and confinement anxiety (Mechem & Manaker, 2005).

#### *Negative Pressure Wound Therapy*

Research findings suggest that negative pressure wound therapy using vacuum-assisted closure (VAC) devices decreases time to healing in complex wounds that have not healed in a 3-week period (Brem, Sheehan, Rosenberg, et al., 2006). Ambulatory patients may be given the small, portable VAC devices that can be strapped around the waist, giving patients the freedom to perform their ADLs.

## NURSING PROCESS

## The Patient With Leg Ulcers

### Assessment

A careful nursing history and assessment are important. The extent and type of pain are carefully assessed, as are the appearance and temperature of the skin of both legs. The quality of all peripheral pulses is assessed, and the pulses in both legs are compared. The legs are checked for edema. If the extremity is edematous, the degree of edema is determined. Any limitation of mobility and activity that results from vascular insufficiency is identified. The patient's nutritional status is assessed, and a history of diabetes, collagen disease, or varicose veins is obtained.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses for the patient may include:

- Impaired skin integrity related to vascular insufficiency
- Impaired physical mobility related to activity restrictions of the therapeutic regimen and pain
- Imbalanced nutrition: less than body requirements, related to increased need for nutrients that promote wound healing

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include:

- Infection
- Gangrene

### Planning and Goals

The major goals for the patient may include restoration of skin integrity, improved physical mobility, adequate nutrition, and absence of complications.

### Nursing Interventions

The nursing challenge in caring for these patients is great, whether the patient is in the hospital, in a long-term care facility, or at home. The physical problem is often a long-term and disabling one that causes a substantial drain on the patient's physical, emotional, and economic resources.

#### *Restoring Skin Integrity*

To promote wound healing, measures are used to keep the area clean. Cleansing requires very gentle handling, a mild soap, and lukewarm water. Positioning of the legs depends on whether the ulcer is of arterial or venous origin. If there is arterial insufficiency, the patient should be referred for evaluation for vascular reconstruction. If there is venous insufficiency, dependent edema can be avoided by elevating the lower extremities. A decrease in edema promotes the exchange of cellular nutrients and waste products in the area of the ulcer, promoting healing.

Avoiding trauma to the lower extremities is imperative in promoting skin integrity. Protective boots may be used (eg, Rooke Vascular boot); they are soft and provide warmth and protection from injury and displace tissue pressure to prevent ulcer formation. If the patient is on bed rest, it is important to relieve pressure on the heels to prevent pressure ulcerations. When the patient is in bed, a bed cradle can be used to relieve pressure from bed linens and to prevent anything from touching the legs. When the patient is ambulatory, all obstacles are moved from the patient's path so that the patient's legs are not bumped. Heating pads, hot water bottles, or hot baths are avoided, because they increase the oxygen demands and thus the blood flow demands of the already compromised tissue. The patient with diabetes mellitus suffers from neuropathy with decreased sensation, and heating pads may produce injury before the patient is aware of being burned.

#### *Improving Physical Mobility*

Generally, physical activity is initially restricted to promote healing. When infection resolves and healing begins, ambulation should resume gradually and progressively. Activity promotes arterial flow and venous return and is encouraged after the acute phase of the ulcer process. Until full activity is resumed, the patient is encouraged to move about when in bed, to turn from side to side frequently, and to exercise the upper extremities to maintain muscle tone and strength. Meanwhile, diversional activities are encouraged. Consultation with an occupational therapist may be helpful if prolonged immobility and inactivity are anticipated.

If pain limits the patient's activity, analgesic agents may be prescribed. The pain of peripheral vascular disease is typically chronic and often disabling. Analgesic agents may be taken before scheduled activities to help the patient participate more comfortably.

#### *Promoting Adequate Nutrition*

Nutritional deficiencies are common, requiring dietary alterations to remedy deficiencies. A diet that is high in protein, vitamins C and A, iron, and zinc is encouraged to promote healing. Many patients with peripheral vascular disease are elderly. Particular consideration should be given to their iron intake, because many elderly people are anemic. After a dietary plan has been developed that meets the patient's nutritional needs and promotes healing, diet instruction is provided to the patient and family.

#### *Promoting Home and Community-Based Care*

The self-care program is planned with the patient so that activities that promote arterial and venous circulation, relieve pain, and promote tissue integrity are encouraged. Reasons for each aspect of the program are explained to the patient and family. Leg ulcers are often chronic and difficult to heal; they frequently recur, even when the patient rigorously follows the plan of care. Long-term care of the feet and legs to promote healing of wounds and prevent recurrence of ulcerations is the primary goal. Leg ulcers increase the patient's risk of infection, may be painful, and may limit mobility, necessitating lifestyle changes. Participation of family members and home health care providers may be necessary for treatments such as dressing changes, reassessments, reinforcement of instruction, and evaluation of the effectiveness of the plan of care. Regular follow-up with a primary health care provider is necessary.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Demonstrates restored skin integrity
   a. Exhibits absence of inflammation
   b. Exhibits absence of drainage; negative wound culture
   c. Avoids trauma to the legs
2. Increases physical mobility
   a. Progresses gradually to optimal level of activity
   b. Reports that pain does not impede activity
3. Attains adequate nutrition
   a. Selects foods high in protein, vitamins, iron, and zinc
   b. Discusses with family members dietary modifications that need to be made at home
   c. Plans, with the family, a diet that is nutritionally sound

## Varicose Veins

Varicose veins (varicosities) are abnormally dilated, tortuous, superficial veins caused by incompetent venous valves (see Fig. 31-15). Most commonly, this condition occurs in the lower extremities, the saphenous veins, or the lower trunk, but it can occur elsewhere in the body, such as the esophagus (eg, esophageal varices; see Chapter 39).

It is estimated that varicose veins occur in up to 60% of the adult population in the United States, with an increased incidence correlated with increased age (Beebe-Dimmer, Pfeifer, Engle, et al., 2005). The condition is most common in women and in people whose occupations require prolonged standing, such as salespeople, hair stylists, teachers, nurses and ancillary medical personnel, and construction workers. A hereditary weakness of the vein wall may contribute to the development of varicosities, and it commonly occurs in several members of the same family. Varicose veins are rare before puberty. Pregnancy may cause varicosities because of hormonal effects related to decreased venous outflow, increased pressure by the gravid uterus, and increased blood volume (James, 2007).

### Pathophysiology

Varicose veins may be primary (without involvement of deep veins) or secondary (resulting from obstruction of deep veins). A reflux of venous blood in the veins results in venous stasis. If only the superficial veins are affected, the person may have no symptoms but may be troubled by their appearance.

### Clinical Manifestations

Symptoms, if present, may include dull aches, muscle cramps, increased muscle fatigue in the lower legs, ankle edema, and a feeling of heaviness of the legs. Nocturnal cramps are common. When deep venous obstruction results in varicose veins, the patient may develop the signs and symptoms of chronic venous insufficiency: edema, pain, pigmentation, and ulcerations. Susceptibility to injury and infection is increased.

### Assessment and Diagnostic Findings

Diagnostic tests for varicose veins include the duplex ultrasound scan, which documents the anatomic site of reflux and provides a quantitative measure of the severity of valvular reflux. Air plethysmography measures the changes in venous blood volume. Venography is not routinely performed to evaluate for valvular reflux. However, when it is used, it involves injecting a radiopaque contrast agent into the leg veins so that the vein anatomy can be visualized by x-ray studies during various leg movements.

## Prevention

The patient should avoid activities that cause venous stasis, such as wearing socks that are too tight at the top or that leave marks on the skin, crossing the legs at the thighs, and sitting or standing for long periods. Changing position frequently, elevating the legs when they are tired, and getting up to walk for several minutes of every hour promote circulation. The patient is encouraged to walk 1 or 2 miles each day if there are no contraindications. Walking up the stairs rather than using the elevator or escalator is helpful, and swimming is good exercise.

Graduated compression stockings, especially knee-high stockings, are useful. The overweight patient should be encouraged to begin a weight reduction plan.

## Medical Management

### Ligation and Stripping

Surgery for varicose veins requires that the deep veins be patent and functional. The saphenous vein is ligated and divided. The vein is ligated high in the groin, where the saphenous vein meets the femoral vein. Also, the vein may be removed (stripped). After the vein is ligated, an incision is made 2 to 3 cm below the knee, and a metal or plastic wire is passed the full length of the vein to the point of ligation. The wire is then withdrawn, pulling (removing, stripping) the vein as it is removed. Pressure and elevation minimize bleeding during surgery.

### Thermal Ablation

Thermal ablation is a nonsurgical approach using thermal energy. Radiofrequency ablation uses an electrical contact inside the vein. As the device is withdrawn, the vein is sealed. Laser ablation uses a laser fiber tip that seals the vein (decompressed). Topical gel may be used first to numb the skin along the course of the saphenous vein. To protect the surrounding tissue, several small punctures are made along the vein, and 100 to 200 mL of dilute lidocaine is delivered to the perivenous space using ultrasound guidance. The goal of this tumescent anesthesia (ie, anesthesia that causes localized swelling) is to provide analgesia, thermal protection (the cuff of fluid surrounds the veins and accompanying nerves), and extrinsic compression of the vein. The saphenous vein is entered percutaneously near the knee using ultrasound guidance. A catheter is introduced into the saphenous vein and advanced to the saphenofemoral junction. The device is then activated and withdrawn, sealing the vein. Small bandages and graduated compression stockings are applied after the procedure. The patient is asked not to remove the stockings for at least 48 hours and then to rewrap the legs and wear the compression stockings while ambulatory for at least 3 weeks. Patients are ambulatory prior to being discharged from the outpatient facility and have no activity restrictions, except that swimming is discouraged for 3 weeks. Nonsteroidal anti-inflammatory medications such as acetaminophen (Tylenol) or ibuprofen (Motrin) are used as needed for pain. The patient is informed that bruising may occur along the course of the saphenous vein, may experience leg cramps for a few days, and may find it difficult to straighten the knees for up to 1.5 weeks.

### Sclerotherapy

Sclerotherapy involves injection of an irritating chemical into a vein to produce localized phlebitis and fibrosis, thereby obliterating the lumen of the vein. This treatment may be performed alone for small varicosities or may follow vein ablation, ligation, or stripping. Sclerosing is palliative rather than curative. Sclerotherapy is typically performed in an examination or procedure room and does not require sedation. After the sclerosing agent is injected, anti-embolism stockings are applied to the leg and are worn for approximately 5 days after the procedure. Graduated compression stockings are then worn for an additional 5 weeks. After sclerotherapy, walking activities are encouraged as prescribed to maintain blood flow in the leg and to dilute the sclerosing agent.

## Nursing Management

Ligation and stripping can be performed in an outpatient setting, or the patient can be admitted to the hospital on the day of surgery and discharged the next day if a bilateral procedure is to be performed and the patient is at high risk for postoperative complications. If the procedure is performed in an outpatient setting, nursing measures are the same as if the patient were hospitalized. Bed rest is discouraged and the patient is encouraged to become ambulatory as soon as sedation has worn off. The patient is instructed to walk every hour for 5 to 10 minutes while awake for the first 24 hours if he or she can tolerate the discomfort, and then to increase walking and activity as tolerated. Graduated compression stockings are worn continuously for about 1 week after vein stripping. The nurse assists the patient to perform exercises and move the legs. The foot of the bed should be elevated. Standing and sitting are discouraged.

### Promoting Comfort and Understanding

Analgesic agents are prescribed to help the patient move the affected extremities more comfortably. Dressings are inspected for bleeding, particularly at the groin, where the risk of bleeding is greatest. The nurse is alert for reported sensations of "pins and needles." Hypersensitivity to touch in the involved extremity may indicate a temporary or permanent nerve injury resulting from surgery, because the saphenous vein and nerve are close to each other in the leg.

Usually, the patient may shower after the first 24 hours. The patient is instructed to dry the incisions well with a clean towel using a patting technique, rather than rubbing. Alternatively, the patient may be instructed to dry the area using a blow-dryer. Application of skin lotion is avoided until the incisions are completely healed to avoid infection. The patient is instructed to apply sunscreen or zinc oxide to the incisional area prior to sun exposure; otherwise, hyperpigmentation of the incision, scarring, or both may occur.

If the patient underwent sclerotherapy, a burning sensation in the injected leg may be experienced for 1 or 2 days. The nurse may encourage the use of a mild analgesic medication as prescribed and walking to provide relief.

### Promoting Home and Community-Based Care

Long-term venous compression is essential after discharge, and the patient needs to obtain adequate supplies of graduated compression stockings or elastic bandages. Exercise of the

legs is necessary; the development of an individualized plan requires consultation with the patient and the health care team.

# LYMPHATIC DISORDERS

The lymphatic system consists of a set of vessels that spread throughout most of the body. These vessels start as lymph capillaries that drain unabsorbed plasma from the interstitial spaces (spaces between the cells). The lymphatic capillaries unite to form the lymph vessels, which pass through the lymph nodes and then empty into the large thoracic duct that joins the jugular vein on the left side of the neck.

The fluid drained from the interstitial space by the lymphatic system is called lymph. The flow of lymph depends on the intrinsic contractions of the lymph vessels, the contraction of muscles, respiratory movements, and gravity. The lymphatic system of the abdominal cavity maintains a steady flow of digested fatty food (chyle) from the intestinal mucosa to the thoracic duct. In other parts of the body, the lymphatic system's function is regional; the lymphatic vessels of the head, for example, empty into clusters of lymph nodes located in the neck, and those of the extremities empty into nodes of the axillae and the groin.

## *Lymphangitis and Lymphadenitis*

Lymphangitis is an acute inflammation of the lymphatic channels. It arises most commonly from a focus of infection in an extremity. Usually, the infectious organism is a hemolytic streptococcus. The characteristic red streaks that extend up the arm or the leg from an infected wound outline the course of the lymphatic vessels as they drain.

The lymph nodes located along the course of the lymphatic channels also become enlarged, red, and tender (acute lymphadenitis). They can also become necrotic and form an abscess (suppurative lymphadenitis). The nodes involved most often are those in the groin, axilla, or cervical region.

Because these infections are nearly always caused by organisms that are sensitive to antibiotics, it is unusual to see abscess formation. Recurrent episodes of lymphangitis are often associated with progressive lymphedema. After acute attacks, a graduated compression stocking should be worn on the affected extremity for several months to prevent long-term edema.

## *Lymphedema and Elephantiasis*

Lymphedema may be primary (congenital malformations) or secondary (acquired obstructions). Tissue swelling occurs in the extremities because of an increased quantity of lymph that results from obstruction of lymphatic vessels. It is especially marked when the extremity is in a dependent position. Initially, the edema is soft and pitting. As the condition progresses, the edema becomes firm, nonpitting, and unresponsive to treatment. The most common type is congenital lymphedema (lymphedema praecox), which is caused by hypoplasia of the lymphatic system of the lower extremity. This disorder is usually seen in women and first appears between 15 and 25 years of age.

The obstruction may be in the lymph nodes and the lymphatic vessels. Sometimes, it is seen in the arm after an axillary node dissection (eg, for breast cancer) and in the leg in association with varicose veins or chronic thrombophlebitis. In the latter case, the lymphatic obstruction usually is caused by chronic lymphangitis. Lymphatic obstruction caused by a parasite (filaria) is most frequently seen in the tropics. When chronic swelling is present, there may be frequent bouts of acute infection characterized by high fever and chills and increased residual edema after the inflammation has resolved. These lead to chronic fibrosis, thickening of the subcutaneous tissues, and hypertrophy of the skin. This condition, in which chronic swelling of the extremity recedes only slightly with elevation, is referred to as elephantiasis.

### Medical Management

The goal of therapy is to reduce and control the edema and prevent infection. Active and passive exercises assist in moving lymphatic fluid into the bloodstream. External compression devices milk the fluid proximally from the foot to the hip or from the hand to the axilla. When the patient is ambulatory, custom-fitted, graduated compression stockings or sleeves are worn; those with the highest compression strength (exceeding 40 mm Hg) are required. When the leg is affected, continuous bed rest with the leg elevated may aid in mobilizing the fluids. Manual lymphatic drainage performed by specially trained therapists is a technique designed to direct or shift the congested lymph through functioning lymphatics that have preserved drainage. Manual lymphatic drainage is incorporated in a sequential treatment approach used in combination with compression bandages, exercises, skin care, pressure gradient sleeves, and pneumatic pumps, depending on the severity and stage of the lymphedema (Ely, Osheroff, Chambliss, et al., 2006).

#### *Pharmacologic Therapy*

As initial therapy, the diuretic furosemide (Lasix) may be prescribed to prevent fluid overload due to mobilization of extracellular fluid. Diuretics have also been used along with elevation of the leg and the use of graduated compression stockings or sleeves. However, the use of diuretics alone has little benefit because their main action is to limit capillary filtration by decreasing the circulating blood volume. If lymphangitis or cellulitis is present, antibiotic therapy is initiated. The patient is taught to inspect the skin for evidence of infection.

#### *Surgical Management*

Surgery is performed if the edema is severe and uncontrolled by medical therapy, if mobility is severely compromised, or if infection persists. One surgical approach involves the excision of the affected subcutaneous tissue and fascia, with skin grafting to cover the defect. Another procedure involves the surgical relocation of superficial lymphatic vessels into the deep lymphatic system by means of a buried dermal flap to provide a conduit for lymphatic drainage.

### Nursing Management

After surgery, the management of skin grafts and flaps is the same as when these therapies are used for other conditions. Antibiotics may be prescribed for 5 to 7 days. Constant elevation of the affected extremity and observation for complications are essential. Complications may include flap necrosis, hematoma or abscess under the flap, and cellulitis. The nurse instructs the patient or caregiver to inspect the dressing daily. Unusual drainage or any inflammation around the wound margin suggests infection and should be reported to the surgeon. The patient is informed that there may be a loss of sensation in the skin graft area. The patient is also instructed to avoid the application of heating pads or exposure to sun to prevent burns or trauma to the area.

## CELLULITIS

Cellulitis is the most common infectious cause of limb swelling. Cellulitis can occur as a single isolated event or a series of recurrent events. It is sometimes misdiagnosed as recurrent thrombophlebitis or chronic venous insufficiency.

### Pathophysiology

Cellulitis occurs when an entry point through normal skin barriers allows bacteria to enter and release their toxins in the subcutaneous tissues.

### Clinical Manifestations

The acute onset of swelling, localized redness, and pain is frequently associated with systemic signs of fever, chills, and sweating. The redness may not be uniform and often skips areas. Regional lymph nodes may also be tender and enlarged.

### Medical Management

Mild cases of cellulitis can be treated on an outpatient basis with oral antibiotic therapy. If the cellulitis is severe, the patient is treated with IV antibiotics. The key to preventing recurrent episodes of cellulitis lies in adequate antibiotic therapy for the initial event and in identifying the site of bacterial entry. Cracks and fissures that occur in the skin between the toes must be examined as potential sites of bacterial entry. Other locations include drug use injection sites, contusions, abrasions, ulceration, ingrown toenails, and hangnails.

### Nursing Management

The patient is instructed to elevate the affected area above heart level and apply warm, moist packs to the site every 2 to 4 hours. Patients with sensory and circulatory deficits, such as those caused by diabetes and paralysis, should use caution when applying warm packs because burns may occur; it is advisable to use a thermometer or have a caregiver ensure that the temperature is not more than lukewarm. Education should focus on preventing a recurrent episode. The patient with peripheral vascular disease or diabetes mellitus should receive education or reinforcement about skin and foot care.

## CRITICAL THINKING EXERCISES

**1** A 75-year-old man has been diagnosed with stenosis of his external iliac artery and is scheduled for an angiogram with a possible balloon angioplasty and stent placement. What factors would you consider when planning his postprocedure care, continuing care, and home care? If the patient is taking warfarin (Coumadin) for atrial fibrillation and has renal insufficiency (creatinine of 1.8 mg/dL) as a complication of diabetes, how would you address these factors in the plan of care?

**2** An 84-year-old woman with diabetes mellitus, hypertension, and heart failure presents to the outpatient clinic with complaints of long-standing edema of her left leg "ever since her hip surgery 20 years ago." Further questioning reveals a previous diagnosis of left femoral DVT. On physical examination, the left lower extremity is edematous (the left calf is 2 cm larger than the right calf), with hemosiderin stains on the lower one-third calf. What additional information regarding the patient's history would be helpful in determining a nursing diagnosis? What additional information is needed as part of the physical examination to aid in determining the diagnosis and implementing an intervention?

EBP **3** A man has been diagnosed with a recurrent DVT of the femoral vein. He has been instructed to wear graduated compression stockings. He tells you that he does not think that they help prevent DVTs. What is the strength of the evidence from the research literature that suggests that graduated compression stockings prevent DVTs in patients with recurrent DVTs? Is the length of the stocking (eg, calf length, midthigh length) associated with decreased rates of recurrence of DVTs?

**4** A 50-year-old man presents to the community clinic. He recently moved to the area and needs a physical examination prior to beginning a job as a truck driver. The patient is found to have a history of diabetes mellitus ("diet controlled") and has a 30-year history of smoking two packs of cigarettes per day (60-year pack-year history). Physical examination reveals bilateral varicose veins and 1+ pitting ankle edema. What additional information is needed as part of the history and physical examination? What risk factor modifications would you want to address with this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American Venous Forum, www.venous-info.com
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov
Peripheral Arterial Disease (PAD) Coalition, www.padcoalition.org
Society for Vascular Nursing, www.svnnet.org
Society for Vascular Surgery, www.vascularweb.org
Society for Vascular Ultrasound, www.svunet.org
Vascular Disease Foundation, www.vdf.org



chapter 32

# Assessment and Management of Patients With Hypertension

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Define normal blood pressure and categories of abnormal pressures.
2. Identify risk factors for hypertension.
3. Explain the differences between normal blood pressure and hypertension and discuss the significance of hypertension.
4. Describe treatment approaches for hypertension, including lifestyle and medication therapy.
5. Use the nursing process as a framework for care of the patient with hypertension.
6. Describe hypertensive crises and their treatment.

## GLOSSARY

**dyslipidemia:** abnormal blood lipid levels, including high total, low-density lipoprotein, and triglyceride levels as well as low high-density lipoprotein levels

**glomerular filtration rate (GFR):** flow rate of filtered fluid through the kidney, an indicator of renal function

**hypertensive emergency:** a situation in which blood pressure is severely elevated and there is evidence of actual or probable target organ damage

**hypertensive urgency:** a situation in which blood pressure is severely elevated but there is no evidence of target organ damage

**isolated systolic hypertension:** a condition mostly commonly seen in the elderly in which the systolic pressure is greater than 140 mm Hg and the diastolic pressure is within normal limits (less than 90 mm Hg)

**monotherapy:** medication therapy with a single medication

**primary hypertension:** also called essential hypertension; denotes high blood pressure from an unidentified cause

**rebound hypertension:** blood pressure that is controlled with medication and that becomes uncontrolled (abnormally high) with the abrupt discontinuation of medication

**secondary hypertension:** high blood pressure from an identified cause, such as renal disease

**Seventh Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7):** committee established to study and make recommendations about hypertension in the United States; findings and recommendations of JNC 7 are contained in an extensive report published in 2003

Hypertension is defined by the **Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7)** as a systolic blood pressure greater than 140 mm Hg and a diastolic pressure greater than 90 mm Hg based on the average of two or more accurate blood pressure measurements taken during two or more contacts with a health care provider (Chobanian, Bakris, Black, et al., 2003). Table 32-1 shows the classification of blood pressure established by JNC 7. The categories of blood pressure, from normal to stage 2 hypertension, emphasize the direct relationship between the risk of morbidity and mortality from increasing levels of blood pressure and the specific levels of both the systolic and diastolic blood pressures. The higher either the systolic or diastolic pressure, the greater the health risk (Lewington, Clarke, Qizilbash, et al., 2002).

JNC 7 defines a blood pressure of less than 120/80 mm Hg diastolic as normal, 120 to 129/80 to 89 mm Hg as prehypertension, and 140/90 mm Hg or higher as hypertension (see Table 32-1) (Chobanian, et al., 2003). The term *stage* is used to define two levels of hypertension so that it is similar to the terms used to describe cancer progression; thus, the public and health care professionals will understand that consistently higher elevations in blood pressure from prehypertension to stage 1 or 2 are associated with greater health risks. JNC 7 introduced the category of *prehypertension* to emphasize that people whose blood pressure begins to rise above 120/80 mm Hg are more likely to become hypertensive, and that even small increases in pressure are associated with increased risk of stroke, heart attack, heart failure, and cardiovascular death (Hsia, Margolis, Eaton, et al., 2007). To prevent or delay progression to hypertension and reduce risk, JNC 7 urged health care providers to encourage people with blood pressures in the prehypertension category to begin lifestyle modifications such as nutritional changes and exercise. JNC 7 recommended that people with stage 1 hypertension be treated with medications and be seen by their health care provider every month until their blood pressure goal is reached and subsequently about every 3 to 6 months. People with stage 2 hypertension or with other complicating conditions need to be seen more frequently.

## Hypertension

About 31% of the adults in the United States have hypertension, and the prevalence increases significantly as people get older or have other cardiovascular risk factors. The prevalence also varies by ethnicity, with African Americans having the highest prevalence at approximately 37% (Wong, Lopez, L'Italien, et al., 2007). In the total U.S. population of persons with hypertension, 90% to 95% have **primary hypertension,** high blood pressure from an unidentified cause (Oparil, Zaman & Calhoun, 2003). The remaining 5% to 10% of this group have **secondary hypertension,** high blood pressure related to identified causes. These causes include narrowing of the renal arteries, renal parenchymal disease, hyperaldosteronism (mineralocorticoid hypertension), certain medications, pregnancy, and coarctation of the aorta (Chiong, Aronow, Khan, et al., 2008).

**Table 32-1 CLASSIFICATION OF BLOOD PRESSURE FOR ADULTS AGE 18 AND OLDER***

| BP Classification* | Systolic BP (mm Hg) | | Diastolic BP (mm Hg) |
|---|---|---|---|
| Normal | <120 | and | <80 |
| Prehypertension | 120–139 | or | or 80–89 |
| Stage 1 hypertension | 140–159 | or | 90–99 |
| Stage 2 hypertension | ≥160 | or | ≥100 |

*Based on the average of two or more properly measured, seated readings taken on each of two or more office visits.

From the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. (2003). *Hypertension, 42*(6), 1206–1252.

Hypertension is sometimes called the "silent killer" because people who have it are often symptom free. In a national survey conducted from 2003 to 2004, 24% of people who had pressures exceeding 140/90 mm Hg were unaware of their elevated blood pressure (Ong, Cheung, Man, et al., 2007). Once identified, elevated blood pressure should be monitored at regular intervals because hypertension is a lifelong condition.

Hypertension often accompanies other risk factors for atherosclerotic heart disease, such as **dyslipidemia** (abnormal blood fat levels), obesity, diabetes mellitus, metabolic syndrome, and a sedentary lifestyle. The prevalence is also higher in persons who have other cardiovascular conditions including heart failure, coronary artery disease, and a history of having had a stroke (Ong, et al., 2007). Cigarette smoking does not cause high blood pressure; however, if a person with hypertension smokes, his or her risk of dying from heart disease or related disorders increases significantly (Baliunas, Patra, Rehm, et al., 2007).

High blood pressure can be viewed in three ways: as a sign, a risk factor for atherosclerotic cardiovascular disease, or a disease. As a sign, nurses and other health care professionals use blood pressure to monitor a patient's clinical status. Elevated pressure may indicate an excessive dose of vasoconstrictive medication or other problems. As a risk factor, hypertension contributes to the rate at which atherosclerotic plaque accumulates within arterial walls. As a disease, hypertension is a major contributor to death from cardiac, cerebrovascular, renal, and peripheral vascular disease.

Prolonged blood pressure elevation eventually damages blood vessels throughout the body, particularly in target organs such as the heart, kidneys, brain, and eyes. The usual consequences of prolonged, uncontrolled hypertension are myocardial infarction, heart failure, renal failure, strokes, and impaired vision. Hypertrophy (enlargement) of the left ventricle of the heart may occur as it works to pump blood against the elevated pressure. An echocardiogram is the recommended method of determining whether hypertrophy has occurred.

### Pathophysiology

Blood pressure is the product of cardiac output multiplied by peripheral resistance. Cardiac output is the product of the heart rate multiplied by the stroke volume. In normal circulation, pressure is transferred from the heart muscle to the blood each time the heart contracts, and then pressure is exerted by the blood as it flows through the blood vessels. Hypertension can result from an increase in cardiac output,

## Physiology ■■■ Pathophysiology

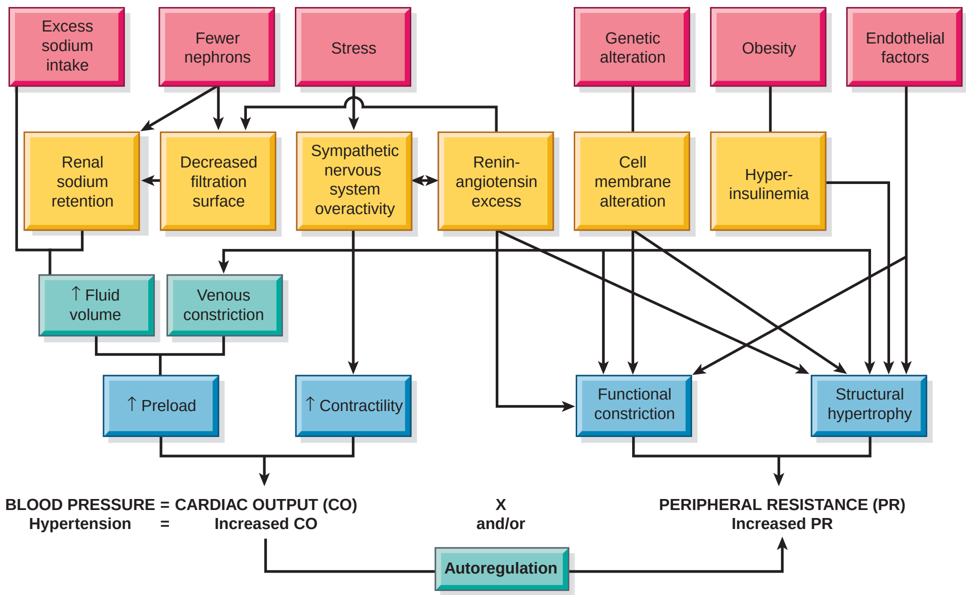



**Figure 32–1** Factors involved in control of blood pressure. (Adapted from Kaplan, N. M., Lieberman, E. & Neal, W. (2006). *Kaplan's clinical hypertension* (9th ed.). Philadelphia: Lippincott Williams & Wilkins.)

an increase in peripheral resistance (constriction of the blood vessels), or both. Although no precise cause can be identified for most cases of hypertension, it is understood that hypertension is a multifactorial condition. Because hypertension is a sign, it is most likely to have many causes, just as fever has many causes. For hypertension to occur there must be a change in one or more factors affecting peripheral resistance or cardiac output (Fig. 32-1). In addition, there must also be a problem with the body's control systems that monitor or regulate pressure. Single gene mutations associated with the mechanisms used by the kidneys to reabsorb sodium ions have been identified for a few rare types of hypertension, but most types of hypertension are thought to be polygenic (ie, mutations in more than one gene) (Williams, 2007).

Many factors have been implicated as causes of hypertension:

- Increased sympathetic nervous system activity related to dysfunction of the autonomic nervous system
- Increased renal reabsorption of sodium, chloride, and water related to a genetic variation in the pathways by which the kidneys handle sodium
- Increased activity of the renin–angiotensin–aldosterone system, resulting in expansion of extracellular fluid volume and increased systemic vascular resistance
- Decreased vasodilation of the arterioles related to dysfunction of the vascular endothelium
- Resistance to insulin action, which may be a common factor linking hypertension, type 2 diabetes mellitus, hypertriglyceridemia, obesity, and glucose intolerance

### *Gerontologic Considerations*

Structural and functional changes in the heart and blood vessels contribute to increases in blood pressure that occur with aging. These changes include accumulation of atherosclerotic plaque, fragmentation of arterial elastins, increased collagen deposits, and impaired vasodilation. The result of these changes is decreased elasticity of the major blood vessels. Consequently, the aorta and large arteries are less able to accommodate the volume of blood pumped out by the heart (stroke volume), and the energy that would have stretched the vessels instead elevates the systolic blood pressure, resulting in an elevated systolic pressure without a change in diastolic pressure. This condition, known as **isolated systolic hypertension,** is more common in older adults and is associated with significant cardiovascular and cerebrovascular morbidity and mortality.

## Clinical Manifestations

Physical examination may reveal no abnormalities other than elevated blood pressure. Occasionally, retinal changes such as hemorrhages, exudates (fluid accumulation), arteriolar narrowing, and cotton-wool spots (small infarctions) occur. In severe hypertension, papilledema (swelling of the optic disk) may be seen. People with hypertension may be asymptomatic and remain so for many years. However, when specific signs and symptoms appear, they usually indicate vascular damage, with specific manifestations related to the organs served by the involved vessels. Coronary artery disease with angina and myocardial infarction are common consequences of hypertension. Left ventricular hypertrophy occurs in response to the increased workload placed on the ventricle as it contracts against higher systemic pressure. When heart damage is extensive, heart failure follows. Pathologic changes in the kidneys (indicated by increased blood urea nitrogen [BUN] and serum creatinine levels) may manifest as nocturia. Cerebrovascular involvement may lead to a stroke or transient ischemic attack (TIA), manifested by alterations in vision or speech, dizziness, weakness, a sudden fall, or transient or permanent paralysis on one side (hemiplegia). Cerebral infarctions account for most of the strokes and TIAs in patients with hypertension.

## Assessment and Diagnostic Findings

A thorough health history and physical examination are necessary. The retinas are examined and laboratory studies are performed to assess possible target organ damage. Routine laboratory tests include urinalysis, blood chemistry (ie, analysis of sodium, potassium, creatinine, fasting glucose, and total and high-density lipoprotein [HDL] cholesterol levels), and a 12-lead electrocardiogram (ECG). Left ventricular hypertrophy can be assessed by echocardiography. Renal damage may be suggested by elevations in BUN and creatinine levels or by microalbuminuria or macroalbuminuria. Additional studies, such as creatinine clearance, renin level, urine tests, and 24-hour urine protein, may be performed.

A risk factor assessment, as advocated by JNC 7, is needed to classify and guide the treatment of hypertensive people at risk for cardiovascular damage. Risk factors and cardiovascular problems related to hypertension are presented in Chart 32-1.

## Medical Management

The goal of hypertension treatment is to prevent complications and death by achieving and maintaining the arterial blood pressure at 140/90 mm Hg or lower. JNC 7 specifies a lower goal pressure of 130/80 mm Hg for people with diabetes mellitus or chronic kidney disease, which is defined as either a reduced **glomerular filtration rate (GFR)** resulting in a serum creatinine of greater than 1.3 mg/dL in women or greater than 1.5 mg/dL in men, or albuminuria of greater than 300 mg/d (Chobanian, et al., 2003). The optimal management plan is one that is inexpensive, simple, and causes the least possible disruption in the patient's life.

The management options for hypertension are summarized in the treatment algorithm issued by JNC 7 (Fig. 32-2); these include lifestyle modifications and pharmacologic therapy. Table 32-2 summarizes recommended lifestyle modifications. The clinician uses the algorithm with the risk factor assessment data and the patient's blood pressure category to choose the initial and subsequent treatment plans for the patient. Research findings demonstrate that weight loss, reduced alcohol and sodium intake, and regular physical activity are effective lifestyle adaptations to reduce blood pressure (Appel, Champagne, Harsha, et al., 2003; Appel, Sacks, Carey, et al., 2005; Cook, Cutler, Obarzanek, et al., 2007; Stranges, Wu, Dorn, et al., 2004). Studies also show that diets high in fruits, vegetables, and low-fat dairy products can prevent the development of hypertension and can lower elevated blood pressure (Appel, et al., 2005). Table 32-3 shows the Dietary Approaches to Stop Hypertension (DASH) diet, which has been shown to lower blood pressure in people who follow it (Appel, et al., 2003).

### CHART 32-1 *Risk Factors for Cardiovascular Problems in Hypertensive Patients*

**Major Risk Factors (in Addition to Hypertension)**

- Smoking
- Dyslipidemia (elevated LDL [or total] cholesterol and/or low HDL cholesterol)*
- Diabetes mellitus*
- Impaired renal function (GFR $<60$ mL/min and/or microalbuminuria)
- Obesity (BMI $\geq 30$ kg/m$^2$)*
- Physical inactivity
- Age (older than 55 years for men, 65 years for women)
- Family history of cardiovascular disease (in female relative younger than 65 years or male relative younger than 55 years)

**Target Organ Damage or Clinical Cardiovascular Disease**

- Heart disease (left ventricular hypertrophy, angina or previous myocardial infarction, previous coronary revascularization, heart failure)
- Stroke (cerebrovascular accident, brain attack) or TIA
- Chronic kidney disease
- Peripheral arterial disease
- Retinopathy

*These risk factors plus hypertension, elevated triglyceride levels, and abdominal obesity are components of the metabolic syndrome.

BMI, body mass index; GFR, glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TIA, transient ischemic attack.

Adapted from Table 6 of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. (2003). *Hypertension, 42*(6), 1206–1252.

### Pharmacologic Therapy

The medications used for treating hypertension decrease peripheral resistance, blood volume, or the strength and rate of myocardial contraction. For patients with uncomplicated hypertension and no specific indications for another medication, the recommended initial medications include diuretics, beta-blockers, or both. Patients are first given low doses of medication. If blood pressure does not fall to less than 140/90 mm Hg, the dose is increased gradually, and additional medications are included as necessary to achieve control. Table 32-4 describes the various pharmacologic agents that are recommended for the treatment of hypertension. When the blood pressure is less than 140/90 mm Hg for at least 1 year, gradual reduction of the types and doses of medication is indicated. To promote compliance, clinicians try to prescribe the simplest treatment schedule possible, ideally one pill once each day (Schroeder, Fahey & Ebrahim, 2004).

### Gerontologic Considerations

Hypertension, particularly elevated systolic blood pressure, increases the risk of death, stroke, and heart failure in people older than 50 years and treatment reduces this risk (Chobanian, et al., 2003). Like younger patients, older patients should begin treatment with lifestyle modifications. If medications are needed to achieve the blood pressure goal of less than 140/90 mm Hg, the starting dose should be half that used in younger patients.

Compared to people between the ages of 50 and 80, there has been much less research on hypertension treatment and appropriate goals in persons over the age of 80. Results from a randomized, controlled trial in participants

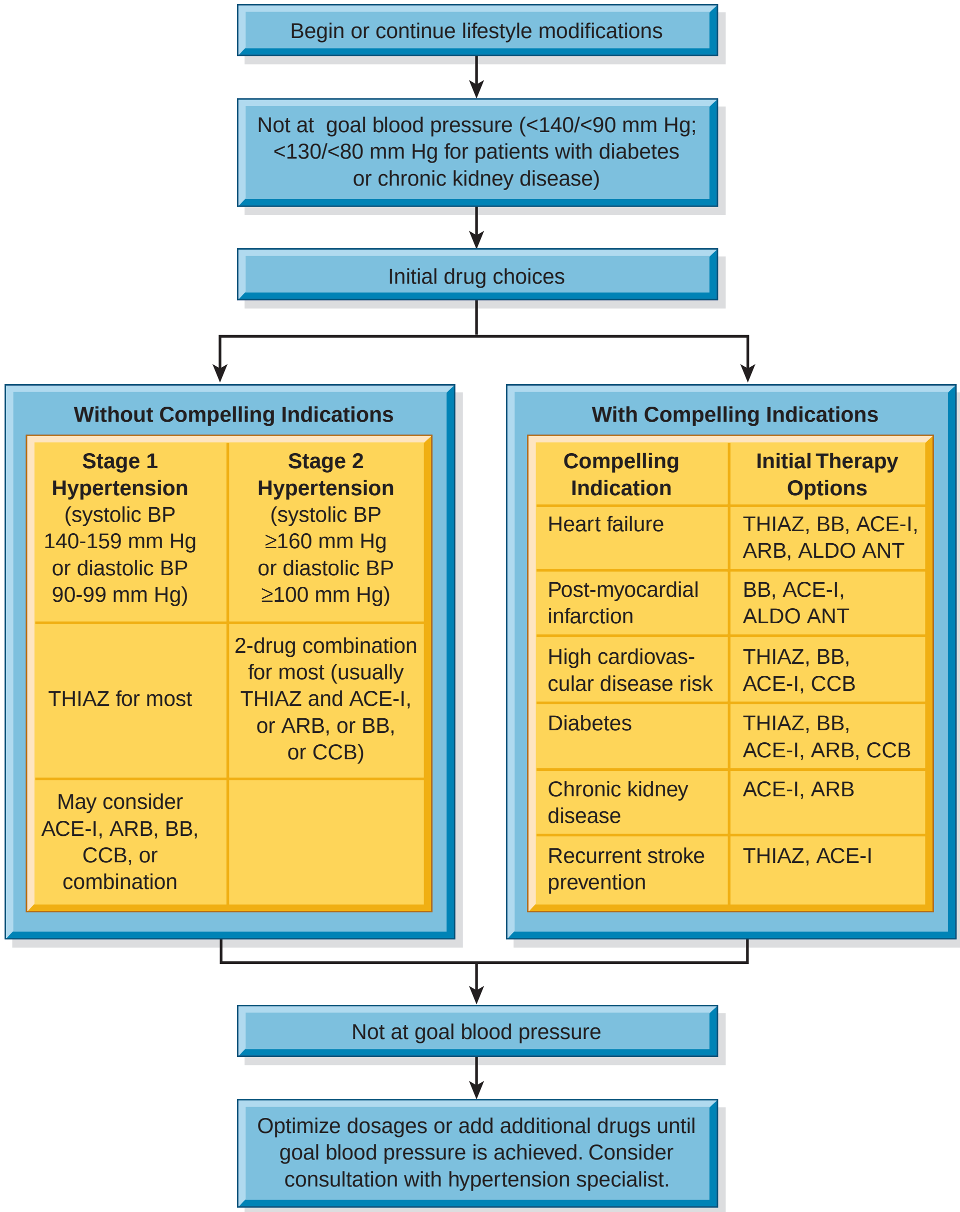



**Figure 32–2** Algorithm of hypertension treatment. Treatment begins with lifestyle modifications and continues with various medication regimens. ACE-I, angiotensin-converting enzyme inhibitor; ALDO ANT, aldosterone antagonist; ARB, angiotensin receptor blocker; BB, beta-blocker; BP, blood pressure; CCB, calcium channel blocker; THIAZ, thiazide diuretic From the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Reference card available from the National, Heart, Lung, and Blood Institute, available at www.nhlbi.nih.gov/guidelines/hypertension/phycard.pdf

**Table 32-2 LIFESTYLE MODIFICATIONS TO PREVENT AND MANAGE HYPERTENSION***

| Modification | Recommendation | Goal of SBP† Reduction (Range)‡ |
|---|---|---|
| Weight reduction | Maintain normal body weight (body mass index 18.5–24.9 kg/m$^2$). | 5–20 mm Hg/10 kg |
| Adopt DASH (Dietary Approaches to Stop Hypertension) eating plan | Consume a diet rich in fruits, vegetables, and low-fat dairy products with a reduced content of saturated and total fat. | 8–14 mm Hg |
| Dietary sodium reduction | Reduce dietary sodium intake to no more than 100 mmol/day (2.4 g sodium or 6 g sodium chloride). | 2–8 mm Hg |
| Physical activity | Engage in regular aerobic physical activity such as brisk walking (at least 30 min/day, most days of the week). | 4–9 mm Hg |
| Moderation of alcohol consumption | Limit consumption to no more than 2 drinks (eg, 24 oz beer, 10 oz wine, or 3 oz 80-proof whiskey) per day in most men and to no more than 1 drink per day in women and lighter-weight people. | 2–4 mm Hg |

*For overall cardiovascular risk reduction, stop smoking.
†SBP, systolic blood pressure.
‡The effects of implementing these modifications are dose- and time-dependent and could be greater for some individuals.
From the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. (2003). *Hypertension*, *42*(6), 1206–1252.

**Table 32-3 THE DASH (DIETARY APPROACHES TO STOP HYPERTENSION) DIET**

| Food Group | Number of Servings/Day |
|---|---|
| Grains and grain products | 7 or 8 |
| Vegetables | 4 or 5 |
| Fruits | 4 or 5 |
| Low-fat or fat-free dairy foods | 2 or 3 |
| Meat, fish, and poultry | 2 or fewer |
| Nuts, seeds, and dry beans | 4 or 5 weekly |

The diet is based on 2,000 calories per day.
*Source:* www.nhlbi.nih.gov/health/public/heart/hbp/dash/index.htm

over 80 years of age demonstrated a significant reduction in strokes, all-cause mortality, cardiovascular mortality, and heart failure in the participants treated with diuretics and angiotensin-converting enzyme (ACE) inhibitors versus a placebo. Because previous research findings suggest that excessive blood pressure may lead to adverse events in persons over the age of 80, the study authors recommended and used a target blood pressure of 150/80 mm Hg (Beckett, Peters, Fletcher, et al., 2008; Gueyffier, Bulpitt, Boissel, et al., 1999).

## NURSING PROCESS

### The Patient With Hypertension

#### Assessment

When hypertension is initially detected, nursing assessment involves carefully monitoring the blood pressure at frequent intervals and then at routinely scheduled intervals. The American Heart Association has defined the standards for blood pressure measurement, including conditions required before measurements are made, equipment specifications, and techniques for measuring blood pressure to obtain accurate and reliable readings (Chart 32-2) (Pickering, Hall, Appel, et al., 2005). When the patient begins an antihypertensive treatment regimen, blood pressure assessments are needed to determine the effectiveness of medication therapy and to detect any changes in blood pressure that may indicate the need for a modification in the treatment plan.

A complete history is obtained to assess for signs and symptoms that indicate target organ damage (ie, whether specific tissues are damaged by the elevated blood pressure). Such manifestations may include anginal pain; shortness of breath; alterations in speech, vision, or balance; nosebleeds; headaches; dizziness; or nocturia.

During the physical examination, the nurse must also pay specific attention to the rate, rhythm, and character of the apical and peripheral pulses to detect effects of hypertension on the heart and blood vessels. A thorough assessment can yield valuable information about the extent to which the hypertension has affected the body and about any other personal, social, or financial factors related to the condition. For example, some patients' ability to adhere to an antihypertensive medication regimen may be influenced by their financial resources to buy the medication and health insurance.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, nursing diagnoses for the patient may include the following:

- Deficient knowledge regarding the relation between the treatment regimen and control of the disease process
- Noncompliance with therapeutic regimen related to side effects of prescribed therapy

##### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include the following:

- Left ventricular hypertrophy
- Myocardial infarction
- Heart failure
- TIAs
- Cerebrovascular accident (CVA, stroke, or brain attack)
- Renal insufficiency and failure
- Retinal hemorrhage

#### Planning and Goals

The major goals for the patient include understanding of the disease process and its treatment, participation in a self-care program, and absence of complications.

#### Nursing Interventions

The objective of nursing care for patients with hypertension focuses on lowering and controlling the blood pressure without adverse effects and without undue cost. To achieve these goals, the nurse must support and teach the patient to adhere to the treatment regimen by implementing necessary lifestyle changes, taking medications as prescribed, and scheduling regular follow-up appointments with the health care provider to monitor progress or identify and treat any complications of disease or therapy.

##### *Increasing Knowledge*

The patient needs to understand the disease process and how lifestyle changes and medications can control hypertension. The nurse needs to emphasize the concept of controlling hypertension rather than curing it. The nurse can encourage the patient to consult a dietitian to help develop a plan for improving nutrient intake or for weight loss. The program usually consists of restricting sodium and fat intake, increasing intake of fruits and vegetables, and implementing regular physical activity. Explaining that it takes 2 to 3 months for the taste buds to adapt to changes in salt intake may help the patient adjust to reduced salt intake. The patient should be advised to limit alcohol intake (see Table 32-2 for specific recommendations), and tobacco should be avoided because anyone with high blood pressure is already at increased risk for heart disease, and smoking amplifies this risk. Support groups for weight control, smoking cessation, and stress reduction may be beneficial for some patients; others can benefit from the support of family and friends. The nurse assists the patient to develop and adhere to an appropriate exercise regimen, because regular activity is a significant factor in weight reduction and a

**Table 32-4 MEDICATION THERAPY FOR HYPERTENSION**

| Medications | Major Action | Advantages and Contraindications | Effects and Nursing Considerations |
|---|---|---|---|
| **Diuretics and Related Drugs** | | | |
| **Thiazide Diuretics**<br>chlorthalidone<br>chlorothiazide (Diuril)<br>hydrochlorothiazide<br>indapamide<br>methyclothiazide<br>metolazone (Zaroxolyn) | Decrease of blood volume, renal blood flow, and cardiac output<br>Depletion of extracellular fluid<br>Negative sodium balance (from natriuresis), mild hypokalemia<br>Directly affect vascular smooth muscle | Relatively inexpensive<br>Effective orally<br>Effective during long-term administration<br>Mild side effects<br>Enhance other antihypertensive medications<br>Counter sodium retention effects of other antihypertensive medications<br>*Contraindications:* Gout, known sensitivity to sulfonamide-derived medications, severely impaired kidney function, and history of hyponatremia | Side effects include dry mouth, thirst, weakness, drowsiness, lethargy, muscle aches, muscular fatigue, tachycardia, GI disturbance.<br>Postural hypotension may be potentiated by alcohol, barbiturates, opioids, or hot weather.<br>Because thiazides cause loss of sodium, potassium, and magnesium, monitor for signs of electrolyte imbalance.<br>Encourage intake of potassium-rich foods (eg, fruits).<br>*Gerontologic Considerations:* Risk of postural hypotension is significant because of volume depletion; measure blood pressure in three positions; caution patient to rise slowly. |
| **Loop Diuretics**<br>furosemide (Lasix)<br>bumetanide (Bumex)<br>torsemide (Demadex) | Volume depletion<br>Blocks reabsorption of sodium, chloride, and water in kidney | Action rapid<br>Potent<br>Used when thiazides fail or patient needs rapid diuresis<br>*Contraindications:* Same as for thiazides | Risk of volume and electrolyte depletion from the profound diuresis that can occur.<br>Fluid and electrolyte replacement may be required.<br>*Gerontologic Considerations:* Same as for thiazides. |
| **Potassium-Sparing Diuretics**<br>amiloride (Midamor)<br>triamterene (Dyrenium) | Blocks sodium reabsorption<br>Acts on distal tubule independently of aldosterone | Causes potassium retention<br>*Contraindications:* Renal disease, azotemia, severe hepatic disease, hyperkalemia | Drowsiness, lethargy, headache.<br>Monitor for hyperkalemia if given with ACE inhibitor or angiotensin receptor blocker.<br>Diarrhea and other GI symptoms—administer medication after meals. |
| **Aldosterone Receptor Blockers**<br>eplerenone (Inspra)<br>spironolactone (Aldactone) | Competitive inhibitors of aldosterone binding | Indicated for patients with a history of myocardial infarction or symptomatic ventricular dysfunction<br>*Contraindications:* Hyperkalemia and impaired renal function<br>Eplerenone is contraindicated in diabetes mellitus with microalbuminuria | Drowsiness, lethargy, headache.<br>Monitor for hyperkalemia if given with ACE inhibitor or angiotensin receptor blocker.<br>Diarrhea and other GI symptoms–administer medication after meals.<br>Avoid use of potassium supplements or salt substitutes.<br>Teach patients, families, and caregivers signs and symptoms of hyperkalemia.<br>Spironolactone may cause gynecomastia. |

*Continued on following page*

**Table 32-4 MEDICATION THERAPY FOR HYPERTENSION (Continued)**

| Medications | Major Action | Advantages and Contraindications | Effects and Nursing Considerations |
|---|---|---|---|
| **Central Alpha2-Agonists and Other Centrally Acting Drugs** | | | |
| reserpine (Harmonyl) | Impairs synthesis and reuptake of norepinephrine | Slows pulse, which counteracts tachycardia of hydralazine<br>*Contraindications:* History of depression, psychosis, obesity, chronic sinusitis, peptic ulcer | May cause severe depression; report manifestations, as this may require that drug be discontinued.<br>Nasal congestion.<br>Use with caution if history of gallbladder, renal, or cardiac disease, or seizure disorder.<br>*Gerontologic Considerations:* Depression and postural hypotension common in elderly. |
| methyldopa (Aldomet) | Dopa-decarboxylase inhibitor; displaces norepinephrine from storage sites | Drug of choice for pregnant women with hypertension<br>Useful in patients with renal failure or prostate disease<br>Does not decrease cardiac output or renal blood flow<br>Does not induce oliguria<br>*Contraindications:* Liver disease | Drowsiness, dizziness.<br>Dry mouth; nasal congestion (troublesome at first but then tends to disappear).<br>Use with caution with renal disease.<br>*Gerontologic Considerations:* May produce mental and behavioral changes in the elderly. |
| clonidine (Catapres)<br>clonidine patch (Catapres-TTs) | Exact mode of action not understood, but acts through the central nervous system, apparently through centrally mediated alpha-adrenergic stimulation in the brain, producing blood pressure reduction | Little or no orthostatic effect; moderately potent, and sometimes is effective when other medications fail to lower blood pressure<br>*Contraindications:* Severe coronary artery disease, pregnancy | Dry mouth, drowsiness, sedation, and occasional headaches and fatigue. Anorexia, malaise, and vomiting with mild disturbance of liver function have been reported.<br>Rebound or withdrawal hypertension is relatively common; monitor blood pressure when stopping medication.<br>Common side effects include dry mouth, dizziness, sleepiness, fatigue, headache, constipation, and impotence. |
| guanfacine (Tenex) | Stimulates central alpha$_2$-adrenergic receptors | Reduces heart rate and causes vasodilation. Serious adverse reactions are uncommon; use with caution in persons with diminished liver function, recent myocardial infarction, or known cardiovascular disease | |
| **Beta-Blockers** | | | |
| atenolol (Tenormin)<br>betaxolol (Kerlone)<br>bisoprolol (Zebeta)<br>propranolol (Inderal)<br>propranolol long-acting (Inderal LA)<br>metoprolol (Lopressor)<br>metoprolol extended release (Toprol XL)<br>nadolol (Corgard)<br>timolol (Blocadren) | Block the sympathetic nervous system (beta-adrenergic receptors), especially the sympathetics to the heart, producing a slower heart rate and lowered blood pressure | Reduce pulse rate in patients with tachycardia and blood pressure elevation<br>Indicated for patients who also have stable angina pectoris and silent ischemia<br>*Contraindications:* Bronchial asthma, allergic rhinitis, right ventricular failure from pulmonary hypertension, heart failure, depression, diabetes mellitus, dyslipidemia, heart block, peripheral vascular disease, heart rate less than 60 bpm | Mental depression manifested by insomnia, lassitude, weakness, and fatigue.<br>Avoid sudden discontinuation.<br>Lightheadedness and occasional nausea, vomiting, and epigastric distress.<br>Check heart rate before giving.<br>*Gerontologic Considerations:* Risk of toxicity is increased for elderly patients with decreased renal and liver function. Take blood pressure in three positions and observe for hypotension. |
| **Beta-Blockers with Intrinsic Sympathomimetic Activity** | | | |
| acebutolol (Sectral)<br>penbutolol (Levatol)<br>pindolol (Visken) | Block both cardiac beta-1 and beta-2 receptors<br>Also have antiarrhythmic activity by slowing atrioventricular conduction | *Advantages:* Similar to beta-blockers<br>*Contraindications:* Similar to beta-blockers | Avoid sudden discontinuation.<br>Withhold if bradycardia or heart block is present.<br>Use with caution with COPD, diabetes mellitus.<br>Similar to beta-blockers. |

*Continued*

**Table 32-4 MEDICATION THERAPY FOR HYPERTENSION (Continued)**

| Medications | Major Action | Advantages and Contraindications | Effects and Nursing Considerations |
|---|---|---|---|
| **Alpha$_1$-Blockers** | | | |
| doxazosin (Cardura)<br>prazosin hydrochloride (Minipress)<br>terazosin (Hytrin) | Peripheral vasodilator acting directly on the blood vessel; similar to hydralazine | Act directly on the blood vessels and are effective agents in patients with adverse reactions to hydralazine<br>*Contraindications:* Angina pectoris and coronary artery disease; induces tachycardia if not preceded by administration of propranolol and a diuretic | Occasional vomiting and diarrhea, urinary frequency, and cardiovascular collapse, especially if given in addition to hydralazine without lowering the dose of the latter. Patients occasionally experience drowsiness, lack of energy, and weakness. |
| **Combined Alpha- and Beta-Blockers** | | | |
| carvedilol (Coreg)<br>labetalol hydrochloride (Trandate) | Block alpha- and beta-adrenergic receptors; cause peripheral dilation and decrease peripheral vascular resistance | Fast acting<br>No decrease in renal blood flow<br>*Contraindications:* Asthma, cardiogenic shock, severe tachycardia, heart block | Orthostatic hypotension, tachycardia. |
| **Vasodilators** | | | |
| fenoldopam mesylate (Corlopam) | Stimulates dopamine and alpha$_2$-adrenergic receptors | Given intravenously for hypertensive emergencies; use with caution in patients with glaucoma, recent stroke (brain attack), asthma, hypokalemia, or diminished liver function | Headache, flushing, hypotension, sweating, tachycardia caused by vasodilation.<br>Observe for local reactions at the injection site. |
| hydralazine (Apresoline) | Decreases peripheral resistance but concurrently elevates cardiac output<br>Acts directly on smooth muscle of blood vessels | Not used as initial therapy; used in combination with other medications<br>Used also in pregnancy-induced hypertension<br>*Contraindications:* Angina or coronary disease, heart failure, hypersensitivity | Headache, tachycardia, flushing, and dyspnea may occur—can be prevented by pretreating with reserpine.<br>Peripheral edema may require diuretics.<br>May produce lupus erythematosus-like syndrome.<br>Tachycardia, angina pectoris, ECG changes, edema. |
| minoxidil (Loniten) | Direct vasodilating action on arteriolar vessels, causing decreased peripheral vascular resistance; reduces systolic and diastolic pressures | Hypotensive effect more pronounced than with hydralazine<br>No effect on vasomotor reflexes so does not cause postural hypotension<br>*Contraindications:* Pheochromocytoma | Take blood pressure and apical pulse before administration.<br>Monitor intake and output and daily weights.<br>Causes hirsutism.<br>Dizziness, headache, nausea, edema, tachycardia, palpitations. |
| sodium nitroprusside (Nitropress)<br>nitroglycerin | Peripheral vasodilation by relaxation of smooth muscle | Fast acting<br>Used only in hypertensive emergencies<br>*Contraindications:* Sepsis, azotemia, high intracranial pressure | Can cause thiocyanate and cyanide intoxication. |
| **Angiotensin-Converting Enzyme Inhibitors** | | | |
| benazepril (Lotensin)<br>captopril (Capoten)<br>enalapril (Vasotec)<br>enalaprilat (Vasotec IV)<br>fosinopril (Monopril)<br>lisinopril (Prinivil, Zestril)<br>moexipril (Univasc)<br>perindopril (Aceon)<br>quinapril (Accupril)<br>ramipril (Altace)<br>trandolapril (Mavik) | Inhibit conversion of angiotensin I to angiotensin II<br>Lower total peripheral resistance | Fewer cardiovascular side effects<br>Can be used with thiazide diuretic and digitalis<br>Hypotension can be reversed by fluid replacement<br>Angioedema is a rare but potentially life-threatening complication<br>*Contraindications:* Renal impairment, pregnancy | *Gerontologic Considerations:* Require reduced dosages and the addition of loop diuretics when there is renal dysfunction. |
| **Angiotensin II Receptor Blockers** | | | |
| candesartan (Atacand)<br>eprosartan (Teveten)<br>irbesartan (Avapro)<br>losartan (Cozaar)<br>olmesartan (Benicar)<br>telmisartan (Micardis)<br>valsartan (Diovan) | Block the effects of angiotensin II at the receptor<br>Reduce peripheral resistance | Minimal side effects<br>*Contraindications:* Pregnancy, renovascular disease | Monitor for hyperkalemia. |

*Continued on following page*

**Table 32-4 MEDICATION THERAPY FOR HYPERTENSION (Continued)**

| Medications | Major Action | Advantages and Contraindications | Effects and Nursing Considerations |
|---|---|---|---|
| **Calcium Channel Blockers** | | | |
| **Nondihydropyridines**<br>diltiazem extended release (Cardizem CD, Dilacor XR, Tiazac)<br>diltiazem long-acting (Cardizem LA) | Inhibit calcium ion influx<br>Reduce cardiac afterload | Inhibit coronary artery spasm not controlled by beta-blockers or nitrates<br>*Contraindications:* Sick sinus syndrome; AV block; hypotension; heart failure | Do not discontinue suddenly.<br>Observe for hypotension.<br>Report irregular heartbeat, dizziness, edema.<br>Instruct on regular dental care because of potential gingivitis. |
| verapamil immediate release (Calan, Isoptin)<br>verapamil long-acting (Calan SR, Isoptin SR)<br>verapamil (Covera HS, Verelan PM) | Inhibits calcium ion influx<br>Slows velocity of conduction of cardiac impulse | Effective antiarrhythmic<br>Rapid IV onset<br>Blocks SA and AV node channels<br>*Contraindications:* Sinus or AV node disease; severe heart failure; severe hypotension | Administer on empty stomach or before meal.<br>Do not discontinue suddenly. Depression may subside when medication is discontinued.<br>To relieve headaches, reduce noise, monitor electrolytes.<br>Decrease dose for patients with liver or renal failure. |
| **Dihydropyridines**<br>amlodipine (Norvasc)<br>felodipine (Plendil)<br>isradipine (Dynacirc CR)<br>nicardipine (Cardene)<br>nifedipine long-acting (Procardia XL, Adalat CC)<br>nisoldipine (Sular) | Inhibit calcium ion influx across membranes<br>Vasodilating effects on coronary arteries and peripheral arteriole<br>Decrease cardiac work and energy consumption, increase delivery of oxygen to myocardium | Rapid action<br>Effective by oral or sublingual route<br>No tendency to slow SA nodal activity or prolong AV node conduction<br>Isolated systolic hypertension<br>*Contraindications:* None (except heart failure for nifedipine) | Administer on empty stomach.<br>Use with caution in patients with diabetes.<br>Small frequent meals if nausea.<br>Muscle cramps, joint stiffness, sexual difficulties may disappear when dose decreased.<br>Report irregular heartbeat, constipation, shortness of breath, edema.<br>May cause dizziness. |
| **Direct Renin Inhibitors** | | | |
| aliskiren (Tekturna) | Blocks the conversion of angiotensinogen to angiotensin I by inhibiting the activity of the enzyme renin | Given once daily for mild to moderate high blood pressure with minimal side effects<br>Headaches, dizziness, and diarrhea are most frequent side effects<br>Angioedema is a rare but potentially life-threatening complication<br>Contraindicated in pregnancy; has not been studied in persons with diminished renal function | Monitor for hyperkalemia and hypotension. |

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; AV, atrioventricular; bpm, beats per minute; COPD, chronic obstructive pulmonary disease; ECG, electrocardiogram; GI, gastrointestinal; IV, intravenous; SA, sinoatrial.

blood pressure–reducing intervention in the absence of any loss in weight (Chobanian, et al., 2003).

### *Promoting Home and Community-Based Care*

Blood pressure screenings with the sole purpose of case finding are not recommended by the National High Blood Pressure Education Program because approximately 75% of people with hypertension are already aware of their blood pressure levels (Ong, et al., 2007). If asked to participate in a blood pressure screening program, the nurse should ensure that proper blood pressure measurement technique is being used (see Chart 32-2), that the manometers used are calibrated (Pickering, et al., 2005), and that provision has been made to provide follow-up for any person identified as having an elevated blood pressure level. Adequate time should also be allowed to teach each person screened what the blood pressure numbers mean. Each person should be given a written record of his or her blood pressure at the screening.

**TEACHING PATIENTS SELF-CARE.** The therapeutic regimen is the responsibility of the patient in collaboration with the health care provider. The nurse can help the patient achieve blood pressure control through education about managing blood pressure (see teaching discussion above), setting goal blood pressures, and providing assistance with social support. Involving family members in education programs enables them to support the patient's efforts to control hypertension. Both the American Heart Association and the National Heart, Lung, and Blood Institute provide printed and electronic patient education materials.

## Chart 32-2 • *Measuring Blood Pressure (BP)*

### Equipment

**For the Patient at Home**

- Automatic or semiautomatic device with digital display of readings.

**For the Practitioner**

- Mercury sphygmomanometer, recently calibrated aneroid manometer, or validated electronic device.
- Cuff.

### Instructions for the Patient

- Avoid smoking cigarettes or drinking caffeine for 30 minutes before BP is measured.
- Sit quietly for 5 minutes before the measurement.
- Sit comfortably with the forearm supported at heart level on a firm surface, with both feet on the ground; avoid talking while the measurement is being taken.

### Instructions for the Practitioner

- Select the size of the cuff based on the size of the patient. (The cuff size should have a bladder width of at least 40% of limb circumference and length at least 80% of limb circumference.) The average adult cuff is 12 to 14 cm wide and 30 cm long. Using a cuff that is too small will give a higher BP measurement, and using a cuff that is too large results in a lower BP measurement compared to one taken with a properly sized cuff.
- Routinely calibrate the sphygmomanometer.
- Wrap the cuff firmly around the arm. Center the cuff bladder directly over the brachial artery.
- Position the patient's arm at the level of the heart.
- Palpate the systolic pressure before auscultating. This technique helps to detect the presence of an auscultatory gap more readily.
- Ask the patient to sit quietly while the BP is measured because the BP can increase when the patient is engaged in conversation.
- Initially, record BP results of both arms and take subsequent measurements from the arm with the higher BP. Normally, the BP should vary by no more than 5 mm Hg between arms.
- Record the site where the BP was measured and the position of the patient (eg, right arm).
- Inform the patient of his or her BP value and what it means. Emphasize the need for periodic reassessment, and encourage patients who measure BP at home to keep a written record of readings.

### Interpretation

Assessment is based on the average of at least two readings. (If two readings differ by more than 5 mm Hg, additional readings are taken and an average reading is calculated from the results.)

Providing written information about the expected effects and side effects of medications is important. When side effects occur, patients need to understand the importance of reporting them and to whom they should be reported. Patients need to be informed that **rebound hypertension** can occur if antihypertensive medications are suddenly stopped. Thus, patients should be advised to have an adequate supply of medication. If they are traveling by airplane, they should pack the medication in their carry-on luggage. Both female and male patients should be informed that some medications, such as beta-blockers, may cause sexual dysfunction and that other medications are available if a problem with sexual function or satisfaction occurs. The nurse can encourage and teach patients to measure their blood pressure at home. This practice involves patients in their own care and emphasizes that failing to take medications may result in an identifiable rise in blood pressure. Patients need to know that blood pressure varies continuously and that the range within which their pressure varies should be monitored.

GERONTOLOGIC CONSIDERATIONS. Compliance with the therapeutic program may be more difficult for elderly people. The medication regimen can be difficult to remember, and the expense can be a problem. **Monotherapy** (treatment with a single agent), if appropriate, may simplify the medication regimen and make it less expensive. Special care must be taken to ensure that the elderly patient understands the regimen and can see and read instructions, open the medication container, and get the prescription refilled. The elderly person's family or caregivers should be included in the teaching program so that they understand the patient's needs, can encourage adherence to the treatment plan, and know when and whom to call if problems arise or information is needed.

CONTINUING CARE. Regular follow-up care is imperative so that the disease process can continue to be optimally assessed and treated, as shown in Table 32-5. A history and physical examination should be completed at each clinic visit. The history should include all data pertaining to any potential problem, specifically medication-related problems such as postural (orthostatic) hypotension (experienced as dizziness or lightheadedness on standing).

#### *NURSING ALERT*

**The patient and caregivers should be cautioned that antihypertensive medications can cause hypotension. Low blood pressure or postural hypotension should be reported immediately. The elderly have impaired cardiovascular reflexes and thus are more sensitive to the extracellular volume depletion caused by diuretics and to the sympathetic inhibition caused by adrenergic antagonists. The nurse teaches patients to change positions slowly when moving from a lying or sitting position to a standing position. The nurse also counsels elderly patients to use supportive devices such as handrails and walkers as necessary to prevent falls that could result from dizziness.**

Deviation from the therapeutic program is a significant problem for people with hypertension and other chronic

**Table 32-5 RECOMMENDATIONS FOR FOLLOW-UP BASED ON INITIAL BLOOD PRESSURE MEASUREMENTS FOR ADULTS WITHOUT ACUTE END ORGAN DAMAGE**

| Initial BP (mm Hg)[*] | Follow-Up Recommended[†] |
|---|---|
| Normal | Recheck in 2 years |
| Prehypertension | Recheck in 1 year[‡] |
| Stage 1 hypertension | Confirm within 2 months[‡] |
| Stage 2 hypertension | Evaluate or refer to source of care within 1 month |
| | For those with higher pressures (eg, >180/100 mm Hg), evaluate and treat immediately or within 1 week, depending on clinical situation and complications |

[*] If systolic and diastolic values fall into different categories, follow recommendations for shorter follow-up (eg, 160/86 mm Hg should be evaluated or referred to source of care within 1 month).
[†] Modify the scheduling of follow-up according to reliable information about past blood pressure measurements, other cardiovascular risk factors, or target organ disease.
[‡] Provide advice about lifestyle modifications.
From the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. (2003). *Hypertension, 42*(6), 1206–1252.

conditions requiring lifetime management. An estimated 50% of patients discontinue their medications within 1 year of beginning to take them. Blood pressure control is achieved by only 37% (Chobanian, et al., 2003; Ong, et al., 2007). Compliance increases, however, when patients actively participate in self-care, including self-monitoring of blood pressure and diet, possibly because patients receive immediate feedback and have a greater sense of control.

Patients with hypertension must make considerable effort to adhere to recommended lifestyle modifications and to take regularly prescribed medications. The effort needed to follow the therapeutic plan may seem unreasonable to some, particularly when they have no symptoms without medications but do have side effects with medications. The recommended lifestyle changes are listed in Table 32-2. Continued education and encouragement are usually needed to enable patients to formulate an acceptable plan that helps them live with their hypertension and adhere to the treatment plan. Compromises may have to be made about some aspects of therapy to achieve higher-priority goals.

The nurse can assist with behavior change by supporting patients in making small changes with each visit that move them toward their goals. Another important factor is following up at each visit to see how the patient has progressed with the plans made at the prior visit. If the patient has had difficulty with a particular aspect of the plan, the patient and nurse can work together to develop an alternative or modification to the plan that the patient believes will be more successful.

#### *Monitoring and Managing Potential Complications*

Symptoms suggesting that hypertension is progressing to the extent that target organ damage is occurring must be detected early so that appropriate treatment can be initiated. When the patient returns for follow-up care, all body systems must be assessed to detect any evidence of vascular damage. An eye examination with an ophthalmoscope is particularly important because retinal blood vessel damage indicates similar damage elsewhere in the vascular system. The patient is questioned about blurred vision, spots in front of the eyes, and diminished visual acuity. The heart, nervous system, and kidneys are also carefully assessed. Any significant findings are promptly reported to determine whether additional diagnostic studies are required. Based on the findings, medications may be changed to improve blood pressure control.

### Evaluation

#### *Expected Patient Outcomes*

1. Maintains adequate tissue perfusion:
   a. Maintains blood pressure at less than 140/90 mm Hg (or less than 130/80 mm Hg for people with diabetes mellitus or chronic kidney disease) with lifestyle modifications, medications, or both
   b. Demonstrates no symptoms of angina, palpitations, or vision changes
   c. Has stable BUN and serum creatinine levels
   d. Has palpable peripheral pulses
2. Complies with the self-care program:
   a. Adheres to the dietary regimen as prescribed: reduces calorie, sodium, and fat intake; increases fruit and vegetable intake
   b. Exercises regularly
   c. Takes medications as prescribed and reports any side effects
   d. Measures blood pressure routinely
   e. Abstains from tobacco and excessive alcohol intake
   f. Keeps follow-up appointments
3. Has no complications:
   a. Reports no changes in vision
   b. Exhibits no retinal damage on vision testing
   c. Maintains pulse rate and rhythm and respiratory rate within normal ranges
   d. Reports no dyspnea or edema
   e. Maintains urine output consistent with intake
   f. Has renal function test results within normal range
   g. Demonstrates no motor, speech, or sensory deficits
   h. Reports no headaches, dizziness, weakness, changes in gait, or falls

## Hypertensive Crises

JNC 7 describes two classes of hypertensive crisis that require immediate intervention: hypertensive emergency and hypertensive urgency (Chobanian, et al., 2003). Hypertensive emergencies and urgencies may occur in patients whose hypertension has been poorly controlled, whose hypertension

has been undiagnosed, or in those who have abruptly discontinued their medications. Once the hypertensive crisis has been managed, a complete evaluation is performed to review the patient's ongoing treatment plan and strategies to minimize the occurrence of subsequent hypertensive crises. The current recommendations for management of both hypertensive emergencies and urgencies are based on expert opinions because there are not clinical trial data comparing treatment options or identifying the impact of treatment on morbidity and mortality (Flanigan & Vitberg, 2006).

A **hypertensive emergency** is a situation in which blood pressure is extremely elevated (more than 180/120 mm Hg) and must be lowered immediately (not necessarily to less than 140/90 mm Hg) to halt or prevent damage to the target organs (Chobanian, et al., 2003; Haas & Marik, 2006). Assessment will reveal actual or developing clinical dysfunction of the target organ. Conditions associated with a hypertensive emergency include hypertension of pregnancy, acute myocardial infarction, dissecting aortic aneurysm, and intracranial hemorrhage. Hypertensive emergencies are acute, life-threatening blood pressure elevations that require prompt treatment in an intensive care setting because of the serious target organ damage that may occur. The therapeutic goals are reduction of the mean blood pressure by up to 25% within the first hour of treatment, a further reduction to a goal pressure of about 160/100 mm Hg over a period of up to 6 hours, and then a more gradual reduction in pressure over a period of days. The exceptions to these goals are the treatment of ischemic stroke (in which there is no evidence of benefit from immediate pressure reduction) and treatment of aortic dissection (in which the goal is to lower systolic pressure to less than 100 mm Hg if the patient can tolerate the reduction) (Chobanian, et al., 2003).

The medications of choice in hypertensive emergencies are those that have an immediate effect. Intravenous vasodilators, including sodium nitroprusside (Nitropress), nicardipine hydrochloride (Cardene), fenoldopam mesylate (Corlopam), enalaprilat, and nitroglycerin have immediate actions that are short lived (minutes to 4 hours), and they are therefore used for initial treatment. For more information about these medications, see Table 32-4. Experts also recommend assessing the individual's fluid volume status. If there is volume depletion secondary to natriuresis caused by the elevated blood pressure, then volume replacement with normal saline can prevent large sudden drops in blood pressure when antihypertensive medications are administered (Haas & Marik, 2006).

A **hypertensive urgency** describes a situation in which blood pressure is very elevated but there is no evidence of impending or progressive target organ damage (Chobanian, et al., 2003). Elevated blood pressures associated with severe headaches, nosebleeds, or anxiety are classified as urgencies. In these situations oral agents can be administered with the goal of normalizing blood pressure within 24 to 48 hours (Haas & Marik, 2006). Oral doses of fast-acting agents such as beta-adrenergic blocking agents (eg, labetalol [Trandate]), ACE inhibitors (eg, captopril [Capoten]), or alpha$_2$-agonists (eg, clonidine [Catapres]) are recommended for the treatment of hypertensive urgencies (see Table 32-4).

Extremely close hemodynamic monitoring of the patient's blood pressure and cardiovascular status is required during treatment of hypertensive emergencies and urgencies (see Chapter 26). The exact frequency of monitoring is a matter of clinical judgment and varies with the patient's condition. Taking vital signs every 5 minutes is appropriate if the blood pressure is changing rapidly; taking vital signs at 15- or 30-minute intervals in a more stable situation may be sufficient. A precipitous drop in blood pressure can occur that would require immediate action to restore blood pressure to an acceptable level.

## CRITICAL THINKING EXERCISES

EBP **1** You are working as the admitting nurse in a hospital hypertension clinic. One of the patients today is an 88-year-old woman who has come in with her daughter. When you take her blood pressure you note that it is 210/158 mm Hg. As you talk with both the mother and daughter you find that the mother has not been taking her medications. She tells you that she thinks that at her age, high blood pressure is not that much of a problem. Her daughter is a nurse and is concerned about her mother. What is the evidence base that indicates that untreated hypertension can cause disability and death in people over the age of 80? What other information do you plan to gather from this patient and her daughter? What plan of action might you initiate?

EBP **2** Your nursing class is participating at a workplace health fair by taking blood pressures. The blood pressure of one young man, aged 32, is 128/88 mm Hg. What classification would be given to his blood pressure according to the JNC 7 recommendations? What further assessment would you do? What lifestyle factors would you discuss with him? Discuss the evidence that supports specific strategies aimed at preventing hypertension and how you would approach a discussion of possible changes he might want to make.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Heart Association National Center, www.americanheart.org/
Centers for Disease Control and Prevention (CDC), www.cdc.gov/cvh
Heart and Stroke Foundation of Canada, www.heartandstroke.ca
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov
World Health Association (WHO), Cardiovascular Disease Information, www.who.int/topics/cardiovascular_diseases/en



chapter 33

# Assessment and Management of Patients With Hematologic Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the process of hematopoiesis.
2. Describe the processes involved in maintaining hemostasis.
3. Differentiate between the hypoproliferative and the hemolytic anemias and compare and contrast the physiologic mechanisms, clinical manifestations, medical management, and nursing interventions for each.
4. Use the nursing process as a framework for care of patients with anemia.
5. Compare the leukemias in terms of their incidence, physiologic alterations, clinical manifestations, management, and prognosis.
6. Use the nursing process as a framework for care of patients with acute leukemia.
7. Use the nursing process as a framework for care of patients with lymphoma or multiple myeloma.
8. Use the nursing process as a framework for care of patients with bleeding or thrombotic disorders.
9. Identify therapies for blood disorders, including the nursing implications for the administration of blood components.

## GLOSSARY

**absolute neutrophil count:** a calculation of the number of circulating neutrophils, derived from the total white blood cells (WBCs) and the percentage of neutrophils counted in a microscope's visual field
**anemia:** decreased red blood cell (RBC) count
**anergy:** diminished reactivity to antigens (transient or complete)
**angiogenesis:** formation of new blood vessels
**angular cheilosis:** cracking sore at corner of mouth
**aplasia:** lack of cellular development (eg, of cells within the bone marrow)
**band cell:** slightly immature neutrophil
**blast cell:** primitive WBC
**cytokines:** hormones produced by leukocytes that are vital to regulation of hematopoiesis, apoptosis, and immune responses
**D-dimer:** test to measure fibrin breakdown; considered more specific than fibrin degradation products in the diagnosis of disseminated intravascular coagulation
**differentiation:** development of functions and characteristics that are different from those of the parent stem cell
**erythrocyte:** see red blood cell
**erythrocyte sedimentation rate:** laboratory test that measures the rate of settling of RBCs; elevation is indicative of inflammation; also called the "sed rate"
**erythroid cells:** any cell that is or will become a mature RBC
**erythropoiesis:** process of formation of RBCs
**erythropoietin:** hormone produced primarily by the kidney; necessary for erythropoiesis
**fibrin:** filamentous protein; basis of thrombus and blood clot
**fibrinogen:** protein converted into fibrin to form thrombus and clot
**fibrinolysis:** process of breakdown of fibrin clot
**granulocyte:** granulated WBC (neutrophil, eosinophil, basophil); sometimes used synonymously with neutrophil
**haptoglobin:** blood protein synthesized by liver; binds free hemoglobin released from erythrocytes, which is then removed by the reticuloendothelial system

## GLOSSARY *(Continued)*

**hematocrit:** percentage of total blood volume consisting of RBCs
**hematopoiesis:** complex process of the formation and maturation of blood cells
**hemoglobin:** iron-containing protein of RBCs; delivers oxygen to tissues
**hemolysis:** destruction of RBCs; can occur within or outside of the vasculature
**hemosiderin:** iron-containing pigment derived from breakdown of hemoglobin
**hemostasis:** intricate balance between clot formation and clot dissolution
**histiocytes:** cells present in all loose connective tissue, capable of phagocytosis
**hypochromia:** pallor within the RBC caused by decreased hemoglobin content
**left shift, or shift to the left:** increased release of immature forms of WBCs from the bone marrow in response to need
**leukocyte:** see white blood cell
**leukemia:** uncontrolled proliferation of WBCs, often immature
**leukopenia:** less-than-normal amount of WBCs in circulation
**lymphocyte:** form of WBC involved in immune functions
**lymphoid:** pertaining to lymphocytes
**lysis:** destruction of cells
**macrophage:** reticuloendothelial cells capable of phagocytosis
**microcytosis:** smaller-than-normal RBCs
**monocyte:** large WBC that becomes a macrophage when it leaves the circulation and moves into body tissues
**myeloid:** pertaining to nonlymphoid blood cells that differentiate into RBCs, platelets, macrophages, mast cells, and various WBCs
**myelopoiesis:** formation and maturation of cells derived from myeloid stem cell
**neutropenia:** lower-than-normal number of neutrophils
**neutrophil:** fully mature WBC capable of phagocytosis; primary defense against bacterial infection
**normochromic:** normal RBC color, indicating normal amount of hemoglobin
**normocytic:** normal size of RBC
**nucleated RBC:** immature form of RBC; portion of nucleus remains within the RBC
**oxyhemoglobin:** combined form of oxygen and hemoglobin; found in arterial blood
**pancytopenia:** abnormal decrease in WBCs, RBCs, and platelets
**petechiae:** tiny capillary hemorrhages
**phagocytosis:** process of cellular ingestion and digestion of foreign bodies
**plasma:** liquid portion of blood
**plasminogen:** protein converted to plasmin to dissolve thrombi and clots
**platelet:** thrombocyte; a cellular component of blood involved in blood coagulation
**poikilocytosis:** variation in shape of RBCs
**polycythemia:** excess RBCs
**red blood cell (RBC):** erythrocyte; a cellular component of blood involved in the transport of oxygen and carbon dioxide
**reticulocytes:** slightly immature RBCs, usually only 1% of total circulating RBCs
**reticuloendothelial system:** complex system of cells throughout body capable of phagocytosis
**serum:** portion of blood remaining after coagulation occurs
**stem cell:** primitive cell, capable of self-replication and differentiation into myeloid or lymphoid stem cell
**thrombin:** enzyme necessary to convert fibrinogen into fibrin clot
**thrombocyte:** see platelet
**thrombocytopenia:** lower-than-normal platelet count
**thrombocytosis:** higher-than-normal platelet count
**white blood cell (WBC):** leukocyte; one of several cellular components of blood involved in defense of the body; subtypes include neutrophils, eosinophils, basophils, monocytes, and lymphocytes

Unlike many other body systems, the hematologic system encompasses the entire human body. Patients with hematologic disorders often have significant abnormalities in blood tests but few or no symptoms. Therefore, the nurse must have a good understanding of the pathophysiology of the patient's condition and the ability to make a thorough assessment that relies heavily on the interpretation of laboratory tests. It is equally important for the nurse to anticipate potential patient needs and to target nursing interventions accordingly. Because it is so important to the understanding of most hematologic diseases, a basic appreciation of blood cells and bone marrow function is necessary.

# HEMATOLOGIC ASSESSMENT

## *Anatomic and Physiologic Overview*

The hematologic system consists of the blood and the sites where blood is produced, including the bone marrow and the **reticuloendothelial system** (RES). Blood is a specialized organ that differs from other organs in that it exists in a fluid state. Blood is composed of plasma and various types of cells. **Plasma** is the fluid portion of blood; it contains various proteins, such as albumin, globulin, **fibrinogen,** and other factors necessary for clotting, as well as electrolytes, waste products, and nutrients. About 55% of blood volume is plasma.

### Blood

The cellular component of blood consists of three primary cell types (Table 33-1): **erythrocytes (red blood cells [RBCs]**, red cells), **leukocytes (white blood cells [WBCs]**), and **thrombocytes (platelets).** These cellular components of blood normally make up 40% to 45% of the blood volume. Because most blood cells have a short lifespan, the need for the body to replenish its supply of cells is continuous; this process is termed **hematopoiesis.** The primary site for hematopoiesis is the bone marrow. During embryonic development and in other conditions, the liver and spleen may also be involved.

Under normal conditions, the adult bone marrow produces about 175 billion erythrocytes, 70 billion **neutrophils** (a mature type of WBC), and 175 billion platelets each day. When the body needs more blood cells, as in infection (when neutrophils are needed to fight the invading pathogen) or in bleeding (when more RBCs are required), the marrow increases its production of the cells required. Thus, under normal conditions, the marrow responds to increased demand and releases adequate numbers of cells into the circulation.

Blood makes up approximately 7% to 10% of the normal body weight and amounts to 5 to 6 L of volume. Circulating through the vascular system and serving as a link between body organs, blood carries oxygen absorbed from the lungs and nutrients absorbed from the gastrointestinal (GI) tract to the body cells for cellular metabolism. Blood also carries hormones, antibodies, and other substances to their sites of action or use. In addition, blood carries waste products produced by cellular metabolism to the lungs, skin, liver, and kidneys, where they are transformed and eliminated from the body.

The danger that trauma can lead to excess blood loss always exists. To prevent this, an intricate clotting mechanism is activated when necessary to seal any leak in the blood vessels. Excessive clotting is equally dangerous, because it can obstruct blood flow to vital tissues. To prevent this, the body has a fibrinolytic mechanism that eventually dissolves clots (thrombi) formed within blood vessels. The balance between these two systems, clot (thrombus) formation and clot dissolution or **fibrinolysis,** is called **hemostasis.**

**Table 33-1 BLOOD CELLS**

| Cell Type | Major Function |
|---|---|
| **WBC (Leukocyte)** | Fights infection |
| Neutrophil | Essential in preventing or limiting bacterial infection via phagocytosis |
| Monocyte | Enters tissue as macrophage; highly phagocytic, especially against fungus; immune surveillance |
| Eosinophil | Involved in allergic reactions (neutralizes histamine); digests foreign proteins |
| Basophil | Contains histamine; integral part of hypersensitivity reactions |
| Lymphocyte | Integral component of immune system |
| T lymphocyte | Responsible for cell-mediated immunity; recognizes material as "foreign" (surveillance system) |
| B lymphocyte | Responsible for humoral immunity; many mature into plasma cells to form antibodies |
| Plasma cell | Secretes immunoglobulin (Ig, antibody); most mature form of B lymphocyte |
| **RBC (Erythrocyte)** | Carries hemoglobin to provide oxygen to tissues; average lifespan is 120 days |
| **Platelet (Thrombocyte)** | Fragment of megakaryocyte; provides basis for coagulation to occur; maintains hemostasis; average lifespan is 10 days |

RBC, red blood cell; WBC, white blood cell.

### Bone Marrow

The bone marrow is the site of hematopoiesis, or blood cell formation (Fig. 33-1). In adults, blood cell formation is usually limited to the pelvis, ribs, vertebrae, and sternum. Marrow is one of the largest organs of the body, making up 4% to 5% of total body weight. It consists of islands of cellular components (red marrow) separated by fat (yellow marrow). As people age, the proportion of active marrow is gradually replaced by fat; however, in healthy adults, the fat can again be replaced by active marrow when more blood cell production is required. In adults with disease that causes marrow destruction, fibrosis, or scarring, the liver and spleen can also resume production of blood cells by a process known as extramedullary hematopoiesis.

The marrow is highly vascular. Within it are primitive cells called **stem cells.** The stem cells have the ability to self-replicate, thereby ensuring a continuous supply of stem cells throughout the life cycle. When stimulated to do so, stem cells can begin a process of **differentiation** into either **myeloid** or **lymphoid** stem cells. These stem cells are committed to produce specific types of blood cells. Lymphoid stem cells produce either T or B **lymphocytes.** Myeloid stem cells differentiate into three broad cell types: erythrocytes,

**Physiology ■■■ Pathophysiology**

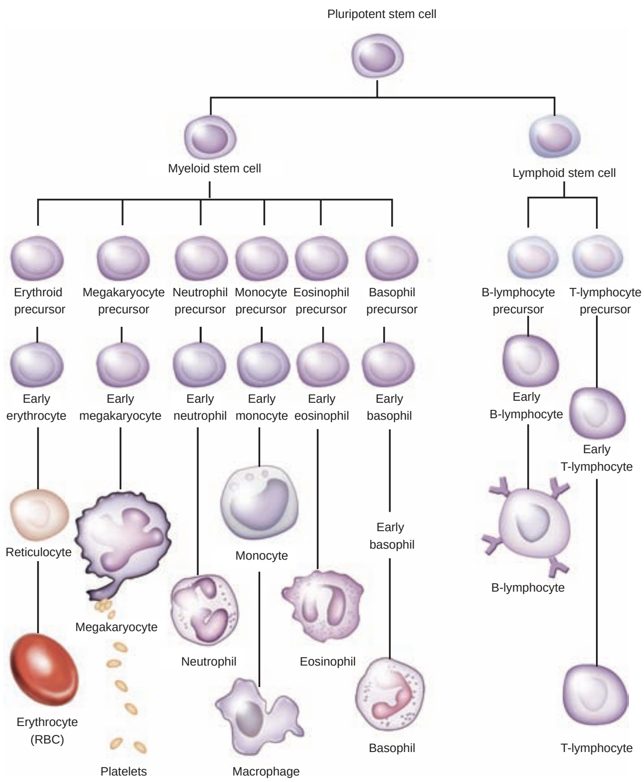



**Figure 33-1** Hematopoiesis. Uncommitted (pluripotent) stem cells can differentiate into myeloid or lymphoid stem cells. These stem cells then undergo a complex process of differentiation and maturation into normal cells that are released into the circulation. The myeloid stem cell is responsible not only for all nonlymphoid white blood cells but also for the production of red blood cells (RBCs) and platelets. Each step of the differentiation process depends in part on the presence of specific growth factors for each cell type. When the stem cells are dysfunctional, they may respond inadequately to the need for more cells, or they may respond excessively, sometimes uncontrollably, as in leukemia.

leukocytes, and platelets. Thus, with the exception of lymphocytes, all blood cells are derived from myeloid stem cells. A defect in a myeloid stem cell can cause problems with erythrocyte, leukocyte, and platelet production.

## Blood Cells

### *Erythrocytes (Red Blood Cells)*

The normal erythrocyte is a biconcave disk that resembles a soft ball compressed between two fingers (Fig. 33-2). It has a diameter of about 8 μm and is so flexible that it can pass easily through capillaries that may be as small as 2.8 μm in diameter. The membrane of the red cell is very thin so that gases, such as oxygen and carbon dioxide, can easily diffuse across it; the disk shape provides a large surface area that facilitates the absorption and release of oxygen molecules.

Mature erythrocytes consist primarily of **hemoglobin,** which contains iron and makes up 95% of the cell mass. Mature erythrocytes have no nuclei, and they have many fewer metabolic enzymes than do most other cells. The presence of a large amount of hemoglobin enables the red cell to perform its principal function, the transport of oxygen between the lungs and tissues. Occasionally the marrow releases slightly immature forms of erythrocytes, called **reticulocytes,** into the circulation. This occurs as a normal response to an increased demand for erythrocytes (as in bleeding) or in some disease states.

The oxygen-carrying hemoglobin molecule is made up of four subunits, each containing a heme portion attached to a globin chain. Iron is present in the heme component of the molecule. An important property of heme is its ability to bind to oxygen loosely and reversibly. Oxygen readily binds to hemoglobin in the lungs and is carried as **oxyhemoglobin** in arterial blood. Oxyhemoglobin is a brighter red than hemoglobin that does not contain oxygen (reduced hemoglobin); thus, arterial blood is a brighter red than venous blood. The oxygen readily dissociates (detaches) from hemoglobin in the tissues, where the oxygen is needed for cellular metabolism. In venous blood, hemoglobin combines with hydrogen ions produced by cellular metabolism and thus buffers excessive acid. Whole blood normally contains about 15 g of hemoglobin per 100 mL of blood.

#### Erythropoiesis

Erythroblasts arise from the primitive myeloid stem cells in bone marrow. The erythroblast is an immature nucleated cell that gradually loses its nucleus. At this stage, the cell is known as a reticulocyte. Further maturation into an erythrocyte entails the loss of the dark-staining material within the cell and slight shrinkage. The mature erythrocyte is then released into the circulation. Under conditions of rapid **erythropoiesis** (ie, erythrocyte production), reticulocytes and other immature cells (eg, **nucleated RBCs**) may be released prematurely into the circulation. This is often seen when the liver or spleen takes over as the site of erythropoiesis and more nucleated red cells appear within the circulation.

Differentiation of the primitive myeloid stem cell into an erythroblast is stimulated by **erythropoietin,** a hormone produced primarily by the kidney. If the kidney detects low levels of oxygen, as occurs when fewer red cells are available to bind oxygen (ie, **anemia**), or with people living at high altitudes with lower atmospheric oxygen concentrations, erythropoietin levels increase. The increased erythropoietin then stimulates the marrow to increase production of erythrocytes. The entire process of erythropoiesis typically takes 5 days.

For normal erythrocyte production, the bone marrow also requires iron, vitamin $B_{12}$, folic acid, pyridoxine (vitamin $B_6$), protein, and other factors. A deficiency of these factors during erythropoiesis can result in decreased red cell production and anemia.

***Iron Stores and Metabolism.*** The average daily diet in the United States contains 10 to 15 mg of elemental iron, but only 0.5 to 1 mg of ingested iron is normally absorbed from the small intestine. The rate of iron absorption is regulated by the amount of iron already stored in the body and by the rate of erythrocyte production. Additional amounts of iron, up to 2 mg daily, must be absorbed by women of childbearing age

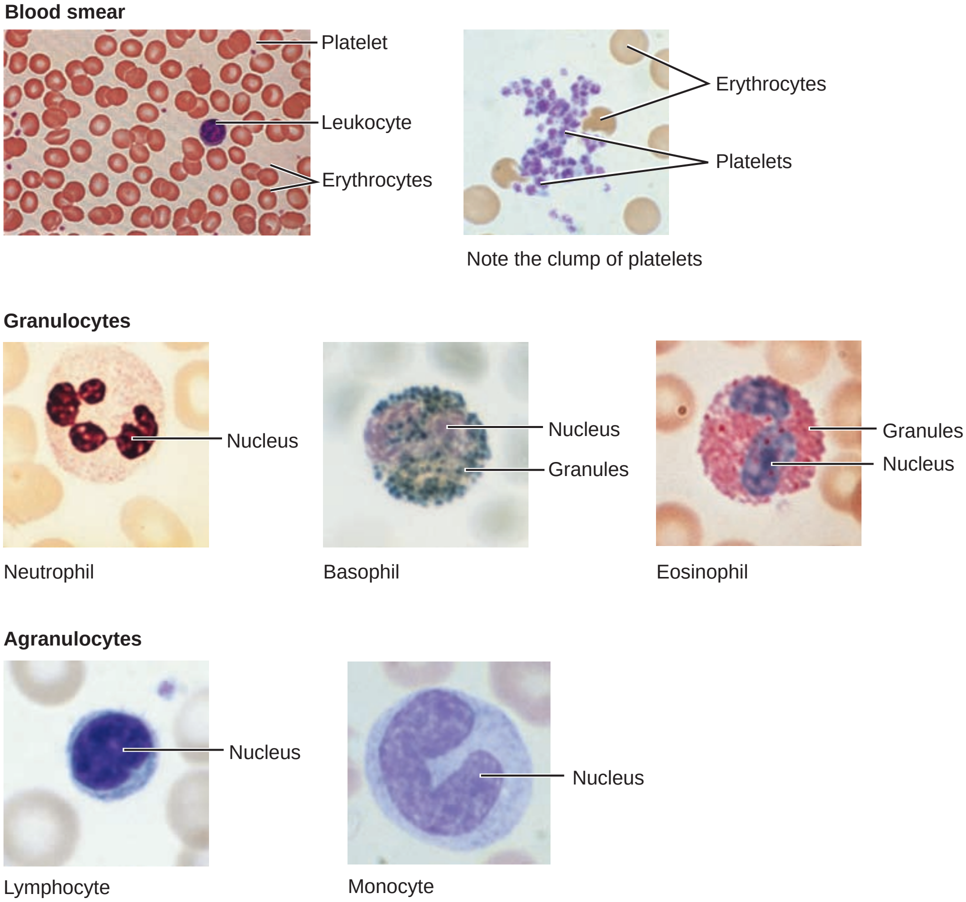



**Figure 33-2** Normal types of blood cells. From Cohen, B. J. (2005). *Memmler's the human body in health and disease* (10th ed.). Philadelphia: Lippincott Williams & Wilkins.

to replace that lost during menstruation. Total body iron content in the average adult is approximately 3 g, most of which is present in hemoglobin or in one of its breakdown products. Iron is stored as ferritin and when required, the iron is released into the plasma, binds to transferrin, and is transported into the membranes of the normoblasts (erythrocyte precursor cells) within the marrow, where it is incorporated into hemoglobin. Iron is lost in the feces, either in bile, blood, or mucosal cells from the intestine.

The concentration of iron in blood is normally about 75 to 175 μg/dL (13 to 31 μmol/L) for men and 65 to 165 μg/dL (11 to 29 μmol/L) for women. With iron deficiency, bone marrow iron stores are rapidly depleted; hemoglobin synthesis is depressed, and the erythrocytes produced by the marrow are small and low in hemoglobin. Iron deficiency in the adult generally indicates blood loss (eg, from bleeding in the GI tract or heavy menstrual flow). Lack of dietary iron is rarely the sole cause of iron deficiency anemia in adults. The source of iron deficiency should be investigated promptly, because iron deficiency in an adult may be a sign of bleeding in the GI tract or colon cancer.

***Vitamin $B_{12}$ and Folic Acid Metabolism.*** Vitamin $B_{12}$ and folic acid are required for the synthesis of deoxyribonucleic acid (DNA) in RBCs. Both vitamin $B_{12}$ and folic acid are derived from the diet. Folic acid is absorbed in the proximal small intestine, but only small amounts are stored within the body. If the diet is deficient in folic acid, stores within the body quickly become depleted. Because vitamin $B_{12}$ is found only in foods of animal origin, strict vegetarians may ingest little vitamin $B_{12}$. Vitamin $B_{12}$ combines with intrinsic factor produced in the stomach. The vitamin $B_{12}$–intrinsic factor complex is absorbed in the distal ileum. People who have had a partial or total gastrectomy may have limited amounts of intrinsic factor, and therefore the absorption of vitamin $B_{12}$ may be diminished. The effects of either decreased absorption or decreased intake of vitamin $B_{12}$ are not apparent for 2 to 4 years.

Vitamin $B_{12}$ and folic acid deficiencies are characterized by the production of abnormally large erythrocytes called megaloblasts. Because these cells are abnormal, many are sequestered (trapped) while still in the bone marrow, and their rate of release is decreased. Some of these cells actually die in the marrow before they can be released into the circulation. This results in megaloblastic anemia.

### Red Blood Cell Destruction

The average lifespan of a normal circulating erythrocyte is 120 days. Aged erythrocytes lose their elasticity and become trapped in small blood vessels and the spleen. They are removed from the blood by the reticuloendothelial cells, particularly in the liver and the spleen. As the erythrocytes are destroyed, most of their hemoglobin is recycled. Some hemoglobin also breaks down to form bilirubin and is secreted in the bile. Most of the iron is recycled to form new hemoglobin molecules within the bone marrow; small amounts

are lost daily in the feces and urine and monthly in menstrual flow.

### Leukocytes (White Blood Cells)

Leukocytes are divided into two general categories: granulocytes and lymphocytes. In normal blood, the total leukocyte count is 4000 to 11,000 cells/mm$^3$. Of these, approximately 60% to 80% are granulocytes and 20% to 40% are lymphocytes. Both of these types of leukocytes primarily protect the body against infection and tissue injury.

#### Granulocytes

**Granulocytes** are defined by the presence of granules in the cytoplasm of the cell. Granulocytes are divided into three main subgroups, which are characterized by the staining properties of these granules (see Fig. 33-2). Eosinophils have bright-red granules in their cytoplasm, whereas the granules in basophils stain deep blue. The third and most numerous cell in this class is the neutrophil, with granules that stain a pink to violet hue. Neutrophils are also called polymorphonuclear neutrophils (PMNs, or polys) or segmented neutrophils (segs).

The nucleus of the mature neutrophil has multiple lobes (usually two to five) that are connected by thin filaments of nuclear material, or a "segmented" nucleus; it is usually twice the size of an erythrocyte. The somewhat less mature granulocyte has a single-lobed, elongated nucleus and is called a **band cell.** Ordinarily, band cells account for only a small percentage of circulating granulocytes, although their percentage can increase greatly under conditions in which neutrophil production increases, such as infection. An increased number of band cells is sometimes called a **left shift** or **shift to the left.** (Traditionally, the diagram of neutrophil maturation showed the myeloid stem cell on the left with progressive maturation stages toward the right, ending with a fully mature neutrophil on the far right side. A shift to the left indicates that more immature cells are present in the blood than normal.)

Fully mature neutrophils result from the gradual differentiation of myeloid stem cells, specifically myeloid **blast cells.** The process, called **myelopoiesis,** is highly complex and depends on many factors. These factors, including specific **cytokines** such as growth factors, are normally present within the marrow itself. As the blast cell matures, the cytoplasm of the cell changes in color (from blue to violet) and granules begin to form with the cytoplasm. The shape of the nucleus also changes. The entire process of maturation and differentiation takes about 10 days (see Fig. 33-1). Once the neutrophil is released into the circulation from the marrow, it stays there for only about 6 hours before it migrates into the body tissues to perform its function of **phagocytosis** (ingestion and digestion of bacteria and particles). Neutrophils die here within 1 to 2 days. The number of circulating granulocytes found in the healthy person is relatively constant, but in infection large numbers of these cells are rapidly released into the circulation.

#### Agranulocytes

***Monocytes.*** **Monocytes** (also called mononuclear leukocytes) are leukocytes with a single-lobed nucleus and a granule-free cytoplasm—hence the term *agranulocyte* (see Fig. 33-2). In normal adult blood, monocytes account for approximately 5% of the total leukocytes. Monocytes are the largest of the leukocytes. Produced by the bone marrow, they remain in the circulation for a short time before entering the tissues and transforming into **macrophages.** Macrophages are particularly active in the spleen, liver, peritoneum, and alveoli; they remove debris from these areas and phagocytize bacteria within the tissues.

***Lymphocytes.*** Mature lymphocytes are small cells with scanty cytoplasm (see Fig. 33-2). Immature lymphocytes are produced in the marrow from the lymphoid stem cells. A second major source of production is the thymus. Cells derived from the thymus are known as T lymphocytes (or T cells); those derived from the marrow can also be T cells but are more commonly B lymphocytes (or B cells). Lymphocytes complete their differentiation and maturation primarily in the lymph nodes and in the lymphoid tissue of the intestine and spleen after exposure to a specific antigen. Mature lymphocytes are the principal cells of the immune system, producing antibodies and identifying other cells and organisms as "foreign."

#### Function of Leukocytes

Leukocytes protect the body from invasion by bacteria and other foreign entities. The major function of neutrophils is phagocytosis. Neutrophils arrive at a given site within 1 hour after the onset of an inflammatory reaction and initiate phagocytosis, but they are short-lived. An influx of monocytes follows; these cells continue their phagocytic activities for long periods as macrophages. This process constitutes a second line of defense for the body against inflammation and infection. Although neutrophils can often work adequately against bacteria without the help of macrophages, macrophages are particularly effective against fungi and viruses. Macrophages also digest senescent (aging or aged) blood cells, primarily within the spleen.

The primary function of lymphocytes is to attack foreign material. One group of lymphocytes (T lymphocytes) kills foreign cells directly or releases lymphokines, substances that enhance the activity of phagocytic cells. T lymphocytes are responsible for delayed allergic reactions, rejection of foreign tissue (eg, transplanted organs), and destruction of tumor cells. This process is known as *cellular immunity*. The other group of lymphocytes (B lymphocytes) is capable of differentiating into plasma cells. Plasma cells, in turn, produce antibodies called immunoglobulins (Ig), which are protein molecules that destroy foreign material by several mechanisms. This process is known as *humoral immunity*.

Eosinophils and basophils function in hypersensitivity reactions. Eosinophils are important in the phagocytosis of parasites. The increase in eosinophil levels in allergic states indicates that these cells are involved in the hypersensitivity reaction; they neutralize histamine. Basophils produce and store histamine as well as other substances involved in hypersensitivity reactions. The release of these substances provokes allergic reactions.

### Platelets (Thrombocytes)

Platelets, or thrombocytes, are not technically cells; rather, they are granular fragments of giant cells in the bone marrow called megakaryocytes (see Fig. 33-2). Platelet production in

the marrow is regulated in part by the hormone thrombopoietin, which stimulates the production and differentiation of megakaryocytes from the myeloid stem cell.

Platelets play an essential role in the control of bleeding. They circulate freely in the blood in an inactive state, where they nurture the endothelium of the blood vessels, maintaining the integrity of the vessel. When vascular injury occurs, platelets collect at the site and are activated. They adhere to the site of injury and to each other, forming a platelet plug that temporarily stops bleeding. Substances released from platelet granules activate coagulation factors in the blood plasma and initiate the formation of a stable clot composed of **fibrin,** a filamentous protein. Platelets have a normal lifespan of 7 to 10 days.

## Plasma and Plasma Proteins

After cellular elements are removed from blood, the remaining liquid portion is called plasma. More than 90% of plasma is water. The remainder consists primarily of plasma proteins, clotting factors (particularly fibrinogen), and small amounts of other substances such as nutrients, enzymes, waste products, and gases. If plasma is allowed to clot, the remaining fluid is called **serum.** Serum has essentially the same composition as plasma, except that fibrinogen and several clotting factors have been removed during the clotting process.

Plasma proteins consist primarily of albumin and the globulins. The globulins can be separated into three main fractions (alpha, beta, and gamma), each of which consists of distinct proteins that have different functions. Important proteins in the alpha and beta fractions are the transport globulins and the clotting factors that are made in the liver. The transport globulins carry various substances in bound form in the circulation. For example, thyroid-binding globulin carries thyroxin, and transferrin carries iron. The clotting factors, including fibrinogen, remain in an inactive form in the blood plasma until activated by the clotting cascade. The gamma-globulin fraction refers to the immunoglobulins, or antibodies. These proteins are produced by well-differentiated B lymphocytes and plasma cells. The actual fractionation of the globulins can be seen on a specific laboratory test (serum protein electrophoresis).

Albumin is particularly important for the maintenance of fluid balance within the vascular system. Capillary walls are impermeable to albumin, so its presence in the plasma creates an osmotic force that keeps fluid within the vascular space. Albumin, which is produced by the liver, has the capacity to bind to several substances that are transported in plasma (eg, certain medications, bilirubin, some hormones). People with impaired hepatic function may have low concentrations of albumin, with a resultant decrease in osmotic pressure and the development of edema.

## Reticuloendothelial System

The RES is composed of special tissue macrophages. When released from the marrow, monocytes spend a short time in the circulation (about 24 hours) and then enter the body tissues. Within the tissues, the monocytes continue to differentiate into macrophages, which can survive for months or years. Macrophages have a variety of important functions. They defend the body against foreign invaders (ie, bacteria and other pathogens) via phagocytosis. They remove old or damaged cells from the circulation. They stimulate the inflammatory process and present antigens to the immune system (see Chapter 50). Macrophages give rise to tissue **histiocytes,** including Kupffer cells of the liver, peritoneal macrophages, alveolar macrophages, and other components of the RES. Thus, the RES is a component of many other organs within the body, particularly the spleen, lymph nodes, lungs, and liver.

The spleen is the site of activity for most macrophages. Most of the spleen (75%) is made of red pulp; here the blood enters the venous sinuses through capillaries that are surrounded by macrophages. Within the red pulp are tiny aggregates of white pulp, consisting of B and T lymphocytes. The spleen sequesters newly released reticulocytes from the marrow, removing nuclear fragments and other materials (eg, denatured hemoglobin, iron) before the now fully mature erythrocyte returns to the circulation. Although a minority of erythrocytes (less than 5%) pool in the spleen, a significant proportion of platelets (20% to 40%) pool here. If the spleen is enlarged, a greater proportion of red cells and platelets can be sequestered. The spleen is a major source of hematopoiesis in fetal life. It can resume hematopoiesis later in adulthood if necessary, particularly when marrow function is compromised (eg, in bone marrow fibrosis). The spleen has important immunologic functions as well. It forms substances called opsonins that promote the phagocytosis of neutrophils; it also forms the antibody immunoglobulin M (IgM) after exposure to an antigen.

## Hemostasis

CONCEPTS IN ACTION

Hemostasis is the process of preventing blood loss from intact vessels and of stopping bleeding from a severed vessel, which requires adequate numbers of functional platelets. Platelets nurture the endothelium and thereby maintain the structural integrity of the vessel wall. Two processes are involved in arresting bleeding: primary and secondary hemostasis (Fig. 33-3).

In primary hemostasis, the severed blood vessel constricts. Circulating platelets aggregate at the site and adhere to the vessel and to one another. An unstable hemostatic plug is formed. For the coagulation process to be correctly activated, circulating inactive coagulation factors must be converted to active forms. This process occurs on the surface of the aggregated platelets at the site of vessel injury. The end result is the formation of fibrin, which reinforces the platelet plug and anchors it to the injury site. This process is termed secondary hemostasis. The process of blood coagulation is highly complex. It can be activated by the intrinsic or the extrinsic pathway. Both pathways are needed for maintenance of normal hemostasis.

Many factors are involved in the reaction cascade that forms fibrin. When tissue is injured, the extrinsic pathway is activated by the release of thromboplastin from the tissue. As the result of a series of reactions, prothrombin is converted to **thrombin,** which in turn catalyzes the conversion of fibrinogen to fibrin. Clotting by the intrinsic pathway is activated when the collagen that lines blood vessels is exposed. Clotting factors are activated sequentially until, as

## Physiology ■■■ Pathophysiology

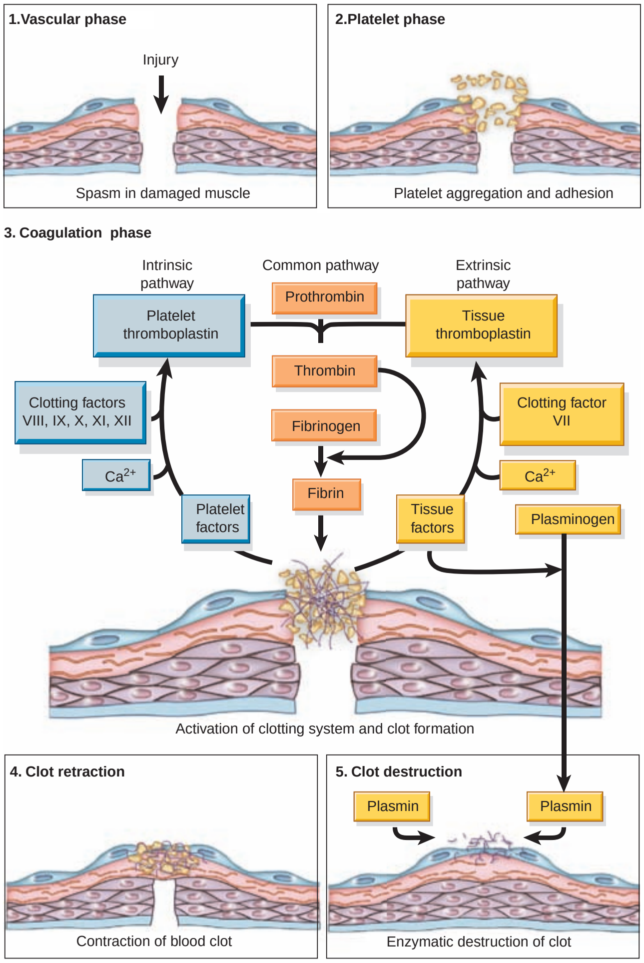



**Figure 33-3** Hemostasis. When the endothelial surface of a blood vessel is injured, several processes occur. In primary hemostasis, platelets within the circulation are attracted to the exposed layer of collagen at the site of injury. They adhere to the site of injury, releasing factors that stimulate other platelets to aggregate at the site, forming an unstable platelet plug. In secondary hemostasis, based on the type of stimulus, one of two clotting pathways is initiated—the intrinsic or extrinsic pathway—and the clotting factors within that pathway are activated. The end result from either pathway is the conversion of prothrombin to thrombin. Thrombin is necessary for fibrinogen to be converted into fibrin, the stabilizing protein that anchors the fragile platelet plug to the site of injury to prevent further bleeding and permit the injuring vessel or site to heal. Modified from www.irvingcrowley.com/cls/clotting.gif.

with the extrinsic pathway, fibrin is ultimately formed. Although the intrinsic pathway is slower, this sequence is probably most often responsible for clotting in vivo.

As the injured vessel is repaired and again covered with endothelial cells, the fibrin clot is no longer needed. The fibrin is digested via two systems: the plasma fibrinolytic system and the cellular fibrinolytic system. The substance **plasminogen** is required to lyse (break down) the fibrin. Plasminogen, which is present in all body fluids, circulates with fibrinogen and is therefore incorporated into the fibrin clot as it forms. When the clot is no longer needed (eg, after an injured blood vessel has healed), the plasminogen is activated to form plasmin. Plasmin digests the fibrinogen and fibrin. The breakdown particles of the clot, called fibrin degradation products, are released into the circulation. Through this system, clots are dissolved as tissue is repaired, and the vascular system returns to its normal baseline state.

### Gerontologic Considerations

In elderly patients, the bone marrow's ability to respond to the body's need for blood cells (erythrocytes, leukocytes, and platelets) may be decreased. This decreased ability is a result of many factors, including diminished production of the growth factors necessary for hematopoiesis by stromal cells within the marrow or a diminished response to the growth factors (in the case of erythropoietin). In addition, in elderly patients, the bone marrow may be more susceptible to the myelosuppressive effects of medications. As a result of these factors, when an elderly person needs more blood cells, the bone marrow may not be able to increase production of these cells adequately. **Leukopenia** (a decreased number of circulating leukocytes) or anemia can result.

## *Assessment and Diagnostic Evaluation*

Most hematologic diseases reflect a defect in the hematopoietic, hemostatic, or reticuloendothelial system. The defect can be quantitative (eg, increased or decreased production of cells), qualitative (eg, the cells that are produced are defective in their normal functional capacity), or both. Initially, many hematologic conditions cause few symptoms. Therefore, extensive laboratory tests are often required to diagnose a hematologic disorder. For most hematologic conditions, continued monitoring via specific blood tests is required because it is very important to assess for changes in test results over time. In general, it is important to assess trends in test results because these trends help the clinician decide whether the patient is responding appropriately to interventions.

### Hematologic Studies

The most common tests used are the complete blood count (CBC) and the peripheral blood smear (see Appendix A). The CBC identifies the total number of blood cells (leukocytes, erythrocytes, and platelets) as well as the hemoglobin, **hematocrit** (percentage of blood volume consisting of erythrocytes), and RBC indices. Because cellular morphology (shape and appearance of the cells) is particularly important in accurately diagnosing most hematologic disorders, the blood cells involved must be examined. This process is referred to as the manual examination of the peripheral smear, which may be part of the CBC. In this test, a drop of blood is spread on a glass slide, stained, and examined under a microscope. The shape and size of the erythrocytes and platelets, as well as the actual appearance of the leukocytes, provide useful information in identifying

hematologic conditions. Blood for the CBC is typically obtained by venipuncture.

### Bone Marrow Aspiration and Biopsy

The bone marrow aspiration and biopsy are crucial when additional information is needed to assess how a person's blood cells are being formed and to assess the quantity and quality of each type of cell produced within the marrow. These tests are also used to document infection or tumor within the marrow.

Normal bone marrow is in a semifluid state and can be aspirated through a special large needle. In adults, bone marrow is usually aspirated from the iliac crest and occasionally from the sternum. The aspirate provides only a sample of cells. Aspirate alone may be adequate for evaluating certain conditions, such as anemia. However, when more information is required, a biopsy is also performed. Biopsy samples are taken from the posterior iliac crest; occasionally, an anterior approach is required. A marrow biopsy shows the architecture of the bone marrow as well as its degree of cellularity.

Most patients need no more preparation than a careful explanation of the procedure, but for some very anxious patients, an antianxiety agent may be useful. It is always important for the physician or nurse to describe and explain to the patient the procedure and the sensations that will be experienced. The risks, benefits, and alternatives are also discussed. A signed informed consent is needed before the procedure is performed.

Before aspiration, the skin is cleansed using aseptic technique. Then a small area is anesthetized with a local anesthetic agent through the skin and subcutaneous tissue to the periosteum of the bone. It is not possible to anesthetize the bone itself. The bone marrow needle is introduced with a stylet in place. When the needle is felt to go through the outer cortex of bone and enter the marrow cavity, the stylet is removed, a syringe is attached, and a small volume (5 mL) of blood and marrow is aspirated. Patients typically feel a pressure sensation as the needle is advanced into position. The actual aspiration always causes sharp but brief pain, resulting from the suction exerted as the marrow is aspirated into the syringe; the patient should be warned about this. Taking deep breaths or using relaxation techniques often helps ease the discomfort.

If a bone marrow biopsy is necessary, it is best performed after the aspiration and in a slightly different location, because the marrow structure may be altered after aspiration. A special biopsy needle is used. Because these needles are large, the skin may be punctured first with a surgical blade to make a 3- or 4-mm incision. The biopsy needle is advanced well into the marrow cavity. When the needle is properly positioned, a portion of marrow is cored out. The patient feels a pressure sensation but should not feel actual pain. The nurse should instruct the patient to inform the physician if pain occurs so that an additional anesthetic agent can be administered.

Hazards of either bone marrow aspiration or biopsy include bleeding and infection. The risk of bleeding is somewhat increased if the patient's platelet count is low or if the patient has been taking a medication (eg, aspirin) that alters platelet function. After the marrow sample is obtained, pressure is applied to the site for several minutes. The site is then covered with a sterile dressing. Most patients have no discomfort after a bone marrow aspiration, but the site of a biopsy may ache for 1 or 2 days. Warm tub baths and a mild analgesic agent (eg, acetaminophen [Tylenol]) may be useful. Aspirin-containing analgesic agents should be avoided because they can aggravate or potentiate bleeding.

## ANEMIA

Anemia is a condition in which the hemoglobin concentration is lower than normal; it reflects the presence of fewer than the normal number of erythrocytes within the circulation. As a result, the amount of oxygen delivered to body tissues is also diminished. Anemia is not a specific disease state but a sign of an underlying disorder. It is by far the most common hematologic condition.

### Classification of Anemias

Anemia may be classified in several ways (Table 33-2). A physiologic approach classifies anemia according to whether the deficiency in erythrocytes is caused by a defect in their production (hypoproliferative anemia), by their destruction (hemolytic anemia), or by their loss (bleeding).

In hypoproliferative anemias, the marrow cannot produce adequate numbers of erythrocytes. Decreased erythrocyte production is reflected by an inappropriately normal or low reticulocyte count. Inadequate production of erythrocytes may result from marrow damage due to medications (eg, chloramphenicol) or chemicals (eg, benzene) or from a lack of factors (eg, iron, vitamin $B_{12}$, folic acid, erythropoietin) necessary for erythrocyte formation.

In hemolytic anemias, premature destruction of erythrocytes results in the liberation of hemoglobin from the erythrocytes into the plasma; the released hemoglobin is converted in large part to bilirubin and therefore, the bilirubin concentration rises. The increased erythrocyte destruction leads to tissue hypoxia, which in turn stimulates erythropoietin production. This increased production is reflected in an increased reticulocyte count as the bone marrow responds to the loss of erythrocytes. Hemolysis can result from an abnormality within the erythrocyte itself (eg, sickle cell anemia, glucose-6-phosphate dehydrogenase [G-6-PD] deficiency) or within the plasma (eg, immune hemolytic anemias), or from direct injury to the erythrocyte within the circulation (eg, hemolysis caused by mechanical heart valve). Chart 33-1 identifies causes of hemolytic anemia.

It is usually possible to determine whether the presence of anemia in a given patient is caused by destruction or by inadequate production of erythrocytes on the basis of the following factors:

- The marrow's ability to respond to decreased erythrocytes (as evidenced by an increased reticulocyte count in the circulating blood)
- The degree to which young erythrocytes proliferate in the bone marrow and the manner in which they mature (as observed on bone marrow biopsy)
- The presence or absence of end products of erythrocyte destruction within the circulation (eg, increased bilirubin level, decreased **haptoglobin** level)

**Table 33-2 CLASSIFICATION OF ANEMIAS**

| Type of Anemia | Laboratory Findings |
|---|---|
| **Hypoproliferative (Resulting From Defective RBC Production)** | |
| Iron deficiency | Decreased reticulocytes, iron, ferritin, iron saturation, MCV; increased TIBC |
| Vitamin $B_{12}$ deficiency (megaloblastic) | Decreased vitamin $B_{12}$ level; increased MCV |
| Folate deficiency (megaloblastic) | Decreased folate level; increased MCV |
| Decreased erythropoietin production (eg, from renal dysfunction) | Decreased erythropoietin level; normal MCV and MCH; increased creatinine level (likely) |
| Cancer/inflammation | Normal MCV, MCH; normal or decreased erythropoietin level; increased % of iron saturation, ferritin level; decreased iron, TIBC |
| **Bleeding (Resulting From RBC Loss)** | |
| Bleeding from gastrointestinal tract, epistaxis (nosebleed), trauma, bleeding from genitourinary tract (eg, menorrhagia) | Increased reticulocyte level; normal Hgb and Hct if measured soon after bleeding starts, but levels decrease thereafter; normal MCV initially but later decreases; decreased ferritin and iron levels (later) |
| **Hemolytic (Resulting From RBC Destruction)** | |
| Altered erythropoiesis (sickle cell anemia, thalassemia, other hemoglobinopathies) | Decreased MCV; fragmented RBCs; increased reticulocyte level |
| Hypersplenism (hemolysis) | Increased MCV |
| Drug-induced anemia | Increased spherocyte level |
| Autoimmune anemia | Increased spherocyte level |
| Mechanical heart valve–related anemia | Fragmented red cells |

Hct, hematocrit; Hgb, hemoglobin concentration; MCH, mean corpuscular hemoglobin; MCV, mean corpuscular volume; RBCs, red blood cells; TIBC, total iron-binding capacity.

## Clinical Manifestations

Aside from the severity of the anemia itself, several factors influence the development of anemia-associated symptoms: the rapidity with which the anemia has developed, the duration of the anemia (ie, its chronicity), the metabolic requirements of the patient, other concurrent disorders or disabilities (eg, cardiac or pulmonary disease), and complications or concomitant features of the condition that produced the anemia.

In general, the more rapidly an anemia develops, the more severe its symptoms. An otherwise healthy person can often tolerate as much as a 50% gradual reduction in hemoglobin without pronounced symptoms or significant incapacity, whereas the rapid loss of as little as 30% may precipitate profound vascular collapse in the same person. A person who has become gradually anemic, with hemoglobin levels between 9 and 11 g/dL, usually has few or no symptoms other than slight tachycardia on exertion and fatigue.

People who customarily are very active or who have significant demands on their lives (eg, a single, working mother of small children) are more likely to have symptoms, and those symptoms are more likely to be pronounced than in more sedentary people. Patients with hypothyroidism with decreased oxygen needs may be completely asymptomatic, without tachycardia or increased cardiac output, at a hemoglobin level of 10 g/dL. Similarly, patients with coexistent cardiac, vascular, or pulmonary disease may develop more pronounced symptoms of anemia (eg, dyspnea, chest pain, muscle pain or cramping) at a higher hemoglobin level than those without these concurrent health problems.

Finally, some anemias are complicated by various other abnormalities that do not result from the anemia but are inherently associated with these particular diseases. These abnormalities may give rise to symptoms that completely overshadow those of the anemia, as in the painful crises of sickle cell anemia.

### Chart 33-1 • *Causes of Hemolytic Anemias*

**Inherited Hemolytic Anemia**

- Abnormal hemoglobin
  - Sickle cell anemia*
  - Thalassemia*
- Red blood cell membrane abnormality
  - Hereditary spherocytosis*
  - Hereditary elliptocytosis
  - Acanthocytosis
  - Stomatocytosis
- Enzyme deficiencies
  - Glucose-6-phosphate dehydrogenase (G-6-PD) deficiency*

**Acquired Hemolytic Anemia**

- Antibody related
  - Iso-antibody/transfusion reaction*
  - Autoimmune hemolytic anemia (AIHA)*
  - Cold agglutinin disease
- Not antibody related
  - Red blood cell membrane defects
  - Paroxysmal nocturnal hemoglobinuria (PNH)
  - Liver disease
  - Uremia
  - Trauma
  - Mechanical heart valve
  - Microangiopathic hemolytic anemia
  - Infection
    - Bacterial
    - Parasitic
  - Disseminated intravascular coagulation (DIC)*
  - Toxins
  - Hypersplenism*

*Discussed in text.

## Assessment and Diagnostic Findings

A variety of hematologic studies are performed to determine the type and cause of the anemia. In an initial evaluation, the hemoglobin, hematocrit, reticulocyte count, and RBC indices, particularly the mean corpuscular volume (MCV) and red cell distribution width (RDW), are particularly useful. Iron studies (serum iron level, total iron-binding capacity [TIBC], percent saturation, and ferritin), as well as serum vitamin $B_{12}$ and folate levels, are also frequently obtained. Other tests include haptoglobin and erythropoietin levels. The remaining CBC values are useful in determining whether the anemia is an isolated problem or part of another hematologic condition, such as leukemia or myelodysplastic syndrome (MDS). Bone marrow aspiration may be performed. In addition, other diagnostic studies may be performed to determine the presence of underlying chronic illness, such as malignancy, or the source of any blood loss, such as polyps or ulcers within the GI tract.

## Complications

General complications of severe anemia include heart failure, paresthesias, and delirium. Patients with underlying heart disease are far more likely to have angina or symptoms of heart failure than those without heart disease. Complications associated with specific types of anemia are included in the description of each type.

## Medical Management

Management of anemia is directed toward correcting or controlling the cause of the anemia; if the anemia is severe, the erythrocytes that are lost or destroyed may be replaced with a transfusion of packed red blood cells (PRBCs). The management of the various types of anemia is covered in the discussions that follow.

## Gerontologic Considerations

Anemia is the most common hematologic condition affecting elderly patients. A systematic review has found that anemia affects 40% of elderly patients admitted to hospitals and 47% of elderly patients in long-term care facilities (Gaskell, Derry, Moore, et al., 2008). In the population at large, anemia occurs in 26% of men and 20% of women older than 85 years of age (Steensma & Tefferi, 2007). The impact of anemia on function is significant. A review among the elderly has noted that increased fragility, decreased mobility and exercise performance, increased risk of falling, diminished cognitive function, increased risk of developing dementia and major depression, and lower skeletal muscle and bone density are associated with anemia (Steensma &Tefferi, 2007).

# NURSING PROCESS

## The Patient With Anemia

### Assessment

The health history and physical examination provide important data about the type of anemia involved, the extent and type of symptoms it produces, and the impact of those symptoms on the patient's life. Weakness, fatigue, and general malaise are common, as are pallor of the skin and mucous membranes (conjunctivae, oral mucosa).

Jaundice may be present in patients with megaloblastic anemia or hemolytic anemia. The tongue may be smooth and red (in iron deficiency anemia) or beefy red and sore (in megaloblastic anemia); the corners of the mouth may be ulcerated **(angular cheilosis)** in both types of anemia. People with iron deficiency anemia may crave ice, starch, or dirt; this craving is known as pica. The nails may be brittle, ridged, and concave.

The health history should include a medication history, because some medications can depress bone marrow activity, induce hemolysis, or interfere with folate metabolism. An accurate history of alcohol intake, including the amount and duration, should be obtained. Family history is important, because certain anemias are inherited. It is necessary to ask about athletic endeavors, because extreme exercise can decrease erythropoiesis and erythrocyte survival.

A nutritional assessment is important, because it may indicate deficiencies in essential nutrients such as iron, vitamin $B_{12}$, and folic acid. Children of indigent families may be at higher risk for anemia because of nutritional deficiencies. Strict vegetarians are also at risk for megaloblastic types of anemia if they do not supplement their diet with vitamin $B_{12}$. The elderly also may have a diminished intake of vitamin $B_{12}$ or folate.

Cardiac status should be carefully assessed. When the hemoglobin level is low, the heart attempts to compensate by pumping faster and harder in an effort to deliver more blood to hypoxic tissue. This increased cardiac workload can result in such symptoms as tachycardia, palpitations, dyspnea, dizziness, orthopnea, and exertional dyspnea. Heart failure may eventually develop, as evidenced by an enlarged heart (cardiomegaly) and liver (hepatomegaly) and by peripheral edema.

Assessment of the GI system may disclose complaints of nausea, vomiting (with specific questions about the appearance of any emesis [eg, looks like "coffee grounds"]), melena or dark stools, diarrhea, anorexia, and glossitis (inflammation of the tongue). Stools should be tested for occult blood. Women should be questioned about their menstrual periods (eg, excessive menstrual flow, other vaginal bleeding) and the use of iron supplements during pregnancy.

Neurologic examination is also important because pernicious anemia affects the central and peripheral nervous systems. Assessment should include the presence and extent of peripheral numbness and paresthesias, ataxia, poor coordination, and confusion. Delirium can sometimes result from other types of anemia, particularly in the elderly. Finally, it is important to monitor relevant laboratory test results and to note any changes over time.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses for the patient with anemia may include:

- Fatigue related to decreased hemoglobin and diminished oxygen-carrying capacity of the blood

- Altered nutrition, less than body requirements, related to inadequate intake of essential nutrients
- Altered tissue perfusion related to inadequate hemoglobin and hematocrit
- Noncompliance with prescribed therapy

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include:

- Heart failure
- Angina
- Paresthesias
- Confusion

### Planning and Goals

The major goals for the patient may include decreased fatigue, attainment or maintenance of adequate nutrition, maintenance of adequate tissue perfusion, compliance with prescribed therapy, and absence of complications.

### Nursing Interventions

#### *Managing Fatigue*

The most common symptom and complication of anemia is fatigue. Fatigue is often the symptom that has the greatest negative impact on a patient's level of functioning and consequent quality of life. Therefore, it should not be minimized. Patients often describe the fatigue from anemia as oppressive. Fatigue can be significant, yet the anemia may not be severe enough to warrant transfusion. Fatigue can interfere with a person's ability to work and to participate in activities with family and friends. Patients often lose interest in hobbies and activities, including sexual activity. The distress from fatigue is often related to a person's responsibilities and life demands as well as the amount of assistance and support received from others.

Nursing interventions can focus on assisting the patient to prioritize activities and to establish a balance between activity and rest that is acceptable to the patient. Patients with chronic anemia need to maintain some physical activity and exercise to prevent the deconditioning that results from inactivity.

#### *Maintaining Adequate Nutrition*

Inadequate intake of essential nutrients, such as iron, vitamin $B_{12}$, folic acid, and protein, can cause some anemias. The symptoms associated with anemia (eg, fatigue, anorexia) can in turn interfere with maintaining adequate nutrition. A healthy diet should be encouraged. The nurse should inform the patient that alcohol interferes with the utilization of essential nutrients and should advise the patient to avoid or limit his or her intake of alcoholic beverages. Dietary teaching sessions should be individualized, involve family members, and include cultural aspects related to food preferences and food preparation. Dietary supplements (eg, vitamins, iron, folate, protein) may be prescribed.

Equally important, the patient and family must understand the role of nutritional supplements in the proper context, because many forms of anemia are not the result of a nutritional deficiency. In such cases, even an excessive intake of nutritional supplements will not improve the anemia. A potential problem in patients with chronic transfusion requirements occurs with the indiscriminate use of iron supplements. Unless an aggressive program of chelation therapy is implemented, these people are at risk for iron overload from their transfusions. The addition of an iron supplement only exacerbates the situation.

#### *Maintaining Adequate Perfusion*

Patients with acute blood loss or severe hemolysis may have decreased tissue perfusion from decreased blood volume or reduced circulating erythrocytes (decreased hematocrit). Lost volume is replaced with transfusions or intravenous (IV) fluids, based on symptoms and laboratory test results. Supplemental oxygen may be necessary, but it is rarely needed on a long-term basis unless there is underlying severe cardiac or pulmonary disease. The nurse monitors the patient's vital signs and pulse oximeter readings closely; other medications, such as antihypertensive agents, may need to be adjusted or withheld.

#### *Promoting Compliance With Prescribed Therapy*

For patients with anemia, medications or nutritional supplements are often prescribed to treat the condition. These patients need to understand the purpose of the medication, how to take the medication and over what time period, and how to manage any side effects of therapy. To enhance compliance, the nurse assists the patient to develop ways to incorporate the therapeutic plan into everyday activities, rather than merely giving the patient a list of instructions. For example, many patients have difficulty taking iron supplements because of related GI effects. Rather than seeking assistance from a health care provider in managing the problem, some patients simply stop taking the iron.

Abruptly stopping some medications can have serious consequences, as in the case of high-dose corticosteroids to manage hemolytic anemias. Some medications, such as growth factors, are extremely expensive. Patients receiving these medications may need assistance to obtain needed insurance coverage or to explore alternative ways to obtain these medications.

#### *Monitoring and Managing Potential Complications*

A significant complication of anemia is heart failure from chronic diminished blood volume and the heart's compensatory effort to increase cardiac output. Patients with anemia should be assessed for signs and symptoms of heart failure (see Chapter 30).

In megaloblastic forms of anemia, the significant potential complications are neurologic. A neurologic assessment should be performed for patients with known or suspected megaloblastic anemia. Patients may initially complain of paresthesias in their lower extremities. These paresthesias are usually manifested as numbness and tingling on the bottom of the foot, and they gradually progress. As the anemia progresses, other signs become apparent. Position and vibration sense may be diminished; difficulty maintaining balance is not uncommon, and some patients have gait disturbances as well. Initially mild confusion may develop; it may become severe.

## Evaluation

### *Expected Patient Outcomes*

1. Reports less fatigue
   a. Follows a progressive plan of rest, activity, and exercise
   b. Prioritizes activities
   c. Paces activities according to energy level
2. Attains and maintains adequate nutrition
   a. Eats a healthy diet
   b. Develops a meal plan that promotes optimal nutrition
   c. Maintains adequate amounts of iron, vitamins, and protein from diet or supplements
   d. Adheres to nutritional supplement therapy when prescribed
   e. Verbalizes understanding of rationale for using recommended nutritional supplements
   f. Verbalizes understanding of rationale for avoiding nonrecommended nutritional supplements
3. Maintains adequate perfusion
   a. Has vital signs within baseline for patient
   b. Has pulse oximetry (arterial oxygenation) value within normal limits
4. Absence of complications
   a. Avoids or limits activities that cause dyspnea, palpitations, dizziness, or tachycardia
   b. Uses rest and comfort measures to alleviate dyspnea
   c. Has vital signs within baseline for patient
   d. Has no signs of increasing fluid retention (eg, peripheral edema, decreased urine output, neck vein distention)
   e. Remains oriented to time, place, and situation
   f. Ambulates safely, using assistive devices as necessary
   g. Remains free of injury
   h. Verbalizes understanding of importance of serial CBC measurements
   i. Maintains safe home environment; obtains assistance as necessary

# *Hypoproliferative Anemias*

## IRON DEFICIENCY ANEMIA

Iron deficiency anemia typically results when the intake of dietary iron is inadequate for hemoglobin synthesis. The body can store about one fourth to one third of its iron, and it is not until those stores are depleted that iron deficiency anemia actually begins to develop. Iron deficiency anemia is the most common type of anemia in all age groups, and it is the most common anemia in the world. It is particularly prevalent in developing countries, where inadequate iron stores can result from inadequate intake of iron (seen with vegetarian diets) or from blood loss (eg, from intestinal hookworm). Iron deficiency is also common among adults in the United States and the most common cause is blood loss. In fact, the cause of iron deficiency anemia should be considered to be bleeding until proven otherwise.

The most common cause of iron deficiency anemia in men and postmenopausal women is bleeding from ulcers, gastritis, inflammatory bowel disease, or GI tumors. The most common causes of iron deficiency anemia in premenopausal women are menorrhagia (ie, excessive menstrual bleeding) and pregnancy with inadequate iron supplementation. Patients with chronic alcoholism often have chronic blood loss from the GI tract, which causes iron loss and eventual anemia. Other causes include iron malabsorption, as is seen after gastrectomy or with celiac disease.

### Clinical Manifestations

Patients with iron deficiency primarily have symptoms of anemia. If the deficiency is severe or prolonged, they may also have a smooth, sore tongue; brittle and ridged nails; and angular cheilosis. These signs subside after iron replacement therapy. The health history may be significant for multiple pregnancies, GI bleeding, and pica.

### Assessment and Diagnostic Findings

The definitive method of establishing the diagnosis of iron deficiency anemia is bone marrow aspiration. The aspirate is stained to detect iron, which is at a low level or even absent. However, few patients with suspected iron deficiency anemia undergo bone marrow aspiration. In many patients, the diagnosis can be established with other tests, particularly in patients with a history of conditions that predispose them to this type of anemia.

There is a strong correlation between laboratory values that measure iron stores and hemoglobin levels. After iron stores are depleted (as reflected by low serum ferritin levels), the hemoglobin level falls. The diminished iron stores cause small erythrocytes to be produced by the marrow. Therefore, as the anemia progresses, the MCV, which measures the size of the erythrocytes, also decreases. Hematocrit and RBC levels are also low in relation to the hemoglobin level. Other laboratory tests that measure iron stores are useful but are not as consistent indicators as a low ferritin level, which reflects low iron stores. Typically, patients with iron deficiency anemia have a low serum iron level and an elevated TIBC, which measures the transport protein supplying the marrow with iron as needed (also referred to as transferrin). However, other disease states, such as infection and inflammatory conditions, can also cause a low serum iron level and TIBC, as well as an elevated ferritin level. Currently, the most reliable and clinically useful laboratory findings in evaluating iron deficiency anemia are the ferritin and hemoglobin values.

### Medical Management

Except in the case of pregnancy, the cause of iron deficiency should be investigated. Anemia may be a sign of a curable GI cancer or of uterine fibroid tumors. Stool specimens should be tested for occult blood. People 50 years of age or older should have periodic colonoscopy, endoscopy, or x-ray examination of the GI tract to detect ulcerations, gastritis, polyps, or cancer (U.S. Preventive Services Task Force, 2008). Several oral iron preparations—ferrous sulfate, ferrous gluconate, and ferrous fumarate—are available for treating iron deficiency anemia. The hemoglobin level may increase in only a few weeks, and the anemia can be

corrected in a few months. Iron store replenishment takes much longer, so it is important that the patient continue taking the iron for as long as 6 to 12 months.

In some cases, oral iron is poorly absorbed or poorly tolerated, or iron supplementation is needed in large amounts. In these situations, IV or, infrequently, intramuscular (IM) administration of iron may be needed. Before parenteral administration of a full dose, a small test dose should be administered parenterally to avoid the risk of anaphylaxis. Emergency medications (eg, epinephrine) should be close at hand. If no signs of allergic reaction have occurred after 30 minutes, the remaining dose of iron may be administered. Newer formulations of iron are associated with a lower incidence of anaphylaxis and test doses may not be necessary. Several doses are required to replenish the patient's iron stores.

## Nursing Management

Preventive education is important, because iron deficiency anemia is common in menstruating and pregnant women. Food sources high in iron include organ meats (eg, beef or calf's liver, chicken liver), other meats, beans (eg, black, pinto, and garbanzo), leafy green vegetables, raisins, and molasses. Taking iron-rich foods with a source of vitamin C (eg, orange juice) enhances the absorption of iron.

The nurse helps the patient select a healthy diet. Nutritional counseling can be provided for those whose usual diet is inadequate. Patients with a history of eating fad diets or strict vegetarian diets are counseled that such diets often contain inadequate amounts of absorbable iron. The nurse encourages the patient to continue iron therapy as long as it is prescribed, although the patient may no longer feel fatigued.

Because iron is best absorbed on an empty stomach, the patient is instructed to take the supplement an hour before meals. Iron supplements are usually given in the oral form, typically as ferrous sulfate. Most patients can use the less expensive, more standard forms of ferrous sulfate. Tablets with enteric coating may be poorly absorbed and should be avoided. Many patients have difficulty tolerating iron supplements because of GI side effects (primarily constipation, but also cramping, nausea, and vomiting). Some iron formulations are designed to limit GI side effects by the addition of a stool softener or use of sustained-release formulations to limit nausea or gastritis. Specific patient teaching aids (Chart 33-2) can assist patients with the use of iron supplements.

If taking iron on an empty stomach causes gastric distress, the patient may need to take it with meals. However, doing so diminishes iron absorption by as much as 50%, thus prolonging the time required to replenish iron stores. Antacids or dairy products should not be taken with iron, because they greatly diminish its absorption. Polysaccharide iron complex forms are also available; they have less GI toxicity but are more expensive.

Liquid forms of iron that cause less GI distress are available. However, they can stain the teeth; the patient should be instructed to take this medication through a straw, to rinse the mouth with water, and to practice good oral hygiene after taking this medication. Finally, the patient should be informed that iron salts may color the stool dark green or black. However, iron replacement therapy does not cause a false-positive result on stool analyses for occult blood.

IV supplementation may be used when the patient's iron stores are completely depleted, the patient cannot tolerate oral forms of iron supplementation (see Medical Management), or both. The volume of iron required when IM administration is used may be excessive, causing some local pain and possibly staining the skin. These side effects are minimized by using the Z-track technique for administering iron dextran deep into the gluteus maximus muscle (buttock). The nurse avoids vigorously rubbing the injection site after the injection. Because of the problems with IM administration, the IV route is preferred when oral administration is not possible.

**CHART 33-2 PATIENT EDUCATION**

***Taking Oral Iron Supplements***

- Take iron on an empty stomach (1 hour before or 2 hours after a meal). Iron absorption is reduced with food, especially dairy products.
- To prevent gastrointestinal distress, the following schedule may work better if more than one tablet a day is prescribed: Start with only one tablet per day for a few days, then increase to two tablets per day, then three tablets per day. This method permits the body to adjust gradually to the iron.
- Increase the intake of vitamin C (citrus fruits and juices, strawberries, tomatoes, broccoli), to enhance iron absorption.
- Eat foods high in fiber to minimize problems with constipation.
- Remember that stools will become dark in color.
- To prevent staining the teeth with a liquid preparation, use a straw or place a spoon at the back of the mouth to take the supplement. Rinse the mouth thoroughly afterward.

## ANEMIAS IN RENAL DISEASE

The degree of anemia in patients with end-stage renal disease varies greatly, but in general patients do not become significantly anemic until the serum creatinine level exceeds 3 mg/100 mL. The symptoms of anemia are often the most disturbing of the patient's symptoms. If untreated, the hematocrit usually falls to between 20% and 30%, although in rare cases it may fall to less than 15%. The erythrocytes are normal in appearance.

This anemia is caused by both a mild shortening of erythrocyte lifespan and a deficiency of erythropoietin (necessary for erythropoiesis). As renal function decreases, erythropoietin, which is produced by the kidney, also decreases. Because erythropoietin is also produced outside the kidney, some erythropoiesis continues, even in patients whose kidneys have been removed. However, the number of RBCs produced is small, and the degree of erythropoiesis is inadequate.

Patients undergoing long-term hemodialysis lose blood into the dialyzer and therefore may become iron deficient. Folic acid deficiency develops because this vitamin passes

into the dialysate. Therefore, patients who receive hemodialysis and who have anemia should be evaluated for iron and folate deficiency and treated appropriately.

The availability of recombinant erythropoietin (epoetin alfa [Epogen, Procrit], darbepoetin alfa [Aranesp]) has dramatically altered the management of anemia in end-stage renal disease by decreasing the need for RBC transfusion, with its associated risks. Erythropoietin, in combination with oral iron supplements, can raise and maintain hematocrit levels significantly. Recent data suggest that targeting too high a hemoglobin level (above 13 g/dL) may lead to increased risk of heart failure, heart attack, or stroke (Saingh, Sczczech, Tang, et al., 2006). The National Kidney Foundation has modified its anemia management guidelines to allow titration of the erythropoietin dose to maintain the hemoglobin level between 11 and 12 g/dL, not to exceed 13 g/dL (Fishbane & Nissenson, 2007). Therefore, the hemoglobin should be checked frequently and the dose of erythropoietin titrated to maintain an appropriate hemoglobin level.

## ANEMIA OF CHRONIC DISEASE

The term *anemia of chronic disease* is a misnomer in that only the chronic diseases of inflammation, infection, and malignancy cause this type of anemia. Many chronic inflammatory diseases are associated with a **normochromic, normocytic** anemia (ie, the erythrocytes are normal in color and size). These disorders include rheumatoid arthritis; severe, chronic infections; and many cancers. It is therefore imperative that the "chronic disease" be diagnosed when this form of anemia is identified so that it can be appropriately managed.

The anemia is usually mild to moderate and nonprogressive. It develops gradually over 6 to 8 weeks and then stabilizes at a hematocrit seldom less than 25%. The hemoglobin level rarely falls below 9 g/dL, and the bone marrow has normal cellularity with increased stores of iron as the iron is diverted from the serum. Erythropoietin levels are low, perhaps because of decreased production, and iron use is blocked by **erythroid cells** (cells that are or will become mature erythrocytes). A moderate shortening of erythrocyte survival also occurs.

Most of these patients have few symptoms and do not require treatment for the anemia. With successful treatment of the underlying disorder, the bone marrow iron is used to make erythrocytes and the hemoglobin level rises. These patients do not benefit from additional iron supplementation.

## APLASTIC ANEMIA

Aplastic anemia is a rare disease caused by a decrease in or damage to marrow stem cells, damage to the microenvironment within the marrow, and replacement of the marrow with fat. The precise etiology is unknown, but it is hypothesized that the body's T cells mediate an inappropriate attack against the bone marrow (Young, Calado & Scheinberg, 2006), resulting in bone marrow **aplasia** (ie, markedly reduced hematopoiesis). Therefore, in addition to severe anemia, significant **neutropenia** and thrombocytopenia (ie, a deficiency of platelets) also occur.

### Pathophysiology

Aplastic anemia can be congenital or acquired, but most cases are idiopathic (ie, without apparent cause). Infections and pregnancy can trigger it, or it may be caused by certain medications, chemicals, or radiation damage. Agents that may produce marrow aplasia include benzene and benzene derivatives (eg, airplane glue, paint remover, dry-cleaning solutions). Certain toxic materials, such as inorganic arsenic, glycol ethers, plutonium, and radon, have also been implicated as potential causes.

### Clinical Manifestations

The manifestations of aplastic anemia are often insidious. Complications resulting from bone marrow failure may occur before the diagnosis is established. Typical complications are infection and the symptoms of anemia (eg, fatigue, pallor, dyspnea). Purpura (bruising) may develop later and should trigger a CBC and hematologic evaluation if these were not performed initially. If the patient has had repeated throat infections, cervical lymphadenopathy may be seen. Other lymphadenopathies and splenomegaly sometimes occur. Retinal hemorrhages are common.

### Assessment and Diagnostic Findings

In many situations, aplastic anemia occurs when a medication or chemical is ingested in toxic amounts. However, in a few people, it develops after a medication has been taken at the recommended dosage. This may be considered an idiosyncratic reaction in those who are highly susceptible, possibly caused by a genetic defect in the medication biotransformation or elimination process. A bone marrow aspirate shows an extremely hypoplastic or even aplastic (very few to no cells) marrow replaced with fat.

### Medical Management

It is presumed that the lymphocytes of patients with aplastic anemia destroy the stem cells and consequently impair the production of erythrocytes, leukocytes, and platelets. Despite its severity, aplastic anemia can be treated in most people. Those who are younger than 60 years, who are otherwise healthy, and who have a compatible donor can be cured of the disease by a bone marrow transplant (BMT) or peripheral blood stem cell transplant (PBSCT). In others, the disease can be managed with immunosuppressive therapy, commonly using a combination of antithymocyte globulin (ATG) and cyclosporine or androgens. ATG, a purified gamma-globulin solution, is obtained from horses or rabbits immunized with human T lymphocytes. Side effects during the infusion are common and may include fever and chills. The sudden onset of a rash or bronchospasm may herald anaphylaxis and requires prompt management (see Chapters 53 and 71). Serum sickness, as evidenced by fever, rash, arthralgias, and pruritus, may develop in some patients; it may take weeks to resolve. A study of almost 1000 patients showed that those over the age of 16, those treated with immunosuppressive therapy other than ATG and cyclosporine, and those whose interval between diagnosis and treatment exceeded 23 days had a poor overall prognosis (Locasciulli, Oneto, Bacigalupo, et al., 2007).

Immunosuppressants prevent the patient's lymphocytes from destroying the stem cells. If relapse occurs (ie, the patient

becomes pancytopenic again), reinstitution of the same immunologic agents may induce another remission. Corticosteroids are not very useful as immunosuppressive agents, because patients with aplastic anemia are particularly susceptible to the development of bone complications from corticosteroids (eg, aseptic necrosis of the head of the femur).

Supportive therapy plays a major role in the management of aplastic anemia. Any offending agent is discontinued. The patient is supported with transfusions of PRBCs and platelets as necessary. Death usually is caused by hemorrhage or infection.

## Nursing Management

Patients with aplastic anemia are vulnerable to problems related to erythrocyte, leukocyte, and platelet deficiencies. They should be assessed carefully for signs of infection and bleeding. Specific interventions are delineated in the sections on neutropenia and thrombocytopenia. Nurses must also monitor for side effects of therapy, particularly for hypersensitivity reaction while administering ATG. If patients require long-term cyclosporine therapy, they should be monitored for long-term effects, including renal or liver dysfunction, hypertension, pruritus, visual impairment, tremor, and skin cancer. They should also be informed that the metabolism of ATG is altered by many other medications; thus, each new prescription needs careful assessment for drug–drug interactions. Patients also need to understand the importance of not abruptly stopping their immunosuppressive therapy.

# MEGALOBLASTIC ANEMIAS

In the anemias caused by deficiencies of vitamin $B_{12}$ or folic acid, identical bone marrow and peripheral blood changes occur because both vitamins are essential for normal DNA synthesis. In either anemia, the erythrocytes that are produced are abnormally large and are called megaloblastic red cells. Other cells derived from the myeloid stem cell (nonlymphoid leukocytes, platelets) are also abnormal. A bone marrow analysis reveals hyperplasia (abnormal increase in the number of cells), and the precursor erythroid and myeloid cells are large and bizarre in appearance. However, many of these abnormal erythroid and myeloid cells are destroyed within the marrow, so the mature cells that do leave the marrow are actually fewer in number. Thus, **pancytopenia** (a decrease in all myeloid-derived cells) can develop. In advanced stages of disease, the hemoglobin value may be as low as 4 to 5 g/dL, the leukocyte count 2000 to 3000/$mm^3$, and the platelet count less than 50,000/$mm^3$. Those cells that are released into the circulation are often abnormally shaped. The neutrophils are hypersegmented. The platelets may be abnormally large. The erythrocytes are abnormally shaped, and the shapes may vary widely **(poikilocytosis).** Because the erythrocytes are very large, the MCV is very high, usually exceeding 110 $\mu m^3$.

## Pathophysiology

### *Folic Acid Deficiency*

Folic acid is stored as compounds referred to as folates. The folate stores in the body are much smaller than those of vitamin $B_{12}$, and they are quickly depleted when the dietary intake of folate is deficient (within 4 months). Folate is found in green vegetables and liver. Folate deficiency occurs in people who rarely eat uncooked vegetables. Alcohol increases folic acid requirements, and at the same time patients with alcoholism usually have a diet that is deficient in the vitamin. Folic acid requirements are also increased in patients with chronic hemolytic anemias and in women who are pregnant, because the need for erythrocyte production is increased in these conditions. Some patients with malabsorptive diseases of the small bowel, such as sprue, may not absorb folic acid normally.

### *Vitamin $B_{12}$ Deficiency*

A deficiency of vitamin $B_{12}$ can occur in several ways. Inadequate dietary intake is rare but can develop in strict vegetarians who consume no meat or dairy products. Faulty absorption from the GI tract is more common. This occurs in conditions such as Crohn's disease, or after ileal resection or gastrectomy. Another cause is the absence of intrinsic factor, as in pernicious anemia. Intrinsic factor is normally secreted by cells within the gastric mucosa; it binds with dietary vitamin $B_{12}$ and travels with it to the ileum, where the vitamin is absorbed. Without intrinsic factor, orally consumed vitamin $B_{12}$ cannot be absorbed, and erythrocyte production is eventually diminished. Even if adequate vitamin $B_{12}$ and intrinsic factor are present, a deficiency may occur if disease involving the ileum or pancreas impairs absorption. Pernicious anemia, which tends to run in families, is primarily a disorder of adults, particularly the elderly.

The body normally has large stores of vitamin $B_{12}$, so years may pass before the deficiency results in anemia. Because the body compensates so well, the anemia can be severe before the patient becomes symptomatic. Patients with pernicious anemia have a higher incidence of gastric cancer than the general population; these patients should have endoscopies at regular intervals (every 1 to 2 years) to screen for early gastric cancer.

## Clinical Manifestations

Symptoms of folic acid and vitamin $B_{12}$ deficiencies are similar, and the two anemias may coexist. However, the neurologic manifestations of vitamin $B_{12}$ deficiency do not occur with folic acid deficiency, and they persist if vitamin $B_{12}$ is not replaced. Therefore, careful distinction between the two anemias must be made. Serum levels of both vitamins can be measured. In the case of folic acid deficiency, even small amounts of folate increase the serum folate level, sometimes to normal. Measuring the amount of folate within the red cell itself (red cell folate) is therefore a more sensitive test in determining true folate deficiency.

After the body stores of vitamin $B_{12}$ are depleted, the patient may begin to show signs and symptoms of the anemia. However, because the onset and progression of the anemia are so gradual, the body can compensate very well until the anemia is severe, so that the typical manifestations of anemia (weakness, listlessness, fatigue) may not be apparent initially. The hematologic effects of deficiency are accompanied by effects on other organ systems, particularly the GI tract and nervous system. Patients with pernicious anemia develop a smooth, sore, red tongue and mild diarrhea. They are extremely pale, particularly in the mucous membranes.

They may become confused; more often they have paresthesias in the extremities (particularly numbness and tingling in the feet and lower legs). They may have difficulty maintaining their balance because of damage to the spinal cord, and they also lose position sense (proprioception). These symptoms are progressive, although the course of illness may be marked by spontaneous partial remissions and exacerbations. Without treatment, patients can die after several years, usually from heart failure secondary to anemia.

### Assessment and Diagnostic Findings

The classic method of determining the cause of vitamin $B_{12}$ deficiency is the Schilling test, in which the patient receives a small oral dose of radioactive vitamin $B_{12}$, followed in a few hours by a large, nonradioactive parenteral dose of vitamin $B_{12}$ (this aids in renal excretion of the radioactive dose). If the oral vitamin is absorbed, more than 8% is excreted in the urine within 24 hours; therefore, if no radioactivity is present in the urine (ie, the radioactive vitamin $B_{12}$ stays within the GI tract), the cause is GI malabsorption of the vitamin $B_{12}$. Conversely, if radioactivity is detected in the urine, the cause of the deficiency is not ileal disease or pernicious anemia. Later, the same procedure is repeated, but this time intrinsic factor is added to the oral radioactive vitamin $B_{12}$. If radioactivity is now detected in the urine (ie, the vitamin $B_{12}$ was absorbed from the GI tract in the presence of intrinsic factor), the diagnosis of pernicious anemia can be made. The Schilling test is useful only if the urine collections are complete; therefore, the nurse must promote the patient's understanding and compliance with this collection.

Other methods of establishing the diagnosis may be used. Although it is possible to measure methylmalonic acid levels in vitamin $B_{12}$ deficiency, these levels also increase in the setting of renal insufficiency. Furthermore, it is expensive to measure these levels, which also limits the utility of the test. A more useful, easier test is the intrinsic factor antibody test. A positive test indicates the presence of antibodies that bind the vitamin $B_{12}$–intrinsic factor complex and prevent it from binding to receptors in the ileum, thus preventing its absorption. Although this test is not specific for pernicious anemia alone, it can aid in the diagnosis.

### Medical Management

Folate deficiency is treated by increasing the amount of folic acid in the diet and administering 1 mg of folic acid daily. Folic acid is administered intramuscularly only to people with malabsorption problems. Although many multivitamin preparations now contain folic acid, additional supplements may be necessary because the amount may be inadequate to fully replace deficient body stores. Patients with alcoholism should receive folic acid as long as they continue to consume alcohol.

Vitamin $B_{12}$ deficiency is treated by vitamin $B_{12}$ replacement. Vegetarians can prevent or treat deficiency with oral supplements with vitamins or fortified soy milk. When the deficiency is due to the more common defect in absorption or the absence of intrinsic factor, replacement is by monthly IM injections of vitamin $B_{12}$. A small amount of an oral dose of vitamin $B_{12}$ can be absorbed by passive diffusion, even in the absence of intrinsic factor, but large doses (2 mg/day) are required if vitamin $B_{12}$ is to be replaced orally.

As vitamin $B_{12}$ is replaced, the reticulocyte count rises within 1 week, and in several weeks the blood counts are all normal. The tongue feels better and appears less red in several days. However, the neurologic manifestations require more time for recovery; if there is severe neuropathy, the patient may never recover fully. To prevent recurrence of pernicious anemia, vitamin $B_{12}$ therapy must be continued for life.

### Nursing Management

Assessment of patients who have or are at risk for megaloblastic anemia includes inspection of the skin, mucous membranes, and tongue. Mild jaundice may be apparent and is best seen in the sclera without using fluorescent lights. Vitiligo (patchy loss of skin pigmentation) and premature graying of the hair are often seen in patients with pernicious anemia. Because of the neurologic complications associated with these anemias, a careful neurologic assessment is important, including tests of position and vibration sense.

The nurse needs to pay particular attention to ambulation and should assess the patient's gait and stability as well as the need for assistive devices (eg, canes, walkers) and for assistance in managing daily activities. Of particular concern is ensuring safety when position sense, coordination, and gait are affected. Physical and occupational therapy referrals may be needed. If sensation is altered, the patient needs to be instructed to avoid excessive heat and cold.

Because mouth and tongue soreness may limit nutritional intake, the nurse advises the patient to eat small amounts of bland, soft foods frequently. The nurse also may explain that other nutritional deficiencies, such as alcohol-induced anemia, can induce neurologic problems.

#### *Promoting Home and Community-Based Care*

The patient must be taught about the chronicity of the disorder and the need for monthly vitamin $B_{12}$ injections or daily oral vitamin $B_{12}$ even in the absence of symptoms. If parenteral replacement is used, many patients can be taught to self-administer their injections. The gastric atrophy associated with pernicious anemia increases the risk for gastric carcinoma, so the patient needs to understand that ongoing medical follow-up and screening are important.

## MYELODYSPLASTIC SYNDROME

Myelodysplastic syndrome (MDS) is a group of disorders of the myeloid stem cell that causes dysplasia (abnormal development) in one or more types of cell lines. The most common feature of MDS—dysplasia of the erythrocytes—is manifested as a macrocytic anemia; however, the leukocytes (myeloid cells, particularly neutrophils) and platelets can also be affected. Although the bone marrow is actually hypercellular, many of the cells within it die before being released into the circulation. Therefore, the actual number of cells in the circulation is typically lower than normal. In addition to the quantitative defect (ie, fewer cells than normal), there is also a qualitative defect: the cells do not function normally. The neutrophils have diminished ability

to destroy bacteria by phagocytosis; platelets are less able to aggregate and are less adhesive than usual. The result of these qualitative defects is an increased risk of infection and bleeding, even when the actual number of circulating cells may not be excessively low.

Primary MDS tends to be a disease of people older than 60 years of age. Because the initial findings are so subtle, the disease may not be diagnosed until later in the illness trajectory, if at all. Thus, the actual incidence of MDS is not known.

Secondary MDS can occur at any age and result from prior toxic exposure to chemicals, including chemotherapeutic medications (particularly alkylating agents). Secondary MDS tends to have a poorer prognosis than does primary MDS. Thirty percent of MDS cases evolve into acute myeloid leukemia (AML); this type of leukemia tends to be resistant to standard therapy.

## Clinical Manifestations

The manifestations of MDS can vary widely. Many patients are asymptomatic, with the illness being discovered incidentally when a CBC is performed for other purposes. Other patients have profound symptoms and complications from the illness. Fatigue is often present, at varying levels. Neutrophil dysfunction puts the person at risk for recurrent pneumonias and other infections. Because platelet function can also be altered, bleeding can occur. These problems may persist in a fairly steady state for months, even years. They may also progress over time; as the dysplasia evolves into a leukemic state, the complications increase in severity.

## Assessment and Diagnostic Findings

The CBC typically reveals a macrocytic anemia; leukocyte and platelet counts may be diminished as well. Serum erythropoietin levels and the reticulocyte count may be inappropriately low. If the disease evolves into AML, more immature blast cells are noted on the CBC.

The official diagnosis of MDS is based on the results of a bone marrow aspiration and biopsy. Cytogenetic analysis of the bone marrow is important in determining the overall prognosis, risk of evolution into AML, and method of treatment.

## Medical Management

Allogeneic BMT is the only cure for MDS. Traditionally, chemotherapy has been used, particularly in patients with more aggressive forms of the illness, but with disappointing results (Kantarjian, O'Brien, Huang, et al., 2007). Lenalidomide (Revlimid), azacitidine (Vidaza), and decitabine (Dacogen) have demonstrated promise in treating various subtypes of MDS (Demakos & Linebaugh, 2005; Giagounidis, Germing & Aul, 2007; Plimack, Kantarjian & Issa, 2007). Effective treatment can reduce dependence on transfusions and improve symptoms associated with the disease if patients are in remission (Thomas, 2007). Patients with hypocellular marrows may respond well to immunosuppressive therapy using ATG (Lim, Killick, Germing, et al., 2007).

For most patients with MDS, transfusions of RBCs may be required to control the anemia and its symptoms. These patients can develop iron overload from the repeated transfusions; this risk can be diminished with prompt initiation of chelation therapy (see Nursing Management). In 20% of patients, the use of erythropoietin can be successful in reducing the need for transfusions and their complications. A recent meta-analysis has suggested that treatment with a specific synthetic form of erythropoietin, darbepoetin alfa (Aranesp), may increase hemoglobin levels (Ross, Allen, Probst, et al., 2007). Some patients may require ongoing platelet transfusions to prevent significant bleeding. Over time, these patients often have suboptimal increases in the platelet count after platelets are transfused. Infections need to be managed aggressively and promptly. The administration of granulocyte colony-stimulating factor (G-CSF) may be useful in some patients with infections and severe neutropenia.

Because MDS tends to occur in elderly people, other concurrent chronic conditions may limit treatment options. Secondary MDS and MDS that evolves into AML tend to be refractory to conventional therapy for leukemia.

## Nursing Management

Caring for patients with MDS can be challenging because the illness is unpredictable. As with other hematologic conditions, some patients (especially those with no symptoms) have difficulty perceiving that they have a serious illness that can place them at risk of life-threatening complications. At the other extreme, many patients have tremendous difficulty coping with the uncertain trajectory of the illness and fear that the illness will evolve into AML. Thus, it is important for patients to understand their unique risk of the disease transforming to AML and to recognize that MDS is a chronic illness.

Patients with MDS need extensive instruction about infection risk, measures to avoid it, signs and symptoms of developing infection, and appropriate actions to take should such symptoms occur. Instruction should also be given regarding the risk of bleeding. Patients with MDS who are hospitalized may require neutropenic precautions.

Laboratory values need to be monitored closely to anticipate the need for transfusion and to determine response to treatment with growth factors. Patients with chronic transfusion requirements often benefit from the insertion of a vascular access device for this purpose. Patients receiving growth factors or chelation therapy need instruction about these medications, their side effects, and administration techniques, if self-administered.

Chelation therapy is a process that is used to remove excess iron acquired from chronic transfusions. Iron is bound to a substance, the chelating agent, and then excreted in the urine. Because chelation therapy removes only a small amount of iron with each treatment, patients with chronic transfusion requirements (and iron overload) need to continue chelation therapy as long as the iron overload exists, potentially for the rest of their lives. Renal and liver dysfunction are possible, so serum creatinine and liver function tests should be monitored and the medication held until the laboratory results return to baseline; the medication is typically resumed at a reduced dose. Patients should also have baseline and annual auditory and eye examinations, because hearing loss and visual changes can occur with chelation treatment.

## Hemolytic Anemias

In hemolytic anemias, the erythrocytes have a shortened lifespan; thus, their number in the circulation is reduced. Fewer erythrocytes result in decreased available oxygen, causing hypoxia, which in turn stimulates an increase in erythropoietin release from the kidney. The erythropoietin stimulates the bone marrow to compensate by producing new erythrocytes and releasing some of them into the circulation somewhat prematurely as reticulocytes. If the red cell destruction persists, the hemoglobin is broken down excessively; about 80% of the heme is converted to bilirubin, conjugated in the liver, and excreted in the bile.

The mechanism of erythrocyte destruction varies, but all types of hemolytic anemia share certain laboratory features: The reticulocyte count is elevated, the fraction of indirect (unconjugated) bilirubin is increased, and the supply of haptoglobin (a binding protein for free hemoglobin) is depleted as more hemoglobin is released. As a result, the plasma haptoglobin level is low. If the marrow cannot compensate to replace the erythrocytes (indicated by a decreased reticulocyte count), the anemia will progress.

Hemolytic anemia has various forms. Inherited forms include sickle cell anemia, thalassemia and thalassemia major, G-6-PD deficiency, and hereditary spherocytosis. Acquired forms include autoimmune hemolytic anemia, non–immune-mediated paroxysmal nocturnal hemoglobinuria, microangiopathic hemolytic anemia, and heart valve hemolysis, as well as anemias associated with hypersplenism.

### SICKLE CELL ANEMIA

Sickle cell anemia is a severe hemolytic anemia that results from inheritance of the sickle hemoglobin gene. This gene causes the hemoglobin molecule to be defective. The sickle hemoglobin (HbS) acquires a crystal-like formation when exposed to low oxygen tension. The oxygen level in venous blood can be low enough to cause this change; consequently, the erythrocyte containing HbS loses its round, pliable, biconcave disk shape and becomes deformed, rigid, and sickle shaped (Fig. 33-4). These long, rigid erythrocytes can adhere to the endothelium of small vessels; when they adhere to each other, blood flow to a region or an organ may be reduced. If ischemia or infarction results, the patient may have pain, swelling, and fever. The sickling process takes time; if the erythrocyte is again exposed to adequate amounts of oxygen (eg, when it travels through the pulmonary circulation) before the membrane becomes too rigid, it can revert to a normal shape. For this reason, the "sickling crises" are intermittent. Cold can aggravate the sickling process, because vasoconstriction slows the blood flow. Oxygen delivery can also be impaired by an increased blood viscosity, with or without occlusion due to adhesion of sickled cells; in this situation, the effects are seen in larger vessels, such as arterioles.

The *HbS* gene is inherited in people of African descent and to a lesser extent in people from the Middle East, the Mediterranean area, and aboriginal tribes in India. Sickle cell anemia is the most severe form of sickle cell disease. Less severe forms include sickle cell hemoglobin C (SC) disease, sickle cell hemoglobin D (SD) disease, and sickle cell beta-thalassemia. The clinical manifestations and management are the same as for sickle cell anemia. The term *sickle cell trait* refers to the carrier state for SC diseases; it is the most benign type of SC disease, in that less than 50% of the hemoglobin within an erythrocyte is HbS. However, if two people with sickle cell trait have children, the children may inherit two abnormal genes and will have sickle cell anemia. (Refer to Chapter 9 for additional discussion of genetic diseases.)

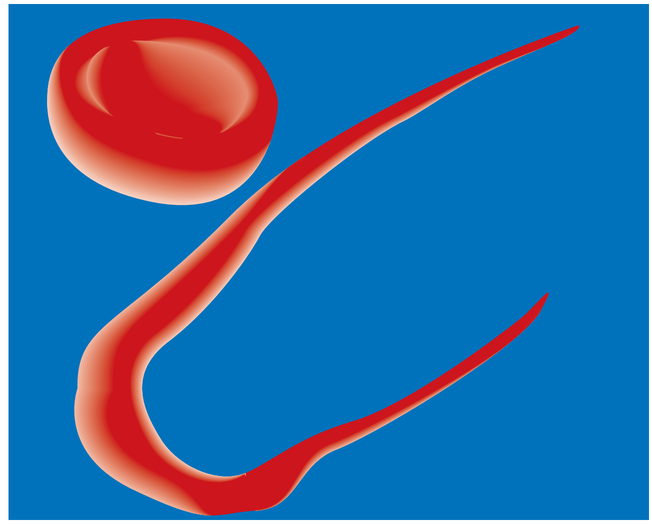


**Figure 33-4** A normal red blood cell (*upper left*) and a sickled red blood cell.

#### Clinical Manifestations

Symptoms of sickle cell anemia vary and are only somewhat based on the amount of HbS. Symptoms and complications result from chronic hemolysis or thrombosis. Sickled cells are rapidly hemolyzed and thus have a very short lifespan (10 to 12 days). Anemia is always present; usually hemoglobin values are 7 to 10 g/dL. Jaundice is characteristic and is usually obvious in the sclerae. The bone marrow expands in childhood in a compensatory effort to offset the anemia, sometimes leading to enlargement of the bones of the face and skull. The chronic anemia is associated with tachycardia, cardiac murmurs, and often an enlarged heart (cardiomegaly). Dysrhythmias and heart failure may occur in adults.

Virtually any organ may be affected by thrombosis, but the primary sites involve those areas with slower circulation, such as the spleen, lungs, and central nervous system. All the tissues and organs are vulnerable to microcirculatory interruptions by the sickling process and therefore are susceptible to hypoxic damage or ischemic necrosis. Patients with sickle cell anemia are unusually susceptible to infection, particularly pneumonia and osteomyelitis. Complications of sickle cell anemia include infection, stroke, renal failure, impotence, heart failure, and pulmonary hypertension (Table 33-3).

##### *Sickle Cell Crisis*

There are three types of sickle cell crisis in the adult population. The most common is the very painful *sickle crisis*, which results from tissue hypoxia and necrosis due to inadequate

**Table 33-3 COMPLICATIONS IN SICKLE CELL ANEMIA***

| Organ Involved | Mechanisms* | Diagnostic Findings | Signs and Symptoms |
|---|---|---|---|
| Spleen | Primary site of sickling → infarctions → ↓ phagocytic function of macrophages | Autosplenectomy; ↑ infection (esp. pneumonia, osteomyelitis) | Abdominal pain; fever, signs of infection |
| Lungs | Infection<br>Infarction → ↑ pulmonary pressure → pulmonary hypertension | Pulmonary infiltrate<br>↑ $sPLA_2$[†] | Chest pain; dyspnea |
| Central nervous system | Infarction | Cerebral vascular accident (stroke) | Weakness (if severe); learning difficulties (if mild) |
| Kidney | Sickling → damage to renal medulla | Hematuria; inability to concentrate urine; renal failure | Dehydration |
| Heart | Anemia | Tachycardia; cardiomegaly → heart failure | Weakness, fatigue, dyspnea |
| Bone | ↑ Erythroid production | Widening of medullary spaces and cortical thinning | Ache, arthralgias |
| | Infarction of bone | Osteosclerosis → avascular necrosis | Bone pain, especially hips |
| Liver | Hemolysis | Jaundice and gallstone formation; hepatomegaly | Abdominal pain |
| Skin and peripheral vasculature | ↑ Viscosity/stasis → infarction → skin ulcers | Skin ulcers; ↓ wound healing | Pain |
| Eye | Infarction | Scarring, hemorrhage, retinal detachment | ↓ Vision; blindness |
| Penis | Sickling → vascular thrombosis | Priapism → impotence | Pain, impotence |

*Problems encountered in sickle cell anemia vary and are the result of a variety of mechanisms, as depicted in this table. Common physical findings and symptoms are also variable.
[†]$sPLA_2$: Secretory phospholipase $A_2$, a laboratory test that can predict impending acute chest syndrome (see text).

blood flow to a specific region of tissue or organ. *Aplastic crisis* results from infection with the human parvovirus. The hemoglobin level falls rapidly and the marrow cannot compensate, as evidenced by an absence of reticulocytes. *Sequestration crisis* results when other organs pool the sickled cells. Although the spleen is the most common organ responsible for sequestration in children, most children with sickle cell anemia have had a splenic infarction by 10 years of age, and the spleen is then no longer functional (autosplenectomy). In adults, the common organs involved in sequestration are the liver and, more seriously, the lungs.

### Acute Chest Syndrome

Acute chest syndrome is manifested by fever, cough, tachycardia, and new infiltrates seen on the chest x-ray. These signs often mimic infection, which is often the cause. However, the infectious etiology appears to be atypical bacteria such as *Chlamydia pneumoniae* and *Mycoplasma pneumoniae* as well as viruses such as respiratory syncytial virus (RSV) and parvovirus (Melton & Haynes, 2006). Other causes include pulmonary fat embolism, pulmonary infarction, and pulmonary thromboembolism. Increased secretory phospholipase $A_2$ concentration has been identified as a predictor of impending acute chest syndrome; the increased amounts of free fatty acids can cause increased permeability of the pulmonary endothelium and leakage of the pulmonary capillaries (Styles, Abboud, Larkin, et al., 2007). Although this syndrome can progress to acute respiratory distress syndrome and death, prompt and aggressive intervention can result in a favorable outcome.

### Pulmonary Hypertension

Pulmonary hypertension is a common sequela of sickle cell disease, and often the cause of death (Darbari, Kple-Faget, Kwagyan, et al., 2006). Diagnosing pulmonary hypertension is difficult because clinical symptoms rarely occur until damage is irreversible. Pulse oximetry measurements are typically normal, and breath sounds are clear to auscultation until the disease has progressed to later stages. Although changes are not evident on chest x-ray, computed tomography (CT) of the chest often demonstrates microvascular pulmonary occlusion and diminished perfusion of the lung. The diagnosis of pulmonary hypertension is elusive, but screening patients with sickle cell disease with Doppler echocardiography is useful in identifying patients with elevated pulmonary artery pressures (Lee, Rosenzweig & Cairo, 2007; Hagar, Michlitsch, Gardner, et al., 2008).

## Assessment and Diagnostic Findings

The patient with sickle cell trait usually has a normal hemoglobin level, a normal hematocrit, and a normal blood smear. In contrast, the patient with sickle cell anemia has a low hematocrit and sickled cells on the smear. The diagnosis is confirmed by hemoglobin electrophoresis.

## Prognosis

Patients with sickle cell anemia are usually diagnosed in childhood, because they become anemic in infancy and begin to have sickle cell crises at 1 or 2 years of age. Some children die in the first years of life, typically of infection, but antibiotic use and parent teaching strategies have greatly improved the outcomes for these children. However, with current management strategies, the average life expectancy is still suboptimal, at 42 to 48 years. Young adults are often forced to live with multiple, often severe, complications from their disease. In some patients, the symptoms and complications diminish by 30 years of age; these patients live into the sixth decade or longer. Currently, there is no way to predict which patients will fall into this subgroup.

## Medical Management

Treatment for sickle cell anemia is the focus of continued research. However, aside from the equally important aggressive management of symptoms and complications, there are currently few primary treatment modalities for sickle cell diseases.

### Peripheral Blood Stem Cell Transplant

PBSCT may cure sickle cell anemia. However, this treatment modality is available to only a small subset of affected patients, because of either the lack of a compatible donor or because severe organ damage (eg, renal, liver, lung) that may be already present in the patient is a contraindication for PBSCT.

### Pharmacologic Therapy

Hydroxyurea (Hydrea), a chemotherapy agent, has been shown to be effective in increasing fetal hemoglobin (ie, hemoglobin F) levels in patients with sickle cell anemia, thereby decreasing the formation of sickled cells. Patients who receive hydroxyurea appear to have fewer painful episodes of sickle cell crisis, a lower incidence of acute chest syndrome, and less need for transfusions. However, whether hydroxyurea can prevent or reverse actual organ damage remains unknown. Side effects of hydroxyurea include chronic suppression of leukocyte formation, teratogenesis, and potential for later development of a malignancy. Patient response to this agent varies significantly. The incidence and severity of side effects are also highly variable within a dose range. Some patients have toxicity with a very small dose (5 mg/kg/day), whereas others have little toxicity with a much higher dose (35 mg/kg/day).

Arginine has antisickling properties and enhances the availability of nitric oxide, the most potent vasodilator, resulting in decreased pulmonary artery pressure. Arginine may be useful in managing pulmonary hypertension and acute chest syndrome (Benza, 2008; Melton & Haynes, 2006).

### Transfusion Therapy

RBC transfusions have been shown to be highly effective in several situations: in an acute exacerbation of anemia (eg, aplastic crisis), in the prevention of severe complications from anesthesia and surgery, in improving the response to infection (when it results in exacerbated anemia), and in severe cases of acute chest syndrome (Melton & Haynes, 2006). Transfusions are also effective in diminishing episodes of sickle cell crisis in pregnant women, but this does not improve fetal survival. Chronic transfusion therapy may be effective in preventing or managing complications from sickle cell disease, including stroke, chronic heart failure, and pulmonary hypertension (Mehta, Afenyi-Annan, Burns, et al., 2006).

The risk of complications from transfusion is important to consider. These risks include iron overload, which necessitates chelation therapy (see Myelodysplastic Syndrome, Nursing Management); poor venous access, which necessitates a vascular access device (and its attendant risk of infection or thrombosis); infections (hepatitis, human immunodeficiency virus [HIV]); and especially alloimmunization (an immune response to antigens from donor cells) from repeated transfusions. Another complication from transfusion is increased blood viscosity without reduction in the concentration of hemoglobin S. Exchange transfusion (in which the patient's own blood is removed and replaced via transfusion) may be performed to diminish the risk of increasing the viscosity excessively; the objective is to reduce the hematocrit to less than 30%, with transfusions supplying more than 80% of the patient's blood volume. Finally, it is important to consider the significant financial cost of an aggressive transfusion and chelation program.

Patients with sickle cell anemia require daily folic acid replacements to maintain the supply required for increased erythropoiesis from hemolysis. Infections must be treated promptly with appropriate antibiotics; infection, particularly pneumococcal infection, remains a major cause of death. These patients should receive pneumococcal and annual influenza vaccinations (Mehta, et al., 2006).

Acute chest syndrome is managed by prompt initiation of antibiotic therapy. Incentive spirometry has been shown to decrease the incidence of pulmonary complications significantly. In severe cases, bronchoscopy may be required to identify the source of pulmonary disease. Hydration is important but must be carefully monitored. Corticosteroids may also be useful. Transfusions reverse the hypoxia and decrease the level of secretory phospholipase $A_2$. Pulmonary function should be monitored regularly to detect pulmonary hypertension early, when therapy (hydroxyurea, arginine, transfusions, or BMT) may have a positive impact.

Because repeated blood transfusions are necessary, patients may develop multiple autoantibodies, making cross-matching difficult. In this patient population, a hemolytic transfusion reaction (see later discussion) may mimic the signs and symptoms of a sickle cell crisis. The classic distinguishing factor is that with a hemolytic transfusion reaction, the patient becomes *more* anemic after being transfused. These patients need very close observation. Further transfusion is avoided if possible until the hemolytic process abates. If possible, the patient is supported with corticosteroids (prednisone), IV immunoglobulin (IVIG), and erythropoietin (Epogen).

### Supportive Therapy

Supportive care is equally important. Pain management is a significant issue. The incidence of painful sickle cell crises is highly variable; many patients have pain on a daily basis. The severity of the pain may not be enough to cause the patient to seek assistance from health care providers but severe enough to interfere with the ability to work and function within the family unit. Acute pain episodes tend to be self-limited, lasting hours to days. If the patient cannot manage the pain at home, intervention is frequently sought in an urgent care facility or emergency department. Adequate hydration is important during a painful sickling episode. Oral hydration is acceptable if the patient can maintain adequate fluid intake; IV hydration with dextrose 5% in water ($D_5W$) or dextrose 5% in 0.25 normal saline solution (3 $L/m^2$/24 hours) is usually required for sickle crisis. Supplemental oxygen may also be needed.

The use of medication to relieve pain is important (see Chapter 13 for a discussion of pain management). Aspirin is very useful in diminishing mild to moderate pain; it also diminishes inflammation and potential thrombosis (due to its ability to decrease platelet adhesion). Nonsteroidal anti-inflammatory drugs (NSAIDs) are useful for moderate pain or in combination with opioid analgesics. Although no tolerance develops with NSAIDs, a "ceiling effect" does develop whereby an increase in dosage does not increase

analgesia. NSAID use must be carefully monitored, because these medications can precipitate renal dysfunction. When opioid analgesic agents are used, morphine is the medication of choice for acute pain. Patient-controlled analgesia (PCA) is frequently used. A study of 19 patients hospitalized with 25 episodes of sickle crisis found that daily pain rating scores were comparable in those receiving morphine by PCA versus by continuous infusion (van Beers, van Tuijn, Nieuwkerk, et al., 2007). In addition, patients in the PCA group used less opioids, had fewer side effects (nausea and constipation), and had shorter hospital stays.

Chronic pain increases in incidence as the patient ages and is caused by continued complications (eg, avascular necrosis of the hip) from the sickling. With chronic pain management, the principal goal is to maximize functioning; pain may not be completely eliminated without sacrificing function. This concept may be difficult for patients to accept; they may need repeated explanations and support from nonjudgmental health care providers. Nonpharmacologic approaches to pain management are crucial in this setting. Examples include physical and occupational therapy, physiotherapy (including the use of heat, massage, and exercise), cognitive and behavioral intervention (including distraction, relaxation, and motivational therapy), and support groups.

Working with patients who have multiple episodes of severe pain can be challenging. It is important for health care providers to realize that patients with sickle cell disease must face a lifelong experience with severe and unpredictable pain. Such pain is disruptive to the patient's level of functioning, including social functioning, and may result in a feeling of helplessness. Patients with inadequate social support systems may have more difficulty coping with chronic pain.

## NURSING PROCESS

## The Patient With Sickle Cell Crisis

### Assessment

The patient is asked to identify factors that precipitated previous crises and measures he or she uses to prevent and manage crises. Pain levels should always be monitored using a pain intensity scale, such as a 0-to-10 scale. The quality of the pain (eg, sharp, dull, burning), the frequency of the pain (constant versus intermittent), and factors that aggravate or alleviate the pain are included in this assessment. If a sickle cell crisis is suspected, the nurse needs to determine whether the pain currently experienced is the same as or different from the pain typically encountered in crisis.

Because the sickling process can interrupt circulation in any tissue or organ, with resultant hypoxia and ischemia, a careful assessment of all body systems is necessary. Particular emphasis is placed on pain, swelling, and fever. All joint areas are carefully examined for pain and swelling. The abdomen is assessed for pain and tenderness because of the possibility of splenic infarction.

The cardiopulmonary systems must be assessed carefully, including auscultation of breath sounds, measurement of oxygen saturation levels, and signs of cardiac failure, such as the presence and extent of dependent edema, an increased point of maximal impulse (PMI), and cardiomegaly (as seen on a chest x-ray). The patient is assessed for signs of dehydration by a history of fluid intake and careful examination of mucous membranes, skin turgor, urine output, and serum creatinine and blood urea nitrogen (BUN) values.

A careful neurologic examination is important to elicit symptoms of cerebral hypoxia. However, ischemic findings on magnetic resonance imaging (MRI) or Doppler studies may precede findings on the physical examination. MRI and Doppler studies are used for early diagnosis and may result in improved patient outcome because therapy can be initiated promptly.

Because patients with sickle cell anemia are susceptible to infections, they are assessed for the presence of any infectious process. Particular attention is given to examination of the chest, long bones, and femoral head, because pneumonia and osteomyelitis are especially common. Leg ulcers, which may be infected and slow to heal, are common.

The extent of anemia and the ability of the marrow to replenish erythrocytes are assessed by the hemoglobin level, hematocrit, and reticulocyte counts, and they are compared with the patient's baseline values. The patient's current and past history of medical management is also obtained, particularly chronic transfusion therapy, hydroxyurea use, and prior treatment for infection.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses for the patient with sickle cell crisis may include:

- Acute pain related to tissue hypoxia due to agglutination of sickled cells within blood vessels
- Risk for infection
- Risk for powerlessness related to illness-induced helplessness
- Deficient knowledge regarding sickle crisis prevention

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include:

- Hypoxia, ischemia, infection, and poor wound healing leading to skin breakdown and ulcers
- Dehydration
- Cerebrovascular accident (CVA, brain attack, stroke)
- Anemia
- Acute and chronic renal failure
- Heart failure, pulmonary hypertension, and acute chest syndrome
- Impotence
- Poor compliance
- Substance abuse related to poorly managed chronic pain

### Planning and Goals

The major goals for the patient are relief of pain, decreased incidence of crisis, enhanced sense of self-esteem and power, and absence of complications.

## Nursing Interventions

### *Managing Pain*

Acute pain during a sickle cell crisis can be severe and unpredictable. The patient's subjective description and rating of pain on a pain scale must guide the use of analgesic agents. Any joint that is acutely swollen should be supported and elevated until the swelling diminishes. Relaxation techniques, breathing exercises, and distraction are helpful for some patients. After the acute painful episode has diminished, aggressive measures should be implemented to preserve function. Physical therapy, whirlpool baths, and transcutaneous electrical nerve stimulation (TENS) are examples of such modalities.

### *Preventing and Managing Infection*

Nursing care focuses on monitoring patients for signs and symptoms of infection. Prescribed antibiotics should be initiated promptly, and patients should be assessed for signs of dehydration. If patients are to take prescribed oral antibiotics at home, they must understand the importance of completing the entire course of antibiotic therapy.

### *Promoting Coping Skills*

This illness frequently leaves the patient feeling powerless and with decreased self-esteem because its acute exacerbations often result in chronic health problems. These feelings can be exacerbated by inadequate pain management, and enhancing pain management can be extremely useful in establishing a therapeutic relationship based on mutual trust. Nursing care that focuses on the patient's strengths rather than deficits can enhance effective coping skills. Providing the patient with opportunities to make decisions about daily care may increase the patient's feelings of control. The patient needs to understand the rationale for and importance of compliance with a therapeutic medication regimen.

### *Minimizing Deficient Knowledge*

Patients with sickle cell anemia benefit from understanding what situations can precipitate a sickle cell crisis and the steps they can take to prevent or diminish such crises. Keeping warm and maintaining adequate hydration can be effective in diminishing the occurrence and severity of attacks.

If hydroxyurea is prescribed for a woman of childbearing age, she should be told that the drug can cause congenital harm to unborn children and advised about pregnancy prevention.

### *Monitoring and Managing Potential Complications*

Management measures for many of the potential complications have been described in previous sections. Other measures follow.

**LEG ULCERS.** Leg ulcers require careful management and protection from trauma and contamination. Referral to a wound-ostomy-continence nurse (WOCN) may facilitate healing and assist with prevention. If leg ulcers fail to heal, skin grafting may be necessary. Scrupulous aseptic technique is warranted to prevent nosocomial infections.

**PRIAPISM LEADING TO IMPOTENCE.** Male patients may develop sudden, painful episodes of priapism (persistent penile erection). The patient is taught to empty his bladder at the onset of the attack, exercise, and take a warm bath. If an episode persists longer than 3 hours, medical attention, which consists of IV hydration, administration of analgesic agents, and possible penile intracavernosal aspiration, is recommended. Repeated episodes may lead to extensive vascular thrombosis, resulting in impotence.

**CHRONIC PAIN AND SUBSTANCE ABUSE.** Many patients have considerable difficulty coping with chronic pain and repeated episodes of sickle cell crisis and may find it difficult to adhere to a prescribed treatment plan. Some patients with sickle cell anemia develop problems with substance abuse. This results from inadequate management of acute pain during episodes of crisis, which then promotes mistrust of the health care system and (from the patient's perspective) the need to seek care from other sources. Prevention is the best way to manage this problem. Receiving care from a single provider over time is much more beneficial than receiving care from rotating physicians and staff in an emergency department. When crises occur, the staff in the emergency department should be in contact with the patient's primary health care provider so that optimal management can be achieved. An established pattern of substance abuse is very difficult to manage, but continuity of care and establishing written contracts with the patient can be useful.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Because patients with sickle cell anemia are typically diagnosed as children, parents participate in the initial education. As the child ages, educational interventions prepare the child to assume more responsibility for self-care. Most families can learn about vascular access device management and chelation therapy. Nurses in outpatient facilities or home care nurses may need to provide follow-up care for patients with vascular access devices.

**CONTINUING CARE.** The illness trajectory of sickle cell anemia is highly varied, with unpredictable episodes of complications and crises. Care is often provided on an emergency basis, especially for some patients with pain management problems (see previous section). All health care providers who provide services to patients with sickle cell disease and their families need to communicate regularly with each other. Patients need to learn which parameters are important for them to monitor and how to monitor them. Guidelines should also be given regarding when it is appropriate to seek urgent care.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Control of pain
   a. Uses analgesic agents to control acute pain
   b. Uses relaxation techniques, breathing exercises, and distraction to help relieve pain
2. Is free of infection
   a. Has normal temperature
   b. Has leukocyte count within normal range ($4500/mm^3$ to $11{,}000/mm^3$)

c. Identifies importance of continuing antibiotics at home (if applicable)
3. Expresses improved sense of control
   a. Participates in goal setting and in planning and implementing daily activities
   b. Participates in decisions about care
4. Increases knowledge about disease process
   a. Identifies situations and factors that can precipitate sickle cell crisis
   b. Describes lifestyle changes needed to prevent crisis
   c. Describes the importance of warmth, adequate hydration, and prevention of infection in preventing crisis
5. Absence of complications

## THALASSEMIA

The thalassemias are a group of hereditary anemias characterized by **hypochromia** (an abnormal decrease in the hemoglobin content of erythrocytes), extreme **microcytosis** (smaller-than-normal erythrocytes), destruction of blood elements (hemolysis), and variable degrees of anemia. The thalassemias occur worldwide, but the highest prevalence is found in people of Mediterranean, African, and Southeast Asian ancestry.

Thalassemias are associated with defective synthesis of hemoglobin; the production of one or more globulin chains within the hemoglobin molecule is reduced. When this occurs, the imbalance in the configuration of the hemoglobin causes it to precipitate in the erythroid precursors or the erythrocytes themselves. This increases the rigidity of the erythrocytes and thus the premature destruction of these cells.

Thalassemias are classified into two major groups according to which hemoglobin chain is diminished: alpha or beta. The alpha-thalassemias occur mainly in people from Asia and the Middle East, and the beta-thalassemias are most prevalent in people from Mediterranean regions but also occur in those from the Middle East or Asia. The alpha-thalassemias are milder than the beta forms and often occur without symptoms; the erythrocytes are extremely microcytic, but the anemia, if present, is mild.

The severity of beta-thalassemia varies depending on the extent to which the hemoglobin chains are affected. Patients with mild forms have microcytosis and mild anemia. If left untreated, severe beta-thalassemia (ie, thalassemia major or Cooley's anemia) can be fatal within the first few years of life. BMT offers a chance of cure, but when this is not possible, the disease is usually treated with transfusion of PRBCs. Patients may survive into their 50s. Patient teaching during the reproductive years should include preconception counseling about the risk of thalassemia major in offspring.

### *Thalassemia Major*

Thalassemia major is characterized by severe anemia, marked hemolysis, and ineffective erythropoiesis. With early regular transfusion therapy, growth and development through childhood are facilitated. Organ dysfunction due to iron overload results from the excessive amounts of iron in multiple PRBC transfusions. Regular chelation therapy can reduce the complications of iron overload and prolong the life of these patients. This disease is potentially curable by PBSCT if the procedure can be performed before liver damage occurs (ie, during childhood).

## GLUCOSE-6-PHOSPHATE DEHYDROGENASE DEFICIENCY

The G-6-PD gene is the source of the abnormality in this disorder; this gene produces an enzyme within the erythrocyte that is essential for membrane stability. A few patients have inherited an enzyme that is so defective that they have a chronic hemolytic anemia; however, the most common type of defect results in hemolysis only when the erythrocytes are stressed by certain situations, such as fever or the use of certain medications. African Americans and people of Greek or Italian origin are those primarily affected by this disorder. The type of deficiency found in the Mediterranean population is more severe than that in the African American population, resulting in greater hemolysis and sometimes in life-threatening anemia. All types of G-6-PD deficiency are inherited as X-linked defects; therefore, many more men are at risk than women. In the United States, about 12% of African American males are affected. The deficiency is also common in those of Asian ancestry and in certain Jewish populations.

Oxidant drugs have hemolytic effects for people with G-6-PD deficiency. These medications include antimalarial agents (eg, chloroquine [Aralen]), sulfonamides (eg, trimethoprim/sulfamethoxazole [Bactrim, Septra]), nitrofurantoin (eg, Macrodantin), dapsone, primaquine, phenazopyridine, chloramphenicol (Chloromycetin), and the street drug amyl nitrite ("poppers"). In affected people, a severe hemolytic episode can also result from ingestion of fava beans.

### Clinical Manifestations

Patients are asymptomatic and have normal hemoglobin levels and reticulocyte counts most of the time. However, several days after exposure to an offending medication, they may develop pallor, jaundice, and hemoglobinuria (hemoglobin in the urine). The reticulocyte count increases, and symptoms of hemolysis develop. Special stains of the peripheral blood may then disclose Heinz bodies (degraded hemoglobin) within the erythrocytes. Hemolysis is often mild and self-limited. However, in the more severe Mediterranean type of G-6-PD deficiency, spontaneous recovery may not occur.

### Assessment and Diagnostic Findings

The diagnosis is made by a screening test or by a quantitative assay of G-6-PD.

### Medical Management

The treatment is to arrest the source and stop the offending medication. Transfusion is necessary only in the severe hemolytic state, which is more commonly seen in the Mediterranean variety of G-6-PD deficiency.

### Nursing Management

Patients are educated about the disease and given a list of medications to avoid. If hemolysis develops, nursing interventions are the same as for hemolysis from other causes.

Patients should be instructed to wear MedicAlert bracelets that identify that they have G-6-PD deficiency. Genetic counseling may be indicated.

# IMMUNE HEMOLYTIC ANEMIA

Hemolytic anemias can result from exposure of the erythrocyte to antibodies. Alloantibodies (ie, antibodies against the host, or "self") result from the immunization of a person with foreign antigens (eg, the immunization of an Rh-negative person with Rh-positive blood). Alloantibodies tend to be large (IgM type) and cause immediate destruction of the sensitized erythrocytes, either within the blood vessel (intravascular hemolysis) or within the liver. An example of alloimmune hemolytic anemia in adults is anemia that results from a hemolytic transfusion reaction.

Autoantibodies may develop for many reasons. In many instances, the person's immune system is dysfunctional, so that it falsely recognizes its own erythrocytes as foreign and produces antibodies against them. This mechanism is seen in people with chronic lymphocytic leukemia (CLL). Another mechanism is a deficiency in suppressor lymphocytes, which normally prevent antibody formation against a person's own antigens. Autoantibodies tend to be of the IgG type. The erythrocytes are sequestered in the spleen and destroyed by the macrophages outside the blood vessel (extravascular hemolysis).

Autoimmune hemolytic anemias can be classified based on the body temperature involved when the antibodies react with the red blood cell antigen. Warm-body antibodies bind to erythrocytes most actively in warm conditions (37°C or 98.6°F); cold-body antibodies react in cold conditions (0°C or 32°F). Most autoimmune hemolytic anemias are the warm-body type. Autoimmune hemolytic anemia is associated with other disorders in most cases (eg, medication exposure, lymphoma, CLL, other malignancy, collagen vascular disease, autoimmune disease, infection). In idiopathic autoimmune hemolytic states, the reason why the immune system produces the antibodies is not known. This primary form affects patients of all ages and both genders equally, whereas the incidence of secondary forms is greater in people older than 45 years of age and in females.

## Clinical Manifestations

Clinical manifestations can vary, and they usually reflect the degree of anemia. The hemolysis may be very mild, so that the patient's marrow compensates adequately and the patient is asymptomatic. At the other extreme, the hemolysis can be so severe that the resultant anemia is life-threatening. Most patients complain of fatigue and dizziness. Splenomegaly is the most common physical finding, occurring in more than 80% of patients; hepatomegaly, lymphadenopathy, and jaundice are also common.

## Assessment and Diagnostic Findings

Laboratory tests show a low hemoglobin level and hematocrit, most often with an accompanying increase in the reticulocyte count. Erythrocytes appear abnormal; spherocytes are common. The serum bilirubin level is elevated, and if the hemolysis is severe, the haptoglobin level is low or absent. The Coombs test (also referred to as the direct antiglobulin test [DAT]), which detects antibodies on the surface of erythrocytes, shows a positive result.

## Medical Management

Any possible offending medication should be immediately discontinued. The treatment consists of high doses of corticosteroids until hemolysis decreases. Corticosteroids decrease the macrophage's ability to clear the antibody-coated erythrocytes. If the hemoglobin level returns toward normal, usually after several weeks, the corticosteroid dose can be lowered or, in some cases, tapered and discontinued. However, corticosteroids rarely produce a lasting remission. In severe cases, blood transfusions may be required. Because the antibody may react with all possible donor cells, careful blood typing is necessary, and the transfusion should be administered slowly and cautiously.

Splenectomy (ie, removal of the spleen) may be performed if corticosteroids do not produce a remission, because it removes the major site of erythrocyte destruction. If neither corticosteroid therapy nor splenectomy is successful, immunosuppressive agents may be administered. The two immunosuppressive agents most frequently used are cyclophosphamide (Cytoxan), which has a more rapid effect but more toxicity, and azathioprine (Imuran), which has a less rapid effect but less toxicity. The synthetic androgen danazol (Danocrine) can be useful in some patients, particularly in combination with corticosteroids. If corticosteroids or immunosuppressive agents are used, the taper must be gradual to prevent a rebound "hyperimmune" response and exacerbation of the hemolysis. Monoclonal antibodies (eg, rituximab [Rituxan]) can also be effective for some patients. Immunoglobulin administration is effective in about one third of patients, but the effect is transient and the medication is expensive. Transfusions may be necessary if the anemia is severe; it may be extremely difficult to cross-match samples of available units of PRBCs with that of the patient.

For patients with cold-antibody hemolytic anemia, no treatment may be required other than to advise the patient to keep warm; relocation to a warm climate may be advisable. However, in other situations, the hemolysis may warrant more aggressive interventions as described previously.

## Nursing Management

Patients may have great difficulty understanding the pathologic mechanisms underlying the disease and may need repeated explanations in terms they can understand. Patients who have had a splenectomy should be vaccinated against pneumococcal infections (eg, with Pneumovax) and informed that they are permanently at greater risk for infection. Patients receiving long-term corticosteroid therapy, particularly those with concurrent diabetes or hypertension, need careful monitoring. They must understand the need for the medication and the importance of never abruptly discontinuing it. A written explanation and a tapering schedule should be provided, and adjustments based on hemoglobin levels should be emphasized. Similar teaching should be provided when immunosuppressive agents are used. Corticosteroid therapy is not without significant risk, and patients need to be monitored closely for complications. The short- and long-term complications of corticosteroid therapy are presented in Chapter 42.

**NURSING ALERT**

**It can be difficult to cross-match blood when antibodies are present. If imperfectly cross-matched RBCs must be transfused, the nurse should begin the infusion very slowly (10 to 15 mL over 20 to 30 minutes) and monitor the patient very closely for signs and symptoms of a hemolytic transfusion reaction.**

## HEREDITARY HEMOCHROMATOSIS

Hemochromatosis is a genetic condition in which excess iron is absorbed from the GI tract. Normally, the GI tract absorbs 1 to 2 mg of iron daily, but in those with hereditary hemochromatosis, this rate increases significantly. The excess iron is deposited in various organs, particularly the liver, myocardium, testes, thyroid, and pancreas. Eventually, the affected organs become dysfunctional. Although hereditary hemochromatosis is diagnosed in 0.5% of the population in the United States (ie, 1 million people), the actual prevalence is unknown because it is not always diagnosed. The genetic defect associated with hemochromatosis is most commonly seen as a specific mutation (C282Y homozygosity) of the *HFE* gene. Despite the high prevalence of the genetic mutation, the actual expression of the disease is much lower; the reason for this discrepancy is unclear (Adams & Barton, 2007). The actual prevalence of hemochromatosis is lower among Asian Americans, African Americans, Latinos, and Pacific Islanders (Whitlock, Garlitz, Harris, et al., 2006). Women are less often affected than men because women lose iron through menses.

### Clinical Manifestations

Often there is no evidence of tissue damage until middle age, because the accumulation of iron in body organs occurs gradually. Symptoms of weakness, lethargy, arthralgia, weight loss, and loss of libido are common and occur earlier in the illness trajectory. The skin may appear hyperpigmented from melanin deposits (and occasionally **hemosiderin,** an iron-containing pigment) or appear bronze in color. Cardiac dysrhythmias and cardiomyopathy can occur, with resulting dyspnea and edema. Endocrine dysfunction is manifested as hypothyroidism, diabetes mellitus, and hypogonadism (testicular atrophy, diminished libido, and impotence). Cirrhosis is common in later stages of the disease, shortens life expectancy, and is a risk factor for hepatocellular carcinoma (Whitlock, et al., 2006).

### Assessment and Diagnostic Findings

Diagnostic laboratory findings include an elevated serum iron level and high transferrin saturation (more than 60% in men, more than 50% in women). CBC values are typically normal. The definitive diagnostic test for hemochromatosis was formerly the liver biopsy, but testing for the associated genetic mutation is now more commonly used.

### Medical Management

Therapy involves the removal of excess iron via therapeutic phlebotomy (removal of whole blood from a vein). Each unit of blood removed results in a decrease of 200 to 250 mg of iron. The objective is to reduce the serum ferritin to less than 50 μg/L and the transferrin saturation to 30% or less. To achieve this, frequent phlebotomy is required (1 to 2 units weekly). Phlebotomy is then necessary only every 1 to 4 months until the serum ferritin levels are maintained at 50 μg/L (Brissot, 2007). After 1 to 3 years, the frequency of phlebotomy can often be further reduced to prevent reaccumulation of iron deposits. The goal is to maintain an iron saturation of less than 50% and a serum ferritin of less than 100 μg/L. Aggressive removal of excess iron can prevent end-organ dysfunction, particularly liver cirrhosis and its complications (ascites, hemorrhage, hepatocellular carcinoma) (Adams & Barton, 2007).

### Nursing Management

Patients with hemochromatosis often limit their dietary intake of iron, although this is not effective. However, it is important for these patients to avoid any additional insults to the liver, such as alcohol abuse. Serial screening tests for hepatoma (eg, through monitoring alpha-fetoprotein) are important. Other body systems should be monitored for signs of organ dysfunction, particularly the endocrine and cardiac systems, so that appropriate management can be implemented quickly. Because patients with hemochromatosis require frequent phlebotomies, problems with venous access are common. Children of patients who are homozygous for the *HFE* gene mutation should be screened for the mutation as well. Patients who are heterozygous for the *HFE* gene do not develop the disease but need to be advised that they can transmit the gene to their children.

## POLYCYTHEMIA

**Polycythemia** refers to an increased volume of erythrocytes. The term is used when the hematocrit is elevated (more than 55% in males, more than 50% in females). Dehydration (decreased volume of plasma) can cause an elevated hematocrit but not typically to the level to be considered polycythemia. Polycythemia is classified as either primary or secondary.

## *Polycythemia Vera*

Polycythemia vera ("P vera"), or primary polycythemia, is a proliferative disorder of the myeloid stem cells. The bone marrow is hypercellular, and the erythrocyte, leukocyte, and platelet counts in the peripheral blood are elevated. However, erythrocyte elevation predominates; the hematocrit can exceed 60%. This phase can last for an extended period of 10 years or more. Over time, the spleen resumes its embryonic function of hematopoiesis and enlarges. Eventually, the bone marrow may become fibrotic, with a resultant inability to produce as many cells ("burnt out" or spent phase). The disease then evolves into myeloid metaplasia with myelofibrosis, MDS, or AML in a significant proportion of patients; this form of AML is usually refractory to standard treatment. The estimated incidence of polycythemia vera is 2 per 100,000 people (Johansson, 2006). The median age at onset is 65 years (Vannucchi, Antonioli,

Guglielmelli, et al., 2007). With treatment, median survival exceeds 10 years. Death typically results from thrombosis, hemorrhage, or evolution to AML.

## Clinical Manifestations

Patients typically have a ruddy complexion and splenomegaly. Symptoms result from increased blood volumes and may include headache, dizziness, tinnitus, fatigue, paresthesias, and blurred vision, or from increased blood viscosity and may include angina, claudication, dyspnea, and thrombophlebitis, particularly if the patient has atherosclerotic blood vessels. For this reason, blood pressure is often elevated. Uric acid may be elevated, resulting in gout and renal stone formation. Another common and bothersome problem is generalized pruritus, which may be caused by histamine release due to an increased number of basophils. Erythromyalgia, a burning sensation in the fingers and toes, may be reported and is only partially relieved by cooling.

## Assessment and Diagnostic Findings

Diagnosis is based on an elevated erythrocyte mass, a normal oxygen saturation level, and often an enlarged spleen. Other factors useful in establishing the diagnosis include elevated leukocyte and platelet counts. The erythropoietin level is not as low as would be expected with an elevated hematocrit; it is normal or only slightly low. Causes of secondary erythrocytosis should not be present (see later discussion).

The mutation of the enzyme JAK2 causes an erythrocyte hypersensitivity to the effects of erythropoietin. Although a mutation in JAK2 is found in the majority of people with polycythemia vera, it is not specific for the disease. Those with other hematologic disorders (essential thrombocythemia and myelofibrosis) also have this mutation (Vannucchi, et al., 2007).

## Complications

Patients with polycythemia vera are at increased risk for thromboses that may result in CVAs (strokes, brain attacks) or myocardial infarctions (MIs); thrombotic complications are the most common cause of death. Bleeding is also a complication, possibly because the platelets are often very large and somewhat dysfunctional. The bleeding can be significant and can occur in the form of nosebleeds, ulcers, frank GI bleeding, hematuria, and intracranial hemorrhage.

## Medical Management

The objective of management is to reduce the high blood cell mass. Phlebotomy is an important part of therapy. It involves removing enough blood (initially 500 mL once or twice weekly) to reduce blood viscosity and to deplete the patient's iron stores, thereby rendering the patient iron deficient and consequently unable to continue to manufacture erythrocytes excessively. Many patients are managed by routine phlebotomy on an intermittent basis, with the target of maintaining the hematocrit less than 45%.

Chemotherapeutic agents (eg, hydroxyurea) can be used to suppress marrow function, but this may increase the risk of leukemia. Patients receiving hydroxyurea appear to have a lower incidence of thrombotic complications than those treated by phlebotomy alone; this may result with a normal platelet count. Anagrelide (Agrylin), which inhibits platelet aggregation, can also be useful in controlling the thrombocytosis associated with polycythemia vera. However, many patients have difficulty tolerating the medication; it can cause significant side effects, including headache, fluid retention, cardiac dysrhythmias, and heart failure. Furthermore, some studies suggest that anagrelide may be leukemogenic (ie, may cause leukemia), although this hypothesis is controversial (Fruchtman, Petitt, Gilbert, et al., 2005). Interferon alfa-2b (Intron-A) is the most effective treatment for managing the pruritus associated with polycythemia vera (McMullin, 2007) but may be difficult for patients to tolerate because of its frequent side effects (eg, flulike syndrome, depression). Antihistamines, including histamine-2 blockers, are not particularly effective in controlling itching. Allopurinol (Zyloprim) is used to prevent gouty attacks in patients with elevated uric acid concentrations.

The use of aspirin to prevent thrombotic complications is controversial. High-dose aspirin may be associated with an increase in risk of bleeding and no decrease in risk of thrombosis. In contrast, low-dose aspirin decreases the risk of significant thrombotic complications (deep vein thrombosis [DVT], pulmonary embolism, MI, stroke) but does not increase the risk of significant bleeding; therefore, it is now recommended as an antithrombotic prophylaxis (Barbui & Finazzi, 2007). Aspirin is also useful in reducing the pain associated with erythromyalgia.

## Nursing Management

The nurse's role is primarily that of educator. Risk factors for thrombotic complications, particularly smoking, obesity, and poorly controlled hypertension, should be assessed, and the patient should be instructed about the signs and symptoms of thrombosis. To reduce the likelihood of DVT, sedentary behavior, crossing the legs, and wearing tight or restrictive clothing (particularly stockings) should be discouraged. Patients with a history of significant bleeding are usually advised to avoid aspirin and aspirin-containing medications, because these medications alter platelet function. Minimizing alcohol intake should also be emphasized to further diminish the risk of bleeding. The patient needs to be instructed to avoid iron supplements, including those within multivitamin supplements, because the iron can further stimulate RBC production. For pruritus, the nurse may recommend bathing in tepid or cool water and avoiding vigorous toweling off after bathing. Cocoa butter– or oatmeal-based lotions and bath products or baking soda dissolved in bath water may also be effective.

# Secondary Polycythemia

Secondary polycythemia is caused by excessive production of erythropoietin. This may occur in response to a reduced amount of oxygen, which acts as a hypoxic stimulus, as in heavy cigarette smoking, chronic obstructive pulmonary disease, or cyanotic heart disease, or in nonpathologic conditions such as living at a high altitude. It can also result from certain hemoglobinopathies (eg, hemoglobin Chesapeake), in which the hemoglobin has an abnormally high affinity for oxygen. Secondary polycythemia can also occur

from neoplasms (eg, renal cell carcinoma) that stimulate erythropoietin production.

### Medical Management

When secondary polycythemia is mild, treatment may not be necessary; when treatment is necessary, it involves treating the primary conditions. If the cause cannot be corrected (eg, by treating the renal cell carcinoma or improving pulmonary function with smoking cessation), therapeutic phlebotomy may be necessary in symptomatic patients to reduce blood viscosity and volume as well as when the hematocrit is significantly elevated.

# LEUKOPENIA

Leukopenia, a condition in which there are fewer leukocytes than normal, results from neutropenia (diminished neutrophils) or lymphopenia (diminished lymphocytes). Even if other types of leukocytes (eg, monocytes, basophils) are diminished, their numbers are too few to reduce the total leukocyte count significantly.

## Neutropenia

Neutropenia (a neutrophil count of less than 2000/mm$^3$) results from decreased production of neutrophils or increased destruction of these cells (Chart 33-3). Neutrophils are essential in preventing and limiting bacterial infection. A patient with neutropenia is at increased risk for infection from both exogenous and endogenous sources. (The GI tract and skin are common endogenous sources.) The risk of infection is based not only on the severity of the neutropenia but also on its duration. The actual number of neutrophils, known as the **absolute neutrophil count** (ANC), is determined by a simple mathematical calculation using data obtained from the CBC and differential (see Chapter 16). The risk of infection increases proportionally with the decrease in neutrophil count. The risk is significant when the ANC is less than 1000/mm$^3$, is high when it is less than 500/mm$^3$, and is almost certain when it is less than 100/mm$^3$. The risk of developing infection also increases with the length of time during which neutropenia persists, even if it is somewhat mild. Conversely, even a severe neutropenia may not result in infection if the duration of the neutropenia is brief, as is often seen after chemotherapy (Chart 33-4).

**Chart 33-3 • *Causes of Neutropenia***

**Decreased Production of Neutrophils**

- Aplastic anemia, due to medications or toxins
- Metastatic cancer, lymphoma, leukemia
- Myelodysplastic syndromes
- Chemotherapy
- Radiation therapy

**Ineffective Granulocytopoiesis**

- Megaloblastic anemia

**Increased Destruction of Neutrophils**

- Hypersplenism
- Medication induced*
- Immunologic disorders (eg, systemic lupus erythematosus)
- Viral disease (eg, infectious hepatitis, mononucleosis)
- Bacterial infections

*Formation of antibody to medication, leading to a rapid decrease in neutrophils.

### Clinical Manifestations

There are no definite symptoms of neutropenia until the patient becomes infected. A routine CBC with differential, as obtained after chemotherapy treatment, can reveal neutropenia before the onset of infection.

***NURSING ALERT***

**Patients with neutropenia often do not exhibit classic signs of infection. Fever is the most common indicator of infection, yet it is not always present, particularly if the patient is taking corticosteroids.**

### Medical Management

Treatment of the neutropenia varies depending on its cause. If the neutropenia is medication induced, the offending agent is stopped immediately, if possible. Treatment of an underlying neoplasm can temporarily make the neutropenia worse, but with bone marrow recovery, treatment may actually improve it. Corticosteroids may be used if the cause is an immunologic disorder. The use of growth factors such as G-CSF or granulocyte-macrophage colony-stimulating factor (GM-CSF) can be effective in increasing neutrophil production when the cause of the neutropenia is decreased production. Withholding or reducing the dose of chemotherapy or radiation therapy may be required when the neutropenia is caused by these treatments; however, in the case of potentially curative therapy, administration of growth factor is considered to be preferable, so that the maximum antitumor effect can be achieved by maintaining the chemotherapy regimen as originally planned.

If the neutropenia is accompanied by fever, the patient is considered to have an infection and usually is admitted to the hospital. Cultures of blood, urine, and sputum, as well as a chest x-ray, are obtained. To ensure adequate therapy against the infectious organisms, broad-spectrum antibiotics are initiated as soon as the cultures are obtained, although the antibiotics may be changed after culture and sensitivity results are available.

### Nursing Management

Nurses in all settings have a crucial role in assessing the severity of neutropenia and in preventing and managing complications, which most often include infections. Patient teaching is equally important, particularly in the outpatient setting, so that the patient can implement appropriate self-care measures and know when and how to seek medical care (Chart 33-5). Patients at risk of neutropenia should have blood drawn for a CBC with differential; the frequency is based on the suspected severity and duration of the neutropenia. Nurses need to be

CHART 33-4

## Risk Factors for Development of Infection and Bleeding in Patients With Hematologic Disorders

**Risk of Infection**

- *Severity of neutropenia:* Risk of infection is proportional to severity of neutropenia
- *Duration of neutropenia:* Increased duration leads to increased risk of infection
- *Nutritional status:* Decreased protein stores lead to decreased immune response and anergy
- *Deconditioning:* Decreased mobility leads to decreased respiratory effort, leading to increased pooling of secretions
- *Lymphocytopenia; disorders of lymphoid system (chronic lymphocytic leukemia [CLL], lymphoma, myeloma):* Decreased cell-mediated and humoral immunity
- *Invasive procedures:* Break in skin integrity leads to increased opportunity for organisms to enter blood system
- *Hypogammaglobulinemia:* Decreased antibody formation
- *Poor hygiene:* Increased organisms on skin and mucous membranes including perineum
- *Poor dentition; mucositis:* Decreased endothelial integrity leads to increased opportunity for organisms to enter blood system
- *Antibiotic therapy:* Increased risk for superinfection, often fungal
- *Certain medications:* See text

**Risk of Bleeding**

- *Severity of thrombocytopenia:* Risk increases when platelet count decreases; usually not a significant risk until platelet count is lower than 20,000/$mm^3$ or lower than 50,000/$mm^3$ when invasive procedure performed
- *Duration of thrombocytopenia:* Risk increases when duration increases (eg, risk is less when duration is transient after chemotherapy than when duration is permanent with poor marrow production)
- *Sepsis:* Mechanism unknown; appears to cause increased platelet consumption
- *Increased intracranial pressure:* Increased blood pressure leads to rupture of blood vessels
- *Liver dysfunction:* Decreased synthesis of clotting factors
- *Renal dysfunction:* Decreased platelet function
- *Dysproteinemia:* Protein coats surface of platelet, leading to decreased platelet function; protein causes increased viscosity, which leads to increased stretching of capillaries and thus increased bleeding
- *Alcohol abuse:* Suppressive effect on marrow leads to decreased platelet production and decreased ability to function; decreased liver function results in decreased production of clotting factors
- *Splenomegaly:* Increased platelet destruction; spleen traps circulating platelets
- *Concurrent medications:* See text

able to calculate the ANC (see Chapter 16) to assess the severity of neutropenia and the risk of infection. Chart 33-6 identifies nursing interventions related to neutropenia. Chart 33-7 discusses the effects of diet among neutropenic outpatients.

## Lymphopenia

Lymphopenia (a lymphocyte count less than 1500/$mm^3$) can result from ionizing radiation, long-term use of corticosteroids, uremia, some neoplasms (eg, breast and lung

CHART 33-5

HOME CARE CHECKLIST

## The Patient at Risk For Infection

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe consequences of alterations in neutrophils, lymphocytes, immunoglobulins, or their sources. | ✔ | ✔ |
| • Verbalize the reason for being at risk for infection. | ✔ | ✔ |
| • Identify signs and symptoms of infection. | ✔ | ✔ |
| • Demonstrate how to monitor for signs of infection. | ✔ | ✔ |
| • Describe to whom, how, and when to report signs of infection. | ✔ | ✔ |
| • Identify appropriate behaviors to take to prevent infection:<br>• Maintain good hand hygiene technique, total body hygiene, and skin integrity.<br>• Avoid fresh flowers, plants, garden work (soil), bird cages, and litter boxes.<br>• Maintain a high-calorie, high-protein diet, with fluid intake of 3000 mL daily (unless fluids are restricted).<br>• Avoid people with infections and crowds.<br>• Perform deep breathing; use incentive spirometer every 4 hour while awake if mobility is restricted.<br>• Provide adequate lubrication with gentle vaginal manipulation during sexual intercourse; avoid anal intercourse. | ✔ | ✔ |
| • Describe appropriate actions to take should infection occur. | ✔ | ✔ |

## Chart 33-6 • *Neutropenia Precautions*

### Nursing Diagnosis

Risk for infection secondary to impaired immunocompetence due to:

- Diminished neutrophil count (see below) secondary to bone marrow invasion or hypocellularity secondary to disease or treatment
- Dysfunctional neutrophils (eg, secondary to myelodysplastic syndrome [MDS])
- Dysfunctional or diminished lymphocytes
- Hypogammaglobulinemia
- Diminished immune response or anergy
- Malnutrition
- Surgery or invasive procedures
- Antibiotic therapy (increased risk of superimposed infection)

### Assessment

**Patient**

Assess the following areas thoroughly every shift or visit (with spot checks throughout shift if the patient is hospitalized) and notify physician of any signs of infection or worsening of status:

- *Skin:* Check for tenderness, edema, breaks in skin integrity, moisture, drainage, lesions (especially under breasts, axillae, groin, skin folds, bony prominences, perineum); check all puncture sites (eg, intravenous sites) for signs and symptoms of inflammation/infection.
  - Skin and mucous membranes are the body's first line of defense against infection; loss of endothelial cell integrity allows organisms to enter the blood and lymph systems.
- *Oral mucosa:* Check for moisture, lesions, color (check palate, tongue, buccal mucosa, gums, lips, oropharynx).
- *Respiratory:* Check for presence of sinus pressure or tenderness, cough, sore throat; auscultate breath sounds; assess rate and depth of respiration, use of accessory muscles.
- *Gastrointestinal:* Check for abdominal discomfort/distention, nausea, change in bowel pattern; auscultate bowel sounds.
- *Genitourinary:* Check for dysuria, urgency, frequency; check urine for color, clarity, odor.
- *Neurologic:* Check for complaints of headache, neck stiffness, visual disturbances; assess level of consciousness, orientation, behavior.
- *Temperature:* Check every 4 hours or every visit; call primary health care provider if temperature is >38°C (>101°F), fever is unresponsive to acetaminophen, or patient shows a decline in hemodynamic status.
  - Neutropenic, infected patients often do not exhibit the classic signs of inflammation/infection (ie, redness, cloudiness of any drainage); the only initial sign may be fever (and it often occurs later in the infectious process with neutropenia).

**Diagnostic Studies**

- Monitor complete blood count (CBC) and differential daily (especially absolute neutrophil count [ANC], lymphocyte count).
- Call physician if ANC is $<1000/mm^3$ or is significantly different from previous count, or whenever patient becomes symptomatic (eg, febrile).
- Monitor globulin, albumin, total protein levels.
- Monitor all culture and sensitivity reports.
- Monitor x-ray reports.

### Nursing Interventions

**Environment and Staff**

- Thorough hand hygiene must be performed by everyone before entering patient's room each and every time.
- Allow no one with a cold or sore throat to care for the patient or to enter room, or come in contact with patient at home.
- Care for neutropenic patients before caring for other patients (as much as possible).
- Use private room for patient if ANC is $<1000/mm^3$.
- Allow no fresh flowers or plants (stagnant water, risk of *Aspergillus* infection).
- Change water in containers every shift (include $O_2$ humidification systems every 24 hours).
- Ensure room is cleaned daily.

**Dietary**

- Provide low-microbial diet.*
- Encourage adequate hydration.

**Patient**

- Avoid suppositories, enemas, rectal temperatures.
- Practice deep breathing (with incentive spirometer) every 4 hours while awake.
- Ambulate; wear high-efficiency particulate air (HEPA) filter mask if neutropenia is severe.
- Prevent skin dryness with water-soluble lubricants, especially in high-risk areas (eg, lips, corners of mouth, elbows, feet, bony prominences).

**Hygiene**

- Provide meticulous total body hygiene daily (preferably with antimicrobial solution), including perineal care after every bowel movement.
- Provide thorough oral hygiene after meals and every 4 hours while awake; warm saline, or salt and soda solution, is effective; avoid use of lemon-glycerine swabs, commercial mouthwashes, and hydrogen peroxide.

**Intravenous (IV) Therapy**

- Avoid plastic cannulas for peripheral IVs when ANC is $<500/mm^3$ if possible; a central vascular access device is preferred for long-term or intensive IV therapy.
- Inspect IV sites every shift; monitor closely for any discomfort; erythema may not be present.
- Maintain meticulous IV site care.
- Cleanse skin with antimicrobial solution before venipuncture (unless patient is allergic).
- Moisture-vapor–permeable dressings are permissible with strict adherence to institutional protocol.
- Change IV tubing per institution policy, using aseptic technique.
- Administer antimicrobial agents on time.

### Expected Patient Outcomes

- Patient demonstrates an absence of infection as evidenced by an absence of fever, chills, inflammation, drainage, cough, dyspnea, sore throat, dysuria, or urinary frequency.
- Patient demonstrates an absence of infection as evidenced by the presence of vital signs within normal limits, including intact neurologic status and intact skin.

### Duration of Evaluation

Until patient is no longer neutropenic and any infection is resolved.

*Note that although it is certainly prudent to avoid uncooked eggs, seafood, and meats as well as unwashed fruits and vegetables, there is little evidence to support this guideline.

CHART 33-7 **NURSING RESEARCH PROFILE**

### *The Effect of a Neutropenic Diet in the Outpatient Setting*

DeMille, D., Deming, P., Lupinacci, P., et al. (2006). The effect of the neutropenic diet in the outpatient setting: A pilot study. *Oncology Nursing Forum, 33*(2), 337–343.

**Purpose**

Infection remains a serious complication for many patients who are neutropenic. In an attempt to decrease infections in patients receiving myelosuppressive chemotherapy, particularly in the context of hematologic malignancy, the neutropenic diet has been used. Although this diet has not been uniformly defined, it often prohibits ingestion of raw, fresh vegetables; fresh juices; raw eggs; and uncooked fish, poultry, and meat. The rationale for this diet is that it decreases the ingestion of potential pathogens (eg, *Pseudomonas, Escherichia coli, Klebsiella,* and *Proteus*) found on such foods, thereby reducing the possible transmission of organisms from the gastrointestinal tract to the bloodstream. The purpose of this study was twofold: (1) to assess patients' compliance with the neutropenic diet outside the hospital, and (2) to compare patients who complied with the diet with those who did not in terms of the rate of hospital admissions for febrile neutropenia and positive blood cultures from gram-negative rods.

**Design**

A convenience sample of 28 patients without neutropenia who were about to begin a type of chemotherapeutic regimen associated with a high incidence of neutropenia was enrolled in this prospective, descriptive study. An investigator-developed questionnaire was used to assess each patient's knowledge regarding food safety and neutropenic diet. Information regarding these concepts was then provided and the questionnaire was readministered 6 and 12 weeks later. Medical records were examined to assess hospitalization admissions and blood culture results.

Seventy percent of the sample (16 of 23 who completed the study) were noncompliant with the neutropenic diet. There was no statistically significant difference in hospital admissions for febrile neutropenia for those who were compliant and those who were not. Similarly, there was no statistically significant difference between groups in incidence of blood cultures yielding gram-negative rods.

**Nursing Implications**

The use of a neutropenic diet is commonly advocated for cancer patients. Although problematic in its methodology and small sample size, this pilot study does not provide evidence to support these diet restrictions. This is one of few studies specifically designed to test the impact of a standard nursing intervention designed to prevent infection in neutropenic patients. Further studies are needed so that nursing interventions can be based on evidence, thereby enhancing patient outcomes.

cancers, advanced Hodgkin disease), and some protein-losing enteropathies (in which the lymphocytes within the intestines are lost). Although when lymphopenia is mild it is often without sequelae, when severe, it can result in bacterial infections (due to low B lymphocytes) or in opportunistic infections (due to low T lymphocytes).

## LEUKEMIA

The term *leukocytosis* refers to an increased level of leukocytes in the circulation. Typically, only one specific cell type is increased. Because the proportions of several types of leukocytes (eg, eosinophils, basophils, monocytes) are small, only an increase in neutrophils or lymphocytes can be great enough to elevate the total leukocyte count. Although leukocytosis can be a normal response to increased need (eg, in acute infection), the elevation in leukocytes should decrease as the physiologic need decreases. A prolonged or progressively increasing elevation in leukocytes is abnormal and should be evaluated. A significant cause of persistent leukocytosis is hematologic malignancy.

Hematopoiesis is characterized by a rapid, continuous turnover of cells. Normally, production of specific blood cells from their stem cell precursors is carefully regulated according to the body's needs. If the mechanisms that control the production of these cells are disrupted, the cells can proliferate excessively. Hematopoietic malignancies are often classified by the cells involved. **Leukemia** is a neoplastic proliferation of one particular cell type (granulocytes, monocytes, lymphocytes, or infrequently erythrocytes or megakaryocytes). The defect originates in the hematopoietic stem cell, the myeloid, or the lymphoid stem cell. The lymphomas are neoplasms of lymphoid tissue, usually derived from B lymphocytes. Multiple myeloma is a malignancy of the most mature form of B lymphocyte, the plasma cell.

The common feature of the leukemias is an unregulated proliferation of leukocytes in the bone marrow. In acute forms (or late stages of chronic forms), the proliferation of leukemic cells leaves little room for normal cell production. There can also be a proliferation of cells in the liver and spleen (extramedullary hematopoiesis). With acute forms, there can be infiltration of leukemic cells in other organs, such as the meninges, lymph nodes, gums, and skin. The cause of leukemia is not fully known, but there is some evidence that genetic influences and viral pathogenesis may be involved (American Cancer Society [ACS], 2008b; Sherbenou & Druker, 2007; Taylor, 2007). Bone marrow damage from radiation exposure or from chemicals such as benzene and alkylating agents (eg, melphalan [Alkeran]) can cause leukemia.

The leukemias are commonly classified according to the stem cell line involved, either lymphoid or myeloid. They are also classified as either acute or chronic, based on the time it takes for symptoms to evolve and the phase of cell development that is halted (ie, with few leukocytes differentiating beyond that phase).

In acute leukemia, the onset of symptoms is abrupt, often occurring within a few weeks. Leukocyte development is halted at the blast phase, so that most leukocytes are undifferentiated cells or are blasts. Acute leukemia progresses very rapidly; death occurs within weeks to months without aggressive treatment.

In chronic leukemia, symptoms evolve over a period of months to years, and the majority of leukocytes produced are mature. Chronic leukemia progresses more slowly; the disease trajectory can extend for years.

## Acute Myeloid Leukemia

AML results from a defect in the hematopoietic stem cell that differentiates into all myeloid cells: monocytes, granulocytes (eg, neutrophils, basophils, eosinophils), erythrocytes, and platelets. All age groups are affected, although it infrequently occurs before age 40 and the incidence rises with age, with a peak incidence at age 67 years (ACS, 2008b). AML is the most common nonlymphocytic leukemia.

The prognosis is highly variable. Patient age is a significant factor; patients who are younger may survive for 5 years or more after diagnosis of AML. However, patients who are older or have a more undifferentiated form of AML tend to have a worse prognosis. The 5-year survival rate for patients with AML who are 65 years of age or younger is 35%; it drops to 4% for those older than 65 years of age (Leukemia & Lymphoma Society, 2007). The development of AML in people with preexisting MDS or in those who previously received alkylating agents for cancer (secondary AML) is also associated with a much worse prognosis; the leukemia tends to be more resistant to treatment, resulting in a much shorter duration of remission. With treatment, patients with secondary AML survive an average of less than 1 year, with death usually a result of infection or hemorrhage. Patients receiving supportive care also usually survive less than 1 year, dying of infection or bleeding.

### Clinical Manifestations

Most signs and symptoms of AML result from insufficient production of normal blood cells. Fever and infection result from neutropenia, weakness and fatigue from anemia, and bleeding tendencies from thrombocytopenia. The proliferation of leukemic cells within organs leads to a variety of additional symptoms: pain from an enlarged liver or spleen, hyperplasia of the gums, and bone pain from expansion of marrow.

### Assessment and Diagnostic Findings

AML develops without warning, with symptoms occurring over a period of weeks to months. The CBC shows a decrease in both erythrocytes and platelets. Although the total leukocyte count can be low, normal, or high, the percentage of normal cells is usually vastly decreased. A bone marrow analysis shows an excess of immature blast cells (more than 20%). AML can be further classified into seven different subgroups, based on cytogenetics, histology, and morphology of the blasts. The actual prognosis varies somewhat between subgroups and with the extent of cytogenetic abnormalities and genetic mutations. The clinical course and treatment differ substantially with only one subtype. Patients with acute promyelocytic leukemia (APL, or AML-M3) often have significantly more problems with bleeding, in that they have underlying coagulopathy and a higher incidence of disseminated intravascular coagulation (DIC).

### Complications

Complications of AML include bleeding and infection, the major causes of death. The risk of bleeding correlates with the level of platelet deficiency (thrombocytopenia). The low platelet count can result in ecchymoses (bruises) and **petechiae** (pinpoint red or purple hemorrhagic spots on the skin; Fig. 33-5). Major hemorrhages also may develop when the platelet count drops to less than 10,000/mm$^3$. The most common bleeding is GI, pulmonary, and intracranial. For undetermined reasons, fever and infection also increase the likelihood of bleeding.

Because of the lack of mature and normal granulocytes, patients with leukemia are always threatened by infection. The likelihood of infection increases with the degree and duration of neutropenia; neutrophil counts that persist at less than 100/mm$^3$ increase the risk of systemic infections. As the duration of severe neutropenia increases, the patient's risk of developing fungal infections also increases. These fungal infections remain difficult to treat, despite the development of new antifungal agents, particularly if the patient has significant neutropenia.

### Medical Management

Despite advances in understanding the biology of the AML, substantive advances in treatment response rates and survival rates have not occurred for decades, with the exception of advances made in treating APL (see later discussion). Even for those subtypes that have not benefited from advances in treatment, cure is still possible. The overall objective of treatment is to achieve complete remission, in which there is no evidence of residual leukemia in the bone marrow. Attempts

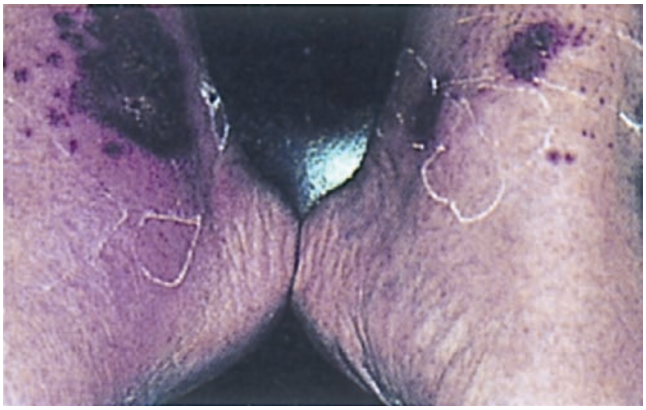


**Figure 33-5** Petechiae and purpura on lower extremities of a thrombocytopenic patient. From Kelley, W. N. (1989). *Textbook of internal medicine.* Philadelphia: Lippincott Williams & Wilkins.

are made to achieve remission by the aggressive administration of chemotherapy, called induction therapy, which usually requires hospitalization for several weeks. Induction therapy typically involves high doses of cytarabine (Cytosar, Ara-C) and daunorubicin (Cerubidine) or mitoxantrone (Novantrone) or idarubicin (Idamycin); sometimes etoposide (VP-16, VePesid) is added to the regimen. The choice of agents is based on the patient's physical status and history of prior antineoplastic treatment.

Treatment of APL revolves around induction therapy using the differentiating agent all-trans retinoic acid (ATRA), which induces the promyelocytic blast cells to differentiate, thereby deterring the cells from proliferating. ATRA is typically combined with a conventional chemotherapeutic agent, usually an anthracycline drug. This regimen yields a very high response rate, and cure is possible.

The aim of induction therapy is to eradicate the leukemic cells, but this is also accompanied by the eradication of normal types of myeloid cells. Thus, the patient becomes severely neutropenic (an ANC of 0 is not uncommon), anemic, and thrombocytopenic (a platelet count of less than 10,000/$mm^3$ is common). During this time, the patient is typically very ill, with bacterial, fungal, and occasionally viral infections; bleeding; and severe mucositis, which causes diarrhea and an inability to maintain adequate nutrition. Supportive care consists of administering blood products (PRBCs and platelets) and promptly treating infections. The use of granulocytic growth factors, either G-CSF (filgrastim [Neupogen]) or GM-CSF (sargramostim [Leukine]), can shorten the period of significant neutropenia by stimulating the bone marrow to produce leukocytes more quickly; these agents do not appear to increase the risk of producing more leukemic cells.

When the patient has recovered from the induction therapy (ie, the neutrophil and platelet counts have returned to normal and any infection has resolved), consolidation therapy (postremission therapy) is administered to eliminate any residual leukemia cells that are not clinically detectable and reduce the chance for recurrence. Multiple treatment cycles of various agents are used, usually containing some form of cytarabine. Frequently, the patient receives one cycle of treatment that is almost the same, if not identical, to the induction treatment but at lower dosages, therefore resulting in less toxicity.

Another aggressive treatment option is BMT or PBSCT. When a suitable tissue match can be obtained, the patient embarks on an even more aggressive regimen of chemotherapy (sometimes in combination with radiation therapy), with the treatment goal of destroying the hematopoietic function of the patient's bone marrow. The patient is then "rescued" with the infusion of the donor stem cells to reinitiate blood cell production. Patients who undergo PBSCT have a significant risk for infection, graft-versus-host disease (GVHD, in which the donor's lymphocytes [graft] recognize the patient's body as "foreign" and set up reactions to attack the "foreign" host), and other complications. The most appropriate use and timing of PBSCT remain unclear. Patients with a poorer prognosis may benefit from early PBSCT; those with a good prognosis may not need transplant at all. (See Chapter 16 for a discussion of nursing management in BMT.)

Another important option for the patient to consider is supportive care alone. In fact, supportive care may be the only option if the patient has significant comorbidity, such as extremely poor cardiac, pulmonary, renal, or hepatic function, and/or is extremely old. In such cases, aggressive antileukemia therapy is not used; occasionally, hydroxyurea (Hydrea) may be used briefly to control the increase of blast cells. Patients are more commonly supported with antimicrobial therapy and transfusions as needed. This treatment approach provides the patient with some additional time outside the hospital (eg, at home); however, death frequently occurs within months, typically from infection or bleeding. (Refer to Chapter 17 for a discussion of end-of-life care.)

#### Complications of Treatment

Massive leukemic cell destruction from chemotherapy results in the release of intracellular electrolytes and fluids into the systemic circulation. Increases in uric acid levels, potassium, and phosphate are seen; this process is referred to as tumor **lysis** syndrome (see Chapter 16). The increased uric acid and phosphorus levels make the patient vulnerable to renal stone formation and renal colic, which can progress to acute renal failure. Hyperkalemia and hypocalcemia can lead to cardiac dysrhythmias; hypotension; neuromuscular effects such as muscle cramps, weakness, and spasm/tetany; confusion; and seizures. Patients require a high fluid intake, alkalization of the urine, and prophylaxis with allopurinol to prevent crystallization of uric acid and subsequent stone formation. GI problems may result from the infiltration of abnormal leukocytes into the abdominal organs and from the toxicity of the chemotherapeutic agents. Anorexia, nausea, vomiting, diarrhea, and severe mucositis are common. Because of the profound myelosuppressive effects of chemotherapy, significant neutropenia and thrombocytopenia typically result in serious infection and increased risk of bleeding.

### Nursing Management

Nursing management of the patient with acute leukemia is presented at the end of the discussion of leukemia in this chapter.

## Chronic Myeloid Leukemia

Chronic myeloid leukemia (CML) arises from a mutation in the myeloid stem cell. Normal myeloid cells continue to be produced, but there is a pathologic increase in the production of forms of blast cells. Therefore, a wide spectrum of cell types exists within the blood, from blast forms through mature neutrophils. Because there is an uncontrolled proliferation of cells, the marrow expands into the cavities of long bones (eg, the femur), and cells are also formed in the liver and spleen (extramedullary hematopoiesis), resulting in enlargement of these organs that is sometimes painful. In 90% to 95% of patients with CML, a section of DNA is missing from chromosome 22 (the Philadelphia chromosome [Ph1]); it is translocated onto chromosome 9. The specific location of these changes is on the *BCR* gene of chromosome 22 and the *ABL* gene on chromosome 9.

When these two genes fuse (*BCR-ABL* gene), they produce an abnormal protein (a tyrosine kinase protein) that causes leukocytes to divide rapidly. This *BCR-ABL* gene is present in virtually all patients with this disease.

CML is uncommon in people younger than 20 years of age; the incidence increases with age (mean age is 67 years) (ACS, 2008a). Patients diagnosed with CML in the chronic phase have an overall median life expectancy exceeding 5 years. During that time, they have few symptoms and complications from the disease itself. Problems with infections and bleeding are rare. However, once the disease transforms to the acute phase (blast crisis), the median survival is typically less than 6 months (Schiffer, 2007).

## Clinical Manifestations

The clinical picture of CML varies. Many patients are asymptomatic, and leukocytosis is detected by a CBC performed for some other reason. The leukocyte count commonly exceeds 100,000/mm$^3$. Patients with extremely high leukocyte counts may be somewhat short of breath or slightly confused because of decreased capillary perfusion to the lungs and brain from leukostasis (the excessive volume of leukocytes inhibits blood flow through the capillaries). The patient may have an enlarged, tender spleen. The liver may also be enlarged. Some patients have insidious symptoms, such as malaise, anorexia, and weight loss. Lymphadenopathy is rare. There are three stages in CML: chronic, transformation, and accelerated or blast crisis. Patients develop more symptoms and complications as the disease progresses.

## Medical Management

Advances in understanding of the pathology of CML at a molecular level have led to dramatic changes in its treatment. An oral formulation of a tyrosine kinase inhibitor, imatinib mesylate (Gleevec), works by blocking signals within the leukemia cells that express the *BCR-ABL* protein, thus preventing a series of chemical reactions that cause the cell to grow and divide. Imatinib therapy appears to be most useful in the chronic phase of the illness. It can induce complete remission at the cellular and even the molecular level. Imatinib is metabolized by the cytochrome P450 pathway, which means that drug–drug interactions are common. Also, antacids and grapefruit juice may limit drug absorption, and large doses of acetaminophen can cause hepatotoxicity.

In those instances where imatinib (at conventional doses) does not elicit a molecular remission, or when that remission is not maintained, other treatment options may be considered. The dosage of imatinib can be increased (with increased toxicity), another inhibitor of *BCR-ABL* can be used (eg, dasatinib [Sprycel]), or allogeneic transplant can be used. CML is a disease that can potentially be cured with BMT or PBSCT in otherwise healthy patients who are younger than 65 years of age. However, with the development of tyrosine kinase inhibitors such as imatinib and dasatinib, the timing of transplant has come into question. Patients who receive such transplants while still in the chronic phase of the illness tend to have a greater chance for cure than those who receive them in the acute phase. The use of imatinib therapy may decrease the need for transplantation in CML; however, the long-term efficacy of imatinib as well as its effects on transplant morbidity, mortality, and risk of relapse remain unknown (Schiffer, 2007).

The transformation phase can be insidious or rapid; it marks the process of evolution (or transformation) to the acute form of leukemia (blast crisis). In the transformation phase, the patient may complain of bone pain and may report fevers (without any obvious sign of infection) and weight loss. Even with chemotherapy, the spleen may continue to enlarge. The patient may become more anemic and thrombocytopenic; an increased basophil level is detected by the CBC.

In the acute form of CML (blast crisis), treatment may resemble induction therapy for acute leukemia, using the same medications as for AML or acute lymphocytic leukemia. Patients whose disease evolves into a "lymphoid" blast crisis are more likely to be able to reenter a chronic phase after induction therapy. For those whose disease evolves into AML, therapy has been largely ineffective in achieving a second chronic phase. However, an increased dose of imatinib or dasatinib can be effective in the later stages of CML. Nonetheless, life-threatening infections and bleeding occur frequently in this phase.

In rare instances, when a purely palliative approach is desired, the therapeutic approach focuses on reducing the leukocyte count to a more normal level but does not alter cytogenetic changes. This goal can be achieved by using oral chemotherapeutic agents, typically hydroxyurea or busulfan (Myleran). In the case of an extreme leukocytosis at diagnosis (eg, leukocyte count greater than 300,000/mm$^3$), a more emergent treatment may be required. In this instance, leukapheresis (in which the patient's blood is removed and separated, with the leukocytes withdrawn and the remaining blood returned to the patient) can temporarily reduce the number of leukocytes. An anthracycline chemotherapeutic agent (eg, daunomycin [Cerubidine]) may also be used to bring the leukocyte count down quickly to a safer level, where more conservative therapy can be instituted.

# *Acute Lymphocytic Leukemia*

Acute lymphocytic leukemia (ALL) results from an uncontrolled proliferation of immature cells (lymphoblasts) derived from the lymphoid stem cell. The cell of origin is the precursor to the B lymphocyte in approximately 75% of ALL cases; T-lymphocyte ALL occurs in approximately 25% of cases. The *BCR-ABL* translocation (see earlier discussion) is found in 20% of ALL blast cells. ALL is most common in young children, with boys affected more often than girls; the peak incidence is 4 years of age. After 15 years of age, it is relatively uncommon. ALL is responsive to treatment; complete remission rates are extremely high in children (98%) and 85% for adults (Pui & Evans, 2006). Increasing age appears to be associated with diminished survival; the 5-year event-free survival rate is almost 80% for children with ALL but drops to 40% for adults (Pui & Evans, 2006). Yet even if relapse occurs, resumption of induction therapy can often achieve a second complete remission. Moreover, BMT may be successful even after a second relapse, particularly in certain subsets of patients

(eg, those with Philadelphia chromosome–positive ALL [Ph+ ALL]) (Chim, Lie, Liang, et al., 2007).

### Clinical Manifestations

Immature lymphocytes proliferate in the marrow and impede the development of normal myeloid cells. As a result, normal hematopoiesis is inhibited, resulting in reduced numbers of leukocytes, erythrocytes, and platelets. Leukocyte counts may be either low or high, but there is always a high proportion of immature cells. Manifestations of leukemic cell infiltration into other organs are more common with ALL than with other forms of leukemia and include pain from an enlarged liver or spleen and bone pain. The central nervous system is frequently a site for leukemic cells; thus, patients may exhibit headache and vomiting because of meningeal involvement. Other extranodal sites include the testes and breasts.

### Medical Management

The expected outcome of treatment is complete remission. Due to the heterogeneity of the disease, treatment plans are based on genetic markers of the disease, as well as risk factors of the patient, primarily age (Pui & Evans, 2006). Because ALL frequently invades the central nervous system, preventive cranial irradiation or intrathecal chemotherapy (eg, methotrexate) or both is also a key part of the treatment plan.

Treatment protocols for ALL tend to be complex, using a wide variety of chemotherapeutic agents. Lymphoid blast cells are typically very sensitive to corticosteroids and to vinca alkaloids; therefore, these medications are an integral part of the initial induction therapy. Typically, an anthracycline is included, sometimes with asparaginase (Elspar). Once a patient is in remission, intensification therapy (consolidation) ensues. In the adult with ALL, allogeneic transplant may be used for intensification therapy. Transplant greatly improves long-term disease-free survival, although the risks of death or long-term morbidity are associated with the procedure. For those for whom transplant is not an option (or is reserved for relapse), a prolonged maintenance phase ensues, when lower doses of medications are given for up to 3 years. Despite its complexity, treatment can be provided in the outpatient setting in some circumstances until severe complications develop. Imatinib appears effective in patients with Philadelphia chromosome–positive ALL. Monoclonal antibodies, in which the antibody specific for the antigen expressed on the ALL blast cell is selected for treatment, are also under study (Pui & Evans, 2006). For example, the CD52 antigen is expressed on approximately 70% of ALL cells; thus, alemtuzumab (Campath), a monoclonal antibody with specific affinity for the CD52 antigen, may be effective therapy for this subset of patients.

Infections, especially viral infections, are common. The use of corticosteroids to treat ALL increases the patient's susceptibility to infection. Patients with ALL tend to have a better response to treatment than do patients with AML. BMT or PBSCT offers a chance for prolonged remission, or even cure, if the illness recurs after therapy.

### Nursing Management

Nursing management of the patient with acute leukemia is presented at the end of the leukemia section in this chapter.

## Chronic Lymphocytic Leukemia

CLL is a common malignancy of older adults; the average age at diagnosis is 72 years (ACS, 2007). CLL is the most common form of leukemia in the United States and Europe, affecting more than 120,000 people. It is rarely seen in Native Americans and infrequently among persons of Asian descent. On average, patients with CLL survive 15 years (early-stage CLL); this period may be as low as 3 to 4 years (late-stage CLL) (Montserrat, 2006).

### Pathophysiology

CLL is typically derived from a malignant clone of B lymphocytes (T-lymphocyte CLL is rare). In contrast to the acute forms of leukemia, most of the leukemia cells in CLL are fully mature. It was initially hypothesized that these cells can escape apoptosis (programmed cell death), resulting in an excessive accumulation of the cells in the marrow and circulation. However, this hypothesis is now being questioned (Chiorazzi & Ferrarini, 2006). The disease is classified into three or four stages (two classification systems are in use). In the early stage, an elevated lymphocyte count is seen; it can exceed 100,000/mm$^3$. Because the lymphocytes are small, they can easily travel through the small capillaries within the circulation, and the pulmonary and cerebral complications of leukocytosis (as seen with myeloid leukemias) typically are not found in CLL. Lymphadenopathy occurs as the lymphocytes are trapped within the lymph nodes. The nodes can become very large and are sometimes painful. Hepatomegaly and splenomegaly then develop.

In later stages, anemia and thrombocytopenia may develop. Autoimmune complications can also occur at any stage, as either autoimmune hemolytic anemia or idiopathic thrombocytopenic purpura. In the autoimmune process, the RES destroys the body's own erythrocytes or platelets.

More sophisticated prognostic markers have recently been identified (Montserrat, 2006). Beta$_2$-microglobulin, a protein found on the surface of lymphocytes, can be measured in the serum; an elevated level correlates with more advanced clinical stage and poorer prognosis. Cytogenetic analysis is also useful.

### Clinical Manifestations

Many patients are asymptomatic and are diagnosed incidentally during routine physical examinations or during treatment for another disease. An increased lymphocyte count (lymphocytosis) is always present. The erythrocyte and platelet counts may be normal or, in later stages of the illness, decreased. Enlargement of lymph nodes (lymphadenopathy) is common; this can be severe and sometimes painful. The spleen can also be enlarged (splenomegaly).

Patients with CLL can develop "B symptoms," a constellation of symptoms including fevers, drenching sweats (especially at night), and unintentional weight loss. Patients with CLL have defects in their humoral and cell-mediated immune systems; therefore, infections are common. The defect in cellular immunity is evidenced by an absent or decreased reaction to skin sensitivity tests (eg, *Candida*, mumps), which is known as **anergy.** Life-threatening infections are common, particularly with advanced disease. Viral infections, such as

herpes zoster, can become widely disseminated. Defects in the complement system are also seen, which results in increased risk of developing infection with encapsulated organisms (eg, *Haemophilus influenzae*) (Moran, Browning, Buckby, et al., 2007).

## Medical Management

A major paradigm shift has occurred in CLL therapy. For years, there appeared to be no survival advantage in treating CLL in its early stages. However, with the advent of more sensitive means of assessing therapeutic response, it has been demonstrated that achieving a complete remission and eradicating even minimal residual disease results in improved survival (Tam & Keating, 2007). Even if treatment is not initiated early in the course of the illness, it typically begins when symptoms are severe (drenching night sweats, painful lymphadenopathy) or when the disease progresses to later stages (with resultant anemia and thrombocytopenia).

The chemotherapy agents fludarabine (Fludara) and cyclophosphamide (Cytoxan) are often given in combination with the monoclonal antibody rituximab (Rituxan). This regimen can result in remission that lasts for 5 years in 70% of patients. The major side effect of fludarabine is prolonged bone marrow suppression, manifested by prolonged periods of neutropenia, lymphopenia, and thrombocytopenia, which puts patients at risk for such infections as *Pneumocystis jiroveci, Listeria,* mycobacteria, herpes viruses, and cytomegalovirus (CMV). The monoclonal antibody alemtuzumab (Campath) is often used in combination with other chemotherapeutic agents when the disease is refractory to fludarabine, the patient has very poor prognostic markers, or it is necessary to eradicate residual disease after initial treatment (Tam & Keating, 2007). Alemtuzumab targets the CD52 antigen commonly found on CLL cells, and it is effective in clearing the marrow and circulation of these cells without affecting the stem cells. Because CD52 is present on both B and T lymphocytes, patients receiving alemtuzumab are at significant risk for infection; prophylactic use of antiviral agents and antibiotics (eg, trimethoprim/sulfamethoxazole [Bactrim, Septra]) is important and needs to continue for several months after treatment ends. Bacterial infections are common in patients with CLL, and IV treatment with immunoglobulin may be given to selected patients with recurrent infection.

# NURSING PROCESS

## The Patient With Acute Leukemia

### Assessment

Although the clinical picture varies with the type of leukemia as well as the treatment implemented, the health history may reveal a range of subtle symptoms reported by the patient before the problem is detectable on physical examination. Weakness and fatigue are common manifestations, not only of the leukemia, but also of the resulting complications of anemia and infection. If the patient is hospitalized, the assessments should be performed daily, or more frequently as warranted. Because the physical findings may be subtle initially, a thorough, systematic assessment incorporating all body systems is essential. For example, a dry cough, mild dyspnea, and diminished breath sounds may indicate a pulmonary infection. However, the infection may not be seen initially on the chest x-ray; the absence of neutrophils delays the inflammatory response against the pulmonary infection, thus delaying the changes seen on x-ray. The platelet count can become dangerously low, leaving the patient at risk for significant bleeding. The specific body system assessments are delineated in the neutropenic precautions and bleeding precautions found in Charts 33-6 and 33-8, respectively. When serial assessments are performed, current findings are compared with previous findings to evaluate improvement or worsening.

The nurse also must closely monitor the results of laboratory studies. Flow sheets and spreadsheets are particularly useful in tracking the leukocyte count, ANC, hematocrit, platelet, creatinine and electrolyte levels, and hepatic function tests. Culture results need to be reported immediately so that appropriate antimicrobial therapy can begin or be modified.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses for the patient with acute leukemia may include:

- Risk for infection and bleeding
- Risk for impaired skin integrity related to toxic effects of chemotherapy, alteration in nutrition, and impaired mobility
- Impaired gas exchange
- Impaired mucous membranes due to changes in epithelial lining of the GI tract from chemotherapy or prolonged use of antimicrobial medications
- Imbalanced nutrition, less than body requirements, related to hypermetabolic state, anorexia, mucositis, pain, and nausea
- Acute pain and discomfort related to mucositis, leukocyte infiltration of systemic tissues, fever, and infection
- Hyperthermia related to tumor lysis or infection
- Fatigue and activity intolerance related to anemia, infection, and deconditioning
- Impaired physical mobility due to anemia, malaise, discomfort, and protective isolation
- Risk for excess fluid volume related to renal dysfunction, hypoproteinemia, and need for multiple IV medications and blood products
- Diarrhea due to altered GI flora, mucosal denudation, and prolonged use of broad-spectrum antibiotics
- Risk for deficient fluid volume related to potential for diarrhea, bleeding, infection, and increased metabolic rate
- Self-care deficit due to fatigue, malaise, and protective isolation
- Anxiety due to knowledge deficit and uncertainty about future
- Disturbed body image related to change in appearance, function, and roles
- Grieving related to anticipatory loss and altered role functioning

## Chart 33-8 • *Bleeding Precautions*

### Nursing Diagnosis

Risk for injury/bleeding secondary to thrombocytopenia/altered coagulation due to:

- Malignant invasion in bone marrow
- Bone marrow suppression resulting from chemotherapy (particularly alkylators, antitumor antibiotics, antimetabolites) and radiation therapy
- Hypersplenism
- Disseminated intravascular coagulation (DIC)
- Altered coagulation

### Assessment

**Patient**

Assess the following systems thoroughly every shift (with spot checks throughout the shift if patient is hospitalized), and notify physician if there is new onset of the following and/or worsening of status:

- *Integumentary:* Petechiae (usually located on trunk, legs), ecchymoses or hematomas, conjunctival hemorrhages, bleeding gums, bleeding at puncture sites (venipuncture, lumbar puncture, bone marrow)
- *Cardiovascular:* Hypotension, tachycardia, dizziness, epistaxis
- *Pulmonary:* Respiratory distress, tachypnea
- *Gastrointestinal:* Hemoptysis, abdominal distention, rectal bleeding
- *Genitourinary:* Vaginal or urethral bleeding; initiate pad count for menstruating patients
- *Neurologic:* Headache, blurred vision, mental status changes

### Laboratory Tests

- Monitor complete blood count (CBC), platelets daily (at least); coagulation panel.
- Notify physician if platelet count is $<10{,}000/mm^3$ or if count has changed significantly from previous count (including coagulation), or whenever patient becomes symptomatic.
- Ensure patient's blood was human leukocyte antigen (HLA) typed before transfusions or chemotherapy begins if admitted for induction therapy (eg, for acute leukemia).
- Obtain 1-hour posttransfusion platelet count if prescribed.
- Test all urine, emesis, stools for occult blood.

### Nursing Interventions

**Prevent Complications**

- Avoid aspirin and aspirin-containing medications or other medications known to inhibit platelet function, if possible.
- Do not give intramuscular injections.
- Avoid indwelling catheters if at all possible.
- Take no rectal temperatures; do not give suppositories, enemas.
- Use stool softeners, oral laxatives to prevent constipation.
- Induce amenorrhea with oral contraceptives (do not administer the placebo pills).
- Use smallest possible needles when performing venipuncture.
- Apply pressure to venipuncture sites for 5 minutes or until bleeding has stopped.
- Permit no flossing of teeth and no commercial mouthwashes.
- Use only soft-bristled toothbrush for mouth care.
- Consider using toothettes for mouth care if platelet count is $<10{,}000/mm^3$, or if gums bleed.
- Lubricate lips with water-soluble lubricant every 2 hours while awake.
- Avoid suctioning if at all possible; if unavoidable, use only gentle suctioning.
- Discourage vigorous coughing or blowing of the nose.
- Use only electric razor for shaving.
- Pad side rails as needed.
- Prevent falls by ambulating with patient as necessary.

**Control Bleeding**

- Apply direct pressure.
- For epistaxis, position patient in high Fowler's position; apply ice pack to back of neck and direct pressure to nose.
- Notify physician for prolonged bleeding (eg, unable to stop within 10 minutes).
- Administer platelets, fresh-frozen plasma, packed red blood cells, as prescribed.

### Evaluation and Expected Patient Outcomes

- Patient demonstrates an absence of bleeding as evidenced by absence of spontaneous petechiae, ecchymoses, epistaxis, hemoptysis, bleeding gums, conjunctival hemorrhage, vaginal bleeding, hematuria, heme-positive stool, blurred vision, orthostatic hypotension, and prolonged bleeding from puncture sites.
- Patient demonstrates an absence of bleeding as evidenced by the presence of vital signs within normal limits and intact neurologic status.

*Serious hemorrhage is unusual in mildly thrombocytopenic patients in absence of local lesions (peptic ulcer, bleeding from hemorrhoids, cystitis).

- Potential for spiritual distress
- Deficient knowledge about disease process, treatment, complication management, and self-care measures

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include:

- Infection
- Bleeding/DIC
- Renal dysfunction
- Tumor lysis syndrome
- Nutritional depletion
- Mucositis
- Depression and anxiety

### Planning and Goals

The major goals for the patient may include absence of complications and pain, attainment and maintenance of adequate nutrition, activity tolerance, ability to provide self-care and to cope with the diagnosis and prognosis, positive body image, and an understanding of the disease process and its treatment.

## Nursing Interventions

### *Preventing or Managing Infection and Bleeding*

The nursing interventions related to diminishing the risk of infection and bleeding are delineated in Charts 33-6 and 33-8.

### *Managing Mucositis*

Although emphasis is placed on the oral mucosa, the entire GI mucosa can be altered, not only by the effects of chemotherapy but also from prolonged administration of antibiotics. See Chapter 16 for assessment and management of mucositis.

### *Improving Nutritional Intake*

The disease process can increase the patient's metabolic rate and nutritional requirements. (Sepsis further increases them.) Nutritional intake is often reduced because of pain and discomfort associated with stomatitis. Encouraging or providing mouth care before and after meals and the administration of analgesic agents before eating can help increase intake. If oral anesthetic agents are used, the patient must be warned to chew with extreme care to avoid inadvertently biting the tongue or buccal mucosa.

Nausea should not deter nutritional intake, because antiemetic therapy is highly effective. However, nausea can result from antimicrobial therapy, so some antiemetic therapy may still be required after the chemotherapy has been completed.

Small, frequent feedings of foods that are soft in texture and moderate in temperature may be better tolerated. Low-microbial diets may be prescribed (avoiding uncooked fruits or vegetables and those without a peelable skin), although there is little evidence to support this intervention (Zitella, Friese, Hauser, et al., 2006). Nutritional supplements are frequently used. Daily body weight (as well as intake and output measurements) is useful in monitoring fluid status. Both calorie counts and more formal nutritional assessments are useful. Parenteral nutrition is often required to maintain adequate nutrition.

### *Easing Pain and Discomfort*

Recurrent fevers are common in acute leukemia; at times, they are accompanied by shaking chills (rigors), which can be severe. Myalgias and arthralgias can result. Acetaminophen is typically given to decrease fever, but it does so by increasing diaphoresis. Sponging with cool water may be useful, but cold water or ice packs should be avoided because the heat cannot dissipate from constricted blood vessels. Bedclothes need frequent changing as well. Gentle back and shoulder massage may provide comfort.

Mucositis can also cause significant discomfort. In addition to oral hygiene practices, PCA can be effective in controlling the pain (see Chapter 13). With the exception of severe mucositis, less pain is associated with acute leukemia than with many other forms of cancer. However, the amount of psychological suffering that the patient must endure can be immense. Patients often benefit from active listening.

Because patients with acute leukemia require hospitalization for extensive nursing care (either during induction or consolidation therapy or during resultant complications), sleep deprivation frequently results. Nurses need to implement creative strategies that permit uninterrupted sleep for at least a few hours while still administering necessary medications on time.

### *Decreasing Fatigue and Deconditioning*

Fatigue is a common and oppressive symptom. Nursing interventions should focus on assisting the patient to establish a balance between activity and rest. Patients with acute leukemia need to maintain some physical activity and exercise to prevent the deconditioning that results from inactivity. Use of a high-efficiency particulate air (HEPA) filter mask can permit the patient to ambulate outside the room despite severe neutropenia. Stationary bicycles may also be set up in the room; however, many patients lack the motivation or stamina to use them. At a minimum, patients should be encouraged to sit up in a chair while awake rather than staying in bed; even this simple activity can improve the patient's tidal volume and enhance circulation. Physical therapy can also be beneficial.

### *Maintaining Fluid and Electrolyte Balance*

Febrile episodes, bleeding, and inadequate or overly aggressive fluid replacement can alter the patient's fluid status. Similarly, persistent diarrhea, vomiting, and long-term use of certain antimicrobial agents can cause significant deficits in electrolytes. Intake and output need to be measured accurately, and daily weights should also be monitored. The patient should be assessed for signs of dehydration as well as fluid overload, with particular attention to pulmonary status and the development of dependent edema. Laboratory test results, particularly electrolytes, blood urea nitrogen, creatinine, and hematocrit, should be monitored and compared with previous results. Replacement of electrolytes, particularly potassium and magnesium, is commonly required. Patients receiving amphotericin or certain antibiotics are at increased risk for electrolyte depletion.

### *Improving Self-Care*

Because hygiene measures are so important in this patient population, they must be performed by the nurse when the patient cannot do so. However, the patient should be encouraged to do as much as possible to preserve mobility and function as well as self-esteem. Patients may have negative feelings because they can no longer care for themselves. Empathetic listening is helpful, as is realistic reassurance that these deficits are temporary. As the patient recovers, it is important to assist him or her to resume more self-care. Patients are usually discharged from the hospital with a vascular access device (eg, Hickman catheter, peripherally inserted central catheter [PICC]), and most patients can care for the catheter with adequate instruction and practice under observation.

### *Managing Anxiety and Grief*

Being diagnosed with acute leukemia can be extremely frightening. In many instances, the need to begin treatment is emergent, and the patient has little time to process the fact that he or she has the illness before making decisions about therapy. Providing emotional support and discussing the uncertain future are crucial. The nurse also needs to assess how much information the patient wants to have regarding the

illness, its treatment, and potential complications. This desire should be reassessed at intervals, because needs and interest in information change throughout the course of the disease and treatment. Priorities must be identified so that procedures, assessments, and self-care expectations are adequately explained even to those who do not wish extensive information.

Many patients become depressed and begin to grieve for the losses they feel, such as normal family functioning, professional roles and responsibilities, and social roles, as well as physical functioning. The nurse can assist the patient to identify the source of the grief and encourage him or her to allow time to adjust to the major life changes produced by the illness. Role restructuring, in both family and professional life, may be required. Again, when possible, encouraging the patient to identify options and to take time making important decisions is helpful.

Discharge from the hospital can also provoke anxiety. Although most patients are eager to go home, they may lack confidence in their ability to manage potential complications and to resume their normal activity. Close communication between nurses across care settings can reassure patients that they will not be abandoned.

#### *Encouraging Spiritual Well-Being*

Because acute leukemia is a serious, potentially life-threatening illness, the nurse may offer support to enhance the patient's spiritual well-being. The patient's spiritual and religious practices should be assessed and pastoral services offered. Throughout the patient's illness, it is important that the nurse assist the patient to maintain hope. However, that hope should be realistic and will certainly change over the course of the illness. For example, the patient may initially hope to be cured, but with repeated relapses and a change to hospice or palliative care the same patient may hope for a quiet, dignified death. (Refer to Chapter 17 for a discussion of end-of-life care.)

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Most patients cope better when they have an understanding of what is happening to them. Based on their education, literacy level, and interest, teaching of the patient and family should focus on the disease (including some pathophysiology), its treatment, and certainly the resulting significant risk of infection and bleeding (see Charts 33-6 and 33-8).

Management of a vascular access device can be taught to most patients or family members. Nurses in outpatient facilities or home care nurses may need to provide follow-up care for patients with vascular access devices.

**CONTINUING CARE.** Shortened hospital stays and outpatient care have significantly altered care for patients with acute leukemia. In many instances, when the patient is clinically stable but still requires parenteral antibiotics or blood products, these procedures can be performed in an outpatient setting. Nurses in these various settings must communicate regularly. They need to tell the patient which parameters are important to monitor and how to monitor them, and give the patient specific instructions about when to seek care from the physician or other health care provider. The primary care provider is responsible for monitoring the patient who is cured or in sustained remission.

The patient and family need to have a clear understanding of the disease, the prognosis, and how to monitor for complications or recurrence. The nurse ensures that this information is provided. Should the patient no longer respond to therapy, it is important to respect the patient's choices about treatment, including measures to prolong life and other end-of-life measures. Advance directives, including living wills, provide patients with some measure of control during terminal illness.

Most patients in this stage choose to be cared for at home, and families often need support when considering this option. Coordination of home care services and instruction can help alleviate anxiety about managing the patient's care in the home. As the patient becomes weaker, the caregivers must assume more of the patient's care. In addition, caregivers often need to be encouraged to take care of themselves, allowing time for rest and accepting emotional support. Hospice staff can assist in providing respite for family members as well as care for the patient. Patients and families also need assistance to cope with changes in their roles and responsibilities. Anticipatory grieving is an essential task during this time (see Chapter 17).

In patients with acute leukemia, death typically occurs from infection or bleeding. Family members need to have information about these complications and the measures to take should either occur. Many family members cannot cope with the care required when a patient begins to bleed actively. It is important to delineate alternatives to keeping the patient at home, such as inpatient hospice units. Should another option be sought, family members who may feel guilty that they could not keep the patient at home will require support from the nurse.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Shows no evidence of infection
2. Experiences no bleeding
3. Has intact oral mucous membranes
   a. Participates in oral hygiene regimen
   b. Reports no discomfort in mouth
4. Attains optimal level of nutrition
   a. Maintains weight with increased food and fluid intake
   b. Maintains adequate protein stores (eg, albumin, prealbumin)
5. Reports satisfaction with pain and comfort levels
6. Has less fatigue and increased activity
7. Maintains fluid and electrolyte balance
8. Participates in self-care
9. Copes with anxiety and grief
   a. Discusses concerns and fears
   b. Uses stress management strategies appropriately
   c. Participates in decisions regarding end-of-life care
   d. Discusses hope for peaceful death
10. Absence of complications

# MYELOFIBROSIS

Myelofibrosis, also known as agnogenic myeloid metaplasia (AMM) or myelofibrosis with myeloid metaplasia (MMM), is a chronic myeloproliferative disorder that arises from neoplastic transformation of an early hematopoietic stem cell. The disease is characterized by marrow fibrosis or scarring, extramedullary hematopoiesis (typically involving the spleen and the liver), leukocytosis, thrombocytosis, and anemia. Some patients have diminished leukocyte, platelet, and erythrocyte counts (ie, pancytopenia). Patients with myelofibrosis have increased **angiogenesis** (formation of new blood vessels) within the marrow. Early forms of blood cells (including nucleated RBCs and megakaryocyte fragments) are frequently found in the circulation. Symptoms may result from an often profoundly enlarged spleen, causing discomfort and early satiety, fatigue, infection and bleeding (from pancytopenia), and cachexia.

Myelofibrosis is a disease of the elderly, with a median age at diagnosis of 65 years. Average survival ranges from 3 to 10 years based on the occurrence of such adverse prognostic indicators as pancytopenia, leukocytosis, presence of blast cells in the circulation, poor-risk cytogenetic results, and constitutional symptoms (eg, fever, night sweats, fatigue, cachexia) (Tefferi, Barosi, Mesa, et al., 2006; Hoffman & Rondelli, 2007). Common causes of death are heart or liver failure, portal hypertension, complications of marrow failure, and transformation to AML. AML is especially difficult to treat successfully in these cases; average survival rate posttransplant is 2.6 months (Mesa, Li, Ketterling, et al., 2005).

## Medical Management

BMT or PBSCT is a useful treatment modality in younger, otherwise healthy people. For patients who are not candidates for transplant, medical management is directed toward palliation, reducing symptoms related to cytopenias, splenomegaly, and hypermetabolic state. Although one third of anemic patients respond to the combination of an androgen plus a corticosteroid, the primary treatment remains PRBC transfusion. Because of the prolonged requirement for these transfusions, iron overload is a common problem. Iron chelation therapy should be initiated in patients in whom survival is expected to exceed a few years. Hydroxyurea is often used to control high leukocyte and platelet counts and to reduce the size of the spleen.

Splenectomy may also be used to control the significant problems that result from a massively enlarged spleen. The mortality rate associated with this procedure is 6.7% (Mesa, Nagorney, Schwager, et al., 2006). Furthermore, a reactive thrombocytosis and leukocytosis can develop because the cells are no longer sequestered out of the circulation. Therefore, the decision to undergo splenectomy warrants careful consideration of the advantages and disadvantages.

## Nursing Management

Splenomegaly can be profound in patients with myelofibrosis, with enlargement of the spleen that may extend to the pelvic rim. This condition is extremely uncomfortable and can severely limit nutritional intake. Analgesic agents are often ineffective. Methods to reduce the size of the spleen are usually more effective in controlling pain. Splenomegaly, coupled with a hypermetabolic state, results in weight loss (often severe) and muscle wasting. Patients benefit from very small, frequent meals of foods that are high in calories and protein. Weakness, fatigue, and altered body image are other significant problems. Energy conservation methods and active listening are important nursing interventions. The patient needs to be educated about signs and symptoms of infection, bleeding, and thrombosis, as well as appropriate interventions if these occur.

# LYMPHOMA

The lymphomas are neoplasms of cells of lymphoid origin. These tumors usually start in lymph nodes but can involve lymphoid tissue in the spleen, GI tract (eg, the wall of the stomach), liver, or bone marrow. They are often classified according to the degree of cell differentiation and the origin of the predominant malignant cell. Lymphomas can be broadly classified into two categories: Hodgkin lymphoma and non-Hodgkin lymphoma (NHL).

## *Hodgkin Lymphoma*

Hodgkin lymphoma is a relatively rare malignancy that has an impressive cure rate. It is somewhat more common in men than women and has two peaks of incidence: one in the early 20s and the other after 50 years of age. Disease occurrence has a familial pattern: First-degree relatives have a higher-than-normal frequency of disease, but the actual incidence of this pattern is low. No increased incidence for nonblood relatives (eg, spouses) has been documented. Hodgkin lymphoma is seen more commonly in patients receiving chronic immunosuppressive therapy (eg, for renal transplant) and also in veterans of the military who were exposed to the herbicide Agent Orange.

### Pathophysiology

Unlike other lymphomas, Hodgkin lymphoma is unicentric in origin in that it initiates in a single node. The disease spreads by contiguous extension along the lymphatic system. The malignant cell of Hodgkin lymphoma is the Reed-Sternberg cell, a gigantic tumor cell that is morphologically unique and is thought to be of immature lymphoid origin. It is the pathologic hallmark and essential diagnostic criterion. However, the tumor is very heterogeneous and may actually contain few Reed-Sternberg cells. Repeated biopsies may be required to establish the diagnosis.

The cause of Hodgkin lymphoma is unknown, but a viral etiology is suspected. Although fragments of the Epstein-Barr virus have been found in some Reed-Sternberg cells, the precise role of this virus in the development of Hodgkin lymphoma remains unknown.

Hodgkin lymphoma is customarily classified into five subgroups based on pathologic analyses that reflect the natural history of the malignancy and suggest the prognosis.

For example, when lymphocytes predominate, with few Reed-Sternberg cells and minimal involvement of the lymph nodes, the prognosis is much more favorable than when the lymphocyte count is low and the lymph nodes are virtually replaced by tumor cells of the most primitive type. Most patients with Hodgkin lymphoma have the types currently designated "nodular sclerosis" or "mixed cellularity." The nodular sclerosis type tends to occur more often in young women, at an earlier stage but with a worse prognosis than the mixed cellularity subgroup, which occurs more commonly in men and causes more constitutional symptoms but has a better prognosis.

## Clinical Manifestations

Hodgkin lymphoma usually begins as a painless enlargement of one or more lymph nodes on one side of the neck. The individual nodes are painless and firm but not hard. The most common sites for lymphadenopathy are the cervical, supraclavicular, and mediastinal nodes; involvement of the iliac or inguinal nodes or spleen is much less common. A mediastinal mass may be seen on chest x-ray; occasionally, the mass is large enough to compress the trachea and cause dyspnea. Pruritus is common; it can be extremely distressing, and the cause is unknown. Some patients experience brief but severe pain after drinking alcohol, usually at the site of the tumor. Again, the cause of this is unknown.

All organs are vulnerable to invasion by tumor cells. The symptoms result from compression of organs by the tumor, such as cough and pulmonary effusion (from pulmonary infiltrates), jaundice (from hepatic involvement or bile duct obstruction), abdominal pain (from splenomegaly or retroperitoneal adenopathy), or bone pain (from skeletal involvement). Herpes zoster infections are common. A cluster of constitutional symptoms has important prognostic implications. Referred to as "B symptoms," they include fever (without chills), drenching sweats (particularly at night), and unintentional weight loss of more than 10% of body weight. B symptoms are found in 40% of patients and are more common in advanced disease.

A mild anemia is the most common hematologic finding. The leukocyte count may be elevated or decreased. The platelet count is typically normal, unless the tumor has invaded the bone marrow, suppressing hematopoiesis. The **erythrocyte sedimentation rate (ESR)** and the serum copper level are used by some clinicians to assess disease activity. Patients with Hodgkin lymphoma have impaired cellular immunity, as evidenced by an absent or decreased reaction to skin sensitivity tests (eg, *Candida*, mumps).

## Assessment and Diagnostic Findings

Because many manifestations are similar to those occurring with infection, diagnostic studies are performed to rule out an infectious origin for the disease. The diagnosis is made by means of an excisional lymph node biopsy and the finding of the Reed-Sternberg cell. Once the diagnosis is confirmed and the histologic type is established, it is necessary to assess the extent of the disease, a process referred to as staging.

During the health history, the patient is assessed for any B symptoms. Physical examination requires a careful, systematic evaluation of the lymph node chains, as well as the size of the spleen and liver. A chest x-ray and a CT scan of the chest, abdomen, and pelvis are crucial to identify the extent of lymphadenopathy within these regions. A positron emission tomography (PET) scan may be the most sensitive imaging test in identifying residual disease. Laboratory tests include CBC, platelet count, ESR, and liver and renal function studies. A bone marrow biopsy is performed if there are signs of marrow involvement, and some physicians routinely perform bilateral biopsies. Bone scans may be performed.

## Medical Management

The general goal in the treatment of Hodgkin lymphoma is cure. Treatment is determined primarily by the stage of the disease, not the histologic type; however, extensive research is ongoing to target treatment regimens to histologic subtypes or prognostic features. Treatment of limited-stage Hodgkin lymphoma commonly involves a short course (2 to 4 months) of chemotherapy followed by radiation therapy to the specific involved area. This strategy has reduced the amount of radiation dosage, with subsequent decrease in long-term side effects (particularly second malignancies and late cardiovascular events) without decreasing the likelihood of controlling the disease (Gospodarowicz & Meyer, 2006). Combination chemotherapy with doxorubicin (Adriamycin), bleomycin (Blenoxane), vinblastine (Velban), and dacarbazine (DTIC), referred to as ABVD, is often considered the standard treatment for more advanced disease (stages III and IV and all stages with B symptoms). Other combinations of chemotherapy may afford higher response rates but result in more toxicity (Horning, 2007).

In addition, chemotherapy is often successful in obtaining remission even when relapse occurs. Transplant is used for advanced or refractory disease. Revised treatment approaches are aimed at diminishing the risk of complications without sacrificing the potential for cure.

### *Long-Term Complications of Therapy*

Much is now known about the long-term effects of chemotherapy and radiation therapy. The complications of treatment are listed in Chart 33-9. Risk factors for other cancers should be assessed, and long-term surveillance is crucial. In large population-based studies of Hodgkin's survivors, the reported actuarial risk of developing a second cancer was 21.9%. Lung cancer is the most common type of second malignancy, particularly following higher doses of thoracic radiation. However, breast cancer appears to be more common in women, particularly in those who were treated with thoracic radiation when younger than 30 years of age (Gospodarowicz & Meyer, 2006). Coronary artery disease is also common, and the risk increases over time.

A systematic review of seven quality-of-life studies of survivors of Hodgkin lymphoma (5 to 14 years since diagnosis) found that fatigue was a long-lasting effect of treatment that did not diminish over time. Mental fatigue was also higher compared with controls, and it appeared to be greater in older patients. In addition, lack of social support was an issue (Bloom, Petersen & Kang, 2007).

## Nursing Management

The potential development of a second malignancy should be addressed with the patient when treatment decisions are made. However, it is also important to tell patients that

**Chart 33-9 • *Potential Long-Term Complications of Therapy for Hodgkin Lymphoma***

- Immune dysfunction
- Herpes infections (zoster and varicella)
- Pneumococcal sepsis
- Acute myeloid leukemia (AML)
- Myelodysplastic syndromes (MDS)
- Non-Hodgkin lymphoma
- Solid tumors
- Thyroid cancer
- Thymic hyperplasia
- Hypothyroidism
- Pericarditis (acute or chronic)
- Cardiomyopathy
- Pneumonitis (acute or chronic)
- Dyspnea on exertion
- Abnormalities in senses of taste, smell, and touch
- Abnormal sense of touch
- Abnormal balance, tremors, or weakness
- Avascular necrosis
- Growth retardation
- Infertility
- Decreased libido
- Dental caries
- Dry mouth
- Dysphagia

Hodgkin lymphoma is often curable. The nurse should encourage patients to reduce other factors that increase the risk of developing second cancers, such as use of tobacco and alcohol and exposure to environmental carcinogens and excessive sunlight. Screening for late effects of treatment (see Chart 33-9) is necessary. In addition, the nurse should provide education about relevant self-care strategies and disease management.

## Non-Hodgkin Lymphomas

The non-Hodgkin lymphomas (NHLs) are a heterogeneous group of cancers that originate from the neoplastic growth of lymphoid tissue. As in CLL, the neoplastic cells are thought to arise from a single clone of lymphocytes; however, in NHL, the cells may vary morphologically. Most NHLs involve malignant B lymphocytes; only 5% involve T lymphocytes. In contrast to Hodgkin lymphoma, the lymphoid tissues involved are largely infiltrated with malignant cells. The spread of these malignant lymphoid cells occurs unpredictably, and true localized disease is uncommon. Lymph nodes from multiple sites may be infiltrated, as may sites outside the lymphoid system (extranodal tissue).

NHL is now the fifth most common type of cancer diagnosed in the United States. The incidence increases with each decade of life; the median age at diagnosis is 67 years (ACS, 2008c). Although no common etiologic factor has been identified, the incidence of NHL has increased in people with immunodeficiencies or autoimmune disorders; prior treatment for cancer; prior organ transplant; viral infections (including Epstein-Barr virus and HIV); and exposure to pesticides, solvents, dyes, or defoliating agents, including Agent Orange. The prognosis varies greatly among the more than 30 subtypes of NHL. For example, diffuse large B-cell lymphoma, the most common form, accounts for 30% of all newly diagnosed lymphomas (80% of all aggressive types); 5-year survival rates are 26% to 73%. Follicular lymphoma, the second most common form, accounts for 22% of all new cases (70% of all indolent [less aggressive] types); median survival is 8 to 10 years (Sehn, 2006).

### Clinical Manifestations

Symptoms are highly variable, reflecting the diverse nature of the NHLs. Lymphadenopathy is most common (66%); however, in indolent types of lymphomas, the lymphadenopathy can wax and wane. With early-stage disease, or with the types that are considered indolent, symptoms may be virtually absent or very minor, and the illness typically is not diagnosed until it progresses to a later stage, when the patient is symptomatic. At these stages (III or IV), lymphadenopathy is distinctly noticeable. One third of patients with NHLs have B symptoms (fever, drenching night sweats, and unintentional weight loss). Lymphomatous masses can compromise organ function. For example, a mass in the mediastinum can cause respiratory distress; abdominal masses can compromise the ureters, leading to renal dysfunction; and splenomegaly can cause abdominal discomfort, nausea, early satiety, anorexia, and weight loss. Involvement of the central nervous system with lymphoma is becoming increasingly common.

### Assessment and Diagnostic Findings

The actual diagnosis of NHL is categorized into a highly complex classification system based on histopathology, immunophenotyping, and cytogenetic analyses of the malignant cells. The specific histopathologic type of the disease has important prognostic implications. Treatment also varies and is based on these features. Indolent types tend to have small cells that are distributed in a follicular pattern. Aggressive types tend to have large or immature cells distributed through the nodes in a diffuse pattern. Staging is typically based on data obtained from CT and PET scans, bone marrow biopsies, and occasionally cerebrospinal fluid analysis. The stage is based on the site of disease and its spread to other sites. For example, in stage I disease, only one area of involvement is detected; thus, stage I disease is highly localized and may respond well to localized therapy (eg, radiation therapy). In contrast, in stage IV disease at least one extranodal site is detected.

Although stage of disease is important, often it is not an accurate predictor of prognosis (Thieblemont & Coiffier, 2007). Two prognostic classification systems have been developed that are particularly useful in the elderly patient population, the International Prognostic Index (IPI) and, for follicular lymphomas, the Follicular Lymphoma International Prognostic Index (FLIPI). Age, performance status, lactate dehydrogenase levels, and extent of disease are scored to determine risk of failure or death from disease. Based on the IPI, 5-year overall survival rates range from 73% (low risk) to 26% (high risk) (Sehn, 2006).

## Medical Management

Treatment is determined by the classification of disease, the stage of disease, prior treatment (if any), and the patient's ability to tolerate therapy. Tolerance to therapy is largely dictated by renal, hepatic, and cardiac function; the presence of concurrent diseases; functional status; and age. If the disease is not aggressive and is localized, radiation alone may be the treatment of choice. With aggressive types of NHL, aggressive combinations of chemotherapeutic agents are used; the combination of the monoclonal antibody rituximab with conventional chemotherapy (Cytoxan, doxorubicin, vincristine, and prednisone [R-CHOP]) is now considered standard treatment for common lymphomas (Thieblemont & Coiffier, 2007). Central nervous system involvement is common with some aggressive forms of NHL; in this situation, cranial radiation or intrathecal chemotherapy is used in addition to systemic chemotherapy.

There is no standard therapy for follicular lymphoma (Morrison, 2007). "Watchful waiting" is often used in those with indolent disease. Rituximab or radiopharmaceutical agents (eg, tositumumab/iodine-131 [Bexxar] or ibritumomab tiuxetan [Zevalin]) are also used, although the latter agents cause technical difficulties with administration due to the radioactivity of the agent. More aggressive treatment (often R-CHOP) may provide a longer duration of remission in which additional treatment is not needed. Unfortunately, in most situations, relapse is commonly seen in patients with low-grade lymphomas. Treatment after relapse is controversial. BMT or PBSCT may be considered for patients younger than 60 years of age (see Chapter 16).

## Nursing Management

Lymphoma is a highly complex constellation of diseases. When caring for patients with lymphoma, it is extremely important to know the specific disease type, stage of disease, treatment history, and current treatment plan. Most of the care for patients with Hodgkin lymphoma or NHL takes place in the outpatient setting, unless complications occur (eg, infection, respiratory compromise due to mediastinal mass). The most commonly used treatment methods are chemotherapy and radiation therapy. Chemotherapy causes systemic side effects (eg, myelosuppression, nausea, hair loss, risk of infection), whereas radiation therapy causes specific side effects that are limited to the area being irradiated. For example, patients receiving abdominal radiation therapy may experience nausea and diarrhea but not hair loss. Regardless of the type of treatment, all patients may experience fatigue.

The risk of infection is significant for these patients, not only from treatment-related myelosuppression but also from the defective immune response that results from the disease itself. Patients need to be taught to minimize the risks of infection, to recognize signs of possible infection, and to contact their health care provider if such signs develop (see Chart 33-5).

Additional complications depend on the location of the lymphoma. Therefore, it is important for the nurse to know the tumor location so that assessments can be targeted appropriately. For example, patients with lymphomatous masses in the upper chest should be assessed for superior vena cava obstruction or airway obstruction, if the mass is near the bronchus or trachea.

Many lymphomas can be cured with current treatments. However, as survival rates increase, the incidence of second malignancies, particularly AML or MDS, also increases. Therefore, survivors should be screened regularly for the development of second malignancies.

# MULTIPLE MYELOMA

Multiple myeloma is a malignant disease of the most mature form of B lymphocyte, the plasma cell. Plasma cells secrete immunoglobulins, proteins necessary for antibody production to fight infection. Myeloma is the second most common hematologic cancer in the United States (Katzel, Hari & Vesole, 2007). The median 5-year survival rate for newly diagnosed patients is 33% (Ries, Melbert, Krapcho, et al., 2007). Currently, prognosis is based on two simple markers, serum albumin (presumed to be a negative acute-phase reactant) and serum beta-2 microglobulin (presumed to be an indirect measure of tumor burden, defined as an approximation of the amount of cancer or the number of cancer cells in the body) (Gertz, 2007). Using this system, patients with a good prognosis have a median survival of 62 months, whereas those with a poor prognosis have a median survival of 29 months (Katzel, et al., 2007). Research is currently directed at identifying specific types of chromosomal abnormalities that will further determine prognosis and treatment (Gertz, 2007).

## Pathophysiology

In multiple myeloma, the malignant plasma cells produce an increased amount of a specific immunoglobulin that is nonfunctional. Functional types of immunoglobulin are still produced by nonmalignant plasma cells, but in lower-than-normal quantity. The specific immunoglobulin secreted by the myeloma cells is detectable in the blood or urine and is referred to as the monoclonal protein, or M protein. This protein serves as a useful marker to monitor the extent of disease and the patient's response to therapy. It is commonly measured by serum or urine protein electrophoresis (Sammet, et al., 2005). The patient's total protein level is also typically elevated because of the production of M protein. Malignant plasma cells also secrete certain substances to stimulate the creation of new blood vessels (ie, angiogenesis) to enhance the growth of these clusters of plasma cell. Occasionally the plasma cells infiltrate other tissue, in which case they are referred to as plasmacytomas. Plasmacytomas can occur in the sinuses, spinal cord, and soft tissues.

## Clinical Manifestations

The classic presenting symptom of multiple myeloma is bone pain, usually in the back or ribs. Bone pain is reported by two thirds of all patients at diagnosis. The bone pain associated with myeloma increases with movement and decreases with rest; patients may report that they have less pain on awakening but more during the day. In myeloma, a substance secreted by the plasma cells, osteoclast activating factor, and other substances (eg, interleukin-6 [IL-6]) are

involved in stimulating osteoclasts. Both mechanisms appear to be involved in the process of bone breakdown. Thus, lytic lesions as well as osteoporosis may be seen on bone x-rays but do not visualize on bone scans. The bone destruction can be severe enough to cause vertebral collapse and fractures, including spinal fractures, which can impinge on the spinal cord and result in spinal cord compression.

If the bone destruction is fairly extensive, excessive ionized calcium is lost from the bone and enters the serum; hypercalcemia may therefore develop (frequently manifested by excessive thirst, dehydration, constipation, altered mental status, confusion, and perhaps coma). Renal failure may also occur; the configuration of the circulating immunoglobulin molecule (particularly the shape of lambda light chains) can damage the renal tubules.

*NURSING ALERT*

**Any elderly patient whose chief complaint is back pain and who has an elevated total protein level should be evaluated for possible myeloma.**

As more and more malignant plasma cells are produced, the marrow has less space for erythrocyte production, and anemia may develop. This anemia is also caused to a great extent by a diminished production of erythropoietin by the kidney. In the late stage of the disease, a reduced number of leukocytes and platelets may also be seen because the bone marrow is infiltrated by malignant plasma cells.

Infection is a concern. Infections occur most commonly within the first 2 months of beginning therapy and in the setting of advanced, refractory disease. In multiple myeloma, in contrast to other hematologic malignancies, the incidence of infection does not appear to be related to the extent of neutropenia. Infections occurring at the beginning of treatment are often caused by *S. pneumoniae*; those that occur when the disease is advanced or in the setting of renal failure are most often caused by gram-negative bacilli or *Staphylococcus aureus* (Blade & Rosinol, 2007). Infection is frequently the cause of death from multiple myeloma.

Neurologic manifestations can also occur. Spinal cord compression is the most common, and other neurologic symptoms may be present (see Chapter 16 for nursing care). When the M protein is IgM, peripheral neuropathy is more likely. Nerve root compression, the presence of intracranial neoplastic cells, and meningeal involvement are quite rare.

When plasma cells secrete excessive amounts of immunoglobulin, the serum viscosity can increase. Hyperviscosity may be manifested by bleeding from the nose or mouth, headache, blurred vision, paresthesias, or heart failure. Thromboembolic events (blood clots) may occur in patients with myeloma; the incidence is thought to be 5% to 10% (Zonder, 2006).

## Assessment and Diagnostic Findings

An elevated monoclonal protein spike in the serum (via serum protein electrophoresis), urine (via urine protein electrophoresis), or light chain (via serum free light chain analysis) is considered to be a major criterion in the diagnosis of multiple myeloma. Evidence of end-organ damage is necessary to establish the diagnosis, using the acronym CRAB (elevated calcium, renal insufficiency, anemia, and/or bone lesions). The diagnosis of myeloma is confirmed by bone marrow biopsy; the presence of more than 10% plasma cells is the hallmark diagnostic criterion. Because the infiltration of the marrow by these malignant plasma cells is not uniform, the plasma cells may not be increased in a given sample (a false-negative result).

## Medical Management

There is no cure for multiple myeloma. Even BMT or PBSCT is considered to extend remission rather than provide a cure. However, for many patients, it is possible to control the illness and maintain their level of functioning quite well for several years or longer. For those who are not candidates for transplant, chemotherapy is the primary treatment. Pharmacotherapeutic advances have resulted in significant improvement in response rates; corticosteroids, particularly dexamethasone (Decadron), are often combined with other agents (eg, melphalan [Alkeran], thalidomide [Thalomid], lenalidomide [Revlimid], and bortezomib [Velcade]).

Radiation therapy is very useful in strengthening the bone at a specific lesion, particularly one at risk for bone fracture or spinal cord compression. It is also useful in relieving bone pain and reducing the size of plasma cell tumors that occur outside the skeletal system. However, because it is a nonsystemic form of treatment, it does not diminish the source of the bone conditions (ie, the production of malignant plasma cells). Therefore, radiation therapy is typically used in combination with systemic treatment such as chemotherapy.

When lytic lesions result in vertebral compression fractures, vertebroplasty is often performed. This procedure is performed under fluoroscopy. A hollow needle is positioned within the fractured vertebra, and when the precise location is confirmed, an orthopedic cement is infiltrated into the vertebra to stabilize the fracture and strengthen the vertebra. For most patients, relief from pain is almost immediate. This procedure has been enhanced by concomitant kyphoplasty, the use of a special inflatable balloon inserted into the vertebra to increase the height of the vertebra prior to injecting the cement.

Some bisphosphonates, such as pamidronate (Aredia) and zoledronic acid (Zometa), have been shown to strengthen bone in multiple myeloma by diminishing survival of osteoclasts, thus controlling bone pain and potentially preventing bone fracture. These agents are also effective in managing and preventing hypercalcemia. Some evidence suggests that bisphosphonates may act against the myeloma cells themselves by inhibiting a growth factor necessary for myeloma cell survival (Van den Wyngaert, Huizing, & Vermorken, 2007). Researchers have found an increased incidence of osteonecrosis of the jaw in people with and without multiple myeloma who have been receiving long-term bisphosphonate therapy; the mandible and/or maxilla are affected. But there is yet no proof of this association between bisphosphonates and osteonecrosis, and the incidence of osteonecrosis appears to be low (2% to 13%) (Mehrotra & Ruggiero, 2006). Nonetheless, careful assessment for this complication should be conducted.

Prior to initiating bisphosphonate therapy, a thorough evaluation of the patient's dentition should be performed, including panoramic dental x-rays. Necessary repairs, including those to ensure that dentures fit properly, should also be performed.

When patients have signs and symptoms of hyperviscosity, plasmapheresis may be used to lower the immunoglobulin level. Symptoms may be more useful than serum viscosity levels in determining the need for this intervention.

Recent advances in the understanding of the process of angiogenesis have resulted in new therapeutic options. The sedative thalidomide (Thalomid), initially used as an antiemetic, has significant antimyeloma effects. It inhibits cytokines necessary for new vascular generation, such as vascular endothelial growth factor, and for myeloma cell growth and survival, such as IL-6 and tumor necrosis factor, by boosting the body's immune response against the tumor and by creating favorable conditions for apoptosis (programmed cell death) of the myeloma cells. Fatigue, dizziness, constipation, rash, and peripheral neuropathy are commonly encountered in patients treated with thalidomide, whereas myelosuppression is not. There is also an increased incidence of DVT; prophylactic anticoagulation should be used to prevent this complication. Strategies to achieve this may range from administration of low-dose aspirin to anticoagulation with warfarin or low-molecular-weight heparin (LMWH) (Zonder, 2006). Thalidomide is contraindicated in pregnancy because of associated severe birth defects. Thus, the patient must be counseled and agree to use approved methods of birth control prior to taking this drug. The thalidomide analog lenalidomide is also effective in myeloma. Side effects are quite different from those of thalidomide: myelosuppression is common, whereas sedation, neuropathy, and constipation are not. However, the drug is excreted by the kidneys, so careful monitoring of renal function is required and dose reduction may be necessary. It also requires concomitant anticoagulation, particularly when used in combination with dexamethasone.

The use of a proteasome inhibiting agent, bortezomib (Velcade), has been approved by the U.S. Food and Drug Administration (FDA) for initial therapy as well as for use in refractory disease. When combined with other medications, it can overcome resistance to those agents (Manochakian, Miller, Chanan-Khan, et al., 2007). Side effects include transient thrombocytopenia, orthostatic hypotension, nausea and vomiting, skin rash, neuropathy, and asthenia (ie, weakness, malaise, fatigue). Because neuropathy is potentially serious, the dosage needs to be decreased as soon as the neuropathy begins to interfere with function. Bortezomib is metabolized by the cytochrome P450 pathway, which means that a careful review of concurrent medications for drug–drug interaction is crucial.

### Nursing Management

Pain management is very important in patients with multiple myeloma. NSAIDs can be very useful for mild pain or can be administered in combination with opioid analgesics. Because NSAIDs can cause gastritis and renal dysfunction, renal function must be carefully monitored and patients assessed for gastritis. The patient needs to be educated about activity restrictions (eg, lifting no more than 10 pounds, use of proper body mechanics). Braces are occasionally needed to support the spinal column.

The patient also needs to be instructed about the signs and symptoms of hypercalcemia. Maintaining mobility and hydration are important to diminish exacerbations of this complication; however, the primary cause is the disease itself. Renal function should also be monitored closely. Renal failure can become severe, and dialysis may be needed. Maintaining high urine output (3 L/day) can be very useful in preventing or limiting this complication.

Because antibody production is impaired, infections, particularly bacterial infections, are common and can be life-threatening. The patient needs to be instructed in appropriate infection prevention measures (see Chart 33-5) and should be advised to contact the health care provider immediately if fever or other signs and symptoms of infection develop. The patient should receive pneumococcal and influenza vaccines. Prophylactic antibiotics are sometimes used. IVIG can be useful for patients with recurrent infections.

Many newer medications incur higher risks of thromboembolism formation. Other risk factors include decreased mobility, poor nutrition, and the presence of a vascular access device (eg, PICC). It is important to maintain mobility and to use strategies that enhance venous return (eg, antiembolism stockings, avoid crossing the legs).

### Gerontologic Considerations

The incidence of multiple myeloma increases with age; the disease rarely occurs in patients younger than 40 years of age. Because of the increasing older population, more patients are seeking treatment for this disease. Back pain, which is often a presenting symptom in this disease, should be closely investigated in older patients. BMT or PBSCT is an option that can prolong remission and potentially cure some patients, but it is unavailable to most older people because of concurrent diminished organ function (eg, kidney, lung, liver, heart) associated with aging.

## BLEEDING DISORDERS

Failure of normal hemostatic mechanisms can result in bleeding, which may be severe. This bleeding is commonly provoked by trauma, but in certain circumstances it can occur spontaneously. When the source is platelet or coagulation factor abnormalities, the site of bleeding can be anywhere in the body. When the source is vascular abnormalities, the site of bleeding may be more localized. Some patients have simultaneous defects in more than one hemostatic mechanism.

The bone marrow may be stimulated to increase platelet production (thrombopoiesis). This may be a reactive response, as in a compensatory response to significant bleeding, or a more general response to increased hematopoiesis, as in iron deficiency anemia. Sometimes, the increase in platelets does not result from increased production but from a loss in platelet pooling within the spleen. The spleen typically holds about one third of the circulating platelets at any time. If the spleen is absent (eg, splenectomy), the platelet reservoir is also lost, and an abnormally high number of platelets enters the circulation. In time, the rate of thrombopoiesis slows to reestablish a more normal platelet level.

## Clinical Manifestations

Signs and symptoms of bleeding disorders vary depending on the type of defect. A careful history and physical examination can be useful in determining the source of the hemostatic defect. Abnormalities of the vascular system give rise to local bleeding, usually into the skin. Because platelets are primarily responsible for stopping bleeding from small vessels, patients with platelet defects develop petechiae, often in clusters; these are seen on the skin and mucous membranes but also occur throughout the body (see Fig. 33-5). Bleeding from platelet disorders can be severe. Unless the platelet disorder is severe, bleeding can often be stopped promptly when local pressure is applied; it does not typically recur when the pressure is released.

In contrast, coagulation factor defects do not tend to cause superficial bleeding, because the primary hemostatic mechanisms are still intact. Instead, bleeding occurs deeper within the body (eg, subcutaneous or IM hematomas, hemorrhage into joint spaces). External bleeding diminishes very slowly when local pressure is applied; it often recurs several hours after pressure is removed. For example, severe bleeding may start several hours after a tooth extraction. Risk factors for bleeding are listed in Chart 33-4.

## Medical Management

Management varies based on the underlying cause of the bleeding disorder. If bleeding is significant, transfusions of blood products are indicated. The specific blood product used is determined by the underlying defect and the extent of the blood loss. If fibrinolysis is excessive, hemostatic agents such as aminocaproic acid (Amicar) can be used to inhibit this process. This agent must be used with caution, because excessive inhibition of fibrinolysis can result in thrombosis. A patient scheduled for an invasive procedure, including a dental extraction, may need a transfusion prior to the procedure to minimize the risk of excessive bleeding.

## Nursing Management

Patients who have bleeding disorders or who have the potential for development of such disorders as a result of disease or therapeutic agents must be taught to observe themselves carefully and frequently for bleeding (Chart 33-10). They need to understand the importance of avoiding activities that increase the risk of bleeding, such as contact sports. It is necessary to examine the skin for petechiae and ecchymoses (bruises) and the nose and gums for bleeding. Hospitalized patients are monitored for bleeding by testing all drainage and excreta (feces, urine, emesis, and gastric drainage) for occult as well as obvious blood. Outpatients are often given fecal occult blood screening cards to detect occult blood in stools.

# Primary Thrombocythemia

Primary thrombocythemia (also called essential thrombocythemia) is a stem cell disorder within the bone marrow. A marked increase in platelet production occurs, with the platelet count consistently greater than 600,000/mm$^3$. Platelet size may be abnormal, but platelet survival is typically normal. Occasionally, the platelet increase is accompanied by an increase in erythrocytes, leukocytes, or both; however, these cells are not increased to the extent that they are in polycythemia vera, CML, or myelofibrosis. Although the exact cause is unknown, primary thrombocythemia is similar to other myeloproliferative disorders, particularly polycythemia vera. However, unlike the other myeloproliferative disorders, it rarely evolves into acute leukemia.

Primary thrombocythemia, which affects women twice as often as men, tends to occur later in life (median age at diagnosis is 65 to 70 years). Survival does not appear to differ from the general population (Johansson, 2006), although conflicting findings have been reported (Brière, 2007).

## Clinical Manifestations

Many patients with primary thrombocythemia are asymptomatic; the illness is diagnosed as the result of finding an elevated platelet count on a CBC. Symptoms occur most often when the platelet count exceeds 1 million/mm$^3$. However, they do not always correlate with the extent to which the platelet count is elevated. When symptoms do

CHART 33-10 HOME CARE CHECKLIST
***The Patient at Risk for Bleeding***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the source and function of platelets and clotting factors. | ✓ | ✓ |
| • Verbalize the rationale for being at risk for bleeding. | ✓ | ✓ |
| • Identify medications and other substances to avoid (eg, aspirin-containing medications, alcohol). | ✓ | ✓ |
| • Demonstrate how to monitor for signs of bleeding. | ✓ | ✓ |
| • Describe to whom, how, and when to report signs of bleeding. | ✓ | ✓ |
| • Notify health care professional before having dental work. | ✓ | ✓ |
| • Describe appropriate ways to prevent bleeding (avoid use of suppositories, enemas, tampons; avoid constipation, vigorous sexual intercourse, anal sex; avoid contact sports; avoid or limit aggressive manual labor; use only electric razor for shaving and a soft-bristled toothbrush for teeth). | ✓ | ✓ |
| • Demonstrate appropriate actions to take should bleeding occur. | ✓ | ✓ |

occur, they result primarily from hemorrhage or vascular occlusion. This occlusion can occur in large vessels (cerebrovascular, coronary, or peripheral arteries) and deep veins, as well as in the microcirculation. Microvascular vasoocclusive manifestations are most frequently seen in the form of erythromyalgia. The toxic effects of platelet substances include painful burning, warmth, and redness in a localized distal area of the extremities. Headaches are the most common neurologic manifestations; other manifestations include transient ischemic attacks and diplopia (Brière, 2007). More common forms of venous thromboembolism include DVT and pulmonary embolism. The spleen may also be enlarged but usually not to a significant extent.

In addition, because the platelets can be dysfunctional, minor or major hemorrhage may occur. Bleeding is commonly limited to recurrent skin manifestations (ecchymoses, hematomas, epistaxis, gum bleeding), although significant GI bleeding is also possible. Bleeding typically does not occur unless the platelet count exceeds 1.5 million/mm$^3$. It results from a deficiency in von Willebrand factor (vWF) as the platelet count increases (Brière, 2007).

## Assessment and Diagnostic Findings

The diagnosis of primary thrombocythemia is made by ruling out other potential disorders—either other myeloproliferative disorders or underlying illnesses that cause a reactive or secondary thrombocytosis (see below). Iron deficiency should be excluded, because a reactive increase in the platelet count often accompanies this deficiency. Occult malignancy should be excluded. The CBC shows markedly large and abnormal platelets; the platelet count is persistently elevated (greater than 600,000/mm$^3$). Analysis of the bone marrow (by aspiration and biopsy) may not be particularly useful.

No data reliably predict the development of complications. Risk factors for the development of thrombotic complications include age older than 60 years and a history of prior thrombotic events. Major bleeding tends to occur when the platelet count is very high (greater than 1,500,000/mm$^3$) and there is a prior history of major bleeding. A history of minor bleeding can also render the patient at risk for further hemorrhage if the platelet count exceeds 1,000,000/mm$^3$ and the duration of disease exceeds 15 years (Brière, 2007). In contrast, patients who are younger than 40 years of age, have no previous history of a thrombotic or hemorrhagic event, and have platelet counts of less than 1,000,000/mm$^3$ are considered to be at low risk for developing thrombotic or hemorrhagic complications.

## Medical Management

The management of primary thrombocythemia is highly controversial. The risk of significant thrombotic or hemorrhagic complications may not be increased until the platelet count exceeds 1.5 million/mm$^3$. A careful assessment of other risk factors, such as history of peripheral vascular disease, history of tobacco use, atherosclerosis, and prior thrombotic events, should be considered in developing the treatment plan.

In younger patients with no risk factors, low-dose aspirin therapy may be sufficient to prevent thrombotic complications. However, the use of aspirin can increase the risk of hemorrhagic complications and is typically a contraindication in patients with a history of GI bleeding. Aspirin can relieve the neurologic symptoms (eg, headache), erythromyalgias, and visual symptoms of primary thrombocythemia.

In older patients and in those with concurrent risk factors, more aggressive measures may be necessary. Hydroxyurea is effective in lowering the platelet count. This agent is taken orally and causes minimal side effects other than dose-related leukopenia. (Its potential for leukogenesis diminishes its utility in younger patients with risk factors.) The medication anagrelide is more specific in lowering the platelet count than hydroxyurea but has more side effects. Severe headaches cause many patients to stop taking the medication. Tachycardia and chest pain may also occur, and anagrelide is contraindicated in patients with concurrent cardiac problems. Anagrelide is also carcinogenic.

Interferon-alfa-2b has been shown to lower platelet counts by an unknown mechanism. The medication is administered subcutaneously at varying frequency, commonly three times per week. Significant side effects, such as fatigue, weakness, memory deficits, dizziness, anemia, and liver dysfunction, limit its usefulness.

Rarely, the occlusive symptoms are so great that the platelet count must be reduced immediately. When necessary, platelet pheresis (see later discussion) can reduce the amount of circulating platelets, but only transiently. The extent to which symptoms and complications (eg, thromboses) are reduced by pheresis is unclear.

## Nursing Management

Patients with primary thrombocythemia need to be instructed about the accompanying risks of hemorrhage and thrombosis. The patient is informed about signs and symptoms of thrombosis, particularly the neurologic manifestations, such as visual changes, numbness, tingling, and weakness. Risk factors for thrombosis are assessed, such as obesity, hypertension, hyperlipidemia, and smoking; measures to diminish these risk factors are encouraged. Patients taking aspirin should be informed about the increased risk of bleeding. Patients who are at risk for bleeding should be instructed about medications (eg, aspirin, NSAIDs) and other substances (eg, alcohol) that can alter platelet function. Patients taking interferon are taught to self-administer the medication and manage side effects. Patients taking hydroxyurea should have CBCs monitored; the dosage is adjusted based on the platelet and white blood cell count.

# *Secondary Thrombocytosis*

Increased platelet production is the primary mechanism of secondary, or reactive, **thrombocytosis.** The platelet count is above normal, but, in contrast to primary thrombocythemia, an increase of more than 1 million/mm$^3$ is rare. Platelet function is normal; the platelet survival time is normal or decreased. Consequently, symptoms associated with hemorrhage or thrombosis are rare. Many disorders or conditions can cause a reactive increase in platelets, including infection, chronic inflammatory disorders, iron deficiency, malignant disease, acute hemorrhage, and splenectomy (see previous discussion of primary thrombocythemia). Treatment is

**Table 33-4 CAUSES AND MANAGEMENT OF THROMBOCYTOPENIA**

| Cause | Management |
|---|---|
| **Decreased Platelet Production** | |
| Hematologic malignancy, especially acute leukemias | Treat leukemia; platelet transfusion |
| Myelodysplastic syndrome (MDS) | Treat MDS; platelet transfusion |
| Metastatic involvement of bone marrow from solid tumors | Treat solid tumor |
| Aplastic anemia | Treat underlying condition |
| Megaloblastic anemia | Treat underlying anemia |
| Toxins | Remove toxin |
| Medications (eg, sulfa drugs, methotrexate) | Stop medication |
| Infection (esp. septicemia, viral infection, tuberculosis, chronic hepatitis C) | Treat infection |
| Alcohol | Refrain from alcohol consumption |
| Chemotherapy | Delay or decrease dose; growth factor; platelet transfusion |
| **Increased Platelet Destruction** | |
| Due to antibodies: | Treat condition |
| Idiopathic thrombocytopenic purpura (ITP) | |
| Lupus erythematosus | |
| Malignant lymphoma | |
| Chronic lymphocytic leukemia (CLL) | Treat CLL and/or treat as ITP |
| Medications | Stop medication |
| Due to infection: | Treat infection |
| Bacteremia | |
| Postviral infection | |
| Sequestration of platelets in an enlarged spleen | If thrombocytopenia is severe, splenectomy may be needed |
| **Increased Platelet Consumption** | |
| Disseminated intravascular coagulation (DIC) | Treat underlying condition triggering DIC; administer heparin, aminocaproic acid (EACA), blood products |

aimed at the underlying disorder. With successful management, the platelet count usually returns to normal.

## Thrombocytopenia

**Thrombocytopenia** (low platelet level) can result from various factors: decreased production of platelets within the bone marrow, increased destruction of platelets, or increased consumption of platelets. Causes and treatments are summarized in Table 33-4.

### Clinical Manifestations

Bleeding and petechiae usually do not occur with platelet counts greater than 50,000/mm$^3$, although excessive bleeding can follow surgery or other trauma. When the platelet count drops to less than 20,000/mm$^3$, petechiae can appear, along with nasal and gingival bleeding, excessive menstrual bleeding, and excessive bleeding after surgery or dental extractions. When the platelet count is less than 5000/mm$^3$, spontaneous, potentially fatal central nervous system or GI hemorrhage can occur. If the platelets are dysfunctional as a result of disease (eg, MDS) or medications (eg, aspirin), the risk of bleeding may be much greater even when the actual platelet count is not significantly reduced, because the function of the platelets is altered.

### Assessment and Diagnostic Findings

A platelet deficiency that results from decreased production (eg, leukemia, MDS) can usually be diagnosed by examining the bone marrow via aspiration and biopsy. Numerous genetic causes of thrombocytopenia have been discovered, including autosomal dominant, autosomal recessive, and X-linked mutations. If platelet destruction is the cause of thrombocytopenia, the marrow shows increased megakaryocytes and normal or even increased platelet production as the body attempts to compensate for the decreased platelets in circulation.

An important cause to exclude is “pseudothrombocytopenia.” Here, platelets aggregate and clump in the presence of ethylenediamine tetra-acetic acid (EDTA), the anticoagulant present in the tube used for CBC collection. This clumping is seen in 1:1000 people (Sekhon & Roy, 2006). A manual examination of the peripheral smear can easily determine platelet clumping as the cause of thrombocytopenia; newer cell counter machines can also detect this.

### Medical Management

The management of secondary thrombocytopenia is usually treatment of the underlying disease. If platelet production is impaired, platelet transfusions may increase the platelet count and stop bleeding or prevent spontaneous hemorrhage. If excessive platelet destruction occurs, transfused platelets are also destroyed, and the platelet count does not increase. The most common cause of excessive platelet destruction is idiopathic thrombocytopenic purpura (see the following discussion). In some instances splenectomy can be a useful therapeutic intervention, but often it is not an option; for example, in patients in whom the enlarged spleen is due to portal hypertension related to cirrhosis, splenectomy may cause more bleeding disorders.

### Nursing Management

The interventions for a patient with thrombocytopenia are listed in Chart 33-8.

## Idiopathic Thrombocytopenic Purpura

Idiopathic thrombocytopenic purpura (ITP) is a disease that affects people of all ages, but it is more common among children and young women. There are two forms of ITP: acute and chronic. Acute ITP, which occurs predominantly in children, often appears 1 to 6 weeks after a viral illness. This form is self-limited; remission often occurs spontaneously within 6 months. Chronic ITP is often diagnosed by exclusion of other causes of thrombocytopenia.

### Pathophysiology

In patients with ITP, antiplatelet autoantibodies that bind to the platelets are found in the blood. When the platelets are bound by the antibodies, the RES or tissue macrophage system ingests the platelets, destroying them. The body attempts to compensate for this destruction by increasing platelet production within the marrow. This mechanism appears to be complicated by the fact that thrombopoietin levels are not elevated in patients with ITP, and as such, platelet production may be diminished (Bussel, Kuter, George, et al., 2006).

As previously stated, viral illness may lead to ITP. Medications such as sulfa drugs as well as conditions such as systemic lupus erythematosus or pregnancy can also induce ITP.

### Clinical Manifestations

Many patients have no symptoms, and the low platelet count (often less than 20,000/mm$^3$; less than 5000/mm$^3$ is not uncommon) is an incidental finding. Common physical manifestations are easy bruising, heavy menses, and petechiae on the extremities or trunk. Patients with simple bruising or petechiae ("dry purpura") tend to have fewer complications from bleeding than those with bleeding from mucosal surfaces, such as the GI tract (including the mouth) and pulmonary system (eg, hemoptysis), which is termed *wet purpura*. Patients with wet purpura have a greater risk of intracranial bleeding than do those with dry purpura. Despite low platelet counts, the platelets are young and very functional. They adhere to endothelial surfaces and to one another, so spontaneous bleeding does not always occur. Thus, treatment may not be initiated unless bleeding becomes severe or life-threatening, or the platelet count is extremely low (less than 10,000/mm$^3$).

### Assessment and Diagnostic Findings

Patients may have an isolated decrease in platelets (less than 20,000/mm$^3$ is common), but they may also have an increase in megakaryocytes within the marrow, as detected on bone marrow aspirate. Some patients are found to be infected with *H. pylori*, and eradicating the infection may improve platelet counts (Emilia, Luppi, Zucchini, et al., 2007). It is unclear why *H. pylori* and ITP are correlated. It is thought that *H. pylori* may cause an autoimmune reaction or that it binds vWF, both of which may result in accelerated platelet demise.

### Medical Management

The primary goal of treatment is a "safe" platelet count. Because the risk of bleeding typically does not increase until the platelet count is less than 10,000/mm$^3$, a patient whose count exceeds 30,000/mm$^3$ to 50,000/mm$^3$ may be carefully observed without additional intervention. However, if the count is less than 20,000/mm$^3$ or if bleeding occurs, the goal is to improve the patient's platelet count rather than to cure the disease. The decision to treat should not be made merely on the basis of the patient's platelet count, but also on his or her lifestyle and activity level. A person with a sedentary lifestyle can tolerate a low platelet count more safely than one with a more active lifestyle.

Treatment for ITP usually involves several approaches. If the patient is taking a medication known to be associated with ITP (eg, quinine, sulfa-containing medications), that medication must be stopped immediately. The mainstay of short-term therapy is the use of immunosuppressive agents. These agents block the binding receptors on macrophages so that the platelets are not destroyed. The corticosteroid prednisone is typically used, although dexamethasone (Decadron) is also effective (Sekhon & Roy, 2006). The immunosuppressant azathioprine (Imuran) may also be used. Platelet counts typically begin to rise within a few days after institution of corticosteroid therapy; this effect takes longer with azathioprine. Because of the associated side effects, patients cannot take high doses of corticosteroids indefinitely. The platelet count tends to drop once the corticosteroid dose is tapered. Some patients can be successfully maintained on low doses of prednisone.

IVIG is also commonly used to treat ITP. It is effective in binding the receptors on the macrophages; however, high doses are required, the drug is very expensive, and the effect is transient. Splenectomy is an alternative treatment but results in a sustained normal platelet count only 50% of the time; however, many patients can maintain a "safe" platelet count of more than 30,000/mm$^3$ after removal of the spleen. Even those who do respond to splenectomy may have recurrences of severe thrombocytopenia months or years later. Patients who have undergone splenectomy are permanently at risk for sepsis and should receive pneumococcal (Pneumovax), *H. influenzae* B, and meningococcal vaccines, preferably 2 to 3 weeks before the splenectomy is performed. The pneumococcal vaccine should be repeated at 5- to 10-year intervals.

Other management options include the chemotherapy agent vincristine (Oncovin). Vincristine appears to work by blocking the receptors on the macrophages and therefore inhibiting platelet destruction; it may also stimulate thrombopoiesis. Certain monoclonal antibodies (eg, rituximab) may increase platelet counts, but the result is often temporary (Beardsley, 2006).

Another approach to the management of chronic ITP involves the use of anti-D (WinRho) in patients who are Rh (D) positive. The actual mechanism of action is unknown. One theory is that the anti-D binds to the patient's erythrocytes, which are in turn destroyed by the body's macrophages. The receptors in the RES may become saturated with the sensitized erythrocytes, diminishing removal of antibody-coated platelets. Anti-D produces a transient decreased hematocrit and increased platelet count in many, but not all, patients with ITP. Anti-D appears to be most effective in children with ITP and least effective in patients who have undergone splenectomy.

In addition, the thrombopoiesis-stimulating protein romiplostin (Nplate) has been successfully used to treat patients with chronic ITP (Bussel, et al., 2006). Side effects include headache, blistering of the oral mucosa, and ecchymoses. Further study is ongoing.

Despite extremely low platelet counts, platelet transfusions are usually avoided. Transfusions tend to be ineffective because the patient's antiplatelet antibodies bind with the transfused platelets, causing them to be destroyed. Platelet counts can actually drop further after platelet transfusion. Occasionally, transfusion of platelets may protect against catastrophic bleeding in patients with severe wet purpura. Aminocaproic acid, a fibrinolytic enzyme inhibitor that slows the dissolution of clots, may be useful for patients with significant mucosal bleeding refractory to other treatments.

### Nursing Management

Nursing care includes an assessment of the patient's lifestyle to determine the risk of bleeding from activity. A careful medication history is also obtained, including use of over-the-counter medications, herbs, and nutritional supplements. The nurse must be alert for sulfa-containing medications and others that alter platelet function (eg, aspirin based or other NSAIDs). The nurse assesses for any history of recent viral illness and reports of headache or visual disturbances, which could be initial symptoms of intracranial bleeding. Patients who are admitted to the hospital with wet purpura and low platelet counts should have a neurologic assessment incorporated into their routine vital sign measurements. All injections or rectal medications should be avoided, and rectal temperature measurements should not be performed, because they can stimulate bleeding.

Patient teaching addresses signs of exacerbation of disease (eg, petechiae, ecchymoses); how to contact appropriate health care personnel; the name and type of medication inducing ITP (if appropriate); current medical treatment (medications, tapering schedule if relevant, side effects); and the frequency of monitoring the platelet count. The patient is instructed to avoid all agents that interfere with platelet function. The patient should avoid constipation, the Valsalva maneuver (eg, straining at stool), and vigorous flossing of the teeth. Electric razors should be used for shaving, and soft-bristled toothbrushes should replace stiff-bristled ones. The patient may also be counseled to refrain from vigorous sexual intercourse when the platelet count is less than $10,000/mm^3$. Patients who are receiving corticosteroids long term are at risk for complications including osteoporosis, proximal muscle wasting, cataract formation, and dental caries (see Chapter 42). Bone mineral density should be monitored, and these patients may benefit from calcium and vitamin D supplementation and bisphosphonate therapy to prevent significant bone disease.

## Platelet Defects

Quantitative platelet defects are relatively common (thrombocytopenia), but qualitative defects can also occur. With qualitative defects, the number of platelets may be normal, but the platelets do not function normally. In the past, the bleeding time was most commonly used to evaluate platelet function. Now a platelet function analyzer is often used; this method is particularly valuable for rapid and simple screening (Scharbert, Gebhardt, Sow, et al., 2007).

Aspirin may induce a functional platelet disorder. Even small amounts of aspirin reduce normal platelet aggregation, and the prolonged bleeding time lasts for several days after aspirin ingestion. Although this does not cause bleeding in most people, patients with a coagulation disorder (eg, hemophilia) or thrombocytopenia can have significant bleeding after taking aspirin, particularly if invasive procedures or trauma has occurred.

NSAIDs can also inhibit platelet function, but the effect is not as prolonged as with aspirin (about 5 days versus 7 to 10 days). Other causes of platelet dysfunction include end-stage renal disease, possibly from metabolic products affecting platelet function; MDS; multiple myeloma (due to abnormal protein interfering with platelet function); cardiopulmonary bypass; and herbs and other medications (Chart 33-11).

### Clinical Manifestations

Bleeding may be mild or severe. Its extent is not necessarily correlated with the platelet count or with tests that measure coagulation (prothrombin time [PT], activated partial thromboplastin time [aPTT]). Ecchymoses are common, particularly on the extremities. Patients with platelet dysfunction may be at risk for significant bleeding after trauma or invasive procedures (eg, biopsy, dental extraction).

### Medical Management

If the platelet dysfunction is caused by medication, its use should be stopped, if possible, particularly when bleeding occurs. If platelet dysfunction is marked, bleeding can often be prevented by transfusion of normal platelets before invasive procedures. Aminocaproic acid may be required to prevent significant bleeding after such procedures.

### Nursing Management

Patients with significant platelet dysfunction need to be instructed to avoid substances that can diminish platelet function, such as certain over-the-counter medications, herbs, nutritional supplements, and alcohol. They also need to inform their health care providers (including dentists) of the underlying condition before any invasive procedure is performed, so that appropriate steps can be initiated to diminish the risk of bleeding. Bleeding precautions should be initiated as appropriate (see Chart 33-8).

## Hemophilia

Two inherited bleeding disorders—hemophilia A and hemophilia B—are clinically indistinguishable, although they can be distinguished by laboratory tests. Hemophilia A is caused by a genetic defect that results in deficient or defective factor VIII. Hemophilia B (also called Christmas disease) stems from a genetic defect that causes deficient or defective factor IX. Hemophilia is a relatively rare disease; hemophilia A, which occurs in 1 of every 5000 births, is three times more common than hemophilia B. Both types of hemophilia are inherited as X-linked traits, so almost all affected people are males; females can be carriers but are

CHART 33-11

PHARMACOLOGY

### *Medications and Substances That Impair Platelet Function*

**Anesthetic Agents**

Local anesthetic agents
Halothane

**Antibiotics**

Beta-lactam antibiotics
- Penicillins
- Cephalosporins

Nitrofurantoin
Sulfonamides

**Anticoagulation Agents**

Heparin
Fibrinolytic agents

**Anti-inflammatory Agents (Nonsteroidal)**

Aspirin
Ibuprofen
Naproxen

**Antineoplastic Agents**

Carmustine
Daunorubicin
Mithramycin

**Cardiovascular Drugs**

Beta-blockers
Calcium channel blockers
Isosorbide
Nitroglycerin
Nitroprusside
Quinidine

**Medications That Increase Platelet cAMP**

Dipyridamole
Prostacycline
Theophylline

**Food and Food Additives**

Caffeine
Chinese black tree fungus
Clove
Cumin
Ethanol
Fish oils
Garlic
Onion extract
Turmeric

**Plasma Expanders**

Dextrans
Hydroxyethyl starch

**Psychotropic Agents**

Tricyclic antidepressants
Phenothiazines

**Miscellaneous**

Antihistamines
Clofibrate
Furosemide
Heroin
Contrast agents
Ticlopidine
Vitamin E

**Herbal Supplements**

Feverfew
Ginger
Gingko
Ginseng
Kava kava

almost always asymptomatic. The disease occurs in all ethnic groups.

Hemophilia is recognized in early childhood, usually in the toddler age group. However, patients with mild hemophilia may not be diagnosed until they experience severe trauma (eg, a high-school football injury) or surgery.

## Clinical Manifestations

Hemophilia is manifested by hemorrhages into various parts of the body; these hemorrhages can be severe and can occur even after minimal trauma. The frequency and severity of the bleeding depend on the degree of factor deficiency as well as the intensity of the precipitating trauma. For example, patients with a mild factor VIII deficiency (ie, 6% to 50% of normal levels) rarely develop hemorrhage spontaneously; hemorrhage tends to occur secondary to trauma. In contrast, spontaneous hemorrhages, particularly hemarthroses and hematomas, can frequently occur in patients with severe factor VIII deficiency (ie, less than 1% of normal levels). These patients require frequent factor VIII replacement therapy.

About 75% of all bleeding in patients with hemophilia occurs into joints. The most commonly affected joints are the knees, elbows, ankles, shoulders, wrists, and hips. Patients often note pain in a joint before they are aware of swelling and limitation of motion. Recurrent joint hemorrhages can result in damage so severe that chronic pain or ankylosis (fixation) of the joint occurs. Many patients with severe factor deficiency are crippled by the joint damage before they become adults. Hematomas can be superficial or deep hemorrhages into muscle or subcutaneous tissue. With severe factor VIII deficiency, hematomas can occur without known trauma and progressively extend in all directions. When the hematomas occur within muscle, particularly in the extremities, peripheral nerves can be compressed. Over time, this compression results in decreased sensation, weakness, and atrophy of the area involved.

Bleeding is not limited to the joints. Spontaneous hematuria and GI bleeding can occur. Bleeding is also common in mucous membranes, such as the nasal passages. The most dangerous site of hemorrhage is in the head (intracranial or

extracranial). Any head trauma requires prompt evaluation and treatment. Surgical procedures typically result in excessive bleeding at the surgical site. Because clot formation is poor, wound healing is also poor. Bleeding is most commonly associated with dental extraction.

## Medical Management

In the past, the only treatment for hemophilia was infusion of fresh-frozen plasma, which had to be administered in such large quantities that patients experienced fluid volume overload. Now factor VIII and factor IX concentrates are available to all blood banks. Recombinant forms of these factors are made available and decrease the need for factor concentrates. Patients are given concentrates when they are actively bleeding or as a preventive measure before traumatic procedures (eg, lumbar puncture, dental extraction, surgery). The patient and family are taught how to administer the concentrate intravenously at home at the first sign of bleeding. It is crucial to initiate treatment as soon as possible so that bleeding complications can be avoided. A study of 133 patients with severe hemophilia evaluated the use of factor replacement at the initial sign of bleeding or as prophylaxis. Although patients assigned to the prophylaxis group used more clotting factors, they also experienced a significant reduction in the number of bleeding episodes (Khoriaty, Taher, Inati, et al., 2005).

Between 15% and 30% of patients with hemophilia A and between 2% and 5% of patients with hemophilia B develop antibodies (inhibitors) to factor concentrates (National Hemophilia Foundation, 2006). Although one third of such inhibitors are transient, their effects can be significant and induce partial or complete refractoriness to factor replacement, thus resulting in increased risk of bleeding. Patients may require plasmapheresis or concurrent immunosuppressive therapy, particularly in the setting of significant bleeding. Factor VIIa can be administered, although it is expensive and requires frequent administration because of its short half-life. Occasionally, tolerance to the antibody can be induced by repeated daily exposure to factor VIII. Patients receiving daily administration of factor VIII can take months or longer for tolerance to develop. Treatment success is optimal when antibody titers remain low; thus, it is important to identify rising titers and act promptly. Activated prothrombin complex concentrates can also be used to control bleeding (National Hemophilia Foundation, 2006). However, efficacy is unpredictable, and if infused too quickly, effective hemostasis is not achieved and bleeding persists; thrombosis is also a possible sequela. Patients with severe factor deficiency should be screened for antibodies, particularly before major surgery. Recombinant factor VIIa is approved by the FDA for patients with acquired antibodies to factors VIII and IX, but treatment is expensive and not always successful.

Aminocaproic acid inhibits fibrinolysis and therefore stabilizes the clot; it is very effective as an adjunctive measure after oral surgery and in treating mucosal bleeding. Another agent, desmopressin (DDAVP), induces a significant but transient rise in factor VIII levels; the mechanism for this response is unknown. In patients with mild forms of hemophilia A, desmopressin is extremely useful, significantly reducing the amount of blood products required. However, desmopressin is not effective in patients with severe factor VIII deficiency.

## Nursing Management

Most patients with hemophilia are diagnosed as children. They often require assistance in coping with the condition because it is chronic, places restrictions on their lives, and is an inherited disorder that can be passed to future generations. From childhood, patients are helped to cope with the disease and to identify the positive aspects of their lives. They are encouraged to be self-sufficient and to maintain independence by preventing unnecessary trauma that can cause acute bleeding episodes and temporarily interfere with normal activities. As they work through their feelings about the condition and progress to accepting it, they can assume more and more responsibility for maintaining optimal health.

Patients with mild factor deficiency may not be diagnosed until adulthood if they do not experience significant trauma or surgery as children. These patients need extensive teaching about activity restrictions and self-care measures to diminish the chance of hemorrhage and complications of bleeding. The nurse should emphasize safety at home and in the workplace.

Patients with hemophilia are instructed to avoid any agents that interfere with platelet aggregation, such as aspirin, NSAIDs, herbs, nutritional supplements, and alcohol. This restriction applies to over-the-counter medications such as cold remedies. Dental hygiene is very important as a preventive measure because dental extractions are hazardous. Applying pressure to a minor wound may be sufficient to control bleeding if the factor deficiency is not severe. Nasal packing should be avoided, because bleeding frequently resumes when the packing is removed. Splints and other orthopedic devices may be useful in patients with joint or muscle hemorrhages. All injections should be avoided; invasive procedures (eg, endoscopy, lumbar puncture) should be minimized or performed after administration of appropriate factor replacement. Patients with hemophilia should carry or wear medical identification.

During hemorrhagic episodes, the extent of bleeding must be assessed carefully. Patients who are at risk for significant compromise (eg, bleeding into the respiratory tract or brain) warrant close observation and systematic assessment for emergent complications (eg, respiratory distress, altered level of consciousness). If the patient has had recent surgery, the nurse frequently and carefully assesses the surgical site for bleeding. Frequent monitoring of vital signs is needed until the nurse is certain that there is no excessive postoperative bleeding.

Analgesic agents are commonly required to alleviate the pain associated with hematomas and hemorrhage into joints. Many patients report that warm baths promote relaxation, improve mobility, and lessen pain. However, during bleeding episodes, heat, which can accentuate bleeding, is avoided; applications of cold are used instead.

Although recent technology (ie, the formulation of heat-solvent or detergent-treated factor concentrates) has rendered factor VIII and IX preparations free of viruses such as HIV and hepatitis, many patients have already been exposed to these infections through previous transfusions.

These patients and their families may need assistance in coping with the diagnosis and the consequences of these infections.

Genetic testing and counseling should be provided to female carriers so that they can make informed decisions regarding having children and managing pregnancy.

## *Von Willebrand's Disease*

Von Willebrand disease (vWD), a common bleeding disorder affecting males and females equally, is usually inherited as a dominant trait. The prevalence of this disease is estimated to be 1% to 2% of the population (National Hemophilia Foundation, 2006). The disease is caused by a deficiency of vWF, which is necessary for factor VIII activity. vWF is also necessary for platelet adhesion at the site of vascular injury. Although synthesis of factor VIII is normal, its half-life is shortened; therefore, factor VIII levels commonly are mildly low (15% to 50% of normal).

There are three types of vWD. Type 1, the most common, is characterized by decreases in structurally normal vWF. Type 2 shows variable qualitative defects based on the specific vWF subtype involved. Type 3 is very rare (less than 5% of cases) (Borel-Derlon, Federici, Roussel-Robert, et al., 2007) and is characterized by a severe vWF deficiency as well as significant deficiency of factor VIII.

### Clinical Manifestations

Bleeding tends to be mucosal. Patients commonly have recurrent nosebleeds, easy bruising, heavy menses, prolonged bleeding from cuts, and postoperative bleeding. Massive soft tissue or joint hemorrhages are not often seen, unless the patient has severe type 3 vWD. As the laboratory values fluctuate (see Assessment and Diagnostic Findings), so does the bleeding. For example, a careful history of prior bleeding may show little problem with postoperative bleeding on one occasion but significant bleeding from a dental extraction at another time.

### Assessment and Diagnostic Findings

Laboratory test results show a normal platelet count but a prolonged bleeding time and a slightly prolonged aPTT. These defects are not static, and laboratory test results can vary widely within the same patient over time. More important tests include the ristocetin cofactor, or vWF collagen binding assay, which measures vWF activity. Other tests include vWF antigen, factor VIII, and, for patients with suspected type 2 defects, vWF multimers.

### Medical Management

The goal of treatment is to replace the deficient protein (eg, vWF or factor VIII) at the time of spontaneous bleeding or prior to an invasive procedure. Desmopressin (DDAVP), a synthetic vasopressin analogue, can be used to prevent bleeding associated with dental or surgical procedures or to manage mild bleeding after surgery in those individuals with mild vWD. DDAVP provides a transient increase in factor VIII coagulant activity and may also correct the bleeding time. It can be administered as an IV infusion or intranasally. With major surgery or invasive procedures, IV administration is preferable. DDAVP is contraindicated in patients with unstable coronary artery disease, because it can induce platelet aggregation and cause MI. Side effects include headache, facial flushing, tachycardia, hyponatremia, and, rarely, seizures.

Replacement products include Humate-P and Alphanate, which are commercial concentrates of vWF and factor VIII. The dosage and frequency of administration of these agents depend on the patient's factor VIII levels and the extent of bleeding. Treatment may be necessary for up to 7 to 10 days after major surgery and 3 to 4 days postpartum. In patients with severe type 3 vWD, the prophylactic administration of these replacement agents has been very successful in preventing or limiting spontaneous bleeding (Berntorp, 2006; Lethagen, 2006). Antibody formation to these products usually occurs only in patients with type 3 vWD, after administration of high doses.

Other agents may be effective in reducing bleeding. Aminocaproic acid is useful in managing mild forms of mucosal bleeding. Estrogen–progesterone compounds may diminish the extent of menses. Platelet transfusions are useful when there is significant bleeding. Medications that interfere with platelet function (eg, aspirin) should be avoided.

# ACQUIRED COAGULATION DISORDERS

## *Liver Disease*

With the exception of factor VIII, most blood coagulation factors are synthesized in the liver. Therefore, hepatic dysfunction (due to cirrhosis, tumor, or hepatitis; see Chapter 39) can result in diminished amounts of the factors needed to maintain coagulation and hemostasis. Prolongation of the PT, unless it is caused by vitamin K deficiency, may indicate severe hepatic dysfunction. Although bleeding is usually minor (eg, ecchymoses), these patients are also at risk for significant bleeding, related especially to trauma or surgery. Transfusion of fresh-frozen plasma may be required to replace clotting factors and to prevent or stop bleeding. Patients may also have life-threatening hemorrhage from peptic ulcers or esophageal varices. In these cases, replacement with fresh-frozen plasma, PRBCs, and platelets is usually required.

## *Vitamin K Deficiency*

The synthesis of many coagulation factors depends on vitamin K. Vitamin K deficiency is common in malnourished patients. Prolonged use of some antibiotics decreases the intestinal flora that produce vitamin K, depleting vitamin K stores. Administration of vitamin K (phytonadione [Mephyton], either orally or as a subcutaneous injection) can correct the deficiency quickly; adequate synthesis of coagulation factors is reflected by normalization of the PT.

## Complications of Anticoagulant Therapy

Anticoagulants are used in the treatment or prevention of thrombosis. These agents, particularly warfarin or heparin, can cause bleeding, particularly if their use is not carefully monitored. If the PT or aPTT is longer than desired and bleeding has not occurred, the medication can be stopped or the dose decreased. Vitamin K is administered as an antidote for warfarin toxicity. Protamine sulfate is rarely needed for heparin toxicity, because the half-life of heparin is very short. With significant bleeding, fresh frozen plasma is needed to replace the vitamin K–dependent coagulation factors.

## Disseminated Intravascular Coagulation

DIC is not a disease but a sign of an underlying condition. DIC may be triggered by sepsis, trauma, cancer, shock, abruptio placentae, toxins, or allergic reactions. The severity of DIC is variable, but it is potentially life-threatening.

### Pathophysiology

In DIC, normal hemostatic mechanisms are altered. The inflammatory response generated by the underlying disease initiates the process of coagulation within the vasculature. The natural anticoagulant pathways within the body are simultaneously impaired, and the fibrinolytic system is suppressed so that a massive amount of tiny clots forms in the microcirculation. Initially, the coagulation time is normal. However, as the platelets and clotting factors are consumed to form microthrombi, coagulation fails. Thus, the paradoxical result of excessive clotting is bleeding.

The clinical manifestations of DIC are primarily reflected in compromised organ function or failure. Decline in organ function is usually a result of excessive clot formation (with resultant ischemia to all or part of the organ) or, less often, of bleeding. The excessive clotting triggers the fibrinolytic system to release fibrin degradation products, which are potent anticoagulants, furthering the bleeding. The bleeding is characterized by low platelet and fibrinogen levels; prolonged PT, aPTT, and thrombin time; and elevated fibrin degradation products (**D-dimers**) (Table 33-5).

The mortality rate can exceed 80% in patients who develop severe DIC with ischemic thrombosis and frank hemorrhage. Identification of patients who are at risk for DIC and recognition of the early clinical manifestations of this syndrome can result in prompt medical intervention, which may improve the prognosis. However, the primary prognostic factor is the ability to treat the underlying condition that precipitated DIC.

### Clinical Manifestations

Patients with frank DIC may bleed from mucous membranes, venipuncture sites, and the GI and urinary tracts. The bleeding can range from minimal occult internal bleeding to profuse hemorrhage from all orifices. Patients typically develop multiple organ dysfunction syndrome (MODS), and they may exhibit renal failure as well as pulmonary and multifocal central nervous system infarctions as a result of microthromboses, macrothromboses, or hemorrhages.

During the initial process of DIC, the patient may have no new symptoms, the only manifestation being a progressive decrease in the platelet count. As the thrombosis becomes more extensive, the patient exhibits signs and symptoms of thrombosis in the organs involved. Then, as the clotting factors and platelets are consumed to form these thrombi, bleeding occurs. Initially the bleeding is subtle, but it can develop into frank hemorrhage. Signs and symptoms, which depend on the organs involved, are listed in Chart 33-12.

### Assessment and Diagnostic Findings

Clinically, the diagnosis of DIC is often established by a drop in platelet count, an increase in PT and aPTT, an elevation in fibrin degradation products, and measurement of one or more clotting factors and inhibitors (eg, antithrombin [AT]). Although each of these tests is useful in establishing the diagnosis of DIC, the specificity of each individual parameter is not great. The International Society of Thrombosis and Haemostasis has developed a highly sensitive and specific scoring system using the platelet count, fibrin degradation products, PT, and fibrinogen level to diagnose DIC (Levi, 2007). This system is also useful in predicting the severity of the disease and subsequent mortality (Voves, Wuillemin, & Zeerleder, 2006).

### Medical Management

The most important management factor in DIC is treating the underlying cause; until the cause is controlled, the DIC will persist. Correcting the secondary effects of tissue ischemia by improving oxygenation, replacing fluids, correcting

**Table 33-5 LABORATORY VALUES COMMONLY FOUND IN DISSEMINATED INTRAVASCULAR COAGULATION (DIC)***

| Test | Function Evaluated | Normal Range | Changes in DIC |
|---|---|---|---|
| Platelet count | Platelet number | 150,000–450,000/mm$^3$ | ↓ |
| Prothrombin time (PT) | Extrinsic pathway | 11–12.5 sec | ↑ |
| Partial thromboplastin time (activated) (aPTT) | Intrinsic pathway | 23–35 sec | ↑ |
| Thrombin time (TT) | Clot formation | 8–11 sec | ↑ |
| Fibrinogen | Amount available for coagulation | 170–340 mg/dL | ↓ |
| D-dimer | Local fibrinolysis | 0–250 ng/mL | ↑ |
| Fibrin degradation products (FDPs) | Fibrinolysis | 0–5 μg/mL | ↑ |
| Euglobulin clot lysis | Fibrinolytic activity | ≥2 h | ≤1 h |

*Because DIC is a dynamic condition, the laboratory values measured will change over time. Therefore, a progressive increase or decrease in a given laboratory value is likely to be more important than the actual value of a test at a single point in time.

CHART 33-12

### Assessing for Recognizing Thrombosis and Bleeding in Disseminated Intravascular Coagulation (DIC)*

| System | Signs and Symptoms of Microvascular Thrombosis | Signs and Symptoms of Microvascular and Frank Bleeding |
|---|---|---|
| Integumentary system (skin) | ↓ Temperature, sensation; ↑ pain; cyanosis in extremities, nose, earlobes; focal ischemia, superficial gangrene | Petechiae, including periorbital and oral mucosa; bleeding: gums, oozing from wounds, previous injection sites, around catheters (IVs, tracheostomies); epistaxis; diffuse ecchymoses; subcutaneous hemorrhage; joint pain |
| Circulatory system | ↓ Pulses; capillary filling time >3 sec | Tachycardia |
| Respiratory system | Hypoxia (secondary to clot in lung); dyspnea; chest pain with deep inspiration; ↓ breath sounds over areas of large embolism | High-pitched bronchial breath sounds; tachypnea; ↑ consolidation; signs and symptoms of acute respiratory distress syndrome |
| Gastrointestinal system | Gastric pain; "heartburn" | Hematemesis (heme⊕[†] NG output) melena (heme⊕ stools → tarry stools → bright-red blood from rectum) retroperitoneal bleeding (abdomen firm and tender to palpation; distended; ↑ abdominal girth) |
| Renal system | ↓ Urine output; ↑ creatinine, ↑ blood urea nitrogen | Hematuria |
| Neurologic system | ↓ Alertness and orientation; ↓ pupillary reaction; ↓ response to commands; ↓ strength and movement ability | Anxiety; restlessness; ↓ mentation, altered level of consciousness; headache; visual disturbances; conjunctival hemorrhage |

**Note:* Signs of microvascular thrombosis are the result of an inappropriate activation of the coagulation system, causing thrombotic occlusion of small vessels within all body organs. As the clotting factors and platelets are consumed, signs of microvascular bleeding appear. This bleeding can quickly extend into frank hemorrhage. Treatment must be aimed at the disorder underlying the DIC; otherwise, the stimulus for the syndrome will persist.

[†]heme⊕, positive for hemoglobin.

electrolyte imbalances, and administering vasopressor medications is also important. If serious hemorrhage occurs, the depleted coagulation factors and platelets may be replaced to reestablish the potential for normal hemostasis and thereby diminish bleeding; however, decisions to provide transfusion support should not be solely based on the laboratory results. Cryoprecipitate is given to replace fibrinogen and factors V and VII; fresh-frozen plasma is administered to replace other coagulation factors.

A controversial treatment strategy is to interrupt the thrombosis process through the use of heparin infusion. Heparin may inhibit the formation of microthrombi and thus permit perfusion of the organs (skin, kidneys, or brain) to resume. Heparin use was traditionally reserved for patients in whom thrombotic manifestations predominated or in whom extensive blood component replacement failed to halt the hemorrhage or increased fibrinogen and other clotting levels. Heparin is now also used in less acute forms of DIC. The effectiveness of heparin can be determined by observing for normalization of the plasma fibrinogen concentration and diminishing signs of bleeding. Fibrinolytic inhibitors, such as aminocaproic acid, may be used with heparin.

Other therapies include recombinant activated protein C (APC, drotrecogin alfa [Xigris]), which is effective in diminishing inflammatory responses on the surface of the vessels as well as having anticoagulant properties. Bleeding is common, can occur at any site, and can be significant. AT infusions can also be used for their anticoagulant and anti-inflammatory properties. Bleeding can be significant, particularly when administered in association with heparin, and the use of both agents may diminish their efficacy (Levi, de Jonge, & van der Poll, 2006). Some studies have demonstrated a decrease in mortality when recombinant APC is used, but similar benefit has not been seen after infusion of AT (Levi, 2007).

## Nursing Management

Nurses need to be aware of which patients are at risk for DIC. Sepsis and acute promyelocytic leukemia are the most common causes of DIC. Patients need to be assessed thoroughly and frequently for signs and symptoms of thrombi and bleeding and monitored for any progression of these signs (see Chart 33-12).

Chart 33-13 describes care of the patient with DIC. Assessment and interventions should target potential sites of end-organ damage. As organs become ischemic from microthrombi, organ function diminishes; the kidneys, lungs, brain, and skin are particularly vulnerable. Lack of renal perfusion may result in acute tubular necrosis and renal failure, sometimes requiring dialysis. Placement of a large-bore dialysis catheter is extremely hazardous for this patient population and should be accompanied by adequate platelet and plasma transfusions. Hepatic dysfunction is also relatively common, reflected in altered liver function tests, depleted albumin stores, and diminished synthesis of clotting factors.

CHART 33-13

PLAN OF NURSING CARE

## The Patient With Disseminated Intravascular Coagulation (DIC)

**NURSING DIAGNOSIS:** Risk for deficient fluid volume related to bleeding
**GOALS:** Hemodynamic status maintained; urine output ≥30 mL/h

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Avoid procedures/activities that can increase intracranial pressure (eg, coughing, straining to have a bowel movement). | 1. Prevents intracranial bleeding | • Level of consciousness (LOC) stable<br>• CVP 5–12 cm $H_2O$, systolic BP ≥70 mm Hg<br>• Urine output ≥30 mL/hour<br>• Decreased bleeding<br>• Decreased oozing<br>• Decreased ecchymoses<br>• Amenorrhea<br>• Absence of oral and bronchial bleeding<br>• Oral mucosa clean, moist, intact |
| 2. Monitor vital signs closely, including neurologic checks:<br>a. Monitor hemodynamics.<br>b. Monitor abdominal girth.<br>c. Monitor urine output. | 2. Identifies signs of hemorrhage/shock quickly | |
| 3. Avoid medications that interfere with platelet function if possible (eg, ASA, NSAIDs, beta-lactam antibiotics). | 3. Decreases problems with platelet aggregation and adhesion | |
| 4. Avoid rectal probes, rectal medications. | 4. Decreases chance for rectal bleeding. | |
| 5. Avoid IM injections. | 5. Decreases chance for intramuscular bleeding | |
| 6. Monitor amount of external bleeding carefully | 6. | |
| a. Monitor number of dressings, % of dressing saturated; time to saturate a dressing is more objective than "dressing saturated a moderate amount." | a. Provides accurate, objective assessment of extent of bleeding | |
| b. Assess suction output, all excreta for frank or occult blood. | b. Identifies presence of or quantifies extent of bleeding | |
| c. Monitor pad counts in women with vaginal bleeding. | c. Quantifies extent of bleeding | |
| d. Females may receive progesterone to prevent menses. | d. Decreases chance for gynecologic source of hemorrhage | |
| 7. Use low pressure with any suctioning needed. | 7. Prevents excessive trauma that could cause bleeding | |
| 8. Administer oral hygiene carefully.<br>a. Avoid lemon-glycerine swabs, hydrogen peroxide, commercial mouthwashes.<br>b. Use sponge-tipped swabs, salt/baking soda (bicarbonate of soda) mouth rinses. | 8. Prevents excessive trauma that could cause bleeding. Glycerin and alcohol (in commercial mouthwashes) will dry mucosa, increasing risk for bleeding | |
| 9. Avoid dislodging any clots, including those around IV sites and injection sites. | 9. Prevents excessive bleeding at sites | |

**NURSING DIAGNOSIS:** Risk for impaired skin integrity related to ischemia or bleeding
**GOALS:** Skin integrity remains intact; oral mucosa remains intact

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess skin, with particular attention to bony prominences, skin folds. | 1. Prompt identification of any area at risk for skin breakdown or showing early signs of breakdown can facilitate prompt intervention and thus prevent complications. | • Skin integrity remains intact; skin is warm, and of normal color.<br>• Oral mucosa is intact, pink, moist, without bleeding. |
| 2. Reposition carefully; use pressure-reducing mattress.<br>3. Perform careful skin care every 2 hours, emphasizing dependent areas, all bony prominences, perineum. | 2–4. Meticulous skin care and use of measures to prevent pressure on bony prominences decrease the risk of skin trauma. | |

*Continued on following page*

CHART 33-13

## PLAN OF NURSING CARE
### *The Patient With Disseminated Intravascular Coagulation (DIC) (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 4. Use lamb's wool between digits, around ears, as needed.<br>5. Use prolonged pressure after injection or procedure when such measures must be performed (at least 5 minutes).<br>6. Perform oral hygiene carefully (see above). | 5. Initial platelet plug is very unstable and easily dislodged, which can lead to increased bleeding.<br>6. Meticulous care is needed to decrease trauma, bleeding, and risk of infection. | |

**NURSING DIAGNOSIS:** Risk for imbalanced fluid volume related to excessive blood and/or factor component replacement
**GOALS:** Absence of edema; absence of rales; intake not greater than output

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Auscultate breath sounds every 2–4 hour.<br>2. Monitor extent of edema.<br>3. Monitor volume of IVs, blood products; decrease volume of IV medications if indicated.<br>4. Administer diuretics as prescribed. | 1. Crackles can develop quickly.<br>2. Fluid may extend beyond intravascular system.<br>3. Helps prevent fluid overload<br>4. Decreases fluid volume | • Breath sounds clear<br>• Absence of edema<br>• Intake does not exceed output<br>• Weight stable |

**NURSING DIAGNOSIS:** Ineffective tissue perfusion related to microthrombi
**GOALS:** Neurologic status remains intact; absence of hypoxemia; peripheral pulses remain intact; skin integrity remains intact; urine output remains ≥30 mL/h

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess neurologic, pulmonary, integumentary systems.<br>2. Monitor response to heparin therapy.<br>3. Assess extent of bleeding.<br>4. Monitor fibrinogen levels.<br>5. Stop aminocaproic acid (EACA) if symptoms of thrombosis occur. | 1. Initial signs of thrombosis can be subtle.<br>2. Response to heparin is most accurately reflected in fibrinogen level.<br>3. Objective measurements of all sites of bleeding are crucial to accurately assess extent of blood loss.<br>4. Response to heparin is most accurately reflected in fibrinogen level.<br>5. EACA should be used only in setting of extensive hemorrhage not responding to replacement therapy. | • Arterial blood gases, $O_2$ saturation, pulse oximetry, LOC within normal limits<br>• Breath sounds clear<br>• Absence of edema<br>• Intake does not exceed output<br>• Weight stable |

**NURSING DIAGNOSIS:** Anxiety related to uncertainty or possible death
**GOALS:** Fears verbalized/identified; realistic hope maintained

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Identify previous coping mechanisms, if possible; encourage patient to use them as appropriate.<br>2. Explain all procedures and rationale for these in terms patient and family can understand.<br>3. Assist family in supporting patient.<br>4. Use services from behavioral medicine, chaplain as needed. | 1. Identifying previous stressful situations can aid in recall of successful coping mechanisms.<br>2. Decreased knowledge and uncertainty can increase anxiety.<br>3. Family can be useful in assisting patient to use coping strategies and to maintain hope.<br>4. Additional professional intervention may be necessary, particularly if previous coping mechanisms are maladaptive or ineffective. Spiritual dimension should be supported. | • Previously used coping strategies identified and tried, to extent patient is able to do so<br>• Patient indicates understanding of procedures and situation as condition permits |

Respiratory function warrants careful monitoring and aggressive measures to diminish alveolar compromise. Suctioning should be performed as gently as possible to diminish the risk of additional bleeding. Central nervous system involvement can be manifested as headache, visual changes, and alteration in level of consciousness.

## Thrombotic Disorders

Several conditions can alter balance within the normal hemostasis process and cause excessive thrombosis. Abnormalities that predispose a person to thrombotic events include decreased clotting inhibitors within the circulation (which enhances coagulation), altered hepatic function (which may decrease production of clotting factors or clearance of activated coagulation factors), lack of fibrinolytic enzymes, and tortuous or atherosclerotic vessels (which promote platelet aggregation). Thrombosis may occur as an initial manifestation of an occult malignancy or as a complication from a preexisting cancer. It can also be caused by more than one predisposing factor. Several inherited or acquired deficiency conditions, including hyperhomocysteinemia, AT deficiency, protein C deficiency, protein S deficiency, APC resistance, and factor V Leiden deficiency, can predispose a patient to repeated episodes of thrombosis; they are referred to as hypercoagulable states or thrombophilia. Table 33-6 lists these disorders, their abnormal laboratory values, and the need for family testing.

**Table 33-6 HYPERCOAGULABLE STATES**

| Disorder | Abnormal Laboratory Value* |
|---|---|
| **Inherited Disorders (Family Testing Recommended)** | |
| Hyperhomocysteinemia | Homocysteine ↑ after methionine load |
| Antithrombin III (AT III) deficiency | AT III ↓ |
| Protein C deficiency | Protein C activity ↓; must be measured off warfarin (Coumadin) |
| Activated protein C (APC) resistance | Must be measured off anticoagulant; <2× prolongation of PTT when APC added. Patients with APC resistance have a smaller increase in clotting time than normal (ie, the prolongation of clotting time is less than normal). |
| Factor V Leiden | Positive |
| Protein S deficiency | Protein S activity ↓; must be measured off warfarin (Coumadin) |
| Dysfibrinogenemia | ↑ Thrombin time; ↑ reptilase time; ↓ functional fibrinogen; often requires special fibrinogen assays |
| **Acquired Disorders (Family Testing Unnecessary)** | |
| Anticardiolipin antibody | Positive |
| Cancer | Varied, depending on disorder |
| Lupus anticoagulant | Positive |
| Hyperhomocysteinemia | Homocysteine ↑ after methionine load |
| AT III deficiency | AT III ↓ |
| Paroxysmal nocturnal hemoglobinuria | + Hamm's test; acid hemolysis |
| Myeloproliferative disorders | Varied, depending on disorder |
| Nephrotic syndrome | Varied, depending on disorder |
| Cancer chemotherapy | Varied, depending on disorder |

*Protein C and protein S are vitamin K–dependent proteins. Warfarin (Coumadin) interferes with the hepatic synthesis of vitamin K–dependent factors, which may decrease levels of protein C or protein S; therefore, protein C and protein S should be measured while the patient is off warfarin.

Conditions that may result from thrombosis include MI (see Chapter 28), CVA (stroke, brain attack; see Chapter 62), and peripheral arterial occlusive disease (see Chapter 31). Anticoagulation therapy is necessary. The duration of therapy varies with the location and extent of the thrombosis, precipitating events (eg, trauma, immobilization), and concurrent risk factors (eg, use of oral contraceptives, tortuous blood vessels, history of thrombotic events). With some conditions, or with repeated thrombosis, lifelong anticoagulant therapy is necessary.

## Hyperhomocysteinemia

Increased plasma levels of homocysteine are a significant risk factor not only for venous thrombosis (eg, DVT, pulmonary embolism) but also for arterial thrombosis (eg, stroke, MI). Hyperhomocysteinemia can be hereditary, or it can result from a nutritional deficiency of folic acid and, to a lesser extent, of vitamins $B_{12}$ and $B_6$, because these vitamins are cofactors in homocysteine metabolism. For unknown reasons, people who are elderly, those with renal failure, and smokers may also have elevated levels of homocysteine in the absence of nutritional deficiencies of these vitamins. Although a simple fasting measurement of plasma homocysteine can serve as a useful screening test, people with genetically inherited hyperhomocysteinemia and those who are vitamin $B_6$ deficient may have normal or minimally elevated levels. A more sensitive method involves obtaining a second measurement 4 hours after the patient consumes methionine; the hyperhomocysteinemia is found twice as often when this method is used. In hyperhomocysteinemia, the endothelial lining of the vessel walls is denuded, which can precipitate thrombus formation. Patients who are found to have hyperhomocysteinemia should receive folic acid, vitamin $B_6$, and vitamin $B_{12}$ supplements and should understand the rationale for their use.

## Antithrombin Deficiency

AT is a protein that inhibits thrombin and certain coagulation factors, and it may also play a role in diminishing inflammation within the endothelium of blood vessels. AT deficiency is a hereditary condition that can cause venous thrombosis, particularly when the AT level is less than 60% of normal. Patients with AT deficiency rarely develop thrombosis before puberty. By 50 years of age, two thirds of patients with AT deficiency have venous thrombosis. The most common sites for thrombosis are the deep veins of the leg and the mesentery. Recurrent thrombosis often occurs, particularly as the patient ages. Patients tend to exhibit heparin resistance; thus, they may require greater amounts of heparin to achieve adequate anticoagulation. Patients with AT deficiency should be encouraged to have their family members tested for the deficiency.

AT deficiency can also be acquired by four mechanisms: accelerated consumption of AT (as in DIC), reduced synthesis of AT (as in hepatic dysfunction), increased excretion

of AT (as in nephrotic syndrome), and medication induced (eg, estrogens, L-asparaginase).

## Protein C Deficiency

Protein C is an enzyme that, when activated, inhibits coagulation. When levels of protein C are deficient, the risk of thrombosis increases, and thrombosis can often occur spontaneously. People who are deficient in protein C are often without symptoms until their 20s; the risk of having a thrombotic event then increases, with a median age at first thrombosis ranging from 30 to 45 years. A rare but significant complication of anticoagulation management in patients with protein C deficiency is warfarin-induced skin necrosis. This complication appears to result from progressive thrombosis in the capillaries within the skin. The extent of the necrosis can be extreme. Prompt cessation of warfarin, treatment with vitamin K, and infusions of heparin and fresh-frozen plasma are crucial to arrest the pathophysiologic process and reverse the effects of the warfarin. Treatment with purified protein C concentrate is sometimes indicated.

## Protein S Deficiency

Protein S is another natural anticoagulant normally produced by the liver. APC requires protein S to inactivate certain clotting factors. When the level of protein S is deficient, this inactivation process is diminished, and the risk of thrombosis can be increased. Like patients with protein C deficiency, those with protein S deficiency have a greater risk of recurrent venous thrombosis early in life, as early as 15 years of age. More than 50% of these thromboses are spontaneous. Thromboses most commonly occur in the axillary, mesenteric, and cerebral veins. Warfarin-induced skin necrosis is possible. Acquired protein S deficiency can also occur. Pregnancy, DIC, liver disease, nephritic syndrome, HIV infection, and the use of L-asparaginase have all been associated with reduced protein S levels.

## Activated Protein C Resistance and Factor V Leiden Mutation

APC resistance is a common condition that can occur with other hypercoagulable states. APC is an anticoagulant, and resistance to APC increases the risk of venous thrombosis. A molecular defect in the factor V gene has been identified in most (90%) patients with APC resistance. This factor V Leiden mutation is the most common cause of inherited hypercoagulability in Caucasians, but its incidence appears to be much lower in other ethnic groups. Factor V Leiden mutation synergistically increases the risk of thrombosis in patients with other risk factors (eg, use of oral contraceptives, hyperhomocysteinemia, increased age). People who are homozygous for the factor V Leiden mutation are at extremely high risk of thrombosis and need anticoagulation for life, whereas those who are heterozygous for the mutation may need anticoagulation for only several months after a thrombotic event.

## Acquired Thrombophilia

### Etiology

#### Antiphospholipid Syndrome

Antibodies to phospholipids are common acquired causes of thrombophilia (hypercoagulable states). The most common of these are either lupus or anticardiolipin antibodies. Both of these antibodies can be transient, resulting from infection or certain medications. In addition, the occurrence of elevated antiphospholipid antibodies becomes increasingly prevalent with age (Rand, 2007). Most thrombotic events are venous, but arterial thrombosis can occur in up to one third of the cases. Patients who persistently test positive for either antibody and who have had a thrombotic event are at significant risk of recurrent thrombosis (greater than 50%). Recurrent thromboses tend to be of the same type—that is, venous thrombosis after an initial venous thrombosis, arterial thrombosis after an initial arterial thrombosis. Thrombi typically occur in large vessels.

#### Malignancy

Another common acquired cause of thrombophilia is cancer, particularly stomach, pancreatic, lung, and ovarian cancers. The type of thrombosis that results is unusual. Rather than DVT or pulmonary embolism, the thrombosis occurs in unusual sites, such as the portal, hepatic, or renal vein or the inferior vena cava. Migratory superficial thrombophlebitis or nonbacterial thrombotic endocarditis can also occur. In these patients, anticoagulation can be difficult to manage, and the thrombosis can progress despite standard doses of anticoagulants. LMWH appears to be a more effective anticoagulant than warfarin in treating this patient population (Korte, 2008).

### Medical Management

The primary method of treating thrombotic disorders is anticoagulation. However, in thrombophilic conditions, when to treat (prophylaxis or not) and how long to treat (lifelong or not) can be controversial. Anticoagulation therapy is not without risks; the most significant risk is bleeding. The most common anticoagulant medications are identified in the following section.

#### Pharmacologic Therapy

Along with administering anticoagulant therapy, concerns include minimizing any risk factors that predispose a patient to thrombosis. When risk factors (eg, immobility after surgery, pregnancy) cannot be avoided, prophylactic anticoagulation may be necessary.

**Unfractionated Heparin Therapy**

Heparin is a naturally occurring anticoagulant that enhances AT III and inhibits platelet function. To prevent thrombosis, heparin is typically given as a subcutaneous injection, two or three times daily. To treat thrombosis, heparin is usually administered intravenously. The therapeutic effect of heparin is monitored by serial measurements of the aPTT; the dose is adjusted to maintain the range at 1.5 to 2.5 times the laboratory control. Oral forms

are being evaluated in clinical trials (Stone, Tonnessen & Money, 2007).

***Heparin-Induced Thrombocytopenia.*** Heparin-induced thrombocytopenia (HIT) is a significant complication of heparin-based therapy. HIT involves the formation of antibodies against the heparin–platelet complex. The actual incidence of HIT is unknown, but it has been shown to occur in as many as 5% of patients receiving heparin (Ahmed, Majeed & Powell, 2007; Levy & Hursting, 2007). The type of heparin used, duration of therapy (beyond 4 days), and surgery appear to be risk factors for developing HIT: Bovine preparations are more likely to lead to HIT than porcine preparations, and LMWH formulations carry a lower risk. Prolonged use of heparin (beyond 4 days) and surgery are also risk factors (Ahmed, et al., 2007). Neither the dose nor the route of administration (IV versus subcutaneous) is a risk. A decline in platelet count is a hallmark sign that typically occurs after 4 to 14 days of heparin therapy; therefore, the platelet count should be monitored in any patient beginning heparin therapy. The platelet count can drop significantly, usually by 50% of baseline. The antibodies typically disappear in 2 to 3 months.

Interestingly, affected patients are at increased risk for thrombosis, either venous, arterial, or both, and the thrombosis can range from DVT to MI or CVA, or to ischemic damage to an extremity, necessitating amputation. The risk of fatal thrombosis is 20% to 30% (Ahmed, et al., 2007).

Heparin-associated thrombocytopenia (previously known as HIT-1) is actually more common than HIT. The platelet count declines slightly (rarely less than 100,000/$mm^3$) within 2 to 3 days after heparin is initiated and it returns to a normal level within 4 days after the heparin is stopped (Ahmed, et al., 2007). The incidence is thought to be as high as 10% of heparin-treated patients, and there is no association with thrombosis.

Treatment of HIT includes prompt cessation of heparin and initiation of an alternative means of anticoagulation. If the heparin is stopped without providing additional anticoagulation, the patient is at increased risk for developing new thrombi. Two inhibitors of thrombin, lepirudin (Refludan) and argatroban, are FDA-approved anticoagulants for the treatment of HIT. Oral anticoagulation with warfarin can be initiated only after the platelet count has recovered.

### Low-Molecular-Weight Heparin Therapy

LMWHs (eg, dalteparin [Fragmin], enoxaparin [Lovenox]) are special forms of heparin that have more selective effects on coagulation. Based on their biochemical properties, LMWHs have a longer half-life and a less variable anticoagulant response than unfractionated heparin. These differences permit LMWHs to be safely administered only once or twice daily, without the need for laboratory monitoring for dose adjustments. The incidence of HIT is much lower when an LMWH is used; however, LMWH is 100% cross-reactive with HIT antibodies and therefore contraindicated in HIT. In certain conditions, the use of an LMWH has allowed anticoagulation therapy to be moved entirely to the outpatient setting. Many cases of uncomplicated DVT are being managed outside the hospital. LMWHs are also used as "bridge therapy" when patients receiving anticoagulation therapy (warfarin) require a major invasive procedure such as surgery (Dunn, 2006; du Breuil & Umland, 2007). In this situation, warfarin is stopped 2 to 3 days preoperatively and a LMWH is used in its place until the procedure is performed. After the procedure, warfarin therapy is resumed. If the LMWH is resumed after the procedure, it is discontinued when a therapeutic level of warfarin is achieved.

### Warfarin (Coumadin) Therapy

Coumarin anticoagulants (warfarin [Coumadin]) are antagonists of vitamin K and therefore interfere with the synthesis of vitamin K–dependent clotting factors. Coumarin anticoagulants bind to albumin, are metabolized in the liver, and have an extremely long half-life. Typically, a patient with a venous thromboembolus is initially treated with both heparin (either unfractionated or an LMWH) and warfarin. When the international normalized ratio (INR), which is a standard method of reporting PT, reaches the desired therapeutic range, the heparin is stopped. The dosage required to maintain the therapeutic range (typically an INR of 2.0 to 3.0) varies widely among patients and even within the same patient, depending on the diagnosis and the rationale for anticoagulation. Frequent monitoring of the INR is extremely important so that the dosage of warfarin can be adjusted as needed.

Warfarin is affected by many medications; consultation with a pharmacist is important to assess the extent to which concurrently administered medications, herbs, and nutritional supplements may interact with warfarin. It is also affected by many foods, so patients need dietary instruction and may benefit from consultation with a dietitian. In particular, foods with high vitamin K content antagonize the effects of warfarin. Some of these foods include spinach, broccoli, and lettuce. Chart 33-14 lists agents that interact with warfarin.

## Nursing Management

Patients with thrombotic disorders should avoid activities that lead to circulatory stasis (eg, immobility, crossing the legs). Exercise, especially ambulation, should be performed frequently throughout the day, particularly during long trips by car or plane. Anti-embolism stockings are often prescribed and patients often need assistance in learning how to use them properly. Surgery further increases the risk of thrombosis. Medications that alter platelet aggregation, such as low-dose aspirin, may be prescribed. Some patients require lifelong therapy with anticoagulants such as warfarin. No evidence supports the use of bed rest as a therapeutic intervention in people with DVT (du Breuil & Umland, 2007).

In addition, patients with thrombotic disorders, particularly those with thrombophilia, should be assessed for concurrent risk factors for thrombosis and should avoid them if possible. For example, use of tobacco and nicotine products should be avoided. In many instances, younger patients with thrombophilia may not require prophylactic anticoagulation; however, with concomitant risk factors (eg, pregnancy), increasing age, or subsequent thrombotic events, prophylactic or long-term anticoagulation therapy may be required. Being able to provide the health care provider with an accurate health history can be extremely useful and can help guide the selection of appropriate therapeutic interventions. Patients with hereditary disorders should encourage their siblings and children to be tested for the disorder.

CHART 33-14

PHARMACOLOGY

### Agents That Interact With Warfarin (Coumadin)

Although warfarin (Coumadin), an anticoagulant medication, is commonly used to treat and prevent thrombosis, many drug–drug and drug–food interactions are associated with its use. A careful medication history (including over-the-counter medications, herbs, and other substances, such as vitamins and minerals) is important when oral anticoagulation therapy is prescribed. Consultation with a pharmacist is recommended to assess the extent to which concurrent medications may affect the anticoagulant and for appropriate dosage adjustments. The following list contains a few examples of agents that interact with warfarin.

#### Agents That Inhibit Warfarin Function

- Azathioprine
- Barbiturates
- Carbamazepine
- Cholestyramine
- Corticosteroids
- Cyclosporine
- Dicloxacillin
- Digitalis
- Estrogens
- Ethanol
- Glutethimide
- Griseofulvin
- Haloperidol
- Herbal medicines: coenzyme Q, ginseng, St. John's wort
- Nafcillin
- Oral contraceptives
- Phenytoin
- Rifampin
- Spironolactone
- Sucralfate
- Trazodone

#### Agents That Potentiate Warfarin Function

- Acetaminophen
- Allopurinol
- Amiodarone
- Anabolic steroids
- Anti-inflammatory agents, including nonsteroidal anti-inflammatory drugs
- Antimalarial agents
- Aspirin
- Broad-spectrum antibiotics
- Chloral hydrate
- Chloramphenicol
- Cimetidine
- Colchicine
- Clofibrate
- Chlorpromazine
- Danazol
- Disulfiram
- Erythromycin
- Ethacrynic acid
- Feprazone
- Fluconazole
- Herbal medicines:
  - Danshen, devil's claw, dong quai, feverfew, garlic, gingko, ginseng, papain
- Vitamin C (in very large doses)
- Vitamin E (in very large doses)
- Isoniazid
- Lovastatin
- Mefenamic acid
- Methotrexate
- Metronidazole
- Miconazole
- Omeprazole
- Oral hypoglycemic agents
- Oxyphenbutazone
- Phenytoin
- Probenecid
- Propranolol
- Propylthiouracil
- Quinidine
- Quinine
- Salicylates
- Sulfinpyrazone
- Sulfonamides (long-acting)
- Tamoxifen
- Thyroxine
- Triclofos
- Tricyclic antidepressants

When a patient with a thrombotic disorder is hospitalized, frequent assessments should be performed for signs and symptoms of beginning thrombus formation, particularly in the legs (DVT) and lungs (pulmonary embolism). Ambulation or range-of-motion exercises as well as the use of anti-embolism stockings should be initiated promptly to decrease stasis. Prophylactic anticoagulants are commonly prescribed.

## THERAPIES FOR BLOOD DISORDERS

### Splenectomy

The surgical removal of the spleen (splenectomy) is sometimes necessary. Splenectomy may be required after trauma to the abdomen. Severe hemorrhage can occur if the spleen is ruptured because the spleen is very vascular. Splenectomy is also a possible treatment for hematologic disorders. For example, an enlarged spleen may be the site of excessive destruction of blood cells. If either of these conditions occurs, splenectomy is performed as an emergency procedure. In addition, some patients with grossly enlarged spleens develop severe thrombocytopenia as a result of platelets being sequestered in the spleen. Splenectomy removes the "trap," and platelet counts may normalize over time.

In general, the mortality rate after splenectomy is low. Laparoscopic splenectomy can be performed in selected patients, with a resultant decrease in postoperative morbidity. Complications that may result from surgery are atelectasis, pneumonia, abdominal distention, and abscess formation. Although young children are at the highest risk after splenectomy, all age groups are vulnerable to overwhelming lethal infections and should receive the pneumococcal vaccine (Pneumovax) before undergoing splenectomy, if possible.

**Table 33-7 TYPES OF APHERESIS***

| Procedure | Purpose | Examples of Clinical Use |
|---|---|---|
| Platelet pheresis | Remove platelets | Extreme thrombocytosis, essential thrombocythemia (temporary measure); single-donor platelet transfusion |
| Leukapheresis | Remove WBCs (can be specific to neutrophils or lymphocytes) | Extreme leukocytosis (eg, AML, CML) (very temporary measure); harvest WBCs for transfusion |
| Erythrocytapheresis (RBC exchange) | Remove RBCs | RBC dyscrasias (eg, sickle cell disease); RBCs replaced via transfusion |
| Plasmapheresis (plasma exchange) | Remove plasma proteins | Hyperviscosity syndromes; treatment for some renal and neurologic diseases (eg, Goodpasture's syndrome, TTP, Guillain-Barré, myasthenia gravis) |
| Stem cell harvest | Remove circulating stem cells | Transplantation (donor harvest or autologous) |

*Therapeutic apheresis can be used to treat a wide variety of conditions. When it is used to treat a disease that causes an increase in a specific cell type with a short life in circulation (ie, WBCs, platelets), the reduction in those cells is temporary. However, this temporary reduction permits a margin of safety while waiting for a longer-lasting treatment modality (eg, chemotherapy) to take effect. Apheresis can also be used to obtain stem cells for transplantation, either from a matched donor (allogenic) or from the patient (autologous).

AML, acute myeloid leukemia; CML, chronic myeloid leukemia; RBC, red blood cell; WBC, white blood cell; TTP, thrombotic thrombocytopenic purpura.

The patient is instructed to seek prompt medical attention if even relatively minor symptoms of infection occur. Often, patients with high platelet counts have even higher counts after splenectomy (more than 1 million/mm$^3$), which can predispose them to serious thrombotic or hemorrhagic problems. However, this increase is transient and usually does not warrant additional treatment.

## Therapeutic Apheresis

*Apheresis* is a Greek word meaning separation. In therapeutic apheresis (or pheresis), blood is taken from the patient and passed through a centrifuge, where a specific component is separated from the blood and removed (Table 33-7). The remaining blood is then returned to the patient. The entire system is closed, so the risk of bacterial contamination is low. When platelets or leukocytes are removed, the decrease in these cells within the circulation is temporary. However, the temporary decrease provides a window of time until suppressive medications (eg, chemotherapy) can have therapeutic effects. Sometimes plasma is removed rather than blood cells—typically so that specific, abnormal proteins within the plasma are transiently lowered until a long-term therapy can be initiated.

Apheresis is also used to obtain larger amounts of platelets from a donor than can be provided from a single unit of whole blood. A unit of platelets obtained in this way is equivalent to 6 to 8 units of platelets obtained from six to eight separate donors via standard blood donation methods. Platelet donors can have their platelets apheresed as often as every 14 days. Leukocytes can be obtained similarly, typically after the donor has received growth factors (G-CSF, GM-CSF) to stimulate the formation of additional leukocytes and thereby increase the leukocyte count. The use of these growth factors also stimulates the release of stem cells within the circulation. Apheresis is used to harvest these stem cells (typically over a period of several days) for use in PBSCT.

## Therapeutic Phlebotomy

Therapeutic phlebotomy is the removal of a certain amount of blood under controlled conditions. Patients with elevated hematocrits (eg, those with polycythemia vera) or excessive iron absorption (eg, hemochromatosis) can usually be managed by periodically removing 1 unit (about 500 mL) of whole blood. Eventually this process can produce iron deficiency, leaving the patient unable to produce as many erythrocytes. The actual procedure for therapeutic phlebotomy is similar to that for blood donation (see later discussion).

## Blood Component Therapy

A single unit of whole blood contains 450 mL of blood and 50 mL of an anticoagulant, which can be processed and dispensed for administration. However, it is more appropriate, economical, and practical to separate that unit of whole blood into its primary components: erythrocytes, platelets, and plasma (leukocytes are rarely used; see later discussion). Because the plasma is removed, a unit of PRBCs is very concentrated (hematocrit approximately 70%).

Each component must be processed and stored differently to maximize the longevity of the viable cells and factors within it; each individual blood component has a different storage life. PRBCs are stored at 4°C (39.2°F). With special preservatives, they can be stored safely for up to 42 days before they must be discarded. In contrast, platelets must be stored at room temperature because they cannot withstand cold temperatures, and they last for only 5 days before they must be discarded. To prevent clumping, platelets are gently agitated while stored. Plasma is immediately frozen to maintain the activity of the clotting factors within; it lasts for 1 year if it remains frozen. Alternatively, plasma can be further pooled and processed into blood derivatives, such as albumin, immune globulin, factor VIII, and factor IX. Table 33-8 describes each blood component and how it is commonly used.

## Special Preparations

Factor VIII concentrate (antihemophilic factor) is a lyophilized, freeze-dried concentrate of pooled fractionated human plasma. It is used in treating hemophilia A. Factor IX concentrate (prothrombin complex) is similarly prepared and contains factors II, VII, IX, and X. It is used primarily for treatment of factor IX deficiency (hemophilia B). Factor IX concentrate is also useful in treating congenital factor VII and factor X deficiencies. Recombinant forms of factor VIII, such as Humate-P or Alphanate, are also useful. Because they contain vWF, these agents are used in vWD as well as in hemophilia A, particularly when patients develop factor VIII inhibitors.

Plasma albumin is a large protein molecule that usually stays within vessels and is a major contributor to plasma

**Table 33-8 BLOOD AND BLOOD COMPONENTS COMMONLY USED IN TRANSFUSION THERAPY***

| | Composition | Indications and Considerations |
|---|---|---|
| Whole blood | Cells and plasma, hematocrit about 40% | Volume replacement and oxygen-carrying capacity; usually used only in significant bleeding (>25% blood volume lost) |
| Packed red blood cells (PRBCs) | RBCs with little plasma (hematocrit about 75%); some platelets and WBCs remain | ↑ RBC mass<br>Symptomatic anemia: platelets in the unit are not functional; WBCs in the unit may cause reaction and are not functional |
| Platelets—random | Platelets ($5.5 \times 10^{10}$ platelets/unit)<br>Plasma; some RBCs, WBCs | Bleeding due to severe ↓ platelets<br>Prevent bleeding when platelets <5000–10,000/mm$^3$<br>Survival ↓ in presence of fever, chills, infection<br>Repeated treatment → ↓ survival due to alloimmunization |
| Platelets—single donor | Platelets ($3 \times 10^{11}$ platelets/unit)<br>1 unit is equivalent to 6–8 units of random platelets | Used for repeated treatment: ↓ alloimmunization risk by limiting exposure to multiple donors |
| Plasma | Plasma; all coagulation factors<br>Complement | Bleeding in patients with coagulation factor deficiencies; plasmapheresis |
| Granulocytes | Neutrophils (>$1 \times 10^{10}$/unit); lymphocytes; some RBCs and platelets | Severe neutropenia in selected patients; controversial |
| Lymphocytes (WBCs) | Lymphocytes (number varies) | Stimulate graft-versus-host disease effect |
| Cryoprecipitate | Fibrinogen ≥150 mg/bag, AHF (VIII:C) 80–110 units/bag, von Willebrand factor; fibronectin | von Willebrand disease<br>Hypofibrinogenemia<br>Hemophilia A |
| AHF | Factor VIII | Hemophilia A |
| Factor IX concentrate | Factor IX | Hemophilia B (Christmas disease) |
| Factor IX complex | Factors II, VII, IX, X | Hereditary factor VII, IX, X deficiency; hemophilia A with factor VII inhibitors |
| Albumin | Albumin 5%, 25% | Hypoproteinemia; burns; volume expansion by 5% to ↑ blood volume; 25% → ↓ hematocrit |
| Intravenous gamma-globulin | IgG antibodies | Hypogammaglobulinemia (in CLL, recurrent infections); ITP; primary immunodeficiency states |
| Antithrombin III concentrate (AT III) | AT III (trace amounts of other plasma proteins) | AT III deficiency with or at risk for thrombosis |

*The composition of each type of blood component is described as well as the most common indications for using a given blood component. RBCs, platelets, and fresh-frozen plasma are the blood products most commonly used. When transfusing these blood products, it is important to realize that the individual product is always "contaminated" with very small amounts of other blood products (eg, WBCs mixed in a unit of platelets). This contamination can cause some difficulties, particularly isosensitization, in certain patients.

AHF, antihemophilic factor; CLL, chronic lymphocytic leukemia; ITP, idiopathic thrombocytopenic purpura; RBCs, red blood cells; WBC, white blood cells.

oncotic pressure. This protein is used to expand the blood volume of patients in hypovolemic shock and, rarely, to increase the concentration of circulating albumin in patients with hypoalbuminemia.

Immune globulin is a concentrated solution of the antibody IgG; it contains very little IgA or IgM. It is prepared from large pools of plasma. The IV form (IVIG) is used in various clinical situations to replace inadequate amounts of IgG in patients who are at risk for recurrent bacterial infection (eg, those with CLL, those receiving BMT or PBSCT). It is also used in certain autoimmune disorders, such as ITP. Both albumin and IVIG, in contrast to all other fractions of human blood, cells, or plasma, can survive being subjected to heating at 60°C (140°F) for 10 hours to free them of the viral contaminants that may be present (Chart 33-15).

# PROCURING BLOOD AND BLOOD PRODUCTS

## Blood Donation

To protect both the donor and the recipients, all prospective donors are examined and interviewed before they are allowed to donate their blood. The intent of the interview is to assess the general health status of the donor and to identify risk factors that might harm a recipient of the donor's blood. Donors should be in good health and without any of the following:

- A history of viral hepatitis at any time in the past, or a history of close contact with a patient who had hepatitis or was undergoing dialysis within 6 months.
- A history of receiving a blood transfusion or an infusion of any blood derivative (other than serum albumin) within 12 months
- Previous transfusion in the United Kingdom, Gibraltar, or Falkland Islands. People who received these transfusions are not allowed to donate blood in the United States because they may have an increased likelihood of transmitting Creutzfeldt-Jakob disease.
- A cumulative total stay since 1980 in the United Kingdom of more than 3 months or in any other European country exceeding 6 months, because the likelihood of transmitting Creutzfeldt-Jakob disease may be increased
- A history of untreated syphilis or malaria, because these diseases can be transmitted by transfusion even years later. A person who has been free of symptoms and off therapy for 3 years after malaria may be a donor.
- A history or evidence of drug abuse in which illicit drugs were self-injected, because many IV/injection drug users are carriers of hepatitis and because the risk of HIV is high in this group
- A history of possible exposure to HIV. The population at risk includes people who engage in anal sex, people with multiple sexual partners, IV/injection drug users,

**Chart 33-15 • *Diseases Transmitted by Blood Transfusion***

**Hepatitis (Viral Hepatitis B, C)**

- Greater risk from pooled blood products and blood of paid donors than from volunteer donors
- Screening test detects most hepatitis B and C
- Transmittal risk estimated at 1:10,000

**AIDS (HIV and HTLV)**

- Donated blood screened for antibodies to HIV
- Transmittal risk estimated at 1:670,000
- People with high-risk behaviors (multiple sex partners, anal sex, IV/injection drug use) and people with signs and symptoms that suggest AIDS should not donate blood

**Cytomegalovirus (CMV)**

- Transmittal risk greater for premature newborns with CMV antibody-negative mothers and for immunocompromised recipients who are CMV negative (eg, those with acute leukemia, organ or tissue transplant recipients)
- Blood products rendered "leukocyte reduced" help reduce transmission of virus

**Graft-Versus-Host Disease (GVHD)**

- Occurs only in severely immunocompromised recipients (eg, Hodgkin disease, bone marrow transplantation)
- Transfused lymphocytes engraft in recipient and attack host lymphocytes or body tissues; signs and symptoms are fever, diffuse reddened skin rash, nausea, vomiting, diarrhea
- Preventive measures include irradiating blood products to inactivate donor lymphocytes (no known radiation risks to transfusion recipient) and processing donor blood with leukocyte reduction filters

**Creutzfeldt-Jakob Disease (CJD)**

- Rare, fatal disease causing irreversible brain damage
- No evidence of transmittal by transfusion, but hemophiliacs and others are concerned that transmittal is possible
- All blood donors must be screened for positive family history of CJD
- Potential donors who spent 3 months or more in the United Kingdom or 6 months or more in Europe since 1980 cannot donate blood; blood products from a donor who develops CJD are recalled

sexual partners of people at risk for HIV, and people with hemophilia.

- A skin infection, because of the possibility of contaminating the phlebotomy needle, and subsequently the blood itself
- A recent history of asthma, urticaria, or allergy to medications, because hypersensitivity can be transferred passively to the recipient
- Pregnancy, because of the nutritional demands of pregnancy on the mother
- A history of tooth extraction or oral surgery within 72 hours, because such procedures are frequently associated with transient bacteremia
- A history of untreated exposure to infectious disease within the past 3 weeks, because of the risk of transmission to the recipient
- Recent immunizations, because of the risk of transmitting live organisms (2-week waiting period for live, attenuated organisms; 1 month for rubella, mumps, varicella; 1 year for rabies)
- A history of recent tattoo, because of the risk of bloodborne infections (eg, hepatitis, HIV)
- Cancer, because of the uncertainty about transmission of the disease. People who have a history of a nonhematologic cancer treated with surgery or radiation and who are without evidence of recurrence for at least 5 years are eligible to donate.
- A diagnosis of hemochromatosis (although this exclusion varies among blood centers)
- A history of whole blood donation within the past 56 days

Potential donors should be asked whether they have consumed any aspirin or aspirin-containing medications within the past 3 days. Although aspirin use does not render the donor ineligible, the platelets obtained may be dysfunctional and therefore not useful; aspirin use within 48 to 72 hours contraindicates platelet donation. Aspirin does not affect the erythrocytes or plasma obtained from the donor.

All donors are expected to meet the following minimal requirements:

- Body weight should exceed 50 kg (110 pounds) for a standard 450-mL donation. Donors weighing less than 50 kg donate proportionately less blood. People younger than 17 years of age are disqualified from donation.
- The oral temperature should not exceed 37.5°C (99.6°F).
- The pulse rate should be regular and between 50 and 100 bpm.
- The systolic arterial blood pressure should be 90 to 180 mm Hg, and the diastolic pressure should be 50 to 100 mm Hg.
- The hemoglobin level should be at least 12.5 g/dL for women and 13.5 g/dL for men.

### *Directed Donation*

At times, friends and family of a patient wish to donate blood for that person. These blood donations are termed directed donations. These donations are not any safer than those provided by random donors, because directed donors may not be as willing to identify themselves as having a history of any of the risk factors that disqualify a person from donating blood.

### *Standard Donation*

Phlebotomy consists of venipuncture and blood withdrawal. Standard precautions are used. Donors are placed in a semirecumbent position. The skin over the antecubital fossa is carefully cleansed with an antiseptic preparation, a tourniquet is applied, and venipuncture is performed. Withdrawal of 450 mL of blood usually takes less than 15 minutes. After the needle is removed, donors are asked to hold the involved arm straight up, and firm pressure is applied with sterile gauze for 2 to 3 minutes or until bleeding stops. A firm bandage is then applied. The donor remains recumbent until he or she feels able to sit up, usually within a few minutes. Donors who experience weakness or faintness should rest for a longer period. The donor then receives food and fluids and is asked to remain another 15 minutes.

The donor is instructed to leave the dressing on and to avoid heavy lifting for several hours, to avoid smoking for 1 hour, to avoid drinking alcoholic beverages for 3 hours, to increase fluid intake for 2 days, and to eat healthy meals for at least 2 weeks. Specimens from this donated blood are tested to detect infections and to identify the specific blood type (see later discussion).

### Autologous Donation

A patient's own blood may be collected for future transfusion; this method is useful for many elective surgeries where the potential need for transfusion is high (eg, orthopedic surgery). Preoperative donations are ideally collected 4 to 6 weeks before surgery. Iron supplements are prescribed during this period to prevent depletion of iron stores. Typically, 1 unit of blood is drawn each week; the number of units obtained varies with the type of surgical procedure to be performed (ie, the amount of blood anticipated to be transfused). Phlebotomies are not performed within 72 hours of surgery. Individual blood components can also be collected.

The primary advantage of autologous transfusions is the prevention of viral infections from another person's blood. Other advantages include safe transfusion for patients with a history of transfusion reactions, prevention of alloimmunization, and avoidance of complications in patients with alloantibodies. It is the policy of the American Red Cross that autologous blood is transfused only to the donor. If the blood is not required, it can be frozen until the donor needs it in the future (for up to 10 years). The blood is never returned to the general donor supply of blood products to be used by another person.

Needless autologous donation (ie, performed when the likelihood of transfusion is small) is discouraged because it is expensive, takes time, and uses resources inappropriately. Moreover, in an emergency situation, the autologous units available may be inadequate, and the patient may still require additional units from the general donor supply. Furthermore, although autologous transfusion can eliminate the risk of viral contamination, the risk of bacterial contamination is the same as that in transfusion from random donors.

Contraindications to donation of blood for autologous transfusion are acute infection, severely debilitating chronic disease, hemoglobin level less than 11 g/dL, hematocrit less than 33%, unstable angina, and acute cardiovascular or cerebrovascular disease. A history of poorly controlled epilepsy may be considered a contraindication in some centers.

### Intraoperative Blood Salvage

This transfusion method provides replacement for patients who cannot donate blood before surgery and for those undergoing vascular, orthopedic, or thoracic surgery. During a surgical procedure, blood lost into a sterile cavity (eg, hip joint) is suctioned into a cell-saver machine. The whole blood or PRBCs are washed, often with saline solution; filtered; and then returned to the patient as an IV infusion. Salvaged blood cannot be stored, because bacteria cannot be completely removed from the blood and it cannot be used when it is contaminated with bacteria. The use of intraoperative blood salvage has decreased the need for autologous blood donation.

### Hemodilution

This transfusion method may be initiated before or after induction of anesthesia. About 1 to 2 units of blood are removed from the patient through a venous or arterial line and simultaneously replaced with a colloid or crystalloid solution. The blood obtained is then reinfused after surgery. The advantage of this method is that the patient loses fewer erythrocytes during surgery, because the added IV solutions dilute the concentration of erythrocytes and lower the hematocrit. However, patients who are at risk for myocardial injury should not be further stressed by hemodilution. The efficacy of hemodilution has not been consistently demonstrated in clinical research, and further study is warranted (Toy, Beattie, Gould, et al., 2008).

## Complications of Blood Donation

Excessive bleeding at the donor's venipuncture site is sometimes caused by a bleeding disorder but more often results from a technique error: laceration of the vein, excessive tourniquet pressure, or failure to apply enough pressure after the needle is withdrawn.

Fainting is common after blood donation and may be related to emotional factors, a vasovagal reaction, or prolonged fasting before donation. Because of the loss of blood volume, hypotension and syncope may occur when the donor assumes an erect position. A donor who appears pale or complains of faintness should immediately lie down or sit with the head lowered below the knees. He or she should be observed for another 30 minutes.

Anginal chest pain may be precipitated in patients with unsuspected coronary artery disease. Seizures can occur in donors with epilepsy, although the incidence is very low. Both angina and seizures require further medical evaluation and treatment.

## Blood Processing

Samples of the unit of blood are always taken immediately after donation so that the blood can be typed and tested. Each donation is tested for antibodies to HIV 1 and 2, hepatitis B core antibody (anti-HBc), hepatitis C virus (HCV), human T-cell lymphotropic virus type I (anti-HTLV-I/II), hepatitis B surface antigen (HbsAG), and syphilis. Negative reactions are required for the blood to be used, and each unit of blood is labeled to certify the results. Nucleic acid amplification testing has increased the ability to detect the presence of HCV, HIV, and West Nile virus infections, because it directly tests for genomic nucleic acids of the viruses rather than for the presence of antibodies to the viruses. This testing significantly shortens the "window" of inability to detect HIV and HCV from a donated unit, further ensuring the safety of the blood; the risk of transmission of HIV or HCV is now estimated at 0.7 and 3.6 in 1 million units of blood transfused, respectively (Stollings & Oyen, 2006). Blood is also screened for CMV; if it tests positive for CMV, it can still be used, except in recipients who are negative for CMV and who are immunocompromised (eg, BMT or PBSCT recipients).

Equally important to viral testing is accurate determination of the blood type. More than 200 antigens have been identified on the surface of RBC membranes. Of these, the most important for safe transfusion are the ABO and Rh systems. The ABO system identifies which sugars are present

on the membrane of a person's erythrocytes: A, B, both A and B, or neither A nor B (type O). To prevent a significant reaction, the same type of PRBCs should be transfused. Previously, it was thought that in an emergency situation in which the patient's blood type was not known, type O blood could be safely transfused. This practice is no longer recommended.

The Rh antigen (also called D) is present on the surface of erythrocytes in 85% of the population (Rh positive). Those who lack the D antigen are called Rh negative. PRBCs are routinely tested for the D antigen as well as ABO. Patients should receive PRBCs with a compatible Rh type.

The majority of transfusion reactions (other than those due to procedural error) are due to the presence of donor leukocytes within the blood component unit (PRBCs or platelets); the recipient may form antibodies to the antigens present on these leukocytes. PRBC components typically have 1 to $3 \times 10^9$ leukocytes remaining in each unit. Leukocytes from the blood product are frequently filtered to diminish the likelihood of developing reactions and refractoriness to transfusions, particularly in patients who have chronic transfusion needs. The process of leukocyte filtration renders the blood component "leukocyte poor" (ie, leukopoor). Filtration can occur at the time the unit is collected from the donor and processed, which achieves better results but is more expensive, or at the time the blood component is transfused by attaching a leukocyte filter to the blood administration tubing. Many centers advocate routinely using leukopoor filtered blood components for people who have or are likely to develop chronic transfusion requirements.

When a patient is immunocompromised, as in the case of bone or stem cell transplant, any donor lymphocytes must be removed from the blood components. In this situation, the blood component is exposed to low amounts of radiation (25 Gy) that kill any lymphocytes within the blood component. Irradiated blood products are highly effective in preventing transfusion-associated GVHD, which is fatal in most cases. Irradiated blood products have a shorter shelf life.

## TRANSFUSION

Administration of blood and blood components requires knowledge of correct administration techniques and possible complications. It is very important to be familiar with the agency's policies and procedures for transfusion therapy. Methods for transfusing blood components are presented in Charts 33-16 and 33-17.

### Chart 33-16 • *Transfusion of Packed Red Blood Cells (PRBCs)*

**Preprocedure**

1. Confirm that the transfusion has been prescribed.
2. Check that patient's blood has been typed and cross-matched.
3. Verify that patient has signed a written consent form per institution or agency policy.
4. Explain the procedure to the patient. Instruct patient in signs and symptoms of transfusion reaction (itching, hives, swelling, shortness of breath, fever, chills).
5. Take patient's temperature, pulse, respiration, and blood pressure to establish a baseline and auscultate lungs; assess for jugular venous distention to serve as a baseline for comparison during transfusion.
6. Use hand hygiene and wear gloves in accordance with standard precautions.
7. Use a 20-gauge or larger needle for insertion in a large vein. Use special tubing that contains a blood filter to screen out fibrin clots and other particulate matter. Do not vent the blood container.

**Procedure**

1. Obtain the PRBCs from the blood bank *after* the intravenous line is started. (Institution policy may limit release to only 1 unit at a time.)
2. Double-check the labels with another nurse or physician to make sure that the ABO group and Rh type agree with the compatibility record. Check to see that the number and type on the donor blood label and on the patient's medical record are correct. Check the patient's identification by asking the patient's name and checking the identification wristband.
3. Check the blood for gas bubbles and any unusual color or cloudiness. (Gas bubbles may indicate bacterial growth. Abnormal color or cloudiness may be a sign of hemolysis.)
4. Make sure PRBC transfusion is initiated within 30 minutes after removal of the PRBCs from the blood bank refrigerator.
5. For first 15 minutes, run the transfusion slowly—no faster than 5 mL/min. Observe the patient carefully for adverse effects. If no adverse effects occur during the first 15 minutes, increase the flow rate unless the patient is at high risk for circulatory overload.
6. Monitor closely for 15 to 30 minutes to detect signs of reaction. Monitor vital signs at regular intervals per institution or agency policy; compare results with baseline measurements. Increase frequency of measurements based on patient's condition. Observe the patient frequently throughout the transfusion for any signs of adverse reaction, including restlessness, hives, nausea, vomiting, torso or back pain, shortness of breath, flushing, hematuria, fever, or chills. Should any adverse reaction occur, stop infusion immediately, notify physician, and follow the agency's transfusion reaction standard.
7. Note that administration time does not exceed 4 hours because of the increased risk of bacterial proliferation.
8. Be alert for signs of adverse reactions: circulatory overload, sepsis, febrile reaction, allergic reaction, and acute hemolytic reaction.
9. Change blood tubing after every 2 units transfused, to decrease chance of bacterial contamination.

**Postprocedure**

1. Obtain vital signs and compare with baseline measurements.
2. Dispose of used materials properly.
3. Document procedure in patient's medical record, including patient assessment findings and tolerance to procedure.
4. Monitor patient for response to and effectiveness of the procedure.

*Note:* Never add medications to blood or blood products; if blood is too thick to run freely, normal saline may be added to the unit. If blood must be warmed, use an in-line blood warmer with a monitoring system.

## Chart 33-17 • *Transfusion of Platelets or Fresh-Frozen Plasma (FFP)*

**Preprocedure**

1. Confirm that the transfusion has been prescribed.
2. Verify that patient has signed a written consent form per institution policy.
3. Explain the procedure to the patient. Instruct patient in signs and symptoms of transfusion reaction (itching, hives, swelling, shortness of breath, fever, chills).
4. Take patient's temperature, pulse, respiration, and blood pressure to establish a baseline and auscultate breath sounds to establish a baseline for comparison during transfusion.
5. Use hand hygiene and wear gloves in accordance with standard precautions.
6. Use a 22-gauge or larger needle for placement in a large vein, if possible. Use appropriate tubing per institution policy (platelets often require different tubing from that used for other blood products).

**Procedure**

1. Obtain the platelets or FFP from the blood bank (only *after* the intravenous line is started.)
2. Double-check the labels with another nurse or physician to make sure that the ABO group matches the compatibility record (not usually necessary for platelets; here only if compatible platelets are ordered). Check to see that the number and type on the donor blood label and on the patient's chart are correct. Check the patient's identification by asking the patient's name and checking the identification wristband.
3. Check the blood product for any unusual color or clumps (excessive redness indicates contamination with larger amounts of red blood cells).
4. Make sure platelets or FFP units are administered immediately after they are obtained.
5. Infuse each unit of FFP over 30 to 60 minutes per patient tolerance; infuse each unit of platelets as fast as patient can tolerate to diminish platelet clumping during administration. Observe the patient carefully for adverse effects, including circulatory overload. Decrease rate of infusion if necessary.
6. Observe the patient closely throughout the transfusion for any signs of adverse reaction, including restlessness, hives, nausea, vomiting, torso or back pain, shortness of breath, flushing, hematuria, fever, or chills. Should any adverse reaction occur, stop infusion immediately, notify physician, and follow the agency's transfusion reaction standard.
7. Monitor vital signs at end of transfusion per institution policy; compare results with baseline measurements.
8. Flush line with saline after transfusion to remove blood component from tubing.

**Postprocedure**

1. Obtain vital signs and compare with baseline measurements.
2. Dispose of used materials properly.
3. Document procedure in patient's medical record, including patient assessment findings and tolerance to procedure.
4. Monitor patient for response to and effectiveness of procedure. A platelet count may be ordered 1 hour after platelet transfusion to facilitate this evaluation.

*Note:* FFP requires ABO but not Rh compatibility. Platelets are not typically cross-matched for ABO compatibility. Never add medications to blood or blood products.

## Setting

Although most blood transfusions are performed in the acute care setting, patients with chronic transfusion requirements often can receive transfusions in other settings. Free-standing infusion centers, ambulatory care clinics, physicians' offices, and even patients' homes may be appropriate settings for transfusion. Typically, patients who need chronic transfusions but are otherwise stable physically are appropriate candidates for outpatient therapy. Verification and administration of the blood product are performed as in a hospital setting. Although most blood products can be transfused in the outpatient setting, the home is typically limited to transfusions of PRBCs and factor components (eg, factor VIII for patients with hemophilia).

## Pretransfusion Assessment

### *Patient History*

Patient history is an important component of the pretransfusion assessment to determine the history of previous transfusions as well as previous reactions to transfusion. The history should include the type of reaction, its manifestations, the interventions required, and whether any preventive interventions were used in subsequent transfusions. It is important to assess the number of pregnancies a woman has had, because a high number can increase her risk of reaction due to antibodies developed from exposure to fetal circulation. Other concurrent health problems should be noted, with careful attention to cardiac, pulmonary, and vascular disease.

### *Physical Assessment*

A systematic physical assessment and measurement of baseline vital signs are important before transfusing any blood product. The respiratory system should be assessed, including careful auscultation of the lungs and the patient's use of accessory muscles. Cardiac system assessment should include careful inspection for any edema as well as other signs of cardiac failure (eg, jugular venous distention). The skin should be observed for rashes, petechiae, and ecchymoses. The sclera should be examined for icterus. In the event of a transfusion reaction, a comparison of findings can help differentiate between types of reactions.

## Patient Teaching

Reviewing the signs and symptoms of a transfusion reaction is crucial for patients who have not received a previous transfusion. Even for patients who have received prior transfusions, a brief review of the signs and symptoms of transfusion reactions is advised. Signs and symptoms of a reaction include fever, chills, respiratory distress, low back pain, nausea, pain at the IV site, or anything "unusual." Although a

thorough review is very important, it is also important to reassure the patient that the blood is carefully tested against the patient's own blood (cross-matched) to diminish the likelihood of any untoward reaction. Similarly, the patient can be reassured about the very low possibility of contracting HIV from the transfusion; this fear persists among many people.

## Complications

Any patient who receives a blood transfusion may develop complications from that transfusion. When explaining the reasons for the transfusion, it is important to include the risks and benefits and what to expect during and after the transfusion. Patients must be informed that, although it has been tested carefully, the supply of blood is not completely risk-free. Nursing management is directed toward preventing complications, promptly recognizing complications if they develop, and promptly initiating measures to control complications. The following sections describe the most common or potentially severe transfusion-related complications.

### *Febrile Nonhemolytic Reaction*

A febrile nonhemolytic reaction is caused by antibodies to donor leukocytes that remain in the unit of blood or blood component; it is the most common type of transfusion reaction, accounting for more than 90% of reactions. It occurs more frequently in patients who have had previous transfusions (exposure to multiple antigens from previous blood products) and in Rh-negative women who have borne Rh-positive children (exposure to an Rh-positive fetus raises antibody levels in the untreated mother). These reactions occur in 3% of PRBC transfusions and 20% of platelet transfusions. More than 10% of patients with chronic transfusion requirements develop this type of reaction.

The diagnosis of a febrile nonhemolytic reaction is made by excluding other potential causes, such as a hemolytic reaction or bacterial contamination of the blood product. The signs and symptoms of a febrile nonhemolytic transfusion reaction are chills (minimal to severe) followed by fever (more than 1°C elevation). The fever typically begins within 2 hours after the transfusion is begun. Although the reaction is not life-threatening, the fever, and particularly the chills and muscle stiffness, can be frightening to the patient.

This reaction can be diminished, even prevented, by further depleting the blood component of donor leukocytes; this is accomplished by a leukocyte reduction filter. Antipyretics can be given to prevent fever, but routine premedication is not advised because it can mask the beginning of a more serious transfusion reaction.

### *Acute Hemolytic Reaction*

The most dangerous, and potentially life-threatening, type of transfusion reaction occurs when the donor blood is incompatible with that of the recipient. Antibodies already present in the recipient's plasma rapidly combine with antigens on donor erythrocytes, and the erythrocytes are destroyed in the circulation (ie, intravascular hemolysis). The most rapid hemolysis occurs in ABO incompatibility. This reaction can occur after transfusion of as little as 10 mL of PRBCs. Rh incompatibility often causes a less severe reaction. The most common causes of acute hemolytic reaction are errors in blood component labeling and patient identification that result in the administration of an ABO-incompatible transfusion.

Symptoms consist of fever, chills, low back pain, nausea, chest tightness, dyspnea, and anxiety. As the erythrocytes are destroyed, the hemoglobin is released from the cells and excreted by the kidneys; therefore, hemoglobin appears in the urine (hemoglobinuria). Hypotension, bronchospasm, and vascular collapse may result. Diminished renal perfusion results in acute renal failure, and DIC may also occur.

The reaction must be recognized promptly and the transfusion discontinued immediately. Blood and urine specimens must be obtained and analyzed for evidence of hemolysis. Treatment goals include maintaining blood volume and renal perfusion and preventing and managing DIC.

Acute hemolytic transfusion reactions are preventable. Meticulous attention to detail in labeling blood samples and blood components and accurately identifying the recipient cannot be overemphasized.

### *Allergic Reaction*

Some patients develop urticaria (hives) or generalized itching during a transfusion. The cause of these reactions is thought to be a sensitivity reaction to a plasma protein within the blood component being transfused. Symptoms of an allergic reaction are urticaria, itching, and flushing. The reactions are usually mild and respond to antihistamines. If the symptoms resolve after administration of an antihistamine (eg, diphenhydramine [Benadryl]), the transfusion may be resumed. Rarely, the allergic reaction is severe, with bronchospasm, laryngeal edema, and shock. These reactions are managed with epinephrine, corticosteroids, and vasopressor support, if necessary.

Giving the patient antihistamines before the transfusion may prevent future reactions. For severe reactions, future blood components are washed to remove any remaining plasma proteins. Leukocyte filters are not useful to prevent such reactions, because the offending plasma proteins can pass through the filter.

### *Circulatory Overload*

If too much blood is infused too quickly, hypervolemia can occur. This condition can be aggravated in patients who already have increased circulatory volume (eg, those with heart failure). PRBCs are safer to use than whole blood. If the administration rate is sufficiently slow, circulatory overload may be prevented. For patients who are at risk for, or already in, circulatory overload, diuretics are administered after the transfusion or between units of PRBCs. Patients receiving fresh-frozen plasma or even platelets may also develop circulatory overload. The infusion rate of these blood components must also be titrated to the patient's tolerance.

Signs of circulatory overload include dyspnea, orthopnea, tachycardia, and sudden anxiety. Jugular vein distention, crackles at the base of the lungs, and an increase in blood pressure can also occur. If the transfusion is continued, pulmonary edema can develop, as manifested by severe dyspnea and coughing of pink, frothy sputum.

If fluid overload is mild, the transfusion can often be continued after slowing the rate of infusion and administering diuretics. However, if the overload is severe, the patient is

placed in an upright position with the feet in a dependent position, the transfusion is discontinued, and the physician is notified. The IV line is kept patent with a very slow infusion of normal saline solution or a saline or heparin lock device to maintain access to the vein in case IV medications are necessary. Oxygen and morphine may be needed to treat severe dyspnea (see Chapter 30).

### Bacterial Contamination

The incidence of bacterial contamination of blood components is very low; however, administration of contaminated products puts the patient at great risk. Contamination can occur at any point during procurement or processing but often results from organisms on the donor's skin. Many bacteria cannot survive in the cold temperatures used to store PRBCs, but some organisms can do so. Platelets are at greater risk of contamination because they are stored at room temperature. Recently, blood centers have developed rapid methods of culturing platelet units (Eder, Kennedy, Dy, et al., 2007), thereby diminishing the risk of using a contaminated platelet unit for transfusion.

Preventive measures include meticulous care in the procurement and processing of blood components. When PRBCs or whole blood is transfused, it should be administered within a 4-hour period, because warm room temperatures promote bacterial growth. A contaminated unit of blood product may appear normal, or it may have an abnormal color.

The signs of bacterial contamination are fever, chills, and hypotension. These signs may not occur until the transfusion is complete, occasionally not until several hours after the transfusion. If the condition is not treated immediately with fluids and broad-spectrum antibiotics, septic shock can occur. Even with aggressive management, including vasopressor support, the mortality rate is high.

As soon as the reaction is recognized, any remaining transfusion is discontinued, and the IV line is kept open with normal saline solution. The physician and the blood bank are notified, and the blood container is returned to the blood bank for testing and culture. Sepsis is treated with IV fluids and antibiotics; corticosteroids and vasopressors are often also necessary (see Chapter 15).

### Transfusion-Related Acute Lung Injury

Transfusion-related acute lung injury (TRALI) is a potentially fatal, idiosyncratic reaction that occurs in less than 1 in 5000 transfusions, but as detection improves, the reported incidence will likely increase. TRALI is now the most common transfusion-related cause of death reported to the FDA (Barrett & Kam, 2006; Triulzi, 2006; Cherry, Steciuk, Reddy, et al., 2008).

The underlying pathophysiologic mechanism for TRALI is unknown but is thought to involve antibodies in the donor's plasma that react to the leukocytes in the recipient's blood. Occasionally, the reverse occurs, and antibodies present in the recipient's plasma agglutinate the antigens on the few remaining leukocytes in the blood component being transfused (Barrett & Kam, 2006; Triulzi, 2006). Another theory suggests that an initial insult to the patient's vascular endothelium causes neutrophils to aggregate at the injured endothelium. Various substances within the transfused plasma (lipids, cytokines) then activate these neutrophils (Barrett & Kam, 2006). The end result of this process is interstitial and intra-alveolar edema, as well as extensive sequestration of WBCs within the pulmonary capillaries (Barrett & Kam, 2006; Cherry, et al., 2008).

Onset is abrupt (usually within 6 hours of transfusion, often within 2 hours). Signs and symptoms include acute shortness of breath, hypoxia (arterial oxygen saturation [$SaO_2$] less than 90%), hypotension, fever, and eventual pulmonary edema. Diagnostic criteria include hypoxemia, bilateral pulmonary infiltrates (seen on chest x-ray), and no evidence of cardiac cause for the pulmonary edema (Cherry, et al., 2008). Aggressive supportive therapy (eg, oxygen, intubation, fluid support) may prevent death.

Although TRALI can occur with the transfusion of any blood component, it is far more likely to occur when plasma and, to a lesser extent, platelets are transfused. One commonly used preventive strategy involves limiting the frequency and amount of blood products transfused. Another entails obtaining plasma and possibly platelets only from either men or from women who have never been pregnant (and, consequently, are less likely to have developed offending antibodies) (Estep, Bucci, Farmer, et al., 2008). The efficacy of this approach and its impact on the availability of these blood components remain unclear.

### Delayed Hemolytic Reaction

Delayed hemolytic reactions usually occur within 14 days after transfusion, when the level of antibody has been increased to the extent that a reaction can occur. The hemolysis of the erythrocytes is extravascular via the RES and occurs gradually.

**Table 33-9 COMMON COMPLICATIONS RESULTING FROM LONG-TERM PRBC TRANSFUSION THERAPY***

| Complication | Manifestation | Management |
|---|---|---|
| Infection | Hepatitis (B, C) | May immunize against hepatitis B; treat hepatitis C; monitor hepatic function |
| | Cytomegalovirus (CMV) | WBC filters to protect against CMV |
| Iron overload | Heart failure | Prevent by chelation therapy |
| | Endocrine failure (diabetes, hypothyroidism, hypoparathyroidism, hypogonadism) | |
| Transfusion reaction | Sensitization | Diminish by RBC phenotyping, using WBC-filtered products |
| | Febrile reactions | Diminish by using WBC-filtered products |

*Patients with long-term transfusion therapy requirements are at risk not only for the transfusion reactions discussed in the text but also for the complications noted above. In many cases, the use of WBC-filtered (eg, leukocyte-poor) blood products is standard for patients who receive long-term PRBC transfusion therapy. An aggressive chelation program initiated early in the course of therapy can prevent problems with iron overload.

PRBC, packed red blood cells; RBC, red blood cell; WBC, white blood cell.

CHART 33-18

PHARMACOLOGY

## Pharmacologic Alternatives to Blood Transfusions

### Growth Factors

Recombinant technology has provided a means to produce hematopoietic growth factors necessary for the production of blood cells within the bone marrow. By increasing the body's production of blood cells, transfusions and complications resulting from diminished blood cells (eg, infection from neutropenia) may be avoided. However, the successful use of growth factors requires functional bone marrow. Moreover, the safety of these products has been questioned and the U.S. Food and Drug Administration is limiting their use in some patient populations.

### Erythropoietin

Erythropoietin (epoetin alfa Epogen, Procrit]) is an effective alternative treatment for patients with chronic anemia secondary to diminished levels of erythropoietin, as in chronic renal disease. This medication stimulates erythropoiesis. It also has been used for patients who are anemic from chemotherapy or zidovudine (AZT) therapy and for those who have diseases involving bone marrow suppression, such as myelodysplastic syndrome (MDS). The use of erythropoietin can also enable a patient to donate several units of blood for future use (eg, preoperative autologous donation). The medication can be administered intravenously or subcutaneously, although plasma levels are better sustained with the subcutaneous route. Side effects are rare, but erythropoietin can cause or exacerbate hypertension. If the anemia is corrected too quickly or is overcorrected, the elevated hematocrit can cause headache and, potentially, seizures. Thrombosis has been noted in some patients whose hemoglobins were raised to a high level and thus, it is recommended that a target hemoglobin level of 12 g/dL be used. These adverse effects are rare except for patients with renal failure. Serial complete blood counts (CBCs) should be performed to evaluate the response to the medication. The dose and frequency of administration are titrated to the hematocrit.

### Granulocyte Colony-Stimulating Factor (G-CSF)

G-CSF (filgrastim [Neupogen]) is a cytokine that stimulates the proliferation and differentiation of myeloid stem cells; a rapid increase in neutrophils is seen within the circulation. G-CSF is effective in improving transient but severe neutropenia after chemotherapy or in some forms of MDS. It is particularly useful in preventing bacterial infections that would be likely to occur with neutropenia. G-CSF is administered subcutaneously on a daily basis. The primary side effect is bone pain; this probably reflects the increase in hematopoiesis within the marrow. Serial CBCs should be performed to evaluate the response to the medication and to ensure that the rise in white blood cells is not excessive. The effect of G-CSF on myelopoiesis is short; the neutrophil count drops once the medication is stopped.

### Granulocyte-Macrophage Colony-Stimulating Factor (GM-CSF)

GM-CSF (sargramostim [Leukine]) is a cytokine that is naturally produced by a variety of cells, including monocytes and endothelial cells. It works either directly or synergistically with other growth factors to stimulate myelopoiesis. GM-CSF is not as specific to neutrophils as is G-CSF; thus, an increase in erythroid (red blood cell) and megakaryocytic (platelet) production may also be seen. GM-CSF serves the same purpose as G-CSF. However, it may have a greater effect on macrophage function and therefore may be more useful against fungal infections, whereas G-CSF may be better used to fight bacterial infections. GM-CSF is also administered subcutaneously. Side effects include bone pain, fevers, and myalgias.

### Thrombopoietin

Thrombopoietin (TPO) is a cytokine that is necessary for the proliferation of megakaryocytes and subsequent platelet formation. Unfortunately, clinical studies were stopped due to antibody formation. A second-generation thrombopoietic growth factor (romiplastin [Nplate]) that is nonimmunogenic was recently approved for the treatment of idiopathic thrombocytopenia purpura.

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Signs and symptoms of a delayed hemolytic reaction are fever, anemia, increased bilirubin level, decreased or absent haptoglobin, and possibly jaundice. Rarely, there is hemoglobinuria. Generally, these reactions are not dangerous, but it is important to recognize them, because subsequent transfusions with blood products containing these antibodies may cause a more severe hemolytic reaction. However, recognition is also difficult, because the patient may not be in a health care setting to be tested for this reaction, and even if the patient is hospitalized, the reaction may be too mild to be recognized clinically. Because the amount of antibody present can be too low to detect, it is difficult to prevent delayed hemolytic reactions. Fortunately, the reaction is usually mild and requires no intervention.

#### *Disease Acquisition*

Despite advances in donor screening and blood testing, certain diseases can still be transmitted by transfusion of blood components (see Chart 33-15).

#### *Complications of Long-Term Transfusion Therapy*

The complications that have been described represent a real risk to any patient any time a blood component is administered. However, patients with long-term transfusion requirements (eg, those with MDS, thalassemia, aplastic anemia, sickle cell anemia) are at greater risk for infection transmission and for becoming more sensitized to donor antigens, simply because they are exposed to more units of blood and, consequently, more donors. A summary of complications associated with long-term transfusion therapy is given in Table 33-9.

Iron overload is a complication unique to people who have had long-term PRBC transfusions. One unit of PRBCs contains 250 mg of iron. Patients with chronic transfusion requirements can quickly acquire more iron than they can use, leading to iron overload. Over time, the excess iron deposits in body tissues and can cause organ damage, particularly in the liver, heart, testes, and pancreas. Promptly initiating a program of iron chelation therapy can prevent end-organ damage from iron toxicity (see Myelodysplastic Syndrome,

Nursing Management, and Hereditary Hemochromatosis, Nursing Management).

### Nursing Management for Transfusion Reactions

If a transfusion reaction is suspected, the transfusion must be immediately stopped and the physician notified. A thorough patient assessment is crucial, because many complications have similar signs and symptoms. The following steps are taken to determine the type and severity of the reaction:

- Stop the transfusion. Maintain the IV line with normal saline solution through new IV tubing, administered at a slow rate.
- Assess the patient carefully. Compare the vital signs with baseline, including oxygen saturation. Assess the patient's respiratory status carefully. Note the presence of adventitious breath sounds, use of accessory muscles, extent of dyspnea, and changes in mental status, including anxiety and confusion. Note any chills, diaphoresis, jugular vein distention, and reports of back pain or urticaria.
- Notify the physician of the assessment findings, and implement any treatments prescribed. Continue to monitor the patient's vital signs and respiratory, cardiovascular, and renal status.
- Notify the blood bank that a suspected transfusion reaction has occurred.
- Send the blood container and tubing to the blood bank for repeat typing and culture. The identifying tags and numbers are verified.

If a hemolytic transfusion reaction or bacterial infection is suspected, the nurse does the following:

- Obtains appropriate blood specimens from the patient
- Collects a urine sample as soon as possible to detect hemoglobin in the urine
- Documents the reaction according to the institution's policy

### Pharmacologic Alternatives to Blood Transfusions

Pharmacologic agents that stimulate production of one or more types of blood cells by the marrow are commonly used (Chart 33-18).

Researchers continue to seek a blood substitute that is practical and safe. Manufacturing artificial blood is problematic, given the myriad functions of blood components. Research findings from a recent trial of an artificial blood product were disappointing; the use of this product was associated with cardiovascular toxicity and regulatory approval is not likely (Estep, et al., 2008). The search for an efficacious artificial blood remains elusive.

## PERIPHERAL BLOOD STEM CELL TRANSPLANTATION AND BONE MARROW TRANSPLANTATION

PBSCT and BMT are therapeutic modalities that offer the possibility of cure for some patients with hematologic disorders such as severe aplastic anemia, some forms of leukemia, and thalassemia. These are discussed in detail in Chapter 16.

## CRITICAL THINKING EXERCISES

EBP **1** You are working in a hematology-oncology clinic. The laboratory reports a critical laboratory result for one of your patients with possible MDS: The leukocyte count is $1800/mm^3$ with 40% neutrophils. What other laboratory results would be important to review or consider? The patient is also anemic (hemoglobin 8.2 mg/dL) and platelets are 65,000/mm.$^3$ What observations will you include in your assessment of this patient? Determine the extent to which this patient is neutropenic. What medical treatments would you anticipate? How would you educate the patient about neutropenia precautions? What evidence exists to support your educational interventions? What is the strength of that evidence?

EBP **2** You are caring for a 32-year-old woman who has had repeated hospitalizations for sickle cell crisis. What is the evidence base that indicates which factors should be assessed to determine the patient's educational, coping, and pain management needs? What is the strength of that evidence? Identify the evidence base that supports concepts that you will incorporate into the patient's discharge plan.

**3** A 63-year-old man presents to the emergency department with unilateral swelling and pain of the left lower extremity. He reports this is the third time he has had a blood clot (DVT). How would you determine if he is at risk for having a hypercoagulable disorder? What would you include in your history to help you? How would you respond if he asks you if he will "ever get off Coumadin"? What would you include in your patient education to aid him in adhering to lifelong anticoagulation? What would your interventions be to decrease the risk of postphlebitic syndrome?

**4** You are caring for a patient who is septic and is now receiving a transfusion of 2 units of PRBCs. The patient's temperature spikes to 38.5°C (101.3°F) after half of the second unit has been transfused. What are the possible causes of the fever? How would you differentiate the cause as sepsis versus a transfusion reaction? What are the appropriate nursing interventions? What are the potential causes of transfusion reaction? How are they manifested?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

Alternative Medicine Foundation, Inc., www.amfoundation.org
American Association of Blood Banks (AABB), www.aabb.org
American Cancer Society, www.cancer.org
American Hemochromatosis Society, www.americanhs.org
American Pain Society, www.ampainsoc.org
American Red Cross, www.redcross.org
Aplastic Anemia and MDS International Foundation, www.aamds.org/aplastic
Blood and Marrow Transplant Infonet, www.bmtinfonet.org
International Myeloma Foundation, www.myeloma.org
Leukemia and Lymphoma Society, www.leukemia-lymphoma.org
Myelodysplastic Syndromes Foundation, www.mds-foundation.org
National Cancer Institute Cancer Information Service, www.nci.nih.gov
National Hemophilia Foundation, www.hemophilia.org
National Marrow Donor Program, www.marrow.org
Oncology Nursing Society, www.ons.org
Sickle Cell Disease Association of America, Inc., www.sicklecelldisease.org

# unit 7

# Digestive and Gastrointestinal Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Nausea, Vomiting, and Diarrhea



**Mr. Doyle** is a 32-year-old man who has had several episodes of bloody diarrhea with severe cramping, nausea, and vomiting after attending a party 12 hours earlier where he drank eggnog and ate foods from a buffet table. Vital signs are: Temp 103°F; HR 108; B/P 118/80; Resp 20. Because Mr. Doyle is a kidney transplant recipient and is on immunosuppressive medications, he is admitted to the hospital; his diagnosis is salmonellosis.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# Nursing Classifications and Languages

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **NAUSEA**—Unpleasant wavelike sensation in the back of the throat, epigastrium, or abdomen that may lead to the urge or need to vomit | **NAUSEA MANAGEMENT**—Prevention and alleviation of nausea | **SYMPTOM SEVERITY**—Severity of perceived adverse changes in physical, emotional, and social functioning |
| **DIARRHEA**—Passage of loose, unformed stools | **DIARRHEA MANAGEMENT**—Prevention and alleviation of diarrhea | **COMFORT LEVEL**—Extent of physical and psychological ease |
| **RISK FOR DEFICIENT FLUID VOLUME**—At risk for experiencing vascular, cellular, or intracellular dehydration | **FLUID/ELECTROLYTE MANAGEMENT**—Regulation and prevention of complications from altered fluid and/or electrolyte levels<br>**VOMITING MANAGEMENT**—Prevention and alleviation of vomiting | **HYDRATION**—Adequate water in the intracellular and extracellular compartments of the body |


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# Assessment of Digestive and Gastrointestinal Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the structure and function of the organs of the gastrointestinal (GI) tract.
2. Describe the mechanical and chemical processes involved in digesting and absorbing foods and eliminating waste products.
3. Use assessment parameters appropriate for determining the status of GI function.
4. Describe the appropriate preparation, teaching, and follow-up care for patients who are undergoing diagnostic testing of the GI tract.

## GLOSSARY

**absorption:** phase of the digestive process that occurs when small molecules, vitamins, and minerals pass through the walls of the small and large intestine and into the bloodstream

**achalasia:** absence of peristalsis of the lower esophagus resulting in difficulty swallowing, regurgitation, and sometimes pain

**amylase:** an enzyme that aids in the digestion of starch

**anus:** last section of the GI tract; outlet for waste products from the system

**chyme:** mixture of food with saliva, salivary enzymes, and gastric secretions that is produced as the food passes through the mouth, esophagus, and stomach

**digestion:** phase of the digestive process that occurs when digestive enzymes and secretions mix with ingested food and when proteins, fats, and sugars are broken down into their component smaller molecules

## GLOSSARY *(Continued)*

**dyspepsia:** indigestion; upper abdominal discomfort associated with eating

**elimination:** phase of digestive process that occurs after digestion and absorption, when waste products are evacuated from the body

**esophagus:** collapsible tube connecting the mouth to the stomach, through which food passes as it is ingested

**fibroscopy (gastrointestinal):** intubation of a part of the GI system with a flexible, lighted tube to assist in diagnosis and treatment of diseases of that area

**hydrochloric acid:** acid secreted by the glands in the stomach; mixes with chyme to break it down into absorbable molecules and to aid in the destruction of bacteria

**ingestion:** phase of the digestive process that occurs when food is taken into the GI tract via the mouth and esophagus

**intrinsic factor:** a gastric secretion that combines with vitamin $B_{12}$ so that the vitamin can be absorbed

**large intestine:** the portion of the GI tract into which waste material from the small intestine passes as absorption continues and elimination begins; consists of several parts—ascending segment, transverse segment, descending segment, sigmoid colon, and rectum

**lipase:** an enzyme that aids in the digestion of fats

**pepsin:** a gastric enzyme that is important in protein digestion

**small intestine:** longest portion of the GI tract, consisting of three parts—duodenum, jejunum, and ileum—through which food mixed with all secretions and enzymes passes as it continues to be digested and begins to be absorbed into the bloodstream

**stomach:** distensible pouch into which the food bolus passes to be digested by gastric enzymes

**trypsin:** enzyme that aids in the digestion of protein

Abnormalities of the gastrointestinal (GI) tract are numerous and represent every type of major pathology that can affect other organ systems, including bleeding, perforation, obstruction, inflammation, and cancer. Congenital, inflammatory, infectious, traumatic, and neoplastic lesions have been encountered in every portion and at every site along the length of the GI tract. As with all other organ systems, the GI tract is subject to circulatory disturbances, faulty nervous system control, and aging.

Apart from the many organic diseases to which the GI tract is susceptible, many extrinsic factors can interfere with its normal function and produce symptoms. Stress and anxiety, for example, often find their chief expression in indigestion, anorexia, or motor disturbances of the intestines, sometimes producing constipation or diarrhea. In addition to the state of mental health, physical factors such as fatigue and an inadequate or abruptly changed dietary intake can markedly affect the GI tract. When assessing and instructing the patient, the nurse should consider the variety of mental and physical factors that affect the function of the GI tract.

## Anatomic and Physiologic Overview

### Anatomy of the Gastrointestinal System

The GI tract is a 23- to 26-foot-long (7 m to 7.9 m) pathway that extends from the mouth to the esophagus, stomach, small and large intestines, and rectum to the terminal structure, the **anus** (Fig. 34-1). The **esophagus** is located in the mediastinum anterior to the spine and posterior to the trachea and heart. This hollow muscular tube, which is approximately 25 cm (10 in) in length, passes through the diaphragm at an opening called the diaphragmatic hiatus.

The remaining portion of the GI tract is located within the peritoneal cavity. The **stomach** is situated in the left upper portion of the abdomen under the left lobe of the liver and the diaphragm, overlaying most of the pancreas (see Fig. 34-1). A hollow muscular organ with a capacity of approximately 1500 mL, the stomach stores food during eating, secretes digestive fluids, and propels the partially digested food, or chyme, into the small intestine. The gastroesophageal junction is the inlet to the stomach. The stomach has four anatomic regions: the cardia (entrance), fundus, body, and pylorus (outlet). Circular smooth muscle in the wall of the pylorus forms the pyloric sphincter and controls the opening between the stomach and the small intestine.

The **small intestine** is the longest segment of the GI tract, accounting for about two thirds of the total length. It folds back and forth on itself, providing approximately 7000 cm (70 m) of surface area for secretion and **absorption,** the process by which nutrients enter the bloodstream through the intestinal walls. It has three sections: The most proximal section is the duodenum, the middle section is the jejunum, and the distal section is the ileum. The ileum terminates at the ileocecal valve. This valve, or sphincter, controls the flow of digested material from the ileum into the cecal portion of the large intestine and prevents reflux

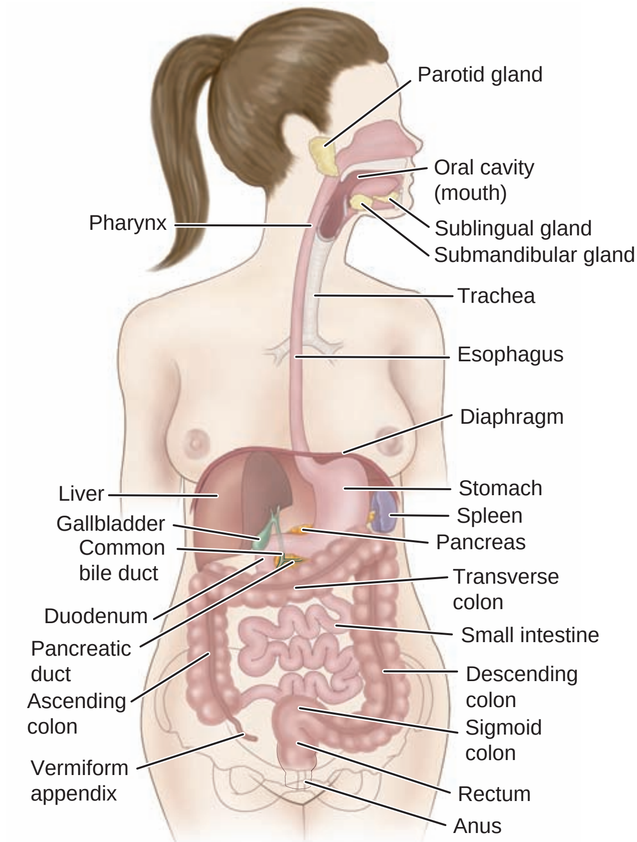



**Figure 34-1** Organs of the digestive system and associated structures.

of bacteria into the small intestine. Attached to the cecum is the vermiform appendix, an appendage that has little or no physiologic function. Emptying into the duodenum at the ampulla of Vater is the common bile duct, which allows for the passage of both bile and pancreatic secretions.

The **large intestine** consists of an ascending segment on the right side of the abdomen, a transverse segment that extends from right to left in the upper abdomen, and a descending segment on the left side of the abdomen. The sigmoid colon, the rectum, and the anus complete the terminal portion of the large intestine. A network of striated muscle that forms both the internal and the external anal sphincters regulates the anal outlet.

The GI tract receives blood from arteries that originate along the entire length of the thoracic and abdominal aorta and veins that return blood from the digestive organs and the spleen. This portal venous system is composed of five large veins: the superior mesenteric, inferior mesenteric, gastric, splenic, and cystic veins, which eventually form the vena portae that enters the liver. Once in the liver, the blood is distributed throughout and collected into the hepatic veins that then terminate in the inferior vena cava. Of particular importance are the gastric artery and the superior and inferior mesenteric arteries. Oxygen and nutrients are supplied to the stomach by the gastric artery and to the intestine by the mesenteric arteries (Fig. 34-2). Venous blood is returned from the small intestine, cecum, and ascending and transverse portions of the colon by the superior mesenteric vein, which corresponds with

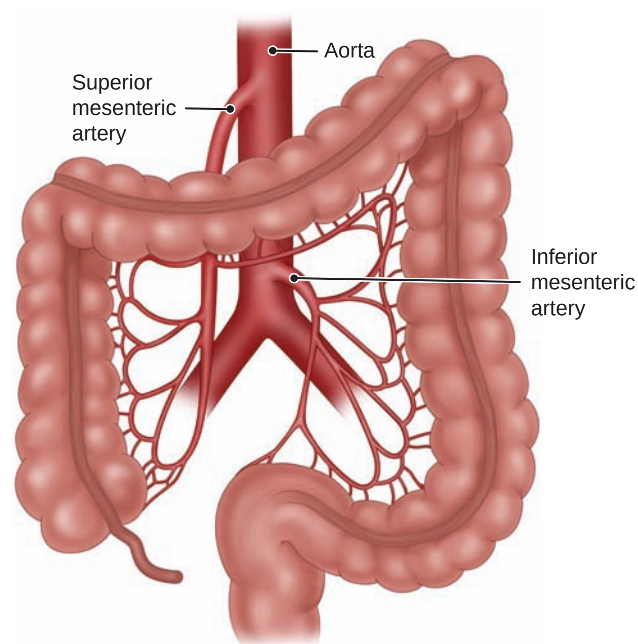



**Figure 34-2** Anatomy and blood supply of the large intestine.

the distribution of the branches of the superior mesenteric artery. Blood flow to the GI tract is about 20% of the total cardiac output and increases significantly after eating.

Both the sympathetic and parasympathetic portions of the autonomic nervous system innervate the GI tract. In general, sympathetic nerves exert an inhibitory effect on the GI tract, decreasing gastric secretion and motility and causing the sphincters and blood vessels to constrict. Parasympathetic nerve stimulation causes peristalsis and increases secretory activities. The sphincters relax under the influence of parasympathetic stimulation except for the sphincter of the upper esophagus and the external anal sphincter, which are under voluntary control.

## Function of the Digestive System

All cells of the body require nutrients. These nutrients are derived from the intake of food that contains proteins, fats, carbohydrates, vitamins, minerals, and cellulose fibers and other vegetable matter, some of which has no nutritional value. Primary functions of the GI tract are the following:

- The breakdown of food particles into the molecular form for **digestion**
- The absorption into the bloodstream of small nutrient molecules produced by digestion
- The **elimination** of undigested unabsorbed foodstuffs and other waste products

After food is ingested, it is propelled through the GI tract, coming into contact with a wide variety of secretions that aid in its digestion, absorption, or elimination from the GI tract.

### *Chewing and Swallowing*

The process of digestion begins with the act of chewing, in which food is broken down into small particles that can be swallowed and mixed with digestive enzymes. Eating—or even the sight, smell, or taste of food—can cause reflex salivation. Approximately 1.5 L of saliva is secreted daily from the parotid, submaxillary, and sublingual glands. Ptyalin, or salivary amylase, is an enzyme that begins the digestion of starches. Water and mucus, also contained in saliva, help lubricate the food as it is chewed, thereby facilitating swallowing.

Swallowing begins as a voluntary act that is regulated by the swallowing center in the medulla oblongata of the central nervous system (CNS). As a bolus of food is swallowed, the epiglottis moves to cover the tracheal opening and prevent aspiration of food into the lungs. Swallowing, which propels the bolus of food into the upper esophagus, thus ends as a reflex action. The smooth muscle in the wall of the esophagus contracts in a rhythmic sequence from the upper esophagus toward the stomach to propel the bolus of food along the tract. During this process of esophageal peristalsis, the lower esophageal sphincter relaxes and permits the bolus of food to enter the stomach. Subsequently, the lower esophageal sphincter closes tightly to prevent reflux of stomach contents into the esophagus.

### *Gastric Function*

The stomach, which stores and mixes food with secretions, secretes a highly acidic fluid in response to the presence or anticipated **ingestion** of food. This fluid, which can total 2.4 L/day, can have a pH as low as 1 and derives its acidity from **hydrochloric acid** (HCl) secreted by the glands of the stomach. The function of this gastric secretion is twofold: to break down food into more absorbable components and to aid in the destruction of most ingested bacteria. **Pepsin,** an important enzyme for protein digestion, is the end product of the conversion of pepsinogen from the chief cells (Table 34-1). **Intrinsic factor,** also secreted by the gastric mucosa, combines with dietary vitamin $B_{12}$ so that the vitamin can be absorbed in the ileum. In the absence of intrinsic factor, vitamin $B_{12}$ cannot be absorbed, and pernicious anemia results (see Chapter 33).

Peristaltic contractions in the stomach propel the stomach's contents toward the pylorus. Because large food particles cannot pass through the pyloric sphincter, they are churned back into the body of the stomach. In this way, food in the stomach is mechanically broken down into smaller particles. Food remains in the stomach for a variable length of time, from 30 minutes to several hours, depending on the volume, osmotic pressure, and chemical composition of the gastric contents. Peristalsis in the stomach and contractions of the pyloric sphincter allow the partially digested food to enter the small intestine at a rate that permits efficient absorption of nutrients. This partially digested food mixed with gastric secretions is called **chyme.** Hormones, neuroregulators, and local regulators found in the gastric secretions control the rate of gastric secretions and influence gastric motility (Table 34-2).

### *Small Intestine Function*

The digestive process continues in the duodenum. Duodenal secretions come from the accessory digestive organs—the pancreas, liver, and gallbladder—and the glands in the wall of the intestine itself. These secretions contain digestive enzymes: amylase, lipase, and bile. Pancreatic secretions have an alkaline pH due to their high concentration of bicarbonate.

**Table 34-1 THE MAJOR DIGESTIVE ENZYMES AND SECRETIONS**

| Enzyme/Secretion | Enzyme Source | Digestive Action |
|---|---|---|
| **Action of Enzymes That Digest Carbohydrates** | | |
| Ptyalin (salivary amylase) | Salivary glands | Starch→dextrin, maltose, glucose |
| Amylase | Pancreas and intestinal mucosa | Starch→dextrin, maltose, glucose<br>Dextrin→maltose, glucose |
| Maltase | Intestinal mucosa | Maltose→glucose |
| Sucrase | Intestinal mucosa | Sucrose→glucose, fructose |
| Lactase | Intestinal mucosa | Lactose→glucose, galactose |
| **Action of Enzymes/Secretions That Digest Protein** | | |
| Pepsin | Gastric mucosa | Protein→polypeptides |
| Trypsin | Pancreas | Proteins and polypeptides→polypeptides, dipeptides, amino acids |
| Aminopeptidase | Intestinal mucosa | Polypeptides→dipeptides, amino acids |
| Dipeptidase | Intestinal mucosa | Dipeptides→amino acids |
| Hydrochloric acid | Gastric mucosa | Protein→polypeptides, amino acids |
| **Action of Enzymes Secretions That Digest Fat (Triglyceride)** | | |
| Pharyngeal lipase | Pharynx mucosa | Triglycerides→fatty acids, diglycerides, monoglycerides |
| Steapsin | Gastric mucosa | Triglycerides→fatty acids, diglycerides, monoglycerides |
| Pancreatic lipase | Pancreas | Triglycerides→fatty acids, diglycerides, monoglycerides |
| Bile | Liver and gallbladder | Fat emulsification |

This alkalinity neutralizes the acid entering the duodenum from the stomach. Digestive enzymes secreted by the pancreas include **trypsin,** which aids in digesting protein; **amylase,** which aids in digesting starch; and **lipase,** which aids in digesting fats. These secretions drain into the pancreatic duct, which empties into the common bile duct at the ampulla of Vater. Bile, secreted by the liver and stored in the gallbladder, aids in emulsifying ingested fats, making them easier to digest and absorb. The sphincter of Oddi, found at the confluence of the common bile duct and duodenum, controls the flow of bile. Hormones, neuroregulators, and local regulators found in these intestinal secretions control the rate of intestinal secretions and also influence GI motility. Intestinal secretions total approximately 1 L/day of pancreatic juice, 0.5 L/day of bile, and 3 L/day of secretions from the glands of the small intestine. Tables 34-1 and 34-2 give further information about the actions of digestive enzymes and GI regulatory substances.

**Table 34-2 THE MAJOR GASTROINTESTINAL REGULATORY SUBSTANCES**

| Substance | Stimulus for Production | Target Tissue | Effect on Secretions | Effect on Motility |
|---|---|---|---|---|
| **Neuroregulators** | | | | |
| Acetylcholine | Sight, smell, chewing food, stomach distention | Gastric glands, other secretory glands, gastric and intestinal muscle | Increased gastric acid | Generally increased; decreased sphincter tone |
| Norepinephrine | Stress, other various stimuli | Secretory glands, gastric and intestinal muscle | Generally inhibitory | Generally decreased; increased sphincter tone |
| **Hormonal Regulators** | | | | |
| Gastrin | Stomach distention with food | Gastric glands | Increased secretion of gastric juice, which is rich in HCl | Increased motility of stomach, decreased time required for gastric emptying<br>Relaxation of ileocecal sphincter<br>Excitation of colon<br>Constriction of gastroesophageal sphincter |
| Cholecystokinin | Fat in duodenum | Gallbladder | Release of bile into duodenum | |
| | | Pancreas | Increased production of enzyme-rich pancreatic secretions | |
| | | Stomach | Inhibits gastric secretion somewhat | |
| Secretin | pH of chyme in duodenum below 4–5 | Stomach | Inhibits gastric secretion somewhat | Inhibits stomach contractions |
| | | Pancreas | Increased production of bicarbonate-rich pancreatic juice | |
| **Local Regulator** | | | | |
| Histamine | Unclear; substances in food | Gastric glands | Increased gastric acid production | |

Two types of contractions occur regularly in the small intestine: segmentation contractions and intestinal peristalsis. *Segmentation contractions* produce mixing waves that move the intestinal contents back and forth in a churning motion. *Intestinal peristalsis* propels the contents of the small intestine toward the colon. Both movements are stimulated by the presence of chyme.

Food, ingested as fats, proteins, and carbohydrates, is broken down into absorbable particles (constituent nutrients) by the process of digestion. Carbohydrates are broken down into disaccharides (eg, sucrose, maltose, and galactose) and monosaccharides (eg, glucose, fructose). Glucose is the major carbohydrate that tissue cells use as fuel. Proteins are a source of energy after they are broken down into amino acids and peptides. Ingested fats become monoglycerides and fatty acid through emulsification, which makes them smaller and easier to absorb. Chyme stays in the small intestine for 3 to 6 hours, allowing for continued breakdown and absorption of nutrients.

Small, fingerlike projections called villi line the entire intestine and function to produce digestive enzymes as well as to absorb nutrients. Absorption is the primary function of the small intestine. Vitamins and minerals are absorbed essentially unchanged. Absorption begins in the jejunum and is accomplished by active transport and diffusion across the intestinal wall into the circulation. Nutrients are absorbed at specific locations in the small intestine and duodenum, whereas fats, proteins, carbohydrates, sodium, and chloride are absorbed in the jejunum. Vitamin $B_{12}$ and bile salts are absorbed in the ileum. Magnesium, phosphate, and potassium are absorbed throughout the small intestine.

#### Colonic Function

Within 4 hours after eating, residual waste material passes into the terminal ileum and slowly into the proximal portion of the right colon through the ileocecal valve. With each peristaltic wave of the small intestine, the valve opens briefly and permits some of the contents to pass into the colon.

Bacteria, a major component of the contents of the large intestine, assist in completing the breakdown of waste material, especially of undigested or unabsorbed proteins and bile salts. Two types of colonic secretions are added to the residual material: an electrolyte solution and mucus. The electrolyte solution is chiefly a bicarbonate solution that acts to neutralize the end products formed by the colonic bacterial action, whereas the mucus protects the colonic mucosa from the interluminal contents and provides adherence for the fecal mass.

Slow, weak peristalsis moves the colonic contents along the tract. This slow transport allows for efficient reabsorption of water and electrolytes, which is the primary function of the colon. Intermittent strong peristaltic waves propel the contents for considerable distances. This generally occurs after another meal is eaten, when intestine-stimulating hormones are released. The waste materials from a meal eventually reach and distend the rectum, usually in about 12 hours. As much as one fourth of the waste materials from a meal may still be in the rectum 3 days after the meal was ingested.

#### Waste Products of Digestion

Feces consist of undigested foodstuffs, inorganic materials, water, and bacteria. Fecal matter is about 75% fluid and 25% solid material. The composition is relatively unaffected by alterations in diet because a large portion of the fecal mass is of nondietary origin, derived from the secretions of the GI tract. The brown color of the feces results from the breakdown of bile by the intestinal bacteria. Chemicals formed by intestinal bacteria are responsible in large part for the fecal odor. Gases formed contain methane, hydrogen sulfide, and ammonia, among others. The GI tract normally contains approximately 150 mL of these gases, which are either absorbed into the portal circulation and detoxified by the liver or expelled from the rectum as flatus.

Elimination of stool begins with distention of the rectum, which initiates reflex contractions of the rectal musculature and relaxes the normally closed internal anal sphincter. The internal sphincter is controlled by the autonomic nervous system; the external sphincter is under the conscious control of the cerebral cortex. During defecation, the external anal sphincter voluntarily relaxes to allow colonic contents to be expelled. Normally, the external anal sphincter is maintained in a state of tonic contraction. Thus, defecation is seen to be a spinal reflex (involving the parasympathetic nerve fibers) that can be inhibited voluntarily by keeping the external anal sphincter closed. Contracting the abdominal muscles (straining) facilitates emptying of the colon. The average frequency of defecation in humans is once daily, but this varies among people.

### Gerontologic Considerations

Although an increased prevalence of several common GI disorders occurs in the elderly population, aging per se appears to have minimal direct effect on most GI functions, in large part because of the functional reserve of the GI tract. Normal physiologic changes of the GI system that occur with aging are identified in Table 34-3. Careful assessment and monitoring of signs and symptoms related to these changes are imperative. Although irritable bowel symptoms decrease with aging, there seems to be an increase in many GI disorders of function and motility. The gastroenterologist frequently encounters elderly patients who report dysphagia, anorexia, dyspepsia, and disorders of colonic function (Salles, 2007).

## Assessment of the Gastrointestinal System

### Health History

A focused GI assessment begins with a complete history. Information about abdominal pain, dyspepsia, gas, nausea and vomiting, diarrhea, constipation, fecal incontinence, jaundice, and previous GI disease is obtained.

#### Common Symptoms

**Pain**

Pain can be a major symptom of GI disease. The character, duration, pattern, frequency, location, distribution of

**Table 34-3 AGE-RELATED CHANGES IN THE GASTROINTESTINAL SYSTEM**

| Structural Changes | Implications |
|---|---|
| **Oral Cavity and Pharynx**<br>• Injury/loss or decay of teeth<br>• Atrophy of taste buds<br>• ↓ Saliva production<br>• Reduced ptyalin and amylase in saliva | Difficulty chewing and swallowing |
| **Esophagus**<br>• ↓ Motility and emptying<br>• Weakened gag reflex<br>• ↓ Resting pressure of lower esophageal sphincter | Reflux and heartburn |
| **Stomach**<br>• Degeneration and atrophy of gastric mucosal surfaces with ↓ production of HCl<br>• ↓ Secretion of gastric acids and most digestive enzymes<br>• ↓ Gastric motility and emptying | Food intolerances, malabsorption, or decrease in vitamin $B_{12}$ absorption |
| **Small Intestine**<br>• Atrophy of muscle and mucosal surfaces<br>• Thinning of villi and epithelial cells | ↓ Motility and transit time, which lead to complaints of indigestion and constipation |
| **Large Intestine**<br>• ↓ Mucus secretion<br>• ↓ Elasticity of rectal wall<br>• ↓ Tone of internal anal sphincter<br>• Slower and duller nerve impulses in rectal area | ↓ Motility and transit time, which lead to complaints of indigestion and constipation<br>↓ Absorption of nutrients (dextrose, fats, calcium, and iron)<br>Fecal incontinence |

↓, decreased; HCl, hydrochloric acid.

referred pain (Fig. 34-3), and time of the pain vary greatly depending on the underlying cause. Other factors such as meals, rest, activity, and defecation patterns may directly affect this pain.

### Dyspepsia

**Dyspepsia,** upper abdominal discomfort associated with eating (commonly called *indigestion*), is the most common symptom of patients with GI dysfunction. Indigestion is an imprecise term that refers to a host of upper abdominal or epigastric symptoms such as pain, discomfort, fullness, bloating, early satiety, belching, heartburn, or regurgitation; it occurs in approximately 25% of the adult population. Typically, fatty foods cause the most discomfort because they remain in the stomach for digestion longer than proteins or carbohydrates. Salads and coarse vegetables as well as highly seasoned foods may also cause considerable GI distress.

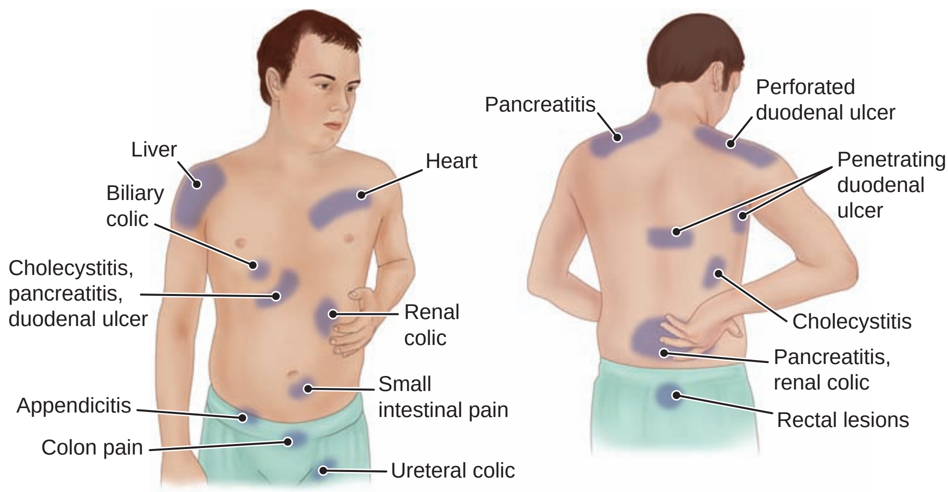



**Figure 34-3** Common sites of referred abdominal pain.

### Intestinal Gas

The accumulation of gas in the GI tract may result in belching (expulsion of gas from the stomach through the mouth) or flatulence (expulsion of gas from the rectum). Usually, gases in the small intestine pass into the colon and are released as flatus. Patients often complain of bloating, distention, or feeling "full of gas" with excessive flatulence as a symptom of food intolerance or gallbladder disease.

### Nausea and Vomiting

Nausea is a vague, uncomfortable sensation of sickness or "queasiness" that may or may not be followed by vomiting. It can be triggered by odors, activity, medications, or food intake. The emesis, or vomitus, may vary in color and content and may contain undigested food particles, blood (hematemesis), or bilious material mixed with gastric juices. The causes of nausea and vomiting are many; they may result from (1) visceral afferent stimulation (ie, dysmotility, peritoneal irritation, infections, hepatobiliary or pancreatic disorders, mechanical obstruction); (2) CNS disorders (ie, vestibular disorders, increased intracranial pressure, infections, psychogenic disorder); or (3) irritation of the chemoreceptor trigger zone from radiation therapy, systemic disorders, and antitumor chemotherapy medications.

### Change in Bowel Habits and Stool Characteristics

Changes in bowel habits may signal colonic dysfunction or disease. Diarrhea, an abnormal increase in the frequency and liquidity of the stool or in daily stool weight or volume, commonly occurs when the contents move so rapidly through the intestine and colon that there is inadequate time for the GI secretions and oral contents to be absorbed. This physiologic function is typically associated with abdominal pain or cramping and nausea or vomiting. Constipation, a decrease in the frequency of stool, or stools that are hard, dry, and of smaller volume than normal, may be associated with anal discomfort and rectal bleeding. See Chapter 38 for further discussion of diarrhea and constipation.

The characteristics of the stool can vary greatly. Stool is normally light to dark brown; however, specific disease processes and ingestion of certain foods and medications may change the appearance of stool (Table 34-4). Blood in the stool can present in various ways and must be investigated. If blood is shed in sufficient quantities into the upper GI tract, it produces a tarry-black color (melena), whereas blood entering the lower portion of the GI tract or passing rapidly through it will appear bright or dark red. Lower rectal or anal bleeding is suspected if there is streaking of blood on the surface of the stool or if blood is noted on toilet tissue.

**Table 34-4 FOODS AND MEDICATIONS THAT ALTER STOOL COLOR**

| Altering Substance | Color |
|---|---|
| Meat protein | Dark brown |
| Spinach | Green |
| Carrots and beets | Red |
| Cocoa | Dark red or brown |
| Senna | Yellow |
| Bismuth, iron, licorice, and charcoal | Black |
| Barium | Milky white |

Other common abnormalities in stool characteristics described by the patient may include:

- Bulky, greasy, foamy stools that are foul in odor and may or may not float
- Light-gray or clay-colored stool, caused by a decrease or absence of conjugated bilirubin
- Stool with mucous threads or pus that may be visible on gross inspection of the stool
- Small, dry, rock-hard masses occasionally streaked with blood
- Loose, watery stool that may or may not be streaked with blood

#### *Past Health, Family, and Social History*

The nurse asks about the patient's normal brushing and flossing routine; frequency of dental visits; awareness of any lesions or irritated areas in the mouth, tongue, or throat; recent history of sore throat or bloody sputum; discomfort caused by certain foods; daily food intake; use of alcohol and tobacco, including smokeless chewing tobacco; and the need to wear dentures or a partial plate. For information about denture care, see Chart 34-1.

Past and current medication use and any previous diagnostic studies, treatments, or surgery are noted. Current nutritional status is assessed via history; laboratory tests (complete metabolic panel including liver function studies, triglycerides, iron studies, and complete blood count [CBC]) are obtained. History of tobacco and alcohol use includes details about type, amount, length of use, and the date of discontinuation, if any. The nurse and patient discuss changes in appetite or eating patterns and any unexplained weight gain or loss over the past year. It is also important to include questions about psychosocial, spiritual, or cultural factors that may be affecting the patient.

## Physical Assessment

The physical examination includes assessment of the mouth, abdomen, and rectum and requires a good source of light, full exposure of the abdomen, warm hands with short fingernails, and a comfortable, relaxed patient with an empty bladder.

#### *Oral Cavity Inspection and Palpation*

Dentures should be removed to allow good visualization of the entire oral cavity.

**CHART 34-1 HEALTH PROMOTION**
***Denture Care***

- Brush dentures twice a day.
- Remove dentures at night and soak them in water or a denture product. (Never put dentures in hot water, because they may warp.)
- Rinse mouth with warm salt water in the morning, after meals, and at bedtime.
- Clean well under partial dentures, where food particles tend to get caught.
- Consume nonsticky foods that have been cut into small pieces; chew slowly.
- See dentist regularly to assess and adjust fit.

### Lips

The examination begins with inspection of the lips for moisture, hydration, color, texture, symmetry, and the presence of ulcerations or fissures. The lips should be moist, pink, smooth, and symmetric. The patient is instructed to open the mouth wide; a tongue blade is then inserted to expose the buccal mucosa for an assessment of color and lesions. Stensen's duct of each parotid gland is visible as a small red dot in the buccal mucosa next to the upper molars.

### Gums

The gums are inspected for inflammation, bleeding, retraction, and discoloration. The odor of the breath is also noted. The hard palate is examined for color and shape.

### Tongue

The dorsum (back) of the tongue is inspected for texture, color, and lesions. A thin white coat and large, vallate papillae in a "V" formation on the distal portion of the dorsum of the tongue are normal findings. The patient is instructed to protrude the tongue and move it laterally. This provides the examiner with an opportunity to estimate the tongue's size as well as its symmetry and strength (to assess the integrity of the 12th cranial nerve [hypoglossal]).

Further inspection of the ventral surface of the tongue and the floor of the mouth is accomplished by asking the patient to touch the roof of the mouth with the tip of the tongue. Any lesions of the mucosa or any abnormalities involving the frenulum or superficial veins on the undersurface of the tongue are assessed for location, size, color, and pain. This is a common area for oral cancer, which presents as a white or red plaque, an indurated ulcer, or a warty growth.

A tongue blade is used to depress the tongue for adequate visualization of the pharynx. It is pressed firmly beyond the midpoint of the tongue; proper placement avoids a gagging response. The patient is told to tip the head back, open the mouth wide, take a deep breath, and say "ah." Often this flattens the posterior tongue and briefly allows a full view of the tonsils, uvula, and posterior pharynx. These structures are inspected for color, symmetry, and evidence of exudate, ulceration, or enlargement. Normally, the uvula and soft palate rise symmetrically with a deep inspiration or "ah"; this indicates an intact vagus nerve (10th cranial nerve).

A complete assessment of the oral cavity is essential because many disorders, such as cancer, diabetes, and immunosuppressive conditions resulting from medication therapy or acquired immunodeficiency syndrome (AIDS), may be manifested by changes in the oral cavity, including stomatitis.

## *Abdominal Inspection, Auscultation, Palpation, and Percussion*

The patient lies supine with knees flexed slightly for inspection, auscultation, palpation, and percussion of the abdomen. For the purposes of examination and documentation, the abdomen can be divided into either four quadrants or nine regions (Fig. 34-4).

Consistent use of one of these mapping methods results in a thorough evaluation of the abdomen and appropriate documentation. The four-quadrant method involves the use of an imaginary line drawn vertically from the sternum to the pubis through the umbilicus and a horizontal line drawn across the abdomen through the umbilicus. Inspection is performed first, noting skin changes, nodules, lesions, scarring, discolorations, inflammation, bruising, or striae. Lesions are of particular importance, because GI diseases often produce skin changes. The contour and symmetry of the abdomen are noted and any localized bulging, distention, or peristaltic waves are identified. Expected contours of the anterior abdominal wall can be described as flat, rounded, or scaphoid.

Auscultation always precedes percussion and palpation because they may alter sounds. It is used to determine the character, location, and frequency of bowel sounds and to identify vascular sounds. Bowel sounds are assessed in all four quadrants using the diaphragm of the stethoscope for high-pitched and gurgling sounds. The frequency and character of the sounds are usually heard as clicks and gurgles that occur irregularly and range from 5 to 35 per minute. The terms *normal* (sounds heard about every 5 to 20 seconds), *hypoactive* (one or two sounds in 2 minutes), *hyperactive* (five to six sounds heard in less than 30 seconds), or *absent* (no sounds in 3 to 5 minutes) are frequently used in documentation, but these assessments are highly subjective. Using the bell of the stethoscope, any bruits in the aortic, renal, iliac, and femoral arteries are noted. Friction rubs are high-pitched and can be heard over the liver and spleen

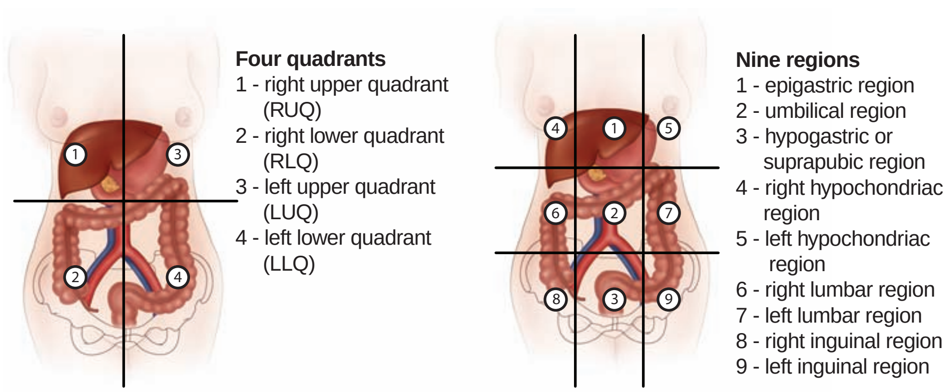



**Figure 34-4** Division of the abdomen into four quadrants or nine regions.

during respiration. Borborygmi or "stomach growling" is heard as a loud prolonged gurgle.

Percussion is used to assess the size and density of the abdominal organs and to detect the presence of air-filled, fluid-filled, or solid masses. Percussion is used either independently or concurrently with palpation because it can validate palpation findings. Use of light palpation is appropriate for identifying areas of tenderness or muscular resistance, and deep palpation is used to identify masses. All quadrants are percussed for overall tympani and dullness. Tympani is the sound that results from the presence of air in the stomach and small intestines; dullness is heard over organs and solid masses. Testing for rebound tenderness is not performed by many examiners because it can cause severe pain; light percussion is used instead to produce a mild localized response when peritoneal irritation is present.

#### Rectal Inspection and Palpation

The final part of the examination is evaluation of the terminal portions of the GI tract, rectum, perianal region, and anus. The anal canal is approximately 2.5 to 4 cm (1 to 1.6 inches) in length and opens into the perineum. Concentric rings of muscle, the internal and external sphincters, normally keep the anal canal securely closed. Gloves, water-soluble lubrication, a penlight, and drapes are necessary tools for the evaluation. Although the rectal examination is generally uncomfortable and often embarrassing for the patient, it is a mandatory part of every thorough examination. For women, the rectal examination may be part of the gynecologic examination. Positions for the rectal examination include knee-chest, left lateral with hips and knees flexed, or standing with hips flexed and upper body supported by the examination table. Most patients are comfortable on the right side with knees brought up to the chest. External examination includes inspection for lumps, rashes, inflammation, excoriation, tears, scars, pilonidal dimpling, and tufts of hair at the pilonidal area. The discovery of tenderness, inflammation, or both should alert the examiner to the possibility of a pilonidal cyst, perianal abscess, or anorectal fistula or fissure. The patient's buttocks are carefully spread and visually inspected until the patient has relaxed the external sphincter control. The patient is asked to bear down, thus allowing the ready appearance of fistulas, fissures, rectal prolapse, polyps, and internal hemorrhoids. Internal examination is performed with a lubricated index finger inserted into the anal canal while the patient bears down. The tone of the sphincter is noted, as are any nodules or irregularities of the anal ring. Because this is an uncomfortable part of the examination for most patients, the patient is encouraged to focus on deep breathing and visualization of a pleasant setting during the brief examination.

## Diagnostic Evaluation

GI diagnostic studies can confirm, rule out, stage, or diagnose disease. The diagnosis and treatment of cancer brings psychological distress to patients and their families and can cause anxiety, depression, and adjustment disorders (Steginga, Campbell, Ferguson, et al., 2008; Pirl, Muriel, Hwang, et al., 2007). After the diagnosis, time should be allotted for discussion with the patient, in addition to offering resource materials for information.

Many modalities are available for diagnostic assessment of the GI tract. The majority of these tests and procedures are performed on an outpatient basis in special settings designed for this purpose (eg, endoscopy suite or GI laboratory). In the past, patients who required such tests frequently were elderly; however, within the past 10 years, in part due to heightened media exposure and early diagnosis of colorectal cancer, the median age of patients evaluated for colorectal cancer has decreased significantly. Preparation for many of these studies includes clear liquid diet, fasting, ingestion of a liquid bowel preparation, the use of laxatives or enemas, and ingestion or injection of a contrast agent or a radiopaque dye. These measures are poorly tolerated by some patients and are especially problematic in the elderly population or patients with comorbidities because bowel preparations can significantly alter the internal fluid and electrolyte balance. If further assessment or treatment is needed after any outpatient procedure, the patient may be admitted to the hospital.

Specific nursing interventions for each test are provided later in this chapter. General nursing interventions for the patient who is undergoing a GI diagnostic evaluation include:

- Establishing the nursing diagnosis
- Providing needed information about the test and the activities required of the patient
- Providing instructions about postprocedure care and activity restrictions
- Providing health information and procedural teaching to patients and significant others
- Helping the patient cope with discomfort and alleviating anxiety
- Informing the primary care provider of known medical conditions or abnormal laboratory values that may affect the procedure
- Assessing for adequate hydration before, during, and immediately after the procedure, and providing education about maintenance of hydration

### Serum Laboratory Studies

Initial diagnostic tests begin with serum laboratory studies, including but not limited to CBC, complete metabolic panel, prothrombin time/partial thromboplastin time, triglycerides, liver function tests, amylase, and lipase. Studies such as carcinoembryonic antigen (CEA) and cancer antigen (CA) 19-9 that have sensitivity for colorectal cancer, and alpha-fetoprotein that has sensitivity for liver cancer may be performed. CEA is a protein that is normally not detected in the blood of a healthy person; therefore, when detected, it indicates that cancer is present, but not what type of cancer is present. Practitioners can use CEA results to determine the stage and extent of the disease and the prognosis for those with cancer, especially GI and, in particular, colorectal cancer (Porth & Matfin, 2009; Wang, Lin, Wu, et al., 2007). CA 19-9 is also a protein that exists on the surface of certain cells and is shed by tumor cells, making it useful as a tumor marker to follow the course of the cancer. CA 19-9 levels are elevated in most patients

with advanced pancreatic cancer, but they may also be elevated in other conditions such as colorectal, lung, and gallbladder cancers; gallstones; pancreatitis; cystic fibrosis; and liver disease.

## Stool Tests

Basic examination of the stool includes inspecting the specimen for consistency, color, and occult (not visible) blood. Additional studies, including fecal urobilinogen, fecal fat, nitrogen, *Clostridium difficile,* fecal leukocytes, calculation of stool osmolar gap, parasites, pathogens, food residues, and other substances, require laboratory evaluation.

Stool samples are usually collected on a random basis unless a quantitative study (eg, fecal fat, urobilinogen) is to be performed. Random specimens should be sent promptly to the laboratory for analysis; however, the quantitative 24- to 72-hour collections must be kept refrigerated until transported to the laboratory. Some stool collections require the patient to follow a specific diet or refrain from taking certain medications before the collection. Thorough and accurate patient education regarding a specific stool study prior to collection greatly increases the accuracy of study results.

Fecal occult blood testing (FOBT) is one of the most commonly performed stool tests. It can be useful in initial screening for several disorders, although it is used most frequently in early cancer detection programs. FOBT can be performed at the bedside, in the laboratory, or at home. Probably the most widely used in-office or at-home occult blood test is the Hemoccult II. It is inexpensive, is noninvasive, and carries minimal risk to the patient. However, it should not be performed when there is hemorrhoidal bleeding. In addition, red meats, aspirin, nonsteroidal anti-inflammatory drugs, turnips, and horseradish should be avoided for 72 hours prior to the study, because they may cause a false-positive result. Also, ingestion of vitamin C from supplements or foods can cause a false-negative result. Therefore, a careful assessment of the patient's diet and medication regimen is essential to avoid incorrect interpretation of results. A small amount of the specimen is applied to the guaiac-impregnated paper slide. If the test is performed at home, the patient mails the slide to the physician in an envelope provided for that purpose. Other occult blood tests that may yield more specific and more sensitive readings include Hematest II SENSA and HemoQuant.

Fecal immunologic tests use monoclonal or polyclonal antibodies to detect the globin protein in human hemoglobin. There is no reaction with nonhuman hemoglobin or with foods that contain peroxidase activity; these tests are therefore more specific than guaiac tests (Mandel, 2008). Hemoporphyrin assays detect the broadest range of blood derivatives, but a strict dietary protocol is essential. Quantitative fecal immunochemical tests may be more accurate than guaiac testing and useful for patients who refuse invasive testing (Deenadayalu & Rex, 2007).

The stool DNA test is a relatively new test to detect certain DNA known to be related to colon cancer. More research is needed to determine how often the test needs to be performed. The stool DNA test does not require any dietary or medication restrictions and can detect neoplasia anywhere in the colon. The stool sample can be collected at home (Schroy, Lal, Glick, et al., 2007).

## Breath Tests

The hydrogen breath test was developed to evaluate carbohydrate absorption, in addition to aiding in the diagnosis of bacterial overgrowth in the intestine and short bowel syndrome. This test determines the amount of hydrogen expelled in the breath after it has been produced in the colon (on contact of galactose with fermenting bacteria) and absorbed into the blood.

Urea breath tests detect the presence of *Helicobacter pylori,* the bacteria that can live in the mucosal lining of the stomach and cause peptic ulcer disease. After the patient ingests a capsule of carbon-labeled urea, a breath sample is obtained 10 to 20 minutes later. Because *H. pylori* metabolizes urea rapidly, the labeled carbon is absorbed quickly; it can then be measured as carbon dioxide in the expired breath to determine whether *H. pylori* is present. The patient is instructed to avoid antibiotics or loperamide (Pepto Bismol) for 1 month before the test; sucralfate (Carafate) and omeprazole (Prilosec) for 1 week before the test; and cimetidine (Tagamet), famotidine (Pepcid), and ranitidine (Zantac) for 24 hours before the test. *H. pylori* also can be detected by assessing serum antibody levels.

## Abdominal Ultrasonography

Ultrasonography is a noninvasive diagnostic technique in which high-frequency sound waves are passed into internal body structures and the ultrasonic echoes are recorded on an oscilloscope as they strike tissues of different densities. It is particularly useful in the detection of an enlarged gallbladder or pancreas, the presence of gallstones, an enlarged ovary, an ectopic pregnancy, or appendicitis. Most recently this technique has proven useful in diagnosing acute colonic diverticulitis.

Advantages of abdominal ultrasonography include an absence of ionizing radiation, no noticeable side effects, relatively low cost, and almost immediate results. It cannot be used to examine structures that lie behind bony tissue because bone prevents sound waves from traveling into deeper structures. Gas and fluid in the abdomen or air in the lungs also prevents transmission of ultrasound. An ultrasound produces no ill effects. However, some patients, typically pregnant women, have concerns regarding the energy emitted by the probe.

Endoscopic ultrasonography (EUS) is a specialized enteroscopic procedure that aids in the diagnosis of GI disorders by providing direct imaging of a target area. A small high-frequency ultrasonic transducer is mounted at the tip of the fiberoptic scope, which displays an image that enables tumor staging and visualization of marginal structures. The resulting images have higher-quality resolution and definition than regular ultrasound imaging. EUS may be used to evaluate submucosal lesions, specifically their location and depth of penetration. In addition, EUS may aid in the evaluation of Barrett's esophagus, portal hypertension, chronic pancreatitis, suspected pancreatic neoplasm, biliary tract disease, and changes in the bowel wall due to ulcerative colitis. EUS is a safe and accurate test to use to select patients suspected of having biliary obstructive disease for therapeutic endoscopic retrograde cholangiopancreatography (ERCP) (Lee, Chan, Leung, et al., 2008). Intestinal gas,

bone, and thick layers of adipose tissue, which hamper conventional ultrasonography, are not problems when EUS is used.

### Nursing Interventions

The patient is instructed to fast for 8 to 12 hours before the test to decrease the amount of gas in the bowel. If gallbladder studies are being performed, the patient should eat a fat-free meal the evening before the test. If barium studies are to be performed, they should be scheduled after ultrasonography; otherwise, the barium could interfere with the transmission of the sound waves.

## DNA Testing

Researchers have refined methods for genetics risk assessment, preclinical diagnosis, and prenatal diagnosis to identify people who are at risk for certain GI disorders (eg, gastric cancer, lactose deficiency, inflammatory bowel disease, colon cancer) (Chart 34-2). In some cases, DNA testing allows clinicians to prevent (or minimize) disease, by intervening before its onset, and to improve therapy (Chan-Smutko, Patel, Shannon, et al., 2008). People who are identified as at risk for certain GI disorders may choose to have genetic counseling to learn about the disease and options for preventing and treating the disease and to receive support in coping with the situation.

## Imaging Studies

Numerous minimally invasive and noninvasive imaging studies, including x-ray and contrast studies, computed tomography (CT), three-dimensional CT, magnetic resonance imaging (MRI), positron emission tomography (PET), scintigraphy (radionuclide imaging), and virtual colonoscopy, are available today.

### Upper Gastrointestinal Tract Study

An upper GI fluoroscopy delineates the entire GI tract after the introduction of a contrast agent. A radiopaque liquid (eg, barium sulfate) is commonly used; however, thin barium, Hypaque, and at times water are used due to their low associated risks. The GI series enables the examiner to detect or exclude anatomic or functional disorders of the upper GI organs or sphincters. It also aids in the diagnosis of ulcers, varices, tumors, regional enteritis, and malabsorption syndromes. The procedure may be extended to examine the duodenum and small bowel (small bowel follow-through). As the barium descends into the stomach, the position, patency, and caliber of the esophagus are visualized, enabling the examiner to detect or exclude any anatomic or functional derangement of that organ. Fluoroscopic examination next extends to the stomach as its lumen fills with barium, allowing observation of stomach motility, thickness of the gastric wall, the mucosal pattern,

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**CHART 34-2** GENETICS IN NURSING PRACTICE

***Digestive and Gastrointestinal Disorders***

Several digestive and gastrointestinal disorders are associated with genetic abnormalities. Some examples are:
- Cleft lip and/or palate
- Familial adenomatous polyposis
- Hereditary nonpolyposis colorectal cancer (HNPCC)
- Hirschsprung disease (aganglionic megacolon)
- Inflammatory bowel disease (eg, Crohn's disease)
- Pyloric stenosis

**Nursing Assessments**

**Family History Assessment**

- Careful family history assessment for other family members with a similar condition (eg, cleft lip/palate, pyloric stenosis)
- Assess for other family members in several generations with early-onset colorectal cancer
- Inquire about other family members with inflammatory bowel disease
- Assess family history for other cancers (eg, endometrial, ovarian, renal)

**Patient Assessment**

Assess for presence of other clinical conditions:
- With clefting—congenital heart defect, other birth defects suggestive of a genetic syndrome
- With familial adenomatous polyposis—congenital hypertrophy of retinal pigment epithelium (CHRPE)

**Management Issues Specific to Genetics**

- Inquire whether any affected family member has had DNA mutation testing
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetic testing, and gene-based interventions
- Offer appropriate genetic information and resources
- Assess patients' understanding of genetic information
- Provide support to families with newly diagnosed genetic digestive disorders
- Participate in management and coordination of care for patients with genetic conditions and for those who are predisposed to develop or pass on a genetic condition

**Genetics Resources**

**American Cancer Society—**offers general information about cancer and support resources for families, www.cancer.org

**Gene Clinics—**a listing of common genetic disorders with up-to-date clinical summaries and genetic counseling and testing information, www.geneclinics.org

**Genetic Alliance—**a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**National Cancer Institute—**current information about cancer research, treatment, resources for health providers, individuals, and families, www.nci.nih.gov

**National Organization of Rare Disorders—**a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**Online Mendelian Inheritance in Man (OMIM)—**a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/omim/stats/html

patency of the pyloric valve, and the anatomy of the duodenum. Multiple x-ray films are obtained during the procedure, and additional images may be taken at intervals for up to 24 hours to evaluate the rate of gastric emptying. Small bowel x-rays taken while the barium is passing through that area allow for observation of the motility of the small bowel. Obstructions, ileitis, and diverticula can also be detected.

Variations of the upper GI study include double-contrast studies and enteroclysis. The double-contrast method of examining the upper GI tract involves administration of a thick barium suspension to outline the stomach and esophageal wall, after which tablets that release carbon dioxide in the presence of water are administered. This technique has the advantage of showing the esophagus and stomach in finer detail, permitting signs of early superficial neoplasms to be noted.

Enteroclysis is a very detailed, double-contrast study of the entire small intestine that involves the continuous infusion, through a duodenal tube, of 500 to 1000 mL of a thin barium sulfate suspension; after this, methylcellulose is infused through the tube. The barium and methylcellulose fill the intestinal loops and are observed continuously by fluoroscopy and viewed at frequent intervals as they progress through the jejunum and the ileum. This process (even with normal motility) can take up to 6 hours and can be quite uncomfortable for the patient. The procedure aids in the diagnosis of partial small bowel obstructions or diverticula. The value of these x-ray screening studies has diminished as better technology has emerged (Mandel, 2008).

**Nursing Interventions**

Education regarding dietary changes prior to the study should include a clear liquid diet, with nothing by mouth (NPO) from midnight the night before the study; however, each physician may prefer a specific bowel preparation for specific studies. The nurse advises against smoking, chewing gum, and using mints because they can stimulate gastric motility. Typically, oral medications are withheld on the morning of the study and resumed that evening, but each patient's medication regimen should be evaluated on an individual basis. When a patient with insulin-dependent diabetes is NPO, his or her insulin requirements will need to be adjusted accordingly.

Follow-up care is provided after the upper GI procedure to ensure that the patient has eliminated most of the ingested barium. Fluids may be increased to facilitate evacuation of stool and barium.

### Lower Gastrointestinal Tract Study

Visualization of the lower GI tract is obtained after rectal installation of barium. The barium enema can be used to detect the presence of polyps, tumors, or other lesions of the large intestine and demonstrate any anatomic abnormalities or malfunctioning of the bowel. After proper preparation and evacuation of the entire colon, each portion of the colon may be readily observed. The procedure usually takes about 15 to 30 minutes, during which time x-ray images are obtained.

Other means for visualizing the colon include double-contrast studies and a water-soluble contrast study. These tests are still occasionally used because they are relatively inexpensive and simple (Rollandi, Biscaldi & DeCicco, 2007). A double-contrast or air-contrast barium enema involves the instillation of a thicker barium solution, followed by the instillation of air. The patient may feel some cramping or discomfort during this process. This test provides a contrast between the air-filled lumen and the barium-coated mucosa, allowing easier detection of smaller lesions.

If active inflammatory disease, fistulas, or perforation of the colon is suspected, a water-soluble iodinated contrast agent (eg, Gastrografin) can be used. The procedure is the same as for a barium enema, but the patient must first be assessed for allergy to iodine or contrast agent. The contrast agent is eliminated readily after the procedure, so there is no need for postprocedure laxatives. Some diarrhea may occur in a few patients until the contrast agent has been totally eliminated.

**Nursing Interventions**

Preparation of the patient includes emptying and cleansing the lower bowel. This often necessitates a low-residue diet 1 to 2 days before the test (the preparation required by different x-ray departments may vary); a clear liquid diet and a laxative the evening before; NPO after midnight; and cleansing enemas until returns are clear the following morning. The nurse makes sure that barium enemas are scheduled before any upper GI studies. If the patient has active inflammatory disease of the colon, enemas are contraindicated. Barium enemas also are contraindicated in patients with signs of perforation or obstruction; instead, a water-soluble contrast study may be performed. Active GI bleeding may prohibit the use of laxatives and enemas.

Postprocedural patient education includes information about increasing fluid intake; evaluating bowel movements for evacuation of barium; and noting increased number of bowel movements, because barium, due to its high osmolarity, may draw fluid into the bowel, thus increasing the intraluminal contents and resulting in greater output.

### Computed Tomography

CT provides cross-sectional images of abdominal organs and structures. Multiple x-ray images are taken from numerous angles, digitized in a computer, reconstructed, and then viewed on a computer monitor. As the sensitivity and specificity of CT have increased in recent years, so has its use. CT is a valuable tool for detecting and localizing many inflammatory conditions in the colon, such as appendicitis, diverticulitis, regional enteritis, and ulcerative colitis, as well as evaluating the abdomen for diseases of the liver, spleen, kidney, pancreas, and pelvic organs, and structural abnormalities of the abdominal wall. Because the adequacy of detail in the test depends on the presence of fat, this diagnostic tool is not useful for very thin, cachectic patients. The procedure is completely painless, but radiation doses are considerable. Continuous-motion (helical or spiral), three-dimensional CT that provides very detailed pictures of the GI organs and vasculature is also available.

**Nursing Interventions**

CT may be performed with or without oral or intravenous (IV) contrast, but the enhancement of the study is greater

with use of a contrast agent. Any allergies to contrast agents, iodine, or shellfish; the patient's current serum creatinine level; and urine human chorionic gonadotropin must be determined before administration of a contrast agent. Patients allergic to the contrast agent may be premedicated with IV prednisone 24 hours, 12 hours, and 1 hour before the scan.

In addition, renal protective measures include the administration of IV sodium bicarbonate 1 hour before and 6 hours after IV contrast and oral acetylcysteine (Mucomyst) before or after the study. Both sodium bicarbonate and Mucomyst are free radical scavengers that sequester the contrast byproducts that are destructive to renal cells (Ozcan, Guneri, Akdeniz, et al., 2007).

### *Magnetic Resonance Imaging*

MRI is used in gastroenterology to supplement ultrasonography and CT. This noninvasive technique uses magnetic fields and radio waves to produce images of the area being studied. The use of oral contrast agents to enhance the image has increased the application of this technique for the diagnosis of GI diseases. It is useful in evaluating abdominal soft tissues as well as blood vessels, abscesses, fistulas, neoplasms, and other sources of bleeding.

The physiologic artifacts of heartbeat, respiration, and peristalsis may create a less-than-clear image; however, newer, fast-imaging MRI techniques help eliminate these physiologic motion artifacts. MRIs are not totally safe for all people. Any ferromagnetic objects (metals that contain iron) can be attracted to the magnet and cause injury. Items that can be problematic or dangerous include jewelry, pacemakers, dental implants, paperclips, pens, keys, IV poles, clips on patient gowns, and oxygen tanks. MRI is contraindicated for patients with permanent pacemakers, artificial heart valves and defibrillators, implanted insulin pumps, or implanted transcutaneous electrical nerve stimulation devices, because the magnetic field could cause malfunction. MRI is also contraindicated for patients with internal metal devices (eg, aneurysm clips), intraocular metallic fragments, or cochlear implants. Foil-backed skin patches (eg, NicoDerm, nitroglycerine [Transderm-Nitro], scopolamine [Transderm-Scop], clonidine [Catapres-TTS]) should be removed before an MRI because of the risk of burns; however, the patient's physician should be consulted before the patch is removed to determine whether an alternate form of the medication should be provided.

#### Nursing Interventions

Prestudy patient education includes NPO status 6 to 8 hours before the study and removal of all jewelry and other metals. The patient and family are informed that the study may take 60 to 90 minutes; during this time, the technician will instruct the patient to take deep breaths at specific intervals. The close-fitting scanners used in many MRI facilities may induce feelings of claustrophobia, and the machine will make a knocking sound during the procedure. Patients may choose to wear a headset and listen to music or to wear a blindfold during the procedure. Open MRIs that are less close-fitting eliminate the claustrophobia that many patients experience.

### *Positron Emission Tomography*

PET scans produce images of the body by detecting the radiation emitted from radioactive substances. The radioactive substances are injected into the body by IV and are usually tagged with a radioactive atom, such as carbon-11, fluorine-18, oxygen-15, or nitrogen-13. The atoms decay quickly, do not harm the body, have lower radiation levels than a typical x-ray or CT scan, and are eliminated in the urine or feces. The scanner essentially "captures" where the radioactive substances are in the body, transmits information to a scanner, and produces a scan with "hot spots" for evaluation by the radiologist or oncologist.

### *Scintigraphy*

Scintigraphy (radionuclide testing) relies on the use of radioactive isotopes (ie, technetium, iodine, and indium) to reveal displaced anatomic structures, changes in organ size, and the presence of neoplasms or other focal lesions, such as cysts or abscesses. Scintigraphic scanning is also used to measure the uptake of tagged red blood cells and leukocytes. Tagging of red blood cells and leukocytes by injection of a radionuclide is performed to define areas of inflammation, abscess, blood loss, or neoplasm. A sample of blood is removed, mixed with a radioactive substance, and reinjected into the patient. Abnormal concentrations of blood cells are then detected at 24- and 48-hour intervals. Tagged red cell studies are useful in determining the source of internal bleeding when all other studies have returned a negative result.

### *Gastrointestinal Motility Studies*

Radionuclide testing also is used to assess gastric emptying and colonic transit time. During gastric emptying studies, the liquid and solid components of a meal (typically scrambled eggs) are tagged with radionuclide markers. After ingestion of the meal, the patient is positioned under a scintiscanner, which measures the rate of passage of the radioactive substance from the stomach. This is useful in diagnosing disorders of gastric motility, diabetic gastroparesis, and dumping syndrome.

Colonic transit studies are used to evaluate colonic motility and obstructive defecation syndromes. The patient is administered a capsule containing 20 radionuclide markers and instructed to follow a regular diet and normal daily activities. Abdominal x-rays are taken every 24 hours until all markers are passed. This process usually takes 4 to 5 days, but in the presence of severe constipation it may take as long as 10 days. Patients with chronic diarrhea may be evaluated at 8-hour intervals. The amount of time that it takes for the radioactive material to move through the colon indicates colonic motility.

## Endoscopic Procedures

Endoscopic procedures used in GI tract assessment include fibroscopy/esophagogastroduodenoscopy (EGD), small bowel enteroscopy, colonoscopy, sigmoidoscopy, proctoscopy, anoscopy, and endoscopy through an ostomy.

### *Upper Gastrointestinal Fibroscopy/ Esophagogastroduodenoscopy*

**Fibroscopy** of the upper GI tract allows direct visualization of the esophageal, gastric, and duodenal mucosa through a



**Figure 34-5** Patient undergoing gastroscopy.

lighted endoscope (gastroscope) (Fig. 34-5). EGD is valuable when esophageal, gastric, or duodenal disorders or inflammatory, neoplastic, or infectious processes are suspected. This procedure also can be used to evaluate esophageal and gastric motility and to collect secretions and tissue specimens for further analysis.

In EGD, the gastroenterologist views the GI tract through a viewing lens and can obtain images through the scope to document findings. Electronic video endoscopes also are available that attach directly to a video processor, converting the electronic signals into pictures on a television screen. This allows larger and continuous viewing capabilities, as well as the simultaneous recording of the procedure.

PillCam ESO, a pill-sized instrument equipped with two cameras, is available. Each camera takes seven photographs per second and transmits them wirelessly to a nearby storage device (Eliakim, Sharma & Yassin, 2005). This technique is gaining popularity with patients and clinicians alike as a comfortable, convenient alternative to endoscopy. Two major drawbacks to this method of endoscopy are that it evaluates only the esophagus and that the instrument may become lodged in a previously anastomosed section of bowel and require further endoscopic or surgical intervention for removal.

ERCP uses the endoscope in combination with x-rays to view the ductal structures of the biliary tract (Tse, Barkum, Romagnuolo, et al., 2006). The side-viewing flexible scopes are used to visualize the common bile duct and the pancreatic and hepatic ducts through the ampulla of Vater in the duodenum. ERCP is helpful in evaluating jaundice, pancreatitis, pancreatic tumors, common bile duct stones, and biliary tract disease. ERCP is described further in Chapter 40.

Upper GI fibroscopy also can be a therapeutic procedure when combined with other procedures. Therapeutic endoscopy can be used to remove common bile duct stones, dilate strictures, and treat gastric bleeding and esophageal varices. Laser-compatible scopes can be used to provide laser therapy for upper GI neoplasms. Sclerosing solutions can be injected through the scope in an attempt to control upper GI bleeding.

After the patient is sedated, the endoscope is lubricated with a water-soluble lubricant and passed smoothly and slowly along the back of the mouth and down into the esophagus. The gastroenterologist views the gastric wall and the sphincters, and then advances the endoscope into the duodenum for further examination. Biopsy forceps to obtain tissue specimens or cytology brushes to obtain cells for microscopic study can be passed through the scope. The procedure usually takes about 30 minutes.

The patient may experience nausea, gagging, or choking. Use of topical anesthetic agents and moderate sedation makes it important to monitor and maintain the patient's oral airway during and after the procedure. Finger or ear oximeters are used to monitor oxygen saturation, and supplemental oxygen may be administered if needed. Precautions must be taken to protect the scope, because the fiberoptic bundles can be broken if the scope is bent at an acute angle. The patient wears a mouth guard to keep from biting the scope.

#### Nursing Interventions

The patient should be NPO for 8 hours prior to the examination. Before the introduction of the endoscope, the patient is given a local anesthetic gargle or spray. Midazolam (Versed), a sedative that provides moderate sedation and relieves anxiety during the procedure, may be administered. Atropine may be administered to reduce secretions, and glucagon may be administered to relax smooth muscle. The patient is positioned in the left lateral position to facilitate clearance of pulmonary secretions and provide smooth entry of the scope.

After gastroscopy, assessment includes level of consciousness, vital signs, oxygen saturation, pain level, and monitoring for signs of perforation (ie, pain, bleeding, unusual difficulty swallowing, and rapidly elevated temperature). After the patient's gag reflex has returned, lozenges, saline gargle, and oral analgesic agents may be offered to relieve minor throat discomfort. Patients who were sedated for the procedure must remain in bed until fully alert. After moderate sedation, the patient must be transported home with a family member or friend if the procedure was performed on an outpatient basis. Someone should stay with the patient until the morning after the procedure. Because of sedation, many patients will not remember postprocedure instructions. For this reason, discharge and follow-up instructions are provided to the person accompanying the patient home, as well as to the patient. In addition, many endoscopy suites have a program in which a nurse telephones the patient the morning after the procedure to find out if the patient has any concerns or questions related to the procedure.

### *Fiberoptic Colonoscopy*

Historically, direct visualization of the bowel was the only means to evaluate the colon, but virtual colonoscopy (also known as CT colonography) has brought a more patient-friendly approach to this study. Virtual colonoscopy provides a computer-simulated endoluminal perspective of the air-filled distended colon using conventional spiral or helical CT scanning (Fletcher, Booya & Johnson, 2005; Burling, Moore, Marshall, et al., 2008).

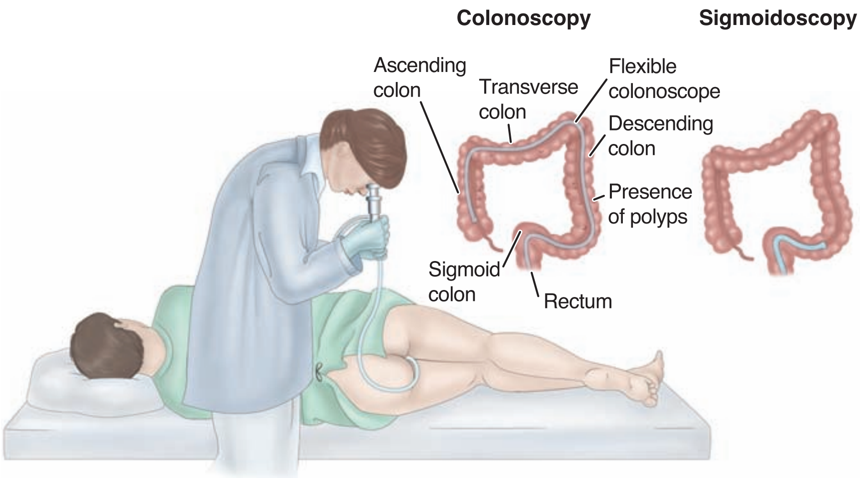



**Figure 34-6** Colonoscopy and flexible fiberoptic sigmoidoscopy. For the colonoscopy, the flexible scope is passed through the rectum and sigmoid colon into the descending, transverse, and ascending colon. For the flexible fiberoptic sigmoidoscopy, the flexible scope is advanced past the proximal sigmoid and then into the descending colon.

Direct visual inspection of the large intestine (anus, rectum, sigmoid, transcending and ascending colon) is possible by means of a flexible fiberoptic colonoscope (Fig. 34-6). These scopes have the same capabilities as those used for EGD but are larger in diameter and longer. Still and video recordings can be used to document the procedure and findings.

This procedure is used commonly as a diagnostic aid and screening device. It is most frequently used for cancer screening (Chart 34-3) and for surveillance in patients with previous colon cancer or polyps. In addition, tissue biopsies can be obtained as needed, and polyps can be removed and evaluated. Other uses of colonoscopy include the evaluation of patients with diarrhea of unknown cause, occult bleeding, or anemia; further study of abnormalities detected on barium enema; and diagnosis, clarification, and determination of the extent of inflammatory or other bowel disease.

Therapeutically, the procedure can be used to remove all visible polyps with a special snare and cautery through the colonoscope. Many colon cancers begin with adenomatous polyps of the colon; therefore, one goal of colonoscopic polypectomy is early detection and prevention of colorectal cancer. This procedure also can be used to treat areas of bleeding or stricture. Use of bipolar and unipolar coagulators, use of heater probes, and injections of sclerosing agents or vasoconstrictors are all possible during this procedure. Laser-compatible scopes provide laser therapy for bleeding lesions or colonic neoplasms. Bowel decompression (removal of intestinal contents to prevent gas and fluid from distending the coils of the intestine) can also be completed during the procedure.

Colonoscopy is performed while the patient is lying on the left side with the legs drawn up toward the chest. The

CHART 34-3

HEALTH PROMOTION

## *American Cancer Society Guidelines for Early Detection of Colon and Rectal Cancer*

Beginning at age 50, both men and women *at average risk* for developing colorectal cancer should use one of the screening tests below. The tests that are designed to find both early cancer and polyps are preferred if these tests are available to you and you are willing to have one of these more invasive tests. Talk to your doctor about what test is best for you.

**Tests That Find Polyps and Cancer**

- Flexible sigmoidoscopy every 5 years*
- Colonoscopy every 10 years
- Double-contrast barium enema every 5 years*
- Computed tomography (CT) colonography (virtual colonoscopy) every 5 years*

**Tests That Mainly Find Cancer**

- Fecal occult blood test (FOBT) every year*,**
- Fecal immunochemical test (FIT) every year*,**
- Stool DNA test (sDNA), interval uncertain*

People should talk to their doctor about starting colorectal cancer screening earlier and/or being screened more often if they have any of the following colorectal cancer risk factors:

- A personal history of colorectal cancer or adenomatous polyps
- A personal history of chronic inflammatory bowel disease (Crohn's disease or ulcerative colitis)
- A strong family history of colorectal cancer or polyps (cancer or polyps in a first-degree relative [parent, sibling, or child] younger than 60 or in two or more first-degree relatives of any age)
- A known family history of hereditary colorectal cancer syndrome such as familial adenomatous polyposis (FAP) or hereditary nonpolyposis colon cancer (HNPCC)

*Colonoscopy should be done if test results are positive.
**For FOBT or FIT used as a screening test, the take-home multiple sample method should be used. An FOBT or FIT done during a digital rectal exam in the doctor's office is not adequate for screening.

patient's position may be changed during the test to facilitate advancement of the scope. Biopsy forceps or a cytology brush may be passed through the scope to obtain specimens for histology and cytology examinations. Complications during and after the procedure can include cardiac dysrhythmias and respiratory depression resulting from the medications administered; vasovagal reactions; and circulatory overload or hypotension resulting from overhydration or underhydration during bowel preparation. The patient's cardiac and respiratory function and oxygen saturation are monitored continuously, with supplemental oxygen used as necessary. Typically the procedure takes about 1 hour, and postprocedure discomfort results from instillation of air to expand the colon and insertion and movement of the scope during the procedure.

**Nursing Interventions**

The success of the procedure depends on how well the colon is prepared and on adequate sedation (Selehi, Leung & Wong, 2008). Adequate colon cleansing provides optimal visualization and decreases the time needed for the procedure. Cleansing of the colon can be accomplished in various ways. The physician may prescribe a laxative for 2 nights before the examination and a Fleet's or saline enema until the return is clear the morning of the test. However, more commonly, polyethylene glycol electrolyte lavage solutions (Go-LYTELY, CoLyte, and Nu-Lytely) are used as intestinal lavages for effective cleansing of the bowel. The patient maintains a clear liquid diet starting at noon the day before the procedure. Then the patient ingests the lavage solution orally at intervals over 3 to 4 hours. If necessary, the nurse can give the solution through a feeding tube if the patient cannot swallow. Patients with a colostomy can receive this same bowel preparation. The use of lavage solutions is contraindicated in patients with intestinal obstruction or inflammatory bowel disease.

A sodium phosphate tablet (Osmoprep, Visicol) can be used for colon cleansing prior to colonoscopy. Dosing consists of 32 tablets: 20 tablets (4 tablets every 15 minutes with 8 ounces of any clear liquid (water, any clear carbonated beverage, or juice) on the evening prior to the examination, and 12 tablets (taken in the same manner) on the morning of the examination (Johanson, Popp, Cohen, et al., 2007).

With the use of lavage solutions, bowel cleansing is fast (rectal effluent is clear in about 4 hours) and is tolerated fairly well by most patients. Side effects of the electrolyte solutions include nausea, bloating, cramps or abdominal fullness, fluid and electrolyte imbalance, and hypothermia (patients are often told to drink the preparation as cold as possible to make it more palatable). The side effects are especially problematic for elderly patients, and sometimes they have difficulty ingesting the required volume of solution. Monitoring elderly patients after a bowel prep is especially important because their physiologic ability to compensate for fluid loss is diminished. Many elderly people take multiple medications each day; therefore, the nurse's knowledge of their daily medication regimen can prompt assessment for and prevention of potential problems and early detection of physiologic changes.

Additionally, the nurse advises the patient with diabetes to consult with his or her physician about medication adjustment to prevent hyperglycemia or hypoglycemia resulting from the dietary modifications required in preparing for the test. The nurse also instructs all patients, especially the elderly, to maintain adequate fluid, electrolyte, and caloric intake while undergoing bowel cleansing.

Special precautions must be taken for some patients. Implantable defibrillators and pacemakers are at high risk of malfunction if electrosurgical procedures (ie, polypectomy) are performed in conjunction with colonoscopy. A cardiologist should be consulted before the test is performed, and the defibrillator should be turned off. These patients require careful cardiac monitoring during the procedure.

Colonoscopy cannot be performed if there is a suspected or documented colon perforation, acute severe diverticulitis, or fulminant colitis. Patients with prosthetic heart valves or a history of endocarditis require prophylactic antibiotics before the procedure.

Informed consent is obtained by the practitioner before the patient is sedated. Before the examination, an opioid analgesic or sedative agent (eg, midazolam [versed]) is administered to provide moderate sedation and relieve anxiety during the procedure. Glucagon may be administered, if needed, to relax the colonic musculature and to reduce spasm during the test. Elderly or debilitated patients may require a reduced dosage of the analgesic or sedative agent to decrease the risks of oversedation and cardiopulmonary complications.

During the procedure, the patient is monitored for changes in oxygen saturation, vital signs, color and temperature of the skin, level of consciousness, abdominal distention, vagal response, and pain intensity. After the procedure, patients are maintained on bed rest until fully alert. Some patients have abdominal cramps caused by increased peristalsis stimulated by the air insufflated into the bowel during the procedure.

Immediately after the test, the patient is monitored for signs and symptoms of bowel perforation (eg, rectal bleeding, abdominal pain or distention, fever, focal peritoneal signs). Because of the amnesic effects of midazolam, it is important to provide written instructions, because the patient may be unable to recall verbal information. If the procedure is performed on an outpatient basis, someone must transport the patient home. After a therapeutic procedure, the nurse instructs the patient to report any bleeding to the physician.

### *Anoscopy, Proctoscopy, and Sigmoidoscopy*

Endoscopic examination of the anus, rectum, and sigmoid and descending colon is used to evaluate chronic diarrhea, fecal incontinence, ischemic colitis, and lower GI hemorrhage and to observe for ulceration, fissures, abscesses, tumors, polyps, or other pathologic processes.

Flexible scopes have largely replaced the rigid scopes used in the past for routine examinations. The flexible fiberoptic sigmoidoscope (see Fig. 34-6) permits the colon to be examined up to 40 to 50 cm (16 to 20 inches) from the anus, much more than the 25 cm (10 inches) that can be visualized with the rigid sigmoidoscope. It has many of the same capabilities as the scopes used for the upper GI study, including the use of still or video images to document findings.

For flexible scope procedures, the patient assumes a comfortable position on the left side with the right leg bent and placed anteriorly. It is important to keep the patient informed throughout the examination and to explain the sensations associated with it. Biopsies and polypectomies can be performed during this procedure. Biopsy is performed with small biting forceps introduced through the endoscope; one or more small pieces of tissue may be removed. If polyps are present, they may be removed with a wire snare, which is used to grasp the pedicle, or stalk. An electrocoagulating current is then used to sever the polyp and prevent bleeding. It is extremely important that all excised tissue be placed immediately in moist gauze or in an appropriate receptacle, labeled correctly, and delivered without delay to the pathology laboratory for examination.

**Nursing Interventions**

These examinations require only limited bowel preparation, including a warm tap water or Fleet's enema until returns are clear. Dietary restrictions usually are not necessary, and sedation usually is not required. During the procedure, the nurse monitors vital signs, skin color and temperature, pain tolerance, and vagal response. After the procedure, the nurse monitors the patient for rectal bleeding and signs of intestinal perforation (ie, fever, rectal drainage, abdominal distention, and pain). On completion of the examination, the patient can resume his or her regular activities and diet.

#### *Small Bowel Enteroscopy*

There are several methods available for visualization of the small intestine, including capsule endoscopy and double-balloon endoscopy. Capsule endoscopy allows the noninvasive visualization of the mucosa throughout the entire small intestine. It is particularly useful in the evaluation of obscure gastrointestinal bleeding. The technique consists of the patient swallowing a capsule that has embedded in it a wireless miniature camera, a light source, and an image transmission system. The capsule is the size of a large vitamin pill (26 mm long, 11 mm wide, and 3.7 g in weight). It is propelled through the intestine by peristalsis. Images are transmitted from the end of the capsule to a recording device worn on a belt. Typically the capsule passes from the rectum in 1 or 2 days. This diagnostic procedure is limited by its inability to allow for obtaining tissue samples for histology and for providing endoscopic therapy (Cellier, 2008).

Double-balloon enteroscopy (DBE), also known as push-and-pull enteroscopy, has made it possible to visualize the mucosa of the entire small bowel as well as carry out diagnostic and therapeutic interventions (Pohl, May, Nachbar, et al., 2007). This endoscope is composed of two balloons, one that is attached to the distal end of the scope and the other that is attached to the transparent overtube that slides over the endoscope. The endoscope is advanced using a push-and-pull technique that involves alternately inflating and deflating the balloons, causes telescoping of the small intestine onto the overtube. As a result of this telescoping, the endoscope can visualize much more of the small intestine than the length of the scope itself. The procedure takes between 1 and 3 hours and requires moderate sedation (Cellier, 2008).

#### *Endoscopy Through Ostomy*

Endoscopy through an ostomy stoma is useful for visualizing a segment of the small or large intestine and may be indicated to evaluate the anastomosis for recurrent disease, or to visualize and treat bleeding in a segment of the bowel. Nursing interventions are similar to those for other endoscopic procedures.

## Manometry and Electrophysiologic Studies

Manometry and electrophysiologic studies are methods for evaluating patients with GI motility disorders. The manometry test measures changes in intraluminal pressures and the coordination of muscle activity in the GI tract with the pressures transmitted to a computer analyzer.

Esophageal manometry is used to detect motility disorders of the esophagus and the upper and lower esophageal sphincter. Also known as esophageal motility studies, these studies are very helpful in the diagnosis of **achalasia,** diffuse esophageal spasm, scleroderma, and other esophageal motor disorders. The patient must refrain from eating or drinking for 8 to 12 hours before the test. Medications that could have a direct effect on motility (eg, calcium channel blockers, anticholinergic agents, sedatives) are withheld for 24 to 48 hours. A pressure-sensitive catheter is inserted through the nose and is connected to a transducer and a video recorder. The patient then swallows small amounts of water while the resultant pressure changes are recorded. Evaluation of a patient for gastroesophageal reflux disease (GERD) typically includes esophageal manometry.

Gastroduodenal, small intestine, and colonic manometry procedures are used to evaluate delayed gastric emptying and gastric and intestinal motility disorders such as irritable bowel syndrome or atonic colon. This is often an ambulatory outpatient procedure lasting 24 to 72 hours. Anorectal manometry measures the resting tone of the internal anal sphincter and the contractibility of the external anal sphincter. It is helpful in evaluating patients with chronic constipation or fecal incontinence and is useful in biofeedback for the treatment of fecal incontinence. It can be performed in conjunction with rectal sensory functioning tests. Phospho-Soda or a saline cleansing enema is administered 1 hour before the test, and positioning for the test is either the prone or the lateral position.

Rectal sensory function studies are used to evaluate rectal sensory function and neuropathy. A catheter and balloon are passed into the rectum, with increasing balloon inflation until the patient feels distention. Then the tone and pressure of the rectum and anal sphincter are measured. The results are especially helpful in the evaluation of patients with chronic constipation, diarrhea, or incontinence.

Electrogastrography, an electrophysiologic study, also may be performed to assess gastric motility disturbances and can be useful in detecting motor or nerve dysfunction in the stomach. Electrodes are placed over the abdomen, and gastric electrical activity is recorded for up to 24 hours. Patients may exhibit rapid, slow, or irregular waveform activity.

Defecography measures anorectal function and is performed with very thick barium paste instilled into the rectum. Fluoroscopy is used to assess the function of the rectum

and anal sphincter while the patient attempts to expel the barium. The test requires no preparation.

### Gastric Analysis, Gastric Acid Stimulation Test, and pH Monitoring

Analysis of the gastric juice yields information about the secretory activity of the gastric mucosa and the presence or degree of gastric retention in patients thought to have pyloric or duodenal obstruction. It is also useful for diagnosing Zollinger-Ellison syndrome, or atrophic gastritis.

The patient is NPO for 8 to 12 hours before the procedure. Any medications that affect gastric secretions are withheld for 24 to 48 hours before the test. Smoking is not allowed on the morning of the test because it increases gastric secretions. A small nasogastric tube with a catheter tip marked at various points is inserted through the nose. When the tube is at a point slightly less than 50 cm (21 inches), it should be within the stomach, lying along the greater curvature. Once in place, the tube is secured to the patient's cheek and the patient is placed in a semireclining position. The entire stomach contents are aspirated by gentle suction into a syringe, and gastric samples are collected every 15 minutes for the next hour.

Important diagnostic information to be gained from gastric analysis includes the ability of the mucosa to secrete HCl. This ability is altered in various disease states, including:

- Pernicious anemia—patients with this disease secrete no acid under basal conditions or after stimulation.
- Severe chronic atrophic gastritis or gastric cancer—patients with these diseases secrete little or no acid.
- Peptic ulcer—patients with this disease secrete some acid.
- Duodenal ulcers—patients with this disease usually secrete an excess amount of acid.

The gastric acid stimulation test usually is performed in conjunction with gastric analysis. Histamine or pentagastrin is administered subcutaneously to stimulate gastric secretions. It is important to inform the patient that this injection may produce a flushed feeling. The nurse monitors the patient's blood pressure and pulse frequently to detect hypotension. Gastric specimens are collected after the injection every 15 minutes for 1 hour and are labeled to indicate the time of specimen collection after histamine injection. The volume and pH of the specimen are measured; in certain instances, cytologic study by the Papanicolaou technique may be used to determine the presence or absence of malignant cells.

Esophageal reflux of gastric acid may be diagnosed by ambulatory pH monitoring (Smout, 2008). The patient is NPO for 6 hours before the test, and all medications affecting gastric secretions are withheld for 24 to 36 hours before the test. A probe that measures pH is inserted through the nose and into position about 5 inches above the lower esophageal sphincter. It is connected to an external recording device and is worn for 24 hours while the patient continues normal daily activities. The end result is a computer analysis and graphic display of the results. This test allows for the direct correlation between chest pain and reflux episodes (Malhotra, Freston & Aziz, 2008).

The Bravo pH monitoring system offers the advantage of pH monitoring of the esophagus without the transnasal catheter. The clinician, by means of endoscopy, attaches a capsule (approximately the size of a gel cap) to the patient's esophageal wall. Data related to pH are transmitted from the capsule to a pager-sized receiver that the patient wears. Data are collected for up to 48 hours and then downloaded and analyzed. The capsule spontaneously detaches from the esophagus in 7 to 10 days and then is passed through the patient's digestive system. The accuracy of this method of pH testing is greater than methods in which a catheter is used because the patient can eat normally and continue normal activities during the testing. The system reliably distinguishes reflux conditions from functional conditions if the study is performed with the patient off medications (Pandolfino & Kwiatek, 2008).

### Laparoscopy (Peritoneoscopy)

With the tremendous advances in minimally invasive surgery, diagnostic laparoscopy is efficient, cost-effective, and useful in the diagnosis of GI disease. After a pneumoperitoneum (injecting carbon dioxide into the peritoneal cavity to separate the intestines from the pelvic organs) is created, a small incision is made lateral to the umbilicus, allowing for the insertion of the fiberoptic laparoscope. This permits direct visualization of the organs and structures within the abdomen, permitting visualization and identification of any growths, anomalies, and inflammatory processes. In addition, biopsy samples can be taken from the structures and organs as necessary. This procedure can be used to evaluate peritoneal disease, chronic abdominal pain, abdominal masses, and gallbladder and liver disease. However, laparoscopy has not become an important diagnostic modality in patients with acute abdominal pain, because less invasive tools (eg, CT and MRI) are readily available. Laparoscopy usually requires general anesthesia and sometimes requires that the stomach and bowel be decompressed. Gas (usually carbon dioxide) is insufflated into the peritoneal cavity to create a working space for visualization. One of the benefits of this procedure is that after visualization of a problem, excision (eg, removal of the gallbladder) can then be performed at the same time, if appropriate.

## CRITICAL THINKING EXERCISES

**1** You are caring for a 60-year-old man with a history of diabetes, pancreatitis, alcohol abuse, and abdominal pain associated with meals. He states that he sometimes has nausea and vomiting after eating dinner. Identify questions that should be asked when taking the patient's history. What assessment parameters would be addressed? What diagnostic tests would you expect to be ordered?

EBP **2** You are working in a medical internist's office. A 56-year-old female patient comes into the office for a routine examination. She states that she did not get her recommended colonoscopy examination because no one in her family has colon cancer and she did not understand the instructions. What education would you provide for this patient? What is the evidence base that supports the education? Discuss the strength of the evidence for the education. Identify the criteria used to evaluate the strength of the evidence.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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chapter 35

# Management of Patients With Oral and Esophageal Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the nursing management of patients with conditions of the oral cavity.
2. Describe the relationship of dental hygiene and dental problems to nutrition.
3. Describe the nursing management of patients with abnormalities of the lips, gums, teeth, mouth, and salivary glands.
4. Describe the nursing management of patients with cancer of the oral cavity.
5. Identify the physical and psychosocial long-term needs of patients with oral cancer.
6. Use the nursing process as a framework for care of patients undergoing neck dissection.
7. Use the nursing process as a framework for care of patients with various conditions of the esophagus.
8. Describe the various conditions of the esophagus and their clinical manifestations and management.

## GLOSSARY

**achalasia:** absent or ineffective peristalsis (wavelike contraction) of the distal esophagus accompanied by failure of the esophageal sphincter to relax in response to swallowing

**dysphagia:** difficulty swallowing

**dysplasia:** abnormal change in cells

**esophagogastroduodenoscopy (EGD):** passage of a fiberoptic tube through the mouth and throat into the digestive tract for visualization of the esophagus, stomach, and small intestine; biopsies can be performed

**gastroesophageal reflux:** back-flow of gastric or duodenal contents into the esophagus

**hernia:** protrusion of an organ or part of an organ through the wall of the cavity that normally contains it

**lithotripsy:** use of shock waves to break up or disintegrate stones

**odynophagia:** pain on swallowing

**parotitis:** inflammation of the parotid gland

**periapical abscess:** abscessed tooth

**pyrosis:** heartburn

**sialadenitis:** inflammation of the salivary glands

**stomatitis:** inflammation of the oral mucosa

**temporomandibular disorders:** a group of conditions that cause pain or dysfunction of the temporomandibular joint (TMJ) and surrounding structures

**vagotomy syndrome:** dumping syndrome; gastrointestinal symptoms, such as diarrhea and abdominal cramping, resulting from rapid gastric emptying

**xerostomia:** dry mouth

Because digestion normally begins in the mouth, adequate nutrition is related to good dental health and the general condition of the mouth. Any discomfort or adverse condition in the oral cavity can affect a person's nutritional status. Changes in the oral cavity can influence the type and amount of food ingested as well as the degree to which food particles are properly mixed with salivary enzymes. Disease of the mouth or tongue can interfere with speech and thus affect communication and self-image. Esophageal problems related to swallowing can also adversely affect food and fluid intake, thereby jeopardizing general health and well-being. Given the close relationship between adequate nutritional intake and the structures of the upper gastrointestinal tract (lips, mouth, teeth, pharynx, esophagus), health teaching can help prevent disorders associated with these structures (Fig. 35-1).

## DISORDERS OF THE ORAL CAVITY

Oral health is a very important component of a person's physical and psychological sense of well-being. Severe periodontal disease affects approximately 14% of adults 45 to 64 years of age and 23% of adults 65 to 74 years of age (U.S. Department of Health and Human Services, 2000). Table 35-1 reviews common abnormalities of the oral cavity, their possible causes, and nursing management. Figure 35-2 illustrates structures of the oral cavity.

## *Dental Plaque and Caries*

Tooth decay is an erosive process that begins with the action of bacteria on fermentable carbohydrates in the mouth, which produces acids that dissolve tooth enamel. Tooth enamel is the hardest substance in the human body, but dental erosion occurs for several reasons. Contributing factors include nutrition, soft drink consumption, and genetic predisposition. In addition, the extent of damage to the teeth may be related to the following:

- The presence of dental plaque. Dental plaque is a gluey, gelatin-like substance that adheres to the teeth. The initial action that causes damage to a tooth occurs under dental plaque.
- The length of time acids are in contact with the teeth.
- The strength of acids and the ability of the saliva to neutralize them.
- The susceptibility of the teeth to decay.

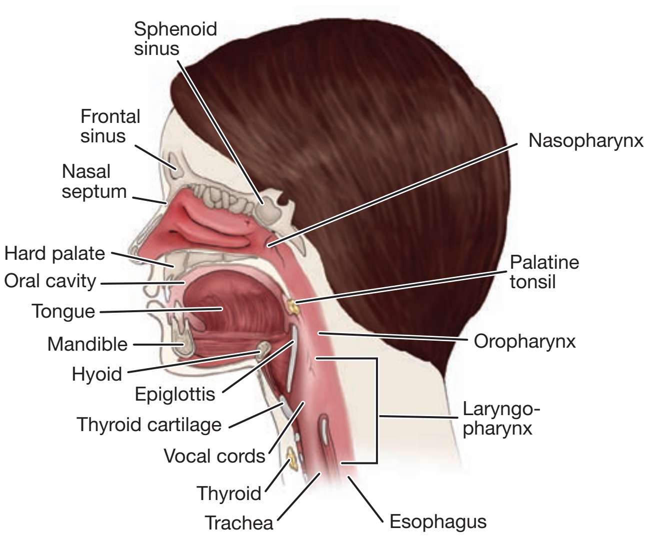



**Figure 35-1** Anatomy of the head and neck.

Dental decay begins with a small hole, usually in a fissure (a break in the tooth's enamel) or in an area that is hard to clean. Left unchecked, the decay extends into the dentin. Because dentin is not as hard as enamel, decay progresses more rapidly and in time reaches the pulp of the tooth.

Dentists can determine the extent of damage and the type of treatment needed using x-ray studies. Treatment for dental caries includes fillings, dental implants, or extraction, if necessary. In general, dental decay can occur in anyone. Contributing factors can be as simple as not brushing teeth on a regular basis to an improper diet. Older adults are subject to decay from drug-induced or age-related oral dryness (Chart 35-1).

### Prevention

Measures used to prevent and control dental caries include practicing effective mouth care, reducing the intake of starches and sugars (refined carbohydrates), applying fluoride to the teeth or drinking fluoridated water, refraining from smoking, controlling diabetes, and using pit and fissure sealants. Regular dental visits are another method of preventive dental maintenance.

#### *Mouth Care*

Healthy teeth must be conscientiously and effectively cleaned on a daily basis. Brushing and flossing are particularly effective in mechanically breaking up the bacterial plaque that collects around teeth.

Normal mastication (chewing) and the normal flow of saliva also aid greatly in keeping the teeth clean. Because many ill patients do not eat adequate amounts of food, they produce less saliva, which in turn reduces this natural tooth-cleaning process. The nurse may need to assume the responsibility for brushing the patient's teeth. Merely wiping the patient's mouth and teeth with a swab is ineffective. The most effective method is mechanical cleansing (brushing). If brushing is impossible, it is better to wipe the teeth with a gauze pad, then have the patient swish an antiseptic mouthwash several times before expectorating into an emesis basin. A soft-bristled toothbrush is more effective than a sponge or foam stick. To prevent drying, the lips may be coated with a water-soluble gel.

#### *Diet*

Dental caries may be prevented by decreasing the amount of sugar and starch in the diet. Patients who snack should be encouraged to choose less cariogenic alternatives, such as fruits, vegetables, nuts, cheeses, or plain yogurt. In addition, frequent brushing, especially after meals, is necessary. Flossing should be performed daily.

#### *Fluoridation*

Fluoridation of public water supplies has been found to decrease dental caries. Some areas of the country have natural

**Table 35-1 DISORDERS OF THE LIPS, MOUTH, AND GUMS**

| Condition | Signs and Symptoms | Possible Causes and Sequelae | Nursing Considerations |
|---|---|---|---|
| **Abnormalities of the Lips** | | | |
| Actinic cheilitis | Irritation of lips associated with scaling, crusty, fissure; white overgrowth of horny layer of epidermis (hyperkeratosis)<br>Considered a premalignant squamous cell skin cancer | Exposure to sun; more common in fair-skinned people and in those whose occupations involve sun exposure, such as farmers<br>May lead to squamous cell cancer | Teach patient importance of protecting lips from the sun by using protective ointment such as sun block<br>Instruct patient to have a periodic checkup by physician |
| Herpes simplex 1 (cold sore or fever blister) | Symptoms may be delayed up to 20 days after exposure; singular or clustered painful vesicles that may rupture | An opportunistic infection; frequently seen in immunosuppressed patients; very contagious<br>May recur with menstruation, fever, or sun exposure | Use acyclovir (Zovirax) ointment or systemic medications as prescribed<br>Administer analgesics as prescribed<br>Instruct patient to avoid irritating foods |
| Chancre | Reddened circumscribed lesion that ulcerates and becomes crusted | Primary lesion of syphilis; very contagious | Comfort measures: cold soaks to lip, mouth care<br>Administer antibiotics as prescribed<br>Instruct patient regarding contagion |
| Contact dermatitis | Red area or rash; itching | Allergic reaction to lipstick, cosmetic ointments, or toothpaste | Instruct patient to avoid possible causes<br>Administer corticosteroids as prescribed |
| **Abnormalities of the Mouth** | | | |
| Leukoplakia | White patches; may be hyperkeratotic; usually in buccal mucosa; usually painless | Fewer than 2% are malignant, but may progress to cancer<br>Common among tobacco users | Instruct patient to see a physician if leukoplakia persists longer than 2 weeks<br>Eliminate risk factors, such as tobacco |
| Hairy leukoplakia | White patches with rough hair-like projections; typically found on lateral border of the tongue | Possibly viral; smoking and use of tobacco<br>Often seen in people who are HIV positive | Instruct patient to see a physician if condition persists longer than 2 weeks |
| Lichen planus | White papules at the intersection of a network of interlacing lesions; usually ulcerated and painful | Recurrences are common<br>May lead to a malignant process<br>Unknown cause | Apply topical corticosteroids such as fluocinolone acetonide oral base gel<br>Avoid foods that irritate<br>Administer corticosteroids systemically or intralesionally as prescribed<br>Instruct the patient of need for follow-up if condition is chronic |
| Candidiasis (moniliasis/thrush) | Cheesy white plaque that looks like milk curds; when rubbed off, it leaves an erythematous and often bleeding base | *Candida albicans* fungus; predisposing factors include diabetes, antibiotic therapy, and immunosuppression | Antifungal medications such as nystatin (Mycostatin), amphotericin B, clotrimazole, or ketoconazole may be prescribed; these may be taken in pill form or as a suspension; when used as a suspension, instruct the patient to swish vigorously for at least 1 minute and then swallow |
| Aphthous stomatitis (canker sore) | Shallow ulcer with a white or yellow center and red border; seen on the inner side of the lip and cheek or on the tongue; it begins with a burning or tingling sensation and slight swelling; painful; usually lasts 7–10 days and heals without a scar | Associated with emotional or mental stress, fatigue, hormonal factors, minor trauma (such as biting), allergies, acidic foods and juices, and dietary deficiencies<br>Associated with HIV infection<br>May recur | Instruct the patient in comfort measures, such as saline rinses, and a soft or bland diet<br>Antibiotics or corticosteroids may be prescribed |
| Nicotine stomatitis (smoker's patch) | Two stages—begins as a red stomatitis; over time the tongue and mouth become covered with a creamy, thick, white mucous membrane, which may slough, leaving a beefy red base | Chronic irritation by tobacco | Cessation of tobacco use; if condition exists for longer than 2 weeks a physician should be consulted and a biopsy may be needed |
| Krythoplakia | Red patch on the oral mucous membrane | Nonspecific inflammation; more frequently seen in the elderly | |
| Kaposi's sarcoma | Appears first on the oral mucosa as a red, purple, or blue lesion; may be singular or multiple; may be flat or raised | HIV infection | Instruct patient regarding side effects of planned treatment |

*Continued on following page*

**Table 35-1 DISORDERS OF THE LIPS, MOUTH, AND GUMS (Continued)**

| Condition | Signs and Symptoms | Possible Causes and Sequelae | Nursing Considerations |
|---|---|---|---|
| Stomatitis | Mild redness (erythema) and edema; if severe, painful ulcerations, bleeding, and secondary infection | Chemotherapy; radiation therapy; severe drug allergy; myelosuppression (bone marrow depression) | Prophylactic mouth care, including brushing, flossing, and rinsing, for any patient receiving chemotherapy or radiation therapy<br>Teach patient proper oral hygiene, including the use of a soft-bristled toothbrush and nonabrasive toothpaste; for painful ulcers, oral swabs with sponge-like applicators can be used in place of a toothbrush; avoid alcohol-based mouth rinses and hot or spicy foods<br>Apply topical anti-inflammatory, antibiotic, and anesthetic agents as prescribed |
| **Abnormalities of the Gums** | | | |
| Gingivitis | Painful, inflamed, swollen gums; usually the gums bleed in response to light contact | Poor oral hygiene: food debris, bacterial plaque, and calculus (tartar) accumulate; the gums may also swell in response to normal processes such as puberty and pregnancy | Teach patient proper oral hygiene; toothbrushing, flossing, rinsing, dental appointments at least every 6 months |
| Necrotizing gingivitis (trench mouth) | Gray-white pseudomembranous ulcerations affecting the edges of the gums, mucosa of the mouth, tonsils, and pharynx; foul breath; painful, bleeding gums; swallowing and talking are painful | Poor oral hygiene; bacterial infection, inadequate rest, overwork, emotional stress, smoking, and poor nutrition may contribute to development | Teach patient proper oral hygiene; see Chart 35-2<br>Irrigate with 2% to 3% hydrogen peroxide or normal saline solution<br>Avoid irritants such as smoking and spicy foods |
| Herpetic gingivostomatitis | Burning sensation with the appearance of small vesicles 24–48 hours later; vesicles may rupture, forming sore, shallow ulcers covered with a gray membrane | Herpes simplex virus; occurs most frequently in people who are immunosuppressed; may occur in other infectious processes such as streptococcal pneumonia, meningococcal meningitis, and malaria | Apply topical anesthetics as prescribed; may need opioids if pain is severe<br>Saline or 2% to 3% hydrogen peroxide irrigations<br>Antiviral agents such as acyclovir may be prescribed |
| Periodontitis | Little discomfort at onset; may have bleeding, infection, gum recession, and loosening of teeth; later in the disease tooth loss may occur | May result from untreated gingivitis<br>Poor or inadequate dental hygiene and inadequate diet contribute to development | Instruct patient in proper oral hygiene<br>Instruct patient to consult a dentist |

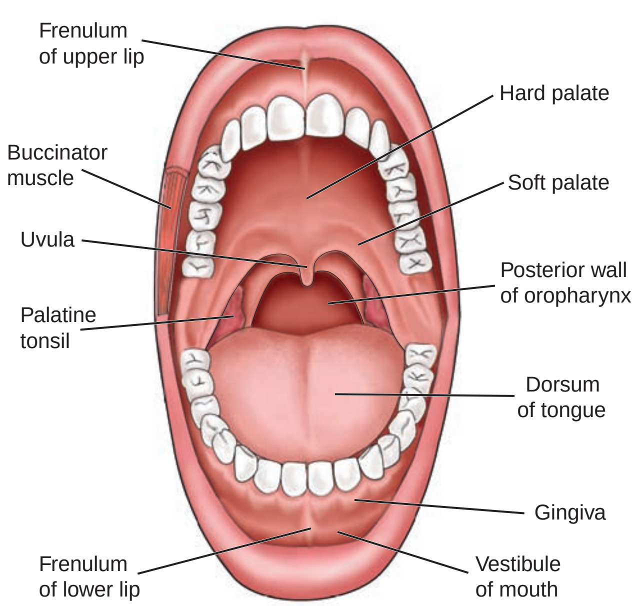



**Figure 35-2** Structures of the mouth, including the tongue and palate.

fluoridation; other communities have added fluoride to public water supplies. Fluoridation may also be achieved by having a dentist apply a concentrated gel or solution to the teeth; adding fluoride to home water supplies; using fluoridated toothpaste or mouth rinse; or using sodium fluoride tablets, drops, or lozenges.

### Pit and Fissure Sealants

The occlusal surfaces of the teeth have pits and fissures, areas that are prone to caries. Some dentists apply a special coating to fill and seal these areas from potential exposure to cariogenic processes. These sealants can last 5 to 10 years, depending on how dry the tooth surface is prior to application.

## Dentoalveolar Abscess or Periapical Abscess

**Periapical abscess,** more commonly referred to as an abscessed tooth, involves a collection of pus in the apical dental periosteum (fibrous membrane supporting the tooth structure) and the tissue surrounding the apex of the tooth

CHART 35-1

GERONTOLOGIC CONSIDERATIONS

### Oral Conditions in the Older Adult

Many medications taken by the elderly cause dry mouth, which is uncomfortable, impairs communication, and increases the risk of oral infection. These medications include the following:

- Diuretics
- Antihypertensive medications
- Anti-inflammatory agents
- Antidepressant medications

Poor dentition can exacerbate problems of aging, such as:

- Decreased food intake
- Loss of appetite
- Social isolation
- Increased susceptibility to systemic infection (from periodontal disease)
- Trauma to the oral cavity secondary to thinner, less vascular oral mucous membranes

(where it is suspended in the jaw bone). The abscess may be acute or chronic. Acute periapical abscess is usually secondary to a suppurative pulpitis (a pus-producing inflammation of the dental pulp) that arises from an infection extending from dental caries. The infection of the dental pulp extends through the apical foramen of the tooth to form an abscess around the apex.

Chronic dentoalveolar abscess is a slowly progressive infectious process. In contrast to the acute form, a fully formed abscess may occur without the patient's knowledge. The infection eventually leads to a "blind dental abscess," which is actually a periapical granuloma. It may enlarge to as much as 1 cm in diameter. It is often discovered on x-ray films and is treated by extraction or root canal therapy, often with apicectomy (excision of the apex of the tooth root).

### Clinical Manifestations

The abscess produces a dull, gnawing, continuous pain, often with a surrounding cellulitis and edema of the adjacent facial structures, and mobility of the involved tooth. The gum opposite the apex of the tooth is usually swollen on the cheek side. Swelling and cellulitis of the facial structures may make it difficult for the patient to open the mouth. There may also be a systemic reaction, fever, and malaise.

### Medical Management

In the early stages of an infection, a dentist or oral surgeon may perform a needle aspiration or drill an opening into the pulp chamber to relieve pressure and pain and to provide drainage. Usually, the infection will have progressed to a periapical abscess. Drainage is provided by an incision through the gingiva down to the jawbone. Purulent material escapes under pressure. This procedure may be performed in the dentist's office, an outpatient surgery center, or a same-day surgery department. After the inflammatory reaction has subsided, the tooth may be extracted or root canal therapy performed. Antibiotics and opioids may be prescribed.

### Nursing Management

The nurse assesses the patient for bleeding after treatment and instructs the patient to use a warm saline or warm water mouth rinse to keep the area clean. The patient is also instructed to take antibiotics and analgesics as prescribed, to advance from a liquid diet to a soft diet as tolerated, and to keep follow-up appointments.

## Malocclusion

Malocclusion is a misalignment of the teeth of the upper and lower dental arcs when the jaws are closed. Malocclusion can be inherited or acquired (from thumb-sucking, trauma, or some medical conditions). Malocclusion makes the teeth difficult to clean and can lead to decay, gum disease, and excess wear on supporting bone and gum tissues. About 50% of the population has some form of malocclusion. Correction of malocclusion requires an orthodontist and a patient who is motivated and cooperative. Most treatments begin when the patient has shed the last primary tooth and the last permanent tooth has erupted, usually at about 12 or 13 years of age, but treatment may occur in adulthood. Preventive orthodontics may be started in children as early as 5 years of age if malocclusion is diagnosed early. The need for teeth straightening in adolescents is reduced if preventive orthodontics is started with the primary teeth.

### Medical Management

People with malocclusion have an obviously misaligned bite or crooked, crowded, widely spaced, or protruding teeth. To realign the teeth, the orthodontist gradually forces the teeth into a new location by using wires or plastic bands (braces). These devices may be unattractive, but this psychological burden must be overcome if good results are to be achieved. In the final phase of treatment, a retaining device is worn for several hours each day to support the tissues as they adjust to the new alignment of the teeth.

### Nursing Management

The patient must practice meticulous oral hygiene, and the nurse encourages the patient to continue this important part of the treatment. An adolescent or adult undergoing orthodontic correction who is admitted to the hospital for some other problem may have to be reminded to continue wearing the retainer (if it does not interfere with the condition requiring hospitalization).

## DISORDERS OF THE JAW

Abnormal conditions affecting the mandible (jaw) and of the temporomandibular joint (which connects the mandible to the temporal bone at the side of the head in front of the ear) include congenital malformation, fracture, chronic

dislocation, cancer, and syndromes characterized by pain and limited motion. Temporomandibular disorders and jaw surgery (a treatment common in many structural abnormalities or cancer of the jaw) are presented in this section.

## Temporomandibular Disorders

**Temporomandibular disorders** are categorized as follows (National Institute of Dental and Craniofacial Research [NICDR], 2006):

- Myofascial pain: a discomfort in the muscles controlling jaw function and in neck and shoulder muscles
- Internal derangement of the joint: a dislocated jaw, a displaced disk, or an injured condyle
- Degenerative joint disease: rheumatoid arthritis or osteoarthritis in the jaw joint

Diagnosis and treatment of temporomandibular disorders remain somewhat ambiguous, but the condition is thought to affect about 10 million people in the United States. Misalignment of the joints in the jaw and other problems associated with the ligaments and muscles of mastication are thought to result in tissue damage and muscle tenderness. Suggested causes include arthritis of the jaw, head injury, trauma or injury to the jaw or joint, stress, and malocclusion (although research does not support malocclusion as a cause).

### Clinical Manifestations

Patients have jaw pain ranging from a dull ache to throbbing, debilitating pain that can radiate to the ears, teeth, neck muscles, and facial sinuses. They often have restricted jaw motion and locking of the jaw. There also may be a sudden change in the way the upper and lower teeth fit together. The patient may hear clicking, popping, and grating sounds when the mouth is opened, and chewing and swallowing may be difficult. Symptoms such as headaches, earaches, dizziness, and hearing problems may sometimes be related to temporomandibular disorders (Buescher, 2007; NICDR, 2006).

### Assessment and Diagnostic Findings

Diagnosis is based on the patient's report of pain, limitations in range of motion, dysphagia, difficulty chewing, difficulty with speech, or hearing difficulties. Magnetic resonance imaging and x-ray studies are generally only used for severe or chronic symptoms.

### Medical Management

Signs and symptoms improve over time for the majority of patients with temporomandibular joint disorders, with or without treatment. Some practitioners think the role of stress in these disorders is overrated, but patient education in stress management may be helpful (to reduce grinding and clenching of teeth). Patients may also benefit from range-of-motion exercises. Pain management measures may include nonsteroidal anti-inflammatory drugs (NSAIDs), with the possible addition of opioids, muscle relaxants, or mild antidepressants. Occasionally, intraoral orthotics (a plastic guard worn over the upper and lower teeth) may be worn to reposition the condyle head in the joint space to a more normal position, which in turn relieves the stress and pressure on the tissues of the joint. This allows the tissues to heal. Conservative and reversible treatment is recommended. If irreversible surgical options are recommended, patients are encouraged to seek a second opinion.

## Jaw Disorders Requiring Surgical Management

Correction of mandibular structural abnormalities may require surgery involving repositioning or reconstruction of the jaw. Simple fractures of the mandible without displacement, resulting from a blow on the chin, and planned surgical interventions, as in the correction of long or short jaw syndrome, may require treatment by these means. Jaw reconstruction may be necessary in the aftermath of trauma from a severe injury or cancer, both of which can cause tissue and bone loss.

Mandibular fractures are usually closed fractures. Rigid plate fixation (insertion of metal plates and screws into the bone to approximate and stabilize the bone) is the current treatment of choice in many cases of mandibular fracture and in some mandibular reconstructive surgery procedures. Bone grafting may be performed to replace structural defects using bones from the patient's own ilium, ribs, or cranial sites. Rib tissue may also be harvested from cadaver donors.

### Nursing Management

The patient who has had rigid fixation should be instructed not to chew food in the first 1 to 4 weeks after surgery. A liquid diet is recommended, and dietary counseling should be obtained to ensure optimal caloric and protein intake.

#### Promoting Home and Community-Based Care

The patient needs specific guidelines for mouth care and feeding. Any irritated areas in the mouth should be reported to the physician. The importance of keeping scheduled appointments to assess the stability of the fixation appliance is emphasized.

Consultation with a dietitian may be indicated so that the patient and family can learn about foods that are high in essential nutrients and ways in which these foods can be prepared so that they can be consumed through a straw or spoon while remaining palatable. Nutritional supplements may be recommended.

# DISORDERS OF THE SALIVARY GLANDS

The salivary glands consist of the parotid glands, one on each side of the face below the ear; the submandibular and sublingual glands, both in the floor of the mouth; and the buccal gland, beneath the lips. About 1200 mL of saliva are produced daily and swallowed. The glands' primary functions are lubrication, protection against harmful bacteria, and digestion.

## Parotitis

**Parotitis** (inflammation of the parotid gland) is the most common inflammatory condition of the salivary glands, although inflammation can occur in the other salivary glands as well. Mumps (epidemic parotitis), a communicable

disease caused by viral infection and most commonly affecting children, is an inflammation of a salivary gland, usually the parotid.

Elderly, acutely ill, or debilitated people with decreased salivary flow from general dehydration or medications are at high risk for parotitis. The infecting organisms travel from the mouth through the salivary duct. The organism is usually *Staphylococcus aureus* (except in mumps). The onset of this complication is sudden, with an exacerbation of both fever and the symptoms of the primary condition. The gland swells and becomes tense and tender. The patient feels pain in the ear, and swollen glands interfere with swallowing. The swelling increases rapidly, and the overlying skin soon becomes red and shiny.

Medical management includes maintaining adequate nutritional and fluid intake, good oral hygiene, and discontinuing medications (eg, tranquilizers, diuretics) that can diminish salivation. Antibiotic therapy is necessary, and analgesics may be prescribed to control pain. If antibiotic therapy is not effective, the gland may need to be drained by a surgical procedure known as parotidectomy. This procedure may be necessary to treat chronic parotitis. The patient is advised to have any necessary dental work performed prior to surgery.

### Sialadenitis

**Sialadenitis** (inflammation of the salivary glands) may be caused by dehydration, radiation therapy, stress, malnutrition, salivary gland calculi (stones), or improper oral hygiene. The inflammation is associated with infection by *S. aureus*, *Streptococcus viridans*, or *pneumococci*. In hospitalized or institutionalized patients, the infecting organism may be methicillin-resistant *S. aureus* (MRSA). Symptoms include pain, swelling, and purulent discharge. Antibiotics are used to treat infections. Massage, hydration, warm compresses, and corticosteroids frequently cure the problem. Chronic sialadenitis with uncontrolled pain is treated by surgical drainage of the gland or excision of the gland and its duct.

### Salivary Calculus (Sialolithiasis)

Sialolithiasis, or salivary calculi (stones), usually occurs in the submandibular gland. Salivary gland ultrasonography or sialography (x-ray studies filmed after the injection of a radiopaque substance into the duct) may be required to demonstrate obstruction of the duct by stenosis. Salivary calculi are formed mainly from calcium phosphate. If located within the gland, the calculi are irregular and vary in diameter from 3 to 30 mm. Calculi in the duct are small and oval.

Calculi within the salivary gland itself cause no symptoms unless infection arises; however, a calculus that obstructs the gland's duct causes sudden, local, and often colicky pain, which is abruptly relieved by a gush of saliva. This characteristic symptom is often disclosed in the patient's health history. On physical assessment, the gland is swollen and quite tender, the stone itself can be palpable, and its shadow may be seen on x-ray films.

The calculus can be extracted fairly easily from the duct in the mouth. Sometimes, enlargement of the ductal orifice permits the stone to pass spontaneously. Occasionally **lithotripsy,** a procedure that uses shock waves to disintegrate the stone, may be used instead of surgical extraction for parotid stones and smaller submandibular stones. Lithotripsy requires no anesthesia, sedation, or analgesia. Side effects can include local hemorrhage and swelling. Surgery may be necessary to remove the gland if symptoms and calculi recur repeatedly.

### Neoplasms

Although they are uncommon, neoplasms (tumors or growths) of almost any type may develop in the salivary gland. Tumors occur more often in the parotid gland. The incidence of salivary gland tumors is similar in men and women. Risk factors include prior exposure to radiation to the head and neck. Diagnosis is based on the health history and physical examination and the results of fine-needle aspiration biopsy.

Management of salivary gland tumors may involve partial excision of the gland, along with the tumor and a wide margin of surrounding tissue. Dissection is carefully performed to preserve the seventh cranial nerve (facial nerve), although it may not be possible to do so if the tumor is extensive. If the tumor is malignant, radiation therapy may follow surgery. Radiation therapy alone may be a treatment choice for tumors that are thought to be localized or if there is risk of facial nerve damage from surgical intervention. Chemotherapy is usually used for palliative purposes. Local recurrences are common, and the recurrence rate can be as high as 25% (Chahin & Kaufman, 2005). Recurrent tumors usually are more aggressive than initial tumors. Tumors of the salivary gland lead to an increased incidence of second primary cancers, which may be due to inadequate excision of the original tumor.

## CANCER OF THE ORAL CAVITY AND PHARYNX

Cancers of the oral cavity and pharynx, which can occur in any part of the mouth or throat, are curable if discovered early. Risk factors for cancer of the oral cavity and pharynx include cigarette, cigar, and pipe smoking; use of smokeless tobacco; and excessive use of alcohol. Oral cancers are often associated with the combined use of alcohol and tobacco; these substances have a synergistic carcinogenic effect. Patient education directed toward avoiding high-risk behaviors is critical to prevent oral cancers.

The incidence of cancers of the oral cavity and pharynx is greatest in men older than 50 years of age. In general, it is almost twice as high in men as it is in women. Cancers of the oral cavity and pharynx occur more often in African Americans than in Caucasians.

Approximately 35,000 new cases of oral cavity and oropharyngeal cancer occur annually in the United States. For the past 20 to 40 years, the number of new cases and death rate has been decreasing. Eighty-four percent of patients with

cancer of the oral cavity and oropharynx survive at least 1 year after diagnosis. Regardless of the stage of cancer at diagnosis, the 5-year relative survival rate is 59%, and the 10-year survival rate is 48% (American Cancer Society, 2008).

### Pathophysiology

Malignancies of the oral cavity are usually squamous cell cancers. Any area of the oropharynx can be a site of malignant growths, but the lips, the lateral aspects of the tongue, and the floor of the mouth are most commonly affected.

### Clinical Manifestations

Many oral cancers produce few or no symptoms in the early stages. Later, the most frequent symptom is a painless sore or mass that does not heal. It may bleed easily and it may present as a red or white patch that persists (American Cancer Society, 2009). A typical lesion in oral cancer is a painless indurated (hardened) ulcer with raised edges. As the cancer progresses, the patient may complain of tenderness; difficulty in chewing, swallowing, or speaking; coughing of blood-tinged sputum; or enlarged cervical lymph nodes.

### Assessment and Diagnostic Findings

Diagnostic evaluation consists of an oral examination as well as an assessment of the cervical lymph nodes to detect possible metastases. Biopsies are performed on suspicious lesions (those that have not healed in 2 weeks). In people who use snuff or smoke cigars or pipes, high-risk areas include the buccal mucosa and gingiva. In those who smoke cigarettes and drink alcohol, high-risk areas include the floor of the mouth, the ventrolateral tongue, and the soft palate complex (soft palate, anterior and posterior tonsillar area, uvula, and the area behind the molar and tongue junction).

### Medical Management

Management varies with the nature of the lesion, the preference of the physician, and patient choice. Surgical resection and radiation therapy are standard treatment. Addition of chemotherapy may be useful for advanced disease (American Cancer Society, 2009).

In cancer of the lip, small lesions are usually excised liberally. Radiation therapy may be more appropriate for larger lesions involving more than one third of the lip because of superior cosmetic results. The choice depends on the extent of the lesion and what is necessary to cure the patient while preserving the best appearance. Tumors larger than 4 cm often recur.

In cancer of the tongue, treatment with radiation therapy and chemotherapy may preserve organ function and maintain quality of life. A combination of radioactive interstitial implants (surgical implantation of a radioactive source into the tissue adjacent to or at the tumor site) and external beam radiation may be used. Surgical procedures include hemiglossectomy (surgical removal of half of the tongue) and total glossectomy (removal of the tongue).

Often, cancer of the oral cavity has metastasized through the extensive lymphatic channel in the neck region, requiring a neck dissection and reconstructive surgery of the oral cavity. One common reconstructive technique involves use of a radial forearm free flap (a thin layer of skin from the forearm along with the radial artery).

### Nursing Management

The nurse assesses the patient's nutritional status preoperatively, and a dietary consultation may be necessary. The patient may require enteral (through the gastrointestinal tract) or parenteral (intravenous [IV]) feedings before and after surgery to maintain adequate nutrition. Continual assessment and reevaluation are necessary. If a radial graft is to be performed, an Allen test on the donor arm must be performed to ensure that the ulnar artery is patent and can provide blood flow to the hand after removal of the radial artery. The Allen test is performed by asking the patient to make a fist and then manually compressing the ulnar artery. The patient is then asked to open the hand into a relaxed, slightly flexed position. The palm is pale. Pressure on the ulnar artery is released. If the ulnar artery is patent, the palm flushes within about 3 to 5 seconds.

Verbal communication may be impaired by radical surgery for oral cancer. It is therefore vital to assess the patient's ability to communicate in writing before surgery. Pen and paper are provided postoperatively to patients who can use them to communicate. A communication board with commonly used words or pictures is obtained preoperatively and given after surgery to patients who cannot write so that they may point to needed items. A speech therapist is also consulted postoperatively.

Postoperatively, the nurse assesses for a patent airway. The patient may be unable to manage oral secretions, making suctioning necessary. If grafting was part of the surgery, suctioning must be performed with care to prevent damage to the graft. The graft is assessed postoperatively for viability. Although color should be assessed (white may indicate arterial occlusion, and blue mottling may indicate venous congestion), it can be difficult to assess the graft by looking into the mouth. A Doppler ultrasound device may be used to locate the radial pulse at the graft site and to assess graft perfusion.

## *Nursing Management of the Patient With Conditions of the Oral Cavity*

### Promoting Mouth Care

The nurse instructs the patient in the importance and techniques of preventive mouth care. If a patient cannot tolerate brushing or flossing, an irrigating solution of 1 tsp of baking soda to 8 oz of warm water, half-strength hydrogen peroxide, or normal saline solution is recommended. The nurse reinforces the need to perform oral care and provides such care to patients who cannot provide it for themselves.

If a bacterial or fungal infection is present, the nurse administers the prescribed medications and instructs the patient how to administer the medications at home. The nurse monitors the patient's physical and psychological response to treatment.

**Xerostomia,** dryness of the mouth, is a frequent sequela of oral cancer, particularly when the salivary glands have

been exposed to radiation or major surgery. It is also seen in patients who are receiving psychopharmacologic agents, patients with human immunodeficiency virus (HIV) infection, and patients who cannot close the mouth and as a result become mouth-breathers. To minimize this problem, the patient is advised to avoid dry, bulky, and irritating foods and fluids, as well as alcohol and tobacco. The patient is also encouraged to increase intake of fluids (when not contraindicated) and to use a humidifier while sleeping. The use of synthetic saliva, a moisturizing antibacterial gel such as Oral Balance, or a saliva production stimulant such as Salagen may be helpful.

**Stomatitis,** or mucositis, which involves inflammation and breakdown of the oral mucosa, is often a side effect of chemotherapy or radiation therapy. Prophylactic mouth care is started when the patient begins receiving treatment; however, mucositis may become so severe that a break in treatment is necessary. If a patient receiving radiation therapy has poor dentition, extraction of the teeth before radiation treatment in the oral cavity is often initiated to prevent infection. Many radiation therapy centers recommend the use of fluoride treatments for patients receiving radiation to the head and neck. (See Chapter 16 for more information about stomatitis.)

## Ensuring Adequate Food and Fluid Intake

The patient's weight, age, and level of activity are recorded to determine whether nutritional intake is adequate. A daily calorie count may be necessary to determine the exact quantity of food and fluid ingested. The frequency and pattern of eating are recorded to determine whether any psychosocial or physiologic factors are affecting ingestion. Based on the disorder and the patient's preferences, the nurse recommends changes in the consistency of foods and the frequency of eating. Consultation with a dietitian may be helpful. The goal is to help the patient attain and maintain desirable body weight and level of energy, as well as to promote the healing of tissue.

## Supporting a Positive Self-Image

A patient who has a disfiguring oral condition or has undergone disfiguring surgery may experience an alteration in self-image. The patient is encouraged to verbalize the perceived change in body appearance and to realistically discuss actual changes or losses. The nurse offers support while the patient verbalizes fears and negative feelings (withdrawal, depression, anger). The nurse listens attentively and determines the patient's needs and individualizes the plan of care. The patient's strengths and achievements are reinforced.

The nurse should determine the patient's anxieties concerning relationships with others. Referral to support groups, a psychiatric liaison nurse, a social worker, or a spiritual advisor may be useful in helping the patient to cope with anxieties and fears. The patient's progress toward development of positive self-esteem is documented. The nurse should be alert to signs of grieving and should document emotional changes. By providing acceptance and support, the nurse encourages the patient to verbalize feelings.

## Minimizing Pain and Discomfort

Oral lesions can be painful. Strategies to reduce pain and discomfort include avoiding foods that are spicy, hot, or hard (eg, pretzels, nuts). A soft or liquid diet may be preferred. The patient is instructed about mouth care. Using a soft tooth brush may prevent secondary trauma. It may be necessary to provide the patient with an analgesic such as viscous lidocaine (Xylocaine Viscous 2%) or opioids, as prescribed. Topical medications such as sucralfate (Carafate) and aluminum-magnesium liquid antacids may provide relief. The nurse can reduce the patient's fear of pain by providing information about pain control methods.

## Preventing Infection

Leukopenia (a decrease in white blood cells) may result from radiation, chemotherapy, acquired immunodeficiency syndrome (AIDS), and some medications used to treat HIV infection. Leukopenia reduces defense mechanisms, increasing the risk of infections. Malnutrition, which is also common among these patients, may further decrease resistance to infection. If the patient has diabetes, the risk of infection is further increased.

Laboratory results should be evaluated frequently and the patient's temperature checked every 4 to 8 hours for an elevation that may indicate infection. Visitors who might transmit microorganisms are prohibited if the patient's immunologic system is depressed. Sensitive skin tissues are protected from trauma to maintain skin integrity and prevent infection. Aseptic technique is necessary when changing dressings. Desquamation (shedding of the epidermis) is a reaction to radiation therapy that causes dryness and itching and can lead to a break in skin integrity and subsequent infection.

Signs of wound infection (redness, swelling, drainage, tenderness) are reported to the physician. Antibiotics may be prescribed prophylactically.

## Promoting Home and Community-Based Care

### *Teaching Patients Self-Care*

The patient who is recovering from treatment of an oral condition is instructed about mouth care, nutrition, prevention of infection, and signs and symptoms of complications (Chart 35-2). Methods of preparing nutritious foods that are seasoned according to the patient's preference and at the preferred temperature are explained to the patient and family. For some patients, it may be more convenient (but also more expensive) to use commercial baby foods than to prepare liquid and soft diets. The patient who cannot take foods orally may receive enteral or parenteral nutrition; the administration of these feedings is explained and demonstrated to the patient and the caregiver.

For patients with oral cancer, instructions are provided in the use and care of any dentures. The importance of keeping dressings clean and the need for conscientious oral hygiene are emphasized.

### *Continuing Care*

The need for ongoing care in the home depends on the patient's condition. The patient, the family members, and others responsible for home care (eg, nurse, speech therapist,

CHART 35-2

HOME CARE CHECKLIST

*The Patient With an Oral Condition*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate use of suction equipment if indicated. | ✔ | ✔ |
| • State rationale for humidification. | ✔ | ✔ |
| • Identify foods necessary to meet caloric needs and dietary needs (ie, change in consistency, seasoning limitations, supplements). | ✔ | ✔ |
| • Demonstrate effective oral hygiene. | ✔ | ✔ |
| • Demonstrate care of incision. | ✔ | ✔ |
| • State when next medical/dental follow-up appointment will be scheduled. | ✔ | ✔ |

nutritionist, psychologist) work together to prepare an individual plan of care.

If suctioning of the mouth or tracheostomy tube is required, the necessary equipment is obtained and the patient and caregivers are taught how to use it. Considerations include the control of odors and humidification of the home to keep secretions moist. The patient and caregivers are taught how to assess for obstruction, hemorrhage, and infection and what actions to take if they occur. The home care nurse may provide physical care, monitor for changes in the patient's physical status (eg, skin integrity, nutritional status, respiratory function), and assess the adequacy of pain control measures. The nurse also assesses the patient's and family's ability to manage incisions, drains, and feeding tubes and the use of recommended strategies for communication. The ability of the patient and family to accept physical, psychological, and role changes is assessed and addressed.

Follow-up visits to the physician are important to monitor the patient's condition and to determine the need for modifications in treatment and general care. Because patients and their family members, as well as health care providers, tend to focus on the most obvious needs and issues, the nurse reminds the patient and family about the importance of continuing health promotion and screening practices and refers them to appropriate practitioners. The nurse also reinforces instructions in an effort to promote the patient's self-care and comfort.

## NECK DISSECTION

Malignancies of the head and neck include those of the oral cavity, oropharynx, hypopharynx, nasopharynx, nasal cavity, paranasal sinus, and larynx. (Laryngeal cancer is presented in Chapter 22.) These cancers account for fewer than 5% of all cancers. Depending on the location and stage, treatment may consist of radiation therapy, chemotherapy, surgery, or a combination of these modalities. Deaths from malignancies of the head and neck are primarily attributable to local-regional metastasis to the cervical lymph nodes in the neck. This often occurs by way of the lymphatics before the primary lesion has been treated. This local-regional metastasis is not amenable to surgical resection and responds poorly to chemotherapy and radiation therapy.

A radical neck dissection involves removal of all cervical lymph nodes (Fig. 35-3) from the mandible to the clavicle and removal of the sternocleidomastoid muscle, internal jugular vein, and spinal accessory muscle on one side of the neck. The associated complications include shoulder drop and poor cosmesis (visible neck depression). Modified radical neck dissection, which preserves one or more of the nonlymphatic structures, is used more often. A selective neck dissection (in comparison to a radical dissection) preserves one or more of the lymph node groups, the internal jugular vein, the sternocleidomastoid muscle, and the spinal accessory nerve (Fig. 35-4).

Reconstructive techniques may be performed with a variety of grafts. A cutaneous flap (skin and subcutaneous tissue), such as the deltopectoral flap, may be used. A myocutaneous flap (subcutaneous tissue, muscle, and skin) is a more frequently used graft; the pectoralis major muscle is usually used. For large grafts, a microvascular free flap may be used. This involves the transfer of muscle, skin, or bone

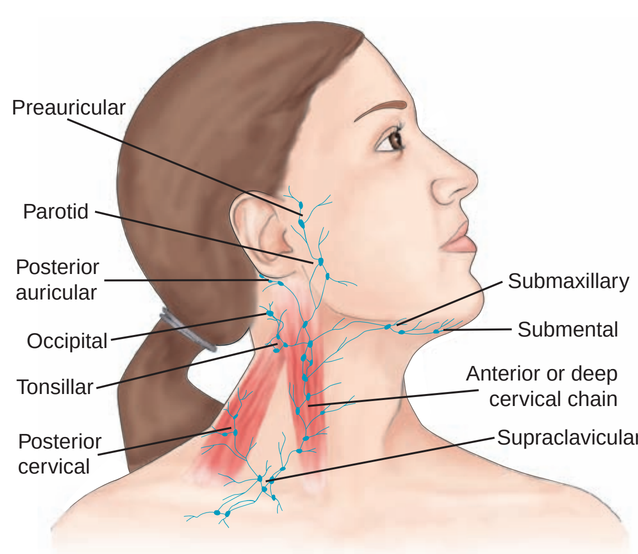



**Figure 35-3** Lymphatic drainage of the head and neck.

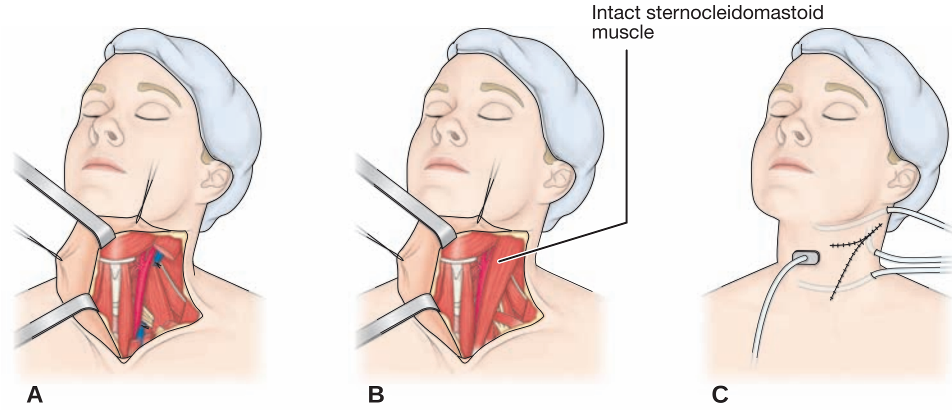



**Figure 35-4** **A,** A classic radical neck dissection in which the sternocleidomastoid and smaller muscles are removed. All tissue is removed, from the ramus of the jaw to the clavicle. The jugular vein has also been removed. **B,** The selective neck dissection is similar but preserves the sternocleidomastoid muscle, internal jugular vein, and spinal accessory nerve. **C,** The wound is closed, and portable suction drainage tubes are in place.

with an artery and vein to the area of reconstruction, using microinstrumentation. Areas used for a free flap include the scapula, the radial area of the forearm, or the fibula. The fibula, which provides a larger bone area, may be used if mandibular reconstruction is involved.

## NURSING PROCESS

## The Patient Undergoing a Neck Dissection

### Assessment

Preoperatively, the patient's physical and psychological preparation for major surgery is assessed, along with his or her knowledge of the preoperative and postoperative procedures. Postoperatively, the patient is assessed for complications such as altered respiratory status, wound infection, and hemorrhage. As healing occurs, neck range of motion is assessed to determine whether there has been a decrease in range of motion due to nerve or muscle damage.

### Diagnosis

#### *Nursing Diagnoses*

Based on all the assessment data, major nursing diagnoses may include the following:

- Deficient knowledge about preoperative and postoperative procedures
- Ineffective airway clearance related to obstruction by mucus, hemorrhage, or edema
- Acute pain related to surgical incision
- Risk for infection related to surgical intervention secondary to decreased nutritional status, or immunosuppression from chemotherapy or radiation therapy
- Impaired tissue integrity secondary to surgery and grafting
- Imbalanced nutrition, less than body requirements, related to disease process or treatment
- Situational low self-esteem related to diagnosis or prognosis
- Impaired verbal communication secondary to surgical resection
- Impaired physical mobility secondary to nerve injury

#### *Collaborative Problems/Potential Complications*

Potential postoperative complications that may develop include the following:

- Hemorrhage
- Chyle fistula
- Nerve injury

### Planning and Goals

The major goals for the patient include participation in the treatment plan, maintenance of respiratory status, attainment of comfort, absence of infection, viability of the graft, maintenance of adequate intake of food and fluids, effective coping strategies, effective communication, maintenance of shoulder and neck motion, and absence of complications.

### Nursing Interventions

#### *Providing Preoperative Patient Education*

Before surgery, the patient should be informed about the nature and extent of the surgery and what the postoperative period will be like. The patient is encouraged to ask questions and to express concerns about the upcoming surgery and the expected results. During this exchange, the nurse has an opportunity to assess the patient's coping abilities, answer questions, and develop a plan for offering assistance. A sense of mutual understanding and rapport make the postoperative experience less traumatic for the patient. The patient's expressions of concern, anxieties, and fears guide the nurse in providing support postoperatively.

#### *Providing General Postoperative Care*

The general postoperative nursing interventions are similar to those presented in Chapter 20 and are directed toward the identified nursing diagnoses and goals.

#### *Maintaining the Airway*

After the endotracheal tube or airway has been removed and the effects of the anesthesia have worn off, the patient may be placed in the Fowler's position to facilitate breathing and promote comfort. This position also increases lymphatic and venous drainage, facilitates swallowing, decreases venous pressure on the skin flaps, and prevents regurgitation and aspiration of stomach contents. Signs of

respiratory distress, such as dyspnea, cyanosis, changes in mental status, and changes in vital signs, are assessed because they may suggest edema, hemorrhage, inadequate oxygenation, or inadequate drainage.

**NURSING ALERT**

**In the immediate postoperative period, the nurse assesses for stridor (coarse, high-pitched sound on inspiration) by listening frequently over the trachea with a stethoscope. This finding must be reported immediately because it indicates obstruction of the airway.**

Pneumonia may occur in the postoperative phase if pulmonary secretions are not removed. To aid in the removal of secretions, coughing and deep breathing are encouraged. With the nurse supporting the neck, the patient should assume a sitting position so that excessive secretions can be coughed up and expectorated. If this is ineffective, the patient's respiratory tract may have to be suctioned. Care is taken to protect the suture lines during suctioning. If a tracheostomy tube is in place, suctioning is performed through the tube. The patient may also be instructed on use of Yankauer suction (tonsil tip suction) to remove oral secretions. Humidified air or oxygen is provided through the tracheostomy to keep secretions thin. Temperature should not be taken orally.

***Relieving Pain***

Pain and the patient's fear of pain are assessed and managed. Patients with head and neck cancer often report less pain than patients with other types of cancer; however, the nurse needs to be aware that each person's pain experience is individual. Pain management is monitored on a continual basis by the nursing staff and adjusted on an individual basis. Patient-controlled analgesia may be prescribed for postoperative pain management, thereby reducing the wait time for pain relief.

***Providing Wound Care***

Wound drainage tubes are usually inserted during surgery to prevent the collection of fluid subcutaneously. The drainage tubes are connected to a portable suction device (eg, Jackson-Pratt), and the container is emptied periodically. Between 80 and 120 mL of serosanguineous secretions may drain over the first 24 hours. Excessive drainage may be indicative of a chyle fistula or hemorrhage (see later discussion). Dressings are reinforced as needed and are observed for evidence of hemorrhage and constriction, which impairs respiration and perfusion of the graft. A graft, if present, is assessed for color and temperature and for the presence of a pulse, if applicable, to determine viability. The graft should be pale pink and warm to the touch. The surgical incisions are also assessed for signs of infection (purulent, malodorous drainage), which are reported immediately. Prophylactic antibiotics may be prescribed in the early postoperative period. Aseptic technique is used when cleansing skin around the drains; dressings are changed as prescribed by the surgeon, usually on the second through the fifth postoperative days.

***Maintaining Adequate Nutrition***

Nutritional status is assessed preoperatively; early intervention to correct nutritional imbalances may decrease the risk of postoperative complications. Frequently, nutrition is less than optimal because of inadequate intake, and the patient often requires enteral or parenteral supplements preoperatively and postoperatively to attain and maintain a positive nitrogen balance. Supplements (eg, Ensure, Sustacal, Boost) that are nutritionally dense may help reestablish a positive nitrogen balance. They may be taken enterally by mouth, by nasogastric feeding tube, or by gastrostomy feeding tube.

The patient who can chew may take food by mouth; the patient's chewing ability determines whether some diet modification (eg, soft, puréed, or liquid foods) is necessary. Food preferences should also be discussed with the patient. Oral care before eating may enhance the patient's appetite, and oral care after eating is important to prevent infection and dental caries. Most patients can maintain and gain weight.

***Supporting Coping Measures***

Preoperatively, information about the planned surgery is given to the patient and family. Any questions are answered as accurately as possible. It is important for the health care provider to pay attention to nonverbal behavior that may indicate something different from what the patient is able to articulate. Postoperatively, psychological nursing interventions are aimed at supporting the patient who has had a change in body image or who has major concerns related to the prognosis. The patient may have difficulty communicating and may be concerned about his or her ability to breathe and swallow normally. The nurse supports the patient's family in encouraging and reassuring the patient that adjusting to the results of this surgery will take time.

The person who has had extensive neck surgery often is sensitive about his or her appearance. This can occur when the operative area is covered by bulky dressings, when the incision line is visible, or later after healing has occurred and the appearance of the neck and possibly the lower face has been significantly altered. If the nurse accepts the patient's appearance and expresses a positive, optimistic attitude, the patient is more likely to be encouraged. The patient also needs an opportunity to express fears and concerns regarding the success of the surgery and the prognosis. The American Cancer Society (ACS) may be a resource to provide a volunteer who meets with the patient either preoperatively or postoperatively and shares his or her own experience about the diagnosis, treatment, and recovery. The "Look Good, Feel Better" programs of the ACS also are a source of information about clothing and cosmetics that can be used to deemphasize physical defects.

People with cancer of the head and neck frequently have used alcohol or tobacco before surgery; postoperatively, they are encouraged to abstain from these substances. Alternative methods of coping need to be explored. A referral to Alcoholics Anonymous, a smoking cessation program, and family counseling may be appropriate.

***Promoting Effective Communication***

Communication begins preoperatively, when the patient and family determine which method of communication will be the best postoperatively. Useful communication methods

for the patient who has undergone a laryngectomy include Magic Slates, writing materials, pictorial guides, computer aids, and hand signals. During the postoperative period, the call bell must be readily accessible to the patient at all times.

The nurse obtains a consultation with a speech or language therapist. Alternative speech techniques, such as an electrolarynx (a mechanical device held against the neck) or esophageal speech, may be taught by a speech or language therapist. The most widely used technique for creating laryngeal speech is tracheoesophageal puncture. A surgically created fistula extends from the superior wall of the tracheal stoma into the proximal esophageal wall. A voice prosthesis is then inserted into the fistula to assist with speech (see Chapter 22).

### *Maintaining Physical Mobility*

Excision of muscles and nerves results in weakness at the shoulder that can cause shoulder drop, a forward curvature of the shoulder. Many problems can be avoided with a conscientious exercise program. These exercises are usually started after the drains have been removed and the neck incision is sufficiently healed. The purpose of the exercises depicted in Figure 35-5 is to promote maximal shoulder function and

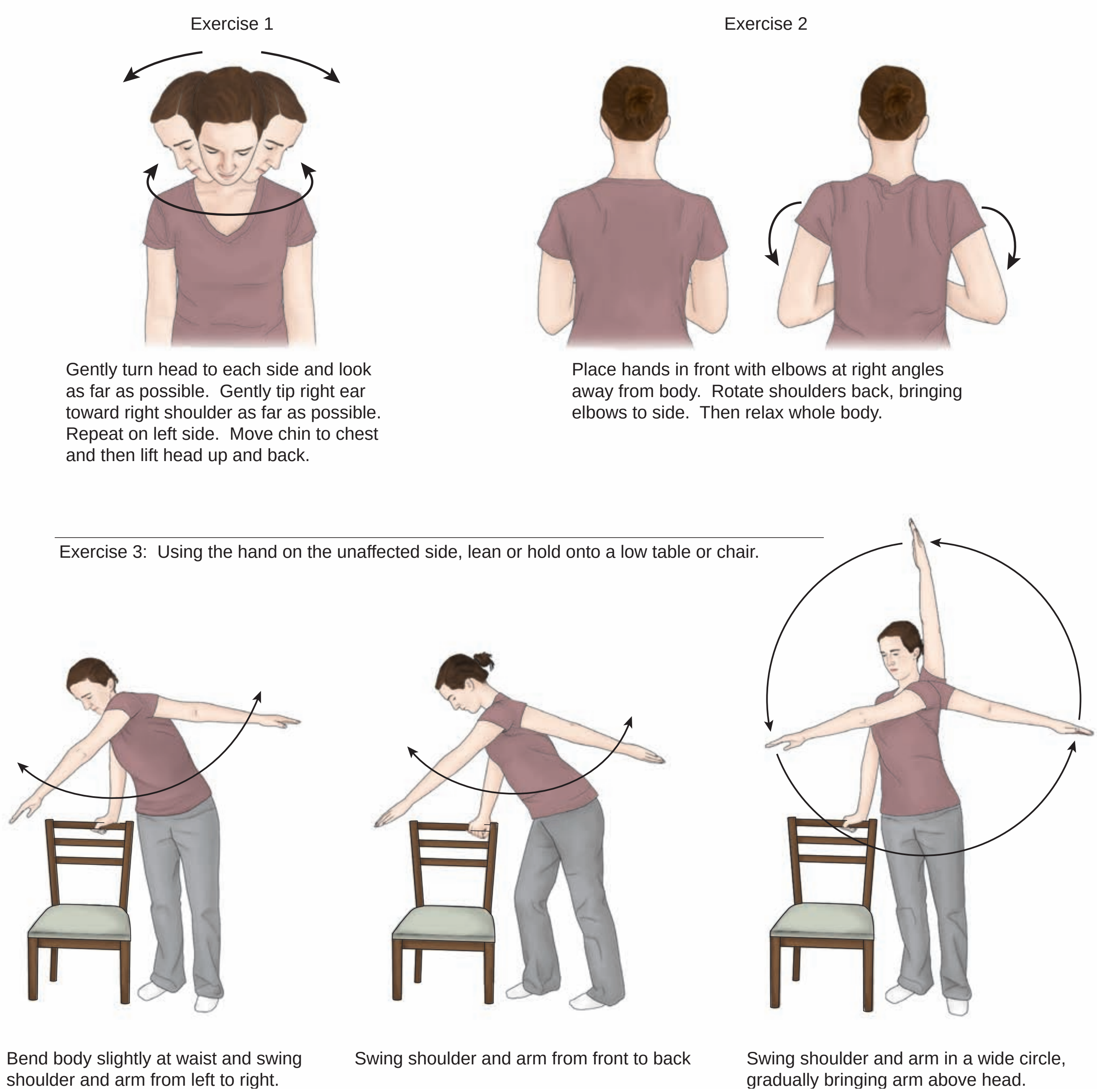



**Figure 35-5** Three rehabilitation exercises after head and neck surgery. The objective is to regain maximum shoulder function and neck motion after neck surgery. From *Exercise for radical neck surgery patients.* Head and Neck Service, Department of Surgery, Memorial Hospital, New York, NY.

neck motion after surgery. Physical therapists and occupational therapists can assist patients in performing these exercises.

### *Monitoring and Managing Potential Complications*

**HEMORRHAGE.** Hemorrhage may occur from carotid artery rupture as a result of necrosis of the graft or damage to the artery itself from tumor or infection. The following measures are indicated:

- Vital signs are assessed frequently (every 1 to 2 hours or every 15 minutes if the patient is critical). Once the patient is stabilized, assessment is increased to every 4 hours. Tachycardia, tachypnea, and hypotension may indicate hemorrhage and impending hypovolemic shock.
- The patient is instructed to avoid the Valsalva maneuver to prevent stress on the graft and carotid artery.
- Signs of impending rupture, such as high epigastric pain or discomfort, are reported.
- Dressings and wound drainage are observed for excessive bleeding.
- If hemorrhage occurs, assistance is summoned immediately.
- Hemorrhage requires the continuous application of pressure to the bleeding site or major associated vessel.
- Although some clinicians advocate placing the patient in the modified Trendelenburg position to maintain blood pressure, others recommend that the head of the patient's bed be elevated to maintain airway patency and prevent aspiration.
- A controlled, calm manner allays the patient's anxiety.
- The surgeon is notified immediately, because a vascular or ligature tear requires surgical intervention.

**CHYLE FISTULA.** A chyle fistula (milklike drainage from the thoracic duct into the thoracic cavity) may develop as a result of damage to the thoracic duct during surgery. The diagnosis is made if there is excess drainage that has a 3% fat content and a specific gravity of 1.012 or greater. Treatment of a small leak (500 mL or less) includes application of a pressure dressing and a diet of medium-chain fatty acids or parenteral nutrition. Surgical intervention to repair the damaged duct is necessary for larger leaks.

**NERVE INJURY.** Nerve injury can occur if the cervical plexus or spinal accessory nerves are severed during surgery. Because lower facial paralysis may occur as a result of injury to the facial nerve, this complication is observed for and reported. Likewise, if the superior laryngeal nerve is damaged, the patient may have difficulty swallowing liquids and food because of the partial lack of sensation of the glottis. Speech therapy may be indicated to assist with the problems related to nerve injury.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient and caregiver require instructions about management of the wound, the dressing, and any drains that remain in place. Patients who require oral suctioning or who have a tracheostomy may be very anxious about their care at home; the transition to home can be eased if the caregiver is given several opportunities to demonstrate the ability to meet the patient's needs (Chart 35-3). The patient and caregiver are also instructed about possible complications such as bleeding and respiratory distress and when to notify the health care provider of signs and symptoms of these complications.

If the patient cannot take food by mouth, detailed instructions and demonstration of enteral or parenteral feedings will be required. Education in techniques of effective oral hygiene is also important.

**CONTINUING CARE.** A referral for home care nursing may be necessary in the early period after discharge. The nurse assesses healing, ensures that feedings are being administered properly, and monitors for any complications. The nurse also assesses the patient's adjustment to changes in physical appearance and status and ability to communicate and eat normally. Physical and speech therapy also are likely to be continued at home.

The patient is given information regarding local support groups such as "I Can Cope" or "New Voice Club," if

**CHART 35-3** HOME CARE CHECKLIST
*Recovering From Neck Surgery*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate use of suction equipment. | ✔ | ✔ |
| • State rationale for humidification. | ✔ | ✔ |
| • State dietary modifications needed to meet caloric needs. | ✔ | ✔ |
| • Demonstrate enteral or parenteral feeding techniques. | ✔ | ✔ |
| • Demonstrate care of incision and drains. | ✔ | ✔ |
| • Identify signs and symptoms (eg, bleeding, respiratory distress, drainage) to be reported to health care provider. | ✔ | ✔ |
| • State when next checkup is needed. | ✔ | ✔ |
| • Demonstrate exercises. | ✔ | |
| • Identify available support groups. | ✔ | ✔ |

indicated. The local chapter of the ACS may be contacted for information and equipment needed for the patient.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Discusses expected course of treatment
2. Demonstrates good respiratory exchange
   a. Lungs are clear to auscultation
   b. Breathes easily with no shortness of breath
   c. Demonstrates ability to use suction effectively
3. Remains free of infection
   a. Maintains normal laboratory values
   b. Is afebrile
4. Graft is pink and warm to touch
5. Maintains adequate intake of foods and fluids
   a. Accepts altered route of feeding
   b. Is well hydrated
   c. Maintains or gains weight
6. Demonstrates ability to cope
   a. Discusses emotional responses to the diagnosis
   b. Attends support group meetings
7. Verbalizes comfort
8. Attains maximal mobility
   a. Adheres to physical therapy exercises
   b. Attains maximal range of motion
9. Exhibits no complications
   a. Vital signs stable
   b. No excessive bleeding or discharge
   c. Able to move muscles of lower face

# DISORDERS OF THE ESOPHAGUS

The esophagus is a mucus-lined, muscular tube that carries food from the mouth to the stomach. It begins at the base of the pharynx and ends about 4 cm below the diaphragm. Its ability to transport food and fluid is facilitated by two sphincters. The upper esophageal sphincter, also called the hypopharyngeal sphincter, is located at the junction of the pharynx and the esophagus. The lower esophageal sphincter, also called the gastroesophageal sphincter or cardiac sphincter, is located at the junction of the esophagus and the stomach. An incompetent lower esophageal sphincter allows reflux (backward flow) of gastric contents. There is no serosal layer of the esophagus; therefore, if surgery is necessary, it is more difficult to perform suturing or anastomosis.

Disorders of the esophagus include motility disorders (achalasia, diffuse spasm), hiatal hernias, diverticula, perforation, foreign bodies, chemical burns, gastroesophageal reflux disease (GERD), Barrett's esophagus, benign tumors, and carcinoma. **Dysphagia** (difficulty swallowing), the most common symptom of esophageal disease, may vary from an uncomfortable feeling that a bolus of food is caught in the upper esophagus to acute pain on swallowing **(odynophagia)**. Obstruction of food (solid and soft) and even liquids may occur anywhere along the esophagus. Often the patient can indicate that the problem is located in the upper, middle, or lower third of the esophagus.

## *Achalasia*

**Achalasia** is absent or ineffective peristalsis of the distal esophagus, accompanied by failure of the esophageal sphincter to relax in response to swallowing. Narrowing of the esophagus just above the stomach results in a gradually increasing dilation of the esophagus in the upper chest. Achalasia may progress slowly and occurs most often in people 40 years of age or older.

### Clinical Manifestations

The primary symptom is difficulty in swallowing both liquids and solids. The patient has a sensation of food sticking in the lower portion of the esophagus. As the condition progresses, food is commonly regurgitated either spontaneously or intentionally by the patient to relieve the discomfort produced by prolonged distention of the esophagus by food that will not pass into the stomach. The patient may also report chest pain and heartburn **(pyrosis)** that may or may not be associated with eating. Secondary pulmonary complications may result from aspiration of gastric contents.

### Assessment and Diagnostic Findings

X-ray studies show esophageal dilation above the narrowing at the gastroesophageal junction. Barium swallow, computed tomography (CT) of the chest, and endoscopy may be used for diagnosis; however, manometry, a process in which the esophageal pressure is measured by a radiologist or gastroenterologist, confirms the diagnosis.

### Management

The patient is instructed to eat slowly and to drink fluids with meals. As a temporary measure, calcium channel blockers and nitrates have been used to decrease esophageal pressure and improve swallowing. Injection of botulinum toxin (Botox) into quadrants of the esophagus via endoscopy has been helpful because it inhibits the contraction of smooth muscle. Periodic injections are required to maintain remission.

Achalasia may be treated conservatively by pneumatic dilation to stretch the narrowed area of the esophagus (Fig. 35-6). Pneumatic dilation has a high success rate. Although perforation is a potential complication, its incidence is low. The procedure can be painful; therefore, moderate sedation in the form of an analgesic or tranquilizer, or both, is administered for the treatment. The patient is monitored for perforation. Abdominal tenderness and fever may indicate perforation (see later discussion).

Achalasia may be treated surgically by esophagomyotomy. The procedure is usually performed laparoscopically, either with a complete lower esophageal sphincter myotomy and an antireflux procedure or without an antireflux procedure. The esophageal muscle fibers are separated to relieve the lower esophageal stricture.

## *Diffuse Esophageal Spasm*

Diffuse spasm is a motor disorder of the esophagus. The cause is unknown, but stress may be a factor. It is more common in women and usually manifests in middle age.

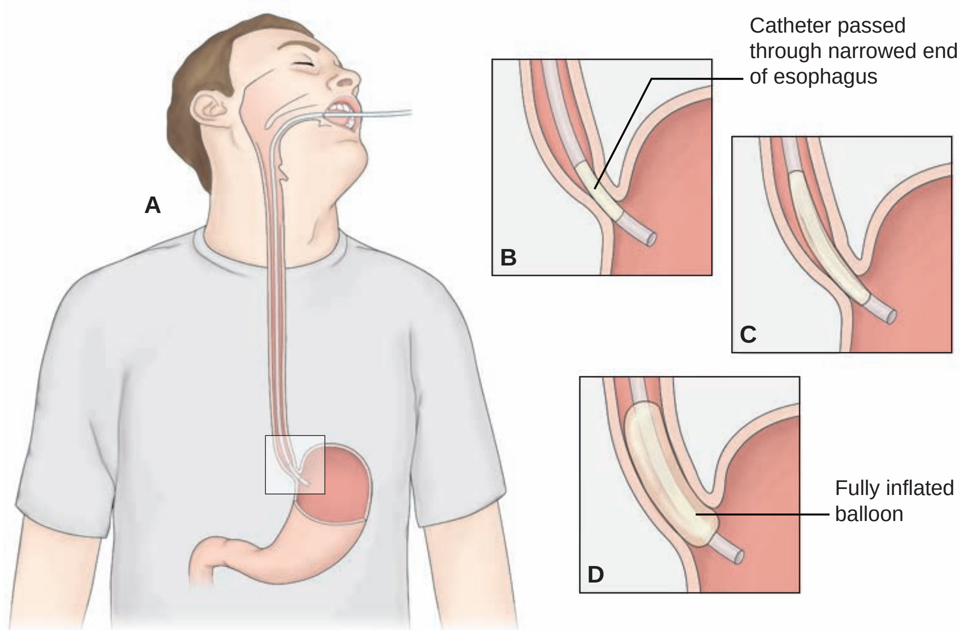



**Figure 35-6** Treatment of achalasia by pneumatic dilation. **A–C,** The dilator is passed, guided by a previously inserted guide wire. **D,** When the balloon is in proper position, it is distended by pressure sufficient to dilate the narrowed area of the esophagus.

### Clinical Manifestations

Diffuse spasm is characterized by difficulty (dysphagia) or pain (odynophagia) on swallowing and by chest pain similar to that of coronary artery spasm.

### Assessment and Diagnostic Findings

Esophageal manometry, which measures the motility of the esophagus and the pressure within the esophagus, indicates that simultaneous contractions of the esophagus occur irregularly. Diagnostic x-ray studies after ingestion of barium show separate areas of spasm.

### Management

Conservative therapy includes administration of sedatives and long-acting nitrates to relieve pain. Calcium channel blockers (eg, nifedipine [Procardia], verapamil [Calan]) have also been used to manage diffuse spasm. Small, frequent feedings and a soft diet are usually recommended to decrease the esophageal pressure and irritation that lead to spasm. Dilation performed by bougienage (use of progressively sized flexible dilators), pneumatic dilation, or esophagomyotomy may be necessary if the pain becomes intolerable.

If none of the conservative approaches is successful in managing symptoms, surgery may be considered. An esophageal Heller myotomy (a surgical procedure in which the cardiac sphincter is cut, allowing food and liquids to pass into the stomach) by a minimally invasive approach is considered first and has shown positive results (Rosemurgy, Villadolid, Thometz, et al., 2005). If an open surgical approach is required, then a transhiatal esophagectomy is performed (see Cancer of the Esophagus).

## Hiatal Hernia

In the condition known as hiatus (or hiatal) **hernia,** the opening in the diaphragm through which the esophagus passes becomes enlarged, and part of the upper stomach tends to move up into the lower portion of the thorax. Hiatal hernia occurs more often in women than in men. There are two types of hiatal hernias: sliding and paraesophageal. Sliding, or type I, hiatal hernia occurs when the upper stomach and the gastroesophageal junction are displaced upward and slide in and out of the thorax (Fig. 35-7A). About 90% of patients with esophageal hiatal hernia have a sliding hernia. A paraesophageal hernia occurs when all or part of the stomach pushes through the diaphragm beside the esophagus (see Fig. 35-7B). Paraesophageal hernias are further classified as types II, III, or IV, depending on the extent of herniation, with type IV having the greatest herniation.

### Clinical Manifestations

The patient with a sliding hernia may have heartburn, regurgitation, and dysphagia, but at least 50% of patients are asymptomatic. Sliding hiatal hernia is often implicated in reflux. The patient with a paraesophageal hernia usually feels a sense of fullness or chest pain after eating, or there may be no symptoms. Reflux usually does not occur, because the gastroesophageal sphincter is intact. Hemorrhage, obstruction, and strangulation can occur with any type of hernia.

### Assessment and Diagnostic Findings

Diagnosis is confirmed by x-ray studies, barium swallow, and fluoroscopy.

### Management

Management for a hiatal hernia includes frequent, small feedings that can pass easily through the esophagus. The patient is advised not to recline for 1 hour after eating, to prevent reflux or movement of the hernia, and to elevate the head of the bed on 4- to 8-inch (10- to 20-cm) blocks to prevent the hernia from sliding upward. Surgery is indicated in about 15% of patients. Medical and surgical management of a paraesophageal hernia is similar to that for gastroesophageal

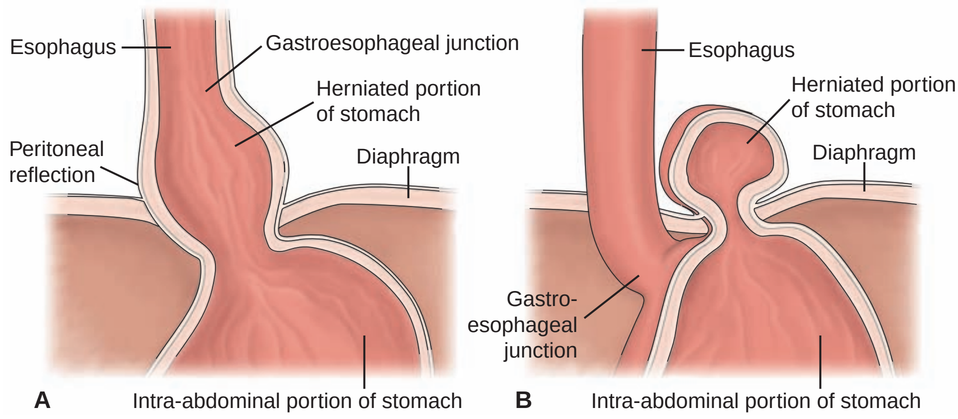



**Figure 35-7** **A,** Sliding esophageal hernia. The upper stomach and gastroesophageal junction have moved upward and slide in and out of the thorax. **B,** Paraesophageal hernia. All or part of the stomach pushes through the diaphragm next to the gastroesophageal junction.

reflux; however, people with paraesophageal hernias may require emergency surgery to correct torsion (twisting) of the stomach or other body organ that leads to restriction of blood flow to that area.

## Diverticulum

A diverticulum is an outpouching of mucosa and submucosa that protrudes through a weak portion of the musculature. Diverticula may occur in one of the three areas of the esophagus—the pharyngoesophageal or upper area of the esophagus, the midesophageal area, or the epiphrenic or lower area of the esophagus—or they may occur along the border of the esophagus intramurally.

The most common type of diverticulum, which is found three times more frequently in men than in women, is Zenker's diverticulum (also known as pharyngoesophageal pulsion diverticulum or a pharyngeal pouch). It occurs posteriorly through the cricopharyngeal muscle in the midline of the neck. It is usually seen in people older than 60 years of age. Other types of diverticula include midesophageal, epiphrenic, and intramural diverticula.

Midesophageal diverticula are uncommon. Symptoms are less acute, and usually the condition does not require surgery. Epiphrenic diverticula are usually larger diverticula in the lower esophagus just above the diaphragm. They may be related to the improper functioning of the lower esophageal sphincter or to motor disorders of the esophagus. Intramural diverticulosis is the occurrence of numerous small diverticula associated with a stricture in the upper esophagus.

### Clinical Manifestations

Symptoms experienced by the patient with a pharyngoesophageal pulsion diverticulum include difficulty swallowing, fullness in the neck, belching, regurgitation of undigested food, and gurgling noises after eating. The diverticulum, or pouch, becomes filled with food or liquid. When the patient assumes a recumbent position, undigested food is regurgitated, and coughing may be caused by irritation of the trachea. Halitosis and a sour taste in the mouth are also common because of the decomposition of food retained in the diverticulum.

Symptoms produced by midesophageal diverticula are less acute. One third of patients with epiphrenic diverticula are asymptomatic, and the remaining two thirds report dysphagia and chest pain. Dysphagia is the most common symptom of patients with intramural diverticulosis.

### Assessment and Diagnostic Findings

A barium swallow may determine the exact nature and location of a diverticulum. Manometric studies are often performed for patients with epiphrenic diverticula to rule out a motor disorder. Esophagoscopy usually is contraindicated because of the danger of perforation of the diverticulum, with resulting mediastinitis (inflammation of the organs and tissues that separate the lungs). Blind insertion of a nasogastric tube should be avoided.

### Management

Because pharyngoesophageal pulsion diverticulum is progressive, the only means of cure is surgical removal of the diverticulum. During surgery, care is taken to avoid trauma to the common carotid artery and internal jugular veins. The sac is dissected free and amputated flush with the esophageal wall. In addition to a diverticulectomy, a myotomy of the cricopharyngeal muscle is often performed to relieve spasticity of the musculature, which otherwise seems to contribute to a continuation of the previous symptoms. A nasogastric tube may be inserted at the time of surgery. Postoperatively, the surgical incision must be observed for evidence of leakage from the esophagus and a developing fistula. Food and fluids are withheld until x-ray studies show no leakage at the surgical site. The diet begins with liquids and is progressed as tolerated.

Surgery is indicated for epiphrenic and midesophageal diverticula only if the symptoms are troublesome and becoming worse. Treatment consists of a diverticulectomy and long myotomy. Intramural diverticula usually regress after the esophageal stricture is dilated.

## Perforation

The esophagus is a common site of injury. Perforation may result from stab or bullet wounds of the neck or chest, trauma from a motor vehicle crash, caustic injury from a

chemical burn, or inadvertent puncture by a surgical instrument during examination or dilation such as endoscopy.

### Clinical Manifestations

The patient has persistent pain followed by dysphagia. Infection, fever, leukocytosis, and severe hypotension may be noted. In some instances, signs of pneumothorax are observed.

### Assessment and Diagnostic Findings

X-ray studies and fluoroscopy by either a barium swallow or esophagram are used to identify the site of the injury.

### Management

Because of the high risk of infection, broad-spectrum antibiotic therapy is initiated. If the perforation is small enough and without symptoms, surgical intervention may not be necessary. The patient is immediately made nothing by mouth status. Nutritional needs are met by parenteral or enteral nutrition. The type of nutritional support depends on the location of the injury. Enteral or parenteral nutrition is provided for at least 1 month to give the esophagus a chance to heal. A repeat barium swallow study is performed after 1 month, and the involved area is reevaluated. If there is no evidence of perforation, foods are reintroduced, beginning with liquids and then slowly progressing to solids as tolerated.

Surgery is performed if the esophageal perforation is large or if mediastinitis or infection of the thoracic cavity is a threat. In a cervical esophagostomy, the upper portion of the esophagus is attached to an opening made in the neck; this "spit" fistula allows for the drainage of saliva. The lower portion of the esophagus remaining within the chest is closed. After 6 months, during which the patient is allowed to heal and recover from possible infection, surgery is again performed to reconnect the two parts of the esophagus.

Postoperative nutritional status is a primary concern. The patient is not allowed any oral nourishment for 6 months. Enteral or parenteral support is maintained. Water to moisten the patient's mouth is allowed for comfort measures only. The postoperative nursing management is similar to that for patients who have had thoracic or abdominal surgery.

## Foreign Bodies

Many swallowed foreign bodies pass through the gastrointestinal tract without the need for medical intervention. However, some swallowed foreign bodies (eg, dentures, fish bones, pins, small batteries, items containing mercury or lead) may injure the esophagus or obstruct its lumen and must be removed. Pain and dysphagia may be present, and dyspnea may occur as a result of pressure on the trachea. The foreign body may be identified by x-ray. Perforation may have occurred (see earlier discussion).

Glucagon, because of its relaxing effect on the esophageal muscle, may be injected intramuscularly. An endoscope (with a covered hood or overtube) may be used to remove the impacted food or object from the esophagus. A mixture consisting of sodium bicarbonate and tartaric acid may be prescribed to increase intraluminal pressure by the formation of a gas. Caution must be used with this treatment because of the risk of perforation.

## Chemical Burns

Chemical burns of the esophagus occur most often when a patient, either intentionally or unintentionally, swallows a strong acid or base (eg, lye). This patient is emotionally distraught as well as in acute physical pain. Chemical burns of the esophagus may also be caused by undissolved medications in the esophagus. This occurs more frequently in the elderly than it does among the general adult population. A chemical burn may also occur after swallowing of a battery, which may release a caustic alkaline. An acute chemical burn of the esophagus may be accompanied by severe burns of the lips, mouth, and pharynx, with pain on swallowing. There may be difficulty in breathing due to either edema of the throat or a collection of mucus in the pharynx.

The patient, who may be profoundly toxic, febrile, and in shock, is treated immediately for shock, pain, and respiratory distress. Esophagoscopy and barium swallow are performed as soon as possible to determine the extent and severity of damage. The patient is given nothing by mouth, and IV fluids are administered. A nasogastric tube may be inserted by the physician. Vomiting and gastric lavage are avoided to prevent further exposure of the esophagus to the caustic agent. The use of corticosteroids to reduce inflammation and minimize subsequent scarring and stricture formation is of questionable value. Antibiotics are prescribed if there is documented infection (Nervi, 2008).

After the acute phase has subsided, the patient may need nutritional support via enteral or parenteral feedings. The patient may require further treatment to prevent or manage strictures of the esophagus. Dilation by bougienage may be sufficient but may need to be repeated periodically. (In bougienage, cylindrical rubber tubes of different sizes, called bougies, are advanced into the esophagus via the oral cavity. Progressively larger bougies are used to dilate the esophagus. The procedure usually is performed in the endoscopy suite or clinic by the gastroenterologist.) Some strictures require rigid dilators, such as Savory dilators. These dilators are used in the same fashion as bougies but may be more successful for opening difficult strictures. For strictures that do not respond to either method of dilation, surgical management may be necessary. Reconstruction may be accomplished by esophagectomy and colon interposition to replace the portion of esophagus removed. This surgery is quite complex and should be considered only when other options have failed.

## Gastroesophageal Reflux Disease

Some degree of **gastroesophageal reflux** (backflow of gastric or duodenal contents into the esophagus) is normal in both adults and children. Excessive reflux may occur because of an incompetent lower esophageal sphincter, pyloric stenosis, or a motility disorder. The incidence of GERD seems to increase with aging.

## Clinical Manifestations

Symptoms may include pyrosis (burning sensation in the esophagus), dyspepsia (indigestion), regurgitation, dysphagia or odynophagia (pain on swallowing), hypersalivation, and esophagitis. The symptoms may mimic those of a heart attack. The patient's history aids in obtaining an accurate diagnosis.

## Assessment and Diagnostic Findings

Diagnostic testing may include an endoscopy or barium swallow to evaluate damage to the esophageal mucosa. Ambulatory 12- to 36-hour esophageal pH monitoring is used to evaluate the degree of acid reflux. Bilirubin monitoring (Bilitec) is used to measure bile reflux patterns. Exposure to bile can cause mucosal damage.

## Management

Management begins with teaching the patient to avoid situations that decrease lower esophageal sphincter pressure or cause esophageal irritation. The patient is instructed to eat a low-fat diet; to avoid caffeine, tobacco, beer, milk, foods containing peppermint or spearmint, and carbonated beverages; to avoid eating or drinking 2 hours before bedtime; to maintain normal body weight; to avoid tight-fitting clothes; to elevate the head of the bed on 6- to 8-inch (15- to 20-cm) blocks; and to elevate the upper body on pillows. If reflux persists, antacids or $H_2$ receptor antagonists, such as famotidine (Pepcid), nizatidine (Axid), or ranitidine (Zantac), may be prescribed. Proton pump inhibitors (medications that decrease the release of gastric acid, such as lansoprazole [Prevacid], rabeprazole [AcipHex], esomeprazole [Nexium], omeprazole [Prilosec], and pantoprazole [Protonix]) may be used; however, these products may increase intragastric bacterial growth and the risk of infection. In addition, the patient may receive prokinetic agents, which accelerate gastric emptying. These agents include bethanechol (Urecholine), domperidone (Motilium), and metoclopramide (Reglan). Because metoclopramide can have extrapyramidal side effects that are increased in certain neuromuscular disorders, such as Parkinson's disease, it should be used only if no other option exists, and the patient should be monitored closely.

If medical management is unsuccessful, surgical intervention may be necessary. Surgical management involves a Nissen fundoplication (wrapping of a portion of the gastric fundus around the sphincter area of the esophagus). A Nissen fundoplication can be performed by the open method or by laparoscopy.

# *Barrett's Esophagus*

Barrett's esophagus is a condition in which the lining of the esophageal mucosa is altered. It typically occurs in association with GERD; indeed, longstanding untreated GERD may lead to Barrett's esophagus. Reflux eventually causes changes in the cells lining the lower esophagus. The cells that are laid to cover the exposed area are no longer squamous in origin. These precancerous cells initiate the healing process and can be a precursor to esophageal cancer.

## Clinical Manifestations

The patient complains of symptoms of GERD, notably frequent heartburn. The patient may also complain of symptoms related to peptic ulcers or esophageal stricture, or both.

## Assessment and Diagnostic Findings

An **esophagogastroduodenoscopy (EGD)** is performed. This usually reveals an esophageal lining that is red rather than pink. Biopsies are performed, and high-grade **dysplasia** (HGD) is evidenced by the squamous mucosa of the esophagus replaced by columnar epithelium that resembles that of the stomach or intestines. HGD has been found to be associated with a 30% risk of development of cancer (Wang & Sampliner, 2008).

## Management

Monitoring varies depending on the extent of cell changes. Follow-up endoscopy is performed within 6 months if there are minor cell changes. Treatment is individualized for each patient. The options include intensive surveillance with biopsies, endoscopic ablation therapy (eg, photodynamic therapy), and esophagectomy, each of which has been found to result in similar outcomes (Wang & Sampliner, 2008).

# *Benign Tumors of the Esophagus*

Benign tumors can arise anywhere along the esophagus. The most common lesion is a leiomyoma (tumor of the smooth muscle), which can occlude the lumen of the esophagus. Most benign tumors are asymptomatic and are distinguished from cancerous lesions by a biopsy. Small lesions are excised during esophagoscopy; lesions that occur within the wall of the esophagus may require treatment via a thoracotomy.

## NURSING PROCESS

### The Patient With a Noncancerous Condition of the Esophagus

#### Assessment

Emergency conditions of the esophagus (perforation, chemical burns) usually occur in the home or away from medical help and require emergency medical care. The patient is treated for shock and respiratory distress and transported as quickly as possible to a health care facility. Foreign bodies in the esophagus do not pose an immediate threat to life unless pressure is exerted on the trachea, resulting in dyspnea or interfering with respiration, or unless there is leakage of caustic alkali from a battery or exposure to another corrosive agent. Educating the public to prevent inadvertent swallowing of foreign bodies or corrosive agents is a major health goal.

For nonemergency symptoms, a complete health history may reveal the nature of the esophageal disorder. The nurse asks about the patient's appetite. Has it remained the same, increased, or decreased? Is there any discomfort

with swallowing? If so, does it occur only with certain foods? Is it associated with pain? Does a change in position affect the discomfort? The patient is asked to describe the pain. Does anything aggravate it? Are there any other symptoms that occur regularly, such as regurgitation, nocturnal regurgitation, eructation (belching), heartburn, substernal pressure, a sensation that food is sticking in the throat, a feeling of fullness after eating a small amount of food, nausea, vomiting, or weight loss? Are the symptoms aggravated by emotional upset? If the patient reports any of these symptoms, the nurse asks about when they occur, their relationship to eating, and factors that relieve or aggravate them (eg, position change, belching, antacids, vomiting).

This history also includes questions about past or present causative factors, such as infections and chemical, mechanical, or physical irritants; alcohol and tobacco use; and the amount of daily food intake. The nurse determines whether the patient appears emaciated and auscultates the patient's chest to assess for pulmonary complications.

## Nursing Diagnosis

Based on the assessment data, the nursing diagnoses may include the following:

- Imbalanced nutrition, less than body requirements, related to difficulty swallowing
- Risk for aspiration related to difficulty swallowing or to tube feeding
- Acute pain related to difficulty swallowing, ingestion of an abrasive agent, tumor, or frequent episodes of gastric reflux
- Deficient knowledge about the esophageal disorder, diagnostic studies, medical management, surgical intervention, and rehabilitation

## Planning and Goals

The major goals for the patient may include attainment of adequate nutritional intake, avoidance of respiratory compromise from aspiration, relief of pain, and increased knowledge level.

## Nursing Interventions

### *Encouraging Adequate Nutritional Intake*

The patient is encouraged to eat slowly and to chew all food thoroughly so that it can pass easily into the stomach. Small, frequent feedings of nonirritating foods are recommended to promote digestion and to prevent tissue irritation. Sometimes liquid swallowed with food helps the food pass through the esophagus, but usually liquids should be consumed between meals. Food should be prepared in an appealing manner to help stimulate the appetite. Irritants such as tobacco and alcohol should be avoided. A baseline weight is obtained, and daily weights are recorded. The patient's intake of nutrients is assessed.

### *Decreasing Risk of Aspiration*

The patient who has difficulty swallowing or difficulty handling secretions should be kept in at least a semi-Fowler's position to decrease the risk of aspiration. The patient is instructed in the use of oral suction to decrease the risk of aspiration further.

### *Relieving Pain*

Small, frequent feedings (six to eight per day) are recommended because large quantities of food overload the stomach and promote gastric reflux. The patient is advised to avoid any activities that increase pain and to remain upright for 1 to 4 hours after each meal to prevent reflux. The head of the bed should be placed on 4- to 8-inch (10- to 20-cm) blocks. Eating before bedtime is discouraged.

The patient is advised that excessive use of over-the-counter antacids can cause rebound acidity. Antacid use should be directed by the primary care provider, who can recommend the daily, safe dose needed to neutralize gastric juices and prevent esophageal irritation. $H_2$ antagonists are administered as prescribed to decrease gastric acid irritation.

### *Providing Patient Education*

The patient is prepared physically and psychologically for diagnostic tests, treatments, and possible surgery. The principal nursing interventions include reassuring the patient and explaining the procedures and their purposes. Some disorders of the esophagus evolve over time, whereas others are the result of trauma (eg, chemical burns, perforation). In instances of trauma, the emotional and physical preparation for treatment is more difficult because of the short time available and the circumstances of the injury. Treatment interventions must be evaluated continually, and the patient is given sufficient information to participate in care and diagnostic tests. If endoscopic diagnostic methods are used, the patient is instructed regarding the moderate sedation that will be used during the procedure. If outpatient procedures are performed with the use of moderate sedation, someone must be available to drive the patient home after the procedure. If surgery is required, immediate and long-term evaluation is similar to that for a patient undergoing thoracic surgery.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The self-care required of the patient depends on the nature of the disorder and on the surgery or treatment measures used (eg, diet, positioning, medications). If an ongoing condition exists, the nurse helps the patient plan for needed physical and psychological adjustments and for follow-up care (Chart 35-4).

Special equipment, such as suction or enteral or parenteral feeding devices, may be required. The patient may need assistance in planning meals, using medications as prescribed, and resuming activities. Education about nutritional requirements and how to measure the adequacy of nutrition is important. Elderly and debilitated patients in particular often need assistance and education about ways they can adjust to their limitations and resume activities that are important to them.

**CONTINUING CARE.** Patients with chronic esophageal conditions require an individualized approach to their management at home. Foods may need to be prepared in a special way (blenderized foods, soft foods), and the patient may need to eat more frequently (eg, six to eight small servings per day). The medication schedule is adjusted to the patient's daily activities as much as possible. Analgesic medications and antacids can usually be taken as needed every 3 to 4 hours.

Postoperative home health care focuses on nutritional support, management of pain, and respiratory function.

CHART 35-4

**HOME CARE CHECKLIST**

***The Patient With an Esophageal Condition***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate use of suction equipment. | ✔ | ✔ |
| • State dietary modifications needed to meet caloric needs. | ✔ | ✔ |
| • Demonstrate enteral or parenteral feeding techniques. | ✔ | ✔ |
| • Demonstrate care of incision if indicated. | ✔ | ✔ |
| • Identify signs and symptoms (eg, difficulty swallowing, pain, respiratory distress) to be reported to health care provider. | ✔ | ✔ |
| • State when next checkup is needed. | ✔ | ✔ |
| • Identify available support groups. | ✔ | ✔ |

Some patients are discharged from the hospital with enteral feeding by means of a gastrostomy or jejunostomy tube or parenteral nutrition. The patient and caregiver need specific instructions regarding management of the equipment and treatments. Home care visits by a nurse may be necessary to assess the patient and the caregiver's ability to provide the necessary care. (See Chapter 36 for more information about parenteral nutrition and management of the patient with a gastrostomy.) For some patients, a multidisciplinary team that includes a dietitian, a social worker, and family members is helpful. Hospice care and consideration of end-of-life issues are appropriate for some patients.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Achieves an adequate nutritional intake
   a. Eats small, frequent meals
   b. Drinks small sips of water with small servings of food
   c. Avoids irritants (alcohol, tobacco, very hot beverages)
   d. Maintains desired weight
2. Does not aspirate or develop pneumonia
   a. Maintains upright position during feeding
   b. Uses oral suction equipment effectively
3. Is free of pain or able to control pain within a tolerable level
   a. Avoids large meals and irritating foods
   b. Takes medications as prescribed and with adequate fluids (at least 4 ounces), and remains upright for at least 10 minutes after taking medications
   c. Maintains an upright position after meals for 1 to 4 hours
   d. Reports that there is less eructation and chest pain
4. Increases knowledge level of esophageal condition, treatment, and prognosis
   a. States cause of condition
   b. Discusses rationale for medical or surgical management and diet or medication regimen
   c. Describes treatment program
   d. Practices preventive measures so injuries are avoided

## Cancer of the Esophagus

In the United States, carcinoma of the esophagus occurs more than three times as often in men as in women. It is seen more frequently in African Americans than in Caucasians and usually occurs in the fifth or sixth decade of life. Cancer of the esophagus has a much higher incidence (10 to 100 times higher) in other parts of the world, including China and northern Iran (American Cancer Society, 2009).

### Pathophysiology

Esophageal cancer can be of two cell types: adenocarcinoma and squamous cell carcinoma. The rate of adenocarcinoma is rapidly increasing in the United States as well as in other Western countries. It is found primarily in the distal esophagus and gastroesophageal junction (American Cancer Society, 2009).

Risk factors for esophageal cancer include chronic esophageal irritation. In the United States, cancer of the esophagus has been associated with ingestion of alcohol and the use of tobacco. There is an apparent association between GERD and adenocarcinoma of the esophagus. People with Barrett's esophagus (which is caused by chronic irritation of the mucous membranes due to reflux of gastric and duodenal contents) have a higher incidence of esophageal cancer (American Cancer Society, 2009). Risk factors for squamous cell carcinoma of the esophagus include chronic ingestion of hot liquids or foods, nutritional deficiencies, poor oral hygiene, exposure to nitrosamines in the environment or food, cigarette smoking or chronic alcohol exposure (especially in Western cultures), and some esophageal medical conditions such as caustic injury.

Tumor cells of adenocarcinoma and of squamous cell carcinoma may spread beneath the esophageal mucosa or directly into, through, and beyond the muscle layers into the lymphatics. In the latter stages, obstruction of the esophagus is noted, with possible perforation into the mediastinum and erosion into the great vessels.

### Clinical Manifestations

Many patients have an advanced ulcerated lesion of the esophagus before symptoms are manifested. Symptoms include dysphagia, initially with solid foods and eventually

with liquids; a sensation of a mass in the throat; painful swallowing; substernal pain or fullness; and, later, regurgitation of undigested food with foul breath and hiccups. The patient first becomes aware of intermittent and increasing difficulty in swallowing. As the tumor grows and the obstruction becomes nearly complete, even liquids cannot pass into the stomach. Regurgitation of food and saliva occurs, hemorrhage may take place, and progressive loss of weight and strength occurs from inadequate nutrition. Later symptoms include substernal pain, persistent hiccup, respiratory difficulty, and foul breath.

The delay between the onset of early symptoms and the patient seeking medical advice is often 12 to 18 months. Any person having swallowing difficulties should be encouraged to consult a physician immediately.

## Assessment and Diagnostic Findings

Currently, diagnosis is confirmed most often by EGD with biopsy and brushings. The biopsy can be used to determine the presence of disease and cell differentiation. At presentation, most patients have moderately differentiated tumors.

Several imaging techniques may provide useful diagnostic information. CT of the chest and abdomen is beneficial for detecting any metastatic disease, especially of the lungs, liver, and kidney. Positron emission tomography (PET) may help detect metastasis with more sensitivity than CT. Endoscopic ultrasound is used to determine whether the cancer has spread to the lymph nodes and other mediastinal structures; it can also determine the size and invasiveness of the tumor. Exploratory laparoscopy is the best method for finding positive lymph nodes in patients with distal lesions.

Future diagnostic techniques that may serve as predictors for dysplastic progression in patients with Barrett's esophagus involve molecular markers. The usefulness of molecular markers in treating esophageal cancer is being researched. Research also includes the development of medications that target the pathways of various molecular markers (D'Amico, 2006).

## Medical Management

If esophageal cancer is detected at an early stage, treatment goals may be directed toward cure; however, it is often detected in late stages, making relief of symptoms the only reasonable goal of therapy. Treatment may include surgery, radiation, chemotherapy, or a combination of these modalities, depending on the type of cancer cell, the extent of the disease, and the patient's condition. A standard treatment plan for a person who is newly diagnosed with esophageal cancer includes the following: preoperative combination chemotherapy and radiation therapy for 4 to 6 weeks; followed by a period of no medical intervention for 4 weeks; and, lastly, surgical resection of the esophagus.

Standard surgical management includes a total resection of the esophagus (esophagectomy) with removal of the tumor plus a wide tumor-free margin of the esophagus and the lymph nodes in the area. The surgical approach may be through the thorax or the abdomen, depending on the location of the tumor. When tumors occur in the cervical or upper thoracic area, esophageal continuity may be maintained by a free jejunal graft transfer, in which the tumor is removed and the area is replaced with a portion of the jejunum (Fig. 35-8). A segment of the colon may be used, or the stomach can be elevated into the chest and the proximal section of the esophagus anastomosed to the stomach.

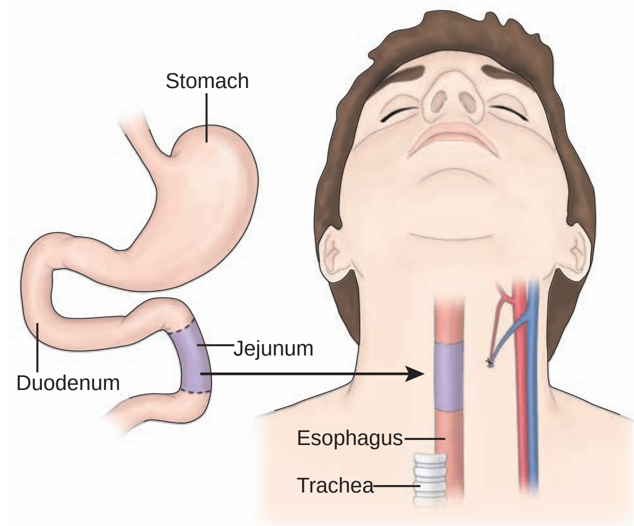
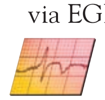



**Figure 35-8** Esophageal reconstruction with free jejunal transfer. A portion of the jejunum is grafted between the esophagus and pharynx to replace the abnormal portion of the esophagus. The vascular structures are also anastomosed.

Tumors of the lower thoracic esophagus are more amenable to surgery than are tumors located higher in the esophagus. Gastrointestinal tract integrity is maintained by anastomosing the lower esophagus to the stomach (Fig. 35-9).

Surgical resection of the esophagus has a relatively high mortality rate because of infection, pulmonary complications, or leakage through the anastomosis. Postoperatively, the patient has a nasogastric tube in place that should not be manipulated. The patient is given nothing by mouth until x-ray studies confirm that the anastomosis is free from an esophageal leak, there is no obstruction, and there is no evidence of pulmonary aspiration.

Palliative treatment may be necessary to keep the esophagus open, to assist with nutrition, and to control saliva. Palliation may be accomplished with dilation of the esophagus, laser therapy, placement of an endoprosthesis (stent) via EGD, radiation, or chemotherapy.



## Nursing Management

Intervention is directed toward improving the patient's nutritional and physical status in preparation for surgery, radiation therapy, or chemotherapy. A program to promote weight gain based on a high-calorie and high-protein diet, in liquid or soft form, is provided if adequate food can be taken by mouth. If this is not possible, parenteral or enteral nutrition is initiated. Nutritional status is monitored throughout treatment. The patient is informed about the nature of the postoperative equipment that will be used, including that required for closed chest drainage, nasogastric suction, parenteral fluid therapy, and gastric intubation.

Immediate postoperative care is similar to that provided for patients undergoing thoracic surgery. It is not uncommon for patients to be placed in an intensive care unit or step-down unit. After recovering from the effects of anesthesia, the patient is placed in a low Fowler's position, and later in a

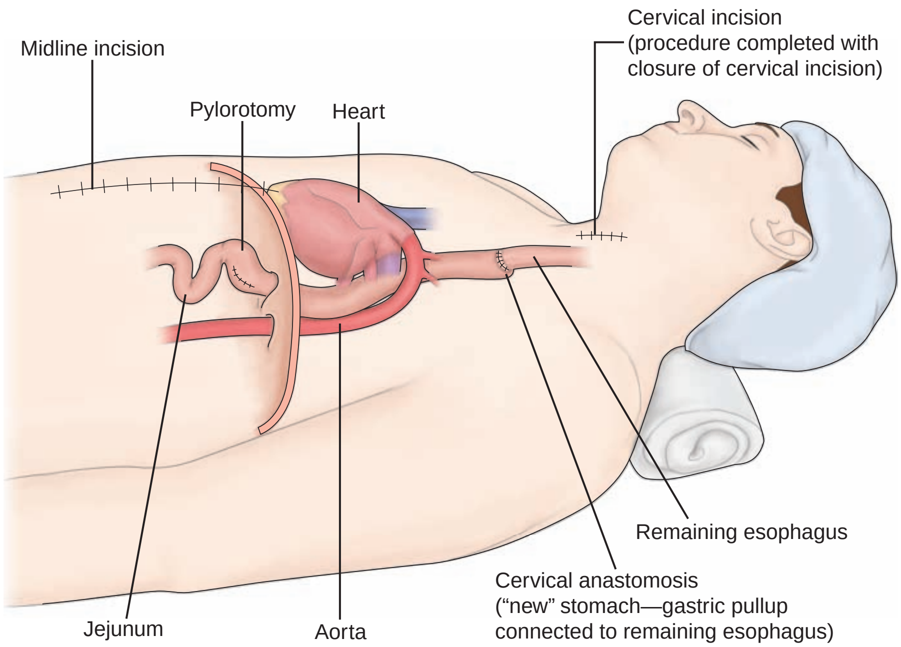



**Figure 35-9** Transhiatal esophagectomy: surgical removal of tumor of the lower esophagus with anastomosis of the remaining esophagus to the stomach. (Redrawn with permission from *Operative Techniques in Thoracic and Cardiovascular Surgery, 4*(3), 263 © 1999 Elsevier Inc.)

Fowler's position, to help prevent reflux of gastric secretions. The patient is observed carefully for regurgitation and dyspnea. A common postoperative complication is aspiration pneumonia. Therefore, the patient is placed on a vigorous pulmonary plan of care that includes incentive spirometry, sitting up in a chair, and, if necessary, nebulizer treatments. Chest physiotherapy is avoided due to the risk of aspiration. The patient's temperature is monitored to detect any elevation that may indicate aspiration or seepage of fluid through the operative site into the mediastinum, which would indicate an esophageal leak. Drainage from the cervical neck wound, usually saliva, is evidence of an early esophageal leak. Typically, no treatment other than nothing by mouth and parenteral or enteral support is warranted.

Cardiac complications include atrial fibrillation, which occurs due to irritation of the vagus nerve at the time of surgery. Typical medical management includes digitalization or use of beta-blockers, depending on the patient's response. Rarely, cardioversion may be used.

During surgery, a nasogastric tube is inserted and taped in place. It is connected to low intermittent suction. The nasogastric tube is not manipulated; if displacement occurs, it is not replaced, because damage to the anastomosis may occur. The nasogastric tube is removed 5 to 7 days after surgery; before the patient is allowed to eat, a barium swallow is performed to assess for any anastomotic leak.

Once feeding begins, the nurse encourages the patient to swallow small sips of water. Eventually, the diet is advanced as tolerated to a soft, mechanical diet. When the patient can increase his or her food and fluid intake to an adequate amount, parenteral fluids are discontinued. After each meal, the patient remains upright for at least 2 hours to allow the food to move through the gastrointestinal tract. It is a challenge to encourage the patient to eat because the appetite is usually poor. Family involvement and home-cooked favorite foods may help the patient to eat. Antacids may help patients with gastric distress. Metoclopramide is useful in promoting gastric motility.

If chemotherapy and radiation are part of the therapy, the patient's appetite will be further depressed, and esophagitis may occur, causing pain when food is eaten. Liquid supplements may be more easily tolerated. However, supplements such as Boost and Ensure should be avoided because they promote **vagotomy syndrome** (dumping syndrome), which can occur with each meal or approximately 20 minutes to 2 hours after eating. The vagotomy syndrome occurs due to interruption of vagal nerve fibers, which in turn causes an alteration in the storage function of the stomach and the pyloric emptying mechanism. As a result, large amounts of solids and liquids rapidly "dump" into the duodenum. The patient experiences severe abdominal cramping, followed by a liquid bowel movement that may or may not be associated with diaphoresis, rapid heart rate or rapid respirations, or both. It can be quite disabling but typically resolves without incident, and the patient is left feeling extremely tired. The vagotomy syndrome is common following esophageal surgery, but as the patient's recovery progresses and the patient begins to eat soft foods and remains in an upright position for 2 hours after eating, the frequency and severity of episodes decrease.

Often, in either the preoperative or the postoperative period, an obstructed or nearly obstructed esophagus causes difficulty with excess saliva, and drooling becomes a problem. Oral suction may be used if the patient cannot handle oral secretions, or a wick-type gauze may be placed at the corner of the mouth to direct secretions to a dressing or emesis basin. The possibility that the patient may aspirate saliva into the tracheobronchial tree and develop pneumonia is of significant concern.

When the patient is ready to go home, the family is instructed about how to promote nutrition, what observations to make, what measures to take if complications occur, how to keep the patient comfortable, and how to obtain needed physical and emotional support.

## CRITICAL THINKING EXERCISES

**1** A patient presents to the medical clinic with symptoms of weight loss and difficulty in swallowing for the past 2 to 3 months. He states that he is only able to swallow liquids and some soft foods such as pudding. Explain what other questions you would ask this patient. What diagnostic tests would you anticipate would be prescribed for this patient? What instructions would you provide to the patient about preparation for these tests?

**2** You are a nurse in the intensive care unit and have been assigned a new postoperative patient who has undergone resection of the esophagus to treat esophageal cancer. What nursing measures would be used to facilitate the patient's breathing and promote comfort? Describe the potential complications of esophageal resection and the assessment parameters that are used to detect the earliest signs and symptoms of these complications. What nursing measures are used to prevent these complications?

EBP **3** An elderly man is brought to the emergency department by the rescue squad. His daughter found him on the kitchen floor. A bottle of cleaning fluid with a poison label was open next to the kitchen sink. On admission the patient was in respiratory distress. Burns were observed around his mouth. What emergency care would be provided for this patient to prevent further trauma to the gastrointestinal and respiratory tracts? Identify the evidence that supports this care and evaluate the strength of the evidence. What needs should be considered prior to the patient's discharge?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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### RESOURCES

Academy of General Dentistry, http://agd.org
American Cancer Society, www.cancer.org
American Dental Association, www.ada.org
Centers for Disease Control and Prevention, www.cdc.gov
National Institute of Dental and Craniofacial Research, National Institutes of Health, www.nidr.nih.gov



chapter 36

# Gastrointestinal Intubation and Special Nutritional Modalities

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the purposes and types of gastrointestinal intubation.
2. Identify the purposes and uses of parenteral nutrition.
3. Discuss nursing management of the patient who has a nasogastric, nasoenteric, gastrostomy, or jejunostomy tube.
4. Use the nursing process as a framework for care of the patient receiving special nutritional modalities.
5. Describe the nursing measures used to prevent complications from enteral and parenteral nutrition.

## GLOSSARY

**antireflux valve:** valve that prevents return or backward flow of fluid

**aspiration:** removal of substance by suction; breathing of fluids or foods into the trachea and lungs

**bolus:** a feeding administered into the stomach in large amounts and at designated intervals

**central venous access device (CVAD):** a device designed and used for long-term administration of medications and fluids into central veins

**cyclic feeding:** periodic infusion of feedings given over a short period (8 to 18 hours)

**decompression (intestinal):** removal of gastric or intestinal contents to prevent gas and fluid distention

**dumping syndrome:** rapid emptying of the stomach contents into the small intestine; causes sweating, weakness, and diarrhea

**duodenum:** the first part of the small intestine, which arises from the pylorus of the stomach and extends to the jejunum

**enteral nutrition:** nutritional formula feedings introduced through a tube directly into the gastrointestinal tract

## GLOSSARY *(Continued)*

**gastrostomy:** surgical creation of an opening into the stomach for the purpose of administering foods and fluids

**intravenous fat emulsion (IVFE):** an oil-in-water emulsion of oils, egg phospholipids, and glycerin

**intubation:** the insertion or placement of a tube into a body structure or passageway

**jejunum:** second portion of the small intestine, which extends from the duodenum to the ileum

**lavage:** flushing of the stomach with water or other fluids with a gastric tube to clear it

**lumen:** the channel within a tube or catheter

**nasoduodenal tube:** tube inserted through the nose into the proximal portion of the small intestine (ie, duodenum)

**nasoenteric tube:** tube inserted through the nose into the stomach and beyond the pylorus into the small intestine

**nasogastric (NG) tube:** tube inserted through the nose into the stomach

**nasojejunal tube:** tube inserted through the nose into the second portion of the small intestine (ie, jejunum)

**orogastric tube:** tube inserted through the mouth into the stomach

**osmolality:** ionic concentration of fluid

**parenteral nutrition (PN):** method of supplying nutrients to the body by an intravenous route

**percutaneous endoscopic gastrostomy (PEG):** a feeding tube inserted endoscopically into the stomach

**peripherally inserted central catheter (PICC):** a device used for intermediate-term intravenous therapy

**peristalsis:** wavelike movement that occurs involuntarily in the alimentary canal

**pH:** the degree of acidity or alkalinity of a substance or solution

**radiopaque:** can be easily localized on x-ray

**stoma:** artificially created opening between a body cavity (eg, intestine) and the body surface

**stylet:** a stiff wire placed in a catheter or other tube that allows the tube to maintain its shape during insertion

**total nutrient admixture (TNA):** an admixture of lipid emulsions, proteins, carbohydrates, electrolytes, vitamins, trace minerals, and water

This chapter presents several topics related to gastrointestinal intubation, including managing the care of patients with nasogastric, nasoenteric, and gastrostomy tubes, providing enteral tube feedings, gastric drainage, and teaching points concerning related home health care. In addition, parenteral nutrition is presented, including general indications for this nutritional modality and nursing care of patients receiving these support measures.

## Gastrointestinal Intubation

Gastrointestinal (GI) **intubation** is the insertion of a flexible tube into the stomach, beyond the pylorus into the **duodenum** (the first section of the small intestine) or the **jejunum** (the second section of the small intestine). The tube may be inserted through the mouth, the nose, or the abdominal wall. The tubes are of various lengths, depending on their intended use. GI intubation may be performed for the following reasons:

- To decompress the stomach and remove gas and fluid
- To **lavage** (flush with water or other fluids) the stomach and remove ingested toxins or other harmful materials
- To diagnose disorders of GI motility and other disorders
- To administer medications and feedings
- To compress a bleeding site
- To aspirate gastric contents for analysis

### Tube Types

A variety of tubes are used for decompression, aspiration, and lavage. An **orogastric tube** is a large-bore tube inserted through the mouth with a wide outlet for removal of gastric contents; it is used primarily in the emergency department or an intensive care setting (see Chapter 71). A **nasogastric (NG) tube** such as the Sengstaken-Blakemore tube is used to treat bleeding esophageal varices (see Chapter 39). Other tubes are used to administer feedings and medications. The tubes are made of various materials, including rubber, polyurethane, and silicone. They vary in length, size, purpose, and placement in the GI tract (Table 36-1). Any solution administered through a tube is poured through a syringe, delivered by gravity drip, or regulated by an electric pump. Removal of gases or fluids by **aspiration** (suctioning) is accomplished with a syringe or mechanical suction.

#### Gastric Tubes

An NG tube is introduced through the nose into the stomach, often before or during surgery or at the bedside. NG tubes may be used to administer medications for up to 4 weeks, to give feedings, or to remove fluid and gas from the upper GI tract by the process known as **decompression.** Commonly used gastric tubes include the Levin tube and the gastric sump tube.

##### Levin Tube

The Levin tube has a single **lumen** and is made of plastic or rubber. This tube is connected to low intermittent suction (30 to 40 mm Hg) to avoid erosion or tearing of the stomach lining, which can result from constant adherence of the tube's lumen to the mucosa of the stomach.

##### Gastric Sump

The gastric sump (Salem) tube is a **radiopaque** (easily seen on x-ray), clear plastic, double-lumen NG tube that is passed into the stomach in the same way as the Levin tube. The inner, smaller lumen (known as the blue port) vents the larger suction-drainage tube to the atmosphere by means of an opening at the distal end of the tube. The sump tube can protect fragile gastric mucosa by maintaining a low (25 mm Hg) continuous force of suction at the drainage opening. The suction lumen is irrigated as prescribed to maintain patency.

The blue vent lumen should be kept above the patient's waist to prevent reflux of gastric contents through it; otherwise it acts as a siphon. A one-way **antireflux valve** seated in the blue pigtail can prevent the reflux of gastric contents out the vent lumen (Fig. 36-1). The valve is removed for irrigation of the suction lumen. To reestablish a buffer of air between the gastric contents and the valve, 20 mL of air is injected through the blue vent and the valve is reinserted.

#### Enteric Tubes

**Nasoenteric tubes** are used for providing nutrients. Nasally inserted feeding tubes placed in the duodenum are called **nasoduodenal tubes;** whereas those placed in the jejunum (the portion of the small intestine distal to the duodenum) are **nasojejunal tubes.** They can be inserted before or

**Table 36-1 NASOGASTRIC AND NASOENTERIC FEEDING TUBES**

| Tube Type | Length (cm) | Size (French) | Lumen | Other Characteristics |
|---|---|---|---|---|
| **Nasogastric Tubes** | | | | |
| Levin (plastic or rubber) | 125 | 14–18 | Single | Circular markings at intervals along the tube serve as guidelines for insertion |
| Gastric sump or Salem (plastic) | 120 | 12–18 | Double | Smaller lumen acts as a vent |
| Moss | 90 | 12–16 | Triple | Contains both a gastric decompression lumen and a duodenal lumen for postoperative feedings |
| Sengstaken-Blakemore (rubber) | | | Triple | Two lumens are used to inflate the gastric and esophageal balloons, and one tube is reserved for suction or drainage |
| **Nasoenteric Feeding Tubes** | | | | |
| Dobbhoff or EnteraFlo (polyurethane or silicone rubber) | 160–175 | 8–12 | Single | Tungsten-weighted tip, radiopaque, stylet |

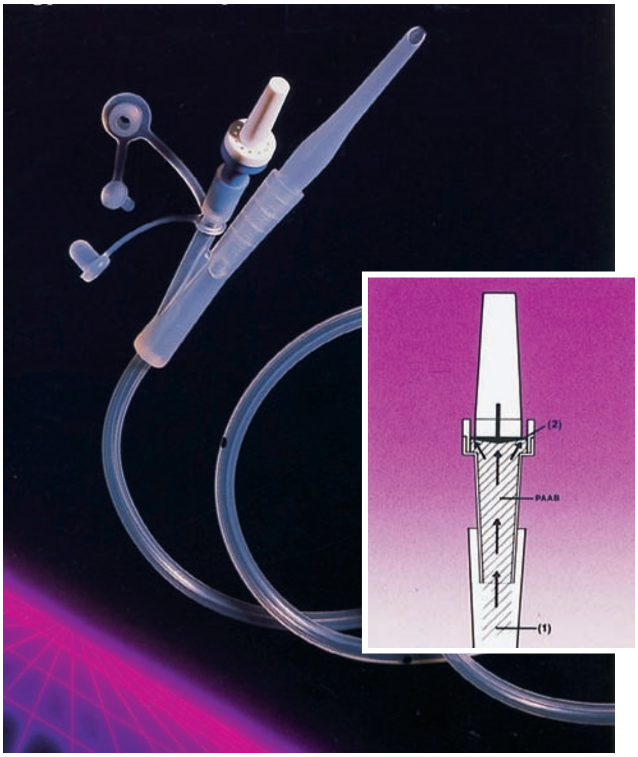



**Figure 36-1** Gastric sump tube (Salem) equipped with a one-way valve that allows air to enter and can prevent reflux of gastric contents. The antireflux valve is designed with a pressure-activated air buffer (PAAB). The buffer is activated (1) and the valve closes (2) when pressure from gastric contents enters the tubing. (Argyle Silicone Salem Sump Tube with preattached Argyle Salem Sump Anti-Reflux Valve courtesy of Sherwood Medical, St. Louis, MO.)

during surgery, by interventional radiologists assisted by fluoroscopy, or at the bedside. The tubing is soft and pliable, and therefore it may kink when a **stylet** is not used, particularly if the patient is uncooperative or unable to swallow. However, caution is required when inserting feeding tubes with a stylet because there is a risk of tissue puncture or placement error.

After insertion, the tip of the tube is initially located in the stomach; it usually takes 24 hours for the tube to pass through the stomach and into the intestine by **peristalsis.** Surgically and endoscopically placed enteric tubes are inserted directly into the duodenum or jejunum. Polyurethane or silicone rubber feeding tubes are typically soft and have narrow diameters (6 to 12 Fr) to ensure patient comfort. Tungsten tips can facilitate migration of the tube's tip from the stomach into the intestine.

## Nursing Management

### Preparing the Patient

The nurse explains the purpose of the tube to the patient prior to insertion to promote cooperation during the procedure. The general activities related to inserting the tube are then reviewed, including the fact that the procedure may cause gagging until the tube has passed beyond the throat.

### Inserting the Tube

Before inserting one of these tubes, the nurse determines the length that will be needed to reach the stomach or the small intestine. A mark is made on the tube to indicate the desired length. This length is traditionally determined by (1) measuring the distance from the tip of the nose to the earlobe and from the earlobe to the xiphoid process, and (2) adding 6 inches for NG placement or 8 to 10 inches for intestinal placement, although studies do not necessarily confirm that this is a reliable technique (Cirgen Ellett, Beckstrand, Flueckiger, et al., 2005) (Chart 36-1; Fig. 36-2).

While the tube is being inserted, the patient usually sits upright with a towel or other protective barrier spread bib-fashion over the chest. The nostril may be swabbed or the oropharynx sprayed with tetracaine or benzocaine to numb the nasal passage and suppress the gag reflex. To make the tube easier to insert, it should be lubricated with a water-soluble lubricant unless it has a dry coating (hydromer), which, when moistened, provides its own lubrication. Gloves should be worn during the procedure. The nostrils are inspected for any obstruction and the more patent nostril is selected for use. The tip of the patient's nose is tilted, and the tube is aligned to enter the nostril. When the tube reaches the nasopharynx, the patient is instructed to lower the head slightly and to begin to swallow as the tube is advanced. The patient may also be encouraged to sip water through a straw to facilitate advancement of the tube if this action is not contraindicated. The oropharynx is inspected to ensure that the tube has not coiled in the pharynx or mouth.

### Confirming Placement

To ensure patient safety, it is essential to confirm that the tube has been placed correctly: The tube may be inadvertently inserted in the lungs, most commonly in the right main bronchus (Metheny, 2006). Inappropriate placement may occur in patients with decreased levels of consciousness, confused mental states, poor or absent cough and gag reflexes, or agitation during insertion. The presence of an endotracheal tube or its recent removal also increases the risk of inadvertent placement of the tube in the lung (Ackerman & Mick, 2006). Initially, an x-ray should be used to confirm tube placement (Elpern, Killeen, Talla, et al., 2007). However, each time liquids or medications are administered, as well as once a shift for continuous feedings, the tube must be checked to ensure that it remains properly placed. Use of a combination of the following methods is recommended:

- Measurement of tube length. It is necessary to measure the length of the exposed portion of the tube and document the length. Every shift the nurse measures this length and compares it with the original measurement. An increase in the length of exposed tube may indicate dislodgement.
- Visual assessment of aspirate color. Gastric aspirate is most frequently cloudy and green, tan, off-white, or brown. Intestinal aspirate is primarily clear and yellow to bile colored.
- pH measurement of aspirate. The **pH** of gastric aspirate is acidic (1 to 5). The pH of intestinal aspirate is typically 6 or higher, and the pH of respiratory aspirate

CHART 36-1 NURSING RESEARCH PROFILE

## *Predicting the Insertion Distance for Placing Gastric Tubes*

Cirgin Ellett, M., Beckstrand, J., Flueckiger, J., et al. (2005). Predicting the insertion distance for placing gastric tubes. *Clinical Nursing Research, 14*(1), 11–26.

**Purpose**

Errors in safe and effective gastric tube placement are common. Researchers conducted this study to develop a clinically useful method to estimate the length of tube insertion to achieve reliable gastric placement of these tubes.

**Design**

An extensive review of the nursing and medical literature and discussions with clinicians yielded 20 "external measures" that included anatomical lengths (eg, nose to xiphoid, lower incisor to midumbilicus) that could be used to predict gastric tube length from the nares to the point in the stomach just beyond the lower esophageal sphincter (LES). These external measures, along with gender, height, weight, and body mass index, comprised the 24 variables tested in a predictor model. The convenience sample included 76 adults who were enrolled in esophageal motility studies at a university medical center. These participants each had an esophageal motility probe inserted through their nares to their LESs. An ultrasound transducer probe was used to verify the LES locations.

**Findings**

Three variables used together accurately predicted appropriate placement of nasally inserted tubes in the stomach: gender, length from nares to umbilicus, and height. Researchers created a gender-specific nomogram that included a patient's height and weight to find the predicted insertion distance or tube length. This new method correctly estimated gastric tube insertion distance from the nares to the LES 85.3% of the time, and it may be an improvement over the more commonly used but invalidated method of measuring from the nares to the earlobe to the xiphoid to estimate correct tube insertion length.

**Nursing Implications**

The availability of a valid nomogram for use by nurses and other clinicians at the bedside could facilitate improved methods for gastric tube placement. Safe and successful insertion increases patient comfort and decreases incidence of complications such as inadvertent pulmonary placement. Validated tools using evidence-based practice are the best resources in nursing care, and facilities and health care providers should encourage use of these tools.

is more alkaline (7 or greater). An enteral tube with a pH sensor that can facilitate distinguishing between gastric and small intestinal placement of the tube is commercially available.

- Air auscultation. Studies have found that the traditional method of injecting air through the tube while auscultating the epigastric area with a stethoscope to detect air insufflation is an unreliable indicator of gastric placement.

Each of these methods of confirming tube placement has its advantages and disadvantages (Table 36-2). One new method under study uses tubes with an end-tidal carbon



Measuring distance from nostril to tip of earlobe.



Measuring distance from earlobe to tip of xiphoid process.

Have the patient sit in a neutral position with head facing forward. Place the distal tip of the tubing at the tip of the patient's nose (N); extend tube to the tragus (tip) of the ear (E), and then extend the tube straight down to the tip of the xiphoid (X). The tube is placed 6–10 cm beyond that measured length.




**Figure 36-2** Measuring length of nasogastric tube for placement into stomach.

**Table 36-2 ASSESSING FOR GASTRIC TUBE PLACEMENT**

| Assessment Method | Advantages | Limitations |
|---|---|---|
| X-ray visualization of tube tip | Most accurate method to verify tube placement | Costly<br>Patient exposed to radiation dose from x-ray |
| Measure exposed tube length | Ease of use | Only indicates change in position, not location |
| Visual assessment of the color of the aspirate | Helpful in distinguishing between gastric (cloudy and green, tan, off-white, or brown) and intestinal (clear and yellow to bile colored) placement<br>Ease of use | Little value in ruling out respiratory placement<br>Aspirate often looks like the feeding formula |
| pH measurement of aspirate | Helpful in distinguishing between gastric (1 to 5) and intestinal (6 or higher) placement<br>Can be used to monitor the advancement of the tube into the small intestine | Several interventions alter aspirate pH: antacids, gastric resection, grossly bloody samples, continuous tube feedings<br>Availability of pH monitoring equipment not universally available |
| Air auscultation | Ease of use | Accuracy highly variable<br>Normal bowel and bronchial breath sounds may interfere with interpretation<br>Small-bore tubes allow less air flow |

dioxide detector that changes color when the tube tip is inappropriately placed in the trachea but not when it is properly placed in the stomach (Roberts, Echevarria & Gabriel, 2007). Another new method uses a copper wire coiled around the stylet of the feeding tube that generates an electromagnetic signal. This signal may be detected via a device that is placed over the patient's xiphoid process and is visualized by computer imaging (Ackerman & Mick, 2006).

Ensuring bedside placement of postpyloric feeding tubes into the duodenum can be a challenge. If the feeding tube is inserted using endoscopy, appropriate confirmation is ensured. Other placement methods are less invasive and less costly. An external magnet device can sometimes be used to help guide a postpyloric feeding tube that has a magnetized tip. A prokinetic agent such as intravenous (IV) metoclopramide (Reglan) can be administered to facilitate peristaltic movement of the feeding tube into the duodenum. Placing the patient on his or her right side is also helpful in facilitating appropriate movement and placement.

After the correct position of the tip of the tube has been confirmed, the NG tube is secured to the nose (Fig. 36-3). A liquid skin barrier (eg, Bard Protective Barrier) should be applied to the skin. The area is then covered with a strip of hypoallergenic tape or a transparent adhesive dressing (eg, Op-Site), and the tube is placed over the tape and secured with a second piece of tape.

### *Clearing Tube Obstruction*

If it is difficult to infuse or aspirate warm water into a clogged feeding tube, several declogging steps can be taken, including air insufflation and infusion of digestive enzymes (Table 36-3). A prescription for a solution of digestive enzymes mixed with sodium bicarbonate is fairly effective; however, confirmation of correct placement of the tube is essential prior to using this and all other techniques. The patient's position should be changed with each attempt. Mechanical methods of declogging such as the insertion of endoscopy or cytology brushes and commercial declogger devices into the feeding tube should be performed only by experienced providers. Cola and cranberry juice have been previously recommended as effective, noninvasive means of declogging tubes, but this practice is no longer advocated.

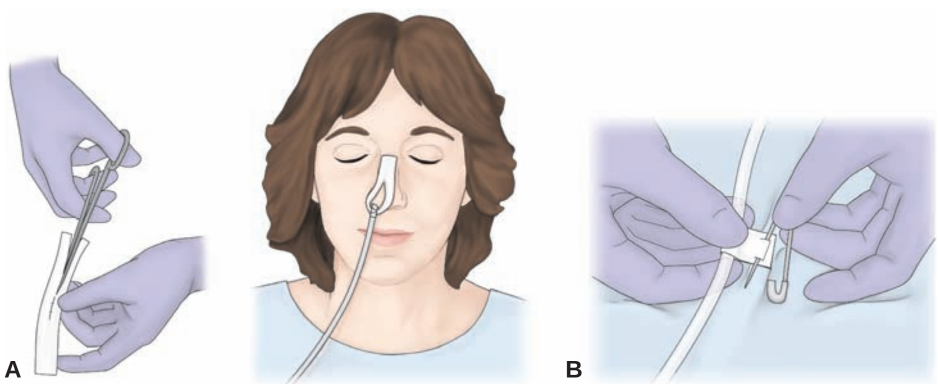



**Figure 36-3** Securing nasogastric (NG) tubes. **A,** The NG tube is secured to the nose with tape to prevent injury to the nasopharyngeal passages. **B,** The tubing is secured to the patient's gown with tape attached to a safety pin to prevent tension on the tube.

**Table 36-3 DECLOGGING AN ENTERAL FEEDING TUBE**

| Method | Steps |
|---|---|
| Air insufflation | • Inject 20 mL of air through the tube with a 30- to 60-mL syringe; pull plunger back<br>• If ineffective, inject an additional 20 mL of air<br>• Replace the large syringe with a 10-mL syringe<br>• Aspirate again<br>• If unsuccessful, notify the physician |
| Digestive enzymes and warm water, using one of the following*<br>• A pancrelipase solution† buffered with a sodium bicarbonate tablet—the following are dissolved together in 5 mL warm water:<br>  • 1 crushed pancrelipase tablet or 1/4 teaspoon of pancrelipase powder<br>  • 1 crushed non-enteric-coated sodium bicarbonate (324 mg) tablet or 1/8 teaspoon of baking soda<br>• A commercially available enzyme product† such as Clog Zapper (Corpak) | • Insert a 30- to 50-mL syringe<br>• Aspirate as much liquid as possible from the feeding tube<br>• Under manual pressure, instill 5 mL of warm water with the syringe for 1 minute<br>• Use a back-and-forth motion with the plunger to help dislodge the occlusion<br>• Clamp the tube for 5 to 15 minutes<br>• Follow above steps with enzyme solution instead of water<br>• Repeat once if necessary |

*Must obtain a prescription/order to administer.
†Verify tube placement before administration.

**NURSING ALERT**

**Feeding tubes are more successfully declogged when intervention is initiated immediately after the obstruction is noted and if the obstruction is close to the proximal tube opening.**

### Monitoring the Patient and Maintaining Tube Function

If the NG tube is used for decompression, it is connected to suction or a collection bag. If it is used for enteral nutrition, the end of the tube is plugged between feedings. Displacement of the tube may be caused by tension on the tube with patient movement, coughing, suctioning, or airway intubation. If the NG tube is removed inadvertently in a patient who has undergone esophageal or gastric surgery, it is usually replaced by the physician with care to avoid trauma to the suture line.

It is important to keep an accurate record of all fluid intake, feedings, and irrigation. To maintain patency, the tube is irrigated every 4 to 6 hours with water or normal saline, depending on the patient's electrolyte levels. The nurse records the amount, color, and type of any drainage every 4 to 8 hours. When double-lumen or triple-lumen tubes are used, each lumen is labeled according to its intended use for aspiration or feeding.

### Providing Oral and Nasal Hygiene

Regular, conscientious oral and nasal hygiene is a vital part of patient care because the tube causes discomfort and pressure and may be in place for several days. The nose is inspected daily for skin irritation, and the nasal tape is changed every 2 to 3 days. If the nasal and pharyngeal mucosa are excessively dry, steam or cool vapor inhalations may be beneficial. Throat lozenges, an ice collar, chewing gum, or sucking on hard candies (if permitted) and limiting talking also assist in relieving patient discomfort.

### Monitoring and Managing Potential Complications

Patients with NG or nasoenteric intubation are susceptible to a variety of problems, including fluid volume deficit, pulmonary complications, and tube-related irritations. These potential complications require careful ongoing assessment.

Symptoms of fluid volume deficit include dry skin and mucous membranes, decreased urinary output, lethargy, and increased heart rate. Assessment involves maintaining an accurate record of intake and output. This includes measuring fluid intake from tube feeding and flushes, oral liquids, and IV fluids. Output of urine, emesis, NG drainage, and diarrhea should also be measured. Laboratory values, particularly blood urea nitrogen and creatinine, are monitored. The nurse assesses 24-hour fluid balance and reports negative fluid balance (output greater than intake), increased NG output, interruption of IV therapy, or any other disturbance in fluid intake or output.

Pulmonary complications from NG intubation can occur because coughing and clearing of the pharynx are impaired. Tubes may become dislodged, retracting the distal end above the esophagogastric sphincter, which places the patient at increased risk of aspiration. Medications such as antacids and metoclopramide can be administered to decrease potential problems. Signs and symptoms of complications include coughing during the administration of foods or medications, difficulty clearing the airway, tachypnea, and fever. Assessment includes regular auscultation of lung sounds and monitoring of vital signs. The nurse also carefully confirms the proper placement of the tube before instilling any fluids or medications.

### Removing the Tube

Before removing a decompression tube, the nurse may intermittently clamp it for a trial period of several hours to ensure that the patient does not experience nausea, vomiting, or distention. Before any tube is removed, it is flushed with 10 mL of water or normal saline to ensure that it is free of

debris and away from the gastric lining. Gloves are worn when removing the tube. The tube is withdrawn gently and slowly for 15 to 20 cm (6 to 8 in) until the tip reaches the esophagus; the remainder is withdrawn rapidly from the nostril. If the tube does not come out easily, force should not be used, and the problem should be reported to the physician. As the tube is withdrawn, it is concealed in a towel to prevent secretions from soiling the patient or nurse. After the tube is removed, the nurse provides oral hygiene.

### *Administering Tube Feedings*

**Enteral nutrition** feedings are given to meet nutritional requirements when oral intake is inadequate or not possible and the middle and lower portions of the GI tract are functioning normally. These tube feedings are delivered to the stomach, distal duodenum, or proximal jejunum and help preserve GI integrity by preserving normal intestinal and hepatic metabolism. Tube feedings have several advantages over parenteral nutrition: They are lower in cost, safe, usually well tolerated by the patient, and easy to use both in extended care facilities and in the patient's home.

Nasoduodenal or nasojejunal feeding is indicated when the esophagus and stomach need to be bypassed or when the patient is at risk for aspiration. For feedings longer than 4 weeks, gastrostomy or jejunostomy tubes are preferred for administration of medications or food. Indications for enteral nutrition are summarized in Table 36-4.

#### Osmolality

The **osmolality** of normal body fluids is approximately 300 mOsm/kg. The body attempts to keep the osmolality of the contents of the stomach and intestines at this level. Osmolality is an important consideration for patients receiving tube feedings through the duodenum or jejunum because feeding formulas with a high osmolality may lead to undesirable effects. When a concentrated solution of high osmolality is taken in large amounts, water moves rapidly to the stomach and intestines from fluid surrounding the organs and the vascular compartment. The patient has a feeling of fullness, nausea, and diarrhea; this can cause dehydration, hypotension, and tachycardia, collectively termed **dumping syndrome.** Patients vary in the degree to which they tolerate the effects of high osmolality; the nurse needs to be knowledgeable about the patient's formula and take steps to prevent this undesired effect.

**Table 36-4 CONDITIONS REQUIRING ENTERAL THERAPY**

| Condition or Need | Examples |
|---|---|
| Preoperative bowel preparation | After administration of larger-volume cathartics |
| Gastrointestinal problems | Fistula, short-bowel syndrome, mild pancreatitis, Crohn's disease, ulcerative colitis, nonspecific maldigestion or malabsorption |
| Cancer therapy | Radiation, chemotherapy |
| Convalescent care | Surgery, injury, severe illness |
| Coma, semi-consciousness* | Stroke, head injury, neurologic disorder, neoplasm |
| Hypermetabolic conditions | Burns, trauma, multiple fractures, sepsis, AIDS, organ transplantation |
| Alcoholism, chronic depression, anorexia nervosa* | Chronic illness, psychiatric or neurologic disorder |
| Debilitation* | Disease or injury |
| Maxillofacial or cervical surgery | Disease or injury |
| Oropharyngeal or esophageal paralysis* | Disease or injury, neoplasm, inflammation, trauma, respiratory failure |

*Because some of these patients are at risk for regurgitating or vomiting and aspirating administered formula, each condition must be considered individually.

#### Formulas

The choice of formula to be delivered by tube feeding is influenced by the status of the GI tract and the nutritional needs of the patient. The formula characteristics that are considered include the chemical composition of the nutrient source (protein, carbohydrates, fat), caloric density, osmolality, fiber content, vitamins, minerals, and cost. A wide variety of containers, delivery systems, and enteral pumps are available for use with tube feedings.

Various tube feeding formulas are available commercially. Polymeric formulas are composed of protein, carbohydrates, and fats in a high molecular-weight form. Chemically defined formulas contain easier to absorb nutrients. Modular products contain only one major nutrient, such as protein, and are used to enhance commercially prepared products. Disease-specific formulas are available as adjuncts to treat various conditions. Fiber in some formulas helps decrease the occurrence of diarrhea. Some feedings are given as supplements, and others are administered to meet the patient's nutritional needs. Dietitians collaborate with physicians and nurses to determine the best formula for each patient.

#### Administration Methods

The tube feeding method chosen depends on the location of the tube in the GI tract, patient tolerance, convenience, and cost. Many patients do not tolerate NG and nasoenteric tube feedings well. Often a medium-bore or fine-bore Silastic nasoenteric tube is better tolerated; however, a small-bore tube requires diligent flushing to remain patent.

Both bolus and intermittent gravity tube feeding methods are practical and inexpensive, but they may be poorly tolerated and time-consuming. A **bolus** feeding can be administered by gravity into the stomach (usually by gastrostomy tube) through a large syringe (Fig. 36-4). Bolus feedings of 300 to 500 mL require 10 to 15 minutes to complete. Raising or lowering the syringe above the abdominal wall regulates the rate of flow. The amount given is often determined by the patient's reaction. If the patient feels full, it may be desirable to give smaller volumes more frequently. The intermittent gravity drip feeding method requires administering feedings over 30 minutes at designated intervals by a reservoir enteral bag and tubing. This method is commonly used when the patient is at home.

Continuous feeding is the delivery of feedings incrementally over long periods. It is associated with reduced rates of aspiration, distention, nausea, vomiting, and diarrhea. Typically, feedings are administered into the small intestine. Rates

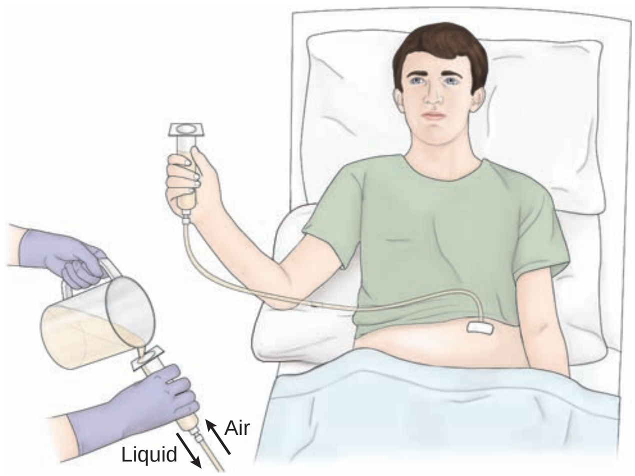



**Figure 36-4** Bolus gastrostomy feeding by gravity. Syringe is raised perpendicular to the abdomen so that feeding can enter by gravity.

vary depending on the caloric density of the formula and the energy needs of the patient. The overall goal is to achieve positive nitrogen balance and weight maintenance or gain without producing discomfort or diarrhea. Enteral pumps control the delivery rate of feeding formula (Fig. 36-5). They allow for a constant flow rate and can infuse a viscous formula through a small-diameter feeding tube. However, they are relatively heavy and must be attached to an IV pole, and they are expensive. Furthermore, they allow the patient less flexibility than intermittent feedings. Portable lightweight enteral pumps that are easier to handle are available for home use. In addition, most feeding pumps have built-in alarms that signal when the bag is empty, the battery is low, or the tube is occluded. The patient and caregiver need to be aware of these alarms and know how to "troubleshoot" the pump.

An alternative to the continuous infusion method is **cyclic feeding,** in which the infused feeding is given over 8 to 18 hours. Feedings may be infused at night to avoid interrupting the patient's lifestyle. Cyclic infusions may be appropriate for patients who are being weaned from tube feedings to an oral diet, for patients who cannot eat enough and need supplements, and for patients at home who need daytime hours free from the pump.

Key assessment findings for patients receiving tube feedings are noted in Chart 36-2.

### Maintaining Feeding Equipment and Nutritional Balance

The temperature and volume of the feeding, the flow rate, and the patient's total fluid intake are important factors to be considered when tube feedings are administered. The schedule of tube feedings, including the correct quantity and frequency, is maintained. The nurse must carefully monitor the drip rate and avoid administering fluids too rapidly.

Residual gastric volumes are measured before each intermittent feeding and every 4 to 8 hours during continuous feedings. Any aspirated fluid is readministered to the patient. A systematic review of the literature conducted by Keithley and Swanson (2004) suggested that there is little correlation between residual volumes and tube feeding tolerance. Furthermore, gastric residual volumes obtained from large diameter sump tubes can be greater than those obtained from smaller diameter tubes. Therefore, it is recommended that tube feedings be continued in patients with gastric residual volumes that exceed 200 mL as long as there is close monitoring of gastric residual volume trends, x-ray study results, and the patient's physical status. If excessive

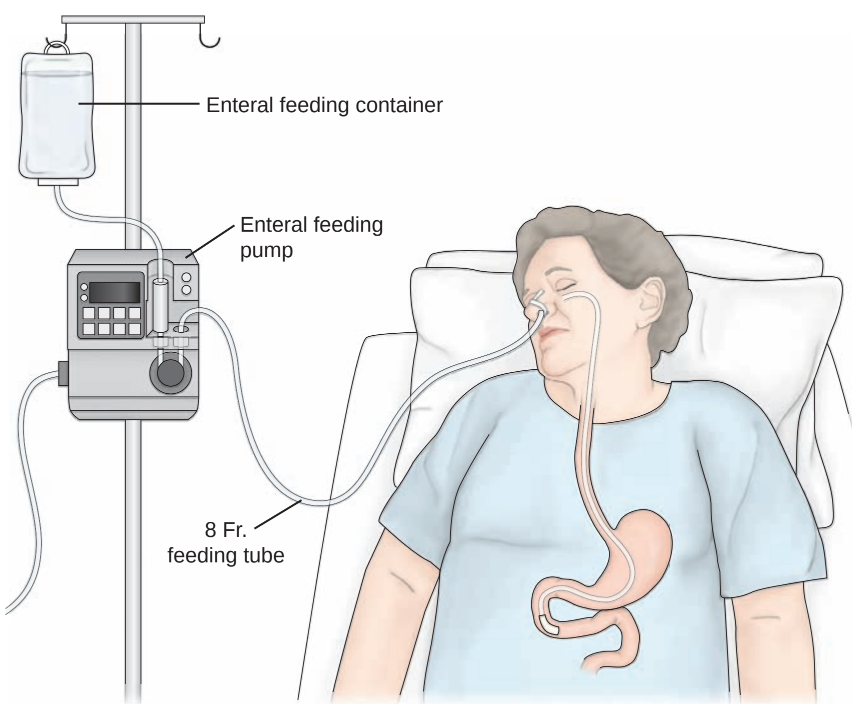



**Figure 36-5** Nasoenteric tube feeding by continuous controlled pump. The head of the bed should be elevated to prevent aspiration.

CHART 36-2

### Assessing Patients Receiving Tube Feedings

Be alert for the following assessment findings:

- Tube placement, patient's position (head of bed elevated 30 to 45 degrees), and formula flow rate
- Patient's ability to tolerate the formula; observe for fullness, bloating, distention, nausea, vomiting, and stool pattern
- Clinical responses, as noted in laboratory findings (blood urea nitrogen, serum protein, prealbumin, electrolytes, renal function, hemoglobin, hematocrit)
- Signs of dehydration (dry mucous membranes, thirst, decreased urine output)
- Amount of formula actually taken in by the patient
- Elevated blood glucose level, decreased urinary output, sudden weight gain, and periorbital or dependent edema
- Infection control practices: replace any formula administered by an open system every 4 hours with fresh formula; change tube feeding container and tubing every 24 to 72 hours
- Residual volume before each feeding or, in the case of continuous feedings, every 4 hours; return the aspirate to the stomach
- Intake and output
- Weekly weights
- Recommendations made on dietitian consult

residual volumes (ie, more than 200 mL) occur twice, the nurse notifies the physician.

**NURSING ALERT**

**Although a residual volume of 200 mL or greater is generally considered a cause for concern in patients at high risk for aspiration, feedings do not necessarily need to be withheld in all patients.**

Maintaining tube function is an ongoing responsibility of the nurse, patient, and primary caregiver. To ensure patency and to decrease the chance of bacterial growth, crusting, or occlusion of the tube, at least 30 to 50 mL of water or normal saline is administered in each of the following instances:

- Before and after each dose of medication and tube feeding
- After checking for gastric residuals and gastric pH
- Every 4 to 6 hours with continuous feedings
- If the tube feeding is discontinued or interrupted for any reason
- When the tube is not being used, where a minimum of twice-daily flushing is recommended

Any water or normal saline used to irrigate these tubes must be recorded as fluid intake. One study suggests that tap water may injure the small bowel and supports the practice of flushing postpyloric nasoduodenal or jejunostomy tubes with normal saline (Schloerb, Wood, Casillan, et al., 2004).

Important complications of enteral therapy are noted in Table 36-5.

#### Providing Medications by Tube

When different types of medications are prescribed, a bolus method is used for administration that is compatible with the medication's preparation (Table 36-6). The tube is flushed with 30 to 50 mL of water after medication administration, and this is recorded as intake. Medications should not be mixed with the feeding formula. When small-bore feeding tubes for continuous infusion are irrigated after administration of medications, a 30-mL or larger syringe is used because the pressure generated by smaller syringes could rupture the tube.

**NURSING ALERT**

**Administering medications through postpyloric enteric tubes may adversely affect their absorption; therefore, this should be avoided if possible.**

#### Maintaining Delivery Systems

Tube feeding formula is delivered to patients by either an open or a closed system. The open system is packaged as a liquid or as a powder to be mixed with water. The feeding container (which is hung on a pole) and the tubing used with the open system are usually changed every 24 hours. To avoid bacterial contamination, the amount of feeding formula in the bag should never exceed what should be infused in a 4-hour period. Closed delivery systems use a prefilled, sterile container that is spiked with enteral tubing.

#### Maintaining Normal Bowel Elimination Pattern

Patients receiving NG or nasoenteric tube feedings can experience diarrhea or constipation. Pasty, unformed stool is expected with enteral therapy because many formulas have little or no residue. Dumping syndrome also leads to diarrhea; and measures for managing the GI symptoms (diarrhea, nausea) associated with the dumping syndrome are presented in Chart 36-3. Other possible causes of diarrhea can include:

- Malnutrition: A decrease in the intestinal absorptive area can cause diarrhea.
- Medication therapy: Elixir-based medications often contain sorbitol, which can act as a cathartic.
- *Clostridium difficile* colitis: Antibiotic therapy often decreases the normal bacteria present in the intestine. The resultant abnormal growth of this microbe occurs most commonly in hospitalized patients treated with antibiotics and causes significant, potentially lethal diarrhea.

#### Reducing the Risk for Aspiration

Aspiration pneumonia occurs when regurgitated stomach contents or enteral feedings from an improperly positioned feeding tube are instilled into the pharynx or the trachea or when oral secretions are aspirated. Feeding patients through tubes placed beyond the pylorus can decrease the frequency of feeding regurgitation and aspiration. In addition, feedings and medications should always be administered with the patient in the semi-Fowler's position, and the patient's head should be elevated at least 30 to 45 degrees to reduce the risk of reflux and pulmonary aspiration. This position is maintained at least 1 hour after completion of an intermittent tube feeding and is maintained at all times for patients receiving continuous tube feedings.

**Table 36-5 COMPLICATIONS OF ENTERAL THERAPY**

| | | Selected Nursing Interventions | |
|---|---|---|---|
| **Complications** | **Causes** | **Therapeutic** | **Preventive** |
| **Gastrointestinal** | | | |
| Diarrhea | Hyperosmolar feedings<br>Rapid infusion/bolus feedings<br>Cold formula<br>Medications, especially antibiotic therapy | Assess fluid balance and electrolyte levels; report findings<br>Implement changes in tube feeding formula or rate<br>Review medications | Appropriate rate of infusion and temperature of formula<br>Avoid multiple elixirs and pro-motility medications |
| Nausea/vomiting | Change in formula or rate<br>Inadequate gastric emptying | Review medications | Check residuals; if ≥200 mL, reinstill and recheck; report if residual is consistently high |
| Gas/bloating/cramping | Air in tube<br>Excess fiber | Notify physician if persistent | Keep tubing free of air |
| Constipation | Lack of fiber<br>Inadequate fluid intake/dehydration<br>Opioid use | Check fiber and water content; report findings | Administer adequate amount of hydration as flushes<br>Consider cathartic |
| **Mechanical** | | | |
| Aspiration pneumonia | Improper tube placement<br>Vomiting with aspiration of tube feeding<br>Flat in bed | Assess respiratory status and notify physician | Implement reliable method for checking tube placement<br>Keep head of bed elevated 30 degrees |
| Tube displacement | Excessive coughing/vomitus<br>Tension on the tube or unsecured tube<br>Tracheal suctioning<br>Airway intubation | Stop feeding and notify physician | Check tube placement before administering feeding |
| Tube obstruction | Inadequate flushing/formula rate<br>Inadequate crushing of medications and flushing after administration | Follow policy for declogging feeding tubes (see Table 36-3) | Obtain liquid medications when possible<br>Flush tube and crush medications adequately |
| Nasopharyngeal irritation | Tube position/improper taping<br>Use of large tubes | Assess nasopharyngeal mucous membranes every 8 hours | Tape tube to prevent pressure on nares<br>Reposition tape |
| **Metabolic** | | | |
| Hyperglycemia | Glucose intolerance<br>High carbohydrate content of the feeding | Check blood glucose levels routinely<br>Dietary consult to reevaluate feeding regimen | |
| Dehydration and azotemia (excessive urea in the blood) | Hyperosmolar feedings with insufficient fluid intake | Report signs and symptoms of dehydration<br>Implement changes in tube feeding formula, rate, or ratio to water | Provide adequate hydration through flushes |

### *Maintaining Adequate Hydration*

The nurse carefully monitors hydration because in many cases the patient cannot communicate the need for water. Water flushes are administered every 4 to 6 hours and after feedings to prevent hypertonic dehydration. The feeding is initially given as a continuous drip, which helps the patient develop tolerance, especially for hyperosmolar solutions. Key nursing interventions include observing for signs of dehydration (eg, dry mucous membranes, thirst, decreased urine output); administering water routinely;

**Table 36-6 PREPARING MEDICATION FOR DELIVERY BY FEEDING TUBE**

| Medication Form | Preparation |
|---|---|
| Liquid | None |
| Simple compressed tablets | Crush and dissolve in water |
| Buccal or sublingual tablets | Administer as prescribed |
| Soft gelatin capsules filled with liquid | Make an opening in capsule and squeeze out contents |
| Enteric-coated tablets | Do not crush; change in form is required |
| Timed-release tablets | Do not crush tablets because doing so may release too much drug too quickly (overdose); check with pharmacist for alternative formulation |
| Timed-release capsules or sustained-release capsules | Some can be opened and contents added to tube-feeding formula; *always* check with pharmacist before doing this |

## Chart 36-3 • *Preventing Dumping Syndrome*

The following strategies may help prevent some of the uncomfortable signs and symptoms of dumping syndrome related to tube feeding:

- Slow the formula instillation rate to provide time for carbohydrates and electrolytes to be diluted.
- Administer feedings at room temperature, because temperature extremes stimulate peristalsis.
- Administer feeding by continuous drip (if tolerated) rather than by bolus, to prevent sudden distention of the intestine.
- Advise the patient to remain in semi-Fowler's position for 1 hour after the feeding; this position prolongs intestinal transit time by decreasing the effect of gravity.
- Instill the minimal amount of water needed to flush the tubing before and after a feeding, because fluid given with a feeding increases intestinal transit time.

and monitoring intake, output, residual volume, and fluid balance.

### Promoting Coping Ability

The psychosocial goal of nursing care is to support and encourage the patient to accept physical changes and to convey hope that daily progressive improvement is possible. If the patient is having difficulty adjusting to the treatment, the nurse intervenes by encouraging self-care, within the parameters of the patient's activity level. In addition, the nurse reinforces an optimistic approach by identifying indicators of progress (daily weight trends, electrolyte balance, absence of nausea and diarrhea).

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

Patients who require long-term tube feedings have conditions such as having had recent surgery or having an obstruction of the upper GI tract or decreased level of consciousness. For a patient to be considered for tube feeding at home, the patient should:

- Be medically stable and successfully tolerating 60% to 70% of the feeding regimen.
- Be capable of self-care or have a caregiver willing to assume the responsibility.
- Have access to supplies and interest in learning how to administer tube feedings at home.

Preparation of the patient for home administration of enteral feedings begins while the patient is still hospitalized. Ideally, the nurse teaches while administering the feedings so that the patient and caregiver can observe the mechanics and participate in the procedure, ask questions, and express any concerns. Before discharge, the nurse provides information about the equipment needed, formula purchase and storage, and administration of the feedings (frequency, quantity, rate of instillation).

Family members who will be active in the patient's home care are encouraged to participate in teaching sessions. Available printed information about the equipment, the formula, and the procedure is reviewed. Arrangements are made to obtain the equipment and formula and have it ready for use before the patient's discharge.

#### Continuing Care

Referral to a home care agency is important so that a nurse can supervise and provide support during the first feeding at home. Additional visits will depend on the skill and comfort of the patient or caregiver in administering the feedings. During all visits, the nurse monitors the patient's physical status (weight, vital signs, activity level) and the ability of the patient and family to administer the tube feedings correctly. In addition, the nurse assesses for any complications. The patient or caregiver is encouraged to record times and amounts of feedings and any symptoms that occur. The nurse can review the record with the patient and caregiver during home visits.

## Gastrostomy and Jejunostomy

A **gastrostomy** is a surgical procedure in which an opening is created into the stomach for the purpose of administering foods and fluids via a feeding tube or for gastric decompression in the setting of intestinal obstruction. A gastrostomy is preferred to deliver enteral nutritional support longer than 4 weeks. Gastrostomy is also preferred over NG feedings in the patient who is comatose because the gastroesophageal sphincter remains intact, making regurgitation and aspiration less likely than with NG feedings. Gastrostomy tubes may be placed surgically through an abdominal incision with sutures to secure the tube to the anterior gastric wall and the creation of a tunnel brought out through the abdomen to form a permanent **stoma.** A jejunostomy is similarly placed, but the distal end extends beyond the pylorus into the jejunum.

Insertion of a **percutaneous endoscopic gastrostomy (PEG)** requires the services of a provider skilled in endoscopy or interventional radiology. After a local anesthetic is administered, a cannula is inserted into the stomach through a small abdominal incision and an endoscope is inserted via the patient's mouth and upper GI tract. The PEG tube is guided down the esophagus, into the stomach, and out through the abdominal incision. A mushroom catheter tip or internal fasteners secure the tube against the stomach wall. An external crossbar or bumper keeps the catheter in place (Fig. 36-6A). If an endoscope cannot be passed through the esophagus, then the gastrostomy can be attempted under x-ray guidance through the abdominal wall.

The initial PEG device can be removed and replaced once the tract is well established, typically 3 to 6 weeks after insertion. Replacement of the PEG device is indicated for a clogged or fractured tube. The PEG should be fitted securely to the stoma to prevent leakage of gastric secretions and is maintained in place through gentle traction between the internal and anchoring devices. Enough space should remain between the skin and the external anchor to allow a gauze pad to be placed between them (Fig. 36-7).

An alternative to the PEG device is a low-profile gastrostomy device (LPGD) (see Fig. 36-6B). LPGDs may be inserted 3 to 6 months after initial gastrostomy tube placement. These devices are inserted flush with the skin; they eliminate the possibility of tube migration and have antireflux valves to prevent gastric leakage. Patients requiring

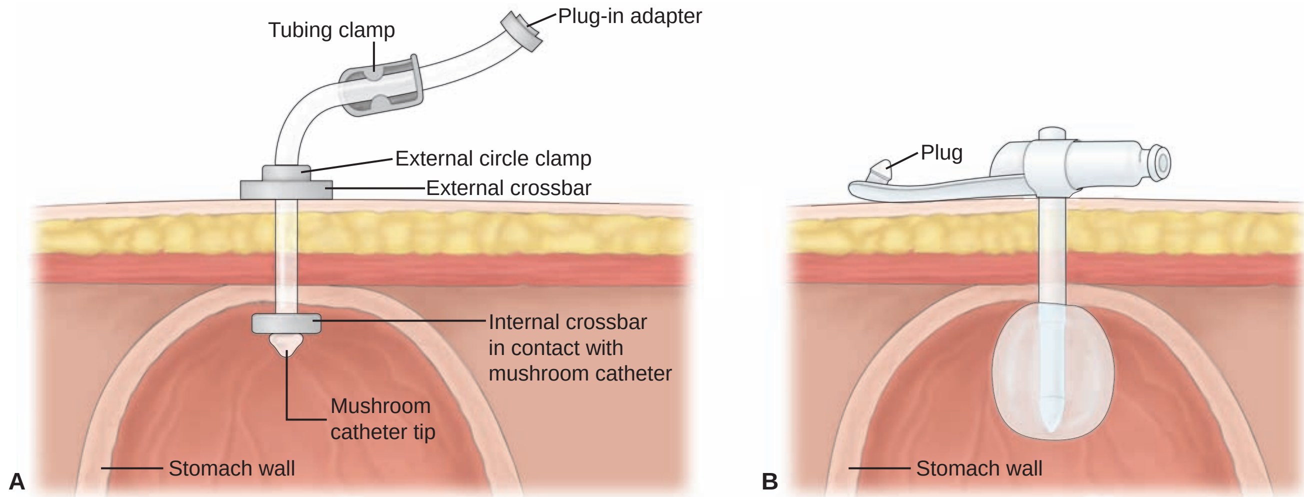



**Figure 36-6** **A,** A detail of the abdomen and the percutaneous endoscopic gastrostomy (PEG) tube, showing catheter fixation. **B,** A detail of the abdomen and the nonobturated low-profile gastrostomy device (LPGD), showing balloon fixation.

lifelong enteral support are able to conceal the feeding tube access site under their clothing. However, it is not possible to assess residual volumes with LPGDs (ie, they have one-way valves), and they also require a special adaptor to connect the device to the feeding container.

## NURSING PROCESS

### The Patient With a Gastrostomy or Jejunostomy

#### Assessment

The focus of the preoperative assessment is to determine the patient's ability both to understand and cooperate with the procedure. The nurse assesses the ability of both patient and family to adjust to a change in body image and to participate in self-care. There are multiple medical and ethical issues that the patient, the caregivers, and the physician should discuss together (Chart 36-4).

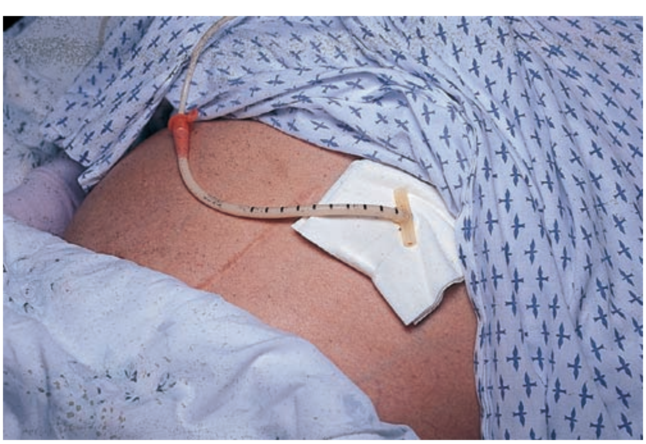


**Figure 36-7** Protection at the gastrostomy site. A percutaneous endoscopic gastrostomy (PEG) tube may be protected by a dressing that allows access to the tube but covers the exit site.

The purpose of the procedure and expected postoperative course should be explained. The patient needs to know that the feeding tube will bypass the mouth and esophagus so that liquid feedings can be administered directly into the stomach or intestine. If the feeding tube is expected to be permanent, the patient should be made aware of this. If the procedure is being performed to relieve discomfort, prolonged vomiting, debilitation, or an inability to eat, the patient may find it more acceptable.

In the postoperative period, the patient's fluid and nutritional needs are assessed to ensure proper intake and GI function. The nurse inspects the tube for proper maintenance and the incision for signs of infection. As the nurse evaluates patients' responses to the change in body image and their understanding of the feeding methods, interventions are identified to help them cope with the tube and learn self-care measures.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses in the postoperative period may include the following:

- Acute pain
- Risk for infection related to presence of wound and tube
- Risk for impaired skin integrity at tube insertion site
- Disturbed body image related to presence of tube

##### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following:

- Wound infection, cellulitis, and leakage
- GI bleeding
- Premature dislodgement of the tube

#### Planning and Goals

The major goals for the patient may include minimizing pain, preventing infection, maintaining skin integrity, enhancing coping, adjusting to changes in body image, and preventing complications.

CHART 36-4 *Ethics and Related Issues*

**Is It Ethical to Withhold or Withdraw Nutrition and Hydration?**

**Situation**

It is generally agreed that patients (or their designated decision makers) can refuse life-saving treatment, particularly if the means of treatment are extraordinary (eg, ventilators, dialysis machines, extracorporeal oxygenators). Extraordinary means include medications, treatments, and procedures that can be obtained only at excessive cost, pain, or inconvenience and offer no reasonable hope of benefit. Nutrition and hydration therapy, however, are perceived as ordinary means by many.

Ordinary means are those medications, treatments, and procedures that offer a reasonable hope of benefit and can be obtained without excessive expense, pain, or inconvenience. Additionally, withdrawing or withholding nutrition and hydration can in and of itself cause death. Thus, some have argued that nutrition and hydration should always be provided to every patient, regardless of the patient's preference or condition.

**Dilemma**

The patient's desire to have nutrition or hydration withdrawn or withheld may conflict with the reluctance of others to harm the patient by withdrawing the food and water needed for survival (autonomy versus nonmaleficence).

**Discussion**

Answer the following questions using as an example a patient in a persistent vegetative state (ie, unable to express his or her wishes).

- What arguments would you offer *against* the withholding and withdrawing of nutrition and hydration?
- What arguments would you offer *in favor of* withholding and withdrawing of nutrition and hydration?
- Are foods and fluids always "ordinary means," or are there instances in which they might be considered "extraordinary"? Support your answer.
- What are some of the religious, cultural, and financial issues that can complicate family and caregiver decisions?
- Should an attempt be made to involve critically ill or sedated patients in their own end-of-life decisions when their death is clearly imminent? How does one balance the issues of patient autonomy versus beneficence in this situation?

## Nursing Interventions

### *Meeting Nutritional Needs*

The first fluid nourishment is administered soon after tube insertion and can consist of tap water, normal saline, or 10% dextrose. At first, this can be administered as a slow hourly infusion of 10 to 20 mL hourly or as small bolus volumes of 30 to 60 mL. The infusion rate or bolus amount administered is gradually increased. By the second day, formula feeding may begin, provided it is tolerated and no fluid leaks from around the tube.

### *Providing Tube Care and Preventing Infection*

A thin gauze dressing should be applied between the tube insertion site and the gastrostomy tube. If the tube is not sutured in place, a thin strip of adhesive tape is placed around the tube and firmly attached to the abdomen. The nurse verifies the tube's placement (eg, pH measurement of aspirate) and gently manipulates the tube or stabilizing disk once daily to prevent skin breakdown. Some gastrostomy tubes have balloons that are inflated with water to anchor the tube in the stomach.

If the tube has been placed to drain the stomach contents because of a GI obstruction, it can be connected to either low, intermittent suction or to a gravity drainage bag. This drainage should be measured and recorded because it is a significant indicator of GI function. A decrease in the amount of drainage may indicate that the tube can be clamped for periods of time, allowing greater freedom of movement. High output can result in significant fluid and electrolyte losses.

### *Providing Skin Care*

The skin surrounding a gastrostomy requires special care because it may become irritated from the enzymatic action of gastric juices that may leak around the tube. Left untreated, the skin becomes macerated and painful. The nurse washes the area around the tube with soap and water daily, removes any encrustation, rinses the area well with water, and pats it dry. Skin at the exit site is evaluated daily for signs of breakdown, irritation, excoriation, and the presence of drainage or gastric leakage. The nurse encourages the patient and family members to participate in this evaluation and in hygiene activities.

### *Enhancing Body Image*

Eating is a major physiologic and social function, and the patient with a gastrostomy has experienced a major change in body image. The patient is also aware that gastrostomy as a therapeutic intervention is performed only in the presence of a major, chronic, or perhaps terminal illness. It is necessary to evaluate the existing family support system because adjustment takes time and is facilitated by family acceptance.

### *Monitoring and Managing Potential Complications*

During the postoperative course, the most common complications are wound infection or cellulitis at the exit site, bleeding, and dislodgement. Because many patients who receive tube feedings are debilitated and have compromised nutritional status, any signs of infection are promptly reported to the physician so that appropriate therapy can be instituted. Bleeding from the insertion site in the stomach can also occur and should be reported promptly. The nurse closely monitors the patient's vital signs and observes all operative site drainage, vomitus, and stool for evidence of bleeding. Dislodgement of a recently inserted tube requires immediate attention because the tract can close within 4 to 6 hours if the tube is not replaced promptly.

### *Promoting Home and Community-Based Care*

TEACHING PATIENTS SELF-CARE. The patient with a gastrostomy or jejunostomy tube in the home setting must be capable of maintaining patency of the tube or have a caregiver who can do so. The nurse assesses the patient's level of knowledge and interest in learning about the tube, as well as an ability to understand how to flush, provide site care, and

administer feedings or facilitate decompression drainage. Teaching is similar to that described earlier. To facilitate self-care, the nurse encourages the patient to participate in flushing the tube, administering medications during hospitalization, and establishing as normal a routine as possible.

Adaptors are available that can be secured to the end of the tube to create a "Y" site for ease of flushing, suction, or medication delivery (Fig. 36-8). The flushing equipment is cleaned with warm, soapy water and rinsed after each use. The tube can be marked at skin level to provide the patient with a baseline for later comparison. The patient or caregiver should be advised to monitor the tube's length and to notify the physician or home care nurse if the segment of the tube outside the body becomes shorter or longer.

**CONTINUING CARE.** Referral to a home care agency is important to ensure initial supervision and support for the patient and caregiver. The home care nurse assesses the patient's status and progress and evaluates the care of the tube and healing status of the tube insertion site. Further instruction and supervision in the home setting may be required to help the patient and caregiver adapt to a physical environment and equipment that are different from the hospital setting. The nurse also reviews with the patient and caregiver complications to report and assists the patient and family in establishing as normal a routine as possible.

## Evaluation

### *Expected Patient Outcomes*

1. Maintains adequate fluid balance
   a. Maintains or gains weight
   b. Has normal electrolyte values
   c. Is adequately hydrated
2. Is free from infection and skin breakdown
   a. Is afebrile
   b. Has no drainage from the incision
   c. Demonstrates intact skin surrounding the exit site
3. Adjusts to change in body image
   a. Is able to discuss expected changes
   b. Verbalizes concerns
4. Demonstrates skill in tube care
   a. Handles equipment competently
   b. Demonstrates how to maintain tube patency
   c. Keeps an accurate record of intake and output
5. Avoids complications
   a. Exhibits adequate wound healing
   b. Has no abnormal bleeding from puncture site
   c. Tube remains intact for the duration of therapy

# *Parenteral Nutrition*

**Parenteral nutrition (PN)** is a method of providing nutrients to the body by an IV route. The nutrients are a complex admixture containing proteins, carbohydrates, fats, electrolytes, vitamins, trace minerals, and sterile water in a single container. The goals of PN are to improve nutritional status, establish a positive nitrogen balance, maintain muscle mass, promote weight maintenance or gain, and enhance the healing process.

## Establishing Positive Nitrogen Balance

Most IV fluids do not provide sufficient calories or protein to meet the body's daily requirements. PN solutions can provide enough calories and nitrogen to meet the patient's daily nutritional needs. The patient with fever, trauma, burns, major surgery, or hypermetabolic disease requires additional daily calories. When highly concentrated dextrose is administered, caloric requirements are satisfied and the body uses amino acids for protein synthesis rather than for energy. Additionally, electrolytes such as calcium, phosphorus, magnesium, and sodium chloride are added to the solution to maintain proper electrolyte balance and to transport glucose and amino acids across cell membranes.

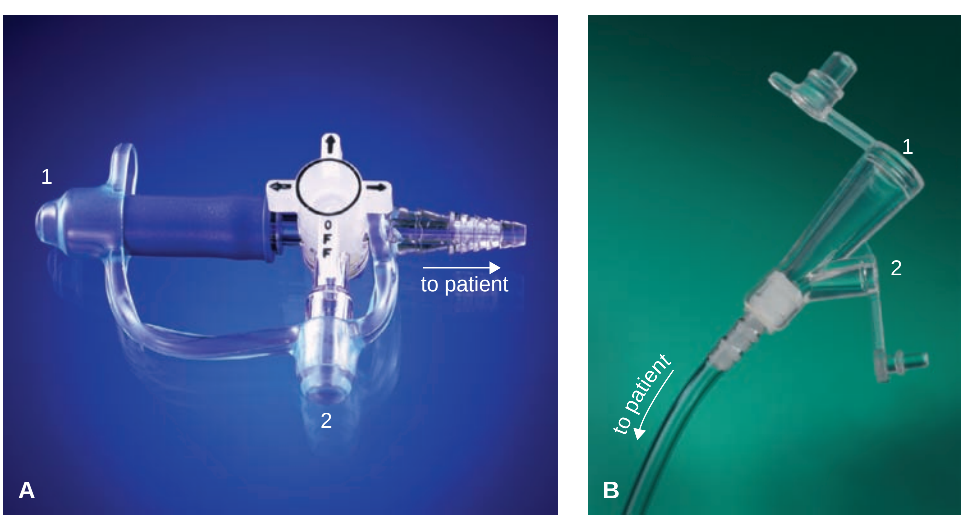



**Figure 36-8** **A,** The Lopez valve and the **B,** Bard adaptor allow feeding to (1) continue through the main port (2) while providing a second port for flushing and medication delivery.

The volume of fluid necessary to provide these calories peripherally can surpass fluid tolerance. To provide the required calories in a smaller volume, it is necessary to increase the concentration of nutrients and use a route of administration that rapidly dilutes incoming nutrients to the proper levels of body tolerance. Typically, a large, high-flow vein such as the subclavian vein or superior vena cava is the preferred site.

## Clinical Indications

The indications for PN include an inability to ingest adequate oral food or fluids within 7 days. Enteral nutrition should be considered before parenteral support because it assists in maintaining gut mucosal integrity and is typically associated with fewer complications. In both the home and hospital setting, PN is indicated in the situations listed in Table 36-7.

## Formulas

A total of 1 to 3 L of solution is administered over a 24-hour period. The label of the solution is verified with the physician's order. **Intravenous fat emulsions (IVFEs)** may be infused simultaneously with PN through a Y connector close to the infusion site and should not be filtered. Usually 500 mL of a 10% IVFE or 250 mL of 20% IVFE is administered over 6 to 12 hours, one to three times a week. IVFEs can provide up to 30% of the total daily calorie intake.

*NURSING ALERT*

**Before PN infusion is administered, the solution must be inspected for separation, oily appearance, or any precipitate. If any of these are present, it is not used.**

IVFEs can be mixed by the pharmacy staff with other components of PN to create a "three-in-one formulation" commonly called a **total nutrient admixture (TNA).** A special final filter (1.5-micron filter) is used with this solution. Advantages of TNA over PN are cost savings in preparation and equipment, decreased risk of catheter or nutrient contamination, decreased nursing time, and increased patient convenience and satisfaction. Ideally, the pharmacist, nutritionist, and physician should collaborate to determine the specific formula needed.

**Table 36-7 INDICATIONS FOR PARENTERAL NUTRITION**

| Condition or Need | Examples |
|---|---|
| Insufficient oral or enteral intake | Severe burns, malnutrition, short bowel syndrome, acquired immunodeficiency syndrome (AIDS), sepsis, cancer |
| Impaired ability to ingest or absorb food orally or enterally | Paralytic ileus, Crohn's disease, short gut, postradiation enteritis, high-output enterocutaneous fistula |
| The patient is unwilling or unable to ingest adequate nutrients orally or enterally | Major psychiatric illness |
| Preoperative and postoperative nutritional needs are prolonged | Extensive bowel surgery, acute pancreatitis |

## Initiating Therapy

PN solutions are initiated slowly and advanced gradually each day to the desired rate as the patient's fluid and dextrose tolerance permits. The patient's laboratory test results and response to PN therapy are monitored on an ongoing basis by the physician. Standing orders are initiated for weighing the patient; monitoring intake, output, and blood glucose; and baseline and periodic monitoring of complete blood count, platelet count, and chemistry panel, including serum carbon dioxide, magnesium, phosphorus, and triglycerides. A 24-hour urine nitrogen determination may be performed for analysis of nitrogen balance. In most hospitals, the PN solutions are prescribed on a daily standard PN order form. The formulation of the PN solutions is calculated carefully each day to meet the complete nutritional needs of the individual patient.

## Administration Methods

Various vascular access devices are used to administer PN solutions in clinical practice. PN may be administered through either peripheral or central IV lines, depending on the patient's condition and the anticipated length of therapy.

*NURSING ALERT*

**An infusion pump is always used for administration of PN.**

### Peripheral Method

To supplement oral intake, peripheral parenteral nutrition (PPN) may be prescribed. PPN is administered through a peripheral vein; this is possible because the solution is less hypertonic than a full-calorie parenteral nutrition solution. PPN formulas are not nutritionally complete because of their low dextrose content. Lipids are administered simultaneously to buffer the PPN and to protect the peripheral vein from irritation. The usual length of therapy using PPN is 5 to 7 days.

*NURSING ALERT*

**Formulations with dextrose concentrations of more than 10% should not be administered through peripheral veins because they irritate the intima (innermost walls) of small veins, causing chemical phlebitis.**

### Central Method

Because central parenteral solutions (CPNs) have five or six times the solute concentration of blood (and exert an osmotic pressure of about 2000 mOsm/L), they are administered into the vascular system through a catheter inserted into a high-flow, large blood vessel (eg, the subclavian vein). Concentrated solutions are then very rapidly diluted to isotonic levels by the blood in this vessel.

Four types of **central venous access devices (CVADs)** are available: nontunneled (or percutaneous) central

catheters, peripherally inserted central catheters, tunneled catheters, and implanted ports.

### Nontunneled Central Catheters

Nontunneled central catheters are used for short-term (less than 6 weeks) IV therapy in acute care settings. The subclavian vein is the most common vessel used because the subclavian area provides a stable insertion site to which the catheter can be anchored, is easily compressible (facilitating control of hemorrhage), allows the patient freedom of movement, and provides easy access to the dressing site. The jugular vein should only be used as a last resort and then only for 1 to 2 days. Single-lumen, double-lumen, and triple-lumen central catheters are available for central lines, but the Centers for Disease Control and Prevention (CDC) recommends that single-lumen catheters be used for CPN whenever practicable (CDC, 2002). For a patient with limited IV access, a triple-lumen subclavian catheter can be used because it offers three ports for various uses (Fig. 36-9). The distal lumen can be used to infuse blood or other viscous fluids. The middle lumen is reserved for PN infusion. The proximal port can be used for administration of blood or medications. A port not being used for fluid administration can be used for obtaining blood specimens if indicated.

If a single-lumen central catheter is used for administering PN, various restrictions apply. Blood should not be drawn from or transfused through the line because red blood cells may coat the lumen of the catheter and reduce the flow of the nutritional solution. Medications should not be administered through it because of potential incompatibilities with the components of the nutritional solution. If medications must be given, they must be infused through a separate peripheral IV line.

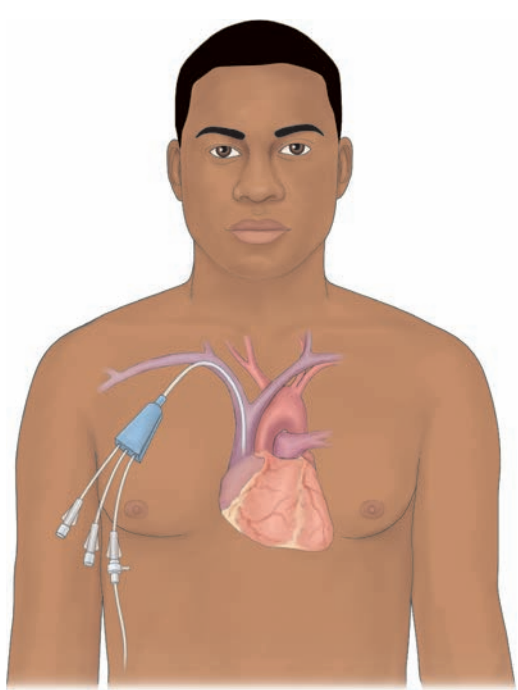


**Figure 36-9** Subclavian triple-lumen catheter used for parenteral nutrition and other adjunctive therapy. The catheter is threaded through the subclavian vein into the vena cava. Each lumen is an avenue for solution administration. The lumens are secured with threaded needleless adapters or Luer-Lok–type caps when the device is not in use.

***Insertion.*** The procedure is explained so that the patient is aware of what to expect. The patient is placed supine in the Trendelenburg position to produce dilation of neck and shoulder vessels, which makes entry easier and decreases the risk of air embolus. The skin is cleansed with chlorhexidine to remove surface oils. To afford maximal accuracy in the placement of the catheter, the patient is instructed to turn his or her head away from the site of venipuncture and to remain motionless while the catheter is inserted and the wound is dressed.

The nurse assists during the insertion process by maintaining the sterile field and supporting the patient throughout the procedure. Full-length sterile drapes are applied and sterile gloves and masks are donned. Lidocaine is injected to anesthetize the skin and underlying issues. A large-bore needle on a syringe is inserted and moved parallel to and beneath the clavicle until it enters the vein. A radiopaque wire is inserted through the needle into the vein. The catheter is then advanced over the wire, the needle is withdrawn, and the hub of the catheter is attached to the IV tubing. Until the syringe is detached from the needle and the catheter is inserted, the patient may be asked to perform the Valsalva maneuver. The patient is instructed to take a deep breath, hold it, and bear down with the mouth closed to produce a positive phase in central venous pressure, thereby lessening the possibility of air being drawn into the circulatory system (air embolism). The catheter is sutured to the skin. A transparent dressing is applied using strict sterile technique.

The position of the tip of the catheter is checked with x-ray or fluoroscopy to confirm its location in the superior vena cava at the junction of the right atrium and to rule out a pneumothorax resulting from inadvertent puncture of the pleura. Once the catheter's position is confirmed, the prescribed CPN solution can be started. The initial rate of infusion is usually low and the rate is gradually increased to the target rate.

An injection site cap is attached to the end of each central catheter lumen, creating a closed system. IV infusion tubing is connected to the insertion site cap of the central catheter with a threaded needleless adapter or Luer-Lok device. To ensure patency, all lumens are initially flushed with diluted heparin or normal saline after each intermittent infusion and after blood drawing; this flushing is necessary daily when the catheter is not in use. Force is never used to flush the catheter. If resistance is met, aspiration may restore lumen patency; if this is not effective, the physician is notified. Low-dose tissue plasminogen activator may be prescribed to dissolve a clot or fibrin sheath. If attempts to clear the lumen are ineffective, the catheter should be changed.

### Peripherally Inserted Central Catheters

**Peripherally inserted central catheters (PICCs)** are used for intermediate-term (several days to months) IV therapy in the hospital, long-term care, or home setting. These catheters may be inserted at the bedside or in the outpatient setting by a physician or specially trained nurse. The basilic or cephalic vein is accessed above the antecubital space, and the catheter is threaded to the superior vena cava. Taking of blood pressure and blood specimens from the

extremity with the PICC is avoided. (See Chapter 14 and Chapter 16, Figure 16–6.)

#### Tunneled Central Catheters

Tunneled central catheters are for long-term use and may remain in place for many years. These catheters are cuffed and can have single or double lumens; examples are the Hickman, Groshong, and Permacath. These catheters are inserted surgically. They are threaded under the skin (reducing the risk of ascending infection) to the subclavian vein and advanced into the superior vena cava.

#### Implanted Ports

Implanted ports are also used for long-term IV therapy; examples include the Port-A-Cath, Mediport, Hickman Port, and P.A.S. Port. Instead of exiting from the skin, as do the Hickman and Groshong catheters, the end of the catheter is attached to a small chamber that is placed in a subcutaneous pocket, either on the anterior chest wall or on the forearm. The port requires minimal care and allows the patient complete freedom of activity. Implanted ports are more expensive than the external catheters, and access requires passing a special noncoring needle (Huber-tipped) through the skin into the chamber to initiate IV therapy (see Chapter 16).

## Discontinuing Parenteral Nutrition

The PN solution is discontinued gradually to allow the patient to adjust to decreased levels of glucose. If the PN solution is abruptly terminated, isotonic dextrose can be administered for 1 to 2 hours to prevent rebound hypoglycemia. Specific symptoms of rebound hypoglycemia include weakness, faintness, sweating, shakiness, feeling cold, confusion, and increased heart rate. Once all IV therapy is completed, the nontunneled central venous catheter or PICC is removed and an occlusive dressing is applied to the exit site. Tunneled catheters and implanted ports are removed only by the physician.

## NURSING PROCESS

## The Patient Receiving Parenteral Nutrition

### Assessment

The nurse assists in identifying patients unable to tolerate oral or enteral feedings who may be candidates for PN. Indicators include significant weight loss (10% or more of usual weight), a decrease in oral food intake for more than 1 week, muscle wasting, decreased tissue healing, abnormal urea nitrogen excretion, and persistent vomiting and diarrhea. The nurse carefully monitors the patient's hydration status, electrolyte levels, and calorie intake.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses may include the following:

- Imbalanced nutrition, less than body requirements, related to inadequate oral intake of nutrients
- Risk for infection related to contamination of the central catheter site or infusion line
- Risk for imbalanced fluid volume related to altered infusion rate
- Anxiety related to catheter care and securement

#### *Collaborative Problems/Potential Complications*

The most common complications are pneumothorax, air embolism, a clotted or displaced catheter, sepsis, hyperglycemia, rebound hypoglycemia, and fluid overload. These problems and the associated collaborative interventions are described in Table 36-8.

### Planning and Goals

The major goals for the patient may include optimal level of nutrition, absence of infection, adequate fluid volume, optimal level of activity (within individual limitations), knowledge of and skill in self-care, and absence of complications.

### Nursing Interventions

#### *Maintaining Optimal Nutrition*

A continuous, uniform infusion of PN solution over a 24-hour period is desired. However, in some cases (eg, home care patients), cyclic PN may be appropriate. With cyclic PN, PN is infused during a set period of time. The time periods for infusion are sufficient to meet the patient's nutritional and pharmacologic needs. Ideally, cyclic PN is infused over a 10- to 15-hour period that continues through the night.

The patient is initially weighed daily (this may be decreased to two or three times per week once stable) at the same time of the day under the same conditions for accurate comparison. Under the PN regimen, satisfactory weight maintenance or gain can usually be achieved. It is important to keep accurate intake and output records and calculations of fluid balance. A calorie count is kept of any oral nutrients. Trace elements (copper, zinc, chromium, manganese, and selenium) are included in PN solutions and are individualized for each patient.

#### *Preventing Infection*

The high dextrose and fat content of PN solutions makes them an ideal culture medium for bacterial and fungal growth, and CVADs provide a port of entry. Gram-positive cocci, Gram-negative bacilli, and *Candida* species are frequently isolated as causes of catheter-related bloodstream infections. Common organisms include *Staphylococcus aureus*, *S. epidermidis*, *Pseudomonas aeruginosa*, *Acinetobacter*, and *Klebsiella pneumoniae*. Meticulous aseptic technique is essential to prevent infection any time the IV line setup is manipulated.

The primary sources of microorganisms for catheter-related bloodstream infections are the skin and the catheter hub. The catheter site is covered with an occlusive gauze dressing that is usually changed using sterile technique every 24 to 72 hours. Alternatively, the site may be covered with a transparent dressing that is changed weekly. Besides allowing frequent examination of the catheter site without changing the dressing, the transparent dressing also adheres well and is more comfortable for the patient. The CDC (2002) recommends changing CVAD dressings more often than every 7 days only if they are damp, bloody, loose, or soiled.

**Table 36-8 COMPLICATIONS OF PARENTAL NUTRITION**

| Complications | Cause | Nursing Actions and Collaborative Interventions: Treatment | Prevention |
|---|---|---|---|
| Pneumothorax | Improper catheter placement and inadvertent puncture of the pleura | Place patient in Fowler's position. Offer reassurance. Monitor vital signs. Prepare for thoracentesis or chest tube insertion. | Assist patient to remain still in Trendelenburg position during catheter insertion. |
| Embolism | Disconnected tubing | Replace tubing immediately and notify physician. | Examine all tubing connection sites for their security. |
| | Cap missing from port | Replace cap and notify physician. | |
| | Blocked segment of vascular system | Turn patient on left side and place in the head-low position. Notify physician. | |
| Clotted catheter line | Inadequate/infrequent heparin flushes<br>Disruption of infusion | At direction of physician, flush with thrombolytic medication as prescribed. | Flush lines per established protocols.<br>Monitor infusion rate hourly and inspect the integrity of the line. |
| Catheter displacement and contamination | Excessive movement, possibly with a nonsecured catheter<br>Separation of tubing and contamination | Stop the infusion and notify the physician. | Examine all tubing connection sites.<br>Avoid interrupting the main line or piggybacking other lines. |
| Sepsis | Separation of dressings | Reinforce or change dressing quickly using aseptic technique. | Maintain sterile technique when changing tubing, dressing, or total nutrient admixture bag. |
| | Contaminated solution | Discard. Notify pharmacist. | |
| | Infection at insertion site of catheter | Notify physician. Monitor vital signs. | |
| Hyperglycemia | Glucose intolerance | Notify physician; addition of insulin to PN solution may be prescribed. | Monitor glucose levels (blood and urine).<br>Monitor urine output.<br>Observe for stupor, confusion, or lethargy. |
| Fluid overload | Fluid infusing rapidly | Decrease infusion rate.<br>Monitor vital signs.<br>Notify physician.<br>Treat respiratory distress by sitting patient upright and administering oxygen as needed, if prescribed. | Use infusion pump.<br>Verify correct infusion rate ordered. |
| Rebound hypoglycemia | Feedings stopped too abruptly | Monitor for symptoms (weakness, tremors, diaphoresis, headache, hunger, and apprehension); notify physician. | Gradually wean patient from PN. |

During dressing changes, the nurse and patient wear masks to reduce the possibility of airborne contamination. Sterile technique is used. The area is checked for leakage, bloody or purulent drainage, a kinked catheter, and skin reactions such as inflammation, redness, swelling, or tenderness. The nurse wears sterile gloves and cleanses the area with tincture of 2% iodine or a chlorhexidine solution on sterile gauze. The site is cleaned thoroughly using a circular motion from the site outward to approximately 3 inches; this procedure is repeated two times. Then the same cleaning procedure is performed, using 2-by-2-inch gauze pads moistened with sterile water or saline solution. Next, the catheter ports are cleaned from the exit site to the distal end with an alcohol wipe. The insertion site is then redressed.

When an extension set is used with a central catheter, it is considered an extension of the catheter itself. It is not routinely changed with dressing or tubing changes. The dressing and tubing are labeled with the date, time of insertion, time of dressing change, and initials of the person who carried out the procedure; this information is also documented in the patient's medical record.

The catheter is another major source of colonization and infection. Researchers have conducted studies on the use of catheters with antiseptic coatings, antimicrobial coatings, and impregnated antimicrobial cuffs with inconsistent findings (Bacuzzi, Cecchin, Del Bosco, et al., 2006). Other proposals for prevention of infection include prophylactic antibiotic therapy, antithrombolytics, various exit-site dressings, and various disinfectants for cleansing catheter exit sites.

### *Maintaining Fluid Balance*

To maintain an accurate rate of PN administration, an infusion pump is necessary. A designated rate is set in milliliters per hour, and the rate is checked every 3 to 4 hours. The infusion rate should not be increased or decreased to compensate for fluids that have infused too quickly or too slowly. If the solution runs out, 10% dextrose and water is infused until the next PN solution is available from the pharmacy.

If the rate is too rapid, hyperosmolar diuresis can occur. Excess glucose is excreted by the renal tubules, pulling large volumes of water into the tubules via osmosis, resulting in higher-than-normal urine output and intravascular fluid

CHART 36-5 **Ethics and Related Issues**

**The Difficult Discharge: Safety Versus Autonomy**

**Situation**

Patients are sometimes discharged home at a lower level of physical and emotional function than when they entered the hospital. This can be secondary to the burden of disease or deterioration after a procedure. Facilitation of a timely, safe discharge can be a challenge for patients requiring home parenteral nutrition support, especially if multiple therapies are required. Although the hospital nursing staff initiates appropriate infusion teaching for both the patient and caregiver(s), a home care nurse does the majority of the assessment and instruction after discharge.

**Dilemma**

Most patients prefer home over the acute care hospital for many reasons, including the desire to be near family and pets and to convalesce in familiar surroundings. To accomplish this, patients or families sometimes describe a distorted scenario of what can be safely provided for the patient at home, facilitating a possibly unsafe discharge plan. Yet identifying and addressing this with the patient, family, and the medical team will likely delay the patient's discharge and disappoint the patient and family.

**Discussion**

Consider the elderly patient postsurgery who needs home parenteral nutrition but lives alone and does not have family nearby. He states that his neighbor (also elderly) will assist him but is unclear about how much time the neighbor is willing to give and the competency of the neighbor's skill sets.

- You have shown the patient proper technique for central line flushing, but he seems hesitant to do it himself and is unable to demonstrate independence with this basic care. He asks that you "sign him off" on the teaching sheet so that he can be cleared for discharge. What are your legal obligations in this situation? What options should you pursue?
- After several teaching sessions, you continue to have concerns about the patient's ability to be independent. His neighbor has been unable to come to the hospital to participate in the care. You verbalize to the patient that you are concerned that home parenteral support may not be a safe option for him. He is very upset and tells you that he has the right to go home and cannot be kept against his will. You explain that you only want him to be safe and to get well at home. From what ethical principle(s) does this conflict originate? What resources do you have in the hospital that may assist you in transitioning this patient out of the hospital?
- The physician clears the patient for discharge late in the afternoon, noting that a home infusion company has been arranged. Supplies will be delivered this evening if the patient arrives home in time to accept the delivery and meet with the nurse. You know he has a 2-hour ride home and there is a likelihood that he will not be home in time. With whom do you discuss this? What is the logistical, financial, and emotional impact of possibly canceling his extensively planned discharge? What is the overriding issue?

volume deficit. If the flow rate is too slow, the patient does not receive the maximal benefit of calories and nitrogen. Intake and output are recorded every 8 hours so that fluid imbalance can be readily detected.

### *Encouraging Activity*

Activities and ambulation are encouraged when the patient is physically able. With a catheter in the subclavian vein, the patient is free to move the extremities, and normal activity should be encouraged to maintain good muscle tone. If applicable, the teaching and exercise program initiated by occupational and physical therapists is reinforced.

## Promoting Home and Community-Based Care

**TEACHING PATIENTS SELF-CARE.** Successful home PN requires teaching the patient and family specialized skills using an intensive training program and follow-up supervision in the home. This is best accomplished through a team effort. Initiation of a home program facilitates the patient's discharge from the hospital.

Ideal candidates for home PN are patients who have a reasonable life expectancy after return home, have a limited number of illnesses other than the one that has resulted in the need for PN, and are highly motivated and fairly self-sufficient. Ethical dilemmas occur when the patient and

CHART 36-6 **Assessing for Home Nutrition Support**

Be alert for the following assessment findings:

- Water: necessary for hand washing and cleaning of work areas
- Electricity: reliable power source is needed to provide proper lighting and charging of pumps
- Refrigeration: must be adequate for accommodation of several bags of parenteral nutrition solution
- Telephone: necessary for contacting home health personnel, arranging for prompt delivery of supplies, and for emergency purposes
- Environment:
  - Should be free of rodents and insects
  - Should have storage that is not accessible to pets and small children
  - Should be assessed for stairs, carpets, and inaccessible areas, which can limit mobility with infusion pumps if the patient has a disability

Adapted from Ireton-Jones, C., DeLegge, M., Epperson, L., et al. (2003). Management of the home parenteral nutrition patient. *Nutrition in Clinical Practice, 18*(4), 310–317.

## Chart 36-7 • *Teaching Patients About Home Parenteral Nutrition*

An effective home care teaching program prepares the patient to store solutions, set up the infusion, flush the line with heparin, change the dressings, and troubleshoot for problems. The most common complication is sepsis. Strict aseptic technique is taught for hand hygiene, handling equipment, changing the dressing, and preparing the solution.

**Troubleshooting Mechanical Difficulties**

Mechanical problems can arise with the infusion pump or catheter site. The patient should measure the external length of the catheter; this measurement is used as a comparison if dislodgement is suspected. The patient should receive a list of instructions on how to recognize catheter problems, including leakage, loose cap, blood clot, and dislodgement and what to do for each problem.

**Recognizing Metabolic Complications**

The patient is given a list of signs and symptoms that indicate metabolic complications (neuropathies, mentation changes, diarrhea, nausea, skin changes, decreased urine output) and directions on how to contact the home health care nurse or physician if any of these complications occurs. The patient is instructed to have routine serum chemistry and hematology tests as well.

**Obtaining Psychosocial Support**

The psychosocial aspects of home parenteral nutrition are as important as the physiologic and technical concerns. Patients must cope with the loss of eating and with changes in lifestyle brought on by sleep disturbances related to frequent urination during night time infusions. Major psychosocial reactions include depression, anger, withdrawal, anxiety, and impaired self-image. A successful home parenteral nutrition program depends on the patient's and family's motivation, emotional stability, and technical competence.

family, as well as the caregiver, do not thoroughly understand what is involved in home PN (Chart 36-5). In addition, the ability to learn, availability of family interest and support, adequate finances, and the physical plan of the home are factors that must be assessed when the decision about home PN is made (Chart 36-6).

Many home health care agencies have developed teaching brochures and videos for home PN treatment. Topics include catheter and dressing care, use of an infusion pump, administration of fat emulsions, and instillation of heparin flushes. Teaching begins in the hospital and continues in the home or ambulatory infusion center (Chart 36-7).

**CONTINUING CARE.** The home care nurse should be aware that the typical patient needs several instruction sessions for assessment of learning and reinforcement. For more information about home patient education, see Chart 36-8. For special considerations for elderly patients who go home with nutrition support, see Chart 36-9.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Attains or maintains nutritional balance
2. Is free of catheter-related infection
   a. Is afebrile
   b. Has no purulent drainage from the catheter insertion site
3. Is hydrated, as evidenced by good skin turgor
4. Achieves an optimal level of activity, within limitations
5. Demonstrates skill in managing PN regimen
6. Prevents complications
   a. Maintains proper catheter and equipment function
   b. Maintains metabolic balance within normal limits

## CHART 36-8 HOME CARE CHECKLIST
### *The Patient Receiving Parenteral Nutrition*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Discuss goal and purpose of PN therapy. | ✔ | ✔ |
| • Discuss basic components of PN solution. | ✔ | ✔ |
| • List emergency phone numbers. | ✔ | ✔ |
| • Demonstrate how to handle PN solutions and medications correctly. | ✔ | ✔ |
| • Demonstrate how to operate infusion pump. | ✔ | ✔ |
| • Demonstrate how to prime tubing and filter. | ✔ | ✔ |
| • Demonstrate how to connect and disconnect PN infusion. | ✔ | ✔ |
| • Demonstrate how to perform catheter dressing changes. | ✔ | ✔ |
| • Demonstrate how to flush central line. | ✔ | ✔ |
| • Identify possible PN complications and interventions. | ✔ | ✔ |

CHART 36-9

GERONTOLOGIC CONSIDERATIONS
**Home Parenteral and Enteral Nutrition**

Age-related conditions that affect home nutrition support goals include the following:

- Arthritis: possible decreased hand dexterity and fine motor coordination
- Sensory impairment: inability to hear pump alarms; vision loss may affect ability to see pump menus or fill syringes
- Constipation: decreased overall bowel tone, which can cause intolerance of enteral feedings; assess water and fiber intake
- Impaired thirst may require close clinical management of fluid needs
- Obesity: decreased basal metabolic rate increases tendency toward weight gain; may require a kilocalorie reduction to compensate
- Diabetes mellitus: increased insulin resistance, which makes glucose control during parenteral nutrition infusion more challenging
- Depression/dementia: mood and memory disorders, which may present as low motivation to learn and adhere to the nutrition support regimen
- Multiple medications: conversion to an appropriate route or form is required

Adapted from White, J., Brewer, D., Stockton, M., et al. (2003). Nutrition in chronic disease management in the elderly. *Nutrition in Clinical Practice, 18*(1), 3–11.

## CRITICAL THINKING EXERCISES

**1** You prepare to administer a patient's scheduled bolus enteral tube feeding, and he states that he feels too full for another feeding. It has been 4 hours since his last feeding. His stomach is somewhat distended but he has bowel sounds. What are some of the causes of abdominal fullness and distention? How would patterns of elimination affect these signs and symptoms? Whom should you consult?

EBP **2** A female patient has recently been diagnosed with a partial gastric outlet obstruction related to a duodenal mass. She initially required parenteral nutrition but is now tolerating nasogastric tube feedings and is scheduled for surgery in 1 week. She does not like that she has a visible tube in place and asks that she be placed back on her previous parenteral nutrition regimen until surgery. In responding to this patient, what evidence-based knowledge would you use to explain the rationale of enteral nutrition as more appropriate than parenteral nutrition? What is the strength of that evidence? How can you address her concerns regarding her change in body image?

**3** A male patient has been struggling with mild obesity all his life and now has new x-ray evidence of small bowel inflammation and strictures from Crohn's disease. He will require several weeks of preoperative parenteral nutrition. He does not want a central access catheter placed and prefers to continue with simple IV fluids so that he can lose weight. What can you tell him about the nutritional advantages of total nutrient admixture (TNA) when compared with simple hydration fluids? Identify any advantages and disadvantages of significant weight loss in this preoperative period of acute illness.

**4** You are preparing to administer a gravity bolus enteral tube feeding to a patient assigned to your care and remember that the patient has been experiencing significant diarrhea over the past 2 days. What types of medications could be contributing to the diarrhea? A consultation with a dietitian may be beneficial to assess what possible issues often implicated in diarrhea? What suggestions would you make to the physician to further assess this problem?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Cancer Society, www.cancer.org
American Society for Clinical Nutrition, www.nutrition.org
American Society for Gastrointestinal Endoscopy, www.asge.org
American Society for Parenteral and Enteral Nutrition (ASPEN), www.nutritioncare.org
Infusion Nurses Society (INS), www.ins1.org
Oley Foundation for Home Parenteral and Enteral Nutrition, www.oley.org
Society of Gastroenterology Nurses and Associates, Inc., www.sgna.org



# chapter 37 Management of Patients With Gastric and Duodenal Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare the etiology, clinical manifestations, and management of acute gastritis, chronic gastritis, and peptic ulcer.
2. Describe nursing management of patients with gastritis.
3. Use the nursing process as a framework for care of patients with peptic ulcer.
4. Describe the dietary, pharmacologic, and surgical treatment of peptic ulcer.
5. Describe the nursing management of patients who undergo surgical procedures to treat obesity.
6. Use the nursing process as a framework for care of patients with gastric cancer.
7. Use the nursing process as a framework for care of patients undergoing gastric surgery.
8. Identify the complications of gastric surgery and their prevention and management.
9. Describe the home health care needs of the patient who has had gastric surgery.

## GLOSSARY

**achlorhydria:** lack of hydrochloric acid in digestive secretions of the stomach

**antrectomy:** removal of the pyloric (antrum) portion of the stomach with anastomosis (surgical connection) to the duodenum (gastroduodenostomy or Billroth I) or anastomosis to the jejunum (gastrojejunostomy or Billroth II)

**bariatric:** relating to obesity; term derives from two Greek words meaning "weight" and "treatment"

**dumping syndrome:** physiologic response to rapid emptying of gastric contents into the jejunum, manifested by nausea, weakness, sweating, palpitations, syncope, and possibly diarrhea; occurs in patients who have had partial gastrectomy and gastrojejunostomy

**duodenum:** first portion of the small intestine, between the stomach and the jejunum

**enteroclysis:** fluoroscopic x-ray of the small intestine; a tube is placed from the nose or mouth through the esophagus and the stomach to the duodenum, a barium-based liquid contrast material is infused through the tube, and x-rays are taken as it travels through the duodenum

**gastric:** refers to the stomach

**gastric outlet obstruction:** any condition that mechanically impedes normal gastric emptying; there is obstruction of the channel of the pylorus and duodenum through which the stomach empties

**gastritis:** inflammation of the stomach

***Helicobacter pylori*:** a spiral-shaped gram-negative bacterium that colonizes the gastric mucosa; is involved in most cases of peptic ulcer disease

**hematemesis:** vomiting of blood

**histamine-2 ($H_2$) receptor antagonist:** a pharmacologic agent that inhibits histamine action at the $H_2$ receptors of the stomach, resulting in inhibition of gastric acid secretion

**ligament of Treitz:** suspensory ligament of the duodenum; important anatomic landmark used to divide the gastrointestinal tract into an upper and a lower portion

**melena:** tarry or black stools; indicative of blood in stools

**morbid obesity:** more than twice ideal body weight, 100 pounds or more over ideal body weight, or body mass index exceeding 40 kg/m$^2$

**omentum:** fold of the peritoneum that surrounds the stomach and other organs of the abdomen

**peritoneum:** thin membrane that lines the inside of the wall of the abdomen and covers all the abdominal organs

**proton pump inhibitors:** pharmacologic agents that block acid secretion by irreversibly binding to and inhibiting the hydrogen–potassium adenosine triphosphatase pump system at the secretory surface of gastric parietal cells; most potent inhibitors of gastric acid secretion

**pyloroplasty:** surgical procedure to increase the opening of the pyloric orifice

**pylorus:** opening between the stomach and the duodenum

**pyrosis:** heartburn

**serosa:** thin membrane that covers the outer surface of the stomach; visceral peritoneum covering the outer surface of the stomach

**stenosis:** narrowing or tightening of an opening or passage in the body

A person's nutritional status depends not only on the type and amount of intake but also on the functioning of the gastric and intestinal portions of the gastrointestinal (GI) system. This chapter describes disorders of the stomach and duodenum, their treatment, and related nursing care.

## Gastritis

**Gastritis** (inflammation of the **gastric** or stomach mucosa) is a common GI problem. Gastritis may be acute, lasting several hours to a few days, or chronic, resulting from repeated exposure to irritating agents or recurring episodes of acute gastritis.

Acute gastritis is often caused by dietary indiscretion—a person eats food that is irritating, too highly seasoned, or contaminated with disease-causing microorganisms. Other causes of acute gastritis include overuse of aspirin and other nonsteroidal anti-inflammatory drugs (NSAIDs), excessive alcohol intake, bile reflux, and radiation therapy. A more severe form of acute gastritis is caused by the ingestion of strong acid or alkali, which may cause the mucosa to become gangrenous or to perforate. Scarring can occur, resulting in pyloric **stenosis** or obstruction. Acute gastritis also may develop in acute illnesses, especially when the patient has had major traumatic injuries; burns; severe infection; hepatic, renal, or respiratory failure; or major surgery. Gastritis may be the first sign of an acute systemic infection.

Chronic gastritis and prolonged inflammation of the stomach may be caused either by benign or malignant ulcers of the stomach or by the bacteria ***Helicobacter pylori*.** Chronic gastritis is sometimes associated with autoimmune diseases such as pernicious anemia; dietary factors such as caffeine; the use of medications such as NSAIDs or bisphosphonates (eg, alendronate [Fosamax], risedronate [Actonel], ibandronate [Boniva]); alcohol; smoking; or chronic reflux of pancreatic secretions and bile into the stomach.

### Pathophysiology

In gastritis, the gastric mucous membrane becomes edematous and hyperemic (congested with fluid and blood) and undergoes superficial erosion (Fig. 37-1). It secretes a scanty amount of gastric juice, containing very little acid but much mucus. Superficial ulceration may occur and can lead to hemorrhage.

### Clinical Manifestations

The patient with acute gastritis may have a rapid onset of symptoms, such as abdominal discomfort, headache, lassitude, nausea, anorexia, vomiting, and hiccupping, which can last from a few hours to a few days. The patient with chronic gastritis may complain of anorexia, heartburn after eating, belching, a sour taste in the mouth, or nausea and vomiting. Some patients may have only mild epigastric discomfort or report intolerance to spicy or fatty foods or slight pain that is relieved by eating. Patients with chronic gastritis from vitamin deficiency usually have evidence of malabsorption of vitamin $B_{12}$ caused by the production of antibodies that interfere with the binding of vitamin $B_{12}$ to intrinsic factor. However, some patients with chronic gastritis have no symptoms.

### Assessment and Diagnostic Findings

Gastritis is sometimes associated with **achlorhydria** or hypochlorhydria (absence or low levels of hydrochloric acid [HCl]) or with hyperchlorhydria (high levels of HCl). Diagnosis can be determined by an upper GI x-ray series or endoscopy and histologic examination of a tissue specimen

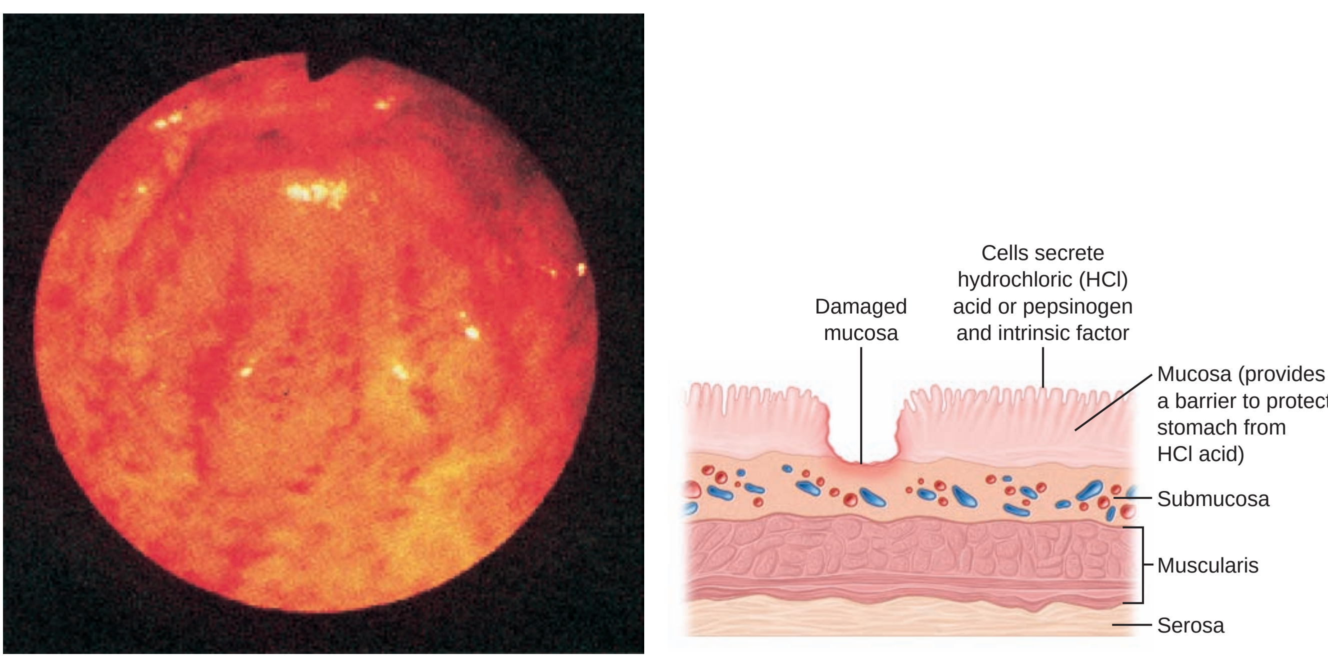



**Figure 37-1** Endoscopic view of erosive gastritis (*left*). Damage from irritants (*right*) results in increased intracellular pH, impaired enzyme function, disrupted cellular structures, ischemia, vascular stasis, and tissue death. Reproduced with permission from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

obtained by biopsy. Diagnostic measures for detecting *H. pylori* infection may be used and are discussed in the section on peptic ulcers.

## Medical Management

The gastric mucosa is capable of repairing itself after an episode of gastritis. As a rule, the patient recovers in about 1 day, although the appetite may be diminished for an additional 2 or 3 days. Acute gastritis is also managed by instructing the patient to refrain from alcohol and food until symptoms subside. When the patient can take nourishment by mouth, a nonirritating diet is recommended. If the symptoms persist, intravenous (IV) fluids may need to be administered. If bleeding is present, management is similar to the procedures used to control upper GI tract hemorrhage discussed later in this chapter.

If gastritis is caused by ingestion of strong acids or alkalis, emergency treatment consists of diluting and neutralizing the offending agent. To neutralize acids, common antacids (eg, aluminum hydroxide) are used; to neutralize an alkali, diluted lemon juice or diluted vinegar is used. If corrosion is extensive or severe, emetics and lavage are avoided because of the danger of perforation and damage to the esophagus.

Therapy is supportive and may include nasogastric (NG) intubation, analgesic agents and sedatives, antacids, and IV fluids. Fiberoptic endoscopy may be necessary. In extreme cases, emergency surgery may be required to remove gangrenous or perforated tissue. A gastric resection or a gastrojejunostomy (anastomosis of jejunum to stomach to detour around the pylorus) may be necessary to treat pyloric obstruction, a narrowing of the pyloric orifice, which cannot be relieved by medical management.

Chronic gastritis is managed by modifying the patient's diet, promoting rest, reducing stress, recommending avoidance of alcohol and NSAIDs, and initiating pharmacotherapy. *H. pylori* may be treated with selected drug combinations (Table 37-1).

## Nursing Management

### Reducing Anxiety

If the patient has ingested acids or alkalis, emergency measures may be necessary. The nurse offers supportive therapy to the patient and family during treatment and after the ingested acid or alkali has been neutralized or diluted. In some cases, the nurse may need to prepare the patient for additional diagnostic studies (endoscopies) or surgery. The patient may be anxious because of pain and planned treatment modalities. The nurse uses a calm approach to assess the patient and to answer all questions as completely as possible. It is important to explain all procedures and treatments based on the patient's level of understanding.

### Promoting Optimal Nutrition

For acute gastritis, the nurse provides physical and emotional support and helps the patient manage the symptoms, which may include nausea, vomiting, heartburn, and fatigue. The patient should take no foods or fluids by mouth—possibly for a few days—until the acute symptoms subside, thus allowing the gastric mucosa to heal. If IV therapy is necessary, the nurse monitors fluid intake and output along with serum electrolyte values. After the symptoms subside, the nurse may offer the patient ice chips followed by clear liquids. Introducing solid food as soon as possible may provide adequate oral nutrition, decrease the need for IV therapy, and minimize irritation to the gastric mucosa. As food is introduced, the nurse evaluates and reports any symptoms that suggest a repeat episode of gastritis.

The nurse discourages the intake of caffeinated beverages, because caffeine is a central nervous system stimulant that increases gastric activity and pepsin secretion. It also is important to discourage alcohol use. Discouraging cigarette smoking is important because nicotine reduces the secretion of pancreatic bicarbonate, which inhibits the neutralization of gastric acid in the duodenum (Suzuki, Matsuo, Ito, et al., 2006). When appropriate, the nurse initiates and refers the patient for alcohol counseling and smoking cessation programs.

### Promoting Fluid Balance

Daily fluid intake and output are monitored to detect early signs of dehydration (minimal fluid intake of 1.5 L/day, minimal output of 30 mL/h). If food and oral fluids are withheld, IV fluids (3 L/day) usually are prescribed and a record of fluid intake plus caloric value (1 L of 5% dextrose in water = 170 calories of carbohydrate) needs to be maintained. Electrolyte values (sodium, potassium, chloride) are assessed every 24 hours to detect any imbalance.

The nurse must always be alert for any indicators of hemorrhagic gastritis, which include **hematemesis** (vomiting of blood), tachycardia, and hypotension. If these occur, the physician is notified and the patient's vital signs are monitored as the patient's condition warrants. Guidelines for managing upper GI tract bleeding are discussed later in this chapter.

### Relieving Pain

Measures to help relieve pain include instructing the patient to avoid foods and beverages that may be irritating to the gastric mucosa and instructing the patient about the correct use of medications to relieve chronic gastritis. The nurse must regularly assess the patient's level of pain and the extent of comfort achieved through the use of medications and avoidance of irritating substances.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

The nurse evaluates the patient's knowledge about gastritis and develops an individualized teaching plan that includes information about stress management, diet, and medications (Chart 37-1). Dietary instructions take into account the patient's daily caloric needs, food preferences, and pattern of eating. The nurse and patient review foods and other substances to be avoided (eg, spicy, irritating, or highly seasoned foods; caffeine; nicotine; alcohol). Consultation with a dietitian may be recommended.

Providing information about prescribed antibiotics, bismuth salts, medications to decrease gastric secretion, and medications to protect mucosal cells from gastric secretions may help the patient to better understand why these

**Table 37-1 PHARMACOTHERAPY FOR PEPTIC ULCER DISEASE AND GASTRITIS**

| Pharmacologic Agent | Major Action | Key Nursing Considerations |
|---|---|---|
| **Antibiotics** | | |
| Amoxicillin (Amoxil) | A bactericidal antibiotic that assists with eradicating *H. pylori* bacteria in the gastric mucosa | • May cause diarrhea<br>• Should not be used in patients allergic to penicillin |
| Clarithromycin (Biaxin) | Exerts bactericidal effects to eradicate *H. pylori* bacteria in the gastric mucosa | • May cause GI upset, headache, altered taste<br>• Many drug–drug interactions (eg, cisapride, colchicine, lovastatin, warfarin [Coumadin]) |
| Metronidazole (Flagyl) | A synthetic antibacterial and antiprotozoal agent that assists with eradicating *H. pylori* bacteria in the gastric mucosa when administered with other antibiotics and proton pump inhibitors | • Should be administered with meals to decrease GI upset; may cause anorexia and metallic taste<br>• Patient should avoid alcohol; Flagyl increases blood-thinning effects of warfarin (Coumadin) |
| Tetracycline | Exerts bacteriostatic effects to eradicate *H. pylori* bacteria in the gastric mucosa | • May cause photosensitivity reaction; warn patient to use sunscreen<br>• May cause GI upset<br>• Must be used with caution in patients with renal or hepatic impairment<br>• Milk or dairy products may reduce effectiveness |
| **Antidiarrheal** | | |
| Bismuth subsalicylate (Pepto-Bismol) | Suppresses *H. pylori* bacteria in the gastric mucosa and assists with healing of mucosal ulcers | • Given concurrently with antibiotics to eradicate *H. pylori* infection<br>• Should be taken on empty stomach |
| **Histamine-2 ($H_2$) Receptor Antagonists** | | |
| Cimetidine (Tagamet) | Decreases amount of HCl produced by stomach by blocking action of histamine on histamine receptors of parietal cells in the stomach | • Least expensive of $H_2$ receptor antagonists<br>• May cause confusion, agitation, or coma in the elderly or those with renal or hepatic insufficiency<br>• Long-term use may cause diarrhea, dizziness, gynecomastia<br>• Many drug–drug interactions (eg, amiodarone, amitriptyline, benzodiazepines, metoprolol, nifedipine, phenytoin, warfarin [Coumadin]) |
| Famotidine (Pepcid) | Same as for cimetidine | • Best choice for critically ill patient because it is known to have the least risk of drug–drug interactions; does not alter liver metabolism<br>• Prolonged half-life in patients with renal insufficiency<br>• Short-term relief for GERD |
| Nizatidine (Axid) | Same as for cimetidine | • Used for treatment of ulcers and GERD<br>• Prolonged half-life in patients with renal insufficiency<br>• May cause headache, dizziness, diarrhea, nausea/vomiting, GI upset as well as urticaria |
| Ranitidine (Zantac) | Same as for cimetidine | • Prolonged half-life in patients with renal and hepatic insufficiency<br>• Causes fewer side effects than cimetidine<br>• May cause headache, dizziness, constipation, nausea and vomiting, or abdominal discomfort |
| **Proton Pump Inhibitors of Gastric Acid (PPIs)** | | |
| Esomeprazole (Nexium) | Decreases gastric acid secretion by slowing the hydrogen-potassium adenosine triphosphatase ($H^+$, $K^+$-ATPase) pump on the surface of the parietal cells of the stomach | • Used mainly for treatment of duodenal ulcer disease and *H. pylori* infection<br>• A delayed-release capsule that is to be swallowed whole and taken before meals |
| Lansoprazole (Prevacid) | Decreases gastric acid secretion by slowing the $H^+$, $K^+$-ATPase pump on the surface of the parietal cells | • A delayed-release capsule that is to be swallowed whole and taken before meals |
| Omeprazole (Prilosec) | Same as for lansoprazole | • A delayed-release capsule that is to be swallowed whole and taken before meals<br>• May cause diarrhea, nausea, constipation, abdominal pain, vomiting, headache, or dizziness |
| Pantoprazole (Protonix) | Same as for lansoprazole | • A delayed-release capsule that is to be swallowed whole and taken before meals<br>• May cause diarrhea and hyperglycemia, headache, abdominal pain, and abnormal liver function tests |
| Rabeprazole (AcipHex) | Same as for lansoprazole | • A delayed-release tablet to be swallowed whole<br>• May cause abdominal pain, diarrhea, nausea, and headache<br>• Drug–drug interactions with digoxin, iron, and warfarin (Coumadin) |

*Continued on following page*

**Table 37-1 PHARMACOTHERAPY FOR PEPTIC ULCER DISEASE AND GASTRITIS (Continued)**

| Pharmacologic Agent | Major Action | Key Nursing Considerations |
|---|---|---|
| **Prostaglandin $E_1$ Analogue** | | |
| Misoprostol (Cytotec) | Synthetic prostaglandin; protects the gastric mucosa from agents that cause ulcers; also increases mucous production and bicarbonate levels | • Used to prevent ulceration in patients using NSAIDs<br>• Administer with food<br>• May cause diarrhea and cramping (including uterine cramping) |
| Sucralfate (Carafate) | Creates a viscous substance in the presence of gastric acid that forms a protective barrier, binding to the surface of the ulcer, and prevents digestion by pepsin | • Used mainly for the treatment of duodenal ulcers<br>• Should be taken without food but with water<br>• Other medications should be taken 2 h before or after this medication<br>• May cause constipation or nausea |

GERD, gastroesophageal reflux disease; GI, gastrointestinal; NSAID, nonsteroidal anti-inflammatory drug.

medications assist in recovery and prevent recurrence. The importance of completing the medication regimen as prescribed to eradicate *H. pylori* infection must be reinforced to the patient and any caregivers.

**Continuing Care**

The nurse reinforces previous teaching and conducts ongoing assessment of the patient's symptoms and progress. Patients with malabsorption of vitamin $B_{12}$ need information about lifelong vitamin $B_{12}$ injections; the nurse may instruct a family member or caregiver how to administer the injections or make arrangements for the patient to receive the injections from a health care provider. Finally, the nurse emphasizes the importance of keeping follow-up appointments with health care providers.

## Peptic Ulcer Disease

A peptic ulcer may be referred to as a gastric, duodenal, or esophageal ulcer, depending on its location. A peptic ulcer is an excavation (hollowed-out area) that forms in the mucosal wall of the stomach, in the **pylorus** (the opening between the stomach and duodenum), in the **duodenum** (the first part of the small intestine), or in the esophagus. Erosion of a circumscribed area of mucous membrane is the cause (Fig. 37-2). This erosion may extend as deeply as the muscle layers or through the muscle to the **peritoneum.**

Peptic ulcers are more likely to occur in the duodenum than in the stomach. As a rule they occur alone, but they may occur in multiples. Chronic gastric ulcers tend to occur in the lesser curvature of the stomach, near the pylorus. Table 37-2 compares the features of gastric and duodenal ulcers. Esophageal ulcers occur as a result of the backward flow of HCl from the stomach into the esophagus (gastroesophageal reflux disease [GERD]).

Peptic ulcer disease occurs with the greatest frequency in people between 40 and 60 years of age. It is relatively uncommon in women of childbearing age, but it has been observed in children and even in infants. After menopause, the incidence of peptic ulcers in women is almost equal to that in men. Peptic ulcers in the body of the stomach can occur without excessive acid secretion.

In the past, stress and anxiety were thought to be causes of ulcers, but research has documented that peptic ulcers result from infection with the gram-negative bacteria *H. pylori*, which may be acquired through ingestion of food and water. Person-to-person transmission of the bacteria also occurs through close contact and exposure to emesis. Although *H. pylori* infection is common in the United States, most infected people do not develop ulcers. It is not known why *H. pylori* infection does not cause ulcers in all people, but most likely the predisposition to ulcer formation depends on certain factors, such as the type of *H. pylori* and other as yet unknown factors (Makola, Peura & Crowe, 2007).

In addition, excessive secretion of HCl in the stomach may contribute to the formation of peptic ulcers, and stress may be associated with its increased secretion. The ingestion of milk and caffeinated beverages, smoking, and alcohol also

**CHART 37-1 HOME CARE CHECKLIST**
***The Patient With Gastritis***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Identify foods and other substances that may cause gastritis. | ✔ | ✔ |
| • Report inability to ingest adequate solids and liquids. | ✔ | ✔ |
| • Describe medication regimen. | ✔ | ✔ |
| • State need for vitamin $B_{12}$ injections if patient has pernicious anemia. | ✔ | ✔ |
| • State schedule of follow-up appointments with health care provider. | ✔ | ✔ |



**Figure 37-2** Deep peptic ulcer. From Rubin, R., Strayer, D. S., Rubin, E., et al. (2008). *Rubin's pathology: Clinicopathologic foundations of medicine* (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

may increase HCl secretion. Stress and eating spicy foods may make peptic ulcers worse.

Familial tendency also may be a significant predisposing factor. People with blood type O are more susceptible to peptic ulcers than are those with blood type A, B, or AB. There also is an association between peptic ulcers and chronic pulmonary disease or chronic renal disease. Other predisposing factors associated with peptic ulcer include chronic use of NSAIDs, alcohol ingestion, and excessive smoking.

**Table 37-2 COMPARISON OF DUODENAL AND GASTRIC ULCERS**

| Duodenal Ulcer | Gastric Ulcer |
|---|---|
| **Incidence** | |
| Age 30–60 | Usually 50 and over |
| Male:female = 2–3:1 | Male: female = 1:1 |
| 80% of peptic ulcers are duodenal | 15% of peptic ulcers are gastric |
| **Signs, Symptoms, and Clinical Findings** | |
| Hypersecretion of stomach acid (HCl) | Normal—hyposecretion of stomach acid (HCl) |
| May have weight gain | Weight loss may occur |
| Pain occurs 2–3 h after a meal; often awakened 1–2 AM; ingestion of food relieves pain | Pain occurs ½ to 1 h after a meal; rarely occurs at night; may be relieved by vomiting; ingestion of food does not help, sometimes increases pain |
| Vomiting uncommon | Vomiting common |
| Hemorrhage less likely than with gastric ulcer, but if present, melena more common than hematemesis | Hemorrhage more likely to occur than with duodenal ulcer; hematemesis more common than melena |
| More likely to perforate than gastric ulcers | |
| **Malignancy Possibility** | |
| Rare | Occasionally |
| **Risk Factors** | |
| *H. pylori*, alcohol, smoking, cirrhosis, stress | *H. pylori*, gastritis, alcohol, smoking, use of NSAIDs, stress |

NSAID, nonsteroidal anti-inflammatory drug.

Peptic ulcers are found in rare cases in patients with tumors that cause secretion of excessive amounts of the hormone gastrin. The Zollinger-Ellison syndrome (ZES) consists of severe peptic ulcers, extreme gastric hyperacidity, and gastrin-secreting benign or malignant tumors of the pancreas.

## Pathophysiology

Peptic ulcers occur mainly in the gastroduodenal mucosa because this tissue cannot withstand the digestive action of gastric acid (HCl) and pepsin. The erosion is caused by the increased concentration or activity of acid–pepsin or by decreased resistance of the mucosa. A damaged mucosa cannot secrete enough mucus to act as a barrier against HCl. The use of NSAIDs inhibits the secretion of mucus that protects the mucosa. Patients with duodenal ulcers secrete more acid than normal, whereas patients with gastric ulcers tend to secrete normal or decreased levels of acid. Damage to the gastroduodenal mucosa results in decreased resistance to bacteria, and thus infection from *H. pylori* bacteria may occur.

ZES is suspected when a patient has several peptic ulcers or an ulcer that is resistant to standard medical therapy. It is identified by the following: hypersecretion of gastric juice, duodenal ulcers, and gastrinomas (islet cell tumors) in the pancreas. Ninety percent of tumors are found in the "gastric triangle," which encompasses the cystic and common bile ducts, the second and third portions of the duodenum, and the junction of the head and body of the pancreas. Approximately one third of gastrinomas are malignant. Diarrhea and steatorrhea (unabsorbed fat in the stool) may be evident. The patient may have coexisting parathyroid adenomas or hyperplasia and may therefore exhibit signs of hypercalcemia. The most common symptom is epigastric pain. *H. pylori* is not a risk factor for ZES (Sesler, 2007).

*Stress ulcer* is the term given to the acute mucosal ulceration of the duodenal or gastric area that occurs after physiologically stressful events, such as burns, shock, severe sepsis, and multiple organ traumas. These ulcers, which are clinically different from peptic ulcers, are most common in ventilator-dependent patients after trauma or surgery. Fiberoptic endoscopy within 24 hours of trauma or surgery reveals shallow erosions of the stomach wall; by 72 hours, multiple gastric erosions are observed. As the stressful condition continues, the ulcers spread. When the patient recovers, the lesions are reversed. This pattern is typical of stress ulceration.

Differences of opinion exist as to the actual cause of mucosal ulceration in stress ulcers. Usually, the ulceration is preceded by shock; this leads to decreased gastric mucosal blood flow and to reflux of duodenal contents into the stomach. In addition, large quantities of pepsin are released. The combination of ischemia, acid, and pepsin creates an ideal climate for ulceration (Sesler, 2007).

Stress ulcers should be distinguished from Cushing's ulcers and Curling's ulcers, two other types of gastric ulcers. Cushing's ulcers are common in patients with head injury and brain trauma. They may occur in the esophagus, stomach, or duodenum and are usually deeper and more penetrating than stress ulcers. Curling's ulcer is frequently observed about 72 hours after extensive burns and involves the antrum of the stomach or the duodenum.

## Clinical Manifestations

Symptoms of an ulcer may last for a few days, weeks, or months and may disappear only to reappear, often without an identifiable cause. Many people with ulcers have no symptoms, and perforation or hemorrhage may occur in 20% to 30% of patients who had no preceding manifestations.

As a rule, the patient with an ulcer complains of dull, gnawing pain or a burning sensation in the midepigastrium or the back. It is believed that the pain occurs when the increased acid content of the stomach and duodenum erodes the lesion and stimulates the exposed nerve endings. Another theory suggests that contact of the lesion with acid stimulates a local reflex mechanism that initiates contraction of the adjacent smooth muscle. Pain is usually relieved by eating, because food neutralizes the acid, or by taking alkali; however, once the stomach has emptied or the alkali's effect has decreased, the pain returns. Sharply localized tenderness can be elicited by applying gentle pressure to the epigastrium at or slightly to the right of the midline.

Other symptoms include **pyrosis** (heartburn), vomiting, constipation or diarrhea, and bleeding. Pyrosis is a burning sensation in the stomach and esophagus that moves up to the mouth. Heartburn is often accompanied by sour eructation, or burping, which is common when the patient's stomach is empty.

Although vomiting is rare in uncomplicated duodenal ulcer, it may be a symptom of a complication of an ulcer. It results from obstruction of the pyloric orifice, caused by either muscular spasm of the pylorus or mechanical obstruction from scarring or acute swelling of the inflamed mucous membrane adjacent to the ulcer. Vomiting may or may not be preceded by nausea; usually it follows a bout of severe pain and bloating, which is relieved by vomiting. Emesis often contains undigested food eaten many hours earlier. Constipation or diarrhea may occur, probably as a result of diet and medications.

Fifteen percent of patients with peptic ulcer experience bleeding. Patients may present with GI bleeding as evidenced by the passage of **melena** (tarry stools). A small portion of patients who bleed from an acute ulcer have only very mild symptoms or none at all (Barba, Fitzgerald & Wood, 2007).

## Assessment and Diagnostic Findings

A physical examination may reveal pain, epigastric tenderness, or abdominal distention. A barium study of the upper GI tract may show an ulcer; however, endoscopy is the preferred diagnostic procedure because it allows direct visualization of inflammatory changes, ulcers, and lesions. Through endoscopy, a biopsy of the gastric mucosa and of any suspicious lesions can be obtained. Endoscopy may reveal lesions that, because of their size or location, are not evident on x-ray studies.

Stools may be tested periodically until they are negative for occult blood. Gastric secretory studies are of value in diagnosing achlorhydria and ZES. *H. pylori* infection may be determined by endoscopy and histologic examination of a tissue specimen obtained by biopsy, or a rapid urease test of the biopsy specimen. Other less invasive diagnostic measures for detecting *H. pylori* include serologic testing for antibodies against the *H. pylori* antigen, stool antigen test, and urea breath test.

## Medical Management

Once the diagnosis is established, the patient is informed that the condition can be controlled. Recurrence may develop; however, peptic ulcers treated with antibiotics to eradicate *H. pylori* have a lower recurrence rate than those not treated with antibiotics. The goals are to eradicate *H. pylori* and to manage gastric acidity. Methods used include medications, lifestyle changes, and surgical intervention.

### Pharmacologic Therapy

Currently, the most commonly used therapy for peptic ulcers is a combination of antibiotics, proton pump inhibitors, and bismuth salts that suppress or eradicate *H. pylori*. Recommended therapy for 10 to 14 days includes triple therapy with two antibiotics (eg, metronidazole [Flagyl] or amoxicillin [Amoxil] and clarithromycin [Biaxin]) plus a proton pump inhibitor (eg, lansoprazole [Prevacid], omeprazole [Prilosec], or rabeprazole [Aciphex]), or quadruple therapy with two antibiotics (metronidazole and tetracycline) plus a proton pump inhibitor and bismuth salts (Pepto-Bismol). Research is being conducted to develop a vaccine against *H. pylori* (Kabir, 2007).

**Histamine-2 ($H_2$) receptor antagonists** and **proton pump inhibitors** are used to treat NSAID-induced ulcers and other ulcers not associated with *H. pylori* infection. Table 37-3 provides information about the medication regimens used for peptic ulcer disease. (Table 37-1 presents details about specific medications.)

The patient is advised to adhere to and complete the medication regimen to ensure complete healing of the ulcer. Because most patients become symptom-free within a week, the nurse stresses to the patient the importance of following the prescribed regimen so that the healing process can continue uninterrupted and the return of chronic ulcer symptoms can be prevented. Rest, sedatives, and tranquilizers may be added for the patient's comfort and are prescribed as needed. Maintenance dosages of $H_2$ receptor antagonists are usually recommended for 1 year.

For patients with ZES, hypersecretion of acid may be controlled with high doses of $H_2$ receptor antagonists. These patients may require twice the normal dose, and dosages usually need to be increased with prolonged use. Octreotide (Sandostatin), a medication that suppresses gastrin levels, also may be prescribed.

Patients at risk for stress ulcers (eg, patients with head injury or extensive burns) may be treated prophylactically with IV $H_2$ receptor antagonists and cytoprotective agents (eg, misoprostol, sucralfate) because of the risk of upper GI tract hemorrhage.

### Stress Reduction and Rest

Reducing environmental stress requires physical and psychological modifications on the patient's part as well as the aid and cooperation of family members and significant others. The nurse assists the patient to identify situations

**Table 37-3 DRUG REGIMENS FOR PEPTIC ULCER DISEASE**

| Indications | Drug Regimen | Comments |
|---|---|---|
| **Ulcer healing** | **$H_2$ receptor antagonists**<br>Ranitidine 150 mg bid or 300 mg at bedtime<br>Cimetidine 400 mg bid or 800 mg at bedtime<br>Famotidine 20 mg bid or 40 mg at bedtime<br>Nizatidine 150 mg bid or 300 mg at bedtime | Should be used for 6 weeks for duodenal ulcer; 8 weeks for gastric ulcer |
| | **Proton pump inhibitors (PPIs)**<br>Omeprazole 20 mg daily<br>Lansoprazole 30 mg daily<br>Rabeprazole 20 mg daily<br>Pantoprazole 40 mg daily<br>Esomeprazole 40 mg daily | Should be used for 4 weeks for duodenal ulcer and 6 weeks for gastric ulcer<br>Healing occurs in 90% of patients who are compliant with therapy |
| **Initial *H. pylori* therapy** | **First-line therapy:**<br>PPI twice a day plus clarithromycin 500 mg twice a day plus amoxicillin 1000 mg twice a day *or* metronidazole 500 mg twice a day for 10–14 days | Efficacy of therapy is approximately 85% |
| | **Second-line therapy:**<br>Pepto-Bismol 2 tabs four times a day plus tetracycline 250 mg four times a day plus metronidazole 250 mg four times a day (optional: add PPI daily) for 14 days | Qid dosing may decrease compliance |
| **Therapy for retreatment of *H. pylori* therapy failure** | Repeat first-line therapy, substitute metronidazole for amoxicillin (or vice versa) for 14 days; may add Pepto-Bismol<br>Add second-line *H. pylori* therapy | Efficacy of retreatment not known; success of more than 2 courses of treatment is very low |
| **Prophylactic therapy for NSAID ulcers** | Peptic ulcer healing doses of PPIs (above)<br>Misoprostol 200 μg twice a day | Prevents recurrent ulceration in approximately 80%–90% of patients |

NSAID, nonsteroidal anti-inflammatory drug.

that are stressful or exhausting. A hectic lifestyle and an irregular schedule may aggravate symptoms and interfere with regular meals taken in relaxed settings along with the regular administration of medications. The patient may benefit from regular rest periods during the day, at least during the acute phase of the disease. Biofeedback, hypnosis, behavior modification, massage, or acupuncture may be helpful.

### *Smoking Cessation*

Studies have shown that smoking decreases the secretion of bicarbonate from the pancreas into the duodenum, resulting in increased acidity of the duodenum. Research indicates that continued smoking may significantly inhibit ulcer repair (Suzuki, et al., 2006). Therefore, the patient is strongly encouraged to stop smoking.

### *Dietary Modification*

The intent of dietary modification for patients with peptic ulcers is to avoid oversecretion of acid and hypermotility in the GI tract. These can be minimized by avoiding extremes of temperature of food and beverage and overstimulation from consumption of meat extracts, alcohol, coffee (including decaffeinated coffee, which also stimulates acid secretion) and other caffeinated beverages, and diets rich in milk and cream (which stimulate acid secretion). In addition, an effort is made to neutralize acid by eating three regular meals a day. Small, frequent feedings are not necessary as long as an antacid or a histamine blocker is taken. Diet compatibility becomes an individual matter: The patient eats foods that are tolerated and avoids those that produce pain.

### *Surgical Management*

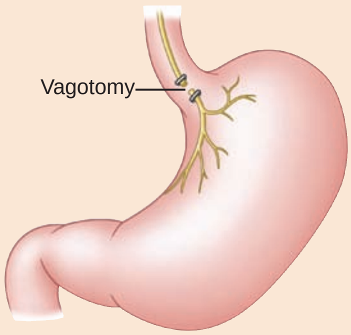
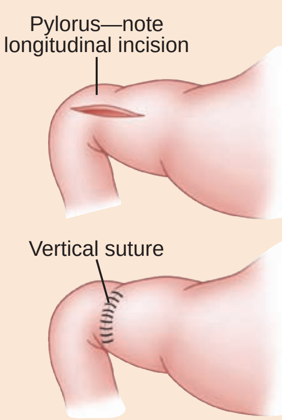
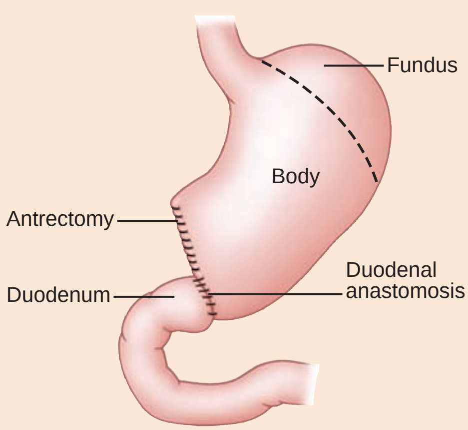
The introduction of antibiotics to eradicate *H. pylori* and of $H_2$ receptor antagonists as treatment for ulcers has greatly reduced the need for surgical intervention. However, surgery is usually recommended for patients with intractable ulcers (those that fail to heal after 12 to 16 weeks of medical treatment), life-threatening hemorrhage, perforation, or obstruction and for those with ZES that is unresponsive to medications (Ramakrishnan & Salinas, 2007). Surgical procedures include vagotomy, with or without **pyloroplasty** (transecting nerves that stimulate acid secretion and opening the pylorus), and **antrectomy**, which is removal of the pyloric (antrum) portion of the stomach with anastomosis (surgical connection) to either the duodenum (gastroduodenostomy or Billroth I) or jejunum (gastrojejunostomy or Billroth II) (Table 37-4; see also the section on gastric surgery later in this chapter).

Patients who require surgery may have had a long illness. They may be discouraged and have had interruptions in their work and pressures in their family life that affect their outlook on surgery and resolution of their disease.

### *Follow-Up Care*

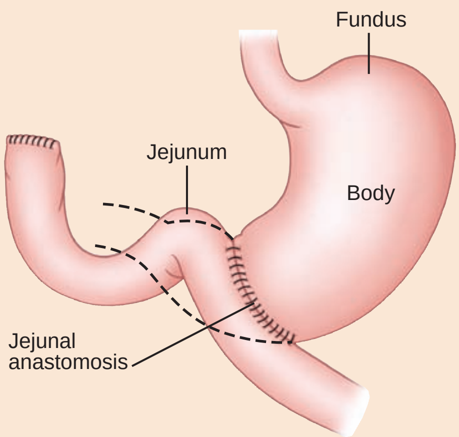
Recurrence of peptic ulcer disease within 1 year may be prevented with the prophylactic use of $H_2$ receptor antagonists taken at a reduced dose. Not all patients require maintenance therapy; it may be prescribed only for those with two or three recurrences per year, those who have had a complication such as bleeding or gastric outlet obstruction, or those who are candidates for gastric surgery but for whom it poses too high a risk. The likelihood of

**Table 37-4 SURGICAL PROCEDURES FOR PEPTIC ULCER DISEASE**

| Operation | Description | Comments |
|---|---|---|
| **Vagotomy**   | Severing of the vagus nerve. Decreases gastric acid by diminishing cholinergic stimulation to the parietal cells, making them less responsive to gastrin. May be performed via open surgical approach, laparoscopy, or thoracoscopy | May be performed to reduce gastric acid secretion. A drainage type of procedure (see pyloroplasty) is usually performed to assist with gastric emptying (because there is total denervation of the stomach). Some patients experience problems with feeling of fullness, dumping syndrome, diarrhea, and gastritis. |
| **Truncal vagotomy** | Severs the right and left vagus nerves as they enter the stomach at the distal part of the esophagus | This type of vagotomy is most commonly used to decrease acid secretions and reduce gastric and intestinal motility. Recurrence rate of ulcer is 10%–15%. |
| **Selective vagotomy** | Severs vagal innervation to the stomach but maintains innervation to the rest of the abdominal organs | |
| **Proximal (parietal cell) gastric vagotomy** without drainage | Denervates acid-secreting parietal cells but preserves vagal innervation to the gastric antrum and pylorus | No dumping syndrome. No need for drainage procedure. Recurrence rate of ulcer is 10%–15%. |
| **Pyloroplasty**   | Longitudinal incision is made into the pylorus and transversely sutured closed to enlarge the outlet and relax the muscle | Usually accompanies truncal and selective vagotomies, which produce delayed gastric emptying due to decreased innervation. |
| **Antrectomy** | | |
| **Billroth I** (gastroduodenostomy)   | Removal of the lower portion of the antrum of the stomach (which contains the cells that secrete gastrin) as well as a small portion of the duodenum and pylorus. The remaining segment is anastomosed to the duodenum | May be performed in conjunction with a truncal vagotomy. The patient may have problems with feeling of fullness, dumping syndrome, and diarrhea. Recurrence rate of ulcer is <1%. |

*Continued on following page*

**Table 37-4 SURGICAL PROCEDURES FOR PEPTIC ULCER DISEASE (Continued)**

| Operation | Description | Comments |
|---|---|---|
| **Billroth II** (gastrojejunostomy)   | Removal of lower portion (antrum) of stomach with anastomosis to jejunum. Dotted lines show portion removed (antrectomy). A duodenal stump remains and is oversewn. | Dumping syndrome, anemia, malabsorption, weight loss. Recurrence rate of ulcer is 10%–15%. |

recurrence is reduced if the patient avoids smoking, coffee (including decaffeinated coffee) and other caffeinated beverages, alcohol, and ulcerogenic medications (eg, NSAIDs).

# NURSING PROCESS

## The Patient With Peptic Ulcer Disease

### Assessment

The nurse asks the patient to describe the pain and strategies used to relieve it (eg, food, antacids). The patient usually describes peptic ulcer pain as burning or gnawing; it occurs about 2 hours after a meal and frequently awakens the patient between midnight and 3 AM. Taking antacids, eating, or vomiting often relieves the pain. If the patient reports a recent history of vomiting, the nurse determines how often emesis has occurred and notes important characteristics of the vomitus: Is it bright red, does it resemble coffee grounds, or is there undigested food from previous meals? Has the patient noted any bloody or tarry stools?

The nurse also asks the patient to list his or her usual food intake for a 72-hour period and to describe food habits (eg, speed of eating, regularity of meals, preference for spicy foods, use of seasonings, use of caffeinated beverages and decaffeinated coffee). Lifestyle and other habits are a concern as well. Does the patient use irritating substances? For example, does he or she smoke cigarettes? If yes, how many? Does the patient ingest alcohol? If yes, how much and how often? Are NSAIDs used? The nurse inquires about the patient's level of anxiety and his or her perception of current stressors. How does the patient express anger or cope with stressful situations? Is the patient experiencing occupational stress or problems within the family? Is there a family history of ulcer disease?

The nurse assesses the patient's vital signs and reports tachycardia and hypotension, which may indicate anemia from GI bleeding. The stool is tested for occult blood, and a physical examination, including palpation of the abdomen for localized tenderness, is performed.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's nursing diagnoses may include the following:

- Acute pain related to the effect of gastric acid secretion on damaged tissue
- Anxiety related to an acute illness
- Imbalanced nutrition related to changes in diet
- Deficient knowledge about prevention of symptoms and management of the condition

#### *Collaborative Problems/Potential Complications*

Potential complications may include the following:

- Hemorrhage
- Perforation
- Penetration
- Pyloric obstruction (gastric outlet obstruction)

### Planning and Goals

The goals for the patient may include relief of pain, reduced anxiety, maintenance of nutritional requirements, knowledge about the management and prevention of ulcer recurrence, and absence of complications.

### Nursing Interventions

#### *Relieving Pain*

Pain relief can be achieved with prescribed medications. The patient should avoid aspirin, foods and beverages that contain caffeine, and decaffeinated coffee. In addition, meals should be eaten at regularly paced intervals in a relaxed

setting. Some patients benefit from learning relaxation techniques to help manage stress and pain.

***Reducing Anxiety***

The nurse assesses the patient's level of anxiety. Patients with peptic ulcers are usually anxious, but their anxiety is not always obvious. Appropriate information is provided at the patient's level of understanding, all questions are answered, and the patient is encouraged to express fears openly. Explaining diagnostic tests and administering medications as scheduled also help reduce anxiety. The nurse interacts with the patient in a relaxed manner, helps identify stressors, and explains various coping techniques and relaxation methods, such as biofeedback, hypnosis, or behavior modification. The patient's family is also encouraged to participate in care and to provide emotional support.

***Maintaining Optimal Nutritional Status***

The nurse assesses the patient for malnutrition and weight loss. After recovery from an acute phase of peptic ulcer disease, the patient is advised about the importance of complying with the medication regimen and dietary restrictions.

***Monitoring and Managing Potential Complications***

**HEMORRHAGE.** Gastritis and hemorrhage from peptic ulcer are the two most common causes of upper GI tract bleeding (which may also occur with esophageal varices, as discussed in Chapter 39). Hemorrhage, the most common complication, occurs in 10% to 20% of patients with peptic ulcers. Bleeding may be manifested by hematemesis or melena (Ramakrishnan & Salinas, 2007). The vomited blood can be bright red, or it can have a dark "coffee grounds" appearance from the oxidation of hemoglobin to methemoglobin. When the hemorrhage is large (2000 to 3000 mL), most of the blood is vomited. Because large quantities of blood may be lost quickly, immediate correction of blood loss may be required to prevent hemorrhagic shock. When the hemorrhage is small, much or all of the blood is passed in the stools, which appear tarry black because of the digested hemoglobin. Management depends on the amount of blood lost and the rate of bleeding.

The nurse assesses the patient for faintness or dizziness and nausea, which may precede or accompany bleeding. It is important to monitor vital signs frequently and to evaluate the patient for tachycardia, hypotension, and tachypnea. Other nursing interventions include monitoring the hemoglobin and hematocrit, testing the stool for gross or occult blood, and recording hourly urinary output to detect anuria or oliguria (absence of or decreased urine production).

Many times the bleeding from a peptic ulcer stops spontaneously; however, the incidence of recurrent bleeding is high. Because bleeding can be fatal, the cause and severity of the hemorrhage must be identified quickly and the blood loss treated to prevent hemorrhagic shock. The nurse monitors the patient carefully so that bleeding can be detected quickly. If bleeding recurs within 48 hours after medical therapy has begun, or if more than 6 to 10 units of blood are required within 24 hours to maintain blood volume, the patient is likely to require surgery. Some physicians recommend surgical intervention if a patient hemorrhages three times. Other criteria for surgery are the patient's age (massive hemorrhaging is three times more likely to be fatal in those older than 60 years of age), a history of chronic duodenal ulcer, and a coincidental gastric ulcer. The area of the ulcer is removed or the bleeding vessels are ligated. Many patients also undergo procedures (eg, vagotomy and pyloroplasty, gastrectomy) aimed at controlling the underlying cause of the ulcers (see Table 37-4).

Other related nursing and collaborative interventions include the following:

- Inserting a peripheral IV line for the infusion of saline or lactated Ringer's solution and blood products. The nurse may need to assist with the placement of a central venous catheter for rapid infusion of large amounts of blood and fluids as well as hemodynamic monitoring. Blood component therapy is initiated if there are signs of shock (eg, tachycardia, sweating, coldness of the extremities).
- Inserting an NG tube to distinguish fresh blood from "coffee grounds" material, to aid in the removal of clots and acid, to prevent nausea and vomiting, and to provide a means of monitoring further bleeding
- Administering an NG lavage of saline solution. The temperature of the solution (cold or room temperature) is a topic of controversy (Yamada & Alpers, 2003).
- Inserting an indwelling urinary catheter and monitoring urinary output
- Monitoring oxygen saturation and administering oxygen therapy
- Placing the patient in the recumbent position with the legs elevated to prevent hypotension, or placing the patient on the left side to prevent aspiration from vomiting
- Treating hemorrhagic shock (described in Chapter 15)

If bleeding cannot be managed by the measures described, other treatment modalities such as endoscopy may be used to halt bleeding and avoid surgical intervention. There is debate regarding how soon endoscopy should be performed. Some clinicians believe endoscopy should be performed within the first 24 hours after hemorrhaging has ceased. Others believe endoscopy may be performed during acute bleeding, as long as the esophageal or gastric area can be visualized (blood may decrease visibility).

For patients who are unable to undergo surgery, selective embolization may be used. This procedure involves forcing emboli of autologous blood clots with or without Gelfoam (absorbable gelatin sponge) through a catheter in the artery to a point above the bleeding lesion. This procedure is performed by an interventional radiologist (Ramakrishnan & Salinas, 2007; Singh, Denyer & Patel, 2007).

**PERFORATION AND PENETRATION.** Perforation is the erosion of the ulcer through the gastric **serosa** into the peritoneal cavity without warning. It is an abdominal catastrophe and requires immediate surgery. Penetration is erosion of the ulcer through the gastric serosa into adjacent structures such as the pancreas, biliary tract, or gastrohepatic **omentum.** Symptoms of penetration include back and epigastric pain not relieved by medications that were effective in the past. Like perforation, penetration usually requires surgical intervention.

CHART 37-2 HOME CARE CHECKLIST
**The Patient With Peptic Ulcer Disease**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State the medication regimen and importance of complying with medication schedule. | ✔ | ✔ |
| • State dietary restrictions and foods that may exacerbate condition (caffeinated and decaffeinated products, milk). | ✔ | ✔ |
| • Identify smoking cessation groups. | ✔ | |
| • Identify methods to reduce stress. | ✔ | ✔ |
| • State signs and symptoms of complications: | ✔ | ✔ |
| Hemorrhage—cool skin, confusion, increased heart rate, labored breathing, blood in stool<br>Penetration and perforation—severe abdominal pain, rigid and tender abdomen, vomiting, elevated temperature, increased heart rate<br>Pyloric obstruction—nausea and vomiting, distended abdomen, abdominal pain | ✔ | ✔ |
| • State need for follow-up medical care. | ✔ | ✔ |

Signs and symptoms of perforation include the following:

- Sudden, severe upper abdominal pain (persisting and increasing in intensity); pain may be referred to the shoulders, especially the right shoulder, because of irritation of the phrenic nerve in the diaphragm
- Vomiting
- Collapse (fainting)
- Extremely tender and rigid (boardlike) abdomen
- Hypotension and tachycardia, indicating shock

Because chemical peritonitis develops within a few hours of perforation and is followed by bacterial peritonitis, the perforation must be closed as quickly as possible and the abdominal cavity lavaged of stomach or intestinal contents. In some patients, it may be safe and advisable to perform surgery to treat the ulcer disease in addition to suturing the perforation.

During surgery and postoperatively, the stomach contents are drained by means of an NG tube. The nurse monitors fluid and electrolyte balance and assesses the patient for localized infection or peritonitis (increased temperature, abdominal pain, paralytic ileus, increased or absent bowel sounds, abdominal distention). Antibiotic therapy is administered parenterally as prescribed.

PYLORIC OBSTRUCTION. Pyloric obstruction, also called **gastric outlet obstruction (GOO),** occurs when the area distal to the pyloric sphincter becomes scarred and stenosed from spasm or edema or from scar tissue that forms when an ulcer alternately heals and breaks down. The patient may have nausea and vomiting, constipation, epigastric fullness, anorexia, and, later, weight loss.

In treating the patient with pyloric obstruction, the first consideration is to insert an NG tube to decompress the stomach. Confirmation that obstruction is the cause of the discomfort is accomplished by assessing the amount of fluid aspirated from the NG tube. A residual of more than 400 mL strongly suggests obstruction. Usually an upper GI study or endoscopy is performed to confirm pyloric obstruction. Decompression of the stomach and management of extracellular fluid volume and electrolyte balances may improve the patient's condition and avert the need for surgical intervention. A balloon dilation of the pylorus via endoscopy may be beneficial. If the obstruction is unrelieved by medical management, surgery (in the form of a vagotomy and antrectomy or gastrojejunostomy and vagotomy) may be required.

### *Promoting Home and Community-Based Care*

TEACHING PATIENTS SELF-CARE. The nurse instructs the patient about the factors that relieve and those that aggravate the condition. The nurse reviews information about medications to be taken at home, including name, dosage, frequency, and possible side effects, stressing the importance of continuing to take medications even after signs and symptoms have decreased or subsided (Chart 37-2). The nurse instructs the patient to avoid certain medications and foods that exacerbate symptoms as well as substances that have acid-producing potential (eg, alcohol; caffeinated and decaffeinated beverages such as coffee, tea, and colas). It is important to counsel the patient to eat meals at regular times and in a relaxed setting and to avoid overeating. If relevant, the nurse also informs the patient about the irritant effects of smoking on the ulcer and provides information about smoking cessation programs.

*NURSING ALERT*

**The nurse reviews with the patient and family the signs and symptoms of complications to be reported. These complications include hemorrhage (cool skin, confusion, increased heart rate, labored breathing, and blood in the stool), penetration and perforation (severe abdominal pain, rigid and tender abdomen, vomiting, elevated temperature, and increased heart rate), and pyloric obstruction (nausea, vomiting, distended abdomen, and abdominal pain).**

CONTINUING CARE. The nurse reinforces the importance of follow-up care for approximately 1 year, the need to report recurrence of symptoms, and the need for treating possible problems that occur after surgery, such as intolerance to dairy products and sweet foods. The nurse also reminds the patient

and family of the importance of participating in health promotion activities and recommended health screening.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports freedom from pain between meals
2. Reports feeling less anxiety
3. Complies with therapeutic regimen
   a. Avoids irritating foods and beverages
   b. Eats regularly scheduled meals
   c. Takes medications as prescribed
   d. Uses coping mechanisms to deal with stress
4. Maintains weight
5. Exhibits no complications

# Morbid Obesity

**Morbid obesity** is a term applied to people who are more than two times their ideal body weight or whose body mass index (BMI) exceeds 40 kg/$m^2$ (see Chapter 5). Another definition of morbid obesity is body weight that is more than 100 pounds greater than the ideal body weight (Fabricatore & Wadden, 2006; Kushner, 2007). In the United States, where morbid obesity is a rapidly growing problem, approximately 65% of people are overweight (Brethauer, Chand & Schauer, 2006; Harrington, 2007).

Patients with morbid obesity are at higher risk for health complications, such as diabetes, heart disease, stroke, hypertension, gallbladder disease, osteoarthritis, sleep apnea and other breathing problems, and some forms of cancer (uterine, breast, colorectal, kidney, and gallbladder). They frequently suffer from low self-esteem, impaired body image, and depression.

## Medical Management

Conservative management of obesity consists of placing the person on a weight loss diet in conjunction with behavioral modification and exercise; however, dietary and behavioral approaches to obesity have had limited success. Depression may contribute to weight gain, and treatment of the depression with an antidepressant may be helpful (Barth & Jenson, 2006; Clayton, 2007; Kloiber, Ising & Reppermund, 2007).

### Pharmacologic Management

Several medications are approved for obesity. Sibutramine HCl (Meridia), which requires a prescription, decreases appetite by inhibiting the reuptake of serotonin and norepinephrine. It may increase blood pressure and should not be taken by people with a history of coronary artery disease, angina pectoris, dysrhythmias, or kidney disease; by those taking antidepressants or monoamine oxidase inhibitors; or by pregnant or nursing women. Other side effects of sibutramine include dry mouth, insomnia, headache, diaphoresis, and increased heart rate. Orlistat (Xenical), which is available both by prescription and over the counter as Alli, reduces caloric intake by binding to gastric and pancreatic lipase to prevent digestion of fats. Side effects of orlistat include increased frequency of bowel movements, gas with oily discharge, decreased food absorption, decreased bile flow, and decreased absorption of some vitamins. A multivitamin is usually recommended. Orlistat should not be taken by pregnant or nursing women or transplant recipients.

Rimonabant (Acomplia), the newest medication used to treat obesity, blocks the cannabinoid-1 receptor that is thought to play an important role in some aspects of human metabolism, including obesity. It stimulates weight reduction and improves cardiovascular disease risk factors in obese patients with metabolic syndrome. The most common side effects include depression, anxiety, agitation, and sleep disorders. Other mild, transient effects are nausea, vomiting, diarrhea, headache, and dizziness.

Unfortunately, these medications rarely result in loss of more than 10% of total body weight. Furthermore, studies are needed to evaluate their long-term efficacy and risks (Fabricatore & Wadden, 2006; Lean & Mullan, 2007; Bray & Ryan, 2007).

### Surgical Management

**Bariatric** surgery, or surgery for morbid obesity, is performed only after other nonsurgical attempts at weight control have failed. The National Institute of Diabetes and Digestive and Kidney Disease reports that the number of bariatric procedures has increased from approximately 13,000 per year in 1998 to more than 121,000 in 2004 (WIN, 2007). Bariatric surgical procedures work by restricting a patient's ability to eat (restrictive procedure), interfering with ingested nutrient absorption (malabsorptive procedures), or both. Different bariatric surgical procedures entail different lifestyle modifications, and patients must be well informed about the specific lifestyle changes, eating habits, and bowel habits that may result from a particular procedure. Studies have shown that the average weight loss after bariatric surgery in the majority of patients is approximately 61% of previous body weight; comorbid conditions such as diabetes mellitus, hypertension, and sleep apnea resolve; and dyslipidemia improves (Zingmond, McGory & Ko, 2005; Kini, Herron & Yanagisawa, 2007). Bariatric surgery has been extended to carefully selected adolescents because of its results in adults (Brethauer, et al., 2006; Van Sickle, 2007).

Patient selection is critical, and the preliminary process may necessitate months of counseling, education, and evaluation by a multidisciplinary team, including social workers, dietitians, a nurse counselor, a psychologist or psychiatrist, and a surgeon (Chart 37-3). Because bariatric surgery involves such a drastic change in the functioning of the digestive system, patients need counseling before and after the surgery. Guidelines have been developed to assist in the care of patients having bariatric surgery (AORN Bariatric Surgery Guideline, 2004). After bariatric surgery, all patients require lifelong monitoring of weight loss, comorbidities, metabolic and nutritional status, and dietary and activity behaviors because they are at risk for developing malnutrition or weight gain (Brethauer, et al., 2006; Tucker, Szomstein & Rosenthal, 2007). Women of childbearing age who have bariatric surgery are advised to use contraceptives for approximately 2 years after surgery to avoid pregnancy until their weight stabilizes.

### Chart 37-3 • *Selection Criteria for Bariatric Surgery*

Body mass index (BMI) ≥40 kg/m$^2$ with no comorbidities
BMI ≥35 kg/m$^2$ with obesity-associated comorbidity
>95th percentile of weight for age + severe comorbidity
Failure of previous nonsurgical attempts at weight loss, including nonprofessional programs
Expectation that patient will adhere to postoperative care, follow-up visits, and recommended medical management, including the use of dietary supplements

**Exclusions**

Reversible endocrine or other disorders that can cause obesity
Current drug or alcohol abuse
Uncontrolled, severe psychiatric illness
Lack of comprehension of risk, benefits, expected outcomes, alternatives, and lifestyle changes required with bariatric surgery

Adapted from Mechanick, J., Kushner, R. & Sugerman, H. (2008). AACE/TOS/ASMBS bariatric surgery guidelines. *Endocrine Practice, 14*(suppl. 1), 318–336.

### CHART 37-4 PATIENT EDUCATION *Dietary Guidelines for the Patient Who Has Had Bariatric Surgery*

- Eat three meals per day (containing protein and fiber).
- Include two protein snacks per day.
- Restrict total meal size to less than 1 cup.
- Eat slowly.
- Chew thoroughly.
- Eat only foods packed with nutrients (eg, peanut butter, cheese, chicken, fish, beans).
- Do not eat and drink at the same time.
- Drink plenty of water, from 90 minutes after each meal to 15 minutes before the next meal.
- Avoid liquid calories, such as alcoholic beverages, fruit drinks, and regular soda (cola).
- Walk for at least 30 minutes per day.

Tucker, O., Szomstein S. & Rosenthal, R. (2007). Nutritional consequences of weight-loss surgery. *Medical Clinics of North America, 91*(3), 499–514.

The first surgical procedure used to treat morbid obesity was jejunoileal bypass. This procedure, which resulted in significant complications, has been largely replaced by gastric restriction procedures. Roux-en-Y gastric bypass, gastric banding, vertical-banded gastroplasty, and biliopancreatic diversion with duodenal switch are the current procedures of choice. These procedures may be performed by laparoscopy or by an open surgical technique.

The Roux-en-Y gastric bypass is recommended for long-term weight loss. It is a combined restrictive and malabsorptive procedure. Gastric banding and vertical-banded gastroplasty are restrictive procedures, and biliopancreatic diversion with duodenal switch combines gastric restriction with intestinal malabsorption. See Figure 37-3A–D for additional details about these procedures. After weight loss, the patient may need surgical intervention for body contouring. This may include lipoplasty to remove fat deposits or a panniculectomy to remove excess abdominal skinfolds.

Bariatric surgical procedures have their own unique complications in addition to those associated with any major abdominal surgery. The most common complications are bleeding, blood clots, bowel obstruction, incisional or ventral hernias, and infection from a leak at the anastomosis. Prevention of complications is critical. Other postoperative problems that may occur include nausea, usually as a result of overfilling the stomach pouch or improper chewing; dumping syndrome associated with the consumption of simple sugars; and changes in bowel function, including diarrhea and constipation. Long-term complications related to nutritional deficiency may occur.

## Nursing Management

Nursing management focuses on care of the patient after surgery. General postoperative nursing care is similar to that for a patient recovering from a gastric resection, but with great attention given to the risks of complications associated with morbid obesity. Complications that may occur in the immediate postoperative period include peritonitis, stomal obstruction, stomal ulcers, atelectasis and pneumonia, thromboembolism, and metabolic imbalances resulting from prolonged vomiting and diarrhea or altered gastrointestinal function. After bowel sounds have returned and oral intake is resumed, six small feedings consisting of a total of 600 to 800 calories per day are provided, and fluids are encouraged to prevent dehydration.

The patient is usually discharged in 4 days (23 to 72 hours for patients who have had laparoscopic procedures) with detailed dietary instructions (Chart 37-4). The nurse instructs the patient to report excessive thirst or concentrated urine, both of which are indications of dehydration. Psychosocial interventions are also essential for these patients. Efforts are directed at helping them modify their eating behaviors and cope with changes in body image. The nurse explains that noncompliance by eating too much or too fast or eating high-calorie liquids and soft foods results in vomiting and painful esophageal distention. The nurse discusses dietary instructions and the need for physical activity before discharge. The nurse also emphasizes the importance of routine follow-up outpatient appointments to ensure medical management of any side effects, which may include increased risk of gallstones, nutritional and vitamin deficiencies, and potential to regain weight.

Patients who undergo laparoscopic or open Roux-en-Y procedures have one or more Jackson Pratt drains, which may remain in place after discharge. The nurse teaches the patient and family how to empty, measure, and record the amount of drainage.

# Gastric Cancer

Although the incidence of gastric or stomach cancer continues to decrease in the United States, it still accounts for more than 11,000 deaths annually (American Cancer

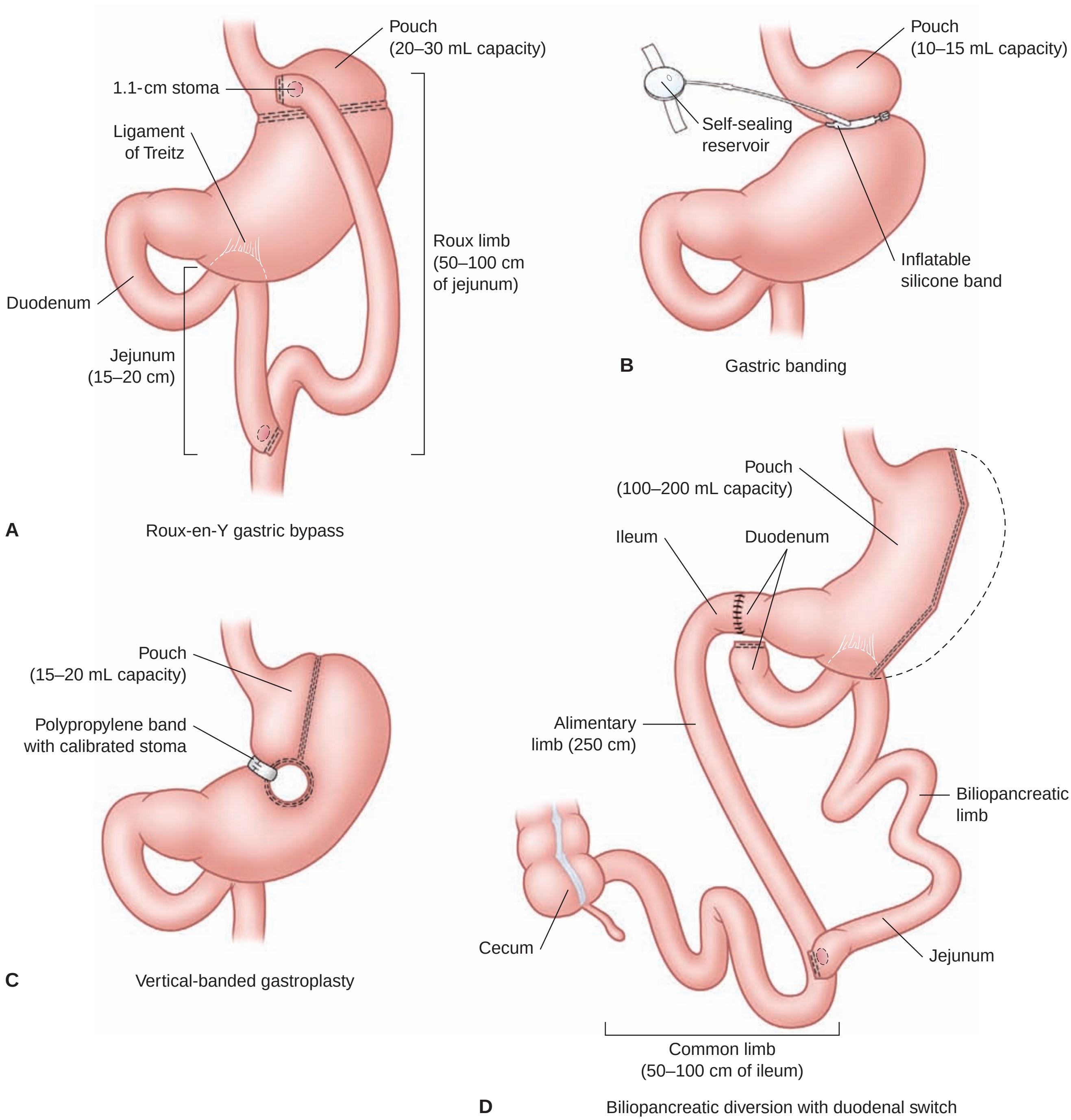



**Figure 37-3** Surgical procedures for morbid obesity. **A,** Roux-en-Y gastric bypass. A horizontal row of staples across the fundus of the stomach creates a pouch with a capacity of 20 to 30 mL. The jejunum is divided distal to the ligament of Treitz and the distal end is anastomosed to the new pouch. The proximal segment is anastomosed to the jejunum. **B,** Gastric banding. A prosthetic device is used to restrict oral intake by creating a small pouch of 10 to 15 mL that empties through the narrow outlet into the remainder of the stomach. **C,** Vertical-banded gastroplasty. A vertical row of staples along the lesser curvature of the stomach creates a new, smaller stomach pouch of 10 to 15 mL. **D,** Biliopancreatic diversion with duodenal switch. Half of the stomach is removed, leaving a small area that holds about 60 mL. The entire jejunum is excluded from the rest of the gastrointestinal tract. The duodenum is disconnected and sealed off. The ileum is divided above the ileocecal junction and the distal end of the jejunum is anastomosed to the first portion of the duodenum. The distal end of the biliopancreatic limb is anastomosed to the ileum.

Society, 2009). The typical patient with gastric cancer is between 40 and 70 years of age, but gastric cancer can occur in people younger than 40 years of age. Men have a higher incidence of gastric cancer than women. Native Americans, Hispanic Americans, and African Americans are twice as likely as Caucasian Americans to develop gastric cancer. The incidence of gastric cancer is much greater in Japan, which has instituted mass screening programs for earlier diagnosis. Diet appears to be a significant factor: A diet high in smoked, salted, or pickled foods and low in fruits and vegetables may increase the risk of gastric cancer. Other factors related to the incidence of gastric cancer include chronic inflammation of the stomach, *H. pylori* infection, pernicious anemia, smoking, achlorhydria, gastric ulcers, previous subtotal gastrectomy (more than 20 years ago), and genetics. The prognosis is generally poor; the diagnosis is usually made late because most patients are asymptomatic during the early stages of the disease. Most cases of gastric cancer are discovered only after local invasion has advanced or metastases are present (Lim, Yum, Kim, et al., 2006).

## Pathophysiology

Most gastric cancers are adenocarcinomas; they can occur anywhere in the stomach. The tumor infiltrates the surrounding mucosa, penetrating the wall of the stomach and adjacent organs and structures. The liver, pancreas, esophagus, and duodenum are often already affected at the time of diagnosis. Metastasis through lymph to the peritoneal cavity occurs later in the disease.

## Clinical Manifestations

Symptoms of early disease, such as pain relieved by antacids, resemble those of benign ulcers and are seldom definitive, because most gastric tumors begin on the lesser curvature of the stomach, where they cause little disturbance of gastric function. Symptoms of progressive disease include dyspepsia (indigestion), early satiety, weight loss, abdominal pain just above the umbilicus, loss or decrease in appetite, bloating after meals, nausea and vomiting, and symptoms similar to those of peptic ulcer disease.

## Assessment and Diagnostic Findings

The physical examination is usually not helpful in detecting the cancer because most early gastric tumors are not palpable. Advanced gastric cancer may be palpable as a mass. Ascites and hepatomegaly (enlarged liver) may be apparent if the cancer cells have metastasized to the liver. Palpable nodules around the umbilicus, called Sister Mary Joseph's nodules, are a sign of a GI malignancy, usually a gastric cancer. Esophagogastroduodenoscopy for biopsy and cytologic washings is the diagnostic study of choice, and a barium x-ray examination of the upper GI tract may also be performed. Endoscopic ultrasound is an important tool to assess tumor depth and any lymph node involvement. Computed tomography (CT) completes the diagnostic studies, particularly to assess for surgical resectability of the tumor before surgery is scheduled. CT of the chest, abdomen, and pelvis is valuable in staging gastric cancer.

## Medical Management

There is no successful treatment for gastric carcinoma except removal of the tumor. If the tumor can be removed while it is still localized to the stomach, the patient may be cured. If the tumor has spread beyond the area that can be excised, cure is less likely. In many patients, effective palliation to prevent discomfort caused by obstruction or dysphagia may be obtained by resection of the tumor (see Gastric Surgery). A diagnostic laparoscopy may be the initial surgical approach to evaluate the gastric tumor, obtain tissue for pathologic diagnosis, and detect metastasis. The patient with a tumor that is deemed resectable undergoes an open surgical procedure to resect the tumor and appropriate lymph nodes. The patient with an unresectable tumor and advanced disease undergoes chemotherapy.

A total gastrectomy may be performed for a resectable cancer in the midportion or body of the stomach. The entire stomach is removed along with the duodenum, the lower portion of the esophagus, supporting mesentery, and lymph nodes. Reconstruction of the GI tract is performed by anastomosing the end of the jejunum to the end of the esophagus, a procedure called an esophagojejunostomy. A radical subtotal gastrectomy is performed for a resectable tumor in the middle and distal portions of the stomach. A Billroth I or a Billroth II operation (see Table 37-4) is performed. The Billroth I involves a limited resection and offers a lower cure rate than the Billroth II. The Billroth II procedure is a wider resection that involves removing approximately 75% of the stomach and decreases the possibility of lymph node spread or metastatic recurrence. A proximal subtotal gastrectomy may be performed for a resectable tumor located in the proximal portion of the stomach or cardia. A total gastrectomy or an esophagogastrectomy is usually performed in place of this procedure to achieve a more extensive resection.

Common problems of advanced gastric cancer that often require surgery include pyloric obstruction, bleeding, and severe pain. Gastric perforation is an emergency situation requiring surgical intervention. A gastric resection may be the most effective palliative procedure for advanced gastric cancer. Palliative procedures such as gastric or esophageal bypass, gastrostomy, or jejunostomy may temporarily alleviate symptoms such as nausea and vomiting. Palliative rather than radical surgery may be performed if there is metastasis to other vital organs, such as the liver, or to achieve a better quality of life.

If surgical treatment does not offer cure, treatment with chemotherapy may offer further control of the disease or palliation. Commonly used single-agent chemotherapeutic medications include 5-fluorouracil (5-FU), cisplatin (Platinol), doxorubicin (Adriamycin), etoposide (Etopophos), and mitomycin-C (Mutamycin). For improved response rates it is more common to administer combination therapy, primarily 5-FU–based therapy, with other agents. Studies are being conducted to assess the use of chemotherapy before surgery. Radiation therapy is mainly used for palliation in patients with obstruction, GI bleeding secondary to tumor, and significant pain. Assessment of tumor markers (blood analysis for antigens indicative of cancer) such as carcinoembryonic antigen (CEA), carbohydrate antigen (CA 19-9), and CA 50 may help determine the effectiveness of treatment. If

these values were elevated before treatment, they should decrease if the tumor is responding to the treatment (Gao, Zhang, Du, et al., 2007).

## Gerontologic Considerations

Despite the decreased incidence of gastric cancer, the number of older patients (75 years of age and older) with gastric cancer is increasing (Orsenigo, Tomajer, Di Palo, et al., 2007). Sixty percent of cancer-related deaths occur in people 65 years of age and older (Jansen, Weert, Dulmen, et al., 2007). Confusion, agitation, and restlessness may be the only symptoms seen in elderly patients, who may have no gastric symptoms until their tumors are well advanced. At this time, they present with reduced functional ability and other signs and symptoms of malignancy.

Surgery is more hazardous for the elderly, and the risk increases with age. Gastric cancer should be treated with traditional surgery in older patients; the survival rate does not differ significantly from that of younger patients (Gasparini, Inelmen, Enzi, et al., 2006). Patient education is important to prepare older patients with cancer for treatment, to help them manage adverse effects, and to face the challenges that cancer and aging present.

## NURSING PROCESS

### The Patient With Gastric Cancer

#### Assessment

The nurse obtains a dietary history from the patient, focusing on recent nutritional intake and status. Has the patient lost weight? If so, how much and over what period of time? Can the patient tolerate a full diet? If not, what foods can he or she eat? What other changes in eating habits have occurred? Does the patient have an appetite? Does the patient feel full after eating a small amount of food? Is the patient in pain? Do foods, antacids, or medications relieve the pain, make no difference, or worsen the pain? Is there a history of infection with *H. pylori?* Other health information to obtain includes the patient's smoking and alcohol history and family history (eg, any first- or second-degree relatives with gastric or other cancer). A psychosocial assessment, including questions about social support, individual and family coping skills, and financial resources, helps the nurse plan for care in acute and community settings.

After the interview, the nurse performs a complete physical examination, carefully assesses the patient's abdomen for tenderness or masses, and palpates and percusses the abdomen to detect ascites.

#### Nursing Diagnosis

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Anxiety related to the disease and anticipated treatment
- Imbalanced nutrition, less than body requirements, related to early satiety or anorexia
- Pain related to tumor mass
- Anticipatory grieving related to the diagnosis of cancer
- Deficient knowledge regarding self-care activities

#### Planning and Goals

The major goals for the patient may include reduced anxiety, optimal nutrition, relief of pain, and adjustment to the diagnosis and anticipated lifestyle changes.

#### Nursing Interventions

##### *Reducing Anxiety*

A relaxed, nonthreatening atmosphere is provided so the patient can express fears, concerns, and possibly anger about the diagnosis and prognosis. The nurse encourages the family or significant other to support the patient, offering reassurance and supporting positive coping measures. The nurse advises the patient about any procedures and treatments so that the patient knows what to expect.

##### *Promoting Optimal Nutrition*

The nurse encourages the patient to eat small, frequent portions of nonirritating foods to decrease gastric irritation. Food supplements should be high in calories, as well as vitamins A and C and iron, to enhance tissue repair. If the patient is unable to eat adequately prior to surgery to meet nutritional requirements, parenteral nutrition may be necessary. Because the patient may develop dumping syndrome when enteral feeding resumes after gastric resection, the nurse explains ways to prevent and manage it (six small feedings daily that are low in carbohydrates and sugar; fluids between meals rather than with meals) and informs the patient that symptoms often resolve after several months. If a total gastrectomy is performed, injection of vitamin $B_{12}$ will be required for life, because dietary vitamin $B_{12}$ is absorbed in the stomach. The nurse monitors the IV therapy and nutritional status and records intake, output, and daily weights to ensure that the patient is maintaining or gaining weight. The nurse assesses for signs of dehydration (thirst, dry mucous membranes, poor skin turgor, tachycardia, decreased urine output) and reviews the results of daily laboratory studies to note any metabolic abnormalities (sodium, potassium, glucose, blood urea nitrogen). Antiemetics are administered as prescribed.

##### *Relieving Pain*

The nurse administers analgesic agents as prescribed. A continuous IV infusion of an opioid may be necessary for postoperative or severe pain. The nurse routinely assesses the frequency, intensity, and duration of the pain to determine the effectiveness of the analgesic agent. The nurse works with the patient to help manage pain by suggesting nonpharmacologic methods for pain relief, such as position changes, imagery, distraction, relaxation exercises (using relaxation audiotapes), back rubs, massage, and periods of rest and relaxation.

##### *Providing Psychosocial Support*

The nurse helps the patient express fears, concerns, and grief about the diagnosis. It is important to answer the patient's questions honestly and to encourage the patient to participate in treatment decisions. Some patients mourn the loss of a body part and perceive their surgery as a type of mutilation. Some express disbelief and need time and support to accept the diagnosis.

CHART 37-5 HOME CARE CHECKLIST
**The Patient With Gastric Cancer**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate safe management of enteral or parenteral feedings, if applicable. | ✔ | ✔ |
| • Describe dietary restrictions. | ✔ | ✔ |
| • Identify potential side effects of chemotherapy or radiation therapy, if applicable. | ✔ | ✔ |
| • Identify signs and symptoms of wound infection. | ✔ | ✔ |
| • State signs and symptoms of obstruction or perforation. | ✔ | ✔ |
| • Describe follow-up needs. | ✔ | ✔ |
| • Make decisions about end-of-life care as appropriate. | ✔ | ✔ |

The nurse offers emotional support and involves family members and significant others whenever possible. This includes recognizing mood swings and defense mechanisms (eg, denial, rationalization, displacement, regression) and reassuring the patient, family members, and significant others that emotional responses are normal and expected. The services of clergy, psychiatric clinical nurse specialists, psychologists, social workers, and psychiatrists are made available, if needed. The nurse projects an empathetic attitude and spends time with the patient. Many patients may begin to participate in self-care activities after they have acknowledged their loss.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Self-care activities depend on the type of treatments used—surgery, chemotherapy, radiation, or palliative care. Patient and family teaching include information about diet and nutrition, treatment regimens, activity and lifestyle changes, pain management, and possible complications (Chart 37-5). Consultation with a dietitian is essential to determine how the patient's nutritional needs can best be met at home. The nurse teaches the patient or caregiver about administration of enteral or parenteral nutrition. If chemotherapy or radiation is prescribed, the nurse provides explanations to the patient and family about what to expect, including the length of treatments, the expected side effects (eg, nausea, vomiting, anorexia, fatigue, neutropenia), and the need for transportation to appointments for treatment. Psychological counseling may also be helpful.

**CONTINUING CARE.** The need for ongoing care in the home depends on the patient's condition and treatment. The home care nurse reinforces nutritional counseling and supervises the administration of any enteral or parenteral feedings; the patient or caregiver must become skillful in administering the feedings and in detecting and preventing untoward effects or complications related to the feedings (see Chapter 36 to review management of enteral and parenteral feedings). The nurse teaches the patient or caregiver to record the patient's daily intake, output, and weight and explains strategies to manage pain, nausea, vomiting, or other symptoms. The nurse also teaches the patient or caregiver to recognize and report signs and symptoms of complications that require immediate attention, such as bleeding, obstruction, perforation, or any symptoms that become progressively worse. It is important to explain the chemotherapy or radiation therapy regimen. The patient and family or significant other need to understand the care that will be needed during and after treatments (see Chapter 16). Because the prognosis for gastric cancer is poor, the nurse may need to assist the patient, family, or significant other with decisions regarding end-of-life care and make referrals as warranted.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports less anxiety
   a. Expresses fears and concerns about surgery
   b. Seeks emotional support
2. Attains optimal nutrition
   a. Eats small, frequent meals high in calories, iron, and vitamins A and C
   b. Complies with enteral or parenteral nutrition as needed
3. Has decreased pain
4. Performs self-care activities and adjusts to lifestyle changes
   a. Resumes normal activities within 3 months
   b. Alternates periods of rest and activity
   c. Manages enteral feedings
5. Prepares for the dying process
   a. Acknowledges disease process
   b. Reports control of symptoms
   c. Verbalizes fears and concerns about dying; involves family/caregiver in discussions
   d. Completes advance directives, and other appropriate documents

## Gastric Surgery

Gastric surgery may be performed on patients with peptic ulcers who have life-threatening hemorrhage, obstruction, perforation, or penetration or whose condition does not respond to medication. It also may be indicated for patients with gastric cancer or trauma. Surgical procedures include a

vagotomy and pyloroplasty, a partial gastrectomy, or a total gastrectomy (see Table 37-4).

## Nursing Management

Before surgery, the nurse assesses the patient's and family's knowledge of preoperative and postoperative surgical routines and the rationale for surgery. The nurse also assesses the patient's nutritional status: Has the patient lost weight? How much? Over how much time? Does the patient have nausea and vomiting? Has the patient had hematemesis? The nurse assesses for the presence of bowel sounds and palpates the abdomen to detect masses or tenderness.

After surgery, the nurse assesses the patient for complications secondary to the surgical intervention, such as hemorrhage, infection, abdominal distention, atelectasis, or impaired nutritional status (see Chapter 20).

In addition to the complications to which all postoperative patients are subject, the patient undergoing gastric surgery is at increased risk for:

- Hemorrhage
- Dietary deficiencies
- Bile reflux
- Dumping Syndrome

### Reducing Anxiety

An important part of the preoperative nursing care involves allaying the patient's fears and anxieties about the impending surgery and its implications. The nurse encourages the patient to verbalize fears and concerns and answers the patient's and family's questions. If the patient has an acute obstruction, a perforated bowel, or an active GI hemorrhage, adequate psychological preparation may not be possible. In this event, the nurse caring for the patient after surgery should anticipate the concerns, fears, and questions that are likely to surface and should be available for support and further explanations.

### Relieving Pain

After surgery, analgesic agents may be administered as prescribed to relieve pain and discomfort. It is important to provide adequate pain relief so the patient can perform pulmonary care activities (deep breathing and coughing) and leg exercises, turn from side to side, and ambulate. The nurse assesses the effectiveness of analgesic intervention and consults with other members of the health care team if pain is not adequately controlled. Positioning the patient in Fowler's position promotes comfort and allows emptying of the stomach after gastric surgery.

The nurse maintains functioning of the NG tube to prevent distention and secures the tube to prevent dislocation, which may result in increased pain and tension on the suture line. Normally, the amount of NG drainage after a total gastrectomy is minimal, because there is no reservoir where secretions can collect.

### Increasing Knowledge

The nurse explains routine preoperative and postoperative procedures to the patient, which include preoperative medications, NG intubation, IV fluids, abdominal dressings, the possible need for a feeding tube, pain management, and pulmonary care. These explanations need to be reinforced after surgery, especially if the patient had emergency surgery.

### Resuming Enteral Intake

The patient's nutritional status is evaluated before surgery. If surgery is performed for gastric cancer, the patient is often malnourished and may require preoperative enteral or, more often, parenteral nutrition (see Chapter 36). After surgery, parenteral nutrition may be continued to meet caloric needs, to replace fluids lost through drainage and vomiting, and to support the patient metabolically until oral intake is adequate.

After the return of bowel sounds and removal of the NG tube, the nurse may give fluids, followed by food in small portions. Foods are gradually added until the patient is able to eat six small meals a day and drink 120 mL of fluid between meals. The key to increasing the dietary content is to offer food and fluids gradually as tolerated and to recognize that each patient's tolerance is different.

### Recognizing Obstacles to Adequate Nutrition

#### Dysphagia and Gastric Retention

Dysphagia may occur in patients who have had a truncal vagotomy, a surgical procedure that may result in trauma to the lower esophagus. Gastric retention may be evidenced by abdominal distention, nausea, and vomiting. Regurgitation may also occur if the patient has eaten too much or too quickly. It also may indicate that edema along the suture line is preventing fluids and food from moving into the intestinal tract. If gastric retention occurs, it may be necessary to reinstate NPO (nothing by mouth) status and NG suction; pressure must be low in the remaining portion of the stomach to avoid disrupting the sutures.

#### Bile Reflux

Bile reflux gastritis and esophagitis may occur with the removal of the pylorus, which acts as a barrier to the reflux of duodenal contents. Burning epigastric pain and vomiting of bilious material manifest this condition. Eating or vomiting does not relieve the situation. Agents that bind with bile acid, such as cholestyramine (Questran), may be helpful. Aluminum hydroxide gel (an antacid) and metoclopramide hydrochloride (Reglan) have been used with limited success.

#### Dumping Syndrome

**Dumping syndrome** is an unpleasant set of vasomotor and GI symptoms that sometimes occur in patients who have had gastric surgery or a form of vagotomy. It may be the mechanical result of surgery in which a small gastric remnant is connected to the jejunum through a large opening. Foods high in carbohydrates and electrolytes must be diluted in the jejunum before absorption can take place, but the passage of food from the stomach remnant into the jejunum is too rapid to allow this to happen. The hypertonic intestinal contents draw extracellular fluid from the circulating blood volume into the jejunum to dilute the high concentration of electrolytes and sugars. The ingestion of

fluid at mealtime also causes the stomach contents to empty rapidly into the jejunum (Pedrazzani, Marrelli, Rampone, et al., 2007).

Early symptoms include a sensation of fullness, weakness, faintness, dizziness, palpitations, diaphoresis, cramping pains, and diarrhea. These symptoms resolve once the intestine has been evacuated. Later, there is a rapid elevation of blood glucose, followed by increased insulin secretion. This results in a reactive hypoglycemia, which also is unpleasant for the patient. Vasomotor symptoms that occur 10 to 90 minutes after eating are pallor, perspiration, palpitations, headache, and feelings of warmth, dizziness, and even drowsiness. Anorexia may also be a result of the dumping syndrome, because the person may be reluctant to eat.

Steatorrhea also may occur in the patient with gastric surgery. It is partially the result of rapid gastric emptying, which prevents adequate mixing with pancreatic and biliary secretions. In mild cases, reducing the intake of fat and administering an antimotility medication (eg, loperamide [Imodium]) may control steatorrhea.

#### Vitamin and Mineral Deficiencies

Other dietary deficiencies that the nurse should be aware of include malabsorption of organic iron, which may require supplementation with oral or parenteral iron, and a low serum level of vitamin $B_{12}$, which may require supplementation by the intramuscular route. Total gastrectomy results in lack of intrinsic factor, a gastric secretion required for the absorption of vitamin $B_{12}$ from the GI tract. Unless this vitamin is supplied by parenteral injection after gastrectomy, the patient inevitably suffers vitamin $B_{12}$ deficiency, which eventually leads to a condition identical to pernicious anemia. All manifestations of pernicious anemia, including macrocytic anemia and combined system disease (neurologic disorders of the central and peripheral nervous systems), may be expected to develop within a period of 5 years or less; they progress in severity thereafter and, in the absence of therapy, are fatal. This complication is avoided by the regular monthly intramuscular injection of vitamin $B_{12}$. This regimen should be started without delay after gastrectomy. Weight loss is a common long-term problem because the patient experiences early fullness, which suppresses the appetite.

### *Teaching Dietary Self-Management*

Because the patient may experience any of the described conditions affecting nutrition, nursing intervention includes proper dietary instruction. The following teaching points are emphasized:

- To delay stomach emptying and dumping syndrome, the patient should assume a low Fowler's position during mealtime and then remain in that position for 20 to 30 minutes.
- Antispasmodics, as prescribed, also may aid in delaying the emptying of the stomach.
- Fluid intake with meals is discouraged; instead, fluids may be consumed up to 1 hour before or 1 hour after mealtime.
- Meals should contain more dry items than liquid items.
- The patient can eat fat as tolerated but should keep carbohydrate intake low and avoid concentrated sources of carbohydrates.
- The patient should eat smaller but more frequent meals.
- Dietary supplements of vitamins and medium-chain triglycerides and injections of vitamin $B_{12}$ and iron may be prescribed.

The nurse also gives instructions regarding enteral or parenteral supplementation if it is needed.

### *Monitoring and Managing Potential Complications*

Occasionally hemorrhage complicates gastric surgery. The patient has the usual signs of rapid blood loss and shock (see Chapter 15) and may vomit considerable amounts of bright-red blood. The nurse assesses NG drainage for type and amount; some bloody drainage for the first 12 hours is expected, but excessive bleeding should be reported. The nurse also assesses the abdominal dressing for bleeding. Because this situation is upsetting to the patient and family, the nurse should remain calm. The nurse performs emergency measures, such as NG lavage and administration of blood and blood products, along with vigilant hemodynamic monitoring.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Patient teaching is based on the assessment of the patient's physical and psychological readiness to participate in self-care. The nurse provides information about nutrition, enteral or parenteral nutrition if required, nutritional supplements, pain management, and the symptoms of dumping syndrome and measures to prevent or minimize these symptoms (Chart 37-6). It is important to emphasize the continued need for vitamin $B_{12}$ injections.

#### Continuing Care

The patient and caregivers benefit from a team approach to discharge planning. The team members include the patient and caregiver along with the nurse, physician, dietitian, and social worker. Written or video instructions about meals, activities, medications, and follow-up care are helpful. After the patient is discharged from the hospital, the home care nurse helps with the transition to home by supervising the administration of any enteral or parenteral feedings and emphasizing information about detection and prevention of untoward effects or complications related to feedings. Information about community support groups and end-of-life care is provided to the patient, family, or significant other when indicated. See the Nursing Research Profile for further discussion of discharge planning (Chart 37-7).

## Duodenal Tumors

Tumors of the duodenum are uncommon and are usually benign and asymptomatic. They are most often discovered at autopsy. Malignant tumors are more likely to cause specific signs and symptoms leading to diagnosis. Unfortunately, malignant tumors are often not discovered until they

CHART 37-6

HOME CARE CHECKLIST

### The Patient Undergoing Gastric Surgery

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate enteral or parenteral feedings as applicable. | ✔ | ✔ |
| • State necessary dietary changes. | ✔ | ✔ |
| • Use nutritional supplements as appropriate. | ✔ | |
| • Relieve pain with pharmacologic or nonpharmacologic interventions. | ✔ | ✔ |
| • Identify available support groups. | ✔ | ✔ |
| • Explain medication regimen. | ✔ | ✔ |
| • Identify the need for continued vitamin $B_{12}$ injections. | ✔ | ✔ |
| • Identify signs and symptoms of complications. | ✔ | ✔ |
| • State schedule of follow-up appointments. | ✔ | ✔ |

have metastasized to distant sites. Benign tumors may place patients at an increased risk for malignancy. The relative rarity of tumors of the duodenum and the nonspecific nature of their manifestations complicate their diagnosis and treatment.

## Clinical Manifestations

Duodenal tumors often present insidiously with vague, nonspecific symptoms. Most benign tumors are discovered incidentally on an x-ray study, during surgery, or at autopsy. When the patient is symptomatic, benign tumors often present with intermittent pain. The next most common presentation is occult bleeding. Malignant tumors often result in symptoms that lead to their diagnosis, although these symptoms may reflect advanced disease. Most patients have sustained weight loss and are malnourished at diagnosis. Bleeding and pain are common. Perforation of the bowel occurs in approximately 10% of patients (Ramakrishnan & Salinas, 2007; Kostakou, Khaldi, Flossos, et al., 2007).

CHART 37-7

NURSING RESEARCH PROFILE

### Discharge Planning to Facilitate Decision Making

McMurray, A., Johnson, P., Wallis, M., et al. (2007). General surgical patients' perspectives of the adequacy and appropriateness of discharge planning to facilitate health decision-making at home. *Journal of Clinical Nursing, 16*(9), 1602–1609.

#### Purpose

The purpose of this study was to investigate how general surgery patients viewed their discharge planning in terms of adequacy and appropriateness. In an attempt to identify ways in which postsurgical patients could manage their care after discharge and promote continuity of care from hospital to home, the researchers hoped to gain insight about any aspects of discharge planning that could be improved.

#### Design

The researchers designed a qualitative, interpretive study that involved patient interviews at least 1 week after discharge from the hospital. They used purposive sampling to select 13 general surgical patients to be interviewed from one of three hospitals. The sample included six men and seven women who underwent the following procedures: spinal surgery, neurosurgery, cholecystectomy, bowel surgery, hernia repair, partial mastectomy, and prostate surgery. Researchers conducted unstructured interviews using questions they developed. They audiotaped the interviews and had them transcribed. Individual team members analyzed the transcripts using thematic analysis techniques. All members of the research team then analyzed the preliminary themes collectively in an attempt to reach a consensus about the patients' perspectives.

#### Results

Analysis of the data revealed four major themes: (1) information was provided in a "one-size-fits-all" manner, (2) advice provided by different health care professionals was often inconsistent or variable, (3) there was a lack of assessment of home and/or work conditions, and (4) there was a lack of follow-up to determine if patients had questions or needs that were not being met. The study participants reported that explanations given to them were often detailed but not tailored to their individual needs. Much of the information that they received was too general to be helpful. All of the subjects reported that a follow-up telephone call after discharge would have been appreciated.

#### Nursing Implications

It is important to recognize the discharge needs of individual patients. Discharge planning should include appropriate discharge assessment that focuses on the needs identified by the patient, specifically the needs of the patient within the home and the work environment. Information provided to patients should be specifically tailored to each patient's individual needs, and the various members of the health care team should provide the same discharge information. The best way to achieve this is to have a written plan that is distributed to the various members of the team. A follow-up telephone call to allow patients to ask questions and communicate their needs is particularly important to many patients.

## Assessment and Diagnostic Findings

An upper GI x-ray series with small bowel follow-through using oral water-insoluble contrast with frequent and detailed x-rays to follow the contrast through the small bowel is the traditional approach to diagnosis. A more sensitive examination is an **enteroclysis,** in which a nasogastric tube is advanced into the small bowel to a position above the area in question; the area is then studied by single-contrast and double-contrast techniques. Abdominal CT is used to determine the extent of disease outside the lumen of the duodenum.

## Management

Benign tumors of the duodenum include adenomas, lipomas, hemangiomas, and hamartomas (a focal malformation that resembles a neoplasm, but unlike a neoplasm does not result in compression of adjacent tissue). These tumors may be treated endoscopically by excision/resection or electrocautery if the patient is symptomatic. Routine monitoring is recommended to assess for malignant transformation.

The most common primary malignant tumor of the duodenum is adenocarcinoma; the second and third portions of the duodenum are most often involved. These tumors may present with bleeding or duodenal obstruction. If the tumor is located at the ampulla of Vater, obstructive jaundice is likely. Other rare malignant tumors of the duodenum include carcinoid tumors, lymphoma, and gastrointestinal stromal tumors. Abdominal surgery may be required to remove these rare tumors. Chemotherapy and radiation therapy may also be part of the treatment regimen.

The nursing process related to the care of the patient with a duodenal tumor is similar to that of the patient with gastric cancer. Each patient requires specialized care, astute assessment for complications, prompt interventions, and individualized teaching for self-care.

# CRITICAL THINKING EXERCISES

**1** You have been assigned to care for a 60-year-old man with a history of diabetes, esophageal reflux, peripheral neuropathy, and smoking. He is complaining of abdominal pain, nausea, and vomiting. What questions should you ask the patient? What signs should be noted during the physical examination? What diagnostic studies should you anticipate for this patient? Describe your nursing interventions, including teaching.

EBP **2** A 27-year-old morbidly obese woman is being evaluated for bariatric surgery. She has tried conservative measures, diets, behavior modification, exercise, and medications for obesity, and these weight loss measures have led to only limited success. Describe the criteria for bariatric surgery. What education would be appropriate for this patient preoperatively? What education and referrals would be appropriate for her postoperatively? What is the evidence base that supports the use of specific dietary modifications to meet her nutritional needs postoperatively? Describe the strength of this evidence and identify the criteria used to evaluate the strength of the evidence that supports the appropriateness of the dietary modifications.

**3** You are caring for a 61-year-old woman who was admitted for weight loss, decreased appetite, early satiety, and indigestion. Gastric cancer is the probable diagnosis. What questions should you ask this patient? What diagnostic studies and treatment plan would you anticipate for this patient? What nursing diagnoses, including knowledge deficit, would you anticipate for this patient?

**4** A 55-year-old man is transferred to your unit from the intensive care unit following a head injury. During your admission assessment, he complains of a burning sensation in his midepigastric area. On examination, you note a distended abdomen with tenderness in the epigastric area. What questions would you ask the patient? What diagnostic tests would you anticipate and how would you prepare your patient for these? Describe your plan of nursing care for this patient.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*


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## RESOURCES

Agency for Healthcare Research and Quality, www.ahrq.gov

American Cancer Society, www.cancer.org

American Gastroenterological Association, www.gastro.org

American Society for metabolic and Bariatric Surgery, www.asbs.org

Centers for Disease Control and Prevention, www.cdc.gov/nccdphp/dnpa/obesity/index.htm

National Comprehensive Cancer Network Clinical Practice Guidelines, www.nccn.org

National Digestive Diseases Information Clearinghouse (NDDIC), http://digestive.niddk.nih.gov/ (NDDIC is a service of the National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK])

Obesity Law and Advocacy Center, www.obesitylaw.com



chapter 38

# Management of Patients With Intestinal and Rectal Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the health care learning needs of patients with constipation or diarrhea.
2. Compare the conditions of malabsorption with regard to their pathophysiology, clinical manifestations, and management.
3. Use the nursing process as a framework for care of patients with diverticular disease.
4. Compare Crohn's disease (regional enteritis) and ulcerative colitis with regard to their pathophysiology; clinical manifestations; diagnostic evaluation; and medical, surgical, and nursing management.
5. Use the nursing process as a framework for care of the patient with inflammatory bowel disease.
6. Describe the responsibilities of the nurse in meeting the needs of the patient with an intestinal diversion.
7. Describe the various types of intestinal obstructions and their management.
8. Use the nursing process as a framework for care of the patient with cancer of the colon or rectum.
9. Describe nursing management of the patient with an anorectal condition.

## GLOSSARY

**abscess:** localized collection of purulent material surrounded by inflamed tissues, typically associated with signs of infection

**borborygmus:** rumbling noise caused by the movement of gas through the intestines

**colostomy:** surgical opening into the colon by means of a stoma to allow drainage of bowel contents; one type of fecal diversion

**constipation:** subjectively described infrequency or irregularity of defecation, with or without an abnormal hardening of feces that makes their passage difficult and sometimes painful, with or without a decrease in fecal volume

**diverticulitis:** inflammation of a diverticulum from obstruction (by fecal matter), resulting in abscess formation

## GLOSSARY *(Continued)*

**diverticulosis:** presence of several diverticula in the intestine; common in middle age

**diverticulum:** saclike outpouching of the lining of the bowel protruding through the muscle of the intestinal wall, usually caused by high intraluminal pressure

**fecal incontinence:** involuntary passage of feces

**fissure:** normal or abnormal fold, groove, or crack in body tissue

**fistula:** anatomically abnormal tract that arises between two internal organs or between an internal organ and the body surface

**hemorrhoids:** dilated portions of the anal veins; can occur internal or external to the anal sphincter

**ileostomy:** surgical opening into the ileum by means of a stoma to allow drainage of bowel contents; one type of fecal diversion

**inflammatory bowel disease (IBD):** group of chronic disorders (most common are ulcerative colitis and Crohn's disease) that result in inflammation or ulceration (or both) of the bowel lining; associated with abdominal pain, diarrhea, fever, and weight loss

**irritable bowel syndrome (IBS):** functional disorder that affects frequency of defecation and consistency of stool; is associated with no specific structural or biochemical alterations; associated with crampy abdominal pain and bloating

**Kock pouch:** type of continent ileal reservoir created surgically by making an internal pouch with a portion of the ileum and placing a nipple valve flush with the stoma

**malabsorption:** impaired transport across the mucosa

**peritonitis:** inflammation of the lining of the abdominal cavity, usually as a result of a bacterial infection of an area in the gastrointestinal tract with leakage of contents into the abdominal cavity

**steatorrhea:** excess of fatty wastes in the feces or the urine

**tenesmus:** ineffective and sometimes painful straining to eliminate either feces or urine

**Valsalva maneuver:** forcible exhalation against a closed glottis followed by a rise in intrathoracic pressure and subsequent possible dramatic rise in arterial pressure; may occur during straining at stool

**wound-ostomy-continence (WOC) nurse:** nurse specially educated in the appropriate management of fecal and urinary diversions; guides patients, their families, surgeons, and nurses by recommending appropriate use of skin, wound, ostomy, and continence products; formerly called enterostomal therapist

The types of diseases and disorders that affect the lower gastrointestinal (GI) tract are many and varied. Between 60 and 70 million people in the United States are diagnosed with some type of disease of the GI tract. These diseases account for more than 45 million office visits and approximately 14 million hospital admissions annually. They cost the American public more than $110 billion each year and account for approximately 9% of all deaths each year (National Institutes of Health [NIH], 2007).

In all age groups, a fast-paced lifestyle, high levels of stress, irregular eating habits, insufficient intake of fiber and water, and lack of daily exercise contribute to GI disorders. There is a growing understanding of the biopsychosocial implications of GI disease. Nurses can have an impact on these GI disorders by identifying behavior patterns that put patients at risk, by educating the public about prevention and management, and by helping those affected to improve their condition and prevent complications.

## ABNORMALITIES OF FECAL ELIMINATION

Changes in patterns of fecal elimination are symptoms of functional disorders or diseases of the GI tract. The most common changes seen are constipation, diarrhea, and fecal incontinence. The nurse should be aware of the causes and therapeutic management of these disorders and of nursing management techniques. Education is important for patients with these conditions.

## *Constipation*

**Constipation** is an abnormal infrequency or irregularity of defecation, abnormal hardening of stools that makes their passage difficult and sometimes painful, a decrease in stool volume, or retention of stool in the rectum for a prolonged period often with a sense of incomplete evacuation after defecation. Any variation from normal habits may be considered a problem. It is estimated that 4.5 million Americans are clinically constipated at any time, that between 12% and 19% of the American population may be affected periodically, and that women and adults older than 65 years are disproportionately constipated (Ginsberg, Phillips, Wallace, et al., 2007; Heitkemper & Wolf, 2007).

Constipation can be caused by certain medications (ie, tranquilizers, anticholinergics, antidepressants, antihypertensives, bile acid sequestrants, diuretics, opioids, aluminum-based antacids, iron preparations, selected antibiotics, and muscle relaxants); rectal or anal disorders (eg, hemorrhoids, fissures); obstruction (eg, bowel tumors); metabolic, neurologic, and neuromuscular conditions (eg, Hirschsprung's disease, Parkinson's disease, multiple sclerosis); endocrine disorders (eg, hypothyroidism, pheochromocytoma); lead poisoning; and connective tissue disorders (eg, scleroderma, systemic lupus erythematosus). Constipation is a major issue for patients taking opioids for pain. Diseases of the colon commonly associated with constipation include irritable bowel syndrome and diverticular disease. Constipation can also occur with an acute disease process in the abdomen (eg, appendicitis).

Other causes of constipation may include weakness, immobility, debility, fatigue, and an inability to increase intra-abdominal pressure to facilitate the passage of stools, as may occur in patients with emphysema or spinal cord injury, for instance. Many people develop constipation because they do not take the time to defecate or they ignore the urge to defecate. Constipation is also a result of dietary habits (ie, low consumption of fiber and inadequate fluid intake), lack of regular exercise, and a stress-filled life. Fiber is particularly important to bowel health as it increases the bulk of stool, generally easing the passage. More importantly, it also promotes optimal fermentation, providing good bowel wall health (Rose, DeMeo, Keshavarzian, et al., 2007).

Perceived constipation can also be an issue. This subjective problem occurs when a person's bowel elimination pattern is not consistent with what he or she considers normal. Chronic laxative use may contribute to this problem and is a major health issue in the United States. "Normal" bowel function varies substantially from three bowel movements a day to three times per week (Bisanz, 2007).

### Pathophysiology

The pathophysiology of constipation is poorly understood, but it is thought to include interference with one of three major functions of the colon: mucosal transport (ie, mucosal secretions facilitate the movement of colon contents), myoelectric activity (ie, mixing of the rectal mass and propulsive actions), or the processes of defecation (eg, pelvic floor dysfunction). Any of the causative factors previously identified can interfere with any of these three processes.

The urge to defecate is stimulated normally by rectal distention that initiates a series of four actions: stimulation of the inhibitory rectoanal reflex, relaxation of the internal sphincter muscle, relaxation of the external sphincter muscle and muscles in the pelvic region, and increased intra-abdominal pressure. Interference with any of these processes can lead to constipation.

If all organic causes are eliminated, idiopathic constipation is diagnosed. When the urge to defecate is ignored, the rectal mucous membrane and musculature become insensitive to the presence of fecal masses, and consequently a stronger stimulus is required to produce the necessary peristaltic rush for defecation. The initial effect of fecal retention is to produce irritability of the colon, which at this stage frequently goes into spasm, especially after meals, giving rise to colicky midabdominal or low abdominal pains. After several years of this process, the colon loses muscular tone and becomes essentially unresponsive to normal stimuli (similar to an overstretched balloon). Atony or decreased muscle tone occurs with aging. This also leads to constipation because the stool is retained for longer periods.

### Clinical Manifestations

Clinical manifestations of constipation include fewer than three bowel movements per week; abdominal distention; pain and pressure; decreased appetite; headache; fatigue; indigestion; a sensation of incomplete evacuation; straining at stool; and the elimination of small-volume, lumpy, hard, dry stools. To make diagnosis more efficient, an international committee developed the Rome criteria. To be considered true chronic constipation, the previously mentioned

manifestations must be present for at least 12 weeks of the preceding 12 months (Bharucha, 2007; Bisanz, 2007).

## Assessment and Diagnostic Findings

Chronic constipation is usually considered idiopathic, but secondary causes should be excluded. In patients with severe, intractable constipation, further diagnostic testing is needed (Heitkemper & Wolf, 2007). The diagnosis of constipation is based on the patient's history, physical examination, possibly the results of a barium enema or sigmoidoscopy, and stool testing for occult blood. These tests are used to determine whether this symptom results from spasm or narrowing of the bowel. Anorectal manometry (ie, pressure studies such as a balloon expulsion test) may be performed to assess malfunction of the sphincter. Defecography and colonic transit studies can also assist in the diagnosis because they permit assessment of active anorectal function (see Chapter 34). Newer tests such as pelvic floor magnetic resonance imaging (MRI) may identify occult pelvic floor defects (Ginsberg, et al., 2007).

## Complications

Complications of constipation include hypertension, fecal impaction, **hemorrhoids** (dilated portions of anal veins), **fissures** (tissue folds), and megacolon. Increased arterial pressure can occur with defecation. Straining at stool, which results in the **Valsalva maneuver** (ie, forcibly exhaling with the glottis closed), has a striking effect on arterial blood pressure. During active straining, the flow of venous blood in the chest is temporarily impeded because of increased intrathoracic pressure. This pressure tends to collapse the large veins in the chest. The atria and the ventricles receive less blood, and consequently less blood is ejected by the left ventricle. Cardiac output is decreased, and there is a transient drop in arterial pressure. Almost immediately after this period of hypotension, an increase in arterial pressure occurs; the pressure is elevated momentarily to a point far exceeding the original level (ie, rebound phenomenon). In patients with hypertension, this compensatory reaction may be exaggerated greatly, and the peak pressure attained may be dangerously high—sufficient to rupture a major artery in the brain or elsewhere.

Fecal impaction occurs when an accumulated mass of dry feces cannot be expelled. The mass may be palpable on digital examination, may produce pressure on the colonic mucosa that results in ulcer formation, and frequently causes seepage of liquid stools.

Hemorrhoids and anal fissures can develop as a result of constipation. Hemorrhoids develop as a result of perianal vascular congestion caused by straining. Anal fissures may result from the passage of the hard stool through the anus, tearing the lining of the anal canal.

Megacolon is a dilated and atonic colon caused by a fecal mass that obstructs the passage of colon contents. Symptoms include constipation, liquid fecal incontinence, and abdominal distention. Megacolon can lead to perforation of the bowel.

## Gerontologic Considerations

Physician visits for treatment of constipation are most common in people 65 years and older (Ginsberg, et al., 2007). The most common complaint they voice is the need to strain at stool. People who have loose-fitting dentures or have lost their teeth have difficulty chewing and frequently choose soft, processed foods that are low in fiber. Older adults tend to have decreased food intake, reduced mobility, and weak abdominal and pelvic muscles, and they are more likely to have multiple chronic illnesses requiring multiple medications (polypharmacy) that often cause constipation (Ginsberg, et al., 2007). Low-fiber convenience foods are widely used by people who have lost interest in eating. Some older people reduce their fluid intake if they are not eating regular meals. Depression, weakness, and prolonged bed rest also contribute to constipation by decreasing intestinal motility and anal sphincter tone. Nerve impulses are dulled, and there is a decreased urge to defecate. Many older people overuse laxatives in an attempt to have a daily bowel movement and become dependent on them.

## Medical Management

Treatment targets the underlying cause of constipation and aims to prevent recurrence. It includes education, bowel habit training, increased fiber and fluid intake, and judicious use of laxatives. Management may also include discontinuing laxative abuse. Routine exercise to strengthen abdominal muscles is encouraged. Biofeedback is a technique that can be used to help patients learn to relax the sphincter mechanism to expel stool (Bharucha, 2007; Heitkemper & Wolf, 2007). Daily dietary intake of 25 to 30 g/day of fiber (soluble and bulk-forming) is recommended, especially for the treatment of constipation in the elderly. If laxative use is necessary, one of the following may be prescribed: bulk-forming agents, saline and osmotic agents, lubricants, stimulants, or fecal softeners. The physiologic action and patient education information related to these laxatives are presented in Table 38-1. Enemas and rectal suppositories are generally not recommended for treating constipation; they should be reserved for the treatment of impaction. Treatment for impaction removal can be embarrassing and painful because it usually also requires digital dislodgement with enema administration. If long-term laxative use is necessary, a bulk-forming agent may be prescribed in combination with an osmotic laxative.

Specific medications may be prescribed to enhance colonic transit by increasing propulsive motor activity. These may include cholinergic agents (eg, bethanechol [Urecholine]), cholinesterase inhibitors (eg, neostigmine [Prostigmin]), or prokinetic agents (eg, metoclopramide [Reglan]). Newer prokinetic agents include serotonin receptors such as tegaserod (Zelnorm) and prostones such as lubiprostone (Amitiza). They should be used only for patients with unremitting constipation (Bharucha, 2007; Ginsberg, et al., 2007).

## Nursing Management

The nurse elicits information about the onset and duration of constipation, current and past elimination patterns, the patient's expectation of normal bowel elimination, and lifestyle information (eg, exercise and activity level, occupation, food and fluid intake, and stress level) during the health history interview. Past medical and surgical history, current medications, and laxative and enema use are

**Table 38-1 LAXATIVE MEDICATIONS**

| Medications (Classification and Sample Drugs) | Action | Patient Education |
|---|---|---|
| **Bulk Forming** | | |
| Psyllium hydrophilic mucilloid (Metamucil)<br>Methylcellulose (Citrucel)<br>Saline agent | Polysaccharides and cellulose derivatives mix with intestinal fluids, swell, and stimulate peristalsis. | Take with 8 oz water and follow with 8 oz water; do not take dry. Report abdominal distention or unusual amount of flatulence. |
| Magnesium hydroxide (Milk of Magnesia) | Nonabsorbable magnesium ions alter stool consistency by drawing water into the intestines by osmosis; peristalsis is stimulated. Action occurs within 2 h. | The liquid preparation is more effective than the tablet form. Only short-term use is recommended because of toxicity (CNS or neuromuscular depression, electrolyte imbalance). Magnesium laxatives should not be taken by patients with renal insufficiency. |
| **Lubricant** | | |
| Mineral oil<br>Glycerin suppository | Nonabsorbable hydrocarbons soften fecal matter by lubricating the intestinal mucosa; the passage of stool is facilitated. Action occurs within 6–8 h for mineral oil and within 30 minutes for glycerin suppository. | Do not take mineral oil with meals because it can impair the absorption of fat-soluble vitamins and delay gastric emptying. Swallow carefully, because drops of oil that gain access to the pharynx can produce a lipid pneumonia. Glycerin suppositories must be inserted fully and retained. |
| **Stimulant** | | |
| Bisacodyl (Dulcolax)<br>Senna (Senokot) | Irritates the colonic epithelium by stimulating sensory nerve endings and increasing mucosal secretions. Action occurs within 6–8 h. | Catharsis may cause fluid and electrolyte imbalance, especially in the elderly. Tablets should be swallowed, not crushed or chewed. Avoid milk or antacids within 1 hour of taking medication, because the enteric coating may dissolve prematurely. Stimulant laxatives are not indicated for long-term use. |
| **Fecal Softener** | | |
| Docusate (Colace) | Hydrates the stool by its surfactant action on the colonic epithelium (increases the wetting efficiency of intestinal water); aqueous and fatty substances are mixed. Does not exert a laxative action. | Can be used safely by patients who should avoid straining (cardiac patients, patients with anorectal disorders). |
| **Osmotic Agent** | | |
| Polyethylene glycol and electrolytes (Colyte) | Cleanses colon rapidly and induces diarrhea. | This is a large-volume product. It takes time to consume it safely. It can cause considerable nausea and bloating. |

important, as is information about the sensation of rectal pressure or fullness, abdominal pain, excessive straining at defecation, and flatulence.

Patient education and health promotion are important functions of the nurse (Chart 38-1). After the health history is obtained, the nurse sets specific goals for teaching. Goals for the patient include restoring or maintaining a regular pattern of elimination by responding to the urge to defecate, ensuring adequate intake of fluids and high-fiber foods, learning about methods to avoid constipation, relieving anxiety about bowel elimination patterns, and avoiding complications.

## Diarrhea

Diarrhea is an increased frequency of bowel movements (more than three per day), an increased amount of stool (more than 200 g/day), and altered consistency (ie, increased liquidity) of stool. It is usually associated with urgency, perianal discomfort, incontinence, or a combination of these factors. Any condition that causes increased intestinal secretions, decreased mucosal absorption, or altered motility can produce diarrhea. Irritable bowel syndrome, inflammatory bowel disease, and lactose intolerance are frequently the underlying disease processes that cause diarrhea.

Diarrhea can be acute or chronic. Acute diarrhea is most often associated with infection and is usually self-limiting, lasting up to 7 to 14 days; chronic diarrhea persists for more than 2 to 3 weeks and may return sporadically. Diarrhea can be caused by certain medications (eg, thyroid hormone replacement, stool softeners and laxatives, prokinetic agents, antibiotics, chemotherapy, antiarrhythmics, antihypertensives, magnesium-based antacids), certain tube-feeding formulas, metabolic and endocrine disorders (eg, diabetes, Addison's disease, thyrotoxicosis), and viral or bacterial infectious processes (eg, dysentery, shigellosis, food poisoning, Norwalk virus). Other disease processes associated with diarrhea include nutritional and malabsorptive disorders

CHART 38-1 HEALTH PROMOTION
**Preventing Constipation**

- Emphasize the importance of responding to the urge to defecate.
- Teach how to establish a bowel routine, and explain that having a regular time for defecation (eg, best time is after a meal) may aid in initiating the reflex.
- Provide dietary information; suggest eating high-residue, high-fiber foods, (eg, fruits, vegetables) adding bran daily (must be introduced gradually), and increasing fluid intake (unless contraindicated).
- Explain how an exercise regimen, increased ambulation, and abdominal muscle toning will increase muscle strength and help propel colon contents.
- Describe abdominal toning exercises (contracting abdominal muscles 4 times daily and leg-to-chest lifts 10 to 20 times each day).
- Explain that the normal position (semisquatting) maximizes use of abdominal muscles and force of gravity.
- Avoid overuse or long-term use of stimulant laxatives (eg, bisacodyl) because they can weaken colonic function.

(eg, celiac disease), anal sphincter defect, Zollinger-Ellison syndrome, paralytic ileus, intestinal obstruction, and acquired immunodeficiency syndrome (AIDS) (Sabol & Carlson, 2007).

## Pathophysiology

Types of diarrhea include secretory, osmotic, malabsorptive, infectious, and exudative. Secretory diarrhea is usually high-volume diarrhea. Often associated with bacterial toxins and neoplasms, it is caused by increased production and secretion of water and electrolytes by the intestinal mucosa into the intestinal lumen. Osmotic diarrhea occurs when water is pulled into the intestines by the osmotic pressure of unabsorbed particles, slowing the reabsorption of water. It can be caused by lactase deficiency, pancreatic dysfunction, or intestinal hemorrhage. Malabsorptive diarrhea combines mechanical and biochemical actions, inhibiting effective absorption of nutrients manifested by markers of malnutrition that include hypoalbuminemia. Low serum albumin levels lead to intestinal mucosa swelling and liquid stool. Infectious diarrhea results from infectious agents invading the intestinal mucosa. *Clostridium difficile* is the most commonly identified agent in antibiotic-associated diarrhea in the hospital. The pathophysiology of diarrhea related to infection is discussed in Chapter 70. Exudative diarrhea is caused by changes in mucosal integrity, epithelial loss, or tissue destruction by radiation or chemotherapy (Sabol & Carlson, 2007).

Notably, other causes of diarrhea also include laxative misuse.

## Clinical Manifestations

In addition to the increased frequency and fluid content of stools, the patient usually has abdominal cramps, distention, intestinal rumbling (ie, **borborygmus**), anorexia, and thirst. Painful spasmodic contractions of the anus and ineffective straining (ie, **tenesmus**) may occur with defecation. Other symptoms depend on the cause and severity of the diarrhea but are related to dehydration and to fluid and electrolyte imbalances.

Watery stools are characteristic of disorders of the small bowel, whereas loose, semisolid stools are associated more often with disorders of the large bowel. Voluminous, greasy stools suggest intestinal malabsorption, and the presence of blood, mucus, and pus in the stools suggests inflammatory enteritis or colitis. Oil droplets on the toilet water are almost always diagnostic of pancreatic insufficiency. Nocturnal diarrhea may be a manifestation of diabetic neuropathy. The possibility of *C. difficile* infection should be considered in all patients with unexplained diarrhea who are taking or have recently taken antibiotics (Sabol & Carlson, 2007).

## Assessment and Diagnostic Findings

When the cause of the diarrhea is not obvious, the following diagnostic tests may be performed: complete blood cell count; serum chemistries; urinalysis; routine stool examination; and stool examinations for infectious or parasitic organisms, bacterial toxins, blood, fat, electrolytes, and white blood cells. Endoscopy or barium enema may assist in identifying the cause.

## Complications

Complications of diarrhea include the potential for cardiac dysrhythmias because of significant fluid and electrolyte loss (especially loss of potassium). Urinary output of less than 30 mL per hour for 2 to 3 consecutive hours, muscle weakness, paresthesia, hypotension, anorexia, and drowsiness with a potassium level of less than 3.5 mEq/L (3.5 mmol/L) must be reported. Chronic diarrhea can also result in skin care issues related to irritant dermatitis, which can be prevented by cleansing with a wet wipe, drying the skin, and then applying barrier cream (Metcalf, 2007; Sabol & Carlson, 2007).

## Gerontologic Considerations

Elderly patients can become dehydrated quickly and develop low potassium levels (ie, hypokalemia) as a result of diarrhea. The nurse observes for clinical manifestations of muscle weakness, dysrhythmias, or decreased peristaltic motility that may lead to paralytic ileus. The older patient taking digitalis (eg, digoxin [Lanoxin]) must be aware of how quickly dehydration and hypokalemia can occur with diarrhea. The nurse teaches the patient to recognize the symptoms of hypokalemia because low levels of potassium potentiate the action of digitalis, leading to digitalis toxicity.

## Medical Management

Primary management is directed at controlling symptoms, preventing complications, and eliminating or treating the underlying disease. Certain medications (eg, antibiotics, anti-inflammatory agents) and antidiarrheals (eg, loperamide [Imodium], diphenoxylate [Lomotil]) may be used to reduce the severity of the diarrhea and treat the underlying disease (Sabol & Carlson, 2007). In most cases, loperamide is the medication of choice because it has fewer side effects than diphenoxylate (Sabol & Carlson, 2007).

## Nursing Management

The nurse's role includes assessing and monitoring the characteristics and pattern of diarrhea. A health history should address the patient's medication therapy, medical and surgical history, and dietary patterns and intake. Reports of recent exposure to an acute illness or recent travel to another geographic area are important. Assessment includes abdominal auscultation and palpation for tenderness. Inspection of the abdomen, mucous membranes, and skin is important to determine hydration status. Stool samples are obtained for testing. It is also necessary to assess the perianal area.

During an episode of acute diarrhea, the nurse encourages bed rest and intake of liquids and foods low in bulk until the acute attack subsides. When the patient is able to tolerate food intake, the nurse recommends a bland diet of semisolid and solid foods. The patient should avoid caffeine, carbonated beverages, and very hot and very cold foods, because they stimulate intestinal motility. It may be necessary to restrict milk products, fat, whole-grain products, fresh fruits, and vegetables for several days. The nurse administers antidiarrheal medications such as diphenoxylate or loperamide as prescribed. Intravenous (IV) fluid therapy may be necessary for rapid rehydration in some patients, especially in elderly patients and in patients with preexisting GI conditions (eg, inflammatory bowel disease). It is important to monitor serum electrolyte levels closely. The nurse immediately reports evidence of dysrhythmias or a change in a patient's level of consciousness.

The perianal area may become excoriated because diarrheal stool contains digestive enzymes that can irritate the skin. The patient should follow a perianal skin care routine to decrease irritation and excoriation (see Chapter 56). The skin of an older person is very sensitive because of decreased turgor and reduced subcutaneous fat layers.

# *Fecal Incontinence*

**Fecal incontinence** describes the involuntary passage of stool from the rectum. Factors that influence fecal continence include the ability of the rectum to sense and accommodate stool, the amount and consistency of stool, the integrity of the anal sphincters and musculature, and rectal motility. It is an embarrassing and socially incapacitating problem that requires a many-tiered approach to treatment and much adaptation on the patient's part.

## Pathophysiology

Fecal incontinence has many causes and risk factors. In general, it results from conditions that interrupt or disrupt the structure or function of the anorectal unit (Beitz, 2006). Causes include trauma (eg, after surgical procedures involving the rectum), neurologic disorders (eg, stroke, multiple sclerosis, diabetic neuropathy, dementia), inflammation, infection, chemotherapy, radiation treatment, fecal impaction, pelvic floor relaxation, laxative abuse, medications, or advancing age (ie, weakness or loss of anal or rectal muscle tone).

## Clinical Manifestations

Patients may have minor soiling, occasional urgency and loss of control, or complete incontinence. Patients may also experience poor control of flatus, diarrhea, or constipation.

## Assessment and Diagnostic Findings

Diagnostic studies are necessary because the treatment of fecal incontinence depends on the cause. A rectal examination and endoscopic examinations such as a flexible sigmoidoscopy are performed to rule out tumors, inflammation, or fissures. X-ray studies such as barium enema, computed tomography (CT), anorectal manometry, and transit studies may be helpful in identifying alterations in intestinal mucosa and muscle tone or in detecting other structural or functional problems.

## Medical Management

Although there is no known cure for fecal incontinence, specific management techniques can help the patient achieve a better quality of life. If fecal incontinence is related to diarrhea, the incontinence may disappear when diarrhea is successfully treated. Fecal incontinence is frequently a symptom of a fecal impaction. After the impaction is removed and the rectum is cleansed, normal functioning of the anorectal area can resume. If the fecal incontinence is related to a more permanent condition, other treatments are initiated. Biofeedback therapy with pelvic floor muscle training can be of assistance if the problem is decreased sensory awareness or sphincter control. Bowel training programs can also be effective. Surgical procedures include surgical reconstruction, artificial sphincter implantation, sphincter repair, or fecal diversion.

## Nursing Management

The nurse obtains a thorough health history, including information about previous surgical procedures, chronic illnesses, dietary patterns, bowel habits and problems, and current medication regimen. The nurse also completes an examination of the rectal area. If a fecal impaction is noted, it must be removed before instituting any preventive therapies.

The nurse initiates a bowel-training program that involves setting a schedule to establish bowel regularity. The goal is to help the patient achieve fecal continence. If this is not possible, the goal should be to manage the problem so the patient can have predictable, planned elimination. Sometimes it is necessary to use suppositories to stimulate the anal reflex. After the patient has achieved a regular schedule, the suppository can be discontinued. Biofeedback can be used in conjunction with these therapies to help the patient improve sphincter contractility and rectal sensitivity. Bowel regulation also involves the therapeutic use of diet and fiber. Foods that thicken stool (eg, applesauce) and fiber products (eg, psyllium) help improve continence.

Fecal incontinence can also cause problems with perineal skin integrity. Maintaining skin integrity is a priority, especially in the debilitated or elderly patient. Incontinence briefs or adult diapers, although helpful in containing the fecal material, permit increased skin contact with feces and may cause skin excoriation. In general, incontinence briefs are to be used only for brief periods of time. The nurse



**Figure 38-1** Flexi-Seal Fecal Management System (Courtesy of Convatec, Inc., © Skillman, NJ).

encourages and teaches meticulous skin hygiene and uses perineal skin cleansers and skin protection products to protect perineal skin (Beitz, 2006).

Continence sometimes cannot be achieved, and the nurse assists the patient and family to accept and cope with this chronic situation. The patient can use fecal incontinence devices, which include external collection devices and internal drainage systems. External devices are special rectal pouches, called fecal incontinence collectors, which are drainable. They are attached to a synthetic adhesive skin barrier specially designed to conform to the buttocks. Internal drainage systems can be used to eliminate fecal skin contact and are especially useful when there is extensive excoriation or skin breakdown. New fecal and bowel management systems (eg, Flexi-Seal Fecal Management System) are available. These systems, which consist of a tube with a low-pressure balloon that conforms to the internal rectal area, may be used for up to 29 consecutive days (Fig. 38-1). Compared with rectal catheters, the newer bowel management systems are associated with improved patient safety; therefore, the former are now generally contraindicated (Beitz, 2006).

## *Irritable Bowel Syndrome*

**Irritable bowel syndrome (IBS)** is one of the most common GI conditions. Approximately 12% of adults in the United States report classic symptoms of IBS (Hadley & Gardner, 2005). IBS accounts for 3.5 million office visits and is a leading cause of workforce absenteeism (Harmon, 2007). It occurs more commonly in women than in men, and the cause remains unknown (Hasler, 2007). Although no anatomic or biochemical abnormalities have been found that account for its common symptoms, various factors are associated with the syndrome: heredity, psychological stress or conditions such as depression and anxiety, a diet high in fat and stimulating or irritating foods, alcohol consumption, and smoking. The diagnosis is made only after tests confirm the absence of structural or other disorders (Hasler, 2007).

### Pathophysiology

IBS results from a functional disorder of intestinal motility. The change in motility may be related to neuroendocrine dysregulation, especially if there are changes in serotonin signaling, which regulates intestinal motility. Changes in intestinal motility may also result from infections or other inflammatory disorders or vascular or metabolic disturbances. The peristaltic waves are affected at specific segments of the intestine and in the intensity with which they propel the fecal matter forward. There is no evidence of inflammation or tissue changes in the intestinal mucosa (Costedio, Hyman & Mawe, 2006; Hasler, 2007).

### Clinical Manifestations

There is a wide variability in symptom presentation. Symptoms range in intensity and duration from mild and infrequent to severe and continuous. The primary symptom is an alteration in bowel patterns: constipation, diarrhea, or a combination of both. Pain, bloating, and abdominal distention often accompany changes in bowel pattern. The abdominal pain is sometimes precipitated by eating and is frequently relieved by defecation.

### Assessment and Diagnostic Findings

Specific diagnostic criteria established through international consensus conferences have led to improved diagnosis of IBS. Criteria include recurrent abdominal pain or discomfort for at least 3 days a month in the past 3 months, including two or more of the following: (1) improvement with defecation; (2) onset associated with change in frequency of stool; and (3) onset associated with change in appearance (form) of stool (Laine & Goldman, 2007; Spiller, 2007).

A definite diagnosis requires tests that confirm the absence of structural or other disorders. Stool studies, contrast x-ray studies, and proctoscopy may be performed to rule out other colon diseases. Barium enema and colonoscopy may reveal spasm, distention, or mucus accumulation in the intestine (Fig. 38-2). Manometry and electromyography (EMG) are used to study intraluminal pressure changes generated by spasticity.

### Medical Management

The goals of treatment are relieving abdominal pain, controlling the diarrhea or constipation, and reducing stress. Restriction and then gradual reintroduction of foods that are possibly irritating may help determine what types of food are acting as irritants (eg, beans, caffeinated products, corn, wheat, dairy lactose, fried foods, alcohol, spicy foods,

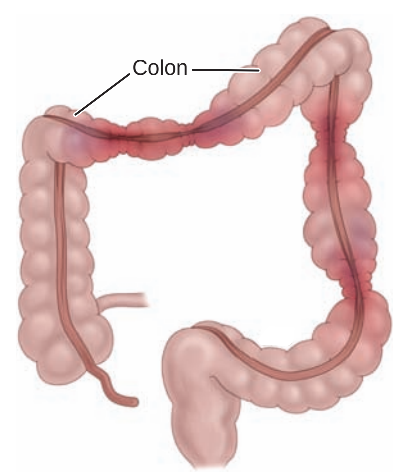



**Figure 38-2** In irritable bowel syndrome (IBS), the spastic contractions of the bowel can be seen on x-ray contrast studies.

aspartame). A high-fiber diet is prescribed to help control the diarrhea and constipation. Exercise can assist in reducing anxiety and increasing intestinal motility. Patients often find it helpful to participate in a stress reduction or behavior modification program. Hydrophilic colloids (ie, bulk) and antidiarrheal agents (eg, loperamide) may be given to control the diarrhea and fecal urgency. Antidepressants can assist in treating underlying anxiety and depression but also have secondary benefits. They may affect serotonin levels, thus slowing intestinal transit time and improving diarrhea and abdominal comfort. Anticholinergics or antispasmodics (eg, propantheline [Pro-Banthine]) may be prescribed to decrease smooth muscle spasm, decreasing cramping and constipation.

Tegaserod was previously prescribed to treat women with IBS whose chief complaint was chronic constipation. Tegaserod was stopped for IBS treatment because it was associated with increased risks of myocardial infarction and stroke (Harmon, 2007; Laine & Goldman, 2007). Other alternatives for IBS management include probiotics and alternative medicines. Probiotics are bacteria that include *Lactobacillus* and *Bifidobacterium* that can be administered to help decrease abdominal bloating and gas. Complementary medicine approaches to treatment of IBS include artichoke leaf extract, peppermint oil, and caraway oil. They reputedly diminish IBS symptoms; however, formal studies are needed to examine their effectiveness (Harmon, 2007; Laine & Goldman, 2007).

### Nursing Management

The nurse's role is to provide patient and family education. Teaching and reinforcement of good dietary habits (eg, avoidance of food triggers) are emphasized. A good method for identifying problem foods involves keeping a symptom and food diary for 1 to 2 weeks. Patients are encouraged to eat at regular times and to chew food slowly and thoroughly. They should understand that although adequate fluid intake is necessary, fluid should not be taken with meals because this results in abdominal distention. Alcohol use and cigarette smoking are discouraged. Stress management via relaxation techniques, yoga, or exercise can be recommended (Harmon, 2007).

## Conditions of Malabsorption

**Malabsorption** is the inability of the digestive system to absorb one or more of the major vitamins (especially A and $B_{12}$), minerals (ie, iron and calcium), and nutrients (ie, carbohydrates, fats, and proteins). Interruptions in the complex digestive process may occur anywhere in the digestive system and cause decreased absorption. Diseases of the small intestine are the most common cause of malabsorption.

### Pathophysiology

The conditions that cause malabsorption can be grouped into the following categories:

- Mucosal (transport) disorders causing generalized malabsorption (eg, celiac sprue, regional enteritis, radiation enteritis)
- Infectious diseases causing generalized malabsorption (eg, small bowel bacterial overgrowth, tropical sprue, Whipple's disease)
- Luminal disorders causing malabsorption (eg, bile acid deficiency, Zollinger-Ellison syndrome, pancreatic insufficiency)
- Postoperative malabsorption (eg, after gastric or intestinal resection)
- Disorders that cause malabsorption of specific nutrients (eg, disaccharidase deficiency leading to lactose intolerance)

Table 38-2 lists the clinical and pathologic aspects of malabsorptive diseases.

### Clinical Manifestations

The hallmarks of malabsorption syndrome from any cause are diarrhea or frequent, loose, bulky, foul-smelling stools that have increased fat content and are often grayish. Patients often have associated abdominal distention, pain, increased flatus, weakness, weight loss, and a decreased sense of well-being. The chief result of malabsorption is malnutrition, manifested by weight loss and other signs of vitamin and mineral deficiency (eg, easy bruising, osteoporosis, anemia). Patients with a malabsorption syndrome, if untreated, become weak and emaciated because of starvation and dehydration. Failure to absorb the fat-soluble vitamins A, D, and K causes a corresponding avitaminosis.

### Assessment and Diagnostic Findings

Several diagnostic tests may be prescribed, including stool studies for quantitative and qualitative fat analysis, lactose tolerance tests, D-xylose absorption tests, and Schilling tests. The hydrogen breath test that is used to evaluate carbohydrate absorption (see Chapter 34) is performed if carbohydrate malabsorption is suspected. Endoscopy with biopsy of the mucosa is the best diagnostic tool. Biopsy of the small intestine is performed to assay enzyme activity or to identify infection or destruction of mucosa. Ultrasound studies, CT scans, and x-ray findings can reveal pancreatic or intestinal tumors that may be the cause. A complete blood cell count is used to detect anemia. Pancreatic function tests can assist in the diagnosis of specific disorders.

### Medical Management

Intervention is aimed at avoiding dietary substances that aggravate malabsorption and at supplementing nutrients that have been lost. Common supplements are water-soluble vitamins (eg, $B_{12}$, folic acid), fat-soluble vitamins (ie, A, D, and K), and minerals (eg, calcium, iron). Primary disease states may be managed surgically or nonsurgically. Dietary therapy is aimed at reducing gluten intake in patients with celiac sprue. Folic acid supplements are prescribed for patients with tropical sprue. Antibiotics (eg, tetracycline [Tetracyn], ampicillin [Polycillin]) are sometimes needed in the treatment of tropical sprue and bacterial overgrowth syndromes. Antidiarrheal agents may be used to decrease intestinal spasms. Parenteral fluids may be necessary to treat dehydration.

**Table 38-2 CHARACTERISTICS OF DISEASES OF MALABSORPTION**

| Diseases/Disorders | Pathophysiology | Clinical Features |
|---|---|---|
| Gastric resection with gastrojejunostomy | Decreased pancreatic stimulation because of duodenal bypass; poor mixing of food, bile, pancreatic enzymes; decreased intrinsic factor | Weight loss, moderate steatorrhea, anemia (combination of iron deficiency, vitamin $B_{12}$ malabsorption, folate deficiency) |
| Pancreatic insufficiency (chronic pancreatitis, pancreatic carcinoma, pancreatic resection, cystic fibrosis) | Reduced intraluminal pancreatic enzyme activity, with maldigestion of lipids and proteins | History of abdominal pain followed by weight loss; marked steatorrhea, azotorrhea (excess of nitrogenous matter in the feces or urine); also frequent glucose intolerance (70% in pancreatic insufficiency) |
| Ileal dysfunction (resection or disease) | Loss of ileal absorbing surface leads to reduced bile-salt pool size and reduced vitamin $B_{12}$ absorption; bile in colon inhibits fluid absorption | Diarrhea, weight loss with steatorrhea, especially when greater than 100 cm resection, decreased vitamin $B_{12}$ absorption |
| Stasis syndromes (surgical strictures, blind loops, enteric fistulas, multiple jejunal diverticula, scleroderma) | Overgrowth of intraluminal intestinal bacteria, especially anaerobic organisms, to greater than $10^6$/mL results in deconjugation of bile salts, leading to decreased effective bile-salt pool size, also bacterial utilization of vitamin $B_{12}$ | Weight loss, steatorrhea; low vitamin $B_{12}$ absorption; may have low D-xylose absorption |
| Zollinger-Ellison syndrome | Hyperacidity in duodenum inactivates pancreatic enzymes | Ulcer diathesis, steatorrhea |
| Lactose intolerance | Deficiency of intestinal lactase results in high concentration of intraluminal lactose with osmotic diarrhea | Varied degrees of diarrhea and cramps after ingestion of lactose-containing foods; positive lactose intolerance test, decreased intestinal lactase |
| Celiac disease (gluten-sensitive enteropathy) | Toxic response to a gluten fraction gliadin by surface epithelium results in destruction of absorbing surface of intestine | Weight loss, diarrhea, bloating, anemia (low iron, folate), osteomalacia, steatorrhea, azotorrhea, low D-xylose absorption; folate and iron malabsorption |
| Tropical sprue | Unknown toxic factor results in mucosal inflammation, partial villous atrophy | Weight loss, diarrhea, anemia (low folate, vitamin $B_{12}$); steatorrhea; low D-xylose absorption, low vitamin $B_{12}$ absorption |
| Whipple's disease | Bacterial invasion of intestinal mucosa | Arthritis, hyperpigmentation, lymphadenopathy, serous effusions, fever, weight loss, steatorrhea, azotorrhea |
| Certain parasitic diseases (giardiasis, strongyloidiasis, coccidiosis, capillariasis) | Damage to or invasion of surface mucosa | Diarrhea, weight loss; steatorrhea; organism may be seen on jejunal biopsy or recovered in stool |
| Immunoglobulinopathy | Decreased local intestinal defenses, lymphoid hyperplasia, lymphopenia | Frequent association with *Giardia:* hypogammaglobulinemia or isolated IgA deficiency |

### Gerontologic Considerations

The older patient may have more subtle symptoms of malabsorption that may be extraintestinal, including fatigue and confusion. Medical management may include the administration of corticosteroids, which may cause a host of adverse effects such as hypertension, hypokalemia, and mood changes. Antibiotics may reduce vitamin K–producing intestinal flora, resulting in a prolonged prothrombin time (PT) and international normalized ratio (INR) if the patient is concurrently taking warfarin (Coumadin). Urinary retention, altered mental status, or glaucoma may occur as adverse effects of anticholinergic drug therapy in older people.

### Nursing Management

The nurse provides patient and family education regarding diet and the use of nutritional supplements (Chart 38-2). It is important to monitor patients with diarrhea for fluid and electrolyte imbalances. The nurse conducts ongoing assessments to determine whether the clinical manifestations related to the nutritional deficits have abated. Patient education includes information about the risk of osteoporosis related to malabsorption of calcium.

# ACUTE INFLAMMATORY INTESTINAL DISORDERS

Any part of the lower GI tract is susceptible to acute inflammation caused by bacterial, viral, or fungal infection. Two such conditions are appendicitis and diverticulitis, both of which may lead to **peritonitis,** an inflammation of the lining of the abdominal cavity.

## *Appendicitis*

The appendix is a small, fingerlike appendage about 10 cm (4 in) long that is attached to the cecum just below the ileocecal valve. The appendix fills with food and empties regularly into the cecum. Because it empties inefficiently and its lumen is small, the appendix is prone to obstruction and is particularly vulnerable to infection (ie, appendicitis).

Appendicitis, the most common cause of acute surgical abdomen in the United States, is the most common reason for emergency abdominal surgery. Although it can occur at any age, it more commonly occurs between the ages of 10 and 30 years (NIH, 2007).

CHART 38-2 PATIENT EDUCATION
**Managing Lactose Intolerance**

- Deficiency of lactase, a digestive enzyme essential for the digestion and absorption of lactose ("milk sugar") from the intestines, results in an intolerance to milk.
- Elimination of milk and milk substances can prevent symptoms.
- Many processed foods have fillers, such as dried milk, added to them.
- Pretreatment of foods with lactase preparations (eg, LactAid drops) before ingestion can reduce symptoms.
- Ingestion of lactase enzyme tablets with the first bite of food can reduce symptoms.
- Most people can tolerate 1 to 2 cups of milk or milk products daily without major problems; they are best tolerated if ingested in small amounts during the day.
- Lactase activity of yogurt with "active cultures" helps the digestion of lactose within the intestine better than lactase preparations do.
- Milk and milk products are rich sources of calcium and vitamin D; elimination of milk from the diet may result in calcium and vitamin D deficiencies; decreased intake without supplements can lead to osteoporosis.

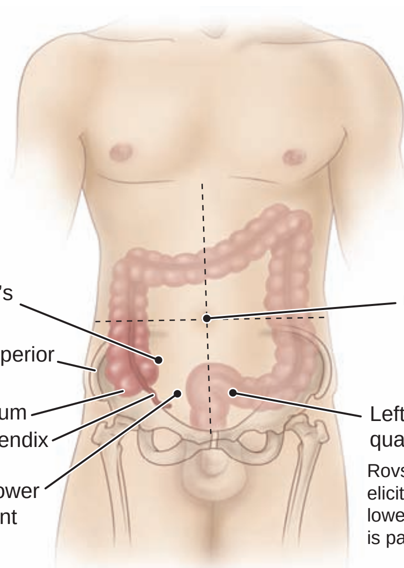



**Figure 38-3** When the appendix is inflamed, tenderness can be noted in the right lower quadrant at McBurney's point, which is between the umbilicus and the anterior superior iliac spine. Rovsing's sign is pain felt in the right lower quadrant after the left lower quadrant has been palpated.

## Pathophysiology

The appendix becomes inflamed and edematous as a result of becoming kinked or occluded by a fecalith (ie, hardened mass of stool), tumor, or foreign body. The inflammatory process increases intraluminal pressure, initiating a progressively severe, generalized, or periumbilical pain that becomes localized to the right lower quadrant of the abdomen within a few hours. Eventually, the inflamed appendix fills with pus.

## Clinical Manifestations

Vague epigastric or periumbilical pain (ie, visceral pain that is dull and poorly localized) progresses to right lower quadrant pain (ie, parietal pain that is sharp, discrete, and well localized) and is usually accompanied by a low-grade fever and nausea and sometimes by vomiting. Loss of appetite is common. In up to 50% of presenting cases, local tenderness is elicited at McBurney's point when pressure is applied (Fig. 38-3). Rebound tenderness (ie, production or intensification of pain when pressure is released) may be present. The extent of tenderness and muscle spasm and the existence of constipation or diarrhea depend not so much on the severity of the appendiceal infection as on the location of the appendix. If the appendix curls around behind the cecum, pain and tenderness may be felt in the lumbar region. If its tip is in the pelvis, these signs may be elicited only on rectal examination. Pain on defecation suggests that the tip of the appendix is resting against the rectum; pain on urination suggests that the tip is near the bladder or impinges on the ureter. Some rigidity of the lower portion of the right rectus muscle may occur. Rovsing's sign may be elicited by palpating the left lower quadrant; this paradoxically causes pain to be felt in the right lower quadrant (see Fig. 38-3). If the appendix has ruptured, the pain becomes more diffuse; abdominal distention develops as a result of paralytic ileus, and the patient's condition worsens.

Constipation can also occur with appendicitis. Laxatives administered in this instance may result in perforation of the inflamed appendix. In general, a laxative or cathartic should never be given when a person has fever, nausea, and abdominal pain.

## Assessment and Diagnostic Findings

Diagnosis is based on results of a complete physical examination and on laboratory findings and imaging studies. The complete blood cell count demonstrates an elevated white blood cell count with an elevation of the neutrophils. Abdominal x-ray films, ultrasound studies, and CT scans may reveal a right lower quadrant density or localized distention of the bowel. A pregnancy test may be performed for women of childbearing age to rule out ectopic pregnancy and before x-rays are obtained. A diagnostic laparoscopy may be used to rule out acute appendicitis in equivocal cases.

## Complications

The major complication of appendicitis is perforation of the appendix, which can lead to peritonitis, **abscess** formation (collection of purulent material), or portal pylephlebitis, which is septic thrombosis of the portal vein caused by vegetative emboli that arise from septic intestines. Perforation generally occurs 24 hours after the onset of pain. Symptoms include a fever of 37.7°C (100°F) or greater, a toxic appearance, and continued abdominal pain or tenderness.

## Gerontologic Considerations

Acute appendicitis is uncommon in the elderly population. When it does occur, classic signs and symptoms are altered and may vary greatly. Pain may be absent or minimal.

Symptoms may be vague, suggesting bowel obstruction or another process. Fever and leukocytosis may not be present. As a result, diagnosis and prompt treatment may be delayed, causing complications and mortality. The patient may have no symptoms until the appendix ruptures. The incidence of perforated appendix is higher in the elderly population because many of these patients do not seek health care as quickly as younger patients.

### Medical Management

Immediate surgery is typically indicated if appendicitis is diagnosed. To correct or prevent fluid and electrolyte imbalance, dehydration, and sepsis, antibiotics and IV fluids are administered until surgery is performed. Appendectomy (ie, surgical removal of the appendix) is performed as soon as possible to decrease the risk of perforation. It may be performed using general or spinal anesthesia with a low abdominal incision (laparotomy) or by laparoscopy. Both laparotomy and laparoscopy are safe and effective in the treatment of appendicitis with perforation. However, recovery after laparoscopic surgery is generally quicker. Consequently, laparoscopic appendectomy is more common.

When perforation of the appendix occurs, an abscess may form. If this occurs, the patient may be initially treated with antibiotics, and the surgeon may place a drain in the abscess. After the abscess is drained and there is no further evidence of infection, an appendectomy is then typically performed.

### Nursing Management

Goals include relieving pain, preventing fluid volume deficit, reducing anxiety, eliminating infection due to the potential or actual disruption of the GI tract, maintaining skin integrity, and attaining optimal nutrition.

The nurse prepares the patient for surgery, which includes an IV infusion to replace fluid loss and promote adequate renal function and antibiotic therapy to prevent infection. If there is evidence or likelihood of paralytic ileus, a nasogastric tube is inserted. An enema is not administered because it can lead to perforation.

After surgery, the nurse places the patient in a high-Fowler's position. This position reduces the tension on the incision and abdominal organs, helping to reduce pain. An opioid, usually morphine sulfate, is prescribed to relieve pain. When tolerated, oral fluids are administered. Any patient who was dehydrated before surgery receives IV fluids. Food is provided as desired and tolerated on the day of surgery when normal bowel sounds are present.

The patient may be discharged on the day of surgery if the temperature is within normal limits, there is no undue discomfort in the operative area, and the appendectomy was uncomplicated. Discharge teaching for the patient and family is imperative. The nurse instructs the patient to make an appointment to have the surgeon remove the sutures between the 5th and 7th days after surgery. Incision care and activity guidelines are discussed; heavy lifting is to be avoided postoperatively, although normal activity can usually be resumed within 2 to 4 weeks.

If there is a possibility of peritonitis, a drain is left in place at the area of the incision. Patients at risk for this complication may be kept in the hospital for several days and are monitored carefully for signs of intestinal obstruction or secondary hemorrhage. Secondary abscesses may form in the pelvis, under the diaphragm, or in the liver, causing elevation of the temperature, pulse rate, and white blood cell count.

When the patient is ready for discharge, the patient and family are taught to care for the incision and perform dressing changes and irrigations as prescribed. A home care nurse may be needed to assist with this care and to monitor the patient for complications and wound healing. Other complications of appendectomy are listed in Table 38-3.

## *Diverticular Disease*

A **diverticulum** is a saclike herniation of the lining of the bowel that extends through a defect in the muscle layer. Diverticula may occur anywhere in the small intestine or colon but most commonly occur in the sigmoid colon (at least 95%) (Beitz, 2004). However, persons of Asian heritage tend to develop diverticula in the right colon, probably because of genetic differences.

**Table 38-3 POTENTIAL COMPLICATIONS AND NURSING INTERVENTIONS AFTER APPENDECTOMY**

| Complication | Nursing Interventions |
|---|---|
| Peritonitis | Monitor for abdominal tenderness, fever, vomiting, abdominal rigidity, and tachycardia.<br>Employ constant nasogastric suction.<br>Correct dehydration as prescribed.<br>Administer antibiotic agents as prescribed. |
| Pelvic abscess | Evaluate for anorexia, chills, fever, and diaphoresis.<br>Observe for diarrhea, which may indicate pelvic abscess.<br>Prepare patient for rectal examination.<br>Prepare patient for surgical drainage procedure. |
| Subphrenic abscess (abscess under the diaphragm) | Assess patient for chills, fever, and diaphoresis.<br>Prepare for x-ray examination.<br>Prepare for surgical drainage of abscess. |
| Ileus (paralytic and mechanical) | Assess for bowel sounds.<br>Employ nasogastric intubation and suction.<br>Replace fluids and electrolytes by intravenous route as prescribed.<br>Prepare for surgery, if diagnosis of mechanical ileus is established. |

**Diverticulosis** exists when multiple diverticula are present without inflammation or symptoms. Diverticular disease of the colon is very common in developed countries, and its prevalence increases with age: More than 50% of Americans older than 80 years have diverticulosis (Beitz, 2004). A low intake of dietary fiber is considered a predisposing factor, but the exact cause has not been identified. Most patients with diverticular disease are asymptomatic, so its exact prevalence is unknown.

**Diverticulitis** results when food and bacteria retained in a diverticulum produce infection and inflammation that can impede drainage and lead to perforation or abscess formation. At least 10% of patients with diverticulosis have diverticulitis at some point. A congenital predisposition is suspected when the disorder occurs in those younger than 40 years. Diverticulitis may occur as an acute attack or may persist as a continuing, smoldering infection. The symptoms manifested generally result from complications: abscess, **fistula** (abnormal tract) formation, obstruction, perforation, peritonitis, and hemorrhage.

## Pathophysiology

Diverticula form when the mucosa and submucosal layers of the colon herniate through the muscular wall because of high intraluminal pressure, low volume in the colon (ie, fiber-deficient contents), and decreased muscle strength in the colon wall (ie, muscular hypertrophy from hardened fecal masses). Bowel contents can accumulate in the diverticulum and decompose, causing inflammation and infection. The diverticulum can also become obstructed and then inflamed if the obstruction continues. The inflammation of the weakened colonic wall of the diverticulum can cause it to perforate, giving rise to irritability and spasticity of the colon (ie, diverticulitis). In addition, abscesses develop and may eventually perforate, leading to peritonitis and erosion of the arterial blood vessels, resulting in bleeding. When symptoms of diverticulitis have developed, microperforation of the colon has occurred (Beitz, 2004).

## Clinical Manifestations

Chronic constipation often precedes the development of diverticulosis by many years. Frequently, no problematic symptoms occur with diverticulosis. Signs and symptoms of diverticulosis are relatively mild and include bowel irregularity with intervals of diarrhea, nausea and anorexia, and bloating or abdominal distention. With repeated local inflammation of the diverticula, the large bowel may narrow with fibrotic strictures, leading to cramps, narrow stools, and increased constipation or at times intestinal obstruction. Weakness, fatigue, and anorexia are common symptoms. With diverticulitis, the patient reports an acute onset of mild to severe pain in the left lower quadrant, accompanied by nausea, vomiting, fever, chills, and leukocytosis. The condition, if untreated, can lead to peritonitis and septicemia.

## Assessment and Diagnostic Findings

Diverticulosis is typically diagnosed by colonoscopy, which permits visualization of the extent of diverticular disease and allows the physician to biopsy tissue to rule out other diseases. Until recently, barium enema had been the preferred diagnostic test, but it is now used less frequently than colonoscopy. If there are symptoms of peritoneal irritation when the diagnosis is diverticulitis, barium enema is contraindicated because of the potential for perforation.

CT with contrast agent is the diagnostic test of choice if the suspected diagnosis is diverticulitis; it can also reveal abscesses. Abdominal x-rays may demonstrate free air under the diaphragm if a perforation has occurred from the diverticulitis. Laboratory tests that assist in diagnosis include a complete blood cell count, revealing an elevated white blood cell count, and elevated erythrocyte sedimentation rate (ESR).

## Complications

Complications of diverticulitis include peritonitis, abscess formation, fistulas, and bleeding. If an abscess develops, the associated findings are tenderness, a palpable mass, fever, and leukocytosis. An inflamed diverticulum that perforates results in abdominal pain localized over the involved segment, usually the sigmoid; local abscess or peritonitis follows. Abdominal pain, a rigid boardlike abdomen, loss of bowel sounds, and signs and symptoms of shock occur with peritonitis. On occasion, the diverticular inflammation creates an abnormal passage between body structures such as a colovesical fistula (between bowel and bladder). Noninflamed or slightly inflamed diverticula may erode areas adjacent to arterial branches, causing massive rectal bleeding.

## Gerontologic Considerations

The incidence of diverticular disease increases with age because of degeneration and structural changes in the circular muscle layers of the colon and because of cellular hypertrophy. The symptoms are less pronounced in the elderly than in other adults. The elderly may not have abdominal pain until infection occurs. They may delay reporting symptoms because they fear surgery or are afraid that they may have cancer. Blood in the stool is overlooked frequently, especially in the elderly, because of a failure to examine the stool or the inability to see changes if vision is impaired.

## Medical Management

### *Dietary and Pharmacologic Management*

Diverticulitis can usually be treated on an outpatient basis with diet and medication. When symptoms occur, rest, analgesics, and antispasmodics are recommended. Initially, a clear liquid diet is consumed until the inflammation subsides; then a high-fiber, low-fat diet is recommended. This type of diet helps increase stool volume, decrease colonic transit time, and reduce intraluminal pressure. Antibiotics are prescribed for 7 to 10 days. A bulk-forming laxative is also prescribed.

In acute cases of diverticulitis with significant symptoms, hospitalization is required. Hospitalization is often indicated for those who are elderly, immunocompromised, or taking corticosteroids. Withholding oral intake, administering IV fluids, and instituting nasogastric suctioning if vomiting or distention occurs are used to rest the bowel. Broad-spectrum antibiotics are prescribed for 7 to 10 days. An opioid (eg, meperidine [Demerol]) is prescribed for pain relief. Morphine is contraindicated because it can increase intraluminal pressure in the colon, exacerbating symptoms (Beitz, 2008). Oral intake is increased as symptoms subside.

A low-fiber diet may be necessary until signs of infection decrease.

Antispasmodics such as propantheline bromide and oxyphencyclimine (Daricon) may be prescribed. Often it is not possible for patients to consume the 20 to 30 g of daily fiber that is recommended. Normal stools can be achieved by supplementing dietary fiber by using bulk preparations (psyllium) or stool softeners (docusate), by instilling warm oil into the rectum, or by inserting an evacuant suppository (bisacodyl). Such a prophylactic plan can reduce the bacterial flora of the bowel, diminish the bulk of the stool, and soften the fecal mass so that it moves more easily through the area of inflammatory obstruction.

### Surgical Management

Although acute diverticulitis usually subsides with medical management, immediate surgical intervention is necessary if complications (eg, perforation, peritonitis, hemorrhage, obstruction) occur. In cases of abscess formation without peritonitis, hemorrhage, or obstruction, CT-guided percutaneous drainage may be performed to drain the abscess, and IV antibiotics are administered. After the abscess is drained and the acute episode of inflammation has subsided (after approximately 6 weeks), surgery may be recommended to prevent repeated episodes. Two types of surgery are typically considered either to treat acute complications or prevent further episodes of inflammation:

- One-stage resection, in which the inflamed area is removed and a primary end-to-end anastomosis is completed
- Multiple-stage procedures for complications such as obstruction or perforation (Fig. 38-4)

The type of surgery performed depends on the extent of complications found during surgery. When possible, the area of diverticulitis is resected and the remaining bowel is joined end-to-end (ie, primary resection and end-to-end anastomosis). This is performed using traditional surgical or laparoscopically assisted colectomy. More primary anastomoses are completed because surgeons are now able to perform intraoperative colonic lavage to decrease intestinal bacterial load. A two-stage resection may be performed in which the diseased colon is resected (as in a one-stage procedure) but no anastomosis is performed. In this procedure, one end of the bowel is brought out to the abdominal wall and the distal end is closed over and left in the abdomen (Hartmann's procedure) or if the blood supply to the distal colon is questionable, both ends of the bowel are brought out to the abdominal wall (double-barrel) (Beitz, 2004). Both Hartmann's and double-barrel colostomies are usually reanastomosed at a later time. Fecal diversion procedures are discussed later in this chapter.

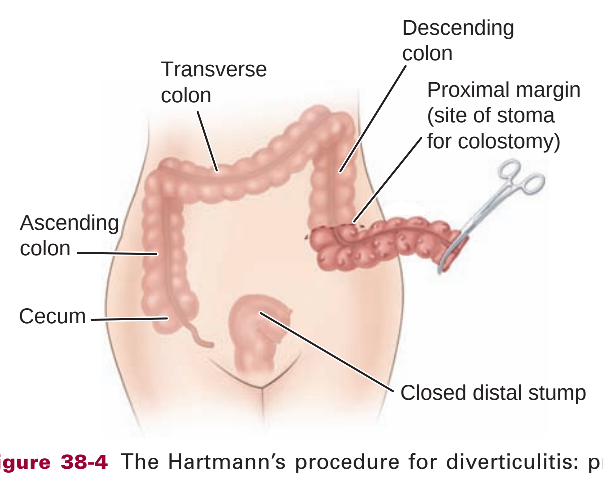



**Figure 38-4** The Hartmann's procedure for diverticulitis: primary resection for diverticulitis of the colon. The affected segment (*clamp attached*) has been divided at its distal end. In a primary anastomosis, the proximal margin (*dotted line*) is transected and the bowel attached end to end. In a two-stage procedure, a colostomy is constructed at the proximal margin with the distal stump oversewn (Hartmann procedure, as shown) and the stump is left in the pelvis. The distal stump may be brought to the surface as a mucous fistula if there is concern about blood supply. The second stage consists of colostomy takedown and anastomosis.

## NURSING PROCESS

## The Patient With Diverticulitis

### Assessment

When obtaining the health history, the nurse asks the patient about the onset and duration of pain and about past and present elimination patterns. The nurse reviews dietary habits to determine fiber intake and asks the patient about straining at stool, history of constipation with periods of diarrhea, tenesmus, abdominal bloating, and distention.

Assessment includes auscultation for the presence and character of bowel sounds and palpation for left lower quadrant pain, tenderness, or firm mass. The stool is inspected for pus, mucus, or blood. Temperature, pulse, and blood pressure are monitored for abnormal variations.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the nursing diagnoses may include the following:

- Constipation related to narrowing of the colon from thickened muscular segments and strictures
- Acute pain related to inflammation and infection

#### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following:

- Peritonitis
- Abscess formation
- Bleeding

### Planning and Goals

The major goals for the patient may include attainment and maintenance of normal elimination patterns, pain relief, and absence of complications.

### Nursing Interventions

#### *Maintaining Normal Elimination Patterns*

The nurse recommends a fluid intake of 2 L per day (within limits of the patient's cardiac and renal reserve) and suggests foods that are soft but have increased fiber, such as prepared

cereals or soft-cooked vegetables, to increase the bulk of the stool and facilitate peristalsis, thereby promoting defecation. An individualized exercise program is encouraged to improve abdominal muscle tone. It is important to review the patient's daily routine to establish a schedule for meals and a set time for defecation and to assist in identifying habits that may have suppressed the urge to defecate. The nurse encourages daily intake of bulk laxatives such as psyllium, which helps propel feces through the colon. Stool softeners are administered as prescribed to decrease straining at stool, which decreases intestinal pressure. Oil retention enemas may be prescribed to soften the stool, making it easier to pass. Some people with diverticulosis may have food triggers such as nuts and popcorn that bring on an attack of diverticulitis. Patients should be urged to identify these triggers and avoid them.

#### *Relieving Pain*

Opioid analgesics (eg, meperidine) to relieve the pain of diverticulitis and antispasmodic agents to decrease intestinal spasm are administered as prescribed (Beitz, 2008). The nurse records the intensity, duration, and location of pain to determine whether the inflammatory process worsens or subsides.

#### *Monitoring and Managing Potential Complications*

The major nursing focus is to prevent complications by identifying patients at risk and managing their symptoms as needed. The nurse assesses for the following signs and symptoms of perforation: increased abdominal pain and tenderness accompanied by abdominal rigidity, elevated white blood cell count, elevated ESR, increased temperature, tachycardia, and hypotension. Perforation is a surgical emergency. The clinical manifestations of perforation and peritonitis and the care of the patient with peritonitis are presented in the next section. The nurse monitors vital signs and urine output and administers IV fluids to replace volume loss as needed.

#### *Promoting Home and Community-Based Care*

Because patients and their family members and health care providers tend to focus on the most obvious needs and issues, the nurse reminds the patient and family about the importance of continuing health promotion and screening practices. The nurse educates patients who have not been involved in these practices in the past about their importance and refers the patients to appropriate health care providers.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Attains a normal pattern of elimination
   a. Reports less abdominal cramping and pain
   b. Reports the passage of soft, formed stool without pain
   c. Adds unprocessed bran to foods
   d. Drinks at least 10 glasses of fluid each day (if fluid intake is tolerated)
   e. Exercises daily
2. Reports decreased pain
   a. Requests analgesics as needed
   b. Adheres to a low-fiber diet during acute episodes
3. Recovers without complications
   a. Is afebrile
   b. Has normal blood pressure
   c. Has a soft, nontender abdomen with normal bowel sounds
   d. Maintains adequate urine output
   e. Has no blood in the stool

## Peritonitis

Peritonitis is inflammation of the peritoneum, the serous membrane lining the abdominal cavity and covering the viscera. Usually, it is a result of bacterial infection; the organisms come from diseases of the GI tract or, in women, from the internal reproductive organs (eg, fallopian tube). Peritonitis can also result from external sources such as injury or trauma (eg, gunshot wound, stab wound) or an inflammation that extends from an organ outside the peritoneal area, such as the kidney. Other common causes of peritonitis are appendicitis, perforated ulcer, diverticulitis, and bowel perforation (Fig. 38-5). Peritonitis may also be associated with abdominal surgical procedures and peritoneal dialysis. The most common bacteria implicated are *Escherichia coli*, *Klebsiella*, *Proteus*, *Pseudomonas*, and *Streptococcus* (Peralta & Genuit, 2006). Inflammation and paralytic ileus are the direct effects of the infection.

### Pathophysiology

Peritonitis is caused by leakage of contents from abdominal organs into the abdominal cavity, usually as a result of inflammation, infection, ischemia, trauma, or tumor perforation. Bacterial proliferation occurs. Edema of the tissues results, and exudation of fluid develops in a short time. Fluid in the peritoneal cavity becomes turbid with increasing amounts of protein, white blood cells, cellular debris,

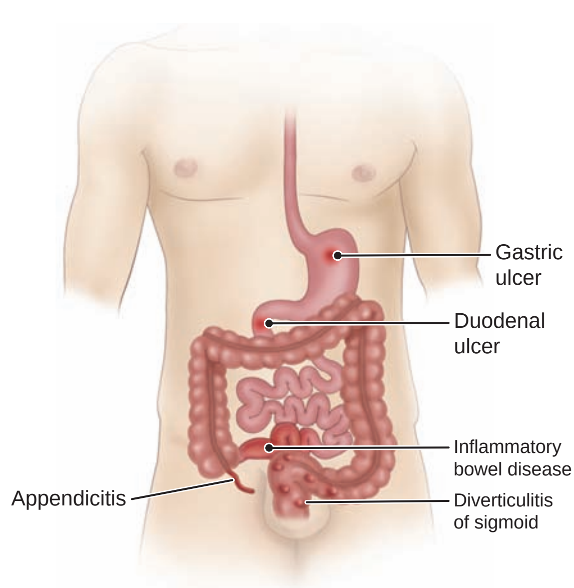



**Figure 38-5** Common gastrointestinal causes of peritonitis.

and blood. The immediate response of the intestinal tract is hypermotility, soon followed by paralytic ileus with an accumulation of air and fluid in the bowel.

## Clinical Manifestations

Symptoms depend on the location and extent of the inflammation. At first, there is diffuse pain, which tends to become constant, localized, and more intense over the site of the pathologic process (site of maximal peritoneal irritation). Movement usually aggravates it. The affected area of the abdomen becomes extremely tender and distended, and the muscles become rigid. Rebound tenderness and paralytic ileus may be present. Diminished perception of pain in peritonitis can occur in people receiving corticosteroids or analgesics. Patients with diabetes who have advanced neuropathy and patients with cirrhosis who have ascites may not experience pain during an acute bacterial infectious process. Usually, anorexia, nausea, and vomiting occur and peristalsis is diminished. A temperature of 37.8°C to 38.3°C (100°F to 101°F) can be expected, along with an increased pulse rate. With progression of the condition, patients may become hypotensive.

## Assessment and Diagnostic Findings

The white blood cell count is almost always elevated. Serum electrolyte studies may reveal altered levels of potassium, sodium, and chloride.

An abdominal x-ray may show air and fluid levels as well as distended bowel loops. Abdominal ultrasound may reveal abscesses and fluid collections, and ultrasound-guided aspiration may assist in easier placement of drains. A CT scan of the abdomen may show abscess formation. MRI may be used for diagnosis of intra-abdominal abscesses (Peralta & Genuit, 2006). Peritoneal aspiration and culture and sensitivity studies of the aspirated fluid may reveal infection and identify the causative organisms.

## Complications

The inflammation is most commonly not localized, and the entire abdominal cavity shows evidence of widespread infection. Sepsis is the major cause of death from peritonitis. Shock may result from septicemia or hypovolemia. The inflammatory process may cause intestinal obstruction, primarily from the development of bowel adhesions.

## Medical Management

Fluid, colloid, and electrolyte replacement is the major focus of medical management. The administration of several liters of an isotonic solution is prescribed. Hypovolemia occurs because massive amounts of fluid and electrolytes move from the intestinal lumen into the peritoneal cavity and deplete the fluid in the vascular space.

Analgesics are prescribed for pain. Antiemetics are administered as prescribed for nausea and vomiting. Intestinal intubation and suction assist in relieving abdominal distention and in promoting intestinal function. Fluid in the abdominal cavity can cause pressure that restricts expansion of the lungs and causes respiratory distress. Oxygen therapy by nasal cannula or mask generally promotes adequate oxygenation, but airway intubation and ventilatory assistance may be required if peritonitis leads to septic shock (refer to Chapter 15 for further discussion).

Antibiotic therapy is initiated early in the treatment of peritonitis. Large doses of a broad-spectrum antibiotic are administered intravenously until the specific organism causing the infection is identified and appropriate antibiotic therapy can be initiated.

Surgical objectives include removing the infected material and correcting the cause. Surgical treatment is directed toward excision (ie, appendix), resection with or without anastomosis (ie, intestine), repair (ie, perforation), and drainage (ie, abscess). With extensive sepsis, a fecal diversion may need to be created. In selected instances, ultrasound-guided and CT-guided peritoneal drainage of abdominal and extraperitoneal abscesses has allowed for avoidance or delay of surgical therapy until the acute septic process has subsided (Peralta & Genuit, 2006).

The two most common postoperative complications are wound evisceration and abscess formation. Any suggestion from the patient that an area of the abdomen is tender or painful or "feels as if something just gave way" must be reported. The sudden occurrence of serosanguineous wound drainage strongly suggests wound dehiscence (see Chapter 20).

## Nursing Management

Intensive care is often needed. The patient's blood pressure is monitored by arterial line if shock is present. The central venous pressure or pulmonary artery wedge pressure and urine output are monitored frequently. In addition, ongoing assessment of pain, GI function, and fluid and electrolyte balance is important. The nurse reports the nature of the pain, its location in the abdomen, and any changes in location. Administering analgesic medication and positioning the patient for comfort are helpful in decreasing pain. The patient is placed on the side with knees flexed; this position decreases tension on the abdominal organs. Accurate recording of all intake and output and central venous pressures and pulmonary artery pressures assist in calculating fluid replacement. The nurse administers and closely monitors IV fluids. Nasogastric intubation may be necessary.

Signs that indicate that peritonitis is subsiding include a decrease in temperature and pulse rate, softening of the abdomen, return of peristaltic sounds, passing of flatus, and bowel movements. The nurse increases fluid and food intake gradually and reduces parenteral fluids as prescribed. A worsening clinical condition may indicate a complication, and the nurse must prepare the patient for emergency surgery.

Drains are frequently inserted during the surgical procedure, and the nurse must monitor and record the character of the drainage postoperatively. Care must be taken when moving and turning the patient to prevent the drains from being dislodged. It is also important for the nurse to prepare the patient and family for discharge by teaching the patient to care for the incision and drains if the patient will be sent home with the drains still in place. Referral for home care may be indicated for further monitoring and patient and family teaching.

# INFLAMMATORY BOWEL DISEASE

**Inflammatory bowel disease (IBD)** refers to two chronic inflammatory GI disorders: Crohn's disease (ie, regional enteritis) and ulcerative colitis. Both disorders have striking

**Table 38-4 COMPARISON OF CROHN'S DISEASE AND ULCERATIVE COLITIS**

| Factor | Crohn's Disease | Ulcerative Colitis |
|---|---|---|
| **Course** | Prolonged, variable | Exacerbations, remissions |
| **Pathology** | | |
| Early | Transmural thickening | Mucosal ulceration |
| Late | Deep, penetrating granulomas | Minute, mucosal ulcerations |
| **Clinical Manifestations** | | |
| Location | Ileum, ascending colon (usually) | Rectum, descending colon |
| Bleeding | Usually not, but if it occurs, tends to be mild | Common–severe |
| Perianal involvement | Common | Rare–mild |
| Fistulas | Common | Rare |
| Rectal involvement | About 20% | Almost 100% |
| Diarrhea | Less severe | Severe |
| Abdominal mass | Common | Rare |
| **Diagnostic Study Findings** | | |
| Barium series | Regional, discontinuous skip lesions<br>Narrowing of colon<br>Thickening of bowel wall<br>Mucosal edema<br>Stenosis, fistulas | Diffuse involvement<br>No narrowing of colon<br>No mucosal edema<br>Stenosis rare<br>Shortening of colon |
| Sigmoidoscopy | May be unremarkable unless accompanied by perianal fistulas | Abnormal inflamed mucosa |
| Colonoscopy | Distinct ulcerations separated by relatively normal mucosa in ascending colon | Friable mucosa with pseudopolyps or ulcers in descending colon |
| **Therapeutic Management** | Corticosteroids, sulfonamides (sulfasalazine [Azulfidine])<br>Antibiotics<br>Parenteral nutrition<br>Partial or complete colectomy, with ileostomy or anastomosis<br>Rectum can be preserved in some patients<br>Recurrence common | Corticosteroids, sulfonamides; sulfasalazine useful in preventing recurrence<br>Bulk hydrophilic agents<br>Antibiotics<br>Proctocolectomy, with ileostomy<br>Rectum can be preserved in only a few patients "cured" by colectomy |
| **Systemic Complications** | Small bowel obstruction<br>Right-sided hydronephrosis<br>Nephrolithiasis<br>Cholelithiasis<br>Arthritis<br>Retinitis, iritis<br>Erythema nodosum | Toxic megacolon<br>Perforation<br>Hemorrhage<br>Malignant neoplasms<br>Pyelonephritis<br>Nephrolithiasis<br>Cholangiocarcinoma<br>Arthritis<br>Retinitis, iritis<br>Erythema nodosum |

similarities but also several differences, which are compared in Table 38-4.

The incidence of IBD in the United States has increased in the past century, and more than 30,000 new cases occur annually. People between 15 and 30 years of age are at the greatest risk of developing IBD, followed by people between 50 and 70 years of age. Women and men tend to be equally affected, and family history appears to predispose people to IBD, particularly if a first-degree relative has the disease. Some genetic linkage exists, and in fact, a positive family history is the largest independent risk factor for IBD. Crohn's disease and ulcerative colitis are more prevalent in Jewish people, especially North American Jews of eastern European descent, than in any other ethnic group (Baumgart & Carding, 2007). It was previously believed that psychological conditions such as anxiety or depression predisposed certain people to IBD; however, this theory has been discarded (NIH, 2007).

Despite extensive research, the cause of IBD is still unknown. Researchers theorize that it is triggered by environmental agents such as pesticides, food additives, tobacco, and radiation (Green, Morris & Lin, 2005; NIH, 2007). Nonsteroidal anti-inflammatory drugs (NSAIDs) have been found to exacerbate IBD. Allergies and immune disorders have also been suggested as causes. Abnormal response to dietary or bacterial antigens has been studied extensively, and genetic factors also are being studied. There is a high prevalence of coexistent IBS, which complicates the overall symptom presentation.

## Types of Inflammatory Bowel Disease

### Crohn's Disease (Regional Enteritis)

Crohn's disease is usually first diagnosed in adolescents or young adults but can appear at any time of life. The incidence has risen over the past 30 years (NIH, 2007). Crohn's

disease is seen more often in smokers than in nonsmokers (Colwell, Goldberg & Carmel, 2004).

### Pathophysiology

Crohn's disease is a subacute and chronic inflammation of the GI tract wall that extends through all layers (ie, transmural lesion). Although its characteristic histopathological changes can occur anywhere in the GI tract, it most commonly occurs in the distal ileum and, to a lesser degree, the ascending colon. It is characterized by periods of remission and exacerbation. The disease process begins with edema and thickening of the mucosa. Ulcers begin to appear on the inflamed mucosa. These lesions are not in continuous contact with one another and are separated by normal tissue. Hence, these clusters of ulcers tend to take on a classic "cobblestone" appearance. Fistulas, fissures, and abscesses form as the inflammation extends into the peritoneum. Granulomas occur in 50% of patients. As the disease advances, the bowel wall thickens and becomes fibrotic, and the intestinal lumen narrows. Diseased bowel loops sometimes adhere to other loops surrounding them.

### Clinical Manifestations

The onset of symptoms is usually insidious in Crohn's disease, with prominent right lower quadrant abdominal pain and diarrhea unrelieved by defecation. Scar tissue and the formation of granulomas interfere with the ability of the intestine to transport products of upper intestinal digestion through the constricted lumen, resulting in crampy abdominal pains. There is abdominal tenderness and spasm. Because eating stimulates intestinal peristalsis, the crampy pains occur after meals. To avoid these bouts of crampy pain, the patient tends to limit food intake, reducing the amounts and types of food to such a degree that normal nutritional requirements are often not met. As a result, weight loss, malnutrition, and secondary anemia occur. Ulcers in the membranous lining of the intestine and other inflammatory changes result in a weeping, edematous intestine that continually empties an irritating discharge into the colon. Disrupted absorption causes chronic diarrhea and nutritional deficits. The result is a person who is thin and emaciated from inadequate food intake and constant fluid loss. In some patients, the inflamed intestine may perforate, leading to intra-abdominal and anal abscesses. Fever and leukocytosis occur. Chronic symptoms include diarrhea, abdominal pain, **steatorrhea** (ie, excessive fat in the feces), anorexia, weight loss, and nutritional deficiencies.

Abscesses, fistulas, and fissures are common. Manifestations may extend beyond the GI tract and can include joint disorders (eg, arthritis), skin lesions (eg, erythema nodosum), ocular disorders (eg, conjunctivitis), and oral ulcers. The clinical course and symptoms can vary; in some patients, periods of remission and exacerbation occur, but in others, the disease follows a fulminating course. When intestinal symptoms worsen, extraintestinal manifestations often worsen also. Both usually improve simultaneously (Baumgart & Carding, 2007).

### Assessment and Diagnostic Findings

A proctosigmoidoscopy is usually performed initially to determine whether the rectosigmoid area is inflamed. A stool examination is also performed; the result may be positive for occult blood and steatorrhea. The most conclusive diagnostic aid for Crohn's disease is a barium study of the upper GI tract that shows the classic "string sign" on an x-ray film of the terminal ileum, indicating the constriction of a segment of intestine. Endoscopy, colonoscopy, and intestinal biopsies may be used to confirm the diagnosis. A barium enema may show ulcerations (the cobblestone appearance described earlier), fissures, and fistulas. A CT scan may show bowel wall thickening and fistula formation.

A complete blood cell count is performed to assess hematocrit and hemoglobin levels (usually decreased) as well as the white blood cell count (may be elevated). The ESR is usually elevated. Albumin and protein levels may be decreased, indicating malnutrition.

### Complications

Complications of Crohn's disease include intestinal obstruction or stricture formation, perianal disease, fluid and electrolyte imbalances, malnutrition from malabsorption, and fistula and abscess formation. The most common type of small bowel fistula caused by Crohn's disease is the enterocutaneous fistula (ie, an abnormal opening between the small bowel and the skin). Abscesses can be the result of an internal fistula that results in fluid accumulation and infection. Patients with Crohn's disease are also at increased risk of colon cancer.

## Ulcerative Colitis

Ulcerative colitis is a recurrent ulcerative and inflammatory disease of the mucosal and submucosal layers of the colon and rectum. The prevalence of ulcerative colitis is highest in Caucasians and people of Jewish heritage (Baumgart & Carding, 2007; Cho & Abraham, 2007). It is typically accompanied by systemic complications and a high mortality rate. Approximately 5% of patients with ulcerative colitis develop colon cancer (NIH, 2007).

### Pathophysiology

Ulcerative colitis affects the superficial mucosa of the colon and is characterized by multiple ulcerations, diffuse inflammations, and desquamation or shedding of the colonic epithelium. Bleeding occurs as a result of the ulcerations. The mucosa becomes edematous and inflamed. The lesions are contiguous, occurring one after the other. Abscesses form, and infiltrate is seen in the mucosa and submucosa, with clumps of neutrophils found in the lumens of the crypts (ie, crypt abscesses) that line the intestinal mucosa (Huether & McCance, 2008). The disease process usually begins in the rectum and spreads proximally to involve the entire colon. Eventually, the bowel narrows, shortens, and thickens because of muscular hypertrophy and fat deposits. Because the inflammatory process is not transmural (ie, it affects the inner lining only), fistulas, obstruction, and fissures are uncommon (Baumgart & Sandborn, 2007).

### Clinical Manifestations

The clinical course is usually one of exacerbations and remissions. The predominant symptoms of ulcerative colitis include diarrhea, passage of mucus and pus, left lower quadrant abdominal pain, intermittent tenesmus, and rectal

bleeding. The bleeding may be mild or severe, and pallor, anemia, and fatigue result. The patient may have anorexia, weight loss, fever, vomiting, and dehydration, as well as cramping, the feeling of an urgent need to defecate, and the passage of 10 to 20 liquid stools each day. The disease is classified as mild, severe, or fulminant, depending on the severity of the symptoms. Hypocalcemia and anemia frequently develop. Rebound tenderness may occur in the right lower quadrant. Extraintestinal manifestations include skin lesions (eg, erythema nodosum), eye lesions (eg, uveitis), joint abnormalities (eg, arthritis), and liver disease.

#### Assessment and Diagnostic Findings

The patient should be assessed for tachycardia, hypotension, tachypnea, fever, and pallor. Other assessments address the level of hydration and nutritional status. The abdomen is examined for bowel sounds, distention, and tenderness. These findings assist in determining the severity of the disease.

The stool is positive for blood, and laboratory test results reveal low hematocrit and hemoglobin levels in addition to an elevated white blood cell count, low albumin levels, and an electrolyte imbalance. Elevated antineutrophil cytoplasmic antibody levels are common (Baumgart & Sandborn, 2007). Abdominal x-ray studies are useful for determining the cause of symptoms. Free air in the peritoneum and bowel dilation or obstruction should be excluded as a source of the presenting symptoms. Sigmoidoscopy or colonoscopy and barium enema are valuable in distinguishing ulcerative colitis from other diseases of the colon with similar symptoms. A barium enema may show mucosal irregularities, focal strictures or fistulas, shortening of the colon, and dilation of bowel loops. Colonoscopy may reveal friable, inflamed mucosa with exudate and ulcerations, and it assists in defining the extent and severity of the disease. CT scanning, MRI, and ultrasound studies can identify abscesses and perirectal involvement. Leukocyte tagging (see Chapter 34) is useful when severe colitis prohibits the use of colonoscopy to determine the extent of inflammation.

Careful stool examination for parasites and other microbes is performed to rule out dysentery caused by common intestinal organisms, especially *Entamoeba histolytica*, *C. difficile*, *Campylobacter*, *Salmonella*, *Shigella*, and *Cryptospora* (Baumgart & Sandborn, 2007).

#### Complications

Complications of ulcerative colitis include toxic megacolon, perforation, and bleeding as a result of ulceration, vascular engorgement, and highly vascular granulation tissue. In toxic megacolon, the inflammatory process extends into the muscularis, inhibiting its ability to contract and resulting in colonic distention. Symptoms include fever, abdominal pain and distention, vomiting, and fatigue. If the patient with toxic megacolon does not respond within 24 to 72 hours to medical management with nasogastric suction, IV fluids with electrolytes, corticosteroids, and antibiotics, surgery is required. Total colectomy is then indicated. For many patients, surgery becomes necessary to relieve the effects of the disease and to treat these serious complications; an ileostomy usually is performed. The surgical procedures involved and the care of patients with this type of fecal diversion are discussed later in this chapter.

Patients with IBD also have a significantly increased risk of osteoporotic fractures due to decreased bone mineral density. Corticosteroid therapy may also contribute to the diminished bone density.

## Management of Chronic Inflammatory Bowel Disease

Medical treatment for both Crohn's disease and ulcerative colitis is aimed at reducing inflammation, suppressing inappropriate immune responses, providing rest for a diseased bowel so that healing may take place, improving quality of life, and preventing or minimizing complications. Most patients have long periods of well-being interspersed with short intervals of illness (Baumgart & Sandborn, 2007). Management depends on the disease location, severity, and complications.

### Nutritional Therapy

Oral fluids and a low-residue, high-protein, high-calorie diet with supplemental vitamin therapy and iron replacement are prescribed to meet nutritional needs, reduce inflammation, and control pain and diarrhea. Fluid and electrolyte imbalances from dehydration caused by diarrhea are corrected by IV therapy as necessary if the patient is hospitalized or by oral fluids if the patient is managed at home. Any foods that exacerbate diarrhea are avoided. Milk may contribute to diarrhea in those with lactose intolerance. Cold foods and smoking are avoided because both increase intestinal motility. Parenteral nutrition may be indicated (see Chapter 36).

### Pharmacologic Therapy

Sedatives and antidiarrheal and antiperistaltic medications are used to minimize peristalsis to rest the inflamed bowel. They are continued until the patient's stools approach normal frequency and consistency.

Aminosalicylates such as sulfasalazine (Azulfidine) are often effective for mild or moderate inflammation and are used to prevent or reduce recurrences in long-term maintenance regimens. Corticosteroids are used to treat severe and fulminant disease and can be administered orally (eg, prednisone [Deltasone]) in outpatient treatment or parenterally (eg, hydrocortisone [Solu-Cortef]) in hospitalized patients. Topical (ie, rectal administration) corticosteroids (eg, budesonide [Entocortec) are also widely used in the treatment of distal colon disease. When the dosage of corticosteroids is reduced or stopped, the symptoms of disease may return. If corticosteroids are continued, numerous adverse sequelae may ensue; these are discussed in Chapter 42 and summarized in Table 42-6.

Immunomodulators (eg, azathioprine [Imuran], mercaptopurine [6-MP], methotrexate [MTX], cyclosporine [Neoral]) have been used to alter the immune response. The exact mechanism of action of these medications in treating IBD is unknown. They are used in patients with severe disease who have not responded favorably to other therapies—in maintenance regimens to prevent relapses. Among the newer biologic therapies using monoclonal antibodies are natalizumab (Tysabri) for Crohn's disease (Sandborn,

Colombel, Enns, et al., 2005) and infliximab (Remicade) for ulcerative colitis (Pizzaro & Cominelli, 2007; Rutgeerts, Sandborn, Feagan, et al., 2005). Clinical outcomes associated with the use of both biologic agents are promising (Rutgeerts, et al., 2005; Sandborn, et al., 2005), although adverse effects may seriously limit their usefulness. Other biologic therapies recently tested in Crohn's disease include anticytokine therapy using anti-interleukin type drugs (eg, anti-IL-12), which has thus far demonstrated a satisfactory safety profile (Pizarro & Cominelli, 2007).

A major issue associated with appropriate pharmacological treatment of IBD is noncompliance. Patients who are noncompliant may suffer a greater chance of disease relapse that can be severe (Turnbough & Wilson, 2007).

## Surgical Management

When nonsurgical measures fail to relieve the severe symptoms of IBD, surgery may be necessary. Ultimately, 75% of patients with Crohn's disease undergo surgery within 10 years of diagnosis and between 25% and 60% require further repeat surgery within the same time frame (Byrne, Solomon, Young, et al., 2007). The most common indications for surgery are medically intractable disease, poor quality of life, or complications from the disease or its treatment. Recurrence of inflammation and disease after surgery in Crohn's disease is inevitable (Colwell, et al., 2004).

A common procedure performed for strictures of the small intestines is laparoscope-guided strictureplasty, in which the blocked or narrowed sections of the intestines are widened, leaving the intestines intact. In some cases, a small bowel resection is performed and diseased segments of the small intestines are resected and the remaining portions of the intestines are anastomosed. Surgical removal of up to 50% of the small bowel usually can be tolerated. In cases of severe Crohn's disease of the colon, a total colectomy and ileostomy may be the procedure of choice.

A newer surgical procedure developed for patients with severe Crohn's disease is intestinal transplant. This technique is now available to children and to young and middle-aged adults who have lost intestinal function from disease. It may provide improvement in quality of life for some patients. The associated technical and immunologic problems remain formidable, and the costs and mortality rates continue to be high. None of the surgical procedures for Crohn's disease are curative. Ultimately, achievement of remission depends on medical therapy (Byrne, et al., 2007).

At least 25% of patients with ulcerative colitis eventually have total colectomies (NIH, 2007). When the colon is surgically removed, the patient is considered "cured" in that extraintestinal manifestations subside and the disease process is otherwise limited to the colon. Indications for surgery include lack of improvement and continued deterioration, profuse bleeding, perforation, continued stricture formation, and cancer. Surgical excision usually improves quality of life. Proctocolectomy with ileostomy (ie, complete excision of colon, rectum, and anus) is recommended when the rectum is severely diseased. If the rectum can be preserved, restorative proctocolectomy with ileal pouch anal anastomosis (IPAA) is the procedure of choice. Although IPAA is not "perfect," it generally leads to a good to excellent quality of life (Beitz, 1999).

Other types of surgical procedures, known as fecal diversions, are discussed later in this chapter.

### Total Colectomy With Ileostomy

An **ileostomy,** the surgical creation of an opening into the ileum or small intestine (usually by means of an ileal stoma on the abdominal wall), is commonly performed after a total colectomy (ie, excision of the entire colon). It allows for drainage of fecal matter (ie, effluent) from the ileum to the outside of the body. The drainage is liquid to unformed and occurs at frequent intervals. Nursing management of the patient with an ileostomy is discussed later in this chapter.

### Continent Ileostomy

Another procedure involves the creation of a continent ileal reservoir (ie, **Kock pouch**) by diverting a portion of the distal ileum to the abdominal wall and creating a stoma. This procedure eliminates the need for an external fecal collection bag. Approximately 30 cm of the distal ileum is reconstructed to form a reservoir with a nipple valve that is created by pulling a portion of the terminal ileal loop back into the ileum. GI effluent can accumulate in the pouch for several hours and then be removed by means of a catheter inserted through the nipple valve. In many patients, a total colectomy is also performed with the Kock pouch. Possible indications for a total colectomy with Kock pouch placement (rather than a restorative proctocolectomy with IPAA) include a badly diseased rectum, lack of rectal sphincter tone, or inability to achieve fecal continence post-IPAA.

The major problem with the Kock pouch is malfunction of the nipple valve, which often requires additional corrective surgery. Research is currently focused on developing valves that may fail less frequently than the nipple valve.

### Restorative Proctocolectomy With Ileal Pouch Anal Anastomosis

A restorative proctocolectomy with IPAA is the surgical procedure of choice in cases where the rectum can be preserved in that it eliminates the need for a permanent ileostomy. It establishes an ileal reservoir that functions as a "new" rectum, and anal sphincter control of elimination is retained. The procedure involves connecting the ileum to the anal pouch (made from a small intestine segment), and the surgeon connects the pouch to the anus in conjunction with removing the colon and the rectal mucosa (ie, total abdominal colectomy and mucosal proctectomy) (Fig. 38-6). A temporary diverting loop ileostomy that promotes healing of the surgical anastomoses is constructed at the time of surgery and closed about 3 months later.

With IPAA or restorative proctocolectomy, the diseased colon and rectum are removed, voluntary defecation is maintained, and anal continence is preserved. The ileal reservoir decreases the number of bowel movements by 50%, from approximately 14 to 20 per day to 7 to 10 per day. Nighttime elimination is gradually reduced to one bowel movement. Complications of ileoanal anastomosis include irritation of the perianal skin from leakage of fecal contents, stricture formation at the anastomosis site, small bowel obstruction, and "pouchitis" (inflammation of the ileoanal pouch due to altered microbial levels).

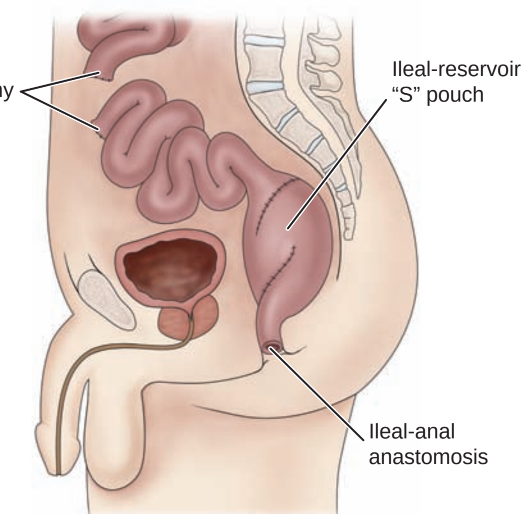



**Figure 38-6** A mucosal proctectomy precedes anastomosis of the ileal reservoir. A temporary loop ileostomy diverts effluent for several months to allow healing.

# NURSING PROCESS

## MANAGEMENT OF THE PATIENT WITH CHRONIC INFLAMMATORY BOWEL DISEASE

### Assessment

The nurse obtains a health history to identify the onset, duration, and characteristics of abdominal pain; the presence of diarrhea or fecal urgency, straining at stool (tenesmus), nausea, anorexia, or weight loss; and family history of IBD. It is important to discuss dietary patterns, including the amounts of alcohol, caffeine, and nicotine-containing products used daily and weekly. The nurse asks about patterns of bowel elimination, including character, frequency, and presence of blood, pus, fat, or mucus. It is important to note allergies and food intolerance, especially milk (lactose) intolerance. The patient may identify sleep disturbances if diarrhea or pain occurs at night.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the nursing diagnoses may include the following:

- Diarrhea related to the inflammatory process
- Acute pain related to increased peristalsis and GI inflammation
- Deficient fluid volume related to anorexia, nausea, and diarrhea
- Imbalanced nutrition, less than body requirements, related to dietary restrictions, nausea, and malabsorption
- Activity intolerance related to generalized weakness
- Anxiety related to impending surgery
- Ineffective coping related to repeated episodes of diarrhea
- Risk for impaired skin integrity related to malnutrition and diarrhea
- Risk for ineffective therapeutic regimen management related to insufficient knowledge concerning the process and management of the disease

#### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following:

- Electrolyte imbalance
- Cardiac dysrhythmias related to electrolyte imbalances
- GI bleeding with fluid volume loss
- Perforation of the bowel

### Planning and Goals

The major goals for the patient include attainment of normal bowel elimination patterns, relief of abdominal pain and cramping, prevention of fluid volume deficit, maintenance of optimal nutrition and weight, avoidance of fatigue, reduction of anxiety, promotion of effective coping, absence of skin breakdown, increased knowledge about the disease process and therapeutic regimen, and avoidance of complications.

### Nursing Interventions

#### *Maintaining Normal Elimination Patterns*

The nurse provides ready access to a bathroom, commode, or bedpan and keeps the environment clean and odor-free. It is important to administer antidiarrheal medications as prescribed, to record the frequency and consistency of stools after therapy is initiated, and to encourage bed rest to decrease peristalsis.

#### *Relieving Pain*

The character of the pain is described as dull, burning, or crampy. It is important to ask about its onset. Does it occur before or after meals, during the night, or before elimination? Is the pattern constant or intermittent? Is it relieved with medications? The nurse administers anticholinergic medications 30 minutes before a meal as prescribed to decrease intestinal motility and administers analgesics as prescribed for pain. Position changes, local application of heat (as prescribed), diversional activities, and prevention of fatigue also are helpful for reducing pain.

#### *Maintaining Fluid Intake*

To detect fluid volume deficit, the nurse keeps an accurate record of oral and IV fluids and maintains a record of output (ie, urine, liquid stool, vomitus, wound or fistula drainage). The nurse monitors daily weights for fluid gains or losses and assesses the patient for signs of fluid volume deficit (ie, dry skin and mucous membranes, decreased skin turgor, oliguria, fatigue, decreased temperature, increased hematocrit, elevated urine specific gravity, and hypotension). It is important to encourage oral intake of fluids and to monitor the flow rate of any IV fluids. The nurse initiates measures to decrease diarrhea (eg, dietary restrictions, stress reduction, antidiarrheal agents).

#### *Maintaining Optimal Nutrition*

Parenteral nutrition is used when the symptoms of IBD are severe. With parenteral nutrition, the nurse maintains an accurate record of fluid intake and output as well as the

daily weight. The patient should gain 0.5 kg daily during parenteral nutrition therapy. Because parenteral nutrition is very high in glucose and can cause hyperglycemia, blood glucose levels are monitored every 6 hours. Once the symptoms of IBD exacerbation have diminished and the patient has gained or stabilized weight, parenteral nutrition is stopped and the patient is advanced on oral elemental feedings. Elemental feedings are high in protein and low in fat and residue. They are digested primarily in the jejunum, do not stimulate intestinal secretions, and allow the bowel to continue to rest. The nurse notes intolerance if the patient exhibits nausea, vomiting, diarrhea, or abdominal distention.

If oral foods are tolerated, small, frequent, low-residue feedings are given to avoid overdistending the stomach and stimulating peristalsis. It is important that the patient restrict activity to conserve energy, reduce peristalsis, and reduce caloric requirements.

### *Promoting Rest*

The nurse recommends intermittent rest periods during the day and schedules or restricts activities to conserve energy and reduce the metabolic rate. It is important to encourage activity within the limits of the patient's capacity. The nurse suggests bed rest for a patient who is febrile, has frequent diarrheal stools, or is bleeding. However, the patient on bed rest should perform active exercises to maintain muscle tone and prevent thromboembolic complications. If the patient cannot perform these active exercises, the nurse performs passive exercises and joint range of motion. Activity restrictions are modified as needed on a day-to-day basis.

### *Reducing Anxiety*

The patient may be emotionally labile because of the consequences of the disease and the uncertainty of exacerbations with complications. The nurse tailors information about possible impending surgery to the patient's level of understanding and desire for detail. If surgery is planned, pictures and illustrations help explain the surgical procedure and help the patient visualize what a stoma looks like.

### *Enhancing Coping Measures*

Any patient suffering the discomforts of frequent bowel movements and rectal soreness is anxious, discouraged, and depressed. It is important to develop a relationship with the patient that supports all attempts to cope with these stressors. Stress reduction measures that may be used include relaxation techniques, visualization, breathing exercises, and biofeedback. Professional counseling may be needed to help the patient and family manage issues associated with chronic illness and resulting disability.

### *Preventing Skin Breakdown*

The nurse examines the patient's skin frequently, especially the perianal skin. Perianal care, including the use of a skin barrier (eg, petroleum ointment [Vaseline]), is important after each bowel movement. The nurse gives immediate attention to reddened or irritated areas over bony prominences and uses pressure-relieving devices to prevent skin breakdown. Consultation with a **wound-ostomy-continence nurse** (WOC nurse, or WOCN) (a nurse specially educated in the management of a variety of fecal and urinary diversions) is often helpful.

### *Monitoring and Managing Potential Complications*

Serum electrolyte levels are monitored daily, and electrolyte replacements are administered as prescribed. It is important to report evidence of dysrhythmias or changes in level of consciousness immediately.

The nurse closely monitors rectal bleeding and administers blood component therapy and volume expanders as prescribed to prevent hypovolemia. It is important to monitor the blood pressure for hypotension and to obtain coagulation profiles and hemoglobin and hematocrit levels frequently. Vitamin K may be prescribed to increase clotting factors.

The nurse closely monitors the patient for indications of perforation (ie, acute increase in abdominal pain, rigid abdomen, vomiting, or hypotension) and obstruction and toxic megacolon (ie, abdominal distention, decreased or absent bowel sounds, change in mental status, fever, tachycardia, hypotension, dehydration, and electrolyte imbalances).

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The nurse assesses the patient's understanding of the disease process and his or her need for additional information about medical management (eg, medications, diet) and surgical interventions. The nurse provides information about nutritional management; a bland, low-residue, high-protein, high-calorie, and high-vitamin diet relieves symptoms and decreases diarrhea. It is important to explain the rationale for the use of corticosteroids and anti-inflammatory, antibacterial, antidiarrheal, and antispasmodic medications. The nurse emphasizes the importance of taking medications as prescribed and not abruptly discontinuing them (especially corticosteroids) to avoid development of serious medical problems (Chart 38-3). The nurse reviews ileostomy care as necessary (see Nursing Management of the Patient Requiring an Ileostomy). Patient education information can be obtained from the Crohn's and Colitis Foundation of America (CCFA).

**CONTINUING CARE.** Patients with chronic IBD are managed at home with follow-up care by their physician or through an outpatient clinic. Those whose nutritional status is compromised and who are receiving parenteral nutrition need home care nursing to ensure that their nutritional requirements are being met and that they or their caregivers can follow through with the instructions for parenteral nutrition. Patients who are undergoing medical treatment need to understand that their disease can be controlled and that they can lead a healthy life between exacerbations. Control implies management based on an understanding of the disease and its treatment. Patients in the home setting need information about their medications (ie, name, dose, side effects, and frequency of administration) and need to take medications on schedule. Medication reminders such as containers that separate pills according to day and time or daily checklists are helpful.

During a flare-up, the nurse encourages the patient to rest as needed and to modify activities according to his or her energy level. Patients should limit tasks that impose strain on the lower abdominal muscles. They should sleep in a room close to the bathroom because of the frequent

**CHART 38-3** HOME CARE CHECKLIST
***Inflammatory Bowel Disease***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Verbalize an understanding of the disease process. | ✔ | ✔ |
| • Discuss nutritional management: bland, low-residue, high-protein, high-vitamin diet; identify foods to include and foods to be avoided. | ✔ | ✔ |
| • Describe medication regimen; identify medications by name, use, route, and frequency. | ✔ | ✔ |
| • Identify measures to be used to treat exacerbation of symptoms, to include rest, dietary modifications, and medications. | ✔ | ✔ |
| • Identify measures to be used to promote fluid and electrolyte balance during acute exacerbations. | ✔ | ✔ |
| • Demonstrate management of parenteral nutrition therapy, if applicable; identify possible complications and interventions. | ✔ | ✔ |
| • Incorporate stress reduction measures into lifestyle. | ✔ | |

diarrhea (10 to 20 times per day); quick access to a toilet helps alleviate worry about having an "accident." Room deodorizers help control odors.

Dietary modifications can control but do not cure the disease; the nurse recommends a low-residue, high-protein, high-calorie diet, especially during an acute phase. It is important to encourage the patient to keep a record of the foods that irritate the bowel and to avoid them and to drink at least eight glasses of water each day.

The prolonged nature of the disease has an impact on the patient and often strains his or her family life and financial resources. Family support is vital; however, some family members may be resentful, or feel guilty, tired, or unable to cope with the emotional demands of the illness and the physical demands of providing care. Some patients with IBD do not socialize for fear of being embarrassed. Many prefer to eat alone. Because they have lost control over elimination, they may fear losing control over other aspects of their lives. They need time to express their fears and frustrations. Individual and family counseling may be helpful.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports a decrease in the frequency of diarrheal stools
   a. Complies with dietary restrictions; maintains bed rest
   b. Takes medications as prescribed
2. Has reduced pain
3. Maintains fluid volume balance
   a. Drinks 1 to 2 L of oral fluids daily
   b. Has normal body temperature
   c. Displays adequate skin turgor and moist mucous membranes
4. Attains optimal nutrition; tolerates small, frequent feedings without diarrhea
5. Avoids fatigue
   a. Rests periodically during the day
   b. Adheres to activity restrictions
6. Is less anxious
7. Copes successfully with diagnosis
   a. Verbalizes feelings freely
   b. Uses appropriate stress reduction behaviors
8. Maintains skin integrity
   a. Cleans perianal skin after defecation
   b. Uses lotion or ointment as skin barrier
9. Acquires an understanding of the disease process
   a. Modifies diet appropriately to decrease diarrhea
   b. Adheres to medication regimen as prescribed
10. Recovers without complications
    a. Electrolytes within normal ranges
    b. Normal sinus or baseline cardiac rhythm
    c. Maintains fluid balance
    d. Experiences no perforation or rectal bleeding

## Nursing Management of the Patient Requiring an Ileostomy

Some patients with IBD eventually require a permanent fecal diversion with creation of an ileostomy to manage symptoms and to treat or prevent complications. The Plan of Nursing Care summarizes care for the patient requiring an ostomy (Chart 38-4).

### *Providing Preoperative Care*

A period of preparation with intensive replacement of fluid, blood, and protein is necessary prior to surgery. Antibiotics may be prescribed. If the patient has been taking corticosteroids, they will be continued during the surgical phase to prevent steroid-induced adrenal insufficiency. Usually, the patient is given a low-residue diet, provided in frequent, small feedings. All other preoperative measures are similar to those for general abdominal surgery. The patient must have a thorough understanding of the surgery to be performed and what to expect after surgery. Preoperative teaching includes management of drainage from the stoma; the nature of drainage; and the need for

CHART 38-4

**PLAN OF NURSING CARE**

## *The Patient Undergoing Ostomy Surgery*

**NURSING DIAGNOSIS:** Deficient knowledge about the surgical procedure and preoperative preparation
**GOAL:** Understands the surgical process and the necessary preoperative preparations

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Preoperative Care** | | |
| 1. Ascertain whether the patient has had a previous surgical experience and ask for recollections of positive and negative impressions. | 1. Fear of a repeated negative experience increases anxiety. Talking about the experience with a nurse helps clarify misconceptions and helps the patient ventilate any repressed emotions. Positive experiences are reinforced. | • Expresses anxieties and fears about the surgical process<br>• Projects a positive attitude toward the surgical procedure<br>• Repeats in own words information given by the surgeon<br>• Identifies normal anatomy and physiology of gastrointestinal tract and how it will be altered; can point to expected location of abdominal wound and stoma; describes stoma appearance and size<br>• Adheres to "bowel prep" regimen of antimicrobials or mechanical cleansing<br>• Tolerates the presence of nasogastric/nasoenteric tube |
| 2. Determine what information the surgeon gave the patient and family and whether it was understood. Clarify and elaborate as necessary. Determine whether the stoma is permanent or temporary. Be aware of the patient's prognosis if carcinoma exists. | 2. Clarification prevents misunderstandings and alleviates anxiety. | |
| 3. Use pictures or drawings to illustrate the location and appearance of the surgical wounds (abdominal, perineal) and the stoma if the patient is receptive. | 3. Knowledge, for some, alleviates anxiety because fear of the unknown is decreased. Others choose not to know because it makes them more anxious. | |
| 4. Explain that oral/parenteral antimicrobials will be administered to cleanse the bowel preoperatively. Mechanical cleansing may also be required. | 4. Antimicrobials and mechanical cleansing (eg, laxatives, enemas) reduce intestinal bacterial flora. | |
| 5. Assist the patient during nasogastric/nasoenteric intubation. Measure drainage from the tube. | 5. Nasoenteral intubation is used for decompression and drainage of gastrointestinal contents before surgery. | |

**NURSING DIAGNOSIS:** Disturbed body image
**GOAL:** Attainment of a positive self-concept

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage the patient to verbalize feelings about the stoma. Offer to be present when the stoma is first viewed and touched. | 1. Free expression of feelings allows the patient the opportunity to verbalize and identify concerns. Expressed concerns can be therapeutically addressed by health care team members. | • Freely expresses concerns and fears<br>• Accepts support<br>• Seeks help as needed<br>• States is willing to talk with another patient with a stoma |
| 2. Suggest that the spouse or significant other view the stoma. | 2. Helps patient to overcome fears about partner's response. | |
| 3. Offer counseling, if desired. | 3. Provides opportunity for additional support. | |
| 4. Arrange for a visit or a phone call with another patient with a stoma. | 4. People with stomas can offer support and share mutual feelings and experiences. | |

**NURSING DIAGNOSIS:** Anxiety related to the loss of bowel control
**GOAL:** Reduction of anxiety

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Postoperative Care** | | |
| 1. Provide information about expected bowel function:<br>a. Characteristics of effluent<br>b. Frequency of discharge. | 1. Emotional adjustment is facilitated if adequate information is provided at the level of the learner. | • Expresses interest in learning about altered bowel function<br>• Handles equipment correctly<br>• Changes the appliance unassisted<br>• Irrigates colostomy successfully<br>• Progresses toward a regular schedule of elimination |

*Continued on following page*

CHART 38-4

**PLAN OF NURSING CARE**

## The Patient Undergoing Ostomy Surgery (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Teach the patient how to prepare the appliance for an adequate fit.<br>a. Choose the drainage appliance that will provide a secure fit around the stoma. Measure the stoma size with a measuring guide provided by the ostomy equipment manufacturer and compare with the opening on the pouch. The barrier opening should be sized to "hug" the stoma and cover the peristomal skin. Note: newer wafer barriers can be pulled or molded to the size of the stoma. | 2. Adequate fit is necessary for successful use of the appliance.<br>a. The appliance opening should be larger than the stoma for an adequate fit. Available brands come in different sizes to fit the stoma. Adjustments are made as necessary. | |
| b. Remove any plastic covering that protects the appliance adhesive. *Note:* The pouch is applied by pressing the adhesive for 30 seconds to the skin or skin barrier. | b. The appliance is ready to apply directly to the skin or skin protector. | |
| 3. Demonstrate how to change the appliance or empty the pouch before leakage occurs. Be aware that the elderly person may have diminished vision and difficulty handling equipment. | 3. Manipulation of the appliance is a learned motor skill that requires practice and positive reinforcement. | |
| 4. When appropriate, demonstrate how to irrigate the colostomy (usually on the 4th or 5th day). Recommend that irrigation be performed at a consistent time, depending on the type of colostomy. | 4. Colostomy irrigation is used to regulate the passage of fecal material; alternatively the bowel can be allowed to evacuate naturally. Irrigation is not routinely indicated. | |

**NURSING DIAGNOSIS:** Risk for impaired skin integrity related to irritation of the peristomal skin by the effluent
**GOAL:** Maintenance of skin integrity

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Provide information about signs and symptoms of irritated or inflamed skin. Use pictures if possible. | 1. Peristomal skin should be slightly pink without abrasions and similar to that of the entire abdomen. | • Describes appearance of healthy skin<br>• Correctly cleanses the skin<br>• Successfully applies a skin barrier<br>• Gently removes the drainage appliance without skin damage<br>• Demonstrates intact skin around the colostomy stoma |
| 2. Teach patient how to cleanse the peristomal skin gently. | 2. Mild friction with warm water and a gentle soap cleanses the skin and minimizes irritation and possible abrasions. After rinsing the soap, patting the skin dry prevents tissue trauma. | |
| 3. Demonstrate how to apply a skin barrier (powder, gel, paste, wafer). | 3. Skin barriers protect the peristomal skin from enzymes and bacteria. | |
| 4. Demonstrate how to remove the pouch. | 4. Gently separate adhesive from the skin to avoid irritation. Never pull! | |

**NURSING DIAGNOSIS:** Potential imbalanced nutrition, less than body requirements, related to avoidance of foods that may cause GI discomfort
**GOAL:** Achievement of an optimal nutritional intake

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Conduct a complete nutritional assessment to identify any foods that may increase peristalsis by irritating the bowel. | 1. Patients react differently to certain foods because of individual sensitivity. | • Modifies diet to avoid offensive foods yet maintains adequate nutritional intake |

*Continued*

CHART 38-4

PLAN OF NURSING CARE

## *The Patient Undergoing Ostomy Surgery* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Advise the patient to avoid food products with a cellulose or hemicellulose base (nuts, seeds). | 2. Cellulose food products are the nondigestible residue of plant foods. They hold water, provide bulk, and stimulate elimination. | • Avoids cellulose-based foods such as peanuts<br>• Modifies intake of certain fruits |
| 3. Recommend moderation in intake of certain irritating fruits such as prunes, grapes, and bananas. | 3. These fruits tend to increase the quantity of effluent. | |

**NURSING DIAGNOSIS:** Sexual dysfunction related to altered body image
**GOAL:** Attainment of satisfactory sexual performance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage the patient to verbalize concerns and fears. The sexual partner is welcomed to participate in the discussion. | 1. Expressed needs help the therapist develop a plan of care. | • Expresses fears and concerns<br>• Discusses alternative sexual positions<br>• Accepts services of a professional counselor |
| 2. Recommend alternative sexual positions. | 2. Avoid patient embarrassment with the visual appearance of the stoma. Avoid peristomal skin irritation or stomal trauma secondary to friction. | |
| 3. Seek assistance from a sexual therapist or wound-ostomy-continence (WOC) nurse. | 3. Some patients need professional sexual counseling. | |

**NURSING DIAGNOSIS:** Risk for deficient fluid volume related to anorexia and vomiting and increased loss of fluids and electrolytes from GI tract
**GOAL:** Attainment of fluid balance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Estimate fluid intake and output: | 1. Provides indication of fluid balance. | • Maintains fluid balance<br>• Maintains normal serum and urinary values for sodium and potassium<br>• Normal skin turgor<br>• Surface of tongue is pink, with a moist mucous membrane |
| a. Strict intake and output | a. An early indicator of fluid imbalance is a daily, significant difference between intake and output. The average person ingests (food, fluids) and loses (urine, feces, lungs) about 2 L of fluid every 24 h. | |
| b. Daily weights | b. A gain/loss of 1 L of fluid is reflected in a body weight change of 2.2 lb. | |
| 2. Assess serum and urinary values of sodium and potassium. | 2. Sodium is the major electrolyte regulating water balance. Vomiting results in decreased urinary and serum sodium levels. Urinary sodium values, in contrast to serum values, reflect early, sensitive changes in sodium balance. Sodium works in conjunction with potassium, which is also decreased with vomiting. A significant deficiency in potassium is associated with a decrease in intracellular potassium bicarbonate, which leads to acidosis and compensatory hyperventilation. | |
| 3. Observe and record skin turgor and the appearance of the tongue. | 3. Adequate hydration is reflected by the skin's ability to return to its normal shape after being grasped between the fingers. *Note:* In the older person, it is normal for the return to be delayed. Changes in the mucous membrane covering the tongue are accurate and early indicators of hydration status. | |

nasogastric intubation, parenteral fluids, and possibly perineal packing.

The abdomen is marked for the proper placement of the stoma by the surgeon or the WOC nurse. Care is taken to ensure that the stoma is conveniently placed—usually in the right lower quadrant about 2 inches below the waist, in an area away from previous scars, bony prominences, skin folds, or fistulas. It is essential that the stoma site be visible to the patient.

### Providing Postoperative Care

General abdominal surgery wound care is required. The nurse observes the stoma for color and size. It should be pink to bright red and shiny. Typically, a temporary plastic bag (ie, appliance or pouch) with an adhesive facing is placed over the ileostomy in the operating room and firmly pressed onto the surrounding skin. The nurse monitors the ileostomy for fecal drainage, which should begin about 24 to 48 hours after surgery. The drainage is a continuous liquid from the small intestine because the stoma does not have a controlling sphincter. The contents drain into the pouch and are thus kept from coming into contact with the skin. They are collected, measured, and discarded when the pouch becomes full. If a continent ileal reservoir was created, as described for the Kock pouch, continuous drainage is provided by an indwelling reservoir catheter for 2 to 3 weeks after surgery. This allows the suture lines to heal.

Because these patients lose large fluid volumes in the early postoperative period, an accurate record of fluid intake, urinary output, and fecal discharge is necessary to help gauge the fluid needs of the patient. There may be 1000 to 2000 mL of fluid lost each day in addition to expected fluid loss through urine, perspiration, respiration, and other sources. With this loss, sodium and potassium are depleted. The nurse monitors laboratory values and administers electrolyte replacements as prescribed. Replacement fluids are administered intravenously for 4 to 5 days.

Nasogastric suction is also a part of the immediate postoperative care, with the tube requiring frequent irrigation, as prescribed. The purpose of nasogastric suction is to prevent a buildup of gastric contents while the intestines are not functioning. After the tube is removed, the nurse offers sips of clear liquids and gradually progresses the diet. It is important to report nausea and abdominal distention, which may indicate intestinal obstruction, immediately.

By the end of the first week, rectal packing is removed. Because this procedure may be uncomfortable, the nurse may administer an analgesic an hour before the removal. After the packing is removed, the perineum is irrigated two or three times daily until full healing takes place.

#### Providing Emotional Support

The patient may think that everyone is aware of the ileostomy and may view the stoma as a mutilation compared with other abdominal incisions that heal and are hidden. Concern about body image may lead to questions related to family relationships, sexual function, and, for women, the ability to become pregnant and to deliver a baby normally. The nurse can coordinate patient care needs, including needs for emotional support, through meetings attended by consultants such as the physician, psychologist, psychiatrist, social worker, WOC nurse, and dietitian. The team approach is important in facilitating the often complex care of the patient.

Conversely, a surgical procedure to create an ileostomy can produce dramatic positive changes in patients who have suffered from IBD for several years. After the discomfort of the disease has decreased and the patient learns how to take care of the ileostomy, he or she often develops a more positive outlook. Until the patient progresses to this phase, an empathetic and tolerant approach by the nurse plays an important part in recovery. The sooner the patient masters the physical care of the ileostomy, the sooner he or she will psychologically accept it.

Support from other people with ostomies is also helpful. The United Ostomy Associations of America (UOAA) is dedicated to the rehabilitation of people with ostomies. This organization gives patients useful information about living with an ostomy through an educational program of literature, lectures, and exhibits. Local associations offer visiting services by qualified members who provide hope and rehabilitation services to patients with new ostomies.

#### Managing Skin and Stoma Care

The patient with a traditional ileostomy cannot establish regular bowel habits because the contents of the ileum are fluid and are discharged continuously. The patient must wear a pouch at all times. Stomal size and pouch size vary initially; the stoma should be rechecked 3 weeks after surgery, when the edema has subsided. The final size and type of appliance is selected in 3 months, after the patient's weight has stabilized and the stoma shrinks to a stable shape.

The location and length of the stoma are significant to the management of the ileostomy by the patient. The surgeon positions the stoma as close to the midline as possible and at a location where even an obese patient with a protruding abdomen can see it and can care for it easily. Usually, the ileostomy stoma is about 2.5 cm (1 in) long, which makes it convenient for the attachment of an appliance.

Skin excoriation around the stoma can be a persistent problem. Peristomal skin integrity may be compromised by several factors, such as an allergic reaction to the ostomy appliance, skin barrier, or paste; chemical irritation from the effluent; mechanical injury from the removal of the appliance; and infection. If irritation and yeast growth occur, nystatin powder (Mycostatin) is dusted lightly on the peristomal skin and a pouch with skin barrier is applied over the affected area.

#### Changing an Appliance

A regular schedule for changing the pouch before leakage occurs must be established for those with a traditional ileostomy. The patient can be taught to change the pouch in a manner similar to that described in Chart 38-5.

The amount of time a person can keep the appliance sealed to the body surface depends on the location of the stoma and on body structure. The usual wearing time, which also depends on the type of skin barrier, is 5 to 10 days. The appliance is emptied every 4 to 6 hours, or at the same time the patient empties the bladder. An emptying spout at the bottom of the appliance is closed with a special clip or Velcro closure.

## CHART 38-5 *Guidelines for Changing an Ostomy Appliance*

### Equipment Needed

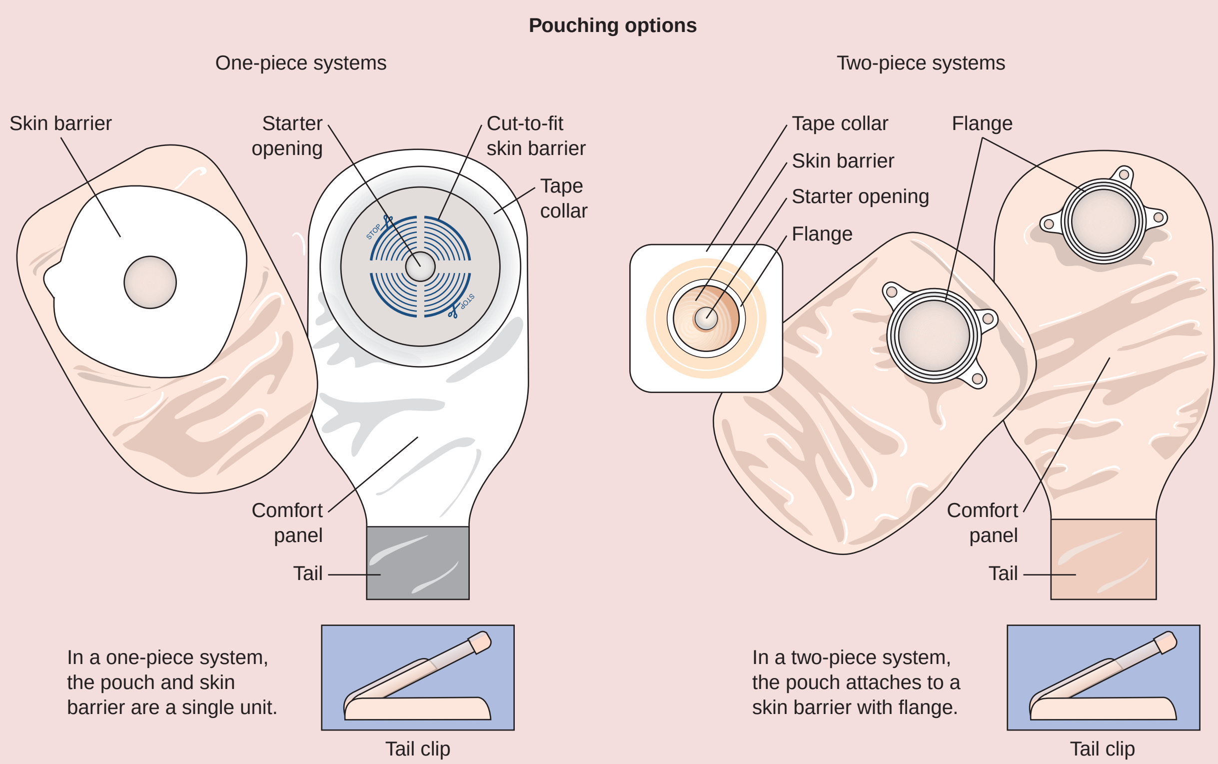
- Mild soap
- Clean cloths or towels
- Skin barrier (stoma adhesive, Convatec)
- Cutting guide
- Appliance pouch

Optional Equipment

- Barrier powder
- Antifungal spray or powder
- Barrier washer

### Implementation

| Nursing Action | Rationale |
| --- | --- |
| 1. Promote patient comfort and involvement in the procedure.<br>a. Have the patient assume a relaxed position.<br>b. Provide privacy.<br>c. Explain details of the procedure.<br>d. Expose the ileostomy area; remove the ileostomy belt (if worn) | 1. Providing a relaxed atmosphere and adequate explanations help the patient to become an active participant in the procedure. |
| 2. Remove the appliance.<br>a. Have the patient sit on the toilet or on a chair facing the toilet. A patient who prefers to stand should face the toilet.<br>b. The appliance (pouch) can be removed by gently pushing the skin away from the adhesive. | 2. These positions facilitate disposal or drainage. |
| 3. Cleanse the skin:<br>a. Wash the skin gently with a soft cloth moistened with tepid water and mild soap; the patient may prefer to bathe before putting on a clean appliance.<br>b. Rinse the soap and dry the skin thoroughly after cleansing. | 3. The patient may shower with or without the pouch.<br>a. Micropore or waterproof tape applied to the sides of the faceplate keeps it secure during bathing.<br>b. Moisture or soap residue interferes with appliance adhesion. |




*Continued on following page*

**CHART 38-5** ***Guidelines for Changing an Ostomy Appliance*** *(Continued)*

| Nursing Action | Rationale |
|---|---|
| 4. Apply appliance:<br>When there is *no* skin irritation:<br>a. An appropriate skin barrier is applied to the peristomal skin before the appliance is applied.<br>b. Remove cover from adherent surface of disk of disposable plastic appliance and apply directly to the skin.<br>c. Press firmly in place for 30 seconds to ensure adherence. | 4. Many appliances have a built-in skin barrier. The skin should be thoroughly dried before applying the appliance. |
| When there is skin irritation:<br>a. Cleanse the skin thoroughly but gently; pat dry. Apply barrier powder. | a. Cleansing removes debris and protects irritated skin under wafer |
| b. If more irritation developed, apply Kenalog spray; blot excess moisture with a cotton pledget and dust lightly with nystatin (Mycostatin) powder.<br>OR<br>Apply as an alternative a wafer or barrier (Stomahesive, ConvaTec), which is commercially available. The stomal opening should be the same size as the stoma; use a cutting guide (supplied with appliance as indicated). The wafer is applied directly to the skin. Barrier powder can be used to dry irritated skin before barrier application. | b. The corticosteroid preparation (Kenalog) helps decrease inflammation. The antifungal agent (nystatin) treats those types of infections that are common around stomas. A prescription is required for either medication. A skin barrier is a substance that facilitates healing of excoriated skin. It adheres well even to moist, irritated skin. |
| c. Another alternative is to apply a special barrier washer (eg, Eakin's Seal). The special barrier adheres well to irritated skin. | c. A special barrier protects skin from effluent, promotes healing and helps with adherence. |
| d. The pouch is then applied to the treated skin. | d. This allows skin to heal while the appliance is in place. |
| 5. Check the pouch bottom for closure; use clamp, Velcro closure, or clip provided. | 5. Proper closure controls leakage. |

Most pouches are disposable and odor-proof. Foods such as spinach and parsley act as deodorizers in the intestinal tract; foods that cause odors include asparagus, cabbage, onions, and fish. Bismuth subcarbonate tablets, which may be prescribed and taken orally three or four times each day, are effective in reducing odor. Oral diphenoxylate atropine (Lomotil) can be prescribed to diminish intestinal motility, thereby thickening the stool and assisting in odor control. Foods such as rice, mashed potatoes, and applesauce may also thicken stool.

### Irrigating a Continent Ileostomy

For a continent ileostomy (ie, Kock pouch), the nurse teaches the patient to drain the pouch, as described in Chart 38-6. A catheter is inserted into the reservoir to drain the fluid. The length of time between drainage periods is gradually increased until the reservoir needs to be drained only every 4 to 6 hours and irrigated once each day. A pouch is not necessary; instead, most patients wear a small dressing over the opening.

When the fecal discharge is thick, water can be injected through the catheter to loosen and soften it. The consistency of the effluent is affected by food intake. At first, drainage is only 60 to 80 mL, but as time goes on, the amount increases significantly. The internal Kock pouch stretches, eventually accommodating 500 to 1000 mL. The patient learns to use the sensation of pressure in the pouch as a gauge to determine how often the pouch should be drained.

### Managing Dietary and Fluid Needs

A low-residue diet is followed for the first 6 to 8 weeks. Strained fruits and vegetables are given. These foods are important sources of vitamins A and C. Later, there are few dietary restrictions, except for avoiding foods that are high in fiber or hard-to-digest kernels, such as celery, popcorn, corn, poppy seeds, caraway seeds, and coconut, which may result in a stomal obstruction (food blockage) for the person with an ileostomy. Foods are reintroduced one at a time. The nurse assesses the patient's tolerance for these foods and reminds him or her to chew food thoroughly.

Fluids may be a problem during the summer, when fluid lost through perspiration adds to the fluid loss through the ileostomy. Fluids such as Gatorade are helpful in maintaining electrolyte balance. If the fecal discharge is too watery, fibrous foods (eg, whole-grain cereals, fresh fruit skins, beans, corn, nuts) are restricted. If the effluent is excessively dry, salt intake is increased. Increased intake of water or fluid does not increase the effluent, because excess water is excreted in the urine.

### Preventing Complications

Monitoring for complications is an ongoing activity for the patient with an ileostomy (Chart 38-7) Peristomal skin irritation, which results from leakage of effluent, is the most common complication of an ileostomy. A drainable pouching system that does not fit well is often the cause. Components

## CHART 38-6 Guidelines for Draining a Continent Ileostomy (Kock Pouch)

A continent ileostomy is the surgical creation of a pouch of small intestine that can serve as an internal receptacle for fecal discharge; a nipple valve is constructed at the outlet. Postoperatively, a catheter extends from the stoma and is attached to a closed drainage suction system. To ensure patency of the catheter, 10 to 20 mL of normal saline is instilled gently into the pouch usually every 3 hours; return flow is not aspirated but is allowed to drain by gravity.

After approximately 2 weeks, when the healing process has progressed to the point at which the catheter is removed from the stoma, the patient is taught to drain the pouch.

The following procedure is used to drain the pouch; the patient is helped to participate in this procedure to learn to perform it unassisted.

### Equipment

- Catheter
- Tissues
- Water-soluble lubricant
- Gauze squares
- Syringe
- Irrigating solution in a bowl
- Emesis or receiving basin

### Implementation

| Nursing Action | Rationale |
|---|---|
| 1. Lubricate the catheter and gently insert it about 5 cm (2 in), at which point some resistance may be felt at the valve or nipple. | 1. When gentle pressure is used, the catheter usually enters the pouch. |
| 2. If there is much resistance, fill a syringe with 20 mL of air or water and inject it through the catheter, while still exerting some pressure on the catheter. | 2. This permits the catheter to enter the pouch. |
| 3. Place the other end of the catheter in a drainage basin held below the level of the stoma. Later this process can be carried out at the toilet with drainage delivered into the toilet bowl. | 3. Gravity facilitates drainage. Drainage may include flatus as well as effluent. |
| 4. After drainage, the catheter is removed and the area around the stoma is gently washed with warm water. Pat dry and apply an absorbent pad over the stoma. Fasten the pad with hypoallergenic tape. | 4. The entire procedure requires about 5 to 10 min; at first it is performed every 3 h. The time between procedures is gradually lengthened to three times daily. |

## CHART 38-7 NURSING RESEARCH PROFILE
## Validation of Stomal and Peristomal Complications

Colwell, J. & Beitz, J. (2007). Survey of wound, ostomy, continence nurse clinicians on stomal and peristomal complications: A content validation study. *Journal of WOCN, 34*(1), 57–69.

### Purpose

The incidence and prevalence of stomal and peristomal complications are not known. Lack of validated and reliable stomal and peristomal complication definitions and interventions hampers effective research and nursing care. The objectives of this study were to establish content validation data for the proposed definitions of stomal and peristomal complications and their associated interventions, to obtain data related to nursing contact with patients who had stomal and peristomal complications, and to gain insight into the ostomy care process.

### Design

The authors sent a researcher-designed survey to 2900 expert wound, ostomy, continence (WOC) nurses via a national mailing to a representative nonrandomized sample of clinicians who identified ostomy care as part of their practice. In total, 686 WOC nurses returned the survey (response rate 24%). The responses from the purposive sample quantified validity of definitions and interventions and also provided qualitative comments. In addition they quantified WOC nurses' contact with patients who had experienced stomal and peristomal complications.

### Findings

WOC nurses reported substantive contact with intestinal diversion patients who experienced stomal and peristomal complications. The WOC nurses supported the proposed definitions and interventions as generally valid (content validity index, 0.91). However, less consensus existed for interventions. The WOC nurses identified some complications and interventions not included in the survey. Nursing problems regarding the ostomy care process involved the art and versatility of ostomy care, clinical inexperience, and the lack of in-depth education regarding the variety of ostomy complications.

### Nursing Implications

Findings from this study confirm that patients with intestinal diversions commonly experience selected stomal and peristomal complications. Researchers validated definitions for stomal and peristomal complications and pertinent interventions. Respondents identified additional complications and interventions not noted in the literature that demand future nursing research and scrutiny, so that ostomy nursing care can become more evidence based.

**CHART 38-8** HOME CARE CHECKLIST
***Managing Ostomy Care***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate ostomy care, including wound cleansing, irrigation, and appliance changing. | ✔ | ✔ |
| • Describe the importance of maintaining peristomal skin integrity. | ✔ | ✔ |
| • Identify sources for obtaining additional dressing and appliance supplies. | ✔ | ✔ |
| • Identify dietary restrictions (foods that can cause diarrhea and constipation). | ✔ | ✔ |
| • Identify measures to be used to promote fluid and electrolyte balance. | ✔ | ✔ |
| • Describe medication regimen: identify medications by name, use, route, and frequency. | ✔ | ✔ |
| • Describe potential complications and necessary actions to be taken if complications occur. | ✔ | ✔ |
| • Identify how to contact wound-ostomy-continence or home health nurse. | ✔ | ✔ |

of the drainable pouching system include the pouch, a solid skin barrier, and adhesive. The WOC nurse typically recommends the appropriate drainable pouching system. The solid skin barrier is the component of this system that is most important in ensuring healthy peristomal skin. Solid skin barriers are typically shaped as rectangular or elliptical wafers and are composed of polymers and hydrocolloids. They protect the skin around the stoma from effluent from the stoma and provide a stable interface between the stoma and the pouch. It is critical that the barrier be sized appropriately to "hug" the stoma (up to the stoma but not touching) and not expose peristomal skin.

Other common complications include diarrhea, stomal stenosis, urinary calculi, and cholelithiasis. Even in the presence of a properly fitted drainable pouching system, diarrhea can be problematic. Diarrhea, manifested by very irritating effluent that rapidly fills the pouch (every hour or sooner), can quickly lead to dehydration and electrolyte losses. Supplemental water, sodium, and potassium are administered to prevent hypovolemia and hypokalemia. Antidiarrheal agents are administered. Stenosis is caused by circular scar tissue that forms at the stoma site. The scar tissue must be surgically released. Urinary calculi may occur in patients with ileostomies and are at least partly attributed to dehydration from decreased fluid intake. Intense lower abdominal pain that radiates to the legs, hematuria, and signs of dehydration indicate that the urine should be strained. Fluid intake is encouraged. Sometimes, small stones are passed during urination; treatment that crushes or removes larger stones is necessary (see Chapter 45).

Cholelithiasis (ie, gallstones) occurs more commonly in patients with an ileostomy than in members of the general population because of changes in the absorption of bile acids that occur postoperatively. Spasm of the gallbladder causes severe upper right abdominal pain that can radiate to the back and right shoulder (see Chapter 40).

#### Promoting Home and Community-Based Care

***Teaching Patients Self-Care.*** The partner and family should be familiar with the adjustments that will be necessary when the patient returns home. They need to know why it is necessary for the patient to occupy the bathroom for 10 minutes or more at certain times of the day and why certain equipment is needed. Their understanding is necessary to reduce tension; a relaxed patient tends to have fewer problems. Visits from a WOC nurse may be arranged to ensure that the patient is progressing as expected and to provide additional guidance and teaching as needed.

***Continuing Care.*** The patient needs to know the commercial name of the drainable pouching system to be used so that he or she can obtain a ready supply and should know how to obtain other supplies. The names and contact information of a local WOC nurse and local self-help groups are often helpful. Any restrictions on driving or working also need to be reviewed. The nurse teaches the patient about common postoperative complications and how to recognize and report them (Chart 38-8).

## INTESTINAL OBSTRUCTION

Intestinal obstruction exists when blockage prevents the normal flow of intestinal contents through the intestinal tract. Two types of processes can impede this flow:

- *Mechanical obstruction:* An intraluminal obstruction or a mural obstruction from pressure on the intestinal wall occurs. Examples are intussusception, polypoid tumors and neoplasms, stenosis, strictures, adhesions, hernias, and abscesses.
- *Functional obstruction:* The intestinal musculature cannot propel the contents along the bowel. Examples are amyloidosis, muscular dystrophy, endocrine disorders such as diabetes mellitus, or neurologic disorders such as Parkinson's disease. The blockage also can be temporary and the result of the manipulation of the bowel during surgery.

The obstruction can be partial or complete. Its severity depends on the region of bowel affected, the degree to which the lumen is occluded, and especially the degree to which the vascular supply to the bowel wall is disturbed.

Most bowel obstructions occur in the small intestine. Adhesions are the most common cause of small bowel obstruction, followed by hernias and neoplasms. Other causes

**Table 38-5 MECHANICAL CAUSES OF INTESTINAL OBSTRUCTION**

| Cause | Course of Events | Result |
|---|---|---|
| Adhesions | Loops of intestine become adherent to areas that heal slowly or scar after abdominal surgery; occurs most commonly in small intestine. | After surgery, adhesions produce a kinking of an intestinal loop. |
| Intussusception | One part of the intestine slips into another part located below it (like a telescope shortening); occurs more commonly in infants than adults | The intestinal lumen becomes narrowed and blood supply becomes strangulated. |
| Volvulus | Bowel twists and turns on itself and occludes the blood supply. | Intestinal lumen becomes obstructed. Gas and fluid accumulate in the trapped bowel. |
| Hernia | Protrusion of intestine through a weakened area in the abdominal muscle or wall. | Intestinal flow may be completely obstructed. Blood flow to the area may be obstructed as well. |
| Tumor | A tumor that exists within the wall of the intestine extends into the intestinal lumen, or a tumor outside the intestine causes pressure on the wall of the intestine. Most common type is colorectal adenocarcinoma. | Intestinal lumen becomes partially obstructed; if the tumor is not removed, complete obstruction results. |

include intussusception, volvulus (ie, twisting of the bowel), and paralytic ileus. Most obstructions in the large bowel occur in the sigmoid colon. The most common causes are carcinoma, diverticulitis, inflammatory bowel disorders, and benign tumors. Table 38-5 and Figure 38-7 list mechanical causes of obstruction and describe how they occur.

## Small Bowel Obstruction

### Pathophysiology

Intestinal contents, fluid, and gas accumulate above the intestinal obstruction. The abdominal distention and retention of fluid reduce the absorption of fluids and stimulate more gastric secretion. With increasing distention, pressure within the intestinal lumen increases, causing a decrease in venous and arteriolar capillary pressure. This causes edema, congestion, necrosis, and eventual rupture or perforation of the intestinal wall, with resultant peritonitis.

Reflux vomiting may be caused by abdominal distention. Vomiting results in loss of hydrogen ions and potassium from the stomach, leading to reduction of chlorides and potassium in the blood and to metabolic alkalosis. Dehydration and acidosis develop from loss of water and sodium. With acute fluid losses, hypovolemic shock may occur.

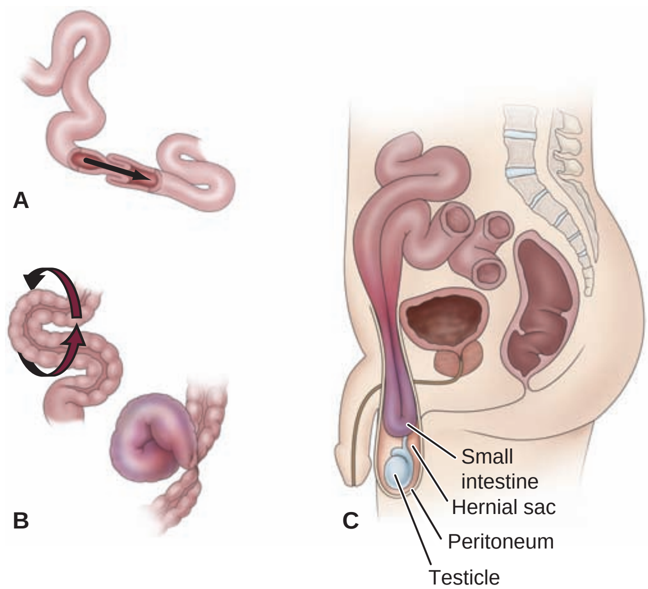



**Figure 38-7** Three causes of intestinal obstruction. **A,** Intussusception; invagination or shortening of the colon caused by the movement of one segment of bowel into another. **B,** Volvulus of the sigmoid colon; the twist is counterclockwise in most cases. Note the edematous bowel. **C,** Hernia (inguinal). The sac of the hernia is a continuation of the peritoneum of the abdomen. The hernial contents are intestine, omentum, or other abdominal contents that pass through the hernial opening into the hernial sac.

### Clinical Manifestations

The initial symptom is usually crampy pain that is wavelike and colicky. The patient may pass blood and mucus but no fecal matter and no flatus. Vomiting occurs. If the obstruction is complete, the peristaltic waves initially become extremely vigorous and eventually assume a reverse direction, with the intestinal contents propelled toward the mouth instead of toward the rectum. If the obstruction is in the ileum, fecal vomiting takes place. First, the patient vomits the stomach contents, then the bile-stained contents of the duodenum and the jejunum, and finally, with each paroxysm of pain, the darker, fecal-like contents of the ileum. The signs of dehydration become evident: intense thirst, drowsiness, generalized malaise, aching, and a parched tongue and mucous membranes. The abdomen becomes distended. The lower the obstruction is in the GI tract, the more marked the abdominal distention. If the obstruction continues uncorrected, hypovolemic shock occurs from dehydration and loss of plasma volume.

### Assessment and Diagnostic Findings

Diagnosis is based on the symptoms described previously and on imaging studies. Abdominal x-ray and CT findings include abnormal quantities of gas, fluid, or both in the intestines. Laboratory studies (ie, electrolyte studies and a complete blood cell count) reveal a picture of dehydration, loss of plasma volume, and possible infection.

### Medical Management

Decompression of the bowel through a nasogastric tube (see Chapter 36) is successful in most cases. When the bowel is completely obstructed, the possibility of strangulation and tissue necrosis (ie, tissue death) warrants surgical intervention. Before surgery, IV fluids are necessary to replace the depleted water, sodium, chloride, and potassium.

The surgical treatment of intestinal obstruction depends on the cause of the obstruction. For the most common causes of obstruction, such as hernia and adhesions, the surgical procedure involves repairing the hernia or dividing the adhesion to which the intestine is attached. In some instances, the portion of affected bowel may be removed and an anastomosis performed. The complexity of the surgical procedure depends on the duration of the intestinal obstruction and the condition of the intestine.

### Nursing Management

Nursing management of the nonsurgical patient with a small bowel obstruction includes maintaining the function of the nasogastric tube, assessing and measuring the nasogastric output, assessing for fluid and electrolyte imbalance, monitoring nutritional status, and assessing improvement (eg, return of normal bowel sounds, decreased abdominal distention, subjective improvement in abdominal pain and tenderness, passage of flatus or stool). The nurse reports discrepancies in intake and output, worsening of pain or abdominal distention, and increased nasogastric output. If the patient's condition does not improve, the nurse prepares him or her for surgery. Nursing care of the patient after surgical repair of a small bowel obstruction is similar to that for other abdominal surgeries (see Chapter 20).

## *Large Bowel Obstruction*

### Pathophysiology

As in small bowel obstruction, large bowel obstruction results in an accumulation of intestinal contents, fluid, and gas proximal to the obstruction. It can lead to severe distention and perforation unless some gas and fluid can flow back through the ileal valve. Large bowel obstruction, even if complete, may be undramatic if the blood supply to the colon is not disturbed. However, if the blood supply is cut off, intestinal strangulation and necrosis occur; this condition is life-threatening. In the large intestine, dehydration occurs more slowly than in the small intestine because the colon can absorb its fluid contents and can distend to a size considerably beyond its normal full capacity.

Adenocarcinoid tumors account for the majority of large bowel obstructions. Most tumors occur beyond the splenic flexure, making them accessible with a flexible sigmoidoscope.

### Clinical Manifestations

Large bowel obstruction differs clinically from small bowel obstruction in that the symptoms develop and progress relatively slowly. In patients with obstruction in the sigmoid colon or the rectum, constipation may be the only symptom for months. The shape of the stool is altered as it passes the obstruction that is gradually increasing in size. Blood loss in the stool may result in iron deficiency anemia. The patient may experience weakness, weight loss, and anorexia. Eventually, the abdomen becomes markedly distended, loops of large bowel become visibly outlined through the abdominal wall, and the patient has crampy lower abdominal pain. Finally, fecal vomiting develops. Symptoms of shock may occur.

### Assessment and Diagnostic Findings

Diagnosis is based on symptoms and on imaging studies. Abdominal x-ray and abdominal CT or MRI findings reveal a distended colon and pinpoint the site of the obstruction. Barium studies are contraindicated.

### Medical Management

Restoration of intravascular volume, correction of electrolyte abnormalities, and nasogastric aspiration and decompression are instituted immediately. A colonoscopy may be performed to untwist and decompress the bowel. A cecostomy, in which a surgical opening is made into the cecum, may be performed in patients who are poor surgical risks and urgently need relief from the obstruction. The procedure provides an outlet for releasing gas and a small amount of drainage. A rectal tube may be used to decompress an area that is lower in the bowel. However, the usual treatment is surgical resection to remove the obstructing lesion. A temporary or permanent colostomy may be necessary. An ileoanal anastomosis may be performed if removal of the entire large bowel is necessary.

### Nursing Management

The nurse's role is to monitor the patient for symptoms that indicate that the intestinal obstruction is worsening and to provide emotional support and comfort. The nurse administers IV fluids and electrolytes as prescribed. If the patient's condition does not respond to nonsurgical treatment, the nurse prepares the patient for surgery. This preparation includes preoperative teaching as the patient's condition indicates. After surgery, general abdominal wound care and routine postoperative nursing care are provided.

## *Colorectal Cancer*

Tumors of the colon and rectum are relatively common; the colorectal area (the colon and rectum combined) is now the third most common site of new cancer cases in the United States. Colorectal cancer is a disease of Western cultures. In the United States, almost 150,000 new cases and 52,000 deaths from colorectal cancer occur annually (American Cancer Society [ACS], 2008). Colorectal cancer is the

second leading cause of cancer death in both men and women (Bazensky, Shoobridge-Moran & Yoder, 2007).

The lifetime risk of developing colorectal cancer is 1 in 17 (Gill, Blackstack & Goldberg, 2007). Incidence increases with age (the incidence is highest in people older than 85 years) and is higher in people with a family history of colon cancer and those with IBD or polyps. The exact cause of colon and rectal cancer is still unknown, but risk factors have been identified (Chart 38-9).

Improved screening strategies have helped reduce the number of deaths from colon cancer in recent years. Of the approximately 150,000 people diagnosed each year, fewer than half that number dies annually (ACS, 2008). Early diagnosis and prompt treatment could save almost three of every four people. If the disease is detected and treated at an early stage before the disease spreads, the 5-year survival rate is 90%; however, only 39% of colorectal cancers are detected at an early stage (ACS, 2008). Survival rates after late diagnosis are very low. Most people are asymptomatic for long periods and seek health care only when they notice a change in bowel habits or rectal bleeding. Prevention and early screening are key to detection and reduction of mortality rates (Bazensky, et al., 2007).

Hereditary colon cancer accounts for about 6% of all colon cancers. Early diagnosis helps target treatment and screening for clients and family members (Kelly, 2008). Genetic counselors are trained to help patients and their family members understand the significance of genetics information (Chan-Smutko, Patel, Shannon, et al., 2008). If patients are found to have a genetic susceptibility to cancer, they should be offered counseling and follow-up to ensure that care is consistent with current standards (Burke & Press, 2006).

## Pathophysiology

Cancer of the colon and rectum is predominantly (95%) adenocarcinoma (ie, arising from the epithelial lining of the intestine) (ACS, 2008). It may start as a benign polyp but may become malignant, invade and destroy normal tissues, and extend into surrounding structures. Cancer cells may migrate away from the primary tumor and spread to other parts of the body (most often to the liver, peritoneum, and lungs) (Field & Lipton, 2007).

### CHART 38-9 *Risk Factors for Colorectal Cancer*

- Increasing age
- Family history of colon cancer or polyps
- Previous colon cancer or adenomatous polyps
- High consumption of alcohol
- Cigarette smoking
- Obesity
- History of gastrectomy
- History of inflammatory bowel disease
- High-fat, high-protein (with high intake of beef), low-fiber diet
- Genital cancer (eg, endometrial cancer, ovarian cancer) or breast cancer (in women)

## Clinical Manifestations

The symptoms are greatly determined by the location of the tumor, the stage of the disease, and the function of the affected intestinal segment. The most common presenting symptom is a change in bowel habits. The passage of blood in or on the stools is the second most common symptom. Symptoms may also include unexplained anemia, anorexia, weight loss, and fatigue.

The symptoms most commonly associated with right-sided lesions are dull abdominal pain and melena (ie, black, tarry stools). The symptoms most commonly associated with left-sided lesions are those associated with obstruction (ie, abdominal pain and cramping, narrowing stools, constipation, distention), as well as bright-red blood in the stool. Symptoms associated with rectal lesions are tenesmus (ie, ineffective, painful straining at stool), rectal pain, the feeling of incomplete evacuation after a bowel movement, alternating constipation and diarrhea, and bloody stool. In many instances, symptoms do not develop until colorectal cancer is at an advanced stage.

## Assessment and Diagnostic Findings

Along with an abdominal and rectal examination, the most important diagnostic procedures for cancer of the colon are fecal occult blood testing, barium enema, proctosigmoidoscopy, and colonoscopy (see Chapter 34). The majority of colorectal cancer cases can be identified by colonoscopy with biopsy or cytology smears.

Carcinoembryonic antigen (CEA) studies may also be performed. Although CEA may not be a highly reliable indicator in diagnosing colon cancer because not all lesions secrete CEA, studies show that CEA levels are reliable prognostic predictors. With complete excision of the tumor, the elevated levels of CEA should return to normal within 48 hours. Elevations of CEA at a later date suggest recurrence.

## Complications

Tumor growth may cause partial or complete bowel obstruction. Extension of the tumor and ulceration into the surrounding blood vessels result in hemorrhage. Perforation, abscess formation, peritonitis, sepsis, and shock may occur.

## Gerontologic Considerations

The incidence of carcinoma of the colon and rectum increases with age. These cancers are considered common malignancies in advanced age. In men, only the incidence of prostate cancer and lung cancer exceeds that of colorectal cancer. In women, only the incidence of breast cancer exceeds that of colorectal cancer (ACS, 2008; Bazensky, et al., 2007). Symptoms are often insidious. Patients with colorectal cancer usually report fatigue, which is caused primarily by iron deficiency anemia. In early stages, minor changes in bowel patterns and occasional bleeding may occur. The later symptoms most commonly reported by the elderly are abdominal pain, obstruction, tenesmus, and rectal bleeding.

Colon cancer in the elderly has been closely associated with dietary carcinogens. Lack of fiber is a major causative factor because the passage of feces through the intestinal tract is prolonged, which extends exposure to possible carcinogens. Excess dietary fat, high alcohol consumption, and smoking all increase the incidence of colorectal tumors. Physical activity and dietary folate have protective effects (Bazensky, et al., 2007).

## Medical Management

The patient with symptoms of intestinal obstruction is treated with IV fluids and nasogastric suction. If there has been significant bleeding, blood component therapy may be required.

Treatment for colorectal cancer depends on the stage of the disease (Chart 38-10) and consists of surgery to remove the tumor, supportive therapy, and adjuvant therapy. Patients who receive some form of adjuvant therapy, which may include chemotherapy, radiation therapy, immunotherapy, or multimodality therapy, typically demonstrate delays in tumor recurrence and increases in survival time (Field & Lipton, 2007; Gill, et al., 2007; Kosmider & Lipton, 2007).

### Adjuvant Therapy

The standard adjuvant therapy administered to patients with Dukes' class C or non-metastasized colon cancer is the 5-fluorouracil (5-FU; Adrucil) plus leucovorin calcium (Wellcovorin) (Kosmider & Lipton, 2007). Other agents include oxaliplatin (Eloxatin) and capecitabine (Xeloda). Patients with Dukes' class B or C rectal cancer are given 5-FU and high doses of pelvic irradiation. Mitomycin is also used. Radiation therapy is used before, during, and after surgery to shrink the tumor; to achieve better results from surgery; and to reduce the risk of recurrence. For inoperative or unresectable tumors, radiation is used to provide significant relief from symptoms. Intracavitary and implantable devices are used to deliver radiation to the site. The response to adjuvant therapy varies. Patients at risk of poor outcomes include those with higher Dukes' or tumor, node, metastasis (TNM) stage (see Chapter 16), elevated CEA levels, insufficient lymph node sampling, and presentation with colonic perforation or obstruction (Kosmider & Lipton, 2007).

### Surgical Management

Surgery is the primary treatment for most colon and rectal cancers. It may be curative or palliative. Advances in surgical techniques can enable the patient with cancer to have sphincter-saving devices that restore continuity of the GI tract. The type of surgery recommended depends on the location and size of the tumor. Cancers limited to one site can be removed through the colonoscope. Laparoscopic colotomy with polypectomy minimizes the extent of

**Chart 38-10 • *Staging of Colorectal Cancer: Dukes' Classification–Modified Staging System***

**Class A:** Tumor limited to muscular mucosa and submucosa
**Class $B_1$:** Tumor extends into mucosa
**Class $B_2$:** Tumor extends through entire bowel wall into serosa or pericolic fat, no nodal involvement
**Class $C_1$:** Positive nodes, tumor is limited to bowel wall
**Class $C_2$:** Positive nodes, tumor extends through entire bowel wall
**Class D:** Advanced and metastasis to liver, lung, or bone

Another staging system, the TNM (tumor, nodal involvement, metastasis) classification, may be used to describe the anatomic extent of the primary tumor, depending on:

- Size, invasion depth, and surface spread
- Extent of nodal involvement
- Presence or absence of metastasis

The higher the score in each category, the worse the disease and prognosis.

Huether, S. E. & McCance, K. L. (2008). *Understanding pathophysiology*. St. Louis, MO: Mosby.

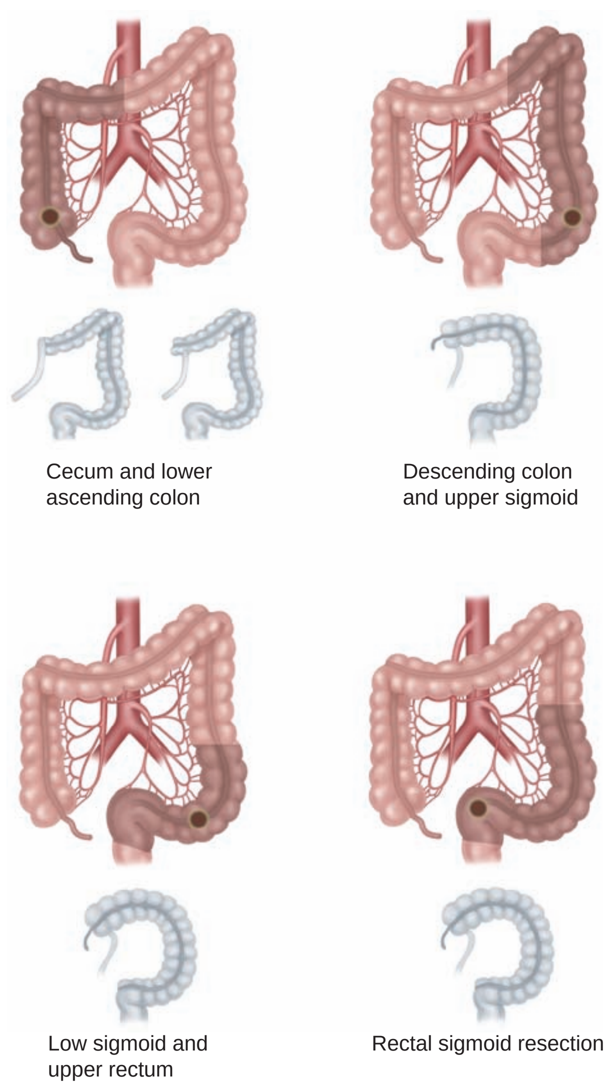



**Figure 38-8** Examples of areas where cancer can occur, the area that is removed, and how the anastomosis is performed (*small diagrams*).

surgery needed in some cases. A laparoscope is used as a guide in making an incision into the colon; the tumor mass is then excised. Laparoscopic colectomy has also been shown to have equivalent surgical outcomes to open colectomy and is associated with decreased length of stay, decreased use of pain medications, and improved quality of life (Gill, et al., 2007). Use of the neodymium/yttrium-aluminum-garnet (Nd:YAG) laser is effective with some lesions as well. Bowel resection is indicated for most class A lesions and all class B and C lesions. Surgery is sometimes recommended for class D colon cancer, but the goal of surgery in this instance is palliative; if the tumor has spread and involves surrounding vital structures, it is considered nonresectable.

Possible surgical procedures include the following:

- Segmental resection with anastomosis (ie, removal of the tumor and portions of the bowel on either side of the growth, as well as the blood vessels and lymphatic nodes) (Fig. 38-8)
- Abdominoperineal resection with permanent sigmoid colostomy (ie, removal of the tumor and a portion of the sigmoid and all of the rectum and anal sphincter, also called Miles resection) (Fig. 38-9)
- Temporary colostomy followed by segmental resection and anastomosis and subsequent reanastomosis of the colostomy, allowing initial bowel decompression and bowel preparation before resection
- Permanent colostomy or ileostomy for palliation of unresectable obstructing lesions
- Construction of a coloanal reservoir called a colonic J pouch, which is performed in two steps. A temporary loop ileostomy is constructed to divert intestinal flow, and the newly constructed J pouch (made from 6 to 10 cm of colon) is reattached to the anal stump. About 3 months after the initial stage, the ileostomy is reversed and intestinal continuity is restored. The anal sphincter and therefore continence are preserved.

A **colostomy** is the surgical creation of an opening (ie, stoma) into the colon. It can be created as a temporary or permanent fecal diversion. It allows the drainage or evacuation of colon contents to the outside of the body. The consistency of the drainage is related to the placement of the colostomy, which is dictated by the location of the tumor and the extent of invasion into surrounding tissues (Fig. 38-10). With improved surgical techniques that allow salvage of the anal sphincter, colostomies are performed in fewer than one third of patients with colorectal cancer. For patients with isolated metastases, newer, less invasive approaches have increased life expectancy. Management includes hepatic arterial infusion

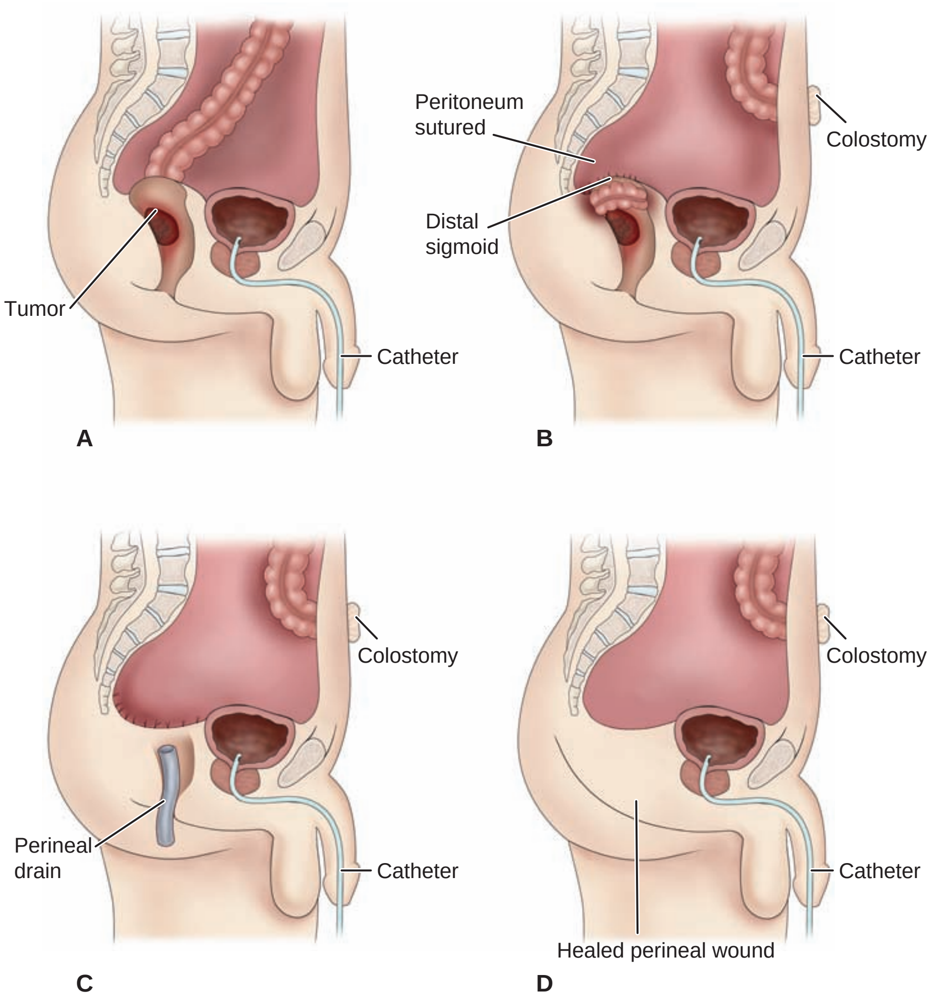



**Figure 38-9** Abdominoperineal resection for carcinoma of the rectum. **A,** Prior to surgery. Note tumor in rectum. **B,** During surgery, the sigmoid is removed and the colostomy is established. The distal bowel is dissected free to a point below the pelvic peritoneum, which is sutured over the closed end of the distal sigmoid and rectum. **C,** Perineal resection includes removal of the rectum and free portion of the sigmoid from below. A perineal drain is inserted. **D,** The final result after healing. Note the healed perineal wound and the permanent colostomy.

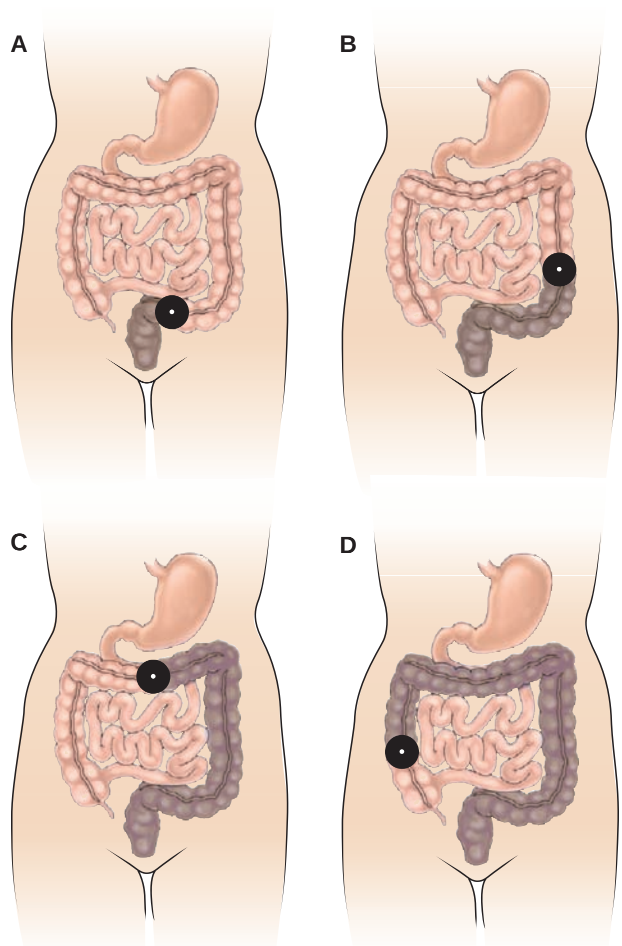



**Figure 38-10** Placement of permanent colostomies. The nature of the discharge varies with the site. Shaded areas show sections of bowel removed. **A,** With a sigmoid colostomy, the feces are formed. **B,** With a descending colostomy, the feces are semiformed. **C,** With a transverse colostomy, the feces are unformed. **D,** With an ascending colostomy, the feces are fluid.

chemotherapy, radiofrequency ablation, and selective internal radiation therapy (Field & Lipton, 2007).

### Gerontologic Considerations

The elderly are at increased risk of complications after surgery and may have difficulty managing colostomy care. Some elderly patients may have decreased vision, impaired hearing, and difficulty with fine motor coordination. It may be helpful for patients to handle ostomy equipment and simulate cleaning the peristomal skin and irrigating the stoma before surgery. Skin care is a major concern in older patients with a colostomy because of the skin changes that occur with aging—the epithelial and subcutaneous fatty layers become thin, and the skin is irritated easily. To prevent skin breakdown, special attention is paid to skin cleansing and the proper fit of an appliance. Newer stoma skin barriers do not have to be cut but can be molded into shape around the stoma (eg, ConvaTec; Fig. 38-11). Arteriosclerosis may also be an issue; it causes decreased blood flow to the wound and stoma site. As a result, transport of nutrients is delayed and

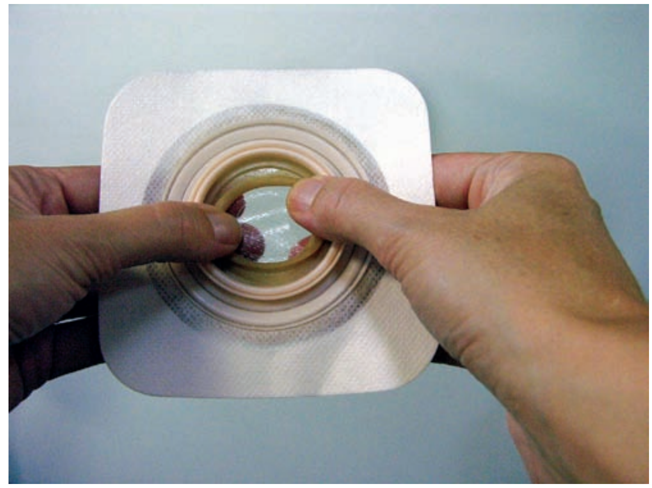


**Figure 38-11** Moldable stomal skin barrier (Moldable Technology, Courtesy of Convatec, Inc., © Skillman, NJ).

healing time may be prolonged. Some patients have delayed elimination after irrigation because of decreased peristalsis and mucus production. Most patients require 6 months before they feel comfortable with their ostomy care.

## NURSING PROCESS

## The Patient With Colorectal Cancer

### Assessment

The nurse obtains a health history about the presence of fatigue, abdominal or rectal pain (eg, location, frequency, duration, association with eating or defecation), past and present elimination patterns, and characteristics of stool (eg, color, odor, consistency, presence of blood or mucus). Additional information includes a history of IBD or colorectal polyps, a family history of colorectal disease, and current medication therapy. The nurse assesses dietary patterns, including fat and fiber intake, as well as amounts of alcohol consumed and history of smoking. The nurse describes and documents a history of weight loss and feelings of weakness and fatigue.

Assessment includes auscultation of the abdomen for bowel sounds and palpation of the abdomen for areas of tenderness, distention, and solid masses. Stool specimens are inspected for character and presence of blood.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses may include the following:

- Imbalanced nutrition, less than body requirements, related to nausea and anorexia
- Risk for deficient fluid volume related to vomiting and dehydration
- Anxiety related to impending surgery and the diagnosis of cancer
- Risk for ineffective therapeutic regimen management related to knowledge deficit concerning the diagnosis, the surgical procedure, and self-care after discharge

- Impaired skin integrity related to the surgical incisions (abdominal and perianal), the formation of a stoma, and frequent fecal contamination of peristomal skin
- Disturbed body image related to colostomy
- Ineffective sexuality patterns related to presence of ostomy and changes in body image and self-concept

#### *Collaborative Problems/Potential Complications*

Potential complications that may develop include the following:

- Intraperitoneal infection
- Complete large bowel obstruction
- GI bleeding
- Bowel perforation
- Peritonitis, abscess, and sepsis

### Planning and Goals

The major goals for the patient may include attainment of optimal level of nutrition; maintenance of fluid and electrolyte balance; reduction of anxiety; learning about the diagnosis, surgical procedure, and self-care after discharge; maintenance of optimal tissue healing; protection of peristomal skin; learning how to irrigate the colostomy (done only with sigmoid colostomies) and change the appliance; expressing feelings and concerns about the colostomy and the impact on self; and avoidance of complications.

### Nursing Interventions

#### *Preparing the Patient for Surgery*

The patient awaiting surgery for colorectal cancer has many concerns, needs, and fears. He or she may be physically debilitated and emotionally distraught with concerns about lifestyle changes after surgery, prognosis, ability to perform in established roles, and finances. Priorities for nursing care include preparing the patient physically for surgery; providing information about postoperative care, including stoma care if a colostomy is to be created; and supporting the patient and family emotionally. Ideally, a WOC nurse or surgeon should identify the stoma site preoperatively to ensure that its placement is visible and accessible to the patient.

Physical preparation for surgery involves building the patient's stamina in the days preceding surgery and cleansing and sterilizing the bowel the day before surgery. If the patient's condition permits, the nurse recommends a diet high in calories, protein, and carbohydrates and low in residue for several days before surgery to provide adequate nutrition and minimize cramping by decreasing excessive peristalsis. A full liquid diet may be prescribed for 24 to 48 hours before surgery to decrease bulk. If the patient is hospitalized in the days preceding surgery, parenteral nutrition may be required to replace depleted nutrients, vitamins, and minerals. In some instances, parenteral nutrition is administered at home before surgery. Antibiotics such as kanamycin (Kantrex), neomycin (Mycifradin), and cephalexin (Keflex) are administered orally the day before surgery to reduce intestinal bacteria. The bowel is cleansed with laxatives, enemas, or colonic irrigations the evening before and the morning of surgery.

For the patient who is very ill and hospitalized, the nurse measures and records intake and output, including vomitus, to provide an accurate record of fluid balance. The patient's intake of oral food and fluids may be restricted to prevent vomiting. The nurse administers antiemetics as prescribed. Full or clear liquids may be tolerated, or the patient may be allowed nothing by mouth. A nasogastric tube may be inserted to drain accumulated fluids and prevent abdominal distention. The nurse monitors the abdomen for increasing distention, loss of bowel sounds, and pain or rigidity, which may indicate obstruction or perforation. It also is important to monitor IV fluids and electrolytes. Monitoring serum electrolyte levels can detect the hypokalemia and hyponatremia that occur with GI fluid loss. The nurse observes for signs of hypovolemia (eg, tachycardia, hypotension, decreased pulse volume); assesses hydration status; and reports decreased skin turgor, dry mucous membranes, and concentrated urine.

The nurse assesses the patient's knowledge about the diagnosis, prognosis, surgical procedure, and expected level of functioning after surgery. It is important to include information about the physical preparation for surgery, the expected appearance and care of the wound, the technique of ostomy care (if applicable), dietary restrictions, pain control, and medication management in the teaching plan (see the Plan of Nursing Care in Chart 38-4). If the patient is admitted the day of surgery, the physician's office may arrange for the patient to be seen by a WOC nurse in the days preceding surgery. The WOC nurse helps determine the optimal site for the stoma and provides teaching about care. If the patient is hospitalized before the day of surgery, the WOC nurse is involved in the preoperative teaching. All procedures are explained in language the patient understands.

#### *Providing Emotional Support*

Patients anticipating bowel surgery for colorectal cancer may be very anxious. They may grieve about the diagnosis, the impending surgery, and possible permanent colostomy. Patients undergoing surgery for a temporary colostomy may express fears and concerns similar to those of a person with a permanent stoma. All members of the health care team, including the WOC nurse, should be available for assistance and support. The nurse's role is to assess the patient's anxiety level and coping mechanisms and suggest methods for reducing anxiety, such as deep-breathing exercises and visualizing a successful recovery from surgery and cancer. The nurse can arrange a meeting with a spiritual advisor if the patient desires or with the physician if the patient wishes to discuss the treatment or prognosis.

The patient undergoing a colostomy may find the anticipated changes in body image and lifestyle profoundly disturbing. Because the stoma is located on the abdomen, the patient may think that everyone will be aware of the ostomy. The nurse helps reduce this fear by presenting facts about the surgical procedure and the creation and management of the ostomy. If the patient is receptive, the nurse can use diagrams, photographs, and appliances to explain and clarify. Because the patient is experiencing emotional stress, the nurse will likely need to repeat some of the information. Consultation with a WOC nurse during the preoperative period can be extremely helpful, as can

speaking with a person who is successfully managing a colostomy. The UOAA provides visiting services by qualified members and rehabilitation services for patients with new ostomies.

*Providing Postoperative Care*

Postoperative nursing care for patients undergoing colon resection or colostomy is similar to nursing care for any abdominal surgery patient (see Chapter 20), including pain management during the immediate postoperative period. The nurse assesses the abdomen for returning peristalsis and assesses the initial stool characteristics. It is important to help patients with a colostomy out of bed on the first postoperative day and to encourage them to begin participating in managing the colostomy.

*Maintaining Optimal Nutrition*

The nurse teaches all patients undergoing surgery for colorectal cancer about the health benefits to be derived from consuming a healthy diet. The diet is individualized as long as it is nutritionally sound and does not cause diarrhea or constipation. The return to normal diet is rapid.

A complete nutritional assessment is important for the patient with a colostomy. The patient avoids foods that cause excessive odor and gas, including foods in the cabbage family, eggs, asparagus, fish, beans, and high-cellulose products such as peanuts. It is important to determine whether the elimination of specific foods is causing any nutritional deficiency. Nonirritating foods are substituted for those that are restricted so that deficiencies are corrected. The nurse advises the patient to experiment with an irritating food several times before restricting it, because an initial sensitivity may decrease with time. The nurse can help the patient identify any foods or fluids that may be causing diarrhea, such as fruits, high-fiber foods, soda, coffee, tea, or carbonated beverages. Diphenoxylate with atropine may be prescribed as needed to control the diarrhea. For constipation, prune or apple juice or a mild laxative is effective. The nurse suggests fluid intake of at least 2 L per day.

*Providing Wound Care*

The nurse frequently examines the abdominal dressing during the first 24 hours after surgery to detect signs of hemorrhage. It is important to help the patient splint the abdominal incision during coughing and deep breathing to lessen tension on the edges of the incision. The nurse monitors temperature, pulse, and respiratory rate for elevations that may indicate an infectious process. If the patient has a colostomy, the stoma is examined for swelling (slight edema from surgical manipulation is normal), color (a healthy stoma is pink or red), discharge (a small amount of oozing is normal), and bleeding (an abnormal sign if bright red or beyond trace amounts).

If the malignancy has been removed using the perineal route, the perineal wound is observed for signs of hemorrhage. This wound may contain a drain or packing that is removed gradually. Bits of tissue may slough off for a week. This process is hastened by mechanical irrigation of the wound or with sitz baths performed two or three times each day initially. The condition of the perineal wound and any bleeding, infection, or necrosis is documented.

*Monitoring and Managing Complications*

The patient is observed for signs and symptoms of complications. It is important to frequently assess the abdomen, including bowel sounds and abdominal girth, to detect bowel obstruction. The nurse monitors vital signs for increased temperature, pulse, and respirations and for decreased blood pressure that may indicate an intra-abdominal infectious process. It is important to report rectal bleeding immediately because it indicates hemorrhage. The nurse monitors hemoglobin and hematocrit levels and administers blood component therapy as prescribed. Any abrupt change in abdominal pain is reported promptly. Elevated white blood cell counts and temperature or symptoms of shock are reported because they may indicate sepsis. The nurse administers antibiotics as prescribed.

Pulmonary complications are always a concern with abdominal surgery; patients older than 50 years are at risk, especially if they are or have been receiving sedatives or are being maintained on bed rest for a prolonged period. Two major pulmonary complications are pneumonia and atelectasis. Frequent activity (eg, turning the patient from side to side every 2 hours), deep breathing, coughing, and early ambulation can reduce the risk for these complications. Table 38-6 lists postoperative complications.

The incidence of complications related to the colostomy is usually less than that of an ileostomy. Some common complications are prolapse of the stoma, parastomal hernia, perforation (from improper stoma irrigation), stoma retraction, mucocutaneous separation, and skin irritation (Colwell & Beitz, 2007). Leakage from an anastomotic site can occur if the remaining bowel segments are diseased or weakened. Leakage from an intestinal anastomosis causes peritonitis with abdominal distention and rigidity, temperature elevation, and signs of shock. Surgical repair is necessary.

*Removing and Applying the Colostomy Appliance*

The colostomy begins to function 3 to 6 days after surgery. The nurse manages the colostomy and teaches the patient about its care until the patient can take over its management. The nurse teaches skin care and how to apply, empty, and remove the drainage pouch. Care of the peristomal skin is an ongoing concern because excoriation or ulceration can develop quickly. The presence of such irritation makes adhering the ostomy appliance difficult, and adhering the ostomy appliance to irritated skin can worsen the skin condition. The effluent discharge and the degree to which it is irritating vary with the type of ostomy. With a transverse colostomy, the stool is soft and unformed and irritating to the skin. With a descending or sigmoid colostomy, the stool is fairly solid and less irritating to the skin. Other skin problems include yeast infections and allergic dermatitis. If the patient wants to bathe or shower before putting on a clean appliance, micropore tape applied to the sides of the pouch keeps it secure during

**Table 38-6 POTENTIAL COMPLICATIONS AND NURSING INTERVENTIONS AFTER INTESTINAL SURGERY**

| Complication | Nursing Interventions |
|---|---|
| **General Complications** | |
| Paralytic ileus | Initiate or continue nasogastric intubation as prescribed.<br>Prepare patient for x-ray study.<br>Ensure adequate fluid and electrolyte replacement.<br>Administer prescribed antibiotics if patient has symptoms of peritonitis. |
| Mechanical obstruction | Assess patient for intermittent colicky pain, nausea, and vomiting. |
| **Intra-abdominal Septic Conditions** | |
| Peritonitis | Evaluate patient for nausea, hiccups, chills, spiking fever, tachycardia, boardlike abdomen.<br>Administer antibiotics as prescribed.<br>Prepare patient for drainage procedure.<br>Administer parenteral fluid and electrolyte therapy as prescribed.<br>Prepare patient for surgery if condition deteriorates. |
| Abscess formation | Administer antibiotics as prescribed.<br>Apply warm compresses as prescribed.<br>Prepare for surgical drainage. |
| **Surgical Wound Complications** | |
| Infection | Monitor temperature; report temperature elevation.<br>Observe for redness, tenderness, hardening (induration), and pain around the surgical wound.<br>Assist in establishing local drainage.<br>Obtain specimen of drainage material for culture and sensitivity studies. |
| Wound disruption | Observe for sudden drainage of profuse serous fluid from wound.<br>Cover wound area with sterile moist dressings supported with binder or similar method.<br>Prepare patient immediately for surgery. |
| Intraperitoneal infection and abdominal wound infection | Monitor for evidence of constant or generalized abdominal pain, rapid pulse, and elevation of temperature.<br>Prepare for tube decompression of bowel.<br>Administer fluids and electrolytes by IV route as prescribed.<br>Administer antibiotics as prescribed. |
| **Anastomotic Complications** | |
| Dehiscence of anastomosis | Prepare patient for surgery. |
| Fistulas | Prepare for tube decompression of bowel.<br>Administer parenteral fluids as prescribed to correct fluid and electrolyte deficits. |

bathing. Refer to Chart 38-5 for guidelines on changing an ostomy appliance.

Colostomy appliances are not always necessary for some patients who have end sigmoid colostomies and who irrigate them. As soon as the patient has learned a routine for evacuation, pouches may be dispensed with, and a closed ostomy appliance or a stoma cap is used to cover the stoma. Except for gas and a slight amount of mucus, nothing escapes from the colostomy opening between irrigations.

### *Irrigating the Colostomy*

The purpose of irrigating a colostomy is to empty the colon of gas, mucus, and feces so that the patient can go about social and business activities without fear of fecal drainage. A stoma does not have voluntary muscular control and may empty at irregular intervals. Regulating the passage of fecal material is achieved by irrigating the colostomy or allowing the bowel to evacuate naturally without irrigations. This choice depends on the person and the type of the colostomy (ie, descending or sigmoid colostomies). By irrigating the stoma at a regular time, there is less gas and retention of the irrigant. The time for irrigating the colostomy should be consistent with the schedule the person will follow after leaving the hospital. Chart 38-11 describes the irrigating procedure.

Colostomy irrigation is not recommended for persons with extensive pelvic irradiation because it carries a risk of perforation (Colwell, et al., 2004).

### *Supporting a Positive Body Image*

The patient is encouraged to verbalize feelings and concerns about altered body image and to discuss the surgery and the stoma (if one was created). If applicable, the patient must learn colostomy care and begin to plan for incorporating stoma care into daily life. The nurse helps the patient overcome aversion to the stoma or fear of self-injury by providing care and teaching in an open, accepting manner and by encouraging the patient to talk about his or her feelings about the stoma.

### *Discussing Sexuality Issues*

The nurse encourages the patient to discuss feelings about sexuality and sexual function. The nurse can say, "Many people after surgery wonder how this will affect their role as a sexual partner. Do you have concerns about that?" (Junkin & Beitz, 2005). Some patients may initiate questions about sexual activity directly or give indirect clues about their fears. Some may view the surgery as mutilating and a threat to their sexuality; some fear impotence. Others may express worry about odor or leakage from the pouch during sexual activity.

CHART 38-11

## Guidelines for Irrigating a Colostomy

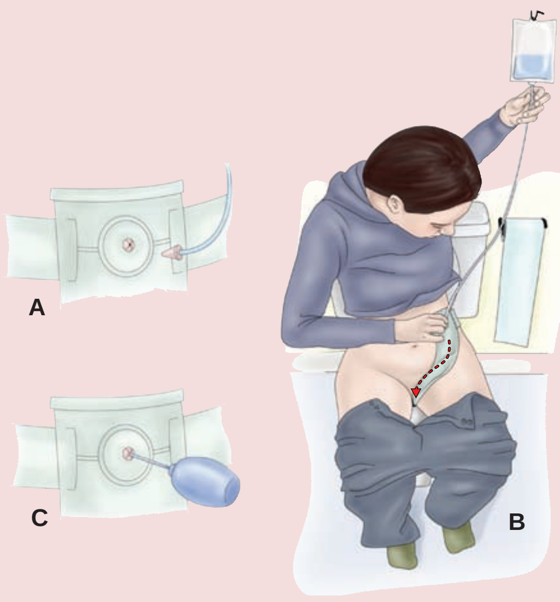
Before the procedure, the patient sits on a chair in front of the toilet or on the toilet itself. An irrigating reservoir containing 500 to 1500 mL of lukewarm tap water is hung 45 to 50 cm (18 to 20 in) above the stoma (shoulder height when the patient is seated). The dressing or pouch is removed. The following procedure is used; the patient is helped to participate in the procedure so he or she can learn to perform it unassisted.

### Equipment

- Irrigating sleeve or sheath
- Irrigating catheter or cone and tubing
- Lubricant
- Clamp
- Mild soap
- Cloth or towel
- New colostomy dressing or appliance

### Implementation

| Nursing Action | Rationale |
|---|---|
| 1. Apply an irrigating sleeve or sheath to the stoma. Place the end in the commode. | 1. This helps control odor and splashing and allows feces and water to flow directly into the commode. |
| 2. Allow some of the solution to flow through the tubing and catheter/cone. | 2. Air bubbles in the setup are released so that air is not introduced into the colon, which would cause crampy pain. |
| 3. Lubricate the irrigating cone and gently insert it into the stoma (Fig. A). Insert the cone into the stoma and hold it gently, but firmly, against the stoma to prevent backflow of water. | 3. Lubrication permits ease of insertion of the cone. A cone is used to prevent internal damage if a catheter is used. |
| 4. Allow water to flow slowly while advancing catheter (Fig. B). | 4. A slow rate of flow helps to relax the bowel. |
| 5. Allow tepid fluid to enter the colon slowly. If cramping occurs, clamp off the tubing and allow the patient to rest before progressing. Water should flow in over a 5- to 10-minute period. | 5. Painful cramps usually are caused by too rapid a flow or by too much solution; 300 mL of fluid may be all that is needed to stimulate evacuation. Volume may be increased with subsequent irrigations to 500, 1000, or 1500 mL as needed by the patient for effective results. |




| Nursing Action | Rationale |
|---|---|
| 6. Hold the cone in place 10 seconds after the water has been instilled; then gently remove it. | 6. This minimizes or eliminates spillage of water. |
| 7. Allow 10 to 15 minutes for most of the return; then dry the bottom of the sleeve/sheath and attach it to the top, or apply the appropriate clamp to the bottom of the sleeve. | 7. Most of the water, feces, and flatus will be expelled in 10 to 15 minutes. |
| 8. Leave the sleeve/sheath in place for 30 to 45 minutes while the patient gets up and moves around. | 8. Ambulation stimulates peristalsis and completion of the irrigation return. |
| 9. Cleanse the area with a mild soap and water; pat the area dry. | 9. Cleanliness and dryness will provide the patient with hours of comfort. |
| 10. Replace the colostomy dressing or appliance. | 10. The patient should use an appliance until the colostomy is sufficiently controlled. Then a dressing may be all that is needed. |

Although the appliance presents no deterrent to sexual activity, some patients wear silk or cotton covers and smaller pouches during sex. Alternative sexual positions are recommended, as well as alternative methods of stimulation to satisfy sexual drives. The nurse assesses the patient's needs and attempts to identify specific concerns. If the nurse is uncomfortable with this or if the patient's concerns seem complex, the nurse may seek assistance from a WOC nurse, sex counselor or therapist, or advanced practice nurse (Junkin & Beitz, 2005).

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patient education and discharge planning require the combined efforts of the physician, nurse, WOC nurse, social worker, and dietitian. Patients are given specific information, individualized to their needs, about ostomy care and signs and symptoms of potential complications. Dietary instructions are essential to help patients identify and eliminate irritating foods that can cause diarrhea or constipation. It is important to teach patients about their prescribed medications (ie, action, purpose, and possible side and toxic effects).

The nurse reviews treatments (eg, irrigations, wound cleansing) and dressing changes and encourages the family to participate. Because the hospital stay is short, the patient may not become proficient in all stoma care techniques before discharge home. However, it is critical that the patient or family member learn how to empty and change the pouch before leaving the hospital. Many patients need referral to a home care agency and the telephone number of the local chapter of the American Cancer Society. The home care nurse provides further care and teaching and assesses the patient's and family's adjustment to the colostomy. The home environment is assessed for adequacy of resources that allow the patient to manage self-care activities. A family member may assume responsibility for purchasing the equipment and supplies needed at home.

Patients need very specific directions about when to call the physician. They need to know which complications require prompt attention (ie, bleeding, abdominal distention and rigidity, diarrhea, fever, wound drainage, and disruption of suture line). If radiation therapy is planned, the possible side effects (ie, anorexia, vomiting, diarrhea, fatigue) are reviewed.

**CONTINUING CARE.** Ongoing care of the patient with cancer and a colostomy often extends well beyond the initial hospital stay. Home care nurses manage ostomy follow-up care, manage the assessment and care of the debilitated patient, and coordinate adjuvant therapy. The home visits also provide an opportunity to assess the patient's physical and emotional status and the patient's and family's ability to carry out recommended care strategies. Visits from a WOC nurse are available to the patient and family as they learn to care for the ostomy and work through their feelings about it, the diagnosis of cancer, and the future. Some patients are interested in and can benefit from involvement in an ostomy support group (eg, the UOAA).

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Consumes a healthy diet
    a. Avoids foods and fluids that cause diarrhea, constipation, and obstruction
    b. Substitutes nonirritating foods and fluids for those that are restricted
2. Maintains fluid balance
    a. Experiences no vomiting or diarrhea
    b. Experiences no signs or symptoms of dehydration
3. Feels less anxious
    a. Expresses concerns and fears freely
    b. Uses coping measures to manage stress
4. Acquires information about diagnosis, surgical procedure, preoperative preparation, and self-care after discharge
    a. Discusses the diagnosis, surgical procedure, and postoperative self-care
    b. Demonstrates techniques of ostomy care
5. Maintains clean incision, stoma, and perineal wound
6. Expresses feelings and concerns about self
    a. Gradually increases participation in stoma and peristomal skin care
    b. Discusses feelings related to changed appearance
7. Discusses sexuality in relation to ostomy and to changes in body image
8. Recovers without complications
    a. Is afebrile
    b. Regains normal bowel activity
    c. Exhibits no signs and symptoms of perforation or bleeding
    d. Identifies signs and symptoms that should be reported to health care provider

## Polyps of the Colon and Rectum

A polyp is a mass of tissue that protrudes into the lumen of the bowel. Polyps can occur anywhere in the intestinal tract and rectum. They can be classified as neoplastic (ie, adenomas and carcinomas) or non-neoplastic (ie, mucosal and hyperplastic). Non-neoplastic polyps, which are benign epithelial growths, are common in the Western world. They occur more commonly in the large intestine than in the small intestine. Although most polyps do not develop into invasive neoplasms, they must be identified and followed closely. Adenomatous polyps are more common in men. The proportion of these polyps arising in the proximal part of the colon increases with age (after 50 years of age). Prevalence rates vary from 25% to 60%, depending on age. Non-neoplastic polyps occur in 80% of the population, and their frequency increases with age. Up to two thirds of people older than 65 years are at risk for colonic adenomas (McPhee, Papadakis & Tierney, 2007).

Clinical manifestations depend on the size of the polyp and the amount of pressure it exerts on intestinal tissue. The most common symptom is rectal bleeding. Lower abdominal pain may also occur. If the polyp is large enough, symptoms of obstruction occur. The diagnosis is based on

history and digital rectal examination, barium enema studies, sigmoidoscopy, or colonoscopy.

After a polyp is identified, it should be removed. Several methods are used: colonoscopy with the use of special equipment (ie, biopsy forceps and snares), laparoscopy, or colonoscopic excision with laparoscopic visualization. The latter technique enables immediate detection of potential problems and allows laparoscopic resection and repair of the major complications of perforation and bleeding that may occur with polypectomy. Microscopic examination of the polyp then identifies the type of polyp and indicates what further surgery is required, if any.

# DISEASES OF THE ANORECTUM

Anorectal disorders are common, and the majority of the population will experience one at some time during their lives. Patients with anorectal disorders seek medical care primarily because of pain, rectal bleeding, or change in bowel habits. Other common complaints are protrusion of hemorrhoids, anal discharge, perianal itching, swelling, anal tenderness, stenosis, and ulceration. Constipation results from delaying defecation because of anorectal pain.

There has been a steady increase in the prevalence of sexually transmitted diseases (STDs; also called sexually transmitted infections, or STIs) in recent decades, leading to the identification of new anorectal syndromes. The prevalence of these conditions is increasing. These syndromes include STIs such as syphilis, gonorrhea, herpes, chlamydia, and candidiasis, and they are most commonly seen in male homosexuals who practice anorectal intercourse.

## *Diseases*

### Anorectal Abscess

An anorectal abscess is caused by obstruction of an anal gland, resulting in retrograde infection. People with Crohn's disease or immunosuppressive conditions such as AIDS are particularly susceptible to these infections. Many of these abscesses result in fistulas.

An abscess may occur in a variety of spaces in and around the rectum. It often contains a quantity of foul-smelling pus and is painful. If the abscess is superficial, swelling, redness, and tenderness are observed. A deeper abscess may result in severe lower abdominal pain and fever.

Palliative therapy consists of sitz baths and analgesics. However, prompt surgical treatment to incise and drain the abscess is the treatment of choice. When a deeper infection exists with the possibility of a fistula, the fistulous tract must be excised. If possible, the fistula is excised when the abscess is incised and drained, or a second procedure may be necessary to do so. The wound may be packed with an absorptive dressing (eg, calcium alginate or hydrofiber) and allowed to heal by granulation.

### Anal Fistula

An anal fistula is a tiny, tubular, fibrous tract that extends into the anal canal from an opening located beside the anus in the perianal skin (Fig. 38-12A). Fistulas usually result from an infection. They may also develop from trauma, fissures, or Crohn's disease (up to 25% of patients with Crohn's disease develop a perianal fistula). Purulent drainage or stool may leak constantly from the cutaneous opening. Other symptoms may be the passage of flatus or feces from the vagina or bladder, depending on the location of the fistula tract. Untreated fistulas may cause systemic infection with related symptoms (Koutroubakis, 2007).

Medical therapy includes antibiotics or anti-inflammatory type agents (eg, azathioprine, infliximab, cyclosporine). Fistula recurrence is common (Koutroubakis, 2007). Surgery is recommended because few fistulas heal spontaneously. A fistulectomy (ie, excision of the fistulous tract) is the recommended surgical procedure. The lower bowel is evacuated thoroughly with several prescribed enemas. The fistula is dissected out or laid open by an incision from its rectal opening to its outlet. The wound is packed with gauze.

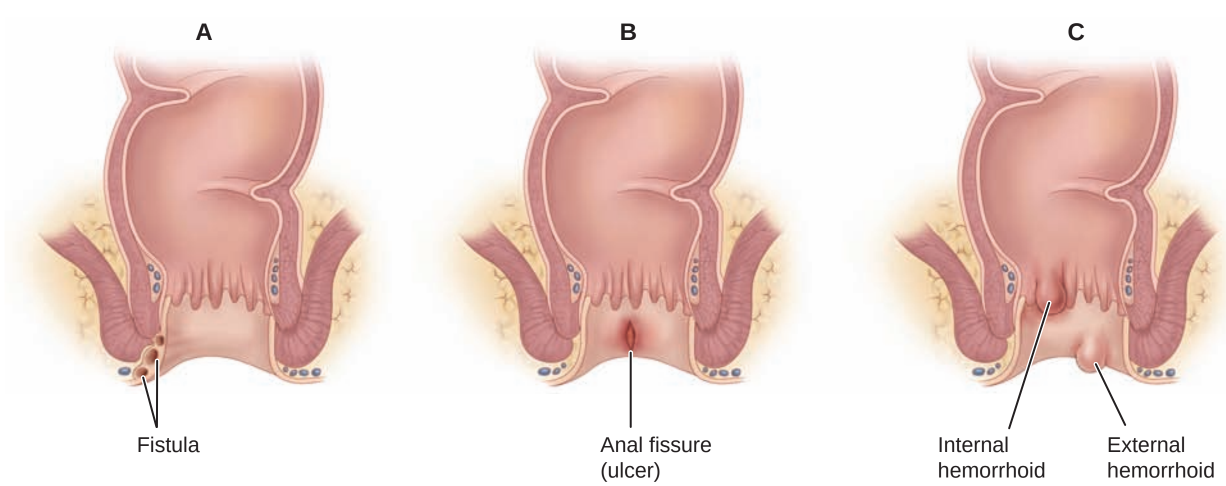



**Figure 38–12** Various types of anal lesions. **A,** Fistula. **B,** Fissure. **C,** External and internal hemorrhoids.

## Anal Fissure

An anal fissure is a longitudinal tear or ulceration in the lining of the anal canal (see Fig. 38-12B). Fissures are usually caused by the trauma of passing a large, firm stool or from persistent tightening of the anal canal because of stress and anxiety (leading to constipation). Other causes include childbirth, trauma, and overuse of laxatives.

Extremely painful defecation, burning, and bleeding characterize fissures. Bright-red blood may be seen on the toilet tissue after a bowel movement. Most of these fissures heal if treated by conservative measures that include dietary modification with addition of fiber supplements, stool softeners and bulk agents, an increase in water intake, sitz baths, and emollient suppositories. A suppository combining an anesthetic with a corticosteroid helps relieve the discomfort. Anal dilation under anesthesia may be required. A novel therapy, perianal or intra-anal application of nitroglycerin ointment, has increased the rate of healing and lowered pain levels in chronic anal fissures. The ointment is believed to increase blood supply to the wound and relax the anal sphincter (Azarnoff, Lee, Lee, et al., 2007; Brown, Dubreuil, Santora, et al., 2007).

If fissures do not respond to conservative treatment, surgery is indicated. Most surgeons consider the procedure of choice to be the lateral internal sphincterotomy with excision of the fissure (Brown, et al., 2007).

## Hemorrhoids

Hemorrhoids are dilated portions of veins in the anal canal. They are very common; by 50 years of age, about 50% of people have hemorrhoids (NIH, 2007). Shearing of the mucosa during defecation results in the sliding of the structures in the wall of the anal canal, including the hemorrhoidal and vascular tissues. Increased pressure in the hemorrhoidal tissue due to pregnancy may initiate hemorrhoids or aggravate existing ones. Hemorrhoids are classified as one of two types: those above the internal sphincter are called internal hemorrhoids, and those appearing outside the external sphincter are called external hemorrhoids (see Fig. 38-12C).

Hemorrhoids cause itching and pain and are the most common cause of bright-red bleeding with defecation. External hemorrhoids are associated with severe pain from the inflammation and edema caused by thrombosis (ie, clotting of blood within the hemorrhoid). This may lead to ischemia of the area and eventual necrosis. Internal hemorrhoids are not usually painful until they bleed or prolapse when they become enlarged.

Hemorrhoid symptoms and discomfort can be relieved by good personal hygiene and by avoiding excessive straining during defecation. A high-residue diet that contains fruit and bran along with an increased fluid intake may be all the treatment that is necessary to promote the passage of soft, bulky stools to prevent straining. If this treatment is not successful, the addition of hydrophilic bulk-forming agents such as psyllium may help. Warm compresses, sitz baths, analgesic ointments and suppositories, astringents (eg, witch hazel), and bed rest reduce engorgement.

There are several types of nonsurgical treatments for hemorrhoids. Infrared photocoagulation, bipolar diathermy, and laser therapy are used to affix the mucosa to the underlying muscle. Injection of sclerosing agents is also effective for small, bleeding hemorrhoids. These procedures help prevent prolapse.

A conservative surgical treatment of internal hemorrhoids is the rubber-band ligation procedure. The hemorrhoid is visualized through the anoscope, and its proximal portion above the mucocutaneous lines is grasped with an instrument. A small rubber band is then slipped over the hemorrhoid. Tissue distal to the rubber band becomes necrotic after several days and sloughs off. Fibrosis occurs; the result is that the lower anal mucosa is drawn up and adheres to the underlying muscle. Although this treatment has been satisfactory for some patients, it has proven painful for others and may cause secondary hemorrhage. It has also been known to cause perianal infection.

Cryosurgical hemorrhoidectomy, another method for removing hemorrhoids, involves freezing the hemorrhoid for a sufficient time to cause necrosis. Although it is relatively painless, this procedure is not widely used because the discharge is foul-smelling and wound healing is prolonged. The Nd:YAG laser is useful in excising hemorrhoids, particularly external hemorrhoidal tags. The treatment is quick and relatively painless. Hemorrhage and abscess are rare postoperative complications.

The previously described methods of treating hemorrhoids are not effective for advanced thrombosed veins, which must be treated by more extensive surgery. Stapled hemorrhoidopexy, a newer procedure, uses surgical staples to treat prolapsing hemorrhoids and is associated with less postoperative pain and fewer complications (Goldstein, Meslin, Mazza, et al., 2007). If it is not successful, hemorrhoidectomy, or surgical excision, may be performed to remove all the redundant tissue involved in the process. During surgery, the rectal sphincter is usually dilated digitally, and the hemorrhoids are removed with a clamp and cautery or are ligated and then excised. After the surgical procedures are completed, a small tube may be inserted through the sphincter to permit the escape of flatus and blood; pieces of Gelfoam or Oxycel gauze may be placed over the anal wounds.

## Sexually Transmitted Anorectal Diseases

Three infectious syndromes that are related to STDs have been identified: proctitis, proctocolitis, and enteritis. Proctitis involves the rectum. It is commonly associated with recent anal-receptive intercourse with an infected partner. Symptoms include mucopurulent discharge or bleeding, rectal pain, and diarrhea. The pathogens most frequently involved are *Neisseria gonorrhoeae*, *Chlamydia*, herpes simplex virus, and *Treponema pallidum*.

Proctocolitis involves the rectum and lowest portion of the descending colon. Symptoms are similar to proctitis but may also include watery or bloody diarrhea, cramps, pain, and bloating. Enteritis involves more of the descending

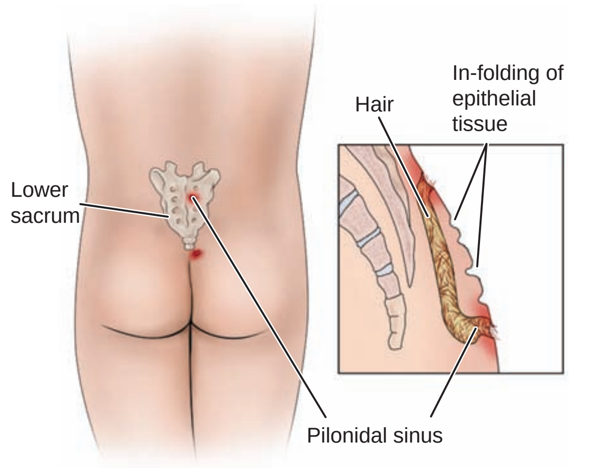



**Figure 38-13** (*Left*) Pilonidal sinus on lower sacrum about 5 cm (2 in) above the anus in the intergluteal cleft. (*Right*) Hair particles emerge from the sinus tract, and localized indentations (pits) can appear on the skin near the sinus openings.

colon, and symptoms include watery, bloody diarrhea; abdominal pain; and weight loss. The most common pathogens causing enteritis are *E. histolytica*, *Giardia lamblia*, *Shigella*, and *Campylobacter*.

Sigmoidoscopy is performed to identify portions of the anorectum involved. Samples are taken with rectal swabs, and cultures are obtained to identify the pathogens involved. Antibiotics (ie, ceftriaxone [Rocephin] or cefixime [Suprax], doxycycline [Vibramycin], and penicillin G) are the treatment of choice for bacterial infections (CDC, 2007). Acyclovir [Zovirax] is given to patients with viral infections. Antiamebic therapy (ie, metronidazole [Flagyl]) is appropriate for infections with *E. histolytica* and *G. lamblia*. Ciprofloxacin (Cipro) is effective for *Shigella*. The antibiotics erythromycin (E-Mycin) and ciprofloxacin are the treatment of choice for *Campylobacter* infection (CDC, 2007).

## Pilonidal Sinus or Cyst

A pilonidal sinus or cyst is found in the intergluteal cleft on the posterior surface of the lower sacrum (Fig. 38-13). Current theories suggest that it results from local trauma, causing penetration of hairs into the epithelium and subcutaneous tissue. It may also be formed congenitally by an infolding of epithelial tissue beneath the skin, which may communicate with the skin surface through one or several small sinus openings. Hair frequently is seen protruding from these openings, and this gives the cyst its name, *pilonidal* (ie, a nest of hair). The cysts rarely cause symptoms until adolescence or early adult life, when infection produces an irritating drainage or an abscess. Perspiration and friction easily irritate this area.

In the early stages of the inflammation, the infection may be controlled by antibiotic therapy, but after an abscess has formed, surgery is indicated. The abscess is incised and drained under local anesthesia. After the acute process resolves, further surgery is performed to excise the cyst and the secondary sinus tracts. The wound is allowed to heal by granulation. Absorptive dressings are placed in the wound to keep its edges separated while healing occurs.

# Nursing Management of Patients With Anorectal Conditions

## Promoting Home and Community-Based Care

### *Teaching Patients Self-Care*

Most patients with anorectal conditions are not hospitalized. Those who undergo surgical procedures to correct the condition often are discharged directly from the outpatient surgical center. If they are hospitalized, it is for a short time, usually only 24 hours. Patient teaching is essential to facilitate recovery at home.

The nurse instructs the patient to keep the perianal area as clean as possible by gently cleansing with warm water and then drying with absorbent cotton wipes. The patient should avoid rubbing the area with toilet tissue. Instructions are provided about how to take a sitz bath and how to test the temperature of the water.

During the first 24 hours after rectal surgery, painful spasms of the sphincter and perineal muscles may occur. The nurse instructs the patient that ice and analgesic ointments may decrease the pain. Warm compresses may promote circulation and soothe irritated tissues. Sitz baths taken three or four times each day can relieve soreness and pain by relaxing sphincter spasm. Twenty-four hours after surgery, topical anesthetic agents may be beneficial in relieving local irritation and soreness. Medications may include topical anesthetics (ie, suppositories), astringents, antiseptics, tranquilizers, and antiemetics. Patients are more compliant and less apprehensive if they are free of pain.

Wet dressings saturated with equal parts of cold water and witch hazel help relieve edema. When wet compresses are being used continuously, petrolatum is applied around the anal area to prevent skin maceration. The patient is instructed to assume a prone position at intervals because this position reduces edema of the tissue.

### *Continuing Care*

Sitz baths may be given in the bathtub or plastic sitz bath unit three or four times each day. Sitz baths should follow each bowel movement for 1 to 2 weeks after surgery. The nurse encourages intake of at least 2 L of water daily to provide adequate hydration and recommends high-fiber foods to promote bulk in the stool and to make it easier to pass fecal matter through the rectum. Bulk laxatives such as psyllium may be recommended and stool softeners (eg, docusate) may be prescribed. The patient is advised to set aside a time for bowel movements and to heed the urge to defecate as promptly as possible. The nurse encourages the patient to respond quickly to the urge to defecate to prevent constipation. The diet is modified to increase fluids and fiber. Moderate exercise is encouraged, and the patient is taught about the prescribed diet, the significance of proper eating habits and exercise, and the laxatives that can be taken safely.

## CRITICAL THINKING EXERCISES

**1** A 92-year-old woman in a long-term care facility is a patient assigned to your care. With visible discomfort, she tells you that she has noticed blood in the toilet bowl with her last several bowel movements and she has had blood on her underwear. What other questions should you ask this woman to clarify potential causes of this problem? Explain how the patient's age might affect your focused assessment.

EBP **2** A fellow nursing student enrolled in your pharmacology class shares with you that she has been feeling poorly for the past 2 weeks. She has been tired, has lost 10 pounds recently, and has had recurrent abdominal pain. She appears pale to you. She is very worried about her success on the final examination that is scheduled for next week. This student casually mentions that she hopes that she does not develop ulcerative colitis like her sister. What further questions might you ask? What is the strength of the evidence that suggests she may be at risk for ulcerative colitis? What advice would you give to your classmate? What further workup do you think should be recommended?

**3** A 40-year-old female teacher is admitted to the outpatient surgery clinic with complaints of anorectal swelling. You note in this patient's health history that her swelling has worsened over the past 2 weeks, and today there is purulent drainage from the anus. A surgeon examines the patient and schedules immediate surgery in the adjacent operating room suite. The patient asks you, "Why can't I just get an antibiotic?" Given the likely pathophysiology involved in her condition, explain to this patient why surgical intervention is indicated. Identify essential actions you must take before she is taken to the operating room. After your interventions, this patient decides to undergo surgery. Later that afternoon, she is prepared for discharge. Design a discharge plan for her for the next 2 weeks, and include the principles of care that you should teach her so that she may understand the reasons for her home care routine.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*


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## RESOURCES

American Cancer Society, www.cancer.org
American Society of Colon and Rectal Surgeons, www.fascrs.org
Colon Cancer Alliance, www.ccalliance.org
Crohn's & Colitis Foundation of America, www.ccfa.org
International Foundation for Functional Gastrointestinal Disorders, www.iffgd.org
J Pouch Group: Source for J-Pouch surgery support; www.j-pouch.org
Medicine Online: Colon Cancer Information Library, www.meds.com/colon/colon.html
National Association for Continence, www.nafc.org
National Digestive Disease Information Clearinghouse, digestive.niddk.nih.gov
STOP Colon/Rectal Cancer Foundation, www.coloncancerprevention.org
United Ostomy Associations of America (UOAA), www.uoaa.org
Wound, Ostomy, Continence Nurses Society, www.wocn.org

unit 8

# Metabolic and Endocrine Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Complications of Diabetes



**Mr. Johansen** is a 58-year-old man with type 2 diabetes, peripheral vascular disease, hyperlipidemia, and peripheral neuropathy. He is also 50 lb over his ideal body weight. He takes an oral antidiabetic agent twice daily and lovastatin for elevated cholesterol levels. Mr. Johansen comes to the clinic for treatment of an unrelated respiratory infection. While there, he tells the nurse that he has numbness and tingling of his feet and has burning pain in his legs if he stands for long periods of time. The nurse assesses his feet and notes decreased sensory function in both feet. Mr. Johansen states that he has not seen his doctor for more than 1 year and only comes to the clinic if he feels sick.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **INEFFECTIVE TISSUE PERFUSION (ALL TYPES)**—Decrease in oxygen resulting in the failure to nourish tissues at the capillary level | **CIRCULATORY CARE: ARTERIAL INSUFFICIENCY**—Promotion of arterial circulation | **CIRCULATION STATUS**—Extent to which blood flows unobstructed, unidirectionally, and at an appropriate pressure through large vessels of the systemic and pulmonary circuits |
| **DISTURBED TACTILE SENSORY PERCEPTION**—Change in the amount or patterning of incoming stimuli accompanied by a diminished, exaggerated, distorted, or impaired response to such stimuli | **CIRCULATORY PRECAUTIONS**—Protection of localized area with limited perfusion | **SENSORY FUNCTION: CUTANEOUS**—Extent to which stimulation of the skin is correctly sensed |
| **INEFFECTIVE THERAPEUTIC REGIMEN MANAGEMENT**—Pattern of regulating and integrating into daily living a program for treatment of illness and the sequelae of illness that is unsatisfactory for meeting specific health goals | **TEACHING: FOOT CARE**—Preparing an at-risk patient and/or a significant other to provide preventive foot care | **TISSUE INTEGRITY: SKIN AND MUCOUS MEMBRANES**—Structural intactness and normal physiologic function of skin and mucous membranes |
| | **SKIN SURVEILLANCE**—Collection and analysis of patient data to maintain skin and mucous membrane integrity | **KNOWLEDGE: DIABETES MANAGEMENT**—Extent of understanding conveyed about diabetes mellitus and its control |
| | **TEACHING: INDIVIDUAL**—Planning, implementation, and evaluation of a teaching program designed to address a patient's particular needs | |

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chapter 39

# Assessment and Management of Patients With Hepatic Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the metabolic functions of the liver and the alterations in these functions that occur with liver disease.
2. Explain liver function tests and the clinical manifestations of liver dysfunction in relation to pathophysiologic alterations of the liver.
3. Relate jaundice, portal hypertension, ascites, varices, nutritional deficiencies, and hepatic coma to pathophysiologic alterations of the liver.
4. Describe the medical, surgical, and nursing management of patients with esophageal varices.
5. Compare the various types of hepatitis and their causes, prevention, clinical manifestations, management, prognosis, and home health care needs.
6. Use the nursing process as a framework for care of the patient with cirrhosis of the liver.
7. Compare the nonsurgical and surgical management of patients with cancer of the liver.
8. Describe the postoperative nursing care of the patient undergoing liver transplantation.

## GLOSSARY

**asterixis:** involuntary flapping movements of the hands associated with metabolic liver dysfunction

**balloon tamponade:** use of balloons placed within the esophagus and proximal portion of the stomach and inflated to compress bleeding vessels (esophageal and gastric varices)

**Budd-Chiari syndrome:** hepatic vein thrombosis resulting in non-cirrhotic portal hypertension

**cirrhosis:** a chronic liver disease characterized by fibrotic changes and the formation of dense connective tissue within the liver, subsequent degenerative changes, and loss of functioning cells

**constructional apraxia:** inability to draw figures in two or three dimensions

**fetor hepaticus:** sweet, slightly fecal odor to the breath, presumed to be of intestinal origin; prevalent with the extensive collateral portal circulation in chronic liver disease

**fulminant hepatic failure:** sudden, severe onset of acute liver failure that occurs within 8 weeks after the first symptoms of jaundice

**hepatic encephalopathy:** central nervous system dysfunction resulting from liver disease; frequently associated with elevated ammonia levels that produce changes in mental status, altered level of consciousness, and coma

**orthotopic liver transplantation (OLT):** grafting of a donor liver into the normal anatomic location, with removal of the diseased native liver

**portal hypertension:** elevated pressure in the portal circulation resulting from obstruction of venous flow into and through the liver

**sclerotherapy:** the injection of substances into or around esophagogastric varices to cause constriction, thickening, and hardening of the vessel and thus to stop bleeding

**variceal banding:** procedure that involves the endoscopic placement of a rubber band–like device over esophageal varices to ligate the area and stop bleeding

**xenograft:** transplantation of organs from one species to another

Liver function is complex, and liver dysfunction affects all body systems. For this reason, the nurse must understand how the liver functions and must have expert clinical assessment and management skills to care for patients undergoing complex diagnostic and treatment procedures. The nurse also must understand technologic advances in the management of liver disorders. Liver disorders are common and may result from a virus, exposure to toxic substances such as alcohol, or tumors.

# ASSESSMENT OF THE LIVER

## *Anatomic and Physiologic Overview*

The liver, the largest gland of the body, can be considered a chemical factory that manufactures, stores, alters, and excretes a large number of substances involved in metabolism. The location of the liver is essential in this function because it receives nutrient-rich blood directly from the gastrointestinal (GI) tract and then either stores or transforms these nutrients into chemicals that are used elsewhere in the body for metabolic needs. The liver is especially important in the regulation of glucose and protein metabolism. The liver manufactures and secretes bile, which has a major role in the digestion and absorption of fats in the GI tract. The liver removes waste products from the bloodstream and secretes them into the bile. The bile produced by the liver is stored temporarily in the gallbladder until it is needed for digestion, at which time the gallbladder empties and bile enters the intestine (Fig. 39-1).

### Anatomy of the Liver

The liver is a large, highly vascular organ located behind the ribs in the upper right portion of the abdominal cavity. It weighs between 1200 and 1500 g and is divided into four lobes. A thin layer of connective tissue surrounds each lobe, extending into the lobe itself and dividing the liver mass into small, functional units called lobules (Rodes, Benhamou, Blei, et al., 2007).

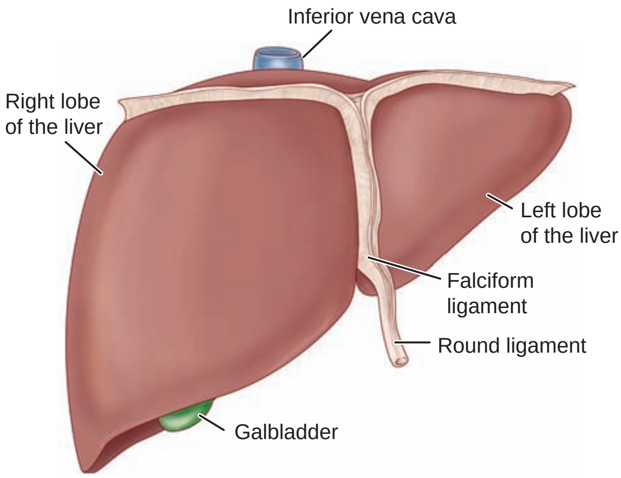



**Figure 39-1** The liver and biliary system.

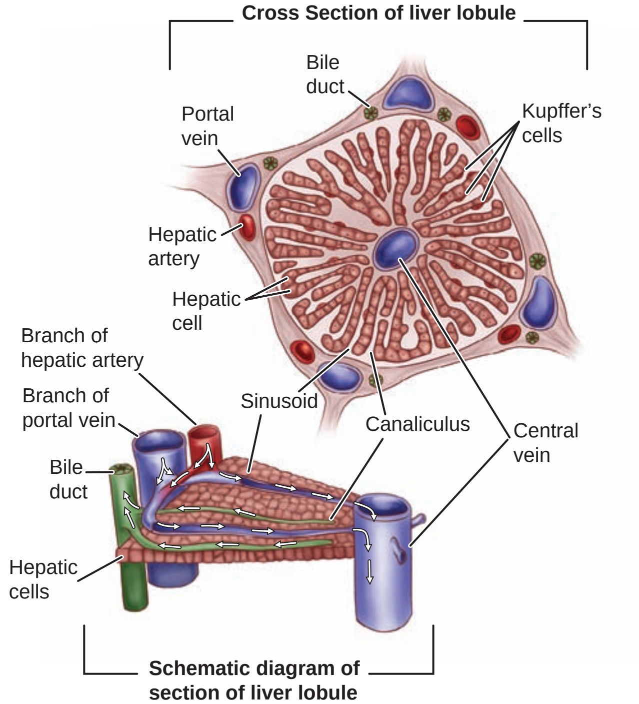



**Figure 39-2** A section of liver lobule showing the location of hepatic veins, hepatic cells, liver sinusoids, and branches of the portal vein and hepatic artery.

The circulation of the blood into and out of the liver is of major importance to liver function. The blood that perfuses the liver comes from two sources. Approximately 80% of the blood supply comes from the portal vein, which drains the GI tract and is rich in nutrients but lacks oxygen. The remainder of the blood supply enters by way of the hepatic artery and is rich in oxygen. Terminal branches of these two blood vessels join to form common capillary beds, which constitute the sinusoids of the liver (Fig. 39-2). Thus, a mixture of venous and arterial blood bathes the liver cells (hepatocytes). The sinusoids empty into venules that occupy the center of each liver lobule and are called the central veins. The central veins join to form the hepatic vein, which constitutes the venous drainage from the liver and empties into the inferior vena cava, close to the diaphragm (Rodes, et al., 2007).

In addition to hepatocytes, phagocytic cells belonging to the reticuloendothelial system are present in the liver. Other organs that contain reticuloendothelial cells are the spleen, bone marrow, lymph nodes, and lungs. In the liver, these cells are called Kupffer cells. As the most common phagocyte in the human body, their main function is to engulf particulate matter (eg, bacteria) that enters the liver through the portal blood.

The smallest bile ducts, called canaliculi, are located between the lobules of the liver. The canaliculi receive secretions from the hepatocytes and carry them to larger bile ducts, which eventually form the hepatic duct. The hepatic duct from the liver and the cystic duct from the gallbladder join to form the common bile duct, which empties into the small intestine. The sphincter of Oddi, located at the

junction where the common bile duct enters the duodenum, controls the flow of bile into the intestine.

## Functions of the Liver

### Glucose Metabolism

The liver plays a major role in the metabolism of glucose and the regulation of blood glucose concentration. After a meal, glucose is taken up from the portal venous blood by the liver and converted into glycogen, which is stored in the hepatocytes. Subsequently, the glycogen is converted back to glucose (glycogenolysis) and released as needed into the bloodstream to maintain normal levels of blood glucose. However, this process provides a limited amount of glucose. Additional glucose can be synthesized by the liver through a process called gluconeogenesis. For this process, the liver uses amino acids from protein breakdown or lactate produced by exercising muscles. This process occurs in response to hypoglycemia (Shils, Shike, Ross, et al., 2006).

### Ammonia Conversion

Use of amino acids from protein for gluconeogenesis results in the formation of ammonia as a byproduct. The liver converts this metabolically generated ammonia into urea. Ammonia produced by bacteria in the intestines is also removed from portal blood for urea synthesis. In this way, the liver converts ammonia, a potential toxin, into urea, a compound that is excreted in the urine (Porth & Matfin, 2009).

### Protein Metabolism

The liver also plays an important role in protein metabolism. It synthesizes almost all of the plasma proteins (except gamma-globulin), including albumin, alpha-globulins and beta-globulins, blood clotting factors, specific transport proteins, and most of the plasma lipoproteins. Vitamin K is required by the liver for synthesis of prothrombin and some of the other clotting factors. Amino acids are used by the liver for protein synthesis (Porth & Matfin, 2009).

### Fat Metabolism

The liver is also active in fat metabolism. Fatty acids can be broken down for the production of energy and ketone bodies (acetoacetic acid, beta-hydroxybutyric acid, and acetone). Ketone bodies are small compounds that can enter the bloodstream and provide a source of energy for muscles and other tissues. Breakdown of fatty acids into ketone bodies occurs primarily when the availability of glucose for metabolism is limited, as in starvation or in uncontrolled diabetes. Fatty acids and their metabolic products are also used for the synthesis of cholesterol, lecithin, lipoproteins, and other complex lipids (Porth & Matfin, 2009).

In some conditions, lipids may accumulate in the hepatocytes, resulting in the abnormal condition called fatty liver.

### Vitamin and Iron Storage

Vitamins A, B, and D and several of the B-complex vitamins are stored in large amounts in the liver. Certain substances, such as iron and copper, are also stored in the liver. Because the liver is rich in these substances, liver extracts have been used for therapy for more than a century for a wide range of nutritional disorders; however, the U.S. Food and Drug Administration (FDA) has urged caution regarding the use of any animal organ extract because of possible risk of exposure to pathogenic organisms.

### Bile Formation

Bile is continuously formed by the hepatocytes and collected in the canaliculi and bile ducts. It is composed mainly of water and electrolytes such as sodium, potassium, calcium, chloride, and bicarbonate, and it also contains significant amounts of lecithin, fatty acids, cholesterol, bilirubin, and bile salts. Bile is collected and stored in the gallbladder and is emptied into the intestine when needed for digestion. The functions of bile are excretory, as in the excretion of bilirubin; bile also serves as an aid to digestion through the emulsification of fats by bile salts.

Bile salts are synthesized by the hepatocytes from cholesterol. After conjugation or binding with amino acids (taurine and glycine), bile salts are excreted into the bile. The bile salts, together with cholesterol and lecithin, are required for emulsification of fats in the intestine, which is necessary for efficient digestion and absorption. Bile salts are then reabsorbed, primarily in the distal ileum, into portal blood for return to the liver and are again excreted into the bile. This pathway from hepatocytes to bile to intestine and back to the hepatocytes is called the enterohepatic circulation. Because of the enterohepatic circulation, only a small fraction of the bile salts that enter the intestine are excreted in the feces. This decreases the need for active synthesis of bile salts by the liver cells (Porth & Matfin, 2009).

### Bilirubin Excretion

Bilirubin is a pigment derived from the breakdown of hemoglobin by cells of the reticuloendothelial system, including the Kupffer cells of the liver. Hepatocytes remove bilirubin from the blood and chemically modify it through conjugation to glucuronic acid, which makes the bilirubin more soluble in aqueous solutions. The conjugated bilirubin is secreted by the hepatocytes into the adjacent bile canaliculi and is eventually carried in the bile into the duodenum.

In the small intestine, bilirubin is converted into urobilinogen, which is partially excreted in the feces and partially absorbed through the intestinal mucosa into the portal blood. Much of this reabsorbed urobilinogen is removed by the hepatocytes and secreted into the bile once again (enterohepatic circulation). Some of the urobilinogen enters the systemic circulation and is excreted by the kidneys in the urine. Elimination of bilirubin in the bile represents the major route of its excretion.

The bilirubin concentration in the blood may be increased in the presence of liver disease, if the flow of bile is impeded (eg, by gallstones in the bile ducts), or if there is excessive destruction of red blood cells. With bile duct obstruction, bilirubin does not enter the intestine; as a consequence, urobilinogen is absent from the urine and decreased in the stool (Porth & Matfin, 2009).

### Drug Metabolism

The liver metabolizes many medications, such as barbiturates, opioids, sedatives, anesthetics, and amphetamines. Metabolism generally results in drug inactivation, although activation may also occur. One of the important pathways

for medication metabolism involves conjugation (binding) of the medication with a variety of compounds, such as glucuronic acid or acetic acid, to form more soluble substances. These substances may be excreted in the feces or urine, similar to bilirubin excretion. Bioavailability is the fraction of the administered medication that actually reaches the systemic circulation. The bioavailability of an oral medication (absorbed from the GI tract) can be decreased if the medication is metabolized to a great extent by the liver before it reaches the systemic circulation; this is known as first-pass effect. Some medications have such a large first-pass effect that their use is essentially limited to the parenteral route, or oral doses must be substantially larger than parenteral doses to achieve the same effect.

### Gerontologic Considerations

Chart 39-1 summarizes age-related changes in the liver. In the elderly, the most common change in the liver is a decrease in size and weight, accompanied by a decrease in total hepatic blood flow. However, in general, these decreases are proportional to the decreases in body size and weight seen in normal aging. Results of liver function tests do not normally change in the elderly; abnormal results in elderly patients indicate abnormal liver function and are not a result of the aging process itself.

Metabolism of medications by the liver decreases in the elderly, but such changes are usually accompanied by changes in intestinal absorption, renal excretion, and altered body distribution of some medications secondary to changes in fat deposition. These alterations necessitate careful medication administration and monitoring; if appropriate, reduced dosages may be needed to prevent medication toxicity.

## Assessment

### Health History

If liver function test results are abnormal, the patient is evaluated for liver disease. In such cases, the health history focuses on previous exposure of the patient to hepatotoxic substances or infectious agents. The patient's occupational, recreational, and travel history may assist in identifying exposure to hepatotoxins (eg, industrial chemicals, other toxins). The patient's history of alcohol and drug use, including but not limited to the use of intravenous (IV) or injection drugs, provides additional information about exposure to toxins and infectious agents. Many medications (including acetaminophen [Tylenol], ketoconazole [Nizoral], and valproic acid [Depakene]) are responsible for hepatic dysfunction and disease. A thorough medication history should address all current and past prescription medications, over-the-counter medications, herbal remedies, and dietary supplements.

Lifestyle behaviors that increase the risk for exposure to infectious agents are identified. IV or injection drug use, sexual practices, and foreign travel are all potential risk factors for liver disease. The amount and type of alcohol consumption are identified using screening tools (questionnaires) that have been developed for this purpose (see Chapter 5). Men who consume 60 to 80 g/day of alcohol (approximately four glasses of beer, wine, or mixed drinks) and women whose alcohol intake is 40 to 60 g/day are considered at high risk for cirrhosis.

The history also includes an evaluation of the patient's past medical history to identify risk factors for the development of liver disease. Current and past medical conditions, including those of a psychological or psychiatric nature, are identified. The family history includes questions about familial liver disorders that may have their origin in alcohol abuse or gallstone disease, as well as other familial or genetic diseases, such as hemochromatosis, Wilson's disease, or $alpha_1$-antitrypsin disease (see Chart 42-1).

The history also addresses symptoms that suggest liver disease. Symptoms that may have their origin in liver disease but are not specific to hepatic dysfunction include jaundice, malaise, weakness, fatigue, pruritus, abdominal pain, fever, anorexia, weight gain, edema, increasing abdominal girth, hematemesis, melena, hematochezia (passage of bloody stools), easy bruising, changes in mental acuity, personality changes, sleep disturbances, and decreased libido in men and secondary amenorrhea in women.

### Physical Assessment

The nurse assesses the patient for physical signs that may occur with liver dysfunction, including the pallor often seen with chronic illness and jaundice. The skin, mucosa, and sclerae are inspected for jaundice, and the extremities are assessed for muscle atrophy, edema, and skin excoriation secondary to scratching. The nurse observes the skin for petechiae or ecchymotic areas (bruises), spider angiomas, and palmar erythema. The male patient is assessed for unilateral or bilateral gynecomastia and testicular atrophy due to hormonal changes. The patient's cognitive status (recall, memory, abstract thinking) and neurologic status are assessed. The nurse observes for general tremor, asterixis, weakness, and slurred speech. These symptoms are discussed later.

The nurse assesses for the presence of an abdominal fluid wave (discussed later). The abdomen is palpated to assess liver size and to detect any tenderness over the liver. The liver may be palpable in the right upper quadrant. A palpable liver presents as a firm, sharp ridge with a smooth surface

**CHART 39-1 Age-Related Changes of the Hepatobiliary System**

- Steady decrease in size and weight of the liver, particularly in women
- Decrease in blood flow
- Decrease in replacement/repair of liver cells after injury
- Reduced drug metabolism
- Slow clearance of hepatitis B surface antigen
- More rapid progression of hepatitis C infection and lower response rate to therapy
- Decline in drug clearance capability
- Increased prevalence of gallstones due to the increase in cholesterol secretion in bile
- Decreased gallbladder contraction after a meal
- Atypical clinical presentation of biliary disease
- More severe complications of biliary tract disease



**Figure 39-3** Technique for palpating the liver. The examiner places one hand under the right lower rib cage and presses downward with light pressure with the other hand.

(Fig. 39-3). The nurse estimates the size of the liver by percussing its upper and lower borders. If the liver is not palpable but tenderness is suspected, tapping the lower right thorax briskly may elicit tenderness. For comparison, the nurse then performs a similar maneuver on the left lower thorax (Bickley, 2007).

If the liver is palpable, the examiner notes and records its size, its consistency, any tenderness, and whether its outline is regular or irregular. If the liver is enlarged, the degree to which it descends below the right costal margin is recorded to provide some indication of its size. The examiner determines whether the liver's edge is sharp and smooth or blunt and whether the enlarged liver is nodular or smooth. The liver of a patient with cirrhosis is small and hard; whereas the liver of a patient with acute hepatitis is soft, and the hand easily moves the edge.

Tenderness of the liver indicates recent acute enlargement with consequent stretching of the liver capsule. The absence of tenderness may imply that the enlargement is of long-standing duration. The liver of a patient with viral hepatitis is tender; whereas that of a patient with alcoholic hepatitis is not. Enlargement of the liver is an abnormal finding that requires evaluation (Bickley, 2007).

## *Diagnostic Evaluation*

### Liver Function Tests

More than 70% of the parenchyma of the liver may be damaged before liver function test results become abnormal. Function is generally measured in terms of serum enzyme activity (ie, serum aminotransferases, alkaline phosphatase, lactic dehydrogenase) and serum concentrations of proteins (albumin and globulins), bilirubin, ammonia, clotting factors, and lipids. Several of these tests may be helpful for assessing patients with liver disease. However, the nature and extent of hepatic dysfunction cannot be determined by these tests alone, because other disorders can affect test results.

Serum aminotransferases (previously called transaminases) are sensitive indicators of injury to the liver cells and are useful in detecting acute liver disease such as hepatitis. Alanine aminotransferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyl transferase (GGT) (also called G-glutamyl transpeptidase) are the most frequently used tests of liver damage. ALT levels increase primarily in liver disorders and may be used to monitor the course of hepatitis or cirrhosis or the effects of treatments that may be toxic to the liver. AST is present in tissues that have high metabolic activity; therefore, the level may be increased if there is damage to or death of tissues of organs such as the heart, liver, skeletal muscle, and kidney. Although not specific to liver disease, levels of AST may be increased in cirrhosis, hepatitis, and liver cancer. Increased GGT levels are associated with cholestasis but can also be due to alcoholic liver disease. Although the kidney has the highest level of the enzyme, the liver is considered the source of normal serum activity. The test determines liver cell dysfunction and is a sensitive indicator of cholestasis. Its main value in liver disease is confirming the hepatic origin of an elevated alkaline phosphatase level. Common liver function tests are summarized in Table 39-1.

### Liver Biopsy

Liver biopsy is the removal of a small amount of liver tissue, usually through needle aspiration. It permits examination of liver cells. The most common indication is to evaluate diffuse disorders of the parenchyma and to diagnose space-occupying lesions. Liver biopsy is especially useful when clinical findings and laboratory tests are not diagnostic. Bleeding and bile peritonitis after liver biopsy are the major complications; therefore, coagulation studies are obtained, their values are noted, and abnormal results are treated before liver biopsy is performed. Other techniques for liver biopsy are preferred if ascites or coagulation abnormalities exist. A liver biopsy can be performed percutaneously with ultrasound guidance or transvenously through the right internal jugular vein to right hepatic vein under fluoroscopic control. Liver biopsy can also be performed laparoscopically. Nursing responsibilities related to percutaneous liver biopsy are summarized in Chart 39-2.

### Other Diagnostic Tests

Ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) are used to identify normal structures and abnormalities of the liver and biliary tree. A radioisotope liver scan may be performed to assess liver size and hepatic blood flow and obstruction.

Laparoscopy (insertion of a fiberoptic endoscope through a small abdominal incision) is used to examine the liver and other pelvic structures. It is also used to perform guided liver biopsy, to determine the cause of ascites, and to diagnose and stage tumors of the liver and other abdominal organs.

**Table 39-1 COMMON LABORATORY TESTS TO ASSESS LIVER FUNCTION**

| Test | Normal | Clinical Functions |
|---|---|---|
| **Pigment Studies** | | |
| Serum bilirubin, direct | 0–0.3 mg/dL (0–5.1 μmol/L) | These studies measure the ability of the liver to conjugate and excrete bilirubin. Results are abnormal in liver and biliary tract disease and are associated with jaundice clinically. |
| Serum bilirubin, total | 0–0.9 mg/dL (1.7–20.5 μmol/L) | |
| Urine bilirubin | 0(0) | |
| Urine urobilinogen | (Urine urobilinogen) 0.05–2.5 mg/24 h (0.5–4.0 Ehrlich U/24 h) | |
| Fecal urobilinogen (infrequently used) | (Fecal urobilinogen) 50–300 mg/24 h (100–400 Ehrlich U/100 g) | |
| **Protein Studies** | | |
| Total serum protein | 7.0–7.5 g/dL (70–75 g/L) | Proteins are manufactured by the liver. Their levels may be affected in a variety of liver impairments: albumin is affected in cirrhosis, chronic hepatitis, edema and ascites, globulins are affected in cirrhosis, liver disease, chronic obstructive jaundice, and viral hepatitis. |
| Serum albumin | 4.0–5.5 g/dL (40–55 g/L) | |
| Serum globulin | 1.7–3.3 g/dL (17–33 g/L) | |
| Serum protein electrophoresis | | |
| Albumin | 4.0–5.5 g/dL (40–55 g/L) | |
| $\alpha_1$-Globulin | 0.15–0.25 g/dL (1.5–2.5 g/L) | |
| $\alpha_2$-Globulin | 0.43–0.75 g/dL (4.3–7.5 g/L) | |
| β-Globulin | 0.5–1.0 g/dL (5–10 g/L) | |
| γ-Globulin | 0.6–1.3 g/dL (6–13 g/L) | |
| Albumin/globulin (A/G) ratio | A > G or 1.5:1–2.5:1 | A/G ratio is reversed in chronic liver disease (decreased albumin and increased globulin). |
| **Prothrombin Time** | 100% or 12–16 seconds | Prothrombin time may be prolonged in liver disease. It will not return to normal with vitamin K in severe liver cell damage. |
| **Serum Alkaline Phosphatase** | Varies with method: 2–5 Bodansky units 30–50 U/L at 34°C (17–142 U/L at 30°C) (20–90 U/L at 30°C) | Serum alkaline phosphatase is manufactured in bones, liver, kidneys, and intestine and excreted through biliary tract. In the absence of bone disease, it is a sensitive measure of biliary tract obstruction. |
| **Serum Aminotransferase Studies** | | |
| AST | 10–40 units (4.8–19 U/L) | The studies are based on release of enzymes from damaged liver cells. These enzymes are elevated in liver cell damage. |
| ALT | 5–35 units (2.4–17 U/L) | |
| **GGT, GGTP** | 10–48 IU/L | Elevated in alcohol abuse. Marker for biliary cholestasis. |
| **LDH** | 100–200 units (100–225 U/L) | |
| **Ammonia (plasma)** | 15–45 μg/dL (11–32 μmol/L) | Liver converts ammonia to urea. Ammonia level rises in liver failure. |
| **Cholesterol** | | |
| Ester | 60% of total (fraction of total cholesterol: 0.60) | Cholesterol levels are elevated in biliary obstruction and decreased in parenchymal liver disease. |
| HDL (high-density lipoprotein) | HDL Male: 35–70 mg/dL, Female: 35–85 mg/dL | |
| LDL (low-density lipoprotein) | LDL <130 μg/dL | |

# MANIFESTATIONS OF HEPATIC DYSFUNCTION

Hepatic dysfunction results from damage to the liver's parenchymal cells, directly from primary liver diseases, or indirectly from either obstruction of bile flow or derangements of hepatic circulation. Liver dysfunction may be acute or chronic; the latter is far more common.

Chronic liver disease, including cirrhosis, is the 12th-leading cause of death in the United States among young and middle-aged adults (Mathews, McGuire & Estrada, 2006). At least 40% of those deaths are associated with alcohol use. The rate of chronic liver disease for men is twice that for women, and chronic liver disease is more common in Asian and African countries than it is in Europe and the United States. Compensated cirrhosis, in which the damaged liver is still able to perform normal functions, often goes undetected for extended periods, and as many as 1% of people may have subclinical cirrhosis (Schuppan & Afdhal, 2008).

Disease processes that lead to hepatocellular dysfunction may be caused by infectious agents such as bacteria and viruses and by anoxia, metabolic disorders, toxins and medications, nutritional deficiencies, and hypersensitivity states. The most common cause of parenchymal damage is malnutrition, especially that related to alcoholism.

The parenchymal cells respond to most noxious agents by replacing glycogen with lipids, producing fatty infiltration with or without cell death or necrosis. This is commonly associated with inflammatory cell infiltration and growth of fibrous tissue. Cell regeneration can occur if the disease process is not too toxic to the cells. The result of chronic parenchymal disease is the shrunken, fibrotic liver seen in cirrhosis.

Among the most common and significant manifestations of liver disease are jaundice, portal hypertension, ascites and varices, nutritional deficiencies (resulting from the inability of damaged liver cells to metabolize certain vitamins), and hepatic encephalopathy or coma. The consequences of

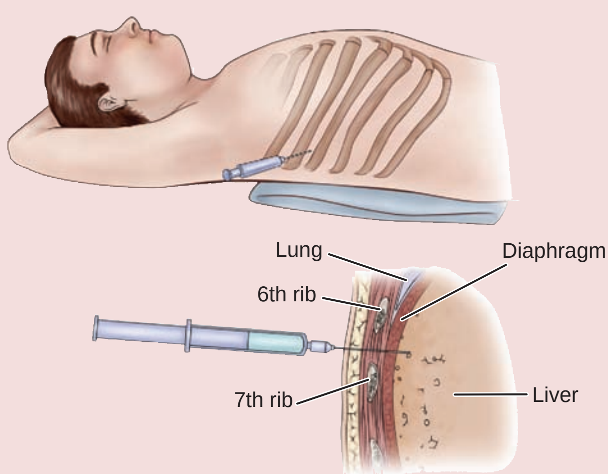
## CHART 39-2 *Guidelines for Assisting With Percutaneous Liver Biopsy*

### Equipment

- Liver biopsy tray (contains needles, scalpel, specimen tubes, etc.)
- Sterile gloves
- Antiseptic solution
- Local anesthetic
- Sterile dressing
- Sphygmomanometer to monitor BP

### Implementation

| Nursing Interventions | Rationale |
|---|---|
| **Preprocedure** | |
| 1. Ascertain that results of coagulation tests (prothrombin time, partial thromboplastin time, and platelet count) are available and that compatible donor blood is available. | 1. Many patients with liver disease have clotting defects and are at risk for bleeding. |
| 2. Check for signed consent; confirm that informed consent has been provided. | 2. Ensures that the patient consents to this invasive procedure. |
| 3. Measure and record the patient's pulse, respirations, and blood pressure immediately before biopsy. | 3. Prebiopsy values provide a basis on which to compare the patient's vital signs and evaluate status after the procedure. |
| 4. Describe to the patient in advance: steps of the procedure; sensations expected; after-effects anticipated; restrictions of activity and monitoring procedures to follow. | 4. Explanations allay fears and ensure cooperation. |
| **During Procedure** | |
| 1. Support the patient during the procedure. | 1. Encouragement and support of the nurse enhance comfort and promote a sense of security. |
| 2. Expose the right side of the patient's upper abdomen (right hypochondriac). | 2. The skin at the site of penetration will be cleansed and a local anesthetic will be infiltrated. |
| 3. Instruct the patient to inhale and exhale deeply several times, finally to exhale, and to hold breath at the end of expiration. The physician promptly introduces the biopsy needle by way of the transthoracic (intercostal) or transabdominal (subcostal) route, penetrates the liver, aspirates, and withdraws. | 3. Holding the breath immobilizes the chest wall and the diaphragm; penetration of the diaphragm thereby is avoided, and the risk of lacerating the liver is minimized. |
| 4. Instruct the patient to resume breathing. | 4. The patient often continues holding his or her breath because of anxiety. |




| Nursing Interventions | Rationale |
|---|---|
| **Postprocedure** | |
| 1. Immediately after the biopsy, assist the patient to turn on to the right side; place a pillow under the costal margin, and caution the patient to remain in this position, recumbent and immobile, for several hours. Instruct the patient to avoid coughing or straining. | 1. In this position, the liver capsule at the site of penetration is compressed against the chest wall, and the escape of blood or bile through the perforation is prevented. |
| 2. Measure and record the patient's pulse, respiratory rate, and blood pressure at 10- to 15-minute intervals for the first hour, then every 30 minutes for the next 1 to 2 hours or until the patient's condition stabilizes. | 2. Changes in vital signs may indicate bleeding, severe hemorrhage, or bile peritonitis, the most frequent complications of liver biopsy. |
| 3. If the patient is discharged after the procedure, instruct the patient to avoid heavy lifting and strenuous activity for 1 week. | 3. Activity restriction reduces the risk of bleeding at the biopsy puncture site. |

liver disease are numerous and varied. Their ultimate effects are often incapacitating or life-threatening, and their presence is ominous. Treatment often is difficult.

## Jaundice

When the bilirubin concentration in the blood is abnormally elevated, all the body tissues, including the sclerae and the skin, become tinged yellow or greenish-yellow, a condition called jaundice. Jaundice becomes clinically evident when the serum bilirubin level exceeds 2.5 mg/dL (43 fmol/L). Increased serum bilirubin levels and jaundice may result from impairment of hepatic uptake, conjugation of bilirubin, or excretion of bilirubin into the biliary system. There are several types of jaundice: hemolytic, hepatocellular, and obstructive jaundice, and jaundice due to hereditary hyperbilirubinemia. Hepatocellular and obstructive jaundice are the two types commonly associated with liver disease.

### Hemolytic Jaundice

Hemolytic jaundice is the result of an increased destruction of the red blood cells, the effect of which is to flood the plasma with bilirubin so rapidly that the liver, although functioning normally, cannot excrete the bilirubin as quickly as it is formed. This type of jaundice is encountered in patients with hemolytic transfusion reactions and other hemolytic disorders. In these patients, the bilirubin in the blood is predominantly unconjugated or free. Fecal and urine urobilinogen levels are increased, but the urine is free of bilirubin. Patients with this type of jaundice, unless their hyperbilirubinemia is extreme, do not experience symptoms or complications as a result of the jaundice per se. However, prolonged jaundice, even if mild, predisposes to the formation of pigment stones in the gallbladder, and extremely severe jaundice (levels of free bilirubin exceeding 20 to 25 mg/dL) poses a risk for brainstem damage.

### Hepatocellular Jaundice

Hepatocellular jaundice is caused by the inability of damaged liver cells to clear normal amounts of bilirubin from the blood. The cellular damage may be caused by hepatitis viruses, other viruses that affect the liver (eg, yellow fever virus, Epstein-Barr virus), medications or chemical toxins (eg, carbon tetrachloride, chloroform, phosphorus, arsenicals, certain medications), or alcohol. Cirrhosis of the liver is a form of hepatocellular disease that may produce jaundice. It is usually associated with excessive alcohol intake, but it may also be a late result of liver cell necrosis caused by viral infection. In prolonged obstructive jaundice, cell damage eventually develops, so that both types of jaundice (ie, obstructive and hepatocellular jaundice) appear together.

Patients with hepatocellular jaundice may be mildly or severely ill, with lack of appetite, nausea, malaise, fatigue, weakness, and possible weight loss. In some cases of hepatocellular disease, jaundice may not be obvious. The serum bilirubin concentration and the urine urobilinogen level may be elevated. In addition, AST and ALT levels may be increased, indicating cellular necrosis. The patient may report headache, chills, and fever if the cause is infectious. Depending on the cause and extent of the liver cell damage, hepatocellular jaundice may be completely reversible.

### Obstructive Jaundice

Obstructive jaundice resulting from extrahepatic obstruction may be caused by occlusion of the bile duct from a gallstone, an inflammatory process, a tumor, or pressure from an enlarged organ (eg, liver, gallbladder). The obstruction may also involve the small bile ducts within the liver (ie, intrahepatic obstruction); this may be caused, for example, by pressure on these channels from inflammatory swelling of the liver or by an inflammatory exudate within the ducts themselves. Intrahepatic obstruction resulting from stasis and inspissation (thickening) of bile within the canaliculi may occur after the ingestion of certain medications, which are referred to as cholestatic agents. These agents include phenothiazines, antithyroid medications, sulfonylureas, tricyclic antidepressant agents, nitrofurantoin, androgens and estrogens, propylthiouracil, amoxicillin-clavulanic acid, and erythromycin estolate.

Regardless of whether the obstruction is intrahepatic or extrahepatic, and regardless of its cause, bile cannot flow normally into the intestine and becomes backed up into the liver substance. It is then reabsorbed into the blood and carried throughout the entire body, staining the skin, mucous membranes, and sclerae. It is excreted in the urine, which becomes deep orange and foamy. Because of the decreased amount of bile in the intestinal tract, the stools become light or clay-colored. The skin may itch intensely, requiring repeated soothing baths. Dyspepsia and intolerance to fatty foods may develop because of impaired fat digestion in the absence of intestinal bile. In general, AST, ALT, and GGT levels rise only moderately, but bilirubin and alkaline phosphatase levels are elevated.

### Hereditary Hyperbilirubinemia

Increased serum bilirubin levels (hyperbilirubinemia), resulting from any of several inherited disorders, can also produce jaundice. Gilbert's syndrome is a familial disorder characterized by an increased level of unconjugated bilirubin that causes jaundice. Although serum bilirubin levels are increased, liver histology and liver function test results are normal, and there is no hemolysis. This syndrome affects 3% to 8% of the population, predominantly males (Hauser, Pardi & Poterucha, 2006).

Other conditions that are probably caused by inborn errors of biliary metabolism include Dubin-Johnson syndrome (chronic idiopathic jaundice, with pigment in the liver) and Rotor's syndrome (chronic familial conjugated hyperbilirubinemia, without pigment in the liver); the "benign" cholestatic jaundice of pregnancy, with retention of conjugated bilirubin, probably secondary to unusual sensitivity to the hormones of pregnancy; and benign recurrent intrahepatic cholestasis.

## Portal Hypertension

**Portal hypotension** is the increased pressure throughout the portal venous system that results from obstruction of blood flow through the damaged liver. Commonly associated with

hepatic cirrhosis, it can also occur with non-cirrhotic liver disease. Although splenomegaly (enlarged spleen) with possible hypersplenism is a common manifestation of portal hypertension, the two major consequences of portal hypertension are ascites and varices.

## *Ascites*

### Pathophysiology

The mechanisms responsible for the development of ascites are not completely understood. Portal hypertension and the resulting increase in capillary pressure and obstruction of venous blood flow through the damaged liver are contributing factors. The vasodilation that occurs in the splanchnic circulation (the arterial supply and venous drainage of the GI system from the distal esophagus to the midrectum including the liver and spleen) is also a suspected causative factor. The failure of the liver to metabolize aldosterone increases sodium and water retention by the kidney. Sodium and water retention, increased intravascular fluid volume, increased lymphatic flow, and decreased synthesis of albumin by the damaged liver all contribute to the movement of fluid from the vascular system into the peritoneal space. The process becomes self-perpetuating; loss of fluid into the peritoneal space causes further sodium and water retention by the kidney in an effort to maintain the vascular fluid volume.

As a result of liver damage, large amounts of albumin-rich fluid, 15 L or more, may accumulate in the peritoneal cavity as ascites. (Ascites may also occur with disorders such as cancer, kidney disease, and heart failure.) With the movement of albumin from the serum to the peritoneal cavity, the osmotic pressure of the serum decreases. This, combined with increased portal pressure, results in movement of fluid into the peritoneal cavity (Fig. 39-4).

**Physiology ■■■ Pathophysiology**

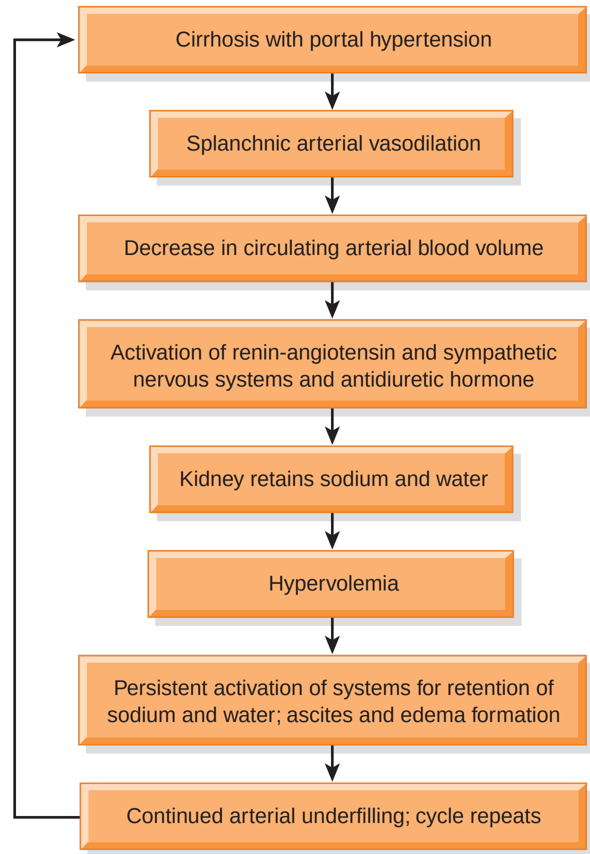



**Figure 39-4** Pathogenesis of ascites (arterial vasodilation theory).

### Clinical Manifestations

Increased abdominal girth and rapid weight gain are common presenting symptoms of ascites. The patient may be short of breath and uncomfortable from the enlarged abdomen, and striae and distended veins may be visible over the abdominal wall. Umbilical hernias also occur frequently in those patients with cirrhosis. Fluid and electrolyte imbalances are common.

### Assessment and Diagnostic Findings

The presence and extent of ascites are assessed by percussion of the abdomen. When fluid has accumulated in the peritoneal cavity, the flanks bulge when the patient assumes a supine position. The presence of fluid can be confirmed either by percussing for shifting dullness or by detecting a fluid wave (Fig. 39-5). A fluid wave is likely to be found only if a large amount of fluid is present. Daily measurement and recording of abdominal girth and body weight are essential to assess the progression of ascites and its response to treatment.

### Medical Management

#### *Dietary Modification*

The goal of treatment for the patient with ascites is a negative sodium balance to reduce fluid retention. Table salt, salty foods, salted butter and margarine, and all ordinary canned and frozen foods that are not specifically prepared for low-sodium (2-g sodium) diets should be avoided. It may take 2 to 3 months for the patient's taste buds to adjust to unsalted foods. In the meantime, the taste of unsalted foods can be improved by using salt substitutes such as lemon juice, oregano, and thyme. Commercial salt substitutes need to be approved by the physician, because those that contain ammonia could precipitate hepatic coma. Most salt substitutes contain potassium and should be avoided if the patient has impaired renal function. The patient should make liberal use of powdered, low-sodium milk and milk products. If fluid accumulation is not controlled with this regimen, the daily sodium allowance may be reduced further to 500 mg, and diuretics may be administered.

Dietary control of ascites via strict sodium restriction is difficult to achieve at home. The likelihood that the patient will follow even a 2-g sodium diet increases if the patient and the person preparing meals understand the rationale for the diet and receive periodic guidance about selecting and preparing appropriate foods. Approximately 10% of patients with ascites respond to these measures alone. Nonresponders and those who find sodium restriction difficult require diuretic therapy.



**Figure 39-5** Assessing for abdominal fluid wave. The examiner places the hands along the sides of the patient's flanks, then strikes one flank sharply, detecting any fluid wave with the other hand. An assistant's hand is placed (ulnar side down) along the patient's midline to prevent the fluid wave from being transmitted through the tissues of the abdominal wall.

### Diuretics

Use of diuretics along with sodium restriction is successful in 90% of patients with ascites. Spironolactone (Aldactone), an aldosterone-blocking agent, is most often the first-line therapy in patients with ascites from cirrhosis. When used with other diuretics, spironolactone helps prevent potassium loss. Oral diuretics such as furosemide (Lasix) may be added but should be used cautiously, because long-term use may induce severe sodium depletion (hyponatremia).

Ammonium chloride and acetazolamide (Diamox) are contraindicated because of the possibility of precipitating hepatic coma. Daily weight loss should not exceed 1 to 2 kg (2.2 to 4.4 lb) in patients with ascites and peripheral edema or 0.5 to 0.75 kg (1.1 to 1.65 lb) in patients without edema. Fluid restriction is not attempted unless the serum sodium concentration is very low.

Possible complications of diuretic therapy include fluid and electrolyte disturbances (including hypovolemia, hypokalemia, hyponatremia, and hypochloremic alkalosis) and encephalopathy. Encephalopathy may be precipitated by dehydration and hypovolemia. In addition, when potassium stores are depleted, the amount of ammonia in the systemic circulation increases, which may cause impaired cerebral functioning and encephalopathy.

### Bed Rest

In patients with ascites, an upright posture is associated with activation of the renin–angiotensin–aldosterone system and sympathetic nervous system (Porth & Matfin, 2009). This causes reduced renal glomerular filtration and sodium excretion and a decreased response to loop diuretics. Therefore, bed rest may be a useful therapy, especially for patients whose condition is refractory to diuretics.

### Paracentesis

Paracentesis is the removal of fluid (ascites) from the peritoneal cavity through a puncture or a small surgical incision through the abdominal wall under sterile conditions. Ultrasound guidance may be indicated in some patients who are at high risk for bleeding because of an abnormal coagulation profile and in those who have had previous abdominal surgery and may have adhesions. Paracentesis was once considered a routine form of treatment for ascites. However, it is now performed primarily for diagnostic examination of ascitic fluid; for treatment of massive ascites that is resistant to nutritional and diuretic therapy and that is causing severe problems to the patient; and as a prelude to diagnostic imaging studies, peritoneal dialysis, or surgery. A sample of the ascitic fluid may be sent to the laboratory for cell count, albumin and total protein levels, culture, and other tests.

Large-volume (5 to 6 L) paracentesis has been shown to be a safe method for treating patients with severe ascites. This technique, in combination with the IV infusion of salt-poor albumin or other colloid, has become a standard management strategy yielding an immediate effect. Refractive, massive ascites is unresponsive to multiple diuretics and sodium restriction for 2 weeks or more and can result in severe sequelae such as respiratory distress, which requires rapid intervention. Albumin infusions help to correct decreases in effective arterial blood volume that lead to sodium retention. Use of this colloid reduces the incidence of postparacentesis circulatory dysfunction with renal dysfunction, hyponatremia, and rapid reaccumulation of ascites associated with decreased effective arterial volume (Hauser, et al., 2006). The beneficial effects of albumin administration on hemodynamic stability and renal functional status may be related to an improvement in cardiac function as well as a decrease in the degree of arterial vasodilation. Although the patient with cirrhosis has a greatly increased extracellular blood volume, the kidney incorrectly senses that the effective volume has decreased. The renin–angiotensin–aldosterone axis is stimulated, and sodium is reabsorbed (Rodes, et al., 2007). In addition, antidiuretic hormone (ADH) secretion increases, which leads to increased retention of free water and sometimes to the development of dilutional hyponatremia. Therapeutic paracentesis provides only temporary removal of fluid; ascites rapidly recurs, necessitating repeated fluid removal. Nursing care of the patient undergoing paracentesis is presented in Chart 39-3.

### Transjugular Intrahepatic Portosystemic Shunt

Transjugular intrahepatic portosystemic shunt (TIPS) is a method of treating ascites in which a cannula is threaded into the portal vein by the transjugular route (Fig. 39-6). To reduce portal hypertension, an expandable stent is inserted to serve as an intrahepatic shunt between the portal circulation and the hepatic vein. TIPS is the treatment of choice for refractive ascites. It is extremely effective in decreasing sodium retention, improving the renal response to diuretic therapy, and preventing recurrence of fluid accumulation (Senzolo, Cholongitas, Tibballs, et al., 2006).

## CHART 39-3 Guidelines for Assisting With a Paracentesis

### Equipment

- Paracentesis tray (contains trocar, syringe, needles, drainage tube)
- Sterile gloves
- Antiseptic solution
- Local anesthetic
- Sterile dressing
- Drainage collection bottles, receptacles
- Sphygmomanometer to monitor BP

### Implementation

| Nursing Interventions | Rationale |
| --- | --- |
| **Preprocedure** | |
| 1. Check for signed consent form. | 1. Ensures that patient has agreed to procedure. |
| 2. Prepare the patient by providing the necessary information and instructions and by offering reassurance. | 2. Having information increases the patient's understanding of the procedure and the reason for it. |
| 3. Instruct the patient to void. | 3. An empty bladder minimizes the risk of inadvertent puncture of the bladder and minimizes discomfort from a full bladder. |
| 4. Gather appropriate sterile equipment and collection receptacles. | 4. Sterility of equipment is essential to minimize risk of infection; having equipment available enables the procedure to be performed smoothly. |
| 5. Place the patient in upright position on the edge of the bed or in a chair with feet supported on a stool. Fowler's position should be used by the patient confined to bed. | 5. An upright position results in movement of the peritoneal fluid close to the abdominal wall and promotes easier puncture and removal of fluid. |
| 6. Place the sphygmomanometer cuff around patient's arm. | 6. This allows the nurse to monitor the patient's blood pressure during procedure. |
| **Procedure** | |
| 1. The physician, using aseptic technique, inserts the trocar through a puncture below the umbilicus. The trocar or needle is connected to a drainage tube, the end of which is inserted into a collecting receptacle. | 1. Sterile technique minimizes the risk of infection. Bleeding at the puncture site is minimal at this location. The fluid drains by gravity or mild siphon into the container. |
| 2. Help the patient maintain position throughout the procedure. | 2. The patient who is fatigued or weak may have difficulty maintaining an optimal position for drainage of fluid. |
| 3. Measure and record blood pressure at frequent intervals throughout the procedure. | 3. Decreased blood pressure may occur with vascular collapse, which can result from removal of the fluid from the peritoneal cavity and fluid shifts. |
| 4. Monitor the patient closely for signs of vascular collapse: pallor, increased pulse rate, or decreased blood pressure. | 4. Vascular collapse (hypovolemia) may occur as fluid moves from the vascular system to replace fluid drained from peritoneal cavity. |

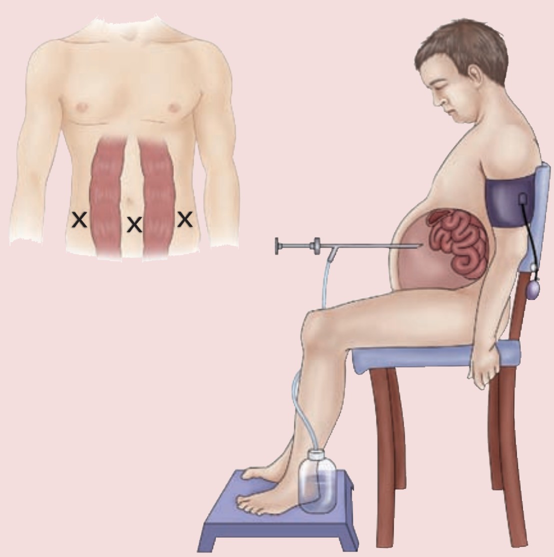


Figure on left shows possible sites for insertion of trocar.

*Continued*

CHART 39-3 *Guidelines for Assisting With a Paracentesis* (Continued)

| Nursing Action | Rationale |
|---|---|
| **Postprocedure** | |
| 1. Return the patient to bed or to a comfortable sitting position. | 1. The weak or fatigued patient may have difficulty resuming a comfortable position without assistance. |
| 2. Measure, describe, and record the fluid collected. | 2. The volume of fluid removed may range from small to very large, and its removal may affect fluid and vascular status; volume should be included in input and output records. The characteristics of the fluid (clear vs. cloudy, red vs. colorless) may be helpful in diagnostic evaluation. |
| 3. Label samples of fluid and send to laboratory. | 3. Peritoneal fluid is analyzed as part of the diagnostic workup. |
| 4. Monitor vital signs every 15 min for 1 h, every 30 min for 2 h, every hour for 2 h, and then every 4 h. | 4. Vital signs (blood pressure, pulse rate) may change as fluid shifts occur after removal of fluid, especially if a large volume of fluid has been removed. |
| 5. Measure the patient's temperature. | 5. An elevated temperature is a sign of infection and should be reported to the patient's physician. |
| 6. Assess for hypovolemia, electrolyte shifts, changes in mental status, and encephalopathy. | 6. Changes in fluid and electrolyte states and mental and cognitive status may occur with removal of fluid and fluid shifts, and should be reported. |
| 7. When taking vital signs, check puncture site for leakage or bleeding. | 7. Leakage of fluid may occur because of changes in abdominal pressure and may contribute to further loss of fluid if undetected. Leakage suggests a possible site for infection, and bleeding may occur in patients with altered clotting secondary to liver disease. |
| 8. Provide patient teaching regarding need to monitor for bleeding or excessive drainage from puncture site, importance of avoiding heavy lifting or straining, the need to change position slowly, and frequency of monitoring for fever. | 8. The patient (or family members) needs to monitor the puncture site for bleeding and excessive drainage if the patient is discharged home after the procedure. Heavy lifting or straining is avoided to enable the puncture site to close. Slow changes in position are recommended because of the risk of hypovolemia related to fluid removal. Monitoring for fever is needed to detect infection. |

Because the development of ascites in patients with cirrhosis is associated with a 50% mortality rate, any patient who is considered a candidate for liver transplantation should be referred for TIPS.

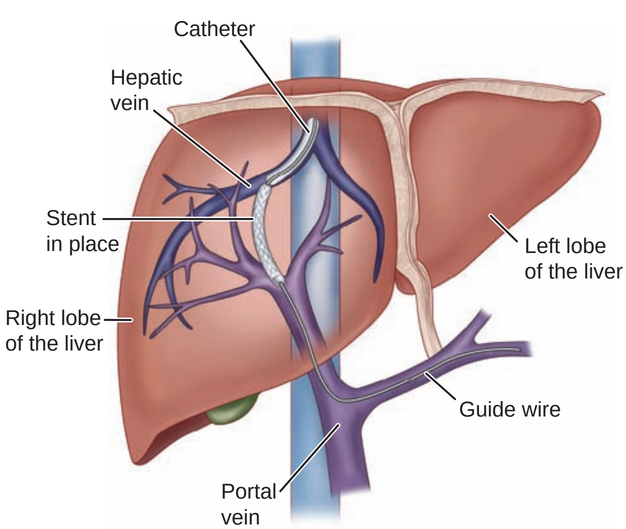



**Figure 39-6** Transjugular intrahepatic portosystemic shunt (TIPS). A stent is inserted via catheter to the portal vein to divert blood flow and reduce portal hypertension.

### *Other Methods of Treatment*

Ascites can also be treated by the insertion of a peritoneovenous shunt to redirect ascitic fluid from the peritoneal cavity into the systemic circulation. However, this procedure is used only for patients who are not candidates for liver transplantation because of the high complication rate and high incidence of shunt failure.

## Nursing Management

If a patient with ascites from liver dysfunction is hospitalized, nursing measures include assessment and documentation of intake and output, abdominal girth, and daily weight to assess fluid status. The nurse monitors serum ammonia and electrolyte levels to assess electrolyte balance, response to therapy, and indicators of encephalopathy.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The patient treated for ascites is likely to be discharged with some ascites still present. Before hospital discharge, the nurse teaches the patient and family about the treatment plan, including the need to avoid all alcohol intake, adhere to a low-sodium diet, take medications as prescribed, and check with the physician before taking any new medications (Chart 39-4). Additional patient and family teaching

CHART 39-4 HOME CARE CHECKLIST
**Management of Ascites**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Make appropriate dietary choices consistent with dietary prescription and recommendations. | ✔ | ✔ |
| • State the importance of weighing self daily and keeping a daily record of weight. | ✔ | ✔ |
| • Maintain record of daily weight and identify daily weight-loss goals. | ✔ | ✔ |
| • List weight changes (loss or gain) that should be reported to the primary health care provider. | ✔ | ✔ |
| • Explain the rationale for monitoring and recording daily intake and output. | ✔ | ✔ |
| • Identify changes in output that should be reported to primary health care provider (eg, decreasing urine output). | ✔ | ✔ |
| • Identify rationale for fluid restrictions (if needed), and comply with fluid restriction. | ✔ | ✔ |
| • Discuss importance of avoiding nonsteroidal anti-inflammatory agents, medications (eg, cough mixtures) containing alcohol, antibiotics, or antacids containing salt. | ✔ | ✔ |
| • Describe effects, side effects, and monitoring parameters for diuretic therapy. | ✔ | ✔ |
| • Identify need to stop all alcohol intake as critical to well-being. | ✔ | ✔ |
| • Explain how to contact Alcoholics Anonymous or alcohol counselors in related organizations. | ✔ | ✔ |
| • Demonstrate how to care for skin, alleviate pressure over bony prominences by turning when in bed or chair, and decrease edema by position changes. | ✔ | ✔ |
| • Identify early signs and symptoms of complications (encephalopathy, spontaneous bacterial peritonitis, dehydration, electrolyte abnormalities, azotemia). | ✔ | ✔ |

addresses skin care and the need to weigh the patient daily and to watch for and report signs and symptoms of complications.

**Continuing Care**

A referral for home care may be warranted, especially if the patient lives alone or cannot provide self-care. The home visit enables the nurse to assess changes in the patient's condition and weight, abdominal girth, skin, and cognitive and emotional status. The home care nurse assesses the home environment and the availability of resources needed to adhere to the treatment plan (eg, a scale to obtain daily weights, facilities to prepare and store appropriate foods, resources to purchase needed medications). It is important to assess the patient's adherence to the treatment plan and the ability to buy, prepare, and eat appropriate foods. The nurse reinforces previous teaching and emphasizes the need for regular follow-up and the importance of keeping scheduled health care appointments.

## Esophageal Varices

Esophageal varices develop in the majority of patients with cirrhosis. Varices are varicosities that develop from elevated pressure in the veins that drain into the portal system. They are prone to rupture and often are the source of massive hemorrhages from the upper GI tract and the rectum. In addition, blood clotting abnormalities, often seen in patients with severe liver disease, increase the likelihood of bleeding and significant blood loss.

Once esophageal varices form, they increase in size and eventually bleed (Albillos, 2007); in cirrhosis, they are the most significant source of bleeding. The first bleeding episode has a mortality rate of 30% to 50% and is one of the major causes of death in patients with cirrhosis. The mortality rate increases with each subsequent bleeding episode (Kravetz, 2007).

### Pathophysiology

Esophageal varices are dilated, tortuous veins that are usually found in the submucosa of the lower esophagus but may develop higher in the esophagus or extend into the stomach. This condition is almost always caused by portal hypertension, which results from obstruction of the portal venous circulation within the damaged liver.

Because of increased obstruction of the portal vein, venous blood from the intestinal tract and spleen seeks an outlet through collateral circulation (new pathways for return of blood to the right atrium). The effect is increased pressure, particularly in the vessels in the submucosal layer of the lower esophagus and upper part of the stomach. These collateral vessels are not very elastic; rather, they are tortuous and fragile, and they bleed easily (Fig. 39-7). Less common causes of varices are abnormalities of the circulation in the splenic vein or superior vena cava and hepatic venothrombosis.

Bleeding esophageal varices are life-threatening and can result in hemorrhagic shock that produces decreased cerebral, hepatic, and renal perfusion. In turn, there is an increased nitrogen load from bleeding into the GI tract and an increased serum ammonia level, increasing the risk of encephalopathy. Usually the dilated veins cause no symptoms. However, if the portal pressure increases sharply and the mucosa or supporting structures become thin, massive hemorrhaging occurs.

**Physiology ■■■ Pathophysiology**

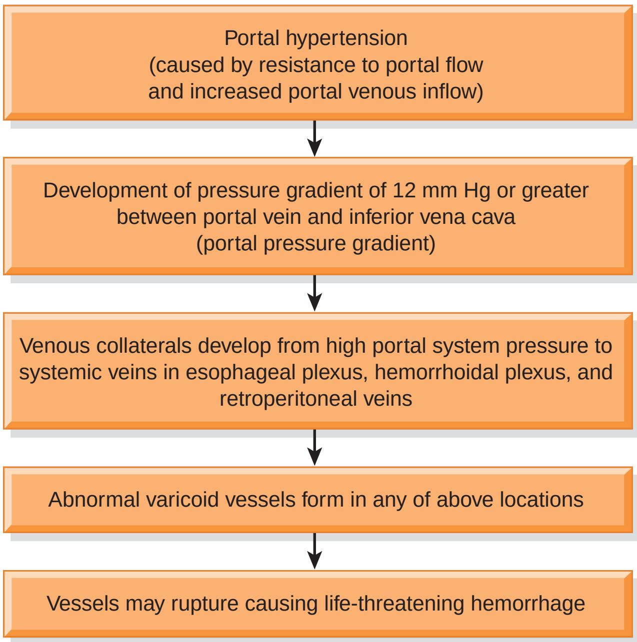



**Figure 39-7** Pathogenesis of bleeding esophageal varices.

Factors that contribute to hemorrhage are muscular exertion from lifting heavy objects; straining at stool; sneezing, coughing, or vomiting; esophagitis; irritation of vessels by poorly chewed foods or irritating fluids; and reflux of stomach contents (especially alcohol). Salicylates and any medication that erodes the esophageal mucosa or interferes with cell replication also may contribute to bleeding.

## Clinical Manifestations

The patient with bleeding esophageal varices may present with hematemesis, melena, or general deterioration in mental or physical status and often has a history of alcohol abuse. Signs and symptoms of shock (cool clammy skin, hypotension, tachycardia) may be present.

## Assessment and Diagnostic Findings

Endoscopy is used to identify the bleeding site, along with barium swallow, ultrasonography, CT, and angiography. Because the incidence of varices is 50% in patients with cirrhosis, it is recommended that these patients undergo screening endoscopy every 2 years in an effort to identify and treat large varices, which are the ones most likely to bleed (Wolfe, 2006).

### Endoscopy

Immediate endoscopy (see Chapter 34) is indicated to identify the cause and the site of bleeding; at least 30% of patients with suspected bleeding from esophageal varices are actually bleeding from another source (gastritis, ulcer). Nursing support is essential during this often stressful experience. Careful monitoring can detect early signs of cardiac dysrhythmias, perforation, and hemorrhage.

After the examination, fluids are not given until the patient's gag reflex returns. Lozenges and gargles may be used to relieve throat discomfort if the patient's physical condition and mental status permit. If the patient is actively bleeding, oral intake will not be permitted, and the patient will be prepared for further diagnostic and therapeutic procedures.

### Portal Hypertension Measurements

Portal hypertension may be suspected if dilated abdominal veins and hemorrhoids are detected. A palpable enlarged spleen (splenomegaly) and ascites may also be present. Portal venous pressure can be measured directly or indirectly. Indirect measurement of the hepatic vein pressure gradient is the most common procedure. The measurement requires insertion of a catheter with a balloon into the antecubital or femoral vein. The catheter is advanced under fluoroscopy to a hepatic vein. Fluid is infused once the catheter is in position to inflate the balloon. A "wedged" pressure (similar to pulmonary artery wedge pressure) is obtained by occluding the blood flow in the blood vessel; pressure in the unoccluded vessel is also measured. Although the values obtained may underestimate portal pressure, this measurement may be taken several times to evaluate the results of therapy.

Direct measurement of portal vein pressure can be obtained by several methods. During laparotomy, a needle may be introduced into the spleen; a manometer reading of more than 20 mL saline is abnormal. Another direct measurement requires insertion of a catheter into the portal vein or one of its branches. Endoscopic measurement of pressure within varices is used only in conjunction with endoscopic sclerotherapy.

### Laboratory Tests

Laboratory tests may include various liver function tests, such as serum aminotransferases, bilirubin, alkaline phosphatase, and serum proteins. Splenoportography, which involves serial or segmental x-rays, is used to detect extensive collateral circulation in esophageal vessels, which would indicate varices. Other tests are hepatoportography and celiac angiography. These are usually performed in the operating room or x-ray department.

## Medical Management

Bleeding from esophageal varices is an emergency that can quickly lead to hemorrhagic shock. The patient is critically ill, requiring aggressive medical care and expert nursing care, and is usually transferred to the intensive care unit (ICU) for close monitoring and management. See Chapter 15 for a discussion of care of the patient in shock.

The extent of bleeding is evaluated, and vital signs are monitored continuously if hematemesis and melena are present. Signs of potential hypovolemia are noted, such as cold clammy skin, tachycardia, a drop in blood pressure, decreased urine output, restlessness, and weak peripheral pulses. The volume of circulating blood is estimated and monitored with a central venous catheter or pulmonary artery catheter. Blood pressure is monitored via an arterial catheter. Oxygen is administered to prevent hypoxia and to maintain adequate blood oxygenation.

Because patients with bleeding esophageal varices have intravascular volume depletion and are subject to electrolyte imbalance, IV fluids with electrolytes and volume expanders are provided to restore fluid volume and replace electrolytes. Transfusion of blood components also may be required.

Caution must be taken with volume resuscitation so that overhydration does not occur, because this would raise portal pressure and increase bleeding. An indwelling urinary catheter is usually inserted to permit frequent monitoring of urine output.

Although a variety of pharmacologic, endoscopic, and surgical approaches are used to treat bleeding esophageal varices, none is ideal, and most are associated with considerable risk to the patient. Nonsurgical treatment of bleeding esophageal varices is preferable because of the high mortality rate of emergency surgery to control bleeding esophageal varices and because of the poor physical condition that is typical of the patient with severe liver dysfunction.

### *Pharmacologic Therapy*

In an actively bleeding patient, medications are administered initially because they can be obtained and administered quicker than other therapies. Vasopressin (Pitressin) may be the initial mode of therapy in urgent situations because it produces constriction of the splanchnic arterial bed and decreases portal pressure. As previously described, splanchnic circulation comprises the arterial blood supply and venous drainage of the entire GI tract from the distal esophagus to the midrectum, including the liver. Vasopressin constricts distal esophageal and proximal gastric veins, thus reducing the inflow into the portal system and therefore the portal pressure. Vital signs and the presence or absence of blood in the gastric aspirate indicate the effectiveness of vasopressin. Monitoring of fluid intake and output and electrolyte levels is necessary because hyponatremia may develop and vasopressin may have an antidiuretic effect.

Coronary artery disease is a contraindication to the use of vasopressin because coronary vasoconstriction is a side effect that may precipitate myocardial infarction. The combination of vasopressin with nitroglycerin (administered by the IV, sublingual, or transdermal route) has been effective in reducing or preventing the side effects (constriction of coronary vessels and angina) caused by vasopressin alone. Side effects include myocardial and extremity ischemia as well as cardiac dysrhythmias; therefore, vasopressin is used only in urgent situations (Floch, 2005; Wolfe, 2006).

Somatostatin and octreotide (Sandostatin) have been reported to be effective in decreasing bleeding from esophageal varices, and they lack the vasoconstrictive effects of vasopressin. These medications cause selective splanchnic vasoconstriction and are used mainly in the management of active hemorrhage. Propranolol (Inderal) and nadolol (Corgard), beta-blocking agents that decrease portal pressure, are the most common medications used both to prevent a first bleeding episode in patients with known varices and to prevent rebleeding (Wolfe, 2006). Beta-blockers should not be used in acute variceal hemorrhage, but they are effective prophylaxis against such an episode. Nitrates such as isosorbide (Isordil) lower portal pressure by venodilation and decreased cardiac output and may be used in combination with beta-blockers (Wolfe, 2006). Further studies of these and other medications are necessary to evaluate their use in the treatment and prevention of bleeding episodes.

### *Balloon Tamponade*

To control hemorrhage in certain patients, **balloon tamponade** may be used. In this procedure, pressure is exerted on the cardia (upper orifice of the stomach) and against the bleeding varices by a double-balloon tamponade (Sengstaken-Blakemore tube) (Fig. 39-8). The tube has four openings, each with a specific purpose: gastric aspiration, esophageal aspiration, gastric balloon inflation, and esophageal balloon inflation.

The balloon in the stomach is inflated with 100 to 200 mL of air. An x-ray confirms proper positioning of the gastric balloon. The tube is pulled gently to exert a force against the gastric cardia. The preferred method for applying traction may be with weights suspended from an overbed trapeze. Irrigation of the tubing is performed to detect bleeding; if returns are clear, the esophageal balloon is not used. If bleeding continues, the esophageal balloon is inflated. The desired pressure in the esophageal and gastric balloons is 25 to 40 mm Hg, as measured by the manometer. On inflation of the esophageal balloon, there is a possibility of injury or rupture of the esophagus, so constant nursing surveillance is necessary.

Gastric suction is provided by connecting the gastric catheter outlet to low suction (80 to 100 mm Hg). The tubing is irrigated hourly, and the color of the drainage indicates whether bleeding has been controlled. Room-temperature lavage or irrigation may be used in the gastric balloon. The pressure within the esophageal balloon is measured and recorded every 2 to 4 hours via the manometer to detect underinflation (which can allow bleeding to continue) or prevent overinflation (which can cause esophageal injury). When it appears that bleeding has stopped, the balloons are deflated carefully and sequentially. The esophageal balloon is deflated first, and the patient is monitored for recurrent bleeding. After several hours without bleeding, the gastric balloon can be deflated safely. If there is still no bleeding, the tamponade tube is removed. The therapy is used for as short a time as possible to control bleeding while emergency treatment is completed and definitive therapies are instituted (no longer than 24 hours).

Although balloon tamponade has been fairly successful, there are some inherent dangers. Displacement of the tube and the inflated balloon into the oropharynx can cause life-threatening obstruction of the airway and asphyxiation. This may occur if the patient pulls on the tube because of confusion or discomfort. It may also result from rupture of the gastric balloon, which causes the esophageal balloon to move into the oropharynx. Sudden rupture of the balloon causes airway obstruction and aspiration of gastric contents into the lungs. Therefore, the tube must be tested before insertion to minimize this risk by ensuring that the balloons can attain and maintain inflation. Aspiration of blood and secretions into the lungs is frequently associated with balloon tamponade, especially in the stuporous or comatose patient. Endotracheal intubation before insertion of the

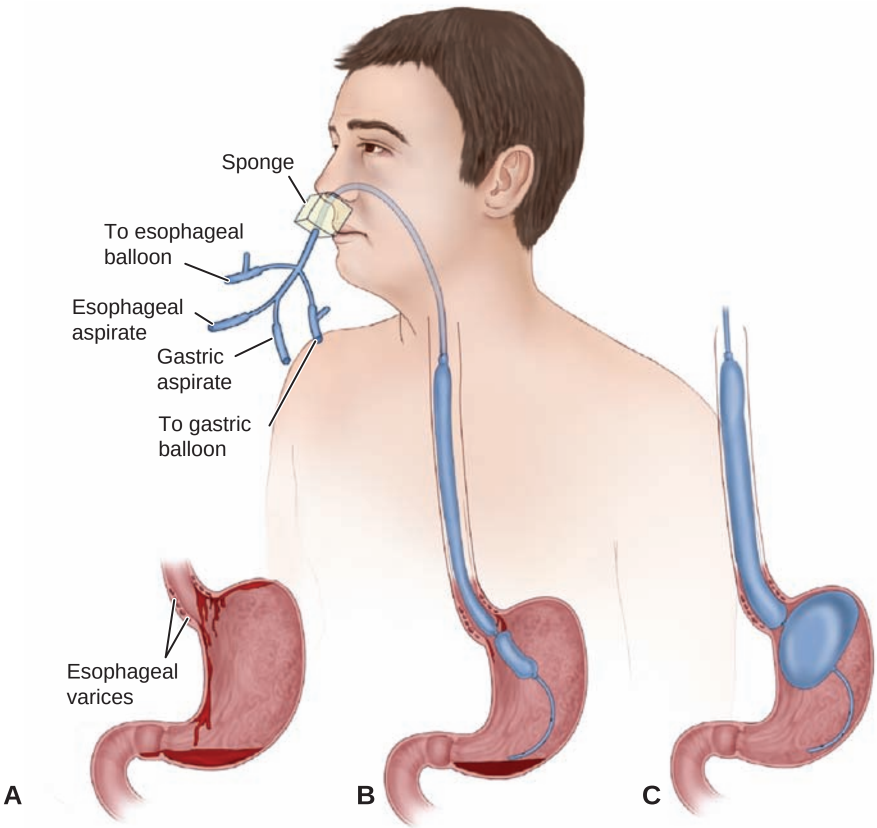



**Figure 39-8** Balloon tamponade to treat esophageal varices. **A,** Dilated, bleeding esophageal veins (varices) of the lower esophagus. **B,** A four-lumen esophageal tamponade tube with balloons (uninflated) in place. **C,** Compression of bleeding esophageal varices by inflated esophageal and gastric balloons. The gastric and esophageal outlets permit the nurse to aspirate secretions.

tube protects the airway and minimizes the risk of aspiration. Ulceration and necrosis of the nose, the mucosa of the stomach, or the esophagus may occur if the tube is left in place too long, inflated too long, or inflated at too high a pressure.

### NURSING ALERT

**The patient being treated with balloon tamponade must remain under close observation in the ICU because of the risk of serious complications. The patient must be monitored closely and continuously. Precautions must be taken to ensure that the patient does not pull on or inadvertently displace the tube.**

Nursing measures include frequent mouth and nasal care. For secretions that accumulate in the mouth, tissues should be within easy reach of the patient. Oral suction may be necessary to remove oral secretions.

The patient with esophageal hemorrhage is usually extremely anxious and frightened. Knowing that the nurse is nearby and ready to respond immediately can help alleviate some of this anxiety. Tube insertion is uncomfortable and never pleasant. Careful explanation during the procedure and while the tube is in place may be reassuring to the patient. Sedation may be prescribed.

Although balloon tamponade stops the bleeding in 90% of patients, bleeding recurs in 60% to 70%, necessitating other treatment modalities, such as sclerotherapy or banding (Wolfe, 2006). Once the balloons are deflated or the tube is removed, the patient must be assessed frequently because of the high risk of recurrent bleeding.

### Endoscopic Therapies

In endoscopic **sclerotherapy** (Fig. 39-9), also referred to as injection sclerotherapy, a sclerosing agent is injected through a fiberoptic endoscope into the bleeding esophageal varices to promote thrombosis and eventual sclerosis. The procedure has been used successfully to treat acute GI hemorrhage but is not recommended for prevention of first and subsequent variceal bleeding episodes (Albillos, 2007; Wolfe, 2006).

After treatment for acute hemorrhage, the patient must be observed for bleeding, perforation of the esophagus, aspiration pneumonia, and esophageal stricture. Antacids, histamine-2 antagonists such as cimetidine (Tagamet), or

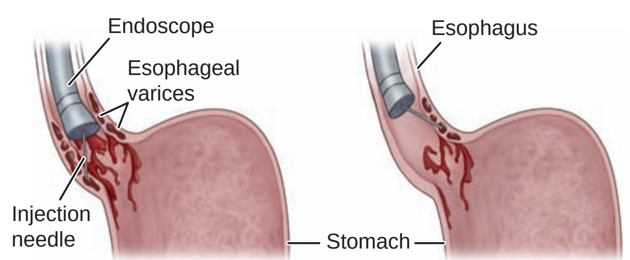



**Figure 39-9** Endoscopic or injection sclerotherapy. Injection of sclerosing agent into esophageal varices through an endoscope promotes thrombosis and eventual sclerosis, thereby obliterating the varices.

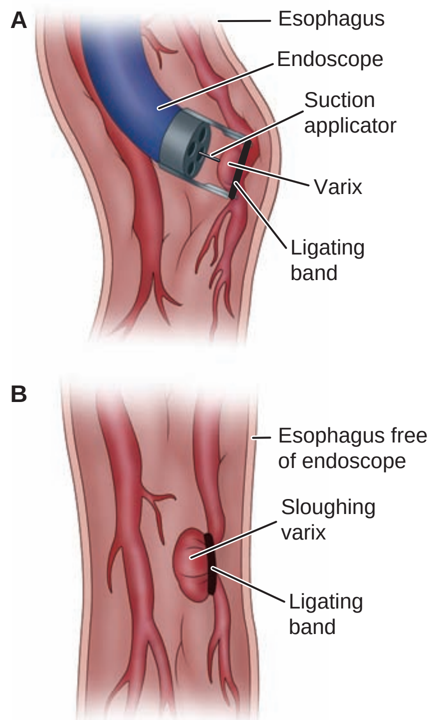



**Figure 39-10** Esophageal banding. **A,** A rubber band–like ligature is slipped over an esophageal varix via an endoscope. **B,** Necrosis results, and the varix eventually sloughs off.

proton pump inhibitors such as pantoprazole (Protonix) may be administered after the procedure to counteract the chemical effects of the sclerosing agent on the esophagus and the acid reflux associated with the therapy.

### *Esophageal Banding Therapy (Variceal Band Ligation)*

In **variceal banding** (Fig. 39-10), also referred to as esophageal variceal ligation (EVL), a modified endoscope loaded with an elastic rubber band is passed through an overtube directly onto the varix (or varices) to be banded. After the bleeding varix is suctioned into the tip of the endoscope, the rubber band is slipped over the tissue, causing necrosis, ulceration, and eventual sloughing of the varix.

Variceal banding is comparable to endoscopic sclerotherapy in its effectiveness in controlling acute bleeding. Compared with sclerotherapy, variceal banding also significantly reduces the rebleeding rate, mortality, procedure-related complications, and the number of sessions needed to eradicate varices. Esophageal band ligation has replaced sclerotherapy as the treatment of choice in the management of esophageal varices. Complications include superficial ulceration and dysphagia, transient chest discomfort, and, rarely, esophageal strictures. Band ligation in combination with pharmacologic therapy may be more effective than monotherapy (ie, a single mode of therapy) in the treatment of acute hemorrhage. EVL is recommended for patients who have experienced variceal bleeding while receiving beta-blocker therapy and for those who cannot tolerate beta-blocking agents (Albillos, 2007).

### *Transjugular Intrahepatic Portosystemic Shunting*

A TIPS procedure (see Fig. 39-6) is indicated for the treatment of an acute episode of variceal bleeding refractory to pharmacologic or endoscopic therapy. In 10% to 20% of patients for whom urgent band ligation or sclerotherapy and medications are not successful in eradicating bleeding, a TIPS procedure can effectively control acute variceal hemorrhage by rapidly lowering portal pressure. TIPS is also indicated for those patients who rebleed after pharmacologic or endoscopic prophylaxis has failed. In addition, this technique is used as a bridge to liver transplantation. Potential complications include bleeding, sepsis, heart failure, organ perforation, shunt thrombosis, and progressive liver failure (Wolfe, 2006).

## Surgical Management

Several surgical procedures have been developed to treat esophageal varices and to minimize rebleeding, but these procedures are often accompanied by significant risk. Procedures that may be used for esophageal varices are direct surgical ligation of varices; splenorenal, mesocaval, and portacaval venous shunts to relieve portal pressure; and esophageal transection with devascularization. Use of these procedures is controversial, and studies regarding their effectiveness and outcomes continue. What is known thus far is that these procedures are very effective in controlling variceal bleeding. They may be considered as second-line management (rescue therapy) for those patients for whom all other treatments have failed, those who are not candidates for liver transplantation, and those who require a bridge to transplantation. There is a high incidence of encephalopathy after the surgical shunting procedures, and morbidity and mortality statistics remain high (Rodes, et al., 2007). The TIPS procedure has largely replaced the use of surgical decompressive shunts and ligation procedures.

### *Surgical Bypass Procedures*

Surgical decompression of the portal circulation can prevent variceal bleeding if the shunt remains patent (Rodes, et al., 2007). One of the various surgical shunting procedures (Fig. 39-11) is the distal splenorenal shunt, which is made between the splenic vein and the left renal vein after splenectomy. A mesocaval shunt is created by anastomosing the superior mesenteric vein to the proximal end of the vena cava or to the side of the vena cava using grafting material. The goal of distal splenorenal and mesocaval shunts is to decrease portal pressure by draining only a portion of venous blood from the portal bed; therefore, they are considered selective shunts. The liver continues to receive some portal flow, and the incidence of encephalopathy may be reduced. Portacaval shunts are considered nonselective shunts because they divert all portal flow to the vena cava via end-to-side or side-to-side approaches.

These procedures are extensive and are not always successful because of secondary thrombosis in the veins used for the shunt and because of complications (eg, encephalopathy, accelerated liver failure). The effectiveness of these procedures has been studied extensively. All shunt procedures are equally effective in preventing recurrent variceal bleeding but may cause further impairment of liver function and encephalopathy. Partial portacaval shunts with interposition grafts are as effective as other shunts but

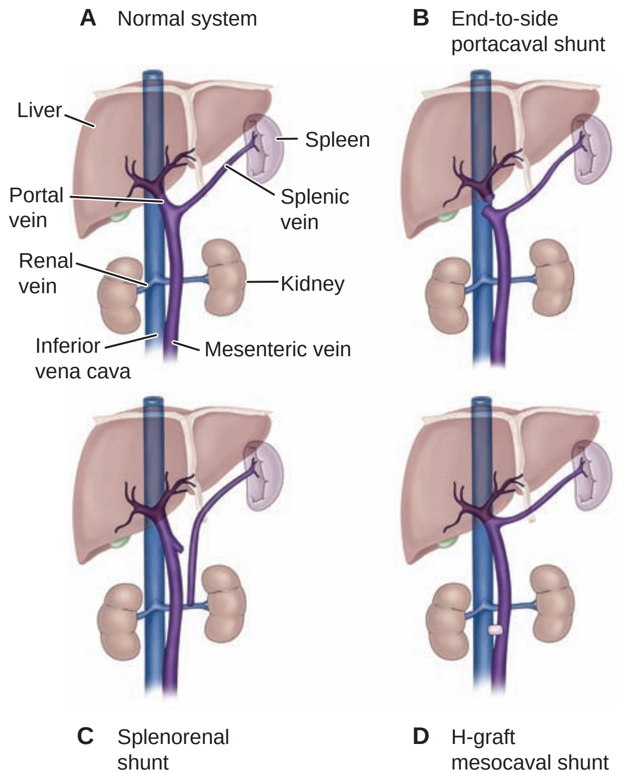



**Figure 39-11** Portal systemic shunts. **A,** Normal portal system. **B–D,** Examples of portal shunts to reduce portal pressure.

are associated with a lower rate of encephalopathy (Rodes, et al., 2007). The severity of the disease (by a classification such as the Child-Pugh system, discussed later) and the potential for future liver transplantation guide the treatment decision. If the cause of portal hypertension is the rare **Budd-Chiari syndrome** or other venous obstructive disease, a portacaval or a mesoatrial shunt may be performed (see Fig. 39-11). The mesoatrial shunt is required when the infrahepatic vena cava is thrombosed and must be bypassed.

### Devascularization and Transection

Devascularization and staple-gun transection procedures to separate the bleeding site from the high-pressure portal system have been used in the emergency management of variceal bleeding. The lower end of the esophagus is reached through a small gastrostomy incision; a staple gun permits anastomosis of the transected ends of the esophagus. Rebleeding is a risk, and the outcomes of these procedures vary among patient populations.

*NURSING ALERT*

**Postoperative care is similar to that for any abdominal surgery, but the risk of complications (hypovolemic or hemorrhagic shock, hepatic encephalopathy, electrolyte imbalance, metabolic and respiratory alkalosis, alcohol withdrawal syndrome, and seizures) is high. The surgical procedures do not alter the course of the progressive liver disease, and bleeding may recur as new collateral vessels develop.**

## Nursing Management

Overall nursing assessment includes monitoring the patient's physical condition and evaluating emotional responses and cognitive status. The nurse monitors and records vital signs and assesses the patient's nutritional and neurologic status. This assessment assists in identifying hepatic encephalopathy, which may result from the breakdown of blood in the GI tract with a rising serum ammonia level. Manifestations range from drowsiness and confusion to profound coma.

If complete rest of the esophagus is indicated because of bleeding, parenteral nutrition is initiated. Gastric suction usually is initiated to keep the stomach as empty as possible and to prevent straining and vomiting. The patient often complains of severe thirst, which may be relieved by frequent oral hygiene and moist sponges to the lips. The nurse closely monitors the blood pressure. Vitamin K therapy and multiple blood transfusions often are indicated because of blood loss. A quiet environment and calm reassurance may help to relieve the patient's anxiety and reduce agitation.

Bleeding anywhere in the body is anxiety provoking, resulting in a crisis for the patient and family. If the patient has been a heavy user of alcohol, delirium secondary to alcohol withdrawal can complicate the situation. The nurse provides support and explanations about medical and nursing interventions. Close monitoring of the patient helps in detecting and managing complications. Management modalities and nursing care of the patient with bleeding esophageal varices are summarized in Table 39-2.

# *Hepatic Encephalopathy and Coma*

**Hepatic encephalopathy,** or portosystemic encephalopathy (PSE), is a life-threatening complication of liver disease that occurs with profound liver failure. Patients with this condition have no overt signs of the illness but do have abnormalities on neuropsychologic testing (Hauser, et al., 2006). Hepatic encephalopathy is the neuropsychiatric manifestation of hepatic failure associated with portal hypertension and the shunting of blood from the portal venous system into the systemic circulation (Hauser, et al., 2006). This reversible metabolic form of encephalopathy can improve with recovery of liver function. The onset is often insidious and subtle, and initially the disease is termed subclinical or minimal hepatic encephalopathy.

Table 39-3 presents the stages of hepatic encephalopathy, common signs and symptoms, and potential nursing diagnoses for each stage.

## Pathophysiology

Despite the frequency with which hepatic encephalopathy occurs, the precise pathophysiology is not fully defined (Feldman, Friedman & Brandt, 2006). Two major alterations underlie its development in acute and chronic liver disease. First, hepatic insufficiency may result in encephalopathy because of the inability of the liver to detoxify toxic byproducts of metabolism. Second, portal-systemic shunting, in which collateral vessels develop as a result of portal hypertension, allows elements of the portal blood

**Table 39-2 MANAGEMENT MODALITIES AND NURSING CARE FOR THE PATIENT WITH BLEEDING ESOPHAGEAL VARICES**

| Treatment Modality* | Action | Nursing Priorities |
|---|---|---|
| **Nonsurgical Modalities** | | |
| Pharmacologic agents | | Observe response to therapy. |
| Propranolol (Inderal)/nadolol (Corgard) | Reduces portal pressure by β-adrenergic blocking action. | Monitor for side effects: *propranolol* and *nadolol*—decreased pulse pressure, impaired cardiovascular response to hemorrhage. |
| Vasopressin (Pitressin) | Reduces portal pressure by constricting splanchnic arteries. | *vasopressin*—angina; nitroglycerin may be prescribed to prevent or treat angina. |
| Somatostatin/octreotide (Sandostatin) | Reduces portal pressure by selective vasodilation of portal system. | Support patient during treatment. |
| Balloon tamponade | Exerts pressure directly to bleeding sites in esophagus and stomach. | Explain procedure to patient briefly to obtain cooperation with insertion and maintenance of esophageal/gastric tamponade tube and reduce patient's fear of the procedure. Monitor closely to prevent inadvertent removal or displacement of tube, subsequent airway obstruction, and aspiration. Provide frequent oral hygiene. |
| Room-temperature saline lavage | Clears blood and secretions before endoscopy and other procedures. | Ensure patency of the nasogastric tube to prevent aspiration. Observe gastric aspirate for blood and cessation of bleeding. |
| Injection sclerotherapy | Promotes thrombosis and sclerosing of bleeding sites by injection of sclerosing agent into the esophageal varices. | Observe for aspiration, perforation of the esophagus, and recurrence of bleeding after treatment. |
| Variceal banding | Provides thrombosis and mucosal necrosis of bleeding sites by band ligation. | Observe for recurrence of bleeding, esophageal perforation. |
| Transjugular intrahepatic portosystemic shunt (TIPS) | Reduces portal pressure by creating a shunt within the liver between the portal and systemic venous systems. | Observe for rebleeding and signs of infection. |
| **Surgical Modalities** | | |
| Portal-systemic shunt | Reduces portal hypertension by diverting blood flow away from obstructed portal system. | Observe for development of portal-systemic encephalopathy (altered mental status, neurologic dysfunction), hepatic failure, and rebleeding. Requires intensive, expert nursing care for prolonged period. |
| Surgical ligation of varices | Ties off blood vessels at the site of bleeding. | Observe for rebleeding. |
| Esophageal transection and devascularization | Separates bleeding site from portal system. | Observe for rebleeding. Provide postthoracotomy care. |

*Several modalities may be used concurrently or in sequence.

(laden with potentially toxic substances usually extracted by the liver) to enter the systemic circulation (Rodes, et al., 2007). Ammonia is considered the major etiologic factor in the development of encephalopathy. It enters the brain and excites peripheral benzodiazepine-type receptors on astrocyte cells, thus increasing neurosteroid synthesis; this then stimulates gamma-aminobutyric acid (GABA) neurotransmission. GABA causes depression of the central nervous system (Hauser, et al., 2007). Ammonia inhibits neurotransmission and synaptic regulation (Onion, 2006), producing

**Table 39-3 STAGES OF HEPATIC ENCEPHALOPATHY AND POSSIBLE NURSING DIAGNOSES***

| Stage | Clinical Symptoms | Clinical Signs and EEG Changes | Selected Potential Nursing Diagnoses |
|---|---|---|---|
| 1 | Normal level of consciousness with periods of lethargy and euphoria; reversal of day–night sleep patterns | Asterixis; impaired writing and ability to draw line figures. Normal EEG. | Activity intolerance<br>Self-care deficit<br>Disturbed sleep pattern |
| 2 | Increased drowsiness; disorientation; inappropriate behavior; mood swings; agitation | Asterixis; fetor hepaticus. Abnormal EEG with generalized slowing. | Impaired social interaction<br>Ineffective role performance<br>Risk for injury |
| 3 | Stuporous; difficult to rouse; sleeps most of time; marked confusion; incoherent speech | Asterixis; increased deep tendon reflexes; rigidity of extremities. EEG markedly abnormal. | Imbalanced nutrition<br>Impaired mobility<br>Impaired verbal communication |
| 4 | Comatose; may not respond to painful stimuli | Absence of asterixis; absence of deep tendon reflexes; flaccidity of extremities. EEG markedly abnormal. | Risk for aspiration<br>Impaired gas exchange<br>Impaired tissue integrity<br>Disturbed sensory perception |

*Nursing diagnoses are likely to progress, so that most nursing diagnoses present at earlier stages will occur during later stages as well.

sleep and behavior patterns associated with hepatic encephalopathy.

Circumstances that increase serum ammonia levels tend to aggravate or precipitate hepatic encephalopathy. The largest source of ammonia is the enzymatic and bacterial digestion of dietary and blood proteins in the GI tract. Ammonia from these sources increases as a result of GI bleeding (ie, bleeding esophageal varices, chronic GI bleeding), a high-protein diet, bacterial infection, or uremia. The ingestion of ammonium salts also increases the blood ammonia level. In the presence of alkalosis or hypokalemia, increased amounts of ammonia are absorbed from the GI tract and from the renal tubular fluid. Conversely, serum ammonia is decreased by elimination of protein from the diet and by the administration of antibiotic agents, such as neomycin sulfate (Mycifradin, Neo-fradin), which reduce the number of intestinal bacteria capable of converting urea to ammonia (Dudek, 2006).

Other factors unrelated to increased serum ammonia levels that can cause hepatic encephalopathy in susceptible patients include excessive diuresis, dehydration, infections, surgery, fever, and some medications (sedatives, tranquilizers, analgesics, and diuretics that cause potassium loss). Additional causes include elevated levels of serum manganese (Hauser, et al., 2006), as well as changes in the types of circulating amino acids, mercaptans, and levels of dopamine and other neurotransmitters in the central nervous system (Feldman, et al., 2006). Mercaptans are toxic metabolites of sulfur-containing compounds that are excreted by the liver under normal conditions. Mercaptans and these other so-called "false" neurotransmitters may be generated from an intestinal source or from metabolism of protein by the liver and, with defective hepatic clearance, may precipitate encephalopathy.

## Clinical Manifestations

The earliest symptoms of hepatic encephalopathy include minor mental changes and motor disturbances. The patient appears slightly confused and unkempt and has alterations in mood and sleep patterns. The patient tends to sleep during the day and has restlessness and insomnia at night. As hepatic encephalopathy progresses, the patient may become difficult to awaken and completely disoriented with respect to time and place. With further progression, the patient lapses into frank coma and may have seizures.

**Asterixis** (flapping tremor of the hands) may be seen in stage II encephalopathy (Fig. 39-12). Simple tasks, such as handwriting, become difficult. A handwriting or drawing sample (eg, star figure), taken daily, may provide graphic evidence of progression or reversal of hepatic encephalopathy. Inability to reproduce a simple figure (Fig. 39-13) is referred to as **constructional apraxia.** In the early stages of hepatic encephalopathy, the deep tendon reflexes are hyperactive; with worsening of the encephalopathy, these reflexes disappear and the extremities may become flaccid.

Occasionally, **fetor hepaticus,** a sweet, slightly fecal odor to the breath that is presumed to be of intestinal origin, may be noticed. The odor has also been described as similar to that of freshly mowed grass, acetone, or old wine. Fetor hepaticus is prevalent with extensive collateral portal circulation in chronic liver disease.

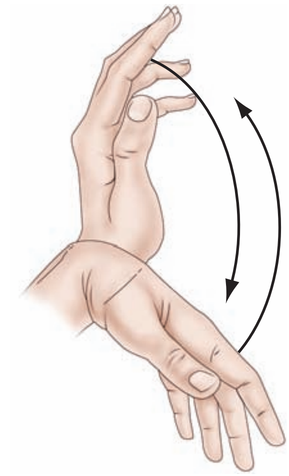


**Figure 39-12** Asterixis or "liver flap" may occur in hepatic encephalopathy. The patient is asked to hold the arm out with the hand held upward (dorsiflexed). Within a few seconds, the hand falls forward involuntarily and then quickly returns to the dorsiflexed position.

## Assessment and Diagnostic Findings

The electroencephalogram (EEG) shows generalized slowing, an increase in the amplitude of brain waves, and characteristic triphasic waves. The survival rate after a first episode of overt hepatic encephalopathy in patients with cirrhosis is approximately 40% at 1 year. Patients should be referred for liver transplantation after this initial episode (Hauser, et al., 2006).

## Medical Management

Medical management of hepatic encephalopathy focuses on identifying and eliminating the precipitating cause if possible, initiating ammonia-lowering therapy, minimizing potential medical complications of cirrhosis and depressed consciousness, and reversing the underlying liver disease, if possible. Correction of the possible reasons for the deterioration such as bleeding, electrolyte abnormalities, sedation, or azotemia is essential (Feldman, et al., 2006). Lactulose (Cephulac) is administered to reduce serum ammonia levels.

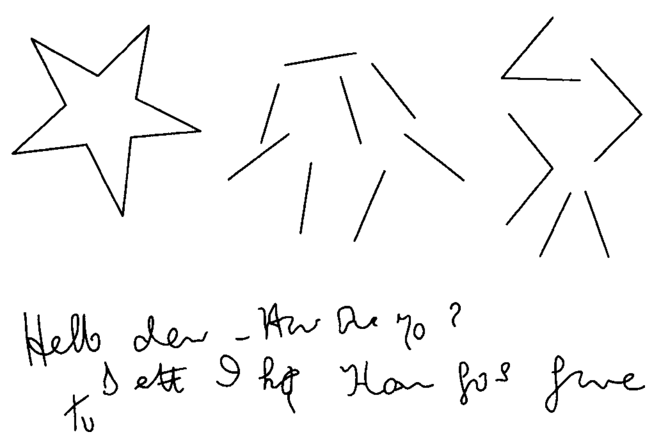


**Figure 39-13** Effects of constructional apraxia. Deterioration of handwriting and inability to draw a simple star figure occurs with progressive hepatic encephalopathy. (With permission from Sherlock, S. & Dooley, J. (2002). *Diseases of the liver and biliary system* (11th ed.). Oxford, UK: Blackwell Scientific Ltd.)

It acts by several mechanisms that promote the excretion of ammonia in the stool: (1) ammonia is kept in the ionized state, resulting in a decrease in colon pH, reversing the normal passage of ammonia from the colon to the blood; (2) evacuation of the bowel takes place, which decreases the ammonia absorbed from the colon; and (3) the fecal flora are changed to organisms that do not produce ammonia from urea. Two or three soft stools per day are desirable; this indicates that lactulose is performing as intended.

**NURSING ALERT**

**The patient receiving lactulose is monitored closely for the development of watery diarrheal stools, because they indicate a medication overdose.**

Possible side effects of lactulose include intestinal bloating and cramps, which usually disappear within a week. To mask the sweet taste, which some patients dislike, it can be diluted with fruit juice. The patient is closely monitored for hypokalemia and dehydration. Other laxatives are not prescribed during lactulose administration because their effects disturb dosage regulation. Lactulose may be administered by nasogastric tube or enema for patients who are comatose or for those in whom oral administration is contraindicated or impossible.

Other aspects of management include IV administration of glucose to minimize protein breakdown, administration of vitamins to correct deficiencies, and correction of electrolyte imbalances (especially potassium). Antibiotics may also be added to the treatment regimen. Neomycin, metronidazole (Flagyl), and rifaximin (Xifaxan) have been used to reduce levels of ammonia-forming bacteria in the colon. However, no benefit has been shown for long-term treatment with these antibiotics (Hauser, et al., 2006). Additional principles of management of hepatic encephalopathy include the following:

- Neurologic status is assessed frequently.
- Mental status is monitored by keeping a daily record of handwriting and arithmetic performance.
- Fluid intake and output and body weight are recorded each day.
- Vital signs are measured and recorded every 4 hours.
- Potential sites of infection (peritoneum, lungs) are assessed frequently, and abnormal findings are reported promptly.
- Serum ammonia level is monitored daily.
- Protein intake is moderately restricted in patients who are comatose or who have encephalopathy that is refractory to lactulose and antibiotic therapy (Chart 39-5). Long-term restriction of dietary protein to less than 1 g/kg daily should be avoided. If animal protein precipitates encephalopathy, vegetable or dairy proteins may be used as most patients can tolerate a diet of vegetable protein up to 120 g/day (Hauser, et al., 2006).
- Patients and families are advised about foods that are high in protein (eg, meat, eggs), which may need to be eliminated from the diet for the short term to reduce production of ammonia.

### Chart 39-5 • *Nutritional Management of Hepatic Encephalopathy*

- Prevent the formation and absorption of toxins, principally ammonia, from the intestine.
- Keep daily protein intake between 1.0 and 1.5 g/kg, depending on the degree of decompensation.
- Avoid protein restriction if possible, even in those with encephalopathy. If necessary, implement temporary restriction of 0.5 to 0.8 g/kg.
- For patients who are truly protein-intolerant, provide additional nitrogen in the form of an amino acid supplement. Use of branched-chain amino acids is still controversial.
- Provide small, frequent meals and an evening snack of complex carbohydrates to avoid protein loading.
- Substitute vegetable protein for animal protein in as high a percentage as possible.

- Enteral feeding is provided for patients whose encephalopathic state persists.
- Reduction in the absorption of ammonia from the GI tract is accomplished by the use of gastric suction, enemas, or oral antibiotics.
- Electrolyte status is monitored and corrected if abnormal.
- Sedatives, tranquilizers, and analgesic medications are discontinued.
- Benzodiazepine antagonists such as flumazenil (Romazicon) may be administered to improve encephalopathy, whether or not the patient has previously taken benzodiazepines. This action may have short-term efficacy because patients with hepatic encephalopathy have an increased concentration of benzodiazepine receptors.

## Nursing Management

The nurse is responsible for maintaining a safe environment to prevent injury, bleeding, and infection. The nurse administers the prescribed treatments and monitors the patient for the numerous potential complications. The potential for respiratory compromise is great given the patient's depressed neurological status. The nurse encourages deep breathing and position changes to prevent the development of atelectasis, pneumonia, and other respiratory complications. Despite aggressive pulmonary care, patients may develop respiratory compromise. They may require intubation and mechanical ventilation to protect the airway, and they are frequently admitted to the ICU.

The nurse communicates with the patient's family to inform them about the patient's status and supports them by explaining the procedures and treatments that are part of the patient's care. If the patient recovers from hepatic encephalopathy and coma, rehabilitation is likely to be prolonged. Therefore, the patient and family will require assistance to understand the causes of this severe complication and to recognize that it may recur.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

If the patient has recovered from hepatic encephalopathy and is to be discharged home, the nurse instructs the family

to watch for subtle signs of recurrent encephalopathy. In the acute phase of hepatic encephalopathy, dietary protein may be reduced for a brief period to 0.8 to 1.0 g/kg per day. During recovery and in the home situation, it is important to instruct the patient in maintenance of a moderate-protein, high-calorie diet. Protein may then be added in 10-g increments every 3 to 5 days if mental status is improving. Any relapse (worsening neurologic assessment) is treated by returning protein intake to the previous level. The limits of tolerance are usually 1.0 to 1.5 g/kg per day. Continued use of lactulose in the home environment is not uncommon, and the patient and family should closely monitor its efficacy and side effects. They should also be cautioned that constipation can precipitate encephalopathy and should be prevented through the prescribed use of lactulose, which is crucial in preventing constipation. Use of vegetable rather than animal protein may be indicated in patients whose total daily protein tolerance is less than 1 g/kg. Vegetable protein intake may result in improved nitrogen balance without precipitating or advancing hepatic encephalopathy (Feldman, et al., 2006).

**Continuing Care**

Referral for home care is warranted for the patient who returns home after recovery from hepatic encephalopathy. The home care nurse assesses the patient's physical and mental status and collaborates closely with the physician. The home visit also provides an opportunity for the nurse to assess the home environment and the ability of the patient and family to monitor signs and symptoms and to follow the treatment regimen. It is important to evaluate the patient's fluid volume status and be alert for changes indicative of hypovolemia due to decreased intake and for decreased urine output associated with hepatorenal syndrome. Monitoring of laboratory values continues to be important, and the home care nurse must obtain physician orders to correct abnormalities, especially electrolyte imbalances, which also can worsen encephalopathy.

The safety of the home environment is also assessed closely to identify areas of risk for falls and other injuries. Home care visits are especially important if the patient lives alone because encephalopathy may affect the patient's ability to remember or follow the treatment regimen. The nurse reinforces previous teaching and reminds the patient and family about the importance of dietary restrictions, close monitoring, and follow-up. In addition, the nurse must observe the patient for subtle behavior changes of worsening hepatic encephalopathy. Patients with all types and stages of hepatic encephalopathy should have periodic neurological evaluations to determine their cognitive function so that they do not engage in potentially harmful activities. Even subtle neuropsychiatric abnormalities may preclude patients from driving, operating machinery, or participating in other activities that require psychomotor coordination.

Patients and families may need additional support during those times that the patient exhibits mood disturbances and sleep disorders. Patients should be as active as possible during the day and develop a normal sleep–wake pattern. Sedating medications should be avoided because they may precipitate encephalopathy. Patients and families may require assistance in developing plans to cope with changes in mood and mental status changes. This plan should identify support persons to attend to the patient in the home situation if needed. Social workers and case managers may make appropriate referrals for assistance with physical and psychosocial support and care. Referrals to other experts such as psychologists, psychiatric liaison nurses, case managers, social workers, or therapists may assist family members with coping. Spiritual advisors may also provide another outlet for communication and guidance. If alcohol played a role in the development of the liver disease and encephalopathy, referral to Alcoholics Anonymous or Al-Anon may provide needed support and education.

## Other Manifestations of Hepatic Dysfunction

### Edema and Bleeding

Many patients with liver dysfunction develop generalized edema caused by hypoalbuminemia due to decreased hepatic production of albumin. The production of blood clotting factors by the liver is also reduced, leading to an increased incidence of bruising, epistaxis, bleeding from wounds, and, as described previously, GI bleeding.

### Vitamin Deficiency

Decreased production of several clotting factors may be partially due to deficient absorption of vitamin K from the GI tract. This probably is caused by the inability of liver cells to use vitamin K to make prothrombin. Absorption of the other fat-soluble vitamins (vitamins A, D, and E) as well as dietary fats may also be impaired because of decreased secretion of bile salts into the intestine.

Another group of problems common to patients with severe chronic liver dysfunction results from inadequate intake of sufficient vitamins. These include the following:

- Vitamin A deficiency, resulting in night blindness and eye and skin changes
- Thiamine deficiency, leading to beriberi, polyneuritis, and Wernicke-Korsakoff psychosis
- Riboflavin deficiency, resulting in characteristic skin and mucous membrane lesions
- Pyridoxine deficiency, resulting in skin and mucous membrane lesions and neurologic changes
- Vitamin C deficiency, resulting in the hemorrhagic lesions of scurvy
- Vitamin K deficiency, resulting in hypoprothrombinemia, characterized by spontaneous bleeding and ecchymoses
- Folic acid deficiency, resulting in macrocytic anemia

Because of these avitaminoses, the diet of every patient with chronic liver disease (especially if alcohol related) is supplemented with vitamins A, B complex, C, K, and folic acid.

### Metabolic Abnormalities

Abnormalities of glucose metabolism also occur; the blood glucose level may be abnormally high shortly after a meal (a diabetic-type glucose tolerance test result), but hypoglycemia may occur during fasting because of decreased

hepatic glycogen reserves and decreased gluconeogenesis. Medications must be used cautiously and in reduced dosages because the ability to metabolize medications is decreased in the patient with liver failure.

Many endocrine abnormalities also occur with liver dysfunction because the liver cannot properly metabolize hormones, including androgens and sex hormones. Failure of the damaged liver to inactivate estrogens normally can cause gynecomastia, amenorrhea, testicular atrophy, loss of pubic hair in the male, menstrual irregularities in the female, and other disturbances of sexual function and sex characteristics.

### Pruritus and Other Skin Changes

Patients with liver dysfunction resulting from biliary obstruction commonly develop severe pruritus due to retention of bile salts. Patients may develop vascular (or arterial) spider angiomas (Fig. 39-14) on the skin, usually above the waistline. These are numerous small vessels resembling a spider's legs. They are most often associated with cirrhosis, especially in alcoholic liver disease. Patients may also develop reddened palms ("liver palms" or palmar erythema).



**Figure 39-14** Spider angioma. This vascular (arterial) spider appears on the skin. Beneath the elevated center and radiating branches, the blood vessels are looped and tortuous.

## VIRAL HEPATITIS

Viral hepatitis is a systemic, viral infection in which necrosis and inflammation of liver cells produce a characteristic cluster of clinical, biochemical, and cellular changes. To date, five definitive types of viral hepatitis have been identified: hepatitis A, B, C, D, and E. Hepatitis A and E are similar in mode of transmission (fecal–oral route), whereas hepatitis B, C, and D share many other characteristics. Terms associated with viral hepatitis are listed in Chart 39-6.

Hepatitis is easily transmitted and causes high morbidity and prolonged loss of time from school or employment. Acute viral hepatitis affects 0.5% to 1% of people in the

### Chart 39-6 • *Hepatitis Terms and Abbreviations*

| Term | Definition |
|---|---|
| **Hepatitis A** | |
| HAV | Hepatitis A virus; etiologic agent of hepatitis A (formerly infectious hepatitis) |
| Anti-HAV | Antibody to hepatitis A virus; appears in serum soon after onset of symptoms; disappears after 3–12 mo |
| IgM anti-HAV | IgM antibody to HAV; indicates recent infection with HAV; positive up to 6 mo after infection |
| **Hepatitis B** | |
| HBV | Hepatitis B virus; etiologic agent of hepatitis B (formerly serum hepatitis) |
| HBsAG | Hepatitis B surface antigen (Australian antigen); indicates acute or chronic hepatitis B or carrier state; indicates infectious state |
| Anti-HBs | Antibody to hepatitis B surface antigen; indicates prior exposure and immunity to hepatitis; may indicate passive antibody from HBIG or immune response from hepatitis B vaccine |
| HBeAg | Hepatitis B e-antigen; present in serum early in course; indicates highly infectious stage of hepatitis B; persistence in serum indicates progression to chronic hepatitis |
| Anti-HBe | Antibody to hepatitis B e-antigen; suggests low titer of HBV |
| HBcAg | Hepatitis B core antigen; found in liver cells; not easily detected in serum |
| Anti-HBc | Antibody to hepatitis B core antigen; most sensitive indicator of hepatitis B; appears late in the acute phase of the disease; indicates infection of HBV at some time in the past |
| IgM anti-HBc | IgM antibody to HBcAg; present for up to 6 mo after HBV infection |
| **Hepatitis C** | |
| HCV | Hepatitis C virus (formerly non-A, non-B virus); may be more than one virus |
| **Hepatitis D** | |
| HDV | Hepatitis D virus (delta agent); etiologic agent to hepatitis D; HBV required for replication |
| HDAg | Hepatitis delta antigen; detectable in early acute HDV infection |
| Anti-HDV | Antibody to HDV; indicates past or present infection with HDV |
| **Hepatitis E** | |
| HEV | Hepatitis E virus; etiologic agent of hepatitis E |
| **Hepatitis G** | |
| HGV | Hepatitis G virus; also known as GB virus C or GB-C |

**Table 39-4 COMPARISON OF MAJOR FORMS OF VIRAL HEPATITIS**

| | Hepatitis A | Hepatitis B | Hepatitis C | Hepatitis D | Hepatitis E |
|---|---|---|---|---|---|
| *Previous names* | Infectious hepatitis | Serum hepatitis | Non-A, non-B hepatitis | | |
| **Epidemiology** | | | | | |
| *Cause* | Hepatitis A virus (HAV) | Hepatitis B virus (HBV) | Hepatitis C virus (HCV) | Hepatitis D virus (HDV) | Hepatitis E virus (HEV) |
| *Mode of transmission* | Fecal–oral route; poor sanitation. Person-to-person contact. Waterborne; foodborne. Transmission possible with oral–anal contact during sex. | Parenterally; by intimate contact with carriers or those with acute disease; sexual and oral–oral contact. Perinatal transmission from mothers to infants. An important occupational hazard for health care personnel. | Transfusion of blood and blood products; exposure to contaminated blood through equipment or drug paraphernalia. Transmission possible with sex with infected partner; risk increased with STD. | Same as HBV. HBV surface antigen necessary for replication; pattern similar to that of hepatitis B. | Fecal–oral route; person to person contact may be possible, although risk appears low |
| *Incubation (days)* | 15–50 days<br>Average: 30 days | 28–160 days<br>Average: 70–80 days | 15–160 days<br>Average: 50 days | 21–140 days<br>Average: 35 days | 15–65 days<br>Average: 42 days |
| *Immunity* | Homologous | Homologous | Second attack may indicate weak immunity or infection with another agent. | Homologous | Unknown |
| **Nature of Illness** | | | | | |
| *Signs and symptoms* | May occur with or without symptoms; flulike illness<br>*Preicteric phase:* Headache, malaise, fatigue, anorexia, fever<br>*Icteric phase:* Dark urine, jaundice of sclera and skin, tender liver | May occur without symptoms<br>May develop arthralgias, rash | Similar to HBV; less severe and anicteric | Similar to HBV | Similar to HAV. Very severe in pregnant women. |
| *Outcome* | Usually mild with recovery. Fatality rate: <1%. No carrier state or increased risk of chronic hepatitis, cirrhosis, or hepatic cancer. | May be severe. Fatality rate: 1–10%. Carrier state possible. Increased risk of chronic hepatitis, cirrhosis, and hepatic cancer. | Frequent occurrence of chronic carrier state and chronic liver disease. Increased risk of hepatic cancer. | Similar to HBV but greater likelihood of carrier state, chronic active hepatitis, and cirrhosis | Similar to HAV except very severe in pregnant women |

United States each year. Hepatitis A is responsible for 37% of all cases, and hepatitis B is the offending agent in 18% of cases. The occurrence rate has been decreasing steadily since 1990, largely because of the use of hepatitis A and B vaccines as well as public health education regarding high-risk behaviors (Goldman & Ausiello, 2008). It is estimated that 60% to 90% of viral hepatitis cases go unreported. The occurrence of subclinical cases, failure to recognize mild cases, and misdiagnosis are thought to contribute to the underreporting. Table 39-4 compares the major forms of viral hepatitis.

## Hepatitis A Virus

Hepatitis A virus (HAV) accounts for 20% to 25% of cases of clinical hepatitis in the United States and other developed countries (Rodes, et al., 2007). Hepatitis A, formerly called infectious hepatitis, is caused by an RNA virus of the Enterovirus family. In the United States, the disease is seen mainly in the adult population. Fewer than 25% of children have antibodies to HAV. This form of hepatitis is transmitted primarily through the fecal–oral route, by the ingestion of food or liquids infected by the virus. It is more prevalent in countries with overcrowding and poor sanitation. The virus has been found in the stool of infected patients before the onset of symptoms and during the first few days of illness.

Typically, a child or a young adult acquires the infection at school through poor hygiene, hand-to-mouth contact, or close contact during play. The virus is carried home, where haphazard sanitary habits spread it through the family. An infected food handler can spread the disease, and people can contract it by consuming water or shellfish from sewage-contaminated waters. Outbreaks have occurred in

day care centers and institutions as a result of poor hygiene among people with developmental disabilities. Hepatitis A can be transmitted during sexual activity; this is more likely with oral–anal contact or anal intercourse and with multiple sex partners (Rodes, et al., 2007). It is rarely, if ever, transmitted by blood transfusions.

The incubation period is estimated to be between 2 to 6 weeks, with a mean of approximately 4 weeks (Rodes, et al., 2007). The illness may be prolonged, lasting 4 to 8 weeks. It usually lasts longer and is more severe in those older than 40 years of age. Most patients recover from hepatitis A; it rarely progresses to acute liver necrosis or fulminant hepatitis resulting in cirrhosis of the liver or death. The mortality rate of hepatitis A is approximately 0.5% for those younger than 40 years of age and 1% to 2% for older people. In patients with underlying chronic liver disease, morbidity and mortality are increased in the presence of an acute hepatitis A infection. No carrier state exists, and no chronic hepatitis is associated with hepatitis A. The virus is present only briefly in the serum; by the time jaundice occurs, the patient is likely to be noninfectious. Although hepatitis A confers immunity against itself, the person may contract other forms of hepatitis.

## Clinical Manifestations

Many patients are anicteric (without jaundice) and symptomless. When symptoms appear, they resemble those of a mild, flulike upper respiratory tract infection, with low-grade fever. Anorexia, an early symptom, is often severe. It is thought to result from release of a toxin by the damaged liver or from failure of the damaged liver cells to detoxify an abnormal product. Later, jaundice and dark urine may become apparent. Indigestion is present in varying degrees, marked by vague epigastric distress, nausea, heartburn, and flatulence. The patient may also develop a strong aversion to the taste of cigarettes or the presence of cigarette smoke and other strong odors. These symptoms tend to clear as soon as the jaundice reaches its peak, perhaps 10 days after its initial appearance. Symptoms may be mild in children; in adults, they may be more severe and the course of the disease prolonged.

## Assessment and Diagnostic Findings

The liver and spleen are often moderately enlarged for a few days after onset; other than jaundice, there are few other physical signs. Hepatitis A antigen may be found in the stool 7 to 10 days before illness and for 2 to 3 weeks after symptoms appear. HAV antibodies are detectable in the serum, but usually not until symptoms appear. Analysis of subclasses of immunoglobulins can help determine whether the antibody represents acute or past infection.

## Prevention

A number of strategies exist to prevent transmission of HAV. Patients and their families are encouraged to follow general precautions that can prevent transmission of the virus. Scrupulous handwashing, safe water supplies, and proper control of sewage disposal are just a few of these prevention strategies.

Effective (95% to 100% after two to three doses) and safe HAV vaccines include Havrix and Vaqta (Goldman & Ausiello, 2008; Rodes, et al., 2007). It is recommended that the two-dose vaccine be given to adults 18 years of age or older, with the second dose given 6 to 12 months after the first. Protection against hepatitis A develops within several weeks after the first dose of the vaccine. Children and adolescents 2 to 18 years of age receive three doses; the second dose is given 1 month after the first, and the third dose is given 6 to 12 months later. Hepatitis A routine immunization of young children has proved effective in reducing disease incidence and maintaining very low incidence levels among vaccine recipients and across all age groups in many settings (Goldman & Ausiello, 2008; Rodes, et al., 2007). Hepatitis A vaccine is recommended for people traveling to locations where sanitation and hygiene are unsatisfactory. Vaccination is also recommended for those from high-risk groups, such as homosexual men, IV or injection drug users, staff of day care centers, and health care personnel (Hauser, et al., 2006; Rodes, et al., 2007; Wolfe, 2006). The vaccine has also been used to interrupt community-wide outbreaks. As with other vaccinations, precautions must be taken to ensure prevention, detection, and treatment of hypersensitivity reactions to the vaccine.

For people who have not been previously vaccinated, hepatitis A can be prevented by intramuscular administration of globulin during the incubation period, if given within 2 weeks of exposure. This bolsters the person's antibody production and provides 6 to 8 weeks of passive immunity. Immune globulin may suppress overt symptoms of the disease; the resulting subclinical case of hepatitis A would produce immunity to subsequent episodes of the virus.

Immune globulin is also recommended for household members and sexual contacts of people with hepatitis A. Susceptible people in the same household as the patient are usually also infected by the time the diagnosis is made and should receive immune globulin. Institutional contacts of patients with hepatitis A should also receive postexposure prophylaxis with immune globulin. Prophylaxis is not necessary for casual contacts of an infected person, such as classmates, coworkers, or hospital employees (Rodes, et al., 2007). Although they are rare, systemic reactions to immune globulin do occur. Caution is required when anyone who has previously had angioedema, hives, or other allergic reactions is treated with any human immune globulin. Epinephrine should be available in case of systemic, anaphylactic reaction.

Preexposure prophylaxis is recommended for those traveling to developing countries or settings with poor or uncertain sanitation conditions who do not have sufficient time to acquire protection by administration of hepatitis A vaccine (Rodes, et al., 2007). Community interventions for preventing hepatitis A are outlined in Chart 39-7.

## Medical Management

Bed rest during the acute stage and a diet that is both acceptable to the patient and nutritious are part of the treatment and nursing care. During the period of anorexia, the patient should receive frequent small feedings, supplemented if necessary by IV fluids with glucose. Because the patient often has an aversion to food, gentle persistence and creativity may be required to stimulate appetite. Optimal

**CHART 39-7 HEALTH PROMOTION**
***Prevention of Hepatitis***

- Encourage proper community and home sanitation.
- Encourage conscientious individual hygiene.
- Instruct patients regarding safe practices for preparing and dispensing food.
- Support effective health supervision of schools, dormitories, extended care facilities, barracks, and camps.
- Promote community health education programs.
- Facilitate mandatory reporting of viral hepatitis to local health departments.
- Recommend vaccination for all children 1 year of age and older.
- Recommend vaccination for travelers to developing countries, illegal drug users (injection and noninjection drug users), men who have sex with men, and people with chronic liver disease, and recipients (eg, hemophiliacs) of pooled plasma products.
- Promote vaccination to interrupt community-wide outbreaks.

food and fluid levels are necessary to counteract weight loss and to speed recovery. Even before the icteric phase, however, many patients recover their appetites (Chart 39-8).

The patient's sense of well-being and laboratory test results are generally appropriate guides to bed rest and restriction of physical activity. Gradual but progressive ambulation seems to hasten recovery, provided the patient rests after activity and does not participate in activities to the point of fatigue.

### Nursing Management

Management usually occurs in the home unless symptoms are severe. Therefore, the nurse assists the patient and family in coping with the temporary disability and fatigue that are common in hepatitis and instructs them to seek additional health care if the symptoms persist or worsen. The patient and family also need specific guidelines about diet, rest, follow-up blood work, and the importance of avoiding alcohol, as well as sanitation and hygiene measures (particularly handwashing) to prevent spread of the disease to other family members.

**Chart 39-8 • *Dietary Management of Viral or Drug-Related Hepatitis***

- Recommend small, frequent meals.
- Provide intake of 2000 to 3000 kcal/d during acute illness.
- Although early studies indicate that a high-protein, high-calorie diet may be beneficial, advise patient not to force food and to restrict fat intake.
- Carefully monitor fluid balance.
- If anorexia and nausea and vomiting persist, enteral feedings may be necessary.
- Instruct patient to abstain from alcohol during acute illness and for at least 6 mo after recovery.
- Advise patient to avoid substances (medications, herbs, illicit drugs, and toxins) that may affect liver function.

Specific teaching to patients and families about reducing the risk of contracting hepatitis A includes good personal hygiene, stressing careful handwashing (after bowel movements and before eating) and environmental sanitation (safe food and water supply, effective sewage disposal).

**NURSING ALERT**

**A combined hepatitis A and B vaccine (Twinrix) is available for vaccination of people 18 years of age and older with indications for both hepatitis A and B vaccination. Vaccination consists of three doses, given on the same schedule as that used for single-antigen hepatitis B vaccine.**

## Hepatitis B Virus

Unlike HAV, the hepatitis B virus (HBV) is transmitted primarily through blood (percutaneous and permucosal routes). HBV can be found in blood, saliva, semen, and vaginal secretions and can be transmitted through mucous membranes and breaks in the skin. HBV is also transferred from carrier mothers to their infants, especially in areas with a high incidence (eg, Southeast Asia). The infection usually is not transmitted via the umbilical vein but from the mother at the time of birth and during close contact afterward.

HBV has a long incubation period. It replicates in the liver and remains in the serum for relatively long periods, allowing transmission of the virus. Risk factors for HBV infection are summarized in Chart 39-9. Screening of blood donors has greatly reduced the occurrence of hepatitis B after blood transfusion.

Most people (more than 90%) who contract HBV infection develop antibodies and recover spontaneously in 6 months. The mortality rate from hepatitis B has been reported to be as high as 10%. Another 10% of patients who have hepatitis B progress to a carrier state or develop chronic hepatitis with persistent HBV infection and hepatocellular

**CHART 39-9** ***Risk Factors for Hepatitis B***

- Frequent exposure to blood, blood products, or other body fluids
- Health care workers: hemodialysis staff, oncology and chemotherapy nurses, personnel at risk for needlesticks, operating room staff, respiratory therapists, surgeons, dentists
- Hemodialysis
- Male homosexual and bisexual activity
- IV/injection drug use
- Close contact with carrier of HBV
- Travel to or residence in area with uncertain sanitary conditions
- Multiple sexual partners
- Recent history of sexually transmitted disease
- Receipt of blood or blood products (eg, clotting factor concentrate)

injury and inflammation. It remains a major worldwide cause of cirrhosis and hepatocellular carcinoma.

The elderly patient who contracts hepatitis B has a serious risk of severe liver cell necrosis or fulminant hepatic failure, particularly if other illnesses are present. Because the patient is seriously ill and the prognosis is poor, efforts should be undertaken to eliminate other factors (eg, medications, alcohol) that may affect liver function.

The immune system is altered in the aged. A less responsive immune system may be responsible for the increased incidence and severity of hepatitis B among elderly people and the increased incidence of liver abscesses secondary to decreased phagocytosis by the Kupffer cells. With the advent of hepatitis B vaccine as the standard for prevention, the incidence of hepatic diseases may decrease in the future.

## Clinical Manifestations

Clinically, the disease closely resembles hepatitis A, but the incubation period is much longer (1 to 6 months). Signs and symptoms of hepatitis B may be insidious and variable. Fever and respiratory symptoms are rare; some patients have arthralgias and rashes. The patient may have loss of appetite, dyspepsia, abdominal pain, generalized aching, malaise, and weakness. Jaundice may or may not be evident. If jaundice occurs, light-colored stools and dark urine accompany it. The liver may be tender and enlarged to 12 to 14 cm vertically. The spleen is enlarged and palpable in a few patients; the posterior cervical lymph nodes may also be enlarged. Subclinical episodes also occur frequently.

## Assessment and Diagnostic Findings

HBV is a DNA virus composed of the following antigenic particles:

- HBcAg—hepatitis B core antigen (antigenic material in an inner core)
- HBsAg—hepatitis B surface antigen (antigenic material on the viral surface, a marker of active replication and infection)
- HBeAg—an independent protein circulating in the blood
- HBxAg—gene product of X gene of HBV DNA

Each antigen elicits its specific antibody and is a marker for different stages of the disease process:

- anti-HBc—antibody to core antigen of HBV; persists during the acute phase of illness; may indicate continuing HBV in the liver
- anti-HBs—antibody to surface determinants on HBV; detected during late convalescence; usually indicates recovery and development of immunity
- anti-HBe—antibody to hepatitis B e-antigen; usually signifies reduced infectivity
- anti-HBxAg—antibody to the hepatitis B x-antigen; may indicate ongoing replication of HBV

HBsAg appears in the circulation in 80% to 90% of infected patients 1 to 10 weeks after exposure to HBV and 2 to 8 weeks before the onset of symptoms or an increase in transferase levels. Patients with HBsAg that persists for 6 months or longer after acute infection are considered to be HBsAg carriers (Rodes, et al., 2007). HBeAg is the next antigen of HBV to appear in the serum. It usually appears within 1 week of the appearance of HBsAg but before changes in aminotransferase levels; it disappears from the serum within 2 weeks. HBV DNA, detected by polymerase chain reaction testing, appears in the serum at about the same time as HBeAg. HBcAg is not always detected in the serum in HBV infection.

About 15% of American adults are positive for anti-HBs, which indicates that they have had hepatitis B. Anti-HBs may be positive in as many as two thirds of IV or injection drug users. Prevaccination screening for anti-HBs is not recommended except for high-risk adults who may have already been exposed to the disease.

## Prevention

### *Preventing Transmission*

Continued screening of blood donors for the presence of hepatitis B antigens further decreases the risk of transmission by blood transfusion. The use of disposable syringes, needles, and lancets and the introduction of needleless IV administration systems have reduced the risk of spreading this infection from one patient to another or to health care personnel during the collection of blood samples or the administration of parenteral therapy. Good personal hygiene is fundamental to infection control. In the clinical laboratory, work areas should be disinfected daily. Gloves are worn when handling all blood and body fluids, as well as HBAg-positive specimens, or when there is potential exposure to blood (eg, blood drawing) or to patients' secretions. Eating and smoking are prohibited in the laboratory and in other areas exposed to secretions, blood, or blood products. Patient education regarding the nature of the disease, its infectiousness, and prognosis is a critical factor in preventing transmission and protecting contacts.

### *Active Immunization: Hepatitis B Vaccine*

Active immunization is recommended for people who are at high risk for hepatitis B (eg, health care personnel, hemodialysis patients). In addition, people with hepatitis C and other chronic liver diseases should receive the vaccine. A yeast-recombinant hepatitis B vaccine (Recombivax HB) is used to provide active immunity and has shown rates of protection greater than 90% in healthy people (Rodes, et al., 2007). Although antibody levels may become low or undetectable, immunologic memory may remain intact for at least 5 to 10 years. Measurable levels of antibodies may not be essential for protection. In general, in those with normal immune systems, booster doses are not required, and no data support the use of booster doses of hepatitis B vaccine among immunocompetent people who have responded to the vaccination series. However, booster doses are recommended for people who are immunocompromised (Rodes, et al., 2007). Additional information is required to determine if booster injections are needed for adults 15 years or more after initial vaccination as well as those at high risk for HBV infection.

A hepatitis B vaccine prepared from plasma of humans chronically infected with HBV is used only rarely in patients who are immunodeficient or allergic to recombinant yeast-derived vaccines.

Both forms of the hepatitis B vaccine are administered intramuscularly in three doses; the second and third doses

are given 1 and 6 months, respectively, after the first dose. The third dose is very important in producing prolonged immunity. Hepatitis B vaccination should be administered to adults in the deltoid muscle. Antibody response may be measured by anti-HBs levels 1 to 3 months after completion of the basic course of vaccine, but this testing is not routine and is not currently recommended. People who do not respond may benefit from one to three additional doses (Rodes, et al., 2007).

People who are at high risk, including nurses and other health care personnel exposed to blood or blood products, should receive active immunization. Health care workers who have had frequent contact with blood are screened for anti-HBs to determine whether immunity is already present from previous exposure. The vaccine produces active immunity to HBV in 90% of healthy people (Rodes, et al., 2007). It does not provide protection to those already exposed to HBV, and it provides no protection against other types of viral hepatitis. Side effects of immunization are infrequent; soreness and redness at the injection site are the most common complaints.

Because hepatitis B infection is frequently transmitted sexually, hepatitis B vaccination is recommended for all unvaccinated people being evaluated for a sexually transmitted disease (STD). It is also recommended for those with a history of an STD, people with multiple sex partners, people who have sex with IV or injection drug users, and sexually active men who have sex with other men (Goldman & Ausiello, 2008).

Universal childhood vaccination for hepatitis B prevention has been instituted in the United States, and universal vaccination of all infants is encouraged. Catch-up vaccination is recommended for all children and prepubertal adolescents up to the age of 19 years who have not been previously immunized (Feldman, et al., 2006). Development of chronic carrier states has not been reported in adult responders to the vaccine.

#### Passive Immunity: Hepatitis B Immune Globulin

Hepatitis B immune globulin (HBIG) provides passive immunity to hepatitis B and is indicated for people exposed to HBV who have never had hepatitis B and have never received hepatitis B vaccine. Specific indications for postexposure vaccine with HBIG include (1) inadvertent exposure to HBAg-positive blood through percutaneous (needlestick) or transmucosal (splashes in contact with mucous membrane) routes, (2) sexual contact with people positive for HBAg, and (3) perinatal exposure (infants born to HBV-infected mothers should receive HBIG within 12 hours after delivery). HBIG is prepared from plasma selected for high titers of anti-HBs. Prompt immunization with HBIG (within hours to a few days after exposure to hepatitis B) increases the likelihood of protection. Both active and passive immunization are recommended for people who have been exposed to hepatitis B through sexual contact or through the percutaneous or transmucosal routes. If HBIG and hepatitis B vaccine are administered at the same time, separate sites and separate syringes should be used. There has been no evidence that human immunodeficiency virus (HIV) infection can be transmitted by HBIG (Wolfe, 2006).

### Medical Management

The goals of treatment are to minimize infectivity and liver inflammation and decrease symptoms. Of all the agents that have been used to treat chronic type B viral hepatitis, alpha-interferon as the single modality of therapy that offers the most promise. A regimen of 5 million units daily or 10 million units three times weekly for 16 to 24 weeks results in remission of disease in approximately one third of patients (Wolfe, 2006). A prolonged course of treatment may also have additional benefits and is currently under study. Interferon must be administered by injection and has significant side effects, including fever, chills, anorexia, nausea, myalgias, and fatigue. Delayed side effects are more serious and may necessitate dosage reduction or discontinuation. These include bone marrow suppression, thyroid dysfunction, alopecia, and bacterial infections. Several recombinant forms of alpha-interferon are also available, including the pegylated form (Pegasys), with once-weekly dosing (Wolfe, 2006).

Two antiviral agents, lamivudine (Epivir) and adefovir (Hepsera), oral nucleoside analogs, have been approved for use in chronic hepatitis B in the United States. Studies have revealed improved seroconversion rates, loss of detectable virus, improved liver function, and reduced progression to cirrhosis with lamivudine. It can be used for patients with decompensated cirrhosis who are awaiting liver transplantation (Rodes, et al., 2007). Adefovir may be effective in people who are resistant to lamivudine.

Bed rest may be recommended, regardless of other treatment, until the symptoms of hepatitis have subsided. Activities are restricted until the hepatic enlargement and levels of serum bilirubin and liver enzymes have decreased. Gradually increased activity is then allowed.

Adequate nutrition should be maintained. Proteins are restricted if symptoms indicate that the liver's ability to metabolize protein byproducts is impaired. Measures to control the dyspeptic symptoms and general malaise include the use of antacids and antiemetics, but all medications should be avoided if vomiting occurs. If vomiting persists, the patient may require hospitalization and fluid therapy. Because of the mode of transmission, the patient is evaluated for other bloodborne diseases (eg, HIV infection).

### Nursing Management

Convalescence may be prolonged, with complete symptomatic recovery sometimes requiring 3 to 4 months or longer. During this stage, gradual resumption of physical activity is encouraged after the jaundice has resolved.

The nurse identifies psychosocial issues and concerns, particularly the effects of separation from family and friends if the patient is hospitalized during the acute and infective stages. Even if not hospitalized, the patient will be unable to work and must avoid sexual contact. Planning is required to minimize social isolation. Planning that includes the family helps to reduce their fears and anxieties about the spread of the disease.

#### Promoting Home and Community-Based Care

##### Teaching Patients Self-Care

Because of the prolonged period of convalescence, the patient and family must be prepared for home care. Provision

for adequate rest and nutrition must be ensured. The nurse informs family members and friends who have had intimate contact with the patient about the risks of contracting hepatitis B and makes arrangements for them to receive hepatitis B vaccine or hepatitis B immune globulin as prescribed. Those at risk must be made aware of the early signs of hepatitis B and of ways to reduce risk by avoiding all modes of transmission. Patients with all forms of hepatitis should avoid drinking alcohol and eating raw shellfish.

**Continuing Care**

Follow-up visits by a home care nurse may be needed to assess the patient's progress and answer family members' questions about disease transmission. During a home visit, the nurse assesses the patient's physical and psychological status and confirms that the patient and family understand the importance of adequate rest and nutrition. The nurse also reinforces previous instructions. Because of the risk of transmission through sexual intercourse, strategies to prevent exchange of body fluids are recommended, such as abstinence or the use of condoms. The nurse emphasizes the importance of keeping follow-up appointments and participating in other health promotion activities and recommended health screenings.

## Hepatitis C Virus

A significant proportion of cases of viral hepatitis are neither hepatitis A, hepatitis B, nor hepatitis D, and are classified as hepatitis C. Whereas blood transfusions and sexual contact once accounted for most cases of hepatitis C in the United States, other parenteral means, such as sharing of contaminated needles by IV or injection drug users and unintentional needlesticks and other injuries in health care workers now account for a significant number of cases. Approximately 35,000 new cases of hepatitis C are reported in the United States each year. About 4 million people (1.8% of the U.S. population) have been infected with the hepatitis C virus (HCV), making it the most common chronic bloodborne infection nationally. A fourfold increase in the number of adults diagnosed with HCV infection is projected from 1990 to 2015. The highest prevalence of hepatitis C is in adults 40 to 59 years of age, and in this age group its prevalence is highest among African Americans. There are 10,000 to 12,000 deaths each year in the United States due to hepatitis C, and it has been suggested that deaths from this cause are underestimated. HCV is the underlying cause of about one third of cases of hepatocellular carcinoma, and it is the most common reason for liver transplantation (Wolfe, 2006).

People who are at particular risk for hepatitis C include IV or injection drug users, sexually active people with multiple partners, patients receiving frequent transfusions, those who require large volumes of blood, and health care personnel (Chart 39-10). The incubation period is variable and may range from 15 to 160 days. The clinical course of acute hepatitis C is similar to that of hepatitis B; symptoms are usually mild. However, a chronic carrier state occurs frequently, and there is an increased risk of chronic liver disease, including cirrhosis or liver cancer, after hepatitis C. Small amounts of alcohol taken regularly appear to cause progression of the disease. Therefore, alcohol and medications that may affect the liver should be avoided.

**CHART 39-10 Risk Factors for Hepatitis C**

- Recipient of blood products or organ transplant before 1992 or clotting factor concentrates before 1987
- Health care and public safety workers after needlestick injuries or mucosal exposure to blood
- Children born to women infected with hepatitis C virus
- Past/current illicit IV/injection drug use
- Past treatment with chronic hemodialysis
- Multiple sex partners, history of sexually transmitted disease, unprotected sex

There is no benefit from rest, diet, or vitamin supplements. Studies have demonstrated that a combination of two antiviral agents, interferon (Intron-A) and ribavirin (Rebetol), is effective in producing improvement in patients with hepatitis C and in treating relapses. Some patients experience complete remission with combination therapy (Hauser, et al., 2006). Hemolytic anemia, the most frequent side effect, may be severe enough to require discontinuation of treatment. Ribavirin must be used with caution in women of childbearing age. The molecule polyethylene glycol moiety (PEG) is added to the interferon to keep it in the body longer without reducing its efficacy; this extends the dosing interval to once a week. Pegylated interferon (Pegasys) is now available, and some studies have shown it to have a somewhat improved virologic response rate compared with interferon (Hauser, et al., 2006; Wolfe, 2006).

Screening of blood has reduced the incidence of hepatitis C associated with blood transfusion, and public health programs are helping to reduce the number of cases associated with shared needles in IV or injection drug use.

## Hepatitis D Virus

Hepatitis D virus (delta agent) infection occurs in some cases of hepatitis B. Because the virus requires hepatitis B surface antigen for its replication, only people with hepatitis B are at risk for hepatitis D. Anti-delta antibodies in the presence of HBAg on testing confirm the diagnosis. Hepatitis D is common among IV or injection drug users, hemodialysis patients, and recipients of multiple blood transfusions. Sexual contact with those with hepatitis B is considered to be an important mode of transmission of hepatitis B and D. The incubation period varies between 30 and 150 days (Goldman & Ausiello, 2008).

The symptoms of hepatitis D are similar to those of hepatitis B, except that patients are more likely to develop fulminant hepatitis and to progress to chronic active hepatitis and cirrhosis. Treatment is similar to that of other forms of hepatitis; interferon as a specific treatment for hepatitis D is under investigation.

### Hepatitis E Virus

It is believed that hepatitis E virus (HEV) is transmitted by the fecal–oral route, principally through contaminated water in areas with poor sanitation. The incubation period is variable, estimated to range between 15 and 65 days. In general, hepatitis E resembles hepatitis A. It has a self-limited course with an abrupt onset. Jaundice is almost always present. Chronic forms do not develop.

Avoiding contact with the virus through good hygiene, including handwashing, is the major method of prevention of hepatitis E. The effectiveness of immune globulin in protecting against hepatitis E virus is uncertain.

### Hepatitis G Virus and GB Virus-C

It has long been believed that there is another non-A–E agent causing hepatitis in humans. The incubation period for posttransfusion hepatitis is 14 to 145 days, too long for hepatitis B or C. In the United States, about 5% of chronic liver disease remains cryptogenic (ie, does not appear to be autoimmune or viral in origin), and 50% of these patients have received blood transfusions before developing disease. Therefore, another form of hepatitis, called hepatitis G virus (HGV) or GB virus-C (GBV-C) has been described; these are thought to be two different isolates of the same virus. Autoantibodies are absent.

The clinical significance of this virus remains uncertain. Risk factors are similar to those for hepatitis C. There is no clear relationship between HGV/GBV-C infection and progressive liver disease. Persistent infection does occur but does not affect the clinical course.

## NONVIRAL HEPATITIS

Certain chemicals have toxic effects on the liver and produce acute liver cell necrosis or toxic hepatitis when inhaled, injected parenterally, or are taken by mouth. The chemicals most commonly implicated in this disease are carbon tetrachloride, phosphorus, chloroform, and gold compounds. These substances are true hepatotoxins. Many medications can induce hepatitis but are only sensitizing rather than toxic. Drug-induced hepatitis is similar to acute viral hepatitis, but parenchymal destruction tends to be more extensive. Medications that can lead to hepatitis include isoniazid (Nydrazid), halothane (Fluothane), acetaminophen, methyldopa (Aldomet), and certain antibiotics, antimetabolites, and anesthetic agents.

### Toxic Hepatitis

At the onset of disease, toxic hepatitis resembles viral hepatitis. Obtaining a history of exposure to hepatotoxic chemicals, medications, botanical agents, or other toxic agents assists in early treatment and removal of the causative agent. Anorexia, nausea, and vomiting are the usual symptoms; jaundice and hepatomegaly are noted on physical assessment. Symptoms are more intense for the more severely toxic patient.

Recovery from acute toxic hepatitis is rapid if the hepatotoxin is identified early and removed or if exposure to the agent has been limited. Recovery is unlikely if there is a prolonged period between exposure and onset of symptoms. There are no effective antidotes. The fever rises; the patient becomes toxic and prostrated. Vomiting may be persistent, with the emesis containing blood. Clotting abnormalities may be severe, and hemorrhages may appear under the skin. The severe GI symptoms may lead to vascular collapse. Delirium, coma, and seizures develop, and within a few days the patient may die of fulminant hepatic failure (discussed later) unless he or she receives a liver transplant.

Short of liver transplantation, few treatment options are available. Therapy is directed toward restoring and maintaining fluid and electrolyte balance, blood replacement, and comfort and supportive measures. A few patients recover from acute toxic hepatitis only to develop chronic liver disease. If the liver heals, there may be scarring, followed by postnecrotic cirrhosis.

### Drug-Induced Hepatitis

Drug-induced liver disease is the most common cause of acute liver failure, accounting for more than 50% of all cases in the United States (Wolfe, 2006). Manifestations of sensitivity to a medication may occur on the first day of its use or not until several months later. Usually, the onset is abrupt, with chills, fever, rash, pruritus, arthralgia, anorexia, and nausea. Later, there may be jaundice, dark urine, and an enlarged and tender liver. After the offending medication is withdrawn, symptoms may gradually subside. However, reactions can be severe, or even fatal, even if the medication is stopped. If fever, rash, or pruritus occurs from any medication, its use should be stopped immediately.

Although any medication can affect liver function, use of acetaminophen (found in many over-the-counter medications used to treat fever and pain) has been identified as the leading cause of acute liver failure (Wolfe, 2006). Other mechanisms commonly associated with liver injury include many anesthetic agents, medications used to treat rheumatic and musculoskeletal disease, antidepressants, psychotropic medications, anticonvulsants, and antituberculosis agents.

A short course of high-dose corticosteroids may be used in patients with severe hypersensitivity reactions, although its efficacy is uncertain. Liver transplantation is an option for drug-induced hepatitis, but outcomes may not be as successful as with other causes of liver failure.

## FULMINANT HEPATIC FAILURE

**Fulminant hepatic failure** is the clinical syndrome of sudden and severely impaired liver function in a previously healthy person. According to the original and generally accepted definition, fulminant hepatic failure develops within 8 weeks after the first symptoms of jaundice (Hauser, et al., 2006). Patterns of the progression from jaundice to encephalopathy have been identified and have led to proposals of time-based classifications. However, no agreement as

to these classifications has been reached. Three categories are frequently cited: hyperacute, acute, and subacute liver failure. In hyperacute liver failure, the duration of jaundice before the onset of encephalopathy is 0 to 7 days; in acute liver failure, it is 8 to 28 days; and in subacute liver failure, it is 28 to 72 days. The prognosis for fulminant hepatic failure is much worse than for chronic liver failure. However, in fulminant failure, the hepatic lesion is potentially reversible, and survival rates are approximately 20% to 50%, depending greatly on the cause of liver failure. Those who do not survive die of massive hepatocellular injury and necrosis (Wolfe, 2006).

Viral hepatitis is a common cause of fulminant hepatic failure; other causes include toxic medications (eg, acetaminophen) and chemicals (eg, carbon tetrachloride), metabolic disturbances (eg, Wilson's disease, a hereditary syndrome with deposition of copper in the liver), and structural changes (eg, Budd-Chiari syndrome, an obstruction to outflow in major hepatic veins).

Jaundice and profound anorexia may be the initial reasons the patient seeks health care. Fulminant hepatic failure is often accompanied by coagulation defects, renal failure and electrolyte disturbances, cardiovascular abnormalities, infection, hypoglycemia, encephalopathy, and cerebral edema.

The key to optimized treatment is rapid recognition of acute liver failure and intensive intervention. Supporting the patient in the ICU and assessing the indications for and feasibility of liver transplantation are hallmarks of management of this population. The use of antidotes for certain conditions may be indicated such as *N*-acetylcysteine for acetaminophen toxicity and penicillin for mushroom poisoning. Treatment modalities may include plasma exchanges (plasmapheresis) to correct coagulopathy and to stabilize the patient awaiting liver transplantation and prostaglandin therapy to enhance hepatic blood flow; however, more clinical trials are needed to determine the effects or outcomes of these treatments. Hepatocytes within synthetic fiber columns have been tested as liver support systems (liver assist devices) to provide a bridge to transplantation.

Research into interventions for acute liver failure has begun to focus on techniques that combine the efficacy of a whole liver with the convenience and biocompatibility of hemodialysis. The acronyms ELAD (*e*xtracorporeal *l*iver *a*ssist *d*evices) and BAL (*b*io*a*rtificial *l*iver) have been used to describe these hybrid devices. These short-term devices, which remain experimental, may help patients survive until transplantation is possible. The BAL device exposes separated plasma to a cartridge containing porcine liver cells after the plasma has flowed through a charcoal column that removes substances toxic to hepatocytes. The ELAD exposes whole blood to cartridges containing human hepatoblastoma cells, resulting in removal of toxic substances. In the near future, similar extracorporeal circuits using **xenografts** may be studied as a bridge to liver transplantation. These approaches appear promising and have had success in animal studies. In human clinical application, the use of various BAL systems has resulted in improved neurologic and biochemical parameters. Adding albumin to the dialysate is effective in removing protein-bound toxins and is potentially useful in unstable patients with fulminant liver failure (Rodes, et al., 2007). To fully determine the clinical applicability of such systems on outcomes and survival rates, controlled, randomized clinical trials in large patient groups are required.

In patients who have fulminant liver failure with stage 4 encephalopathy, there is a high risk of cerebral edema, a life-threatening complication. The cause is not fully understood, although disruption of the blood–brain barrier and plasma leakage into the cerebrospinal fluid may be one cause. An increase in the intracellular osmolarity within cerebral astrocyte cells, possibly related to increased sodium and glutamine in these cells, may be another (Rodes, et al., 2007). These patients require intracranial pressure monitoring. Measures to promote adequate cerebral perfusion include careful fluid balance and hemodynamic assessments, a quiet environment, and diuresis with mannitol (Osmitrol), an osmotic diuretic.

Use of barbiturate anesthesia or pharmacologic paralysis and sedation is indicated to prevent surges in intracranial pressure related to agitation. Other support measures include monitoring for and treating hypoglycemia, coagulopathies, and infection. Despite these treatment modalities, the mortality rate remains high. Consequently, liver transplantation (discussed later) has become the treatment of choice for fulminant hepatic failure.

## HEPATIC CIRRHOSIS

**Cirrhosis** is a chronic disease characterized by replacement of normal liver tissue with diffuse fibrosis that disrupts the structure and function of the liver. There are three types of cirrhosis or scarring of the liver:

- Alcoholic cirrhosis, in which the scar tissue characteristically surrounds the portal areas. This is most frequently caused by chronic alcoholism and is the most common type of cirrhosis.
- Postnecrotic cirrhosis, in which there are broad bands of scar tissue. This is a late result of a previous bout of acute viral hepatitis.
- Biliary cirrhosis, in which scarring occurs in the liver around the bile ducts. This type of cirrhosis usually results from chronic biliary obstruction and infection (cholangitis); it is much less common than the other two types.

The portion of the liver chiefly involved in cirrhosis consists of the portal and the periportal spaces, where the bile canaliculi of each lobule communicate to form the liver bile ducts. These areas become the sites of inflammation, and the bile ducts become occluded with inspissated (thickened) bile and pus. The liver attempts to form new bile channels; hence, there is an overgrowth of tissue made up largely of disconnected, newly formed bile ducts and surrounded by scar tissue.

### Pathophysiology

Although several factors have been implicated in the etiology of cirrhosis, alcohol consumption is considered the major causative factor. Cirrhosis occurs with greatest frequency among people with alcoholism. Although nutritional deficiency with reduced protein intake contributes to liver

destruction in cirrhosis, excessive alcohol intake is the major causative factor in fatty liver and its consequences. However, cirrhosis has also occurred in people who do not consume alcohol and in those who consume a normal diet and have a high alcohol intake.

Some people appear to be more susceptible than others to this disease, whether or not they have alcoholism or are malnourished. Other factors may play a role, including exposure to certain chemicals (carbon tetrachloride, chlorinated naphthalene, arsenic, or phosphorus) or infectious schistosomiasis. Twice as many men as women are affected, although, for unknown reasons, women are at greater risk for development of alcohol-induced liver disease. Most patients are between 40 and 60 years of age. Each year more than 27,000 people die of chronic liver diseases and cirrhosis in the United States (Rodes, et al., 2007).

Alcoholic cirrhosis is characterized by episodes of necrosis involving the liver cells, which sometimes occur repeatedly throughout the course of the disease. The destroyed liver cells are gradually replaced by scar tissue. Eventually, the amount of scar tissue exceeds that of the functioning liver tissue. Islands of residual normal tissue and regenerating liver tissue may project from the constricted areas, giving the cirrhotic liver its characteristic hobnail appearance. The disease usually has an insidious onset and a protracted course, occasionally proceeding over a period of 30 or more years.

The prognoses for different forms of cirrhosis caused by various liver diseases have been investigated in several studies. Of the many prognostic indicators, the Child-Pugh classification seems most useful in predicting the outcome of patients with liver disease (Table 39-5). It is also used in choosing management approaches.

## Clinical Manifestations

Signs and symptoms of cirrhosis increase in severity as the disease progresses. Their severity is used to categorize the disorder as compensated or decompensated cirrhosis (Chart 39-11). Compensated cirrhosis, with its less severe, often vague symptoms, may be discovered secondarily at a routine physical examination. The hallmarks of decompensated cirrhosis result from failure of the liver to synthesize proteins, clotting factors, and other substances and manifestations of portal hypertension (see earlier sections of this chapter for clinical manifestations and management of portal hypertension, ascites, varices, and hepatic encephalopathy).

**Table 39-5 MODIFIED CHILD-PUGH CLASSIFICATION OF THE SEVERITY OF LIVER DISEASE***

| | Points Assigned | | |
|---|---|---|---|
| **Parameter** | **1** | **2** | **3** |
| Ascites | Absent | Slight | Moderate |
| Bilirubin (mg/dL) | ≤ 2 | 2–3 | > 3 |
| Albumin (g/dL) | > 3.5 | 2.8–3.5 | < 2.8 |
| Prothrombin time (seconds over control) | 1–3 | 4–6 | > 6 |
| Encephalopathy | None | Grade 1–2 | Grade 3–4 |

*Total score of 1–6, grade A; 7–9, grade B; 10–15, grade C.

Schiff, E. R., Somell, M. F. & Maddrey, W. C. (Eds.) (2006). *Schiff's diseases of the liver* (10th ed.). Philadelphia: Lippincott Williams & Wilkins.

**CHART 39-11 Assessing for Cirrhosis**

Be alert for the following signs and symptoms:

**Compensated**

- Intermittent mild fever
- Vascular spiders
- Palmar erythema (reddened palms)
- Unexplained epistaxis
- Ankle edema
- Vague morning indigestion
- Flatulent dyspepsia
- Abdominal pain
- Firm, enlarged liver
- Splenomegaly

**Decompensated**

- Ascites
- Jaundice
- Weakness
- Muscle wasting
- Weight loss
- Continuous mild fever
- Clubbing of fingers
- Purpura (due to decreased platelet count)
- Spontaneous bruising
- Epistaxis
- Hypotension
- Sparse body hair
- White nails
- Gonadal atrophy

### Liver Enlargement

Early in the course of cirrhosis, the liver tends to be large, and the cells are loaded with fat. The liver is firm and has a sharp edge that is noticeable on palpation. Abdominal pain may be present because of recent, rapid enlargement of the liver, which produces tension on the fibrous covering of the liver (Glisson's capsule). Later in the disease, the liver decreases in size as scar tissue contracts the liver tissue. The liver edge, if palpable, is nodular.

### Portal Obstruction and Ascites

Portal obstruction and ascites, late manifestations of cirrhosis, are caused partly by chronic failure of liver function and partly by obstruction of the portal circulation. Almost all of the blood from the digestive organs is collected in the portal veins and carried to the liver. Because a cirrhotic liver does not allow free blood passage, blood backs up into the spleen and the GI tract, and these organs become the seat of chronic passive congestion; that is, they are stagnant with blood and therefore cannot function properly. Indigestion and altered bowel function result. Fluid rich in protein may accumulate in the peritoneal cavity, producing ascites. This can be detected through percussion for shifting dullness or a fluid wave (see Fig. 39-5).

### Infection and Peritonitis

Bacterial peritonitis may develop in patients with cirrhosis and ascites in the absence of an intra-abdominal source of infection or an abscess. This condition is referred to as spontaneous bacterial peritonitis (SBP). Bacteremia due to translocation of intestinal flora is believed to be the most likely route of infection. Clinical signs may be absent, necessitating paracentesis for diagnosis. Antibiotic therapy is effective in the treatment and prevention of recurrent episodes of SBP. The most severe complication of SBP is hepatorenal syndrome, a form of renal failure unresponsive to administration of fluid or diuretics. This type of renal failure is characterized by a lack of pathologic changes in the kidney; there is no evidence of dehydration or obstruction of the urinary tract or any other renal disorder.

### Gastrointestinal Varices

The obstruction to blood flow through the liver caused by fibrotic changes also results in the formation of collateral blood vessels in the GI system and shunting of blood from the portal vessels into blood vessels with lower pressures. As a result, the patient with cirrhosis often has prominent, distended abdominal blood vessels, which are visible on abdominal inspection (caput medusae) and distended blood vessels throughout the GI tract. The esophagus, stomach, and lower rectum are common sites of collateral blood vessels. These distended blood vessels form varices or hemorrhoids, depending on their location (see Fig. 39-6).

Because these vessels were not intended to carry the high pressure and volume of blood imposed by cirrhosis, they may rupture and bleed. Therefore, assessment must include observation for occult and frank bleeding from the GI tract.

### Edema

Another late symptom of cirrhosis is edema, which is attributed to chronic liver failure. A reduced plasma albumin concentration predisposes the patient to the formation of edema. Although edema is generalized, it often affects the lower extremities, the upper extremities, and the presacral area. Facial edema is not typical. Overproduction of aldosterone occurs, causing sodium and water retention and potassium excretion.

### Vitamin Deficiency and Anemia

Because of inadequate formation, use, and storage of certain vitamins (notably vitamins A, C, and K), signs of deficiency are common, particularly hemorrhagic phenomena associated with vitamin K deficiency. Chronic gastritis and impaired GI function, together with inadequate dietary intake and impaired liver function, account for the anemia that is often associated with cirrhosis. The patient's anemia, poor nutritional status, and poor state of health result in severe fatigue, which interferes with the ability to carry out routine activities of daily living (ADLs).

### Mental Deterioration

Additional clinical manifestations include deterioration of mental and cognitive function with impending hepatic encephalopathy and hepatic coma, as previously described. Neurologic assessment is indicated, including assessment of the patient's general behavior, cognitive abilities, orientation to time and place, and speech patterns.

## Assessment and Diagnostic Findings

The extent of liver disease and the type of treatment are determined after review of the laboratory findings. The functions of the liver are complex, and many diagnostic tests provide information about liver function (see Table 39-1). The patient needs to know why these tests are being performed and how to cooperate.

In severe parenchymal liver dysfunction, the serum albumin level tends to decrease, and the serum globulin level rises. Enzyme tests indicate liver cell damage: serum alkaline phosphatase, AST, ALT, and GGT levels increase, and the serum cholinesterase level may decrease. Bilirubin tests are performed to measure bile excretion or retention; increased levels of bilirubin can occur with cirrhosis and other liver disorders. Prothrombin time is prolonged.

Ultrasound scanning is used to measure the difference in density of parenchymal cells and scar tissue. CT, MRI, and radioisotope liver scans give information about liver size and hepatic blood flow and obstruction. Diagnosis is confirmed by liver biopsy. Arterial blood gas analysis may reveal a ventilation–perfusion imbalance and hypoxia.

## Medical Management

The management of the patient with cirrhosis is usually based on the presenting symptoms. For example, antacids or histamine-2 ($H_2$) antagonists are prescribed to decrease gastric distress and minimize the possibility of GI bleeding. Vitamins and nutritional supplements promote healing of damaged liver cells and improve the patient's general nutritional status. Potassium-sparing diuretics such as spironolactone or triamterene (Dyrenium) may be indicated to decrease ascites, if present; these diuretics are preferred because they minimize the fluid and electrolyte changes commonly seen with other agents. An adequate diet and avoidance of alcohol are essential. Although the fibrosis of the cirrhotic liver cannot be reversed, its progression may be halted or slowed by such measures.

Preliminary studies indicate that colchicine, an anti-inflammatory agent used to treat the symptoms of gout, may increase survival time in patients with mild to moderate cirrhosis. Many medications have been shown to possess antifibrotic activity for the treatment of cirrhosis. Some of these medications include angiotensin system inhibitors, statins, diuretics, immunosuppressants, and glitazones. These medications have reasonable safety profiles, but their long-term safety and efficacy in patients with cirrhosis has yet to be demonstrated (Schuppan & Afdhal, 2008).

Many patients who have end-stage liver disease (ESLD) with cirrhosis use the herb milk thistle (*Silybum marianum*) to treat jaundice and other symptoms. This herb has been used for centuries because of its healing and regenerative properties for liver disease. Silymarin from milk thistle has anti-inflammatory and antioxidant properties that may have beneficial effects, especially in hepatitis. The natural compound, SAM-e (s-adenosylmethionine), may improve outcomes in liver disease by improving liver function, possibly through enhancing antioxidant function. Primary

biliary cirrhosis has been treated with ursodeoxycholic acid (Actigall, URSO) to improve liver function.

## Nursing Management

Nursing management for the patient with cirrhosis of the liver is described in detail in the Plan of Nursing Care for the Patient with Impaired Liver Function (Chart 39-12). Nursing interventions are directed toward promoting patient's rest, improving nutritional status, providing skin care, reducing risk of injury, and monitoring and managing potential complications.

### Promoting Rest

The patient with cirrhosis requires rest and other supportive measures to permit the liver to reestablish its functional ability. If the patient is hospitalized, weight and fluid intake and output are measured and recorded daily. The nurse adjusts the patient's position in bed for maximal respiratory efficiency, which is especially important if ascites is marked, because it interferes with adequate thoracic excursion. Oxygen therapy may be required in liver failure to oxygenate the damaged cells and prevent further cell destruction.

Rest reduces the demands on the liver and increases the liver's blood supply. Because the patient is susceptible to the hazards of immobility, efforts to prevent respiratory, circulatory, and vascular disturbances are initiated. These measures may help prevent such problems as pneumonia, thrombophlebitis, and pressure ulcers. After nutritional status improves and strength increases, the nurse encourages the patient to increase activity gradually. Activity and mild exercise, as well as rest, are planned.

### Improving Nutritional Status

The patient with cirrhosis without ascites, edema, or signs of impending hepatic coma should receive a nutritious, high-protein diet, if tolerated, supplemented by vitamins of the B complex, as well as A, C, and K. The nurse encourages the patient to eat. If ascites is present, small, frequent meals may be better tolerated than three large meals because of the abdominal pressure exerted by ascites. Patient preferences are considered. Patients with prolonged or severe anorexia and those who are vomiting or eating poorly for any reason may receive nutrients by the enteral or parenteral route.

Patients with fatty stools (steatorrhea) should receive water-soluble forms of fat-soluble vitamins A, D, and E (Aquasol A, D, and E). Folic acid and iron are prescribed to prevent anemia. If the patient shows signs of impending or advancing coma, the amount of protein in the diet is decreased temporarily. Protein is restricted if encephalopathy develops. Incorporating vegetable protein to meet protein needs may decrease the risk for encephalopathy. Sodium restriction is also indicated to prevent ascites.

### Providing Skin Care

Providing careful skin care is important because of subcutaneous edema, the patient's immobility, jaundice, and increased susceptibility to skin breakdown and infection. Frequent changes in position are necessary to prevent pressure ulcers. Irritating soaps and the use of adhesive tape are avoided to prevent trauma to the skin. Lotion may be soothing to irritated skin; the nurse takes measures to minimize scratching by the patient.

### Reducing Risk of Injury

The nurse protects the patient with cirrhosis from falls and other injuries. The side rails should be in place and padded with blankets or other materials in case the patient becomes agitated or restless. To minimize agitation, the nurse orients the patient to time and place and explains all procedures. The nurse instructs the patient to ask for assistance to get out of bed. The nurse carefully evaluates any injury because of the possibility of internal bleeding.

Because of the risk for bleeding from abnormal clotting, the patient should use an electric razor rather than a safety razor. A soft-bristled toothbrush helps minimize bleeding gums, and pressure applied to all venipuncture sites helps minimize bleeding.

### Monitoring and Managing Potential Complications

A major role of the nurse is monitoring of the patient with cirrhosis for complications.

#### Bleeding and Hemorrhage

The patient is at increased risk for bleeding and hemorrhage because of decreased production of prothrombin and decreased ability of the diseased liver to synthesize the necessary substances for blood coagulation. This was discussed earlier in the section on esophageal varices.

#### Hepatic Encephalopathy

As previously described, hepatic encephalopathy and coma, complications of cirrhosis, may manifest as deteriorating mental status and dementia or as physical signs such as abnormal voluntary and involuntary movements. Hepatic encephalopathy was discussed earlier in the chapter in detail and in Chart 39-12.

Monitoring is an essential nursing function to identify early deterioration in mental status. The nurse monitors the patient's mental status closely and reports changes so that treatment of encephalopathy can be initiated promptly. An extensive neurologic evaluation is key to identify progression through the four stages of encephalopathy.

Each advancing stage demands more intensive nursing interventions aimed at providing for patient safety and prevention and early identification of life-threatening complications such as respiratory failure and cerebral edema, which would necessitate interventions in an ICU. Because electrolyte disturbances can contribute to encephalopathy, serum electrolyte levels are carefully monitored and corrected if abnormal. Oxygen is administered if oxygen desaturation occurs. The nurse monitors for fever or abdominal pain, which may signal the onset of bacterial peritonitis or other infection (see earlier discussion of hepatic encephalopathy).

#### Fluid Volume Excess

Patients with advanced chronic liver disease develop cardiovascular abnormalities. These occur due to an increased cardiac output and decreased peripheral vascular resistance, possibly resulting from the release of vasodilators.

CHART 39-12

## PLAN OF NURSING CARE
### *The Patient With Impaired Liver Function*

**NURSING DIAGNOSIS:** Activity intolerance related to fatigue, lethargy, and malaise
**GOAL:** Patient reports decrease in fatigue and reports increased ability to participate in activities

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess level of activity tolerance and degree of fatigue, lethargy, and malaise when performing routine activities of daily living. | 1. Provides baseline for further assessment and criteria for assessment of effectiveness of interventions. |
| 2. Assist with activities and hygiene when fatigued. | 2. Promotes exercise and hygiene within patient's level of tolerance. |
| 3. Encourage rest when fatigued or when abdominal pain or discomfort occurs. | 3. Conserves energy and protects the liver. |
| 4. Assist with selection and pacing of desired activities and exercise. | 4. Stimulates patient's interest in selected activities. |
| 5. Provide diet high in carbohydrates with protein intake consistent with liver function. | 5. Provides calories for energy and protein for healing. |
| 6. Administer supplemental vitamins (A, B complex, C, and K). | 6. Provides additional nutrients. |

**Expected Outcomes**

- Exhibits increased interest in activities and events.
- Participates in activities and gradually increases exercise within physical limits.
- Reports increased strength and well-being.
- Reports absence of abdominal pain and discomfort.
- Plans activities to allow ample periods of rest.
- Takes vitamins as prescribed.

**NURSING DIAGNOSIS:** Imbalanced nutrition: less than body requirements, related to abdominal distention and discomfort and anorexia
**GOAL:** Positive nitrogen balance, no further loss of muscle mass; meets nutritional requirements

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess dietary intake and nutritional status through diet history and diary, daily weight measurements, and laboratory data. | 1. Identifies deficits in nutritional intake and adequacy of nutritional state. |
| 2. Provide diet high in carbohydrates with protein intake consistent with liver function. | 2. Provides calories for energy, sparing protein for healing. |
| 3. Assist patient in identifying low-sodium foods. | 3. Reduces edema and ascites formation. |
| 4. Elevate the head of the bed during meals. | 4. Reduces discomfort from abdominal distention and decreases sense of fullness produced by pressure of abdominal contents and ascites on the stomach. |
| 5. Provide oral hygiene before meals and pleasant environment for meals at meal time. | 5. Promotes positive environment and increased appetite; reduces unpleasant taste. |
| 6. Offer smaller, more frequent meals (6 per day). | 6. Decreases feeling of fullness, bloating. |
| 7. Encourage patient to eat meals and supplementary feedings. | 7. Encouragement is essential for the patient with anorexia and gastrointestinal discomfort. |
| 8. Provide attractive meals and an aesthetically pleasing setting at meal time. | 8. Promotes appetite and sense of well-being. |
| 9. Eliminate alcohol. | 9. Eliminates "empty calories" and further damage from alcohol. |
| 10. Apply an ice collar for nausea. | 10. May reduce incidence of nausea. |
| 11. Administer medications prescribed for nausea, vomiting, diarrhea, or constipation. | 11. Reduces gastrointestinal symptoms and discomforts that decrease the appetite and interest in food. |
| 12. Encourage increased fluid intake and exercise if the patient reports constipation. | 12. Promotes normal bowel pattern and reduces abdominal discomfort and distention. |

**Expected Outcomes**

- Exhibits improved nutritional status by increased weight (without fluid retention) and improved laboratory data.
- States rationale for dietary modifications.
- Identifies foods high in carbohydrates and within protein requirements (moderate to high protein in cirrhosis and hepatitis, low protein in hepatic failure).
- Reports improved appetite.
- Participates in oral hygiene measures.
- Reports increased appetite; identifies rationale for smaller, frequent meals.
- Demonstrates intake of high-calorie diet; adheres to protein restriction.
- Identifies foods and fluids that are nutritious and permitted on diet.
- Gains weight without increased edema or ascites formation.
- Reports increased appetite and well-being.
- Excludes alcohol from diet.
- Takes medications for gastrointestinal disorders as prescribed.
- Reports normal gastrointestinal function with regular bowel function.

*Continued*

CHART 39-12

## PLAN OF NURSING CARE
## *The Patient With Impaired Liver Function (Continued)*

**NURSING DIAGNOSIS:** Impaired skin integrity related to pruritus from jaundice and edema
**GOAL:** Decrease potential for pressure ulcer development; breaks in skin integrity

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess degree of discomfort related to pruritus and edema. | 1. Assists in determining appropriate interventions. |
| 2. Note and record degree of jaundice and extent of edema. | 2. Provides baseline for detecting changes and evaluating effectiveness of interventions. |
| 3. Keep patient's fingernails short and smooth. | 3. Prevents skin excoriation and infection from scratching. |
| 4. Provide frequent skin care; avoid use of soaps and alcohol-based lotions. | 4. Removes waste products from skin while preventing dryness of skin. |
| 5. Massage every 2 h with emollients; turn every 2 h. | 5. Promotes mobilization of edema. |
| 6. Initiate use of alternating-pressure mattress or low air loss bed. | 6. Minimizes prolonged pressure on bony prominences susceptible to breakdown. |
| 7. Recommend avoiding use of harsh detergents. | 7. May decrease skin irritation and need for scratching. |
| 8. Assess skin integrity every 4–8 h. Instruct patient and family in this activity. | 8. Edematous skin and tissue have compromised nutrient supply and are vulnerable to pressure and trauma. |
| 9. Restrict sodium as prescribed. | 9. Minimizes edema formation. |
| 10. Perform range of motion exercises every 4 h; elevate edematous extremities whenever possible. | 10. Promotes mobilization of edema. |

**Expected Outcomes**

- Exhibits intact skin without redness, excoriation, or breakdown.
- Reports relief from pruritus.
- Exhibits no skin excoriation from scratching.
- Uses nondrying soaps and lotions. States rationale for use of nondrying soaps and lotions.
- Turns self periodically. Exhibits reduced edema of dependent parts of the body.
- Exhibits no areas of skin breakdown.
- Exhibits decreased edema; normal skin turgor.

**NURSING DIAGNOSIS:** High risk for injury related to altered clotting mechanisms and altered level of consciousness
**GOAL:** Reduced risk of injury

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess level of consciousness and cognitive level. | 1. Assists in determining patient's ability to protect self and comply with required self-protective actions; may detect deterioration of hepatic function. |
| 2. Provide safe environment (pad side rails, remove obstacles in room, prevent falls). | 2. Minimizes falls and injury if falls occur. |
| 3. Provide frequent surveillance to orient patient and avoid use of restraints. | 3. Protects patient from harm while stimulating and orienting patient; use of restraints may disturb patient further. |
| 4. Replace sharp objects (razors) with safer items. | 4. Avoids cuts and bleeding. |
| 5. Observe each stool for color, consistency, and amount. | 5. Permits detection of bleeding in gastrointestinal tract. |
| 6. Be alert for symptoms of anxiety, epigastric fullness, weakness, and restlessness. | 6. May indicate early signs of bleeding and shock. |
| 7. Test each stool and emesis for occult blood. | 7. Detects early evidence of bleeding. |
| 8. Observe for hemorrhagic manifestations: ecchymosis, epistaxis, petechiae, and bleeding gums. | 8. Indicates altered clotting mechanisms. |
| 9. Record vital signs at frequent intervals, depending on patient acuity (every 1–4 h). | 9. Provides baseline and evidence of hypovolemia, and hemorrhagic shock. |

**Expected Outcomes**

- Is oriented to time, place, and person.
- Exhibits no hallucinations, and demonstrates no efforts to get up unassisted or to leave hospital.
- Exhibits no ecchymoses (bruises), cuts, or hematoma.
- Uses electric razor rather than sharp-edged razor.
- Exhibits absence of frank bleeding from gastrointestinal tract.
- Exhibits absence of restlessness, epigastric fullness, and other indicators of hemorrhage and shock.
- Exhibits negative results of test for occult gastrointestinal bleeding.
- Is free of ecchymotic areas or hematoma formation.
- Exhibits normal vital signs.
- Maintains rest and remains quiet if active bleeding occurs.
- Identifies rationale for blood transfusions and measures to treat bleeding.
- Uses measures to prevent trauma (eg, uses soft toothbrush, blows nose gently, avoids bumps and falls, avoids straining during defecation).
- Experiences no side effects of medications.

*Continued on following page*

CHART 39-12 PLAN OF NURSING CARE
**The Patient With Impaired Liver Function** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 10. Keep patient quiet and limit activity. | 10. Minimizes risk of bleeding and straining. | • Takes all medications as prescribed.<br>• Identifies rationale for precautions with use of all medications.<br>• Cooperates with treatment modalities. |
| 11. Assist physician in passage of tube for esophageal balloon tamponade, if its insertion is indicated. | 11. Promotes nontraumatic insertion of tube in anxious and combative patient for immediate treatment of bleeding. | |
| 12. Observe during blood transfusions. | 12. Permits detection of transfusion reactions (risk is increased with multiple blood transfusions needed for active bleeding from esophageal varices). | |
| 13. Measure and record nature, time, and amount of vomitus. | 13. Assists in evaluating extent of bleeding and blood loss. | |
| 14. Maintain patient in fasting state, if indicated. | 14. Reduces risk of aspiration of gastric contents and minimizes risk of further trauma to esophagus and stomach by preventing vomiting. | |
| 15. Administer vitamin K as prescribed. | 15. Promotes clotting by providing fat-soluble vitamin necessary for clotting. | |
| 16. Remain with patient during episodes of bleeding. | 16. Reassures anxious patient and permits monitoring and detection of further needs of the patient. | |
| 17. Offer cold liquids by mouth when bleeding stops (if prescribed). | 17. Minimizes risk of further bleeding by promoting vasoconstriction of esophageal and gastric blood vessels. | |
| 18. Institute measures to prevent trauma: | 18. Promotes safety of patient | |
| a. Maintain safe environment. | a. Minimizes risk of trauma and bleeding by avoiding falls and cuts, etc. | |
| b. Encourage *gentle* blowing of nose. | b. Reduces risk of nosebleed (epistaxis) secondary to trauma and decreased clotting. | |
| c. Provide soft toothbrush and avoid use of toothpicks. | c. Prevents trauma to oral mucosa while promoting good oral hygiene. | |
| d. Encourage intake of foods with high content of vitamin C. | d. Promotes healing. | |
| e. Apply cold compresses where indicated. | e. Minimizes bleeding into tissues by promoting local vasoconstriction. | |
| f. Record location of bleeding sites. | f. Permits detection of new bleeding sites and monitoring of previous sites of bleeding. | |
| g. Use small-gauge needles for injections. | g. Minimizes oozing and blood loss from repeated injections. | |
| 19. Administer medications carefully; monitor for side effects. | 19. Reduces risk of side effects secondary to damaged liver's inability to detoxify (metabolize) medications normally. | |

**NURSING DIAGNOSIS:** Disturbed body image related to changes in appearance, sexual dysfunction, and role function
**GOAL:** Patient verbalizes feelings consistent with improvement of body image and self-esteem

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess changes in appearance and the meaning these changes have for patient and family. | 1. Provides information for assessing impact of changes in appearance, sexual function, and role on the patient and family. | • Verbalizes concerns related to changes in appearance, life, and lifestyle. |

*Continued*

CHART 39-12

PLAN OF NURSING CARE

## *The Patient With Impaired Liver Function* (Continued)

**Nursing Interventions**

2. Encourage patient to verbalize reactions and feelings about these changes.
3. Assess patient's and family's previous coping strategies.
4. Assist and encourage patient to maximize appearance (such as strategies to limit the appearance of jaundice and ascites through careful selection of colors and type of clothing) and explore alternatives to previous sexual and role functions.
5. Assist patient in identifying short-term goals.
6. Encourage and assist patient in decision making about care.
7. Identify with patient resources to provide additional support (counselor, spiritual advisor).
8. Assist patient in identifying previous practices that may have been harmful to self (alcohol and drug abuse). Involve patient in goal-setting and provide positive feedback for accomplishments.

**Rationale**

2. Enables patient to identify and express concerns; encourages patient and significant others to share these concerns.
3. Permits encouragement of those coping strategies that are familiar to patient and have been effective in the past.
4. Encourages patient to continue safe roles and functions while encouraging exploration of alternatives.
5. Accomplishing these goals serves as positive reinforcement and increases self-esteem.
6. Promotes patient's control of life and improves sense of well-being and self-esteem.
7. Assists patient in identifying resources and accepting assistance from others when indicated.
8. Recognition and acknowledgment of the harmful effects of these practices are necessary for identifying a healthier lifestyle.

**Expected Outcomes**

- Shares concerns with significant others.
- Identifies past coping strategies that have been effective.
- Uses past effective coping strategies to deal with changes in appearance, life, and lifestyle.
- Maintains good grooming and hygiene.
- Identifies short-term goals and strategies to achieve them.
- Takes an active role in decision making about self and care.
- Identifies resources that are not harmful.
- Verbalizes that some of previous lifestyle practices have been harmful.
- Uses healthy expressions of frustration, anger, anxiety.

**NURSING DIAGNOSIS:** Chronic pain and discomfort related to enlarged tender liver and ascites
**GOAL:** Increased level of comfort

**Nursing Interventions**

1. Maintain bed rest when patient experiences abdominal discomfort.
2. Administer antispasmodic and analgesic agents as prescribed.
3. Observe, record, and report presence and character of pain and discomfort.
4. Reduce sodium and fluid intake if prescribed.
5. Prepare patient and assist with paracentesis.
6. Encourage the use of distracting activities such as music, reading or meditation.

**Rationale**

1. Reduces metabolic demands and protects the liver.
2. Reduces irritability of the gastrointestinal tract and decreases abdominal pain and discomfort.
3. Provides baseline to detect further deterioration of status and to evaluate interventions.
4. Minimizes further formation of ascites.
5. Removal of ascites fluid may decrease abdominal discomfort.
6. Distraction may limit the perception of pain.

**Expected Outcomes**

- Reports pain and discomfort if present.
- Maintains bed rest and decreases activity in presence of pain.
- Takes antispasmodic and analgesics as indicated and as prescribed.
- Reports decreased pain and abdominal discomfort.
- Reduces sodium and fluid intake to prescribed levels if indicated to treat ascites.
- Exhibits decreased abdominal girth and appropriate weight changes.
- Reports decreased discomfort after paracentesis.

**NURSING DIAGNOSIS:** Fluid volume excess related to ascites and edema formation
**GOAL:** Restoration of normal fluid volume

**Nursing Interventions**

1. Restrict sodium and fluid intake if prescribed.
2. Administer diuretics, potassium, and protein supplements as prescribed.

**Rationale**

1. Minimizes formation of ascites and edema.
2. Promotes excretion of fluid through the kidneys and maintenance of normal fluid and electrolyte balance.

**Expected Outcomes**

- Consumes diet low in sodium and within prescribed fluid restriction.
- Takes diuretics, potassium, and protein supplements as indicated without experiencing side effects.

*Continued on following page*

CHART 39-12

PLAN OF NURSING CARE

## *The Patient With Impaired Liver Function (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Record intake and output every 1 to 8 h depending on response to interventions and on patient acuity. | 3. Indicates effectiveness of treatment and adequacy of fluid intake. | • Exhibits increased urine output.<br>• Exhibits decreasing abdominal girth.<br>• Exhibits no rapid increase in weight.<br>• Identifies rationale for sodium and fluid restriction.<br>• Shows a decrease in ascites with decreased weight. |
| 4. Measure and record abdominal girth and weight daily. | 4. Monitors changes in ascites formation and fluid accumulation. | |
| 5. Explain rationale for sodium and fluid restriction. | 5. Promotes patient's understanding of restriction and cooperation with it. | |
| 6. Prepare patient and assist with paracentesis. | 6. Paracentesis will temporarily decrease amount of ascites present. | |

**NURSING DIAGNOSIS:** Disturbed thought processes and potential for mental deterioration related to abnormal liver function and increased serum ammonia level

**GOAL:** Improved mental status; safety maintained; ability to cope with cognitive and behavioral changes

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Restrict dietary protein as prescribed for transient period. | 1. Reduces source of ammonia (protein foods). | • Adheres to protein restriction.<br>• Demonstrates an interest in events and activities in environment.<br>• Demonstrates normal attention span.<br>• Follows and participates in conversation appropriately.<br>• Is oriented to person, place, and time.<br>• Remains in bed when indicated.<br>• Reports no urinary or fecal incontinence.<br>• Experiences no seizures.<br>• No neurological or respiratory depression.<br>• Develops no cognitive impairments but if they develop they are quickly identified and treated enhancing the potential of recovery.<br>• Patient and family describe adequate feelings of coping and lowered anxiety. They demonstrate ability to listen and to make decisions as able.<br>• Patient and family communicate their feelings and their needs in a secure and caring environment. |
| 2. Give frequent, small feedings of carbohydrates. | 2. Promotes consumption of adequate carbohydrates for energy requirements and spares protein from breakdown for energy. | |
| 3. Protect from infection. | 3. Minimizes risk for further increase in metabolic requirements. | |
| 4. Keep environment warm and draft-free. | 4. Minimizes shivering, which would increase metabolic requirements. | |
| 5. Pad the side rails of the bed. | 5. Provides protection for the patient should hepatic coma and seizure activity occur. | |
| 6. Limit visitors. | 6. Minimizes patient's activity and metabolic requirements. | |
| 7. Provide careful nursing surveillance to ensure patient's safety. | 7. Provides close monitoring of new symptoms and minimizes trauma to the confused patient. | |
| 8. Avoid opioids and barbiturates. | 8. Prevents masking of symptoms of hepatic coma and prevents drug overdose secondary to reduced ability of the damaged liver to metabolize opioids and barbiturates. Prevents respiratory depression. | |
| 9. Awaken at intervals (every 2–4 h) to assess cognitive status. | 9. Provides stimulation to the patient and opportunity for observing the patient's level of consciousness. | |
| 10. Identify subtle changes in behavior or sleep–wake pattern (consistent staff caring for the patient enhances this assessment as they become familiar with patient's baseline). | 10/11. These changes may herald worsening of encephalopathy which requires rapid intervention including medication. | |
| 11. Assess handwriting or drawing skill daily as indication of cognitive ability. | | |
| 12. Encourage patient and family to participate in therapeutic strategies to enhance coping with episodes of mental deterioration. | 12. Promoting activities such as listening to music, relaxation techniques or preillness coping strategies can reduce anxiety. | |
| 13. Encourage patient and family to discuss feeling of fear, powerlessness or emotional distress related to patient's mental deterioration. | 13. Actively listening demonstrates caring and concern. | |

*Continued*

CHART 39-12

## PLAN OF NURSING CARE
## *The Patient With Impaired Liver Function (Continued)*

**NURSING DIAGNOSIS:** Risk for imbalanced body temperature: hyperthermia related to inflammatory process of cirrhosis or hepatitis
**GOAL:** Maintenance of normal body temperature, free from infection

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Record temperature regularly (every 4 h). | 1. Provides baseline to detect fever and to evaluate interventions. | • Exhibits normal temperature and reports absence of chills or sweating. |
| 2. Encourage fluid intake. | 2. Corrects fluid loss from perspiration and fever and increases patient's level of comfort. | • Demonstrates adequate intake of fluids. |
| 3. Apply cool sponges or ice bag for elevated temperature. | 3. Promotes reduction of fever and increases patient's comfort. | • Exhibits no evidence of local or systemic infection. |
| 4. Administer antibiotics as prescribed. | 4. Ensures appropriate serum concentration of antibiotics to treat infection. | • Develops no nosocomial infections related to invasive procedures/lines. |
| 5. Avoid exposure to infections. | 5. Minimizes risk of further infection and further increases in body temperature and metabolic rate. | |
| 6. Keep patient at rest while temperature is elevated. | 6. Reduces metabolic rate. | |
| 7. Assess for abdominal pain, tenderness. | 7. May occur with bacterial peritonitis. | |
| 8. Use sterile technique for all invasive procedures. | 8. Many evidence-based practice guidelines (for example central venous catheter care) recommend the use of sterile technique to prevent nosocomial infections. | |

**NURSING DIAGNOSIS:** Ineffective breathing pattern related to ascites and restriction of thoracic excursion secondary to ascites, abdominal distention, and fluid in the thoracic cavity
**GOAL:** Improved respiratory status

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Elevate head of bed to at least 30 degrees. | 1. Reduces abdominal pressure on the diaphragm and permits fuller thoracic excursion and lung expansion. | • Experiences improved respiratory status. |
| 2. Conserve patient's strength by providing rest periods and assisting with activities. | 2. Reduces metabolic and oxygen requirements. | • Reports decreased shortness of breath. |
| 3. Change position every 2 h. | 3. Promotes expansion and oxygenation of all areas of the lungs. | • Reports increased strength and sense of well-being. |
| 4. Assist with paracentesis or thoracentesis. | 4. Paracentesis and thoracentesis (performed to remove fluid from the abdominal and thoracic cavities, respectively) may be frightening to the patient. | • Exhibits normal respiratory rate (12–18/min) with no adventitious sounds. |
| a. Explain procedure and its purpose to patient. | a. Helps obtain patient's cooperation with procedures. | • Exhibits full thoracic excursion without shallow respirations. |
| b. Have patient void before paracentesis. | b. Prevents inadvertent bladder injury. | • Exhibits normal arterial blood gases. |
| c. Support and maintain position during procedure. | c. Prevents inadvertent organ or tissue injury. | • Exhibits adequate oxygen saturation by pulse oximetry. |
| d. Record both the amount and the character of fluid aspirated. | d. Provides record of fluid removed and indication of severity of limitation of lung expansion by fluid. | • Experiences absence of confusion or cyanosis. |
| e. Observe for evidence of coughing, increasing dyspnea, or pulse rate. | e. Indicates irritation of the pleural space and evidence of pneumothorax or hemothorax. | |

*Continued on following page*

CHART 39-12

## PLAN OF NURSING CARE

### *The Patient With Impaired Liver Function (Continued)*

**COLLABORATIVE PROBLEM:** Gastrointestinal bleeding and hemorrhage
**GOAL:** Absence of episodes of gastrointestinal bleeding and hemorrhage

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient for evidence of gastrointestinal bleeding or hemorrhage. If bleeding does occur:<br>a. Monitor vital signs (blood pressure, pulse, respiratory rate) every 4 h or more frequently, depending on acuity.<br>b. Assess skin temperature, level of consciousness every 4 h or more frequently, depending on acuity.<br>c. Monitor gastrointestinal secretions and output (emesis, stool for occult or obvious bleeding). Test emesis for blood once per shift and with any color change. Hematest each stool.<br>d. Monitor hematocrit and hemoglobin for trends and changes. | 1. Allows early detection of signs and symptoms of bleeding and hemorrhage. | • Experiences no episodes of bleeding and hemorrhage.<br>• Vital signs are within acceptable range for patient.<br>• No evidence of bleeding from gastrointestinal tract.<br>• Hematocrit and hemoglobin levels within acceptable limits.<br>• Turns and moves without straining and increasing intra-abdominal pressure.<br>• No straining with bowel movements.<br>• No further bleeding episodes if aggressive treatment of bleeding and hemorrhage was needed.<br>• Patient and family state rationale for treatments.<br>• Patient and family identify supports available to them.<br>• Patient and family describe signs and symptoms of a recurrent bleeding episode and identify needed action. |
| 2. Avoid activities that increase intra-abdominal pressure (straining, turning).<br>a. Avoid coughing/sneezing.<br>b. Assist patient to turn.<br>c. Keep all needed items within easy reach.<br>d. Use measures to prevent constipation such as adequate fluid intake; stool softeners.<br>e. Ensure small meals. | 2. Minimizes increases in intra-abdominal pressure that could lead to rupture and bleeding of esophageal or gastric varices. | |
| 3. Have equipment (Blakemore tube, medications, IV fluids) available if indicated. | 3. Equipment, medications, and supplies will be readily available if patient experiences bleeding from ruptured esophageal or gastric varices. | |
| 4. Assist with procedures and therapy needed to treat gastrointestinal bleeding and hemorrhage. | 4. Gastrointestinal bleeding and hemorrhage require emergency measures (eg, insertion of Blakemore tube, administration of fluids and medications). | |
| 5. Monitor respiratory status every hour and minimize risk of respiratory complications if balloon tamponade is needed. | 5. The patient is at high risk for respiratory complications, including asphyxiation if gastric balloon of tamponade tube ruptures or migrates upward. | |
| 6. Prepare patient physically and psychologically for other treatment modalities if needed. | 6. The patient who experiences hemorrhage is very anxious and fearful; minimizing anxiety assists in control of hemorrhage. | |
| 7. Monitor patient for recurrence of bleeding and hemorrhage. | 7. Risk of rebleeding is high with all treatment modalities used to halt gastrointestinal bleeding. | |
| 8. Keep family informed of patient's status. | 8. Family members are likely to be anxious about the patient's status; providing information will reduce their anxiety level and promote more effective coping. | |
| 9. Once recovered from bleeding episode, provide patient and family with information regarding signs and symptoms of gastrointestinal bleeding. | 9. Risk of rebleeding is high. Subtle signs may be more quickly identified. | |

*Continued*

CHART 39-12

PLAN OF NURSING CARE

## *The Patient With Impaired Liver Function (Continued)*

**COLLABORATIVE PROBLEM:** Hepatic encephalopathy
**GOAL:** Absence of changes in cognitive status and of injury

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess cognitive status every 4–8 h:<br>a. Assess patient's orientation to person, place, and time.<br>b. Monitor patient's level of activity, restlessness, and agitation. Assess for presence of flapping hand tremors (asterixis).<br>c. Obtain and record daily sample of patient's handwriting or ability to construct a simple figure (eg, star).<br>d. Assess neurologic signs (deep tendon reflexes, ability to follow instructions). | 1. Data will provide baseline of patient's cognitive status and enable detection of changes. | • Remains awake, alert, and aware of surroundings.<br>• Is oriented to time, place, and person.<br>• Exhibits no restlessness or agitation.<br>• Record of handwriting demonstrates no deterioration in cognitive function.<br>• States rationale for treatment used to prevent or treat hepatic encephalopathy.<br>• Demonstrates stable serum ammonia level within acceptable limits.<br>• Consumes adequate caloric intake and adheres to protein restriction.<br>• Takes medications as prescribed.<br>• Breath sounds are normal without adventitious sounds.<br>• Skin and tissue intact without evidence of pressure or breaks in integrity.<br>• Verbalizes understanding of need for treatments and procedures to promote recovery. |
| 2. Monitor medications to prevent administration of those that may precipitate hepatic encephalopathy (sedatives, hypnotics, analgesics). | 2. Medications are a common precipitating factor in development of hepatic encephalopathy in patients at risk. | |
| 3. Monitor laboratory data, especially serum ammonia level. | 3. Increases in serum ammonia level are associated with hepatic encephalopathy and coma. | |
| 4. Notify physician of even subtle changes in patient's neurologic assessment, cognitive function, sleep pattern, or mood. | 4. Allows early initiation of treatment of hepatic encephalopathy and prevention of hepatic coma. | |
| 5. Limit sources of protein from diet if indicated. | 5. Reduces breakdown and conversion of protein to ammonia. | |
| 6. Administer medications prescribed to reduce serum ammonia level (eg, lactulose, antibiotics, glucose, benzodiazepine antagonist [Flumazenil] if indicated). | 6. Reduces serum ammonia level. | |
| 7. Assess respiratory status and initiate measures to prevent complications. | 7. The patient who develops hepatic coma is at risk for respiratory complications (ie, pneumonia, atelectasis, infection). | |
| 8. Protect patient's skin and tissue from pressure and breakdown. | 8. The patient in coma is at risk for skin breakdown and pressure ulcer formation. | |
| 9. Provide support and active listening for patient and family as patient's mental status deteriorates. | 9. The patient with hepatic encephalopathy can experience episodes of mental deterioration due to liver failure. This can produce feelings of fear and anxiety. | |

A hyperdynamic circulatory state develops in patients with cirrhosis, and plasma volume increases. This increase in circulating plasma volume is probably multifactorial, but some studies have implicated excess production of nitrous oxide, like that seen in sepsis, as one causative factor (Rodes, et al., 2007). The greater the degree of hepatic decompensation, the more severe the hyperdynamic state. Close assessment of cardiovascular and respiratory status is of key importance for the care of patients with this disorder. Pulmonary compromise, which is always a potential complication of ESLD because of plasma volume excess, makes prevention of pulmonary complications an important role for the nurse. Administering diuretics, implementing fluid restrictions, and enhancing patient positioning can optimize pulmonary function. Fluid retention may be noted in the development of ascites, lower extremity swelling, and dyspnea. Monitoring of intake and output, daily weight changes, changes in abdominal girth, and edema formation is part of nursing assessment in the hospital or in the home setting. Patients are also monitored for nocturia and, later, for oliguria, because these states indicate increasing severity of liver dysfunction (Rodes, et al., 2007).

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

During the hospital stay, the nurse and other health care providers prepare the patient with cirrhosis for discharge, focusing on dietary instruction. Of greatest importance is the exclusion of alcohol from the diet. The patient may need referral to Alcoholics Anonymous, psychiatric care, or counseling or may benefit from support from a spiritual advisor. The patient should also avoid the consumption of raw shellfish.

Sodium restriction will continue for a considerable time, if not permanently. The patient will require written instructions, teaching, reinforcement, and support from the staff as well as family members.

Successful treatment depends on convincing the patient of the need to adhere completely to the therapeutic plan. This includes rest, lifestyle changes, adequate dietary intake, and the elimination of alcohol. The nurse also instructs the patient and family about symptoms of impending encephalopathy, possible bleeding tendencies, and susceptibility to infection.

Recovery is neither rapid nor easy; there are frequent setbacks and apparent lack of improvement. Many patients find it difficult to refrain from using alcohol for comfort or escape. The nurse has a significant role in offering support and encouragement to the patient and in providing positive feedback when the patient experiences success.

#### Continuing Care

Referral for home care may assist the patient in dealing with the transition from hospital to home. The use of alcohol may have been an important part of normal home and social life in the past. The home care nurse assesses the patient's progress at home and the manner in which the patient and family are coping with the elimination of alcohol and the dietary restrictions. The nurse also reinforces previous teaching and answers questions that may not have occurred to the patient or family until the patient is back home and trying to establish new patterns of eating, drinking, and lifestyle.

# CANCER OF THE LIVER

Hepatic tumors may be malignant or benign. Benign liver tumors were uncommon until oral contraceptives were in widespread use. Now benign liver tumors occur most frequently in women in their reproductive years who are taking oral contraceptives.

## Primary Liver Tumors

Few cancers originate in the liver. Primary liver tumors usually are associated with chronic liver disease, hepatitis B and C infections, and cirrhosis. Hepatocellular carcinoma (HCC) is the most common type of primary liver cancer, with more than half a million cases diagnosed each year on a worldwide basis. HCC is the third leading cause of cancer-related mortality worldwide. It is rare in the United States and Northern Europe, accounting for less than 5 cases per 100,000 inhabitants (Rodes, et al., 2007). Other types of primary liver cancer include cholangiocellular carcinoma and combined hepatocellular and cholangiocellular carcinoma. HCC is usually nonresectable because of rapid growth and metastasis. If found early, resection of primary liver cancer may be possible, but early detection is unlikely.

Cirrhosis, chronic infection with hepatitis B and C, and exposure to certain chemical toxins (eg, vinyl chloride, arsenic) have been implicated as causes of HCC. Cigarette smoking has also been identified as a risk factor, especially when combined with alcohol use. Some evidence suggests that aflatoxin, a metabolite of the fungus *Aspergillus flavus*, may be a risk factor for HCC. This is especially true in areas where HCC is endemic (ie, Asia and Africa). Aflatoxin and other similar toxic molds can contaminate food such as ground nuts and grains and may act as co-carcinogens with hepatitis B. The risk of contamination is greatest when these foods are stored unrefrigerated in tropical or subtropical climates.

## Liver Metastases

Metastases from other primary sites, particularly the digestive system, breast, and lung, are found in the liver 2.5 times more frequently than tumors due to primary liver cancers (Rodes, et al., 2007). Malignant tumors are likely to reach the liver eventually, by way of the portal system or lymphatic channels, or by direct extension from an abdominal tumor. Moreover, the liver apparently is an ideal place for these malignant cells to thrive. Often the first evidence of cancer in an abdominal organ is the appearance of liver metastases; unless exploratory surgery or an autopsy is performed, the primary tumor may never be identified.

### Clinical Manifestations

The early manifestations of malignancy of the liver include pain—a continuous dull ache in the right upper quadrant, epigastrium, or back. Weight loss, loss of strength, anorexia, and anemia may also occur. The liver may be enlarged and irregular on palpation. Jaundice is present only if the larger bile ducts are occluded by the pressure of malignant nodules in the hilum of the liver. Ascites develops if such nodules obstruct the portal veins or if tumor tissue is seeded in the peritoneal cavity.

### Assessment and Diagnostic Findings

The diagnosis of liver cancer is based on clinical signs and symptoms, the history and physical examination, and the results of laboratory and x-ray studies. Increased serum levels of bilirubin, alkaline phosphatase, AST, GGT, and lactic dehydrogenase may occur. Leukocytosis (increased white blood cells), erythrocytosis (increased red blood cells), hypercalcemia, hypoglycemia, and hypocholesterolemia may also be seen on laboratory assessment.

The serum level of alpha-fetoprotein (AFP), which serves as a tumor marker, is elevated in 30% to 40% of patients with primary liver cancer. The level of carcinoembryonic antigen (CEA), a marker of advanced cancer of the digestive tract, may be elevated. These two markers together

are useful to distinguish between metastatic liver disease and primary liver cancer.

Many patients have metastases from the primary liver tumor to other sites by the time the diagnosis is made; metastases occur primarily to the lung but may also occur to regional lymph nodes, adrenals, bone, kidneys, heart, pancreas, or stomach.

X-rays, liver scans, CT scans, ultrasound studies, MRI, arteriography, and laparoscopy may be part of the diagnostic workup and may be performed to determine the extent of the cancer. Positive emission tomograms (PET) scans are used to evaluate a wide range of metastatic tumors of the liver.

Confirmation of a tumor's histology can be made by biopsy under imaging guidance (CT scan or ultrasound) or laparoscopically. Local or systemic dissemination of the tumor by needle biopsy or fine-needle biopsy can occur but is rare. Some clinicians believe that these procedures should not be performed if the tumor is thought to be resectable; rather, primary HCC diagnosis should be confirmed by frozen section at the time of laparotomy in those patients with resectable lesions detected by imaging studies.

## Medical Management

Although surgical resection of the liver tumor is possible in some patients, the underlying cirrhosis is so prevalent in cancer of the liver that it increases the risks associated with surgery. Radiation therapy and chemotherapy have been used to treat cancer of the liver with varying degrees of success. Although these therapies may prolong survival and improve quality of life by reducing pain and discomfort, their major effect is palliative.

### *Radiation Therapy*

The use of external beam radiation for the treatment of liver tumors has been limited by the radiosensitivity of normal hepatocytes and the risk of destruction of normal liver parenchyma. More effective methods of delivering radiation to tumors of the liver include (1) IV or intra-arterial injection of antibodies tagged with radioactive isotopes that specifically attack tumor-associated antigens and (2) percutaneous placement of a high-intensity source for interstitial radiation therapy (delivery of radiation directly to the tumor cells). Internal radiotherapy can result in reduction in tumor size, but its effect on survival is yet to be determined.

### *Chemotherapy*

Typically, studies of patients with advanced cases of liver cancer have shown that the use of systemic chemotherapeutic agents leads to poor outcomes. There is no evidence to support a standard systemic chemotherapy and, in the United States, there is no approved systemic treatment for HCC (Wolfe, 2006). However, systemic chemotherapy may be used to treat metastatic liver lesions. Embolization of tumor vessels with chemotherapy (a process known as transarterial chemoembolization [TACE]) produces anoxic necrosis with high concentrations of trapped chemotherapeutic agents. This therapy has begun to show some promising results. An implantable pump has been used to deliver a high concentration of chemotherapy by constant infusion to the liver through the hepatic artery in cases of metastatic disease. This method has shown a moderate response rate, (Rodes, et al., 2007).

### *Percutaneous Biliary Drainage*

Percutaneous biliary or transhepatic drainage is used to bypass biliary ducts obstructed by liver, pancreatic, or bile duct tumors in patients who have inoperable tumors or are considered poor surgical risks. Under fluoroscopy, a catheter is inserted through the abdominal wall and past the obstruction into the duodenum. Such procedures are used to reestablish biliary drainage, relieve pressure and pain from the buildup of bile behind the obstruction, and decrease pruritus and jaundice. As a result, the patient is made more comfortable and quality of life and survival are improved.

For several days after its insertion, the catheter is opened to external drainage. The bile is observed closely for amount, color, and presence of blood and debris. Complications of percutaneous biliary drainage include sepsis, leakage of bile, hemorrhage, and reobstruction of the biliary system by debris in the catheter or by encroaching tumor. Therefore, the patient is observed for fever and chills, bile drainage around the catheter, changes in vital signs, and evidence of biliary obstruction, including increased pain or pressure, pruritus, and recurrence of jaundice.

### *Other Nonsurgical Treatments*

Laser hyperthermia has been used to treat hepatic metastases. Heat has been directed to tumors through several methods to cause necrosis of the tumor cells while sparing normal tissue. In radiofrequency thermal ablation, a needle electrode is inserted into the liver tumor under imaging guidance. Radiofrequency energy passes through to the noninsulated needle tip, causing heat and tumor cell death from coagulation necrosis.

Immunotherapy is another treatment modality under investigation. In this therapy, lymphocytes with antitumor reactivity are administered to the patient with hepatic cancer. Tumor regression has been demonstrated in patients with metastatic cancer for whom standard treatment has failed.

Transcatheter arterial embolization interrupts the arterial blood flow to small tumors by injecting small particulate embolic or chemotherapeutic agents (as previously described) into the artery supplying the tumor. As a result, ischemia and necrosis of the tumor occur.

For multiple small lesions, ultrasound-guided injection of alcohol promotes dehydration of tumor cells and tumor necrosis (Rodes, et al., 2007; Wolfe, 2006).

## Surgical Management

Surgical resection is the treatment of choice when HCC is confined to one lobe of the liver and the function of the remaining liver is considered adequate for postoperative recovery. In the case of metastasis, hepatic resection can be performed if the primary site can be completely excised and the metastasis is limited. However, metastases to the liver are rarely limited or solitary. Capitalizing on the regenerative capacity of the liver cells, some surgeons have successfully removed 90% of the liver. However, the presence of cirrhosis limits the ability of the liver to regenerate. Staging of liver tumors aids in predicting the likelihood of surgical cure.

In preparation for surgery, the patient's nutritional, fluid, and general physical status are assessed, and efforts are undertaken to ensure the best physical condition possible. Extensive diagnostic studies may be performed. Specific studies may include liver scan, liver biopsy, cholangiography, selective hepatic angiography, percutaneous needle biopsy, peritoneoscopy, laparoscopy, ultrasound, CT scan, PET scan, MRI, and blood tests, particularly determinations of serum alkaline phosphatase, AST, and GGT and its isoenzymes.

### Lobectomy

Removal of a lobe of the liver is the most common surgical procedure for excising a liver tumor. If it is necessary to restrict blood flow from the hepatic artery and portal vein for longer than 15 minutes, it is likely that hypothermia will be used. For a right-liver lobectomy or an extended right lobectomy (including the medial left lobe), a thoracoabdominal incision is used. An extensive abdominal incision is made for a left lobectomy.

### Local Ablation

In patients who are not candidates for resection or transplantation, ablation of HCC may be accomplished by chemicals such as ethanol or by physical means such as radiofrequency ablation or microwave coagulation. These techniques may be performed under ultrasound or CT guidance laparoscopically or percutaneously. Radiofrequency ablation is becoming a standard mode of treatment; a tumor up to 5 cm in size can be destroyed in one session. The most common complications following ablation are local pain or bleeding. Serious complications are rare (Wolfe, 2006).

Immunotherapy with interferon has been under study as an adjuvant after liver resection or ablation of HCC. When patients have developed HCC related to hepatitis B or C, interferon may prevent recurrence of the lesion (Clavien, 2007; Rodes, et al., 2007).

### Liver Transplantation

Removing the liver and replacing it with a healthy donor organ is another way to treat liver cancer. Studies have shown decreased recurrence rates of the primary liver malignancy after transplantation, with improvement in 5-year survival rates to consistently greater than 70% (Rodes, et al., 2007; Wolfe, 2006). Metastasis and recurrence may be enhanced by the immunosuppressive therapy that is needed to prevent rejection of the transplanted liver. In patients with small (less than 5 cm), single lesions, liver transplantation has been shown to be beneficial, but its use is limited by organ shortages. The increasing use of living donor transplantation may improve this situation and decrease the waiting time and tumor proliferation that is characteristic of patients with liver cancer (see later discussion).

## Nursing Management

For the surgical patient, support, explanation, and encouragement are provided to help the patient prepare psychologically for the surgery. After surgery, potential problems related to cardiopulmonary involvement may include vascular complications and respiratory and liver dysfunction. Metabolic abnormalities require careful attention. A constant infusion of 10% glucose may be required in the first 48 hours to prevent a precipitous fall in the blood glucose level that results from decreased gluconeogenesis. Because extensive blood loss may occur as well, the patient receives infusions of blood and IV fluids. The patient requires constant, close monitoring and care for the first 2 or 3 days, similar to postsurgical abdominal and thoracic nursing care.

If the patient is to receive chemotherapy or radiation therapy in an effort to relieve symptoms, he or she may be discharged home while still receiving one or both of these therapies. The patient may also go home with a biliary drainage system or hepatic artery catheter in place. In most cases, the hepatic artery catheter has been inserted surgically and has a prefilled infusion pump that delivers a continuous chemotherapeutic dose until completed. An hepatic artery port may also be inserted to provide access for intermittent chemotherapy infusion. This port dwells under the skin, but, because it provides direct arterial access, it is not used for continuous infusion therapy in the home environment; the access line is discontinued once the chemotherapeutic agent has infused. The patient and family require teaching about care of the biliary catheter and the effects and side effects of hepatic artery chemotherapy. This teaching is necessary because of participation of the patient and family in patient care in the home setting.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

The nurse instructs the patient to recognize and report the potential complications and side effects of the chemotherapy and the desirable and undesirable effects of the specific chemotherapy regimen. The nurse also emphasizes the importance of follow-up visits to assess the patient and the tumor's response to chemotherapy and radiation therapy. In addition, if the patient is receiving chemotherapy on an outpatient basis, the nurse explains the patient's and family's role in managing the chemotherapy infusion and in assessing the infusion or insertion site. The nurse encourages the patient to resume routine activities as soon as possible, while cautioning about activities that may damage the infusion pump or site.

The family of as well as the patient at home with a biliary drainage system in place typically fear that the catheter will become dislodged. Reassurance and instruction can help reduce their fear that the catheter will fall out easily. The patient and family also require instruction on catheter care. The family and the patient need to learn how to keep the catheter site clean and dry and how to assess the catheter and its insertion site. Irrigation of the catheter with sterile normal saline solution or water may be prescribed to keep the catheter patent and free of debris. The patient and caregivers are taught proper technique to avoid introducing bacteria into the biliary system or catheter during irrigation. They are instructed not to aspirate or draw back on the syringe during irrigation, to prevent entry of irritating duodenal contents into the biliary tree or catheter. The patient and caregivers are also instructed about the signs of complications and are encouraged to notify the nurse or physician if problems or questions arise.

Patients with implantable ports are instructed about the chemotherapy regimen, types of medications, effects and side effects that may occur, and appropriate management strategies if problems occur. If a hepatic artery port is inserted for intermittent chemotherapy, patients and their families are provided the same educational content. Such a port has an internal one-way valve; therefore, it is not aspirated for a blood return before the infusion is initiated. The patient is instructed to assess the port site between infusions and to note and report any sign of infection or inflammation.

**Continuing Care**

In many cases, referral for home care enables the patient with liver cancer to be at home in a familiar environment with family and friends. Because of the poor prognosis associated with liver cancer, the home care nurse serves a vital role in assisting the patient and family to cope with the symptoms that may occur and the prognosis. The home care nurse assesses the patient's physical and psychological status, adequacy of pain relief, nutritional status, and presence of symptoms indicating complications of treatment or progression of disease. During home visits, the nurse assesses the function of the chemotherapy pump, the infusion site, and the biliary drainage system, if indicated. The nurse collaborates with the other members of the health care team, the patient, and the family to ensure effective pain management and to manage potential problems, which include weakness, pruritus, inadequate dietary intake, jaundice, and symptoms associated with metastasis to other sites. The home care nurse also assists the patient and family in making decisions about hospice care and assists with initiation of referrals. The patient is encouraged to discuss preferences for end-of-life care with family members and health care providers (see Chapter 17).

## Liver Transplantation

Liver transplantation is used to treat life-threatening ESLD for which no other form of treatment is available. The transplantation procedure involves total removal of the diseased liver and replacement with a healthy liver in the same anatomic location **(orthotopic liver transplantation [OLT])**. Removal of the liver creates a space for the new liver and permits anatomic reconstruction of the hepatic vasculature and biliary tract as close to normal as possible.

The success of liver transplantation depends on successful immunosuppression. Immunosuppressants currently used include cyclosporine (Neoral), tacrolimus (Prograf), corticosteroids, azathioprine (Imuran), mycophenolate mofetil (CellCept), OKT3 (a monoclonal antibody), sirolimus (formerly known as rapamycin [Rapamune]), anti-thymocyte globulin (Thymoglobulin), basiliximab (Simulect), and daclizumab (Zenapax). There is no one, accepted, optimal immunosuppressive regimen. Most centers have developed their own therapeutic practices, largely based on experience. Few large-scale trials have been undertaken and even if they reach established endpoints, many experts agree that newer agents will be developed, making findings less useful (Rodes, et al., 2007).

Despite the success of immunosuppression in reducing the incidence of rejection of transplanted organs, liver transplantation is not routine and may be accompanied by complications related to the lengthy surgical procedure, immunosuppressive therapy, infection, and the technical difficulties encountered in reconstructing the blood vessels and biliary tract. Long-standing systemic problems resulting from the primary liver disease may complicate the preoperative and postoperative course. Previous surgery of the abdomen, including procedures to treat complications of advanced liver disease (ie, shunt procedures used to treat portal hypertension and esophageal varices) increase the complexity of the transplantation procedure.

The indications for liver transplantation are not as limited today as they were when the procedure was first introduced because of advances in immunosuppressive therapy, improvements in biliary tract reconstruction, and, in some cases, the use of venovenous bypass. General indications for liver transplantation include irreversible advanced chronic liver disease, fulminant hepatic failure, metabolic liver diseases, and some hepatic malignancies. Examples of disorders that are indications for liver transplantation include hepatocellular liver diseases (eg, viral hepatitis, drug-induced or alcohol-induced liver disease, Wilson's disease) and cholestatic diseases (primary biliary cirrhosis, sclerosing cholangitis, and biliary atresia).

The patient being considered for liver transplantation frequently has many systemic problems that influence preoperative and postoperative care. Because transplantation is more difficult if the patient has developed severe GI bleeding and hepatic coma, efforts are made to perform the procedure before the disease progresses to this stage. The patient must undergo a thorough evaluation of hepatic reserve and general health. Part of this evaluation includes classification of the degree of medical need, an objective determination known as the Model of End-Stage Liver Disease (MELD) classification, which stratifies the level of illness of those awaiting a liver transplant. The MELD score is derived from a complex formula incorporating bilirubin levels, prothrombin time (reported as international normalized ratio [INR]), creatinine, and the cause of the liver disease (ie, cholestatic, alcoholic, or other). This system has replaced the Child-Pugh classification and other related scoring systems for prioritizing patients on the liver transplantation list (Rodes, et al., 2007; Wolfe, 2006). Although the Child-Pugh score classifies the severity of liver disease and stratifies patients into levels for varied treatment regimens, the MELD score is an indicator of short-term mortality for those with ESLD. Organs are allocated using the MELD score in an effort to provide transplants to the most severely ill patients.

Because liver transplantation is now an established therapeutic modality, rather than an experimental procedure, the number of liver transplantation centers is increasing. Patients requiring transplantation are often referred from distant hospitals to these centers. To prepare the patient and family for liver transplantation, nurses in all settings must understand the processes and procedures of liver transplantation.

Many ethical issues arise concerning liver transplantation, particularly concerning the allocation of organs. The

way in which some persons contracted liver disease (eg, alcohol use; hepatitis) leads others to question allocation of organs to them, and some believe that preference should be given to people who need liver transplants but do not have a history of socially unacceptable behavior. Even more controversy exists when a patient requires a second transplant operation because of a return to alcohol or drug use or failure to follow immunosuppressive regimens (Chart 39-13). These are difficult issues with no easy solutions. Transplant recipients must go through a rigorous selection and preparation process that includes counseling and education to aid them in making critical choices for their improved health. Nurses and other health care providers need to be aware of and confront their own biases and work toward improved understanding and acceptance.

## Surgical Procedure

During the procedure, the donor liver is freed from other structures, the bile is flushed from the gallbladder to prevent damage to the walls of the biliary tract, and the liver is perfused with a preservative and cooled. Before the donor liver is placed in the recipient, it is flushed with cold lactated Ringer's solution to remove potassium and air bubbles. The presence of portal hypertension increases the difficulty of the procedure.

CHART 39-13 *Ethics and Related Issues*

**What Ethical Principles Apply When a Candidate for a Second Liver Transplantation Continues His Drug Use?**

**Situation**

A 34-year-old man received a liver transplant a year ago for end-stage liver disease due to hepatitis C (with a history of IV or injection use) and alcoholic liver disease. He experienced a difficult postoperative course with many complications. His liver function has now deteriorated to the point that he is listed to receive a second organ. He is in the hospital, where he is quite ill and in pain. Although he denies further use of alcohol and drug use following his first liver transplant, several bottles of opioids and sedatives are found in his bedside table.

What ethical implications exist in this case? What actions should be taken by the transplant team? What should the nurse document concerning this situation? What factors should be considered when deciding how to proceed in this case?

**Dilemma**

This patient has already received one liver transplant, and he will not survive unless he receives a another one. He is on the list for a second transplant. Because of the limited availability of livers for transplantation and the fact that there is a strong likelihood of his continued use of drugs, questions have been raised about the appropriateness of a second transplant.

**Discussion**

1. What ethical principles are involved in this situation?
2. What are the competing issues in this case that must be considered in this man's case?
3. How does the nurse respond if the patient asks about the likelihood of his receiving a second liver transplant?

To minimize this problem, many centers use venovenous bypass, which decompresses the venous system below the diaphragm by temporarily shunting blood to the superior vena cava via the axillary vein (Bayless & Diehl, 2005).

Anastomoses (connections) of the blood vessels and bile duct are performed between the donor liver and the recipient liver. There are two types of biliary anastomoses. Biliary reconstruction is performed with an end-to-end anastomosis of the donor and recipient common bile ducts; a stented T-tube may be inserted for external drainage of bile. In patients with biliary disease such as primary sclerosing cholangitis or if the recipient's bile duct is not suitable for anastomosis for other reasons, a biliary-enteric end-to-side anastomosis with a 40 to 50 cm Roux-en-Y loop of jejunum is created for biliary drainage (known as a Roux-en-Y procedure) (Fig. 39-15A); in this case, bile drainage is internal, and a T-tube is not inserted (Rodes, et al., 2007). Figure 39-15B and C illustrates the final appearance of the grafted liver and final closure and drain placement.

Several additional techniques have been developed to expand the donor pool for liver transplantation. In a split liver transplant, a single organ is used to provide grafts for two individuals with ESLD, with the smaller patient receiving the smaller left lobe. This procedure has resulted in a higher complication rate and lower survival rate than traditional liver transplantation. Auxiliary liver transplantation has been used in adults with fulminant hepatic failure until the patient's own liver recovers function. This procedure incorporates removal of a segment of diseased liver and implantation of a reduced-size graft. Living donor transplantation is being increasingly performed from adult to adult using full right lobes, although it is controversial because it is a major surgical procedure for the donor, and some donor deaths have occurred. The results thus far have indicated that this procedure is most successful when donor and recipient are appropriately selected using careful screening criteria (Rodes, et al., 2007).

Liver transplantation is a long surgical procedure, partly because the patient with liver failure often has portal hypertension, requiring ligation of many venous collateral vessels. Blood loss during the surgical procedure may be extensive. If the patient has adhesions from previous abdominal surgery, lysis of adhesions is often necessary. If a shunt procedure was performed previously, it must be surgically reversed to permit adequate portal venous blood supply to the new liver. During the lengthy surgery, it is important to provide regular updates to the family about the progress of the operation and the patient's status.

## Complications

The postoperative complication rate is high, primarily because of technical complications or infection. Immediate postoperative complications may include bleeding, infection, and rejection. Disruption, infection, obstruction of the biliary anastomosis, and impaired biliary drainage may occur. Vascular thrombosis and stenosis are other potential complications.

### *Bleeding*

Bleeding is common in the postoperative period and may result from coagulopathy, portal hypertension, and fibrinolysis caused by ischemic injury to the donor liver. Hypotension

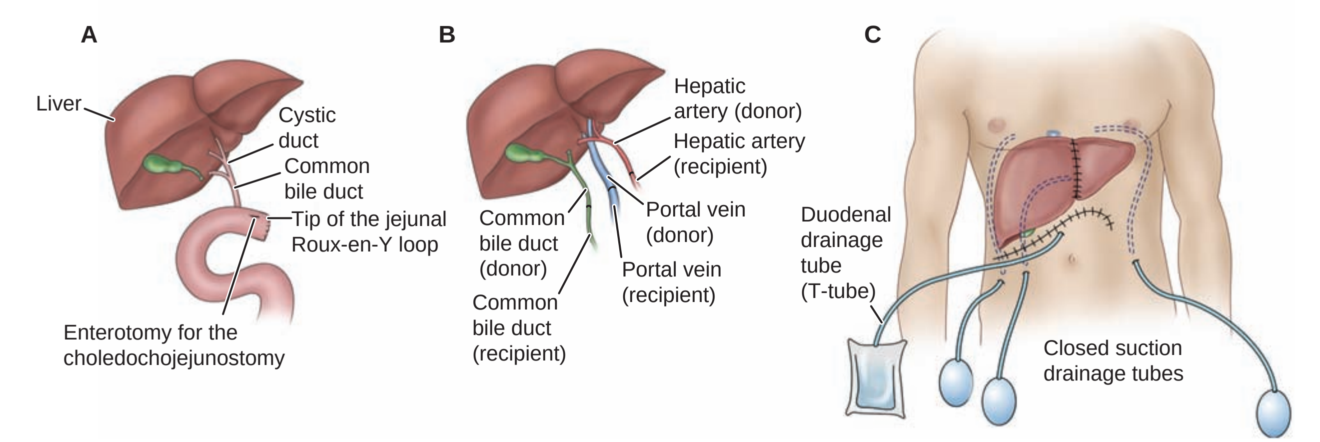



**Figure 39-15** **A,** Some transplant recipients have diseases or conditions that cause their bile ducts to be unusable for anastomosis to the donor liver bile duct. In this case, a loop of jejunum is used as a bridge from the donor liver bile duct to the recipient's small bowel for biliary continuity and drainage. This procedure is termed a Roux-en-Y hepaticojejunostomy. **B,** Final appearance of implanted liver graft with an end-to-end biliary anastomosis. **C,** Final closure and drain placement after liver transplantation with an end-to-end biliary anastomosis and T-tube placement.

may occur in this phase, secondary to blood loss. Administration of platelets, fresh-frozen plasma, or other blood products may be necessary. Hypertension is more common, although its cause is uncertain. Blood pressure elevation that is significant or sustained is treated.

### Infection

Infection is the leading cause of death after liver transplantation. Pulmonary and fungal infections are common; susceptibility to infection is increased by the immunosuppressive therapy that is needed to prevent rejection (Rodes, et al., 2007). Therefore, precautions must be taken to prevent healthcare–associated infections. The nurse uses strict asepsis when manipulating central venous catheters, arterial lines, and urine, bile, and other drainage systems; obtaining specimens; and changing dressings. Meticulous hand hygiene is crucial. In the ICU, the nurse uses evidence-based practice guidelines in the care of the postoperative liver transplant patient. Some of these care guidelines include prevention of sepsis and its rapid treatment, prevention of ventilator-associated pneumonia (VAP), and prevention of catheter-related bloodstream infections (American Thoracic Society, 2005).

### Rejection

Rejection is a primary concern. A transplanted liver is perceived by the immune system as a foreign antigen. This triggers an immune response, leading to the activation of T lymphocytes that attack and destroy the transplanted liver. Immunosuppressive agents are used as long-term therapy to prevent this response and rejection of the transplanted liver. These agents inhibit the activation of immunocompetent T lymphocytes to prevent the production of effector T cells.

Although the 1- and 5-year survival rates have increased dramatically with the use of new immunosuppressive therapies, these advances are not without major side effects. A major side effect of cyclosporine, which was widely used in transplantation, is nephrotoxicity; this problem seems to be dose related. Cyclosporine-related side effects have caused many centers to use tacrolimus as first-line therapy because of its efficacy and lower side-effect profile.

Corticosteroids, azathioprine, mycophenolate mofetil, sirolimus (formerly known as rapamycin) anti-thymocyte globulin, basiliximab, daclizumab, and muromonab-CD3 (OKT3) are also used in various regimens of immunosuppression. These agents may be used as the initial therapy to prevent rejection or used later to treat rejection. Liver biopsy and ultrasound may be required to evaluate suspected episodes of rejection.

Retransplantation is usually attempted if the transplanted liver fails, but the success rate of retransplantation does not approach that of initial transplantation.

## Nursing Management

The patient considering transplantation, together with the family, must make difficult choices about treatment, use of financial resources, and relocation to another area to be closer to the medical center. They must also be aware of the risks and benefits of the procedure and its consequences. In addition, they must also cope with the patient's long-standing health problems and any social and family problems associated with behaviors that may have caused the patient's liver failure. As a result, considerable emotional stress occurs while the patient and family consider liver transplantation and wait for an available liver (Chart 39-14). The nurse must be aware of these issues and attuned to the emotional and psychological status of the patient and family. Referral to a psychiatric liaison nurse, psychologist, psychiatrist, or spiritual advisor may help them cope with the stressors associated with ESLD and liver transplantation.

If the patient and family are considering undergoing a live donor liver transplant, they are subject to additional stressors. Both the patient and the potential donor must undergo a thorough and exhaustive physical and psychological workup to ensure that all involved parties are physically and emotionally prepared. Often, but not always, the donor

## CHART 39-14 NURSING RESEARCH PROFILE
### Waiting for a Liver Transplant

Brown, J., Sorrell, J. H., McClaren, J., et al. (2006). Waiting for a liver transplant. *Qualitative Health Research, 16*(1), 119–136.

**Purpose**

Potential transplant recipients who are waiting for donor livers suffer a high rate of illness and death. In addition, they must cope with the fact that many livers become available for transplant only after the death of a suitable donor. Little definitive information is known about what patients experience as they wait for a liver transplant. This study examined patients' experiences while they wait for a transplant.

**Design**

Researchers used a phenomenological approach to examine the experience of patients with end-stage liver disease (ESLD) waiting for a transplant. They conducted nine interviews with six patients with ESLD during their wait for a liver transplant. Interviews with six participants were open ended, with three participants having follow-up interviews. The interviews focused on what it was like for patients with ESLD to be on the waiting list for a liver transplant and their experiences during the period of waiting. Researchers performed a qualitative analysis of transcriptions of the interviews to extract statements and ultimately themes that described the experience of waiting for a liver transplant. They identified and verified themes through review of the literature, member checks, and peer review of the data analysis process.

**Findings**

Eight themes that described the experience of waiting for a liver transplant emerged from the data analysis: transformation; doctors, teams, and trust; transition from elation to despair; loss; questioning the process; searching; coping; and the paradox of time. Patients characterized transformation as experiencing acute episodes of illness and possible death. The theme of doctors, teams, and trust was one of feeling that one became part of the team but dependent on others for the outcome. The transition from elation to despair was experienced as a roller coaster effect over time, ranging from elation that one was put on the list for a transplant to despair because of the length of time, uncertainty of the wait, and the realization that usually someone had to die for a liver to become available. Loss included all the physical, psychological, and emotional changes that occurred during the course of illness and waiting for a transplant. Questioning the process reflected the ambivalence and doubt that were experienced by people as they questioned the wisdom of having a transplant. Searching referred to patients' developing theories about their experiences and the personal search for meaning given their predicament. Coping referred to strategies patients used to grapple with their situation; strategies included denial and patience. Lastly, the paradox of time referred to patients' views of life before and after transplantation and the effect of waiting on their perception of time.

**Nursing Implications**

The impact on patients of being placed on a wait list for liver transplant needs to be considered by those providing care. The lack of control and the losses experienced by patients waiting for a liver transplant need to be acknowledged and addressed during care by allowing patients to have as much control over their lives as possible. Providing patients with an opportunity to verbalize their fears and concerns about their situation and their future may be helpful in reducing some of the patients' sense of uncertainty and sense of ambivalence about waiting and their uncertain future.

is a close family member. Coercion must be excluded as influencing the decision to donate a portion of one's liver to another. The potential donor must be aware of the risks associated with the procedure.

If the patient and family believe that liver transplantation may be appropriate, the nurse, surgeon, hepatologist, and other health care team members provide the patient and family with full explanations about the procedure, the chances of success, and the risks, including the side effects of long-term immunosuppression. The need for close follow-up and lifelong compliance with the therapeutic regimen, including immunosuppression, is emphasized to the patient and family.

#### *Preoperative Nursing Interventions*

Once the patient has been accepted as a candidate, he or she is placed on a waiting list at the transplant center, and patient information is entered into the United Network for Organ Sharing (UNOS) computer system. The UNOS system uses the MELD score to determine organ allocation priorities so that the patient with the highest MELD score will receive the first available organ. Candidates may be matched with appropriate organs as they become available. MELD scores provide the necessary information regarding medical need.

Except in the case of segmental liver transplantation from a living donor, a liver becomes available for transplantation only with the death of another person, usually someone who had been healthy except for severe brain injury and brain death. Therefore, the patient and family undergo a stressful waiting period, and the nurse is often their major source of support. The patient must be accessible at all times in case an appropriate liver becomes available. During this time, liver function may deteriorate further, and the patient may experience other complications from the primary liver disease. Because of the shortage of donor organs, many patients die awaiting transplantation.

Malnutrition, massive ascites, and fluid and electrolyte disturbances are treated before surgery to increase the likelihood of a successful outcome. If the patient's liver dysfunction has a very rapid onset, as in fulminant hepatic failure, there is little time or opportunity for the patient to consider and weigh options and their consequences; often this patient is in a coma, and the decision to proceed with transplantation is made by the family.

The nurse coordinator is an integral member of the transplant team and plays an important role in preparing the patient for liver transplantation. The nurse serves as an advocate for the patient and family and assumes the important role of liaison between the patient and the other members of the transplant team. The nurse also serves as a resource to other nurses and health care team members involved in evaluating and caring for the patient.

### *Postoperative Nursing Interventions*

The patient is maintained in an environment as free from bacteria, viruses, and fungi as possible, because immunosuppressive medications reduce the body's natural defenses. In the immediate postoperative period, cardiovascular, pulmonary, renal, neurologic, and metabolic functions are monitored continuously. Mean arterial and pulmonary artery pressures are also monitored continuously. Cardiac output, central venous pressure, pulmonary capillary wedge pressure, arterial and mixed venous blood gases, oxygen saturation, oxygen demand and delivery, urine output, heart rate, and blood pressure are used to evaluate the patient's hemodynamic status and intravascular fluid volume. Liver function tests, electrolyte levels, the coagulation profile, chest x-ray, electrocardiogram, and fluid output (including urine, bile from the T-tube, and drainage from Jackson-Pratt tubes) are monitored closely. Because the liver is responsible for the storage of glycogen and the synthesis of protein and clotting factors, these substances need to be monitored and replaced in the immediate postoperative period.

There is a high risk of atelectasis and an altered ventilation–perfusion ratio caused by insult to the diaphragm during the surgical procedure, prolonged anesthesia, immobility, and postoperative pain. The patient will have an endotracheal tube in place and will require mechanical ventilation during the initial postoperative period. Suctioning is performed as required, and sterile humidification is provided. Evidence-based practice guidelines are implemented to prevent the development of VAP in the postoperative liver transplant recipient (American Thoracic Society, 2005). Actions such as keeping the head of the bed elevated at least 30 degrees and performing frequent oral suctioning and cleansing are effective in preventing VAP.

As the patient's condition stabilizes, efforts are made to promote recovery from the trauma of this complex surgery. After removal of the endotracheal tube, the nurse encourages the patient to use an incentive spirometer to decrease the risk of atelectasis. Following extubation, the patient is assisted to get out of bed, to ambulate as tolerated, and to participate in self-care to prevent the complications associated with immobility. Close monitoring for signs and symptoms of liver dysfunction and rejection continue throughout the hospital stay. Plans are made for close follow-up after discharge as well. Teaching is initiated during the preoperative period and continues after surgery.

### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

Teaching the patient and family about long-term measures to promote health is crucial for the success of transplantation and is an important role of the nurse. The patient and family must understand why they need to adhere closely to the therapeutic regimen, with special emphasis on the methods of administration, rationale, and side effects of the prescribed immunosuppressive agents. The nurse provides written as well as verbal instructions about how and when to take the medications. To avoid running out of medication or skipping a dose, the patient must make sure that an adequate supply of medication is available. Instructions are also provided about the signs and symptoms that indicate problems necessitating consultation with the transplant team. The patient with a T-tube in place must be taught how to manage the tube, drainage, and skin care.

**Continuing Care**

The nurse emphasizes the importance of follow-up blood tests and appointments with the transplant team. Trough blood levels of immunosuppressive agents are obtained, along with other blood tests that assess the function of the liver and kidneys. During the first months, the patient is likely to require blood tests two or three times a week. As the patient's condition stabilizes, blood studies and visits to the transplant team are less frequent. The importance of routine ophthalmologic examinations is emphasized because of the increased incidence of cataracts and glaucoma associated with the long-term corticosteroid therapy used with transplantation. Regular oral hygiene and follow-up dental care, with administration of prophylactic antibiotics before dental examinations and treatments, are recommended because of the immunosuppression.

The nurse reminds the patient that preventing rejection and infection is essential and increases the chances for survival and a more normal life than before transplantation. Many patients have lived successful and productive lives after receiving a liver transplant. In fact, pregnancy can be considered 1 year after transplantation. Although successful outcomes have been reported, these pregnancies are considered high risk for both mother and infant. Transplant recipients should be advised about birth control. The 1-year waiting period allows time to establish good health, stable liver function, and lower maintenance levels of immunosuppressive therapy (Rodes, et al., 2007).

# Liver Abscesses

Two categories of liver abscess have been identified: amebic and pyogenic. Amebic liver abscesses are most commonly caused by *Entamoeba histolytica*. Most amebic liver abscesses occur in the developing countries of the tropics and subtropics because of poor sanitation and hygiene. Pyogenic liver abscesses are much less common, but they are more common in developed countries than the amebic type.

## Pathophysiology

Whenever an infection develops anywhere along the biliary or GI tract, infecting organisms may reach the liver through the biliary system, portal venous system, or hepatic arterial or lymphatic system. Most bacteria are destroyed promptly, but occasionally some gain a foothold. The bacterial toxins destroy the neighboring liver cells, and the

resulting necrotic tissue serves as a protective wall for the organisms.

Meanwhile, leukocytes migrate into the infected area. The result is an abscess cavity full of a liquid containing living and dead leukocytes, liquefied liver cells, and bacteria. Pyogenic abscesses of this type may be either single or multiple and small. Examples of causes of pyogenic liver abscess include cholangitis (usually related to benign or malignant obstruction of the biliary tree) and abdominal trauma.

### Clinical Manifestations

The clinical picture is one of sepsis with few or no localizing signs. Fever with chills and diaphoresis, malaise, anorexia, nausea, vomiting, and weight loss may occur. The patient may complain of dull abdominal pain and tenderness in the right upper quadrant of the abdomen. Hepatomegaly, jaundice, anemia, and pleural effusion may develop. Sepsis and shock may be severe and life-threatening. In the past, the mortality rate was 100% because of the vague clinical symptoms, inadequate diagnostic tools, and inadequate surgical drainage of the abscess. With the aid of ultrasound, CT, MRI, and liver scans, early diagnosis and surgical drainage of abscesses have greatly reduced the mortality rate.

### Assessment and Diagnostic Findings

Although blood cultures are obtained, the organism may not be identified. Aspiration of the liver abscess, guided by ultrasound, CT, or MRI, may be performed to assist in diagnosis and to obtain cultures of the organism. Percutaneous drainage of pyogenic abscesses is carried out to evacuate the abscess material and promote healing. A catheter may be left in place for continuous drainage; the patient must be instructed about its management.

### Medical Management

Treatment includes IV antibiotic therapy; the specific antibiotic used in treatment depends on the organism identified. Continuous supportive care is indicated because of the serious condition of the patient. Open surgical drainage may be required if antibiotic therapy and percutaneous drainage are ineffective.

### Nursing Management

Although the manifestations of liver abscess vary with the type of abscess, most patients appear acutely ill. Others appear to be chronically ill and debilitated. The nursing management depends on the patient's physical status and the medical management that is indicated. For patients who undergo evacuation and drainage of an abscess, monitoring of the drainage and skin care are imperative. Strategies must be implemented to contain the drainage and to protect the patient from other sources of infection. Vital signs are monitored to detect changes in the patient's physical status. Deterioration in vital signs or the onset of new symptoms such as increasing pain, which may indicate rupture or extension of the abscess, is reported promptly. The nurse administers IV antibiotic therapy as prescribed. The white blood cell count and other laboratory test results are monitored closely for changes consistent with worsening infection. The nurse prepares the patient for discharge by providing instruction about symptom management, signs and symptoms that should be reported to the physician, management of drainage, and the importance of taking antibiotics as prescribed.

## CRITICAL THINKING EXERCISES

**1** A 56-year-old professor and consultant has just received unexpected notice that she must travel to Nicaragua for a conference in 2 days. What prophylactic measures to reduce her risk of contracting hepatitis A are available before she leaves for her trip? What signs and symptoms are important for her to watch for and to report to her health care provider? What modifications, if any, should be implemented for her close household contacts? If this woman had 6 months to prepare for her trip, how would the answers to these questions be different?

**2** A 36-year-old African man came to the United States from Botswana 3 years ago to live with relatives. He is being treated for end-stage liver disease (ESLD) with cirrhosis related to hepatitis B and is undergoing evaluation for liver transplantation. The sequelae of ESLD that he is experiencing include encephalopathy and ascites. What would you anticipate this patient's treatment regimen to include? What medications would be most appropriate for him? What would you include in your cultural assessment when you develop a preoperative teaching plan for this patient? What alternative therapies might be used preoperatively? Once the patient receives a liver transplant, what medications would you expect to be prescribed for him in addition to an immunosuppressant regimen?

**3** A 68-year-old man is admitted to the hospital with a diagnosis of bleeding esophageal varices. Describe the monitoring you would initiate. What possible management strategies to prevent bleeding and to treat active bleeding of the esophageal varices would you anticipate? What are the nursing implications for each of these strategies? How would medical management and nursing care be modified if the patient had chronic obstructive pulmonary disease in addition to esophageal varices? How would you explain treatment strategies to the patient and his family if one or more of them had hearing impairment?

**4** A 26-year-old man is transferred to your transplant center with the diagnosis of end-stage liver disease with a severe coagulopathy and encephalopathy. He presents with extreme jaundice, multiple bruises, and severe confusion and agitation. In addition, he is trying to climb out of bed and strike family members and hospital personnel. The cause of his liver failure is hepatitis C from intravenous (IV) or injection drug use along with alcohol abuse. The referring institution had indicated that the man had not used drugs or alcohol for more than 6 months. On obtaining a detailed history from the patient's mother and sister, the nurse and physician learn that his family had seen him use IV or injection drugs only 2 weeks prior to admission. What are the nursing priorities in the care of this patient? What measures would you institute to ensure patient safety? What medications are

likely to be used to improve the patient's mental status? Is the patient an appropriate candidate for a liver transplant? If the patient does not receive a liver transplant, what is the likely outcome?

EBP **5** A 19-year-old college student with fulminant liver failure is hospitalized with hepatic coma related to an acetaminophen overdose. She is in the intensive care unit, intubated and on a ventilator. A pulmonary artery catheter has been placed as well as an arterial line and indwelling urinary catheter. She has also had a device placed to monitor and treat intracranial hypertension. What factors place her at high risk for infection? What particular types of infection are most likely? What evidence-based practice guidelines are you most likely to institute to prevent sepsis in this patient? What criteria will you use to determine the strength of the evidence? On receiving a liver transplant, what other risk factors for infection will she have?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

Al-Anon Family Group Headquarters, www.al-anon.alateen.org
Alcoholics Anonymous World Services, http://aa.org
American Association for the Study of Liver Diseases, www.aasld.org
American College of Gastroenterology, www.acg.gi.org
American Liver Foundation, www.liverfoundation.org
Hepatitis Foundation International, www.hepfi.org
National Council on Alcoholism and Drug Dependence, www.ncadd.org
National Digestive Diseases Information Clearing House, www.niddk.nih.gov
National Institute on Alcohol Abuse and Alcoholism, www.niaaa.nih.gov
United Network for Organ Sharing, www.unos.org



chapter 40

# Assessment and Management of Patients With Biliary Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare approaches to management of cholelithiasis.
2. Use the nursing process as a framework for care of patients with cholelithiasis and those undergoing laparoscopic or open cholecystectomy.
3. Differentiate between acute and chronic pancreatitis.
4. Describe nursing management of patients with acute pancreatitis.
5. Describe the nutritional and metabolic effects of surgical treatment of tumors of the pancreas.

## GLOSSARY

**amylase:** pancreatic enzyme; aids in the digestion of carbohydrates
**cholecystectomy:** removal of the gallbladder
**cholecystitis:** inflammation of the gallbladder
**cholecystojejunostomy:** anastomosis of the jejunum to the gallbladder to divert bile flow
**cholecystokinin-pancreozymin (CCK-PZ):** hormone; major stimulus for digestive enzyme secretion; stimulates contraction of the gallbladder
**cholecystostomy:** opening and drainage of the gallbladder
**choledochojejunostomy:** anastomosis of common duct to jejunum
**choledocholithiasis:** stones in the common duct
**choledocholithotomy:** incision of common bile duct for removal of stones
**choledochostomy:** opening into the common duct
**cholelithiasis:** calculi in the gallbladder

## GLOSSARY *(Continued)*

**dissolution therapy:** use of medications to break up/dissolve gallstones
**endocrine:** secreting internally; hormonal secretion of a ductless gland
**endoscopic retrograde cholangiopancreatography (ERCP):** an endoscopic procedure using fiberoptic technology to visualize the biliary system
**exocrine:** secreting externally; hormonal secretion from excretory ducts
**laparoscopic cholecystectomy:** removal of gallbladder through an endoscopic procedure
**lipase:** pancreatic enzyme; aids in the digestion of fats
**lithotripsy:** disintegration of gallstones by shock waves
**pancreaticojejunostomy:** joining of the pancreatic duct to the jejunum by side-to-side anastomosis; allows drainage of the pancreatic secretions into the jejunum
**pancreatitis:** inflammation of the pancreas; may be acute or chronic
**secretin:** hormone responsible for stimulating secretion of pancreatic juice; also used as an aid in diagnosing pancreatic exocrine disease and in obtaining desquamated pancreatic cells for cytologic examination
**steatorrhea:** frothy, foul-smelling stools with a high fat content; results from impaired digestion of proteins and fats due to a lack of pancreatic juice in the intestine
**trypsin:** pancreatic enzyme; aids in digestion of proteins
**wound-ostomy-continence (WOC) nurse:** nurse specially educated in appropriate skin, wound, ostomy, and continence care; often referred to as wound-care specialist or enterostomal therapist
**Zollinger-Ellison tumor:** hypersecretion of gastric acid that produces peptic ulcers as a result of a non–beta-cell tumor of the pancreatic islets

Disorders of the biliary tract and pancreas are common and include gallbladder stones and pancreatic dysfunction. An understanding of the structure and function of the biliary tract and pancreas is essential, along with an understanding of how biliary tract disorders are closely linked with liver disease. Patients with acute or chronic biliary tract or pancreatic disease require care from nurses who are knowledgeable about the diagnostic procedures and interventions that are used in the management of gallbladder and pancreatic disorders.

## ANATOMIC AND PHYSIOLOGIC OVERVIEW

### The Gallbladder

The gallbladder, a pear-shaped, hollow, saclike organ, 7.5 to 10 cm (3 to 4 in) long, lies in a shallow depression on the inferior surface of the liver, to which it is attached by loose connective tissue. The capacity of the gallbladder is 30 to 50 mL of bile. Its wall is composed largely of smooth muscle. The gallbladder is connected to the common bile duct by the cystic duct (Fig. 40-1).

The gallbladder functions as a storage depot for bile. Between meals, when the sphincter of Oddi is closed, bile produced by the hepatocytes enters the gallbladder. During storage, a large portion of the water in bile is absorbed through the walls of the gallbladder, so that bile in the gallbladder is five to 10 times more concentrated than that originally secreted by the liver. When food enters the duodenum, the gallbladder contracts and the sphincter of Oddi (located at the junction of the common bile duct with the duodenum) relaxes. Relaxation of this sphincter allows the bile to enter the intestine. This response is mediated by secretion of the hormone **cholecystokinin-pancreozymin (CCK-PZ)** from the intestinal wall. Bile is composed of water and electrolytes (sodium, potassium, calcium, chloride, and bicarbonate) along with significant amounts of lecithin, fatty acids, cholesterol, bilirubin, and bile salts. The bile salts, together with cholesterol, assist in emulsification of fats in the distal ileum. They are then reabsorbed into the portal blood for return to the liver, after which they are once again excreted into the bile. This pathway from hepatocytes to bile to intestine and back to the hepatocytes is called the enterohepatic circulation. Because of this circulation, only a small fraction of the bile salts that enter the intestine are excreted in the feces. This decreases the need for active synthesis of bile salts by the liver cells.

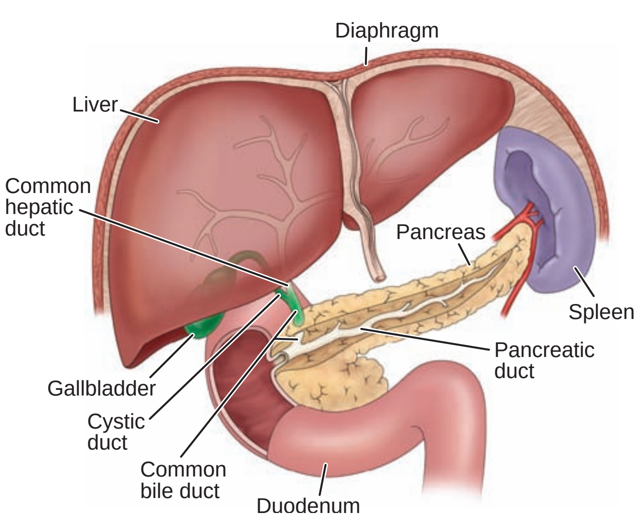



**Figure 40-1** The liver, biliary system, and pancreas.

Approximately half of the bilirubin, a pigment derived from the breakdown of red blood cells, is a component of bile. It is converted by the intestinal flora into urobilinogen, a highly soluble substance. Urobilinogen is either excreted in the feces or returned to the portal circulation, where it is reexcreted into the bile. About 5% is normally absorbed into the general circulation and then excreted by the kidneys (Porth & Matfin, 2009).

If the flow of bile is impeded (eg, by gallstones in the bile ducts), bilirubin does not enter the intestine. As a result, blood levels of bilirubin increase. This causes increased renal excretion of urobilinogen, which results from conversion of bilirubin in the small intestine, and decreased excretion in the stool. These changes produce many of the signs and symptoms seen in gallbladder disorders.

### The Pancreas

The pancreas, located in the upper abdomen, has **endocrine** as well as **exocrine** functions (see Fig. 40-1). The exocrine functions include secretion of pancreatic enzymes into the gastrointestinal (GI) tract through the pancreatic duct. The endocrine functions include secretion of insulin, glucagon, and somatostatin directly into the bloodstream.

#### *The Exocrine Pancreas*

The secretions of the exocrine portion of the pancreas are collected in the pancreatic duct, which joins the common bile duct and enters the duodenum at the ampulla of Vater. Surrounding the ampulla is the sphincter of Oddi, which partially controls the rate at which secretions from the pancreas and the gallbladder enter the duodenum.

The secretions of the exocrine pancreas are digestive enzymes high in protein content and an electrolyte-rich fluid. The secretions, which are very alkaline because of their high concentration of sodium bicarbonate, are capable of neutralizing the highly acid gastric juice that enters the duodenum. The enzyme secretions include **amylase,** which aids in the digestion of carbohydrates; **trypsin,** which aids in the digestion of proteins; and **lipase,** which aids in the digestion of fats. Other enzymes that promote the breakdown of more complex foodstuffs are also secreted.

Hormones originating in the GI tract stimulate the secretion of these exocrine pancreatic juices. The hormone **secretin** is the major stimulus for increased bicarbonate secretion from the pancreas, and the major stimulus for digestive enzyme secretion is the hormone CCK-PZ. The vagus nerve also influences exocrine pancreatic secretion.

#### *The Endocrine Pancreas*

The islets of Langerhans, the endocrine part of the pancreas, are collections of cells embedded in the pancreatic tissue. They are composed of alpha, beta, and delta cells. The hormone produced by the beta cells is called insulin;

the alpha cells secrete glucagon, and the delta cells secrete somatostatin.

#### Insulin

A major action of insulin is to lower blood glucose by permitting entry of glucose into the cells of the liver, muscle, and other tissues, where it is either stored as glycogen or used for energy. Insulin also promotes the storage of fat in adipose tissue and the synthesis of proteins in various body tissues. In the absence of insulin, glucose cannot enter the cells and is excreted in the urine. This condition, called diabetes mellitus, can be diagnosed by high levels of glucose in the blood. In diabetes mellitus, stored fats and protein are used for energy instead of glucose, causing loss of body mass. (Diabetes mellitus is discussed in detail in Chapter 41.) The level of glucose in the blood normally regulates the rate of insulin secretion from the pancreas.

#### Glucagon

The effect of glucagon (opposite to that of insulin) is chiefly to raise the blood glucose by converting glycogen to glucose in the liver. Glucagon is secreted by the pancreas in response to a decrease in the level of blood glucose.

#### Somatostatin

Somatostatin exerts a hypoglycemic effect by interfering with release of growth hormone from the pituitary and glucagon from the pancreas, both of which tend to raise blood glucose levels.

### *Endocrine Control of Carbohydrate Metabolism*

Glucose required for energy is derived by metabolism of ingested carbohydrates and also from proteins by the process of gluconeogenesis. Glucose can be stored temporarily in the form of glycogen in the liver, muscles, and other tissues. The endocrine system controls the level of blood glucose by regulating the rate at which glucose is synthesized, stored, and moved to and from the bloodstream. Through the action of hormones, blood glucose is normally maintained at less than 100 mg/dL (5.5 mmol/L). Insulin is the primary hormone that lowers the blood glucose level. Hormones that raise the blood glucose level are glucagon, epinephrine, adrenocorticosteroids, growth hormone, and thyroid hormone.

The endocrine and exocrine functions of the pancreas are interrelated. The major exocrine function is to facilitate digestion through secretion of enzymes into the proximal duodenum. Secretin and CCK-PZ are hormones from the GI tract that aid in the digestion of food substances by controlling the secretions of the pancreas. Neural factors also influence pancreatic enzyme secretion. Considerable dysfunction of the pancreas must occur before enzyme secretion decreases and protein and fat digestion becomes impaired. Pancreatic enzyme secretion is normally 1500 to 2500 mL/day.

### *Gerontologic Considerations*

There is little change in the size of the pancreas with age. However, there is an increase in fibrous material and some fatty deposition in the normal pancreas in people older than 70 years of age. Some localized arteriosclerotic changes occur with age. There is also a decreased rate of pancreatic secretion (decreased lipase, amylase, and trypsin) and decreased bicarbonate output in older people. Some impairment of normal fat absorption occurs with increasing age, possibly because of delayed gastric emptying and pancreatic insufficiency. Decreased calcium absorption may also occur. These changes require care in interpreting diagnostic test results in the normal elderly patient and in providing dietary counseling.

## DISORDERS OF THE GALLBLADDER

Several disorders affect the biliary system and interfere with normal drainage of bile into the duodenum. These disorders include inflammation of the biliary system and carcinoma that obstructs the biliary tree. Gallbladder disease with gallstones is the most common disorder of the biliary system. Although not all occurrences of gallbladder inflammation (**cholecystitis**) are related to gallstones (**cholelithiasis**), more than 90% of patients with acute cholecystitis have gallstones. However, most of the 15 million Americans with gallstones have no pain and are unaware of the presence of stones.

## *Cholecystitis*

Cholecystitis, acute inflammation of the gallbladder, causes pain, tenderness, and rigidity of the upper right abdomen that may radiate to the midsternal area or right shoulder and is associated with nausea, vomiting, and the usual signs of an acute inflammation. An empyema of the gallbladder develops if the gallbladder becomes filled with purulent fluid (pus).

Calculous cholecystitis is the cause of more than 90% of cases of acute cholecystitis (Feldman, Friedman & Brandt, 2006). In calculous cholecystitis, a gallbladder stone obstructs bile outflow. Bile remaining in the gallbladder initiates a chemical reaction; autolysis and edema occur; and the blood vessels in the gallbladder are compressed, compromising its vascular supply. Gangrene of the gallbladder with perforation may result. Bacteria play a minor role in acute cholecystitis; however, secondary infection of bile occurs in approximately 50% of cases. The organisms involved are generally enteric (normally live in the GI tract) and include *Escherichia coli*, *Klebsiella* species, and *Streptococcus*. Bacterial contamination is not believed to stimulate the actual onset of acute cholecystitis (Feldman, et al., 2006).

Acalculous cholecystitis describes acute gallbladder inflammation in the absence of obstruction by gallstones. Acalculous cholecystitis occurs after major surgical procedures, severe trauma, or burns. Other factors associated with this type of cholecystitis include torsion, cystic duct obstruction, primary bacterial infections of the gallbladder, and multiple blood transfusions. It is speculated that acalculous cholecystitis is caused by alterations in fluids and electrolytes and alterations in regional blood flow in the visceral circulation. Bile stasis (lack of gallbladder contraction) and increased viscosity of the bile are also thought to play a role.

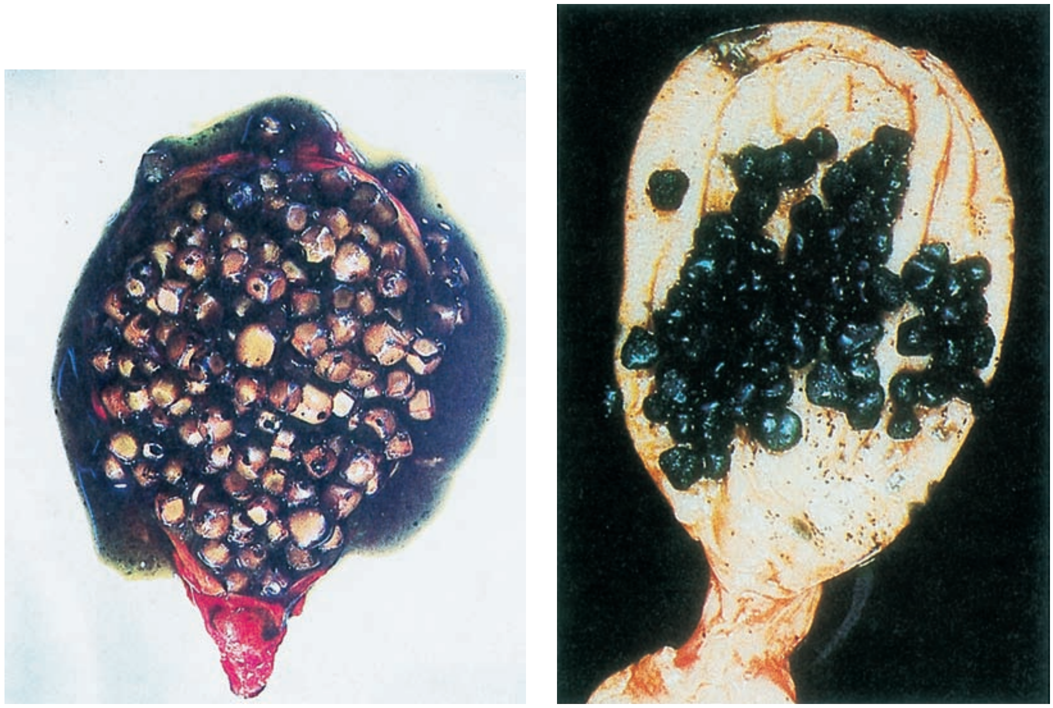


**Figure 40-2** Examples of cholesterol gallstones (*left*) made up of a coalescence of multiple small stones and pigment gallstones (*right*) composed of calcium bilirubinate. From Rubin, E. & Farber, J. L. (2005). *Pathology* (4th ed.). Philadelphia: Lippincott Williams & Wilkins.

The occurrence of acalculous cholecystitis with major surgical procedures or trauma makes its diagnosis difficult.

## Cholelithiasis

Calculi, or gallstones, usually form in the gallbladder from the solid constituents of bile; they vary greatly in size, shape, and composition (Fig. 40-2). They are uncommon in children and young adults but become more prevalent with increasing age, affecting 30% to 40% of people by the age of 80 years.

### Pathophysiology

There are two major types of gallstones: those composed predominantly of pigment and those composed primarily of cholesterol. Pigment stones probably form when unconjugated pigments in the bile precipitate to form stones; these stones account for about 10% to 25% of cases in the United States (Feldman, et al., 2006). The risk of developing such stones is increased in patients with cirrhosis, hemolysis, and infections of the biliary tract. Pigment stones cannot be dissolved and must be removed surgically.

Cholesterol stones account for most of the remaining 75% of cases of gallbladder disease in the United States. Cholesterol, a normal constituent of bile, is insoluble in water. Its solubility depends on bile acids and lecithin (phospholipids) in bile. In gallstone-prone patients, there is decreased bile acid synthesis and increased cholesterol synthesis in the liver, resulting in bile supersaturated with cholesterol, which precipitates out of the bile to form stones. The cholesterol-saturated bile predisposes to the formation of gallstones and acts as an irritant that produces inflammatory changes in the gallbladder.

Two to three times more women than men develop cholesterol stones and gallbladder disease; affected women are usually older than 40 years of age, multiparous, and obese. Stone formation is more frequent in people who use oral contraceptives, estrogens, or clofibrate; these medications are known to increase biliary cholesterol saturation. The incidence of stone formation increases with age as a result of increased hepatic secretion of cholesterol and decreased bile acid synthesis. In addition, there is an increased risk because of malabsorption of bile salts in patients with GI disease or T-tube fistula and in those who have undergone ileal resection or bypass. The incidence is also greater in people with diabetes (Chart 40-1).

**CHART 40-1** ***Risk Factors for Cholelithiasis***

- Obesity
- Women, especially those who have had multiple pregnancies or who are of Native American or U.S. Southwestern Hispanic ethnicity
- Frequent changes in weight
- Rapid weight loss (leads to rapid development of gallstones and high risk of symptomatic disease)
- Treatment with high-dose estrogen (eg, in prostate cancer)
- Low-dose estrogen therapy–a small increase in the risk of gallstones
- Ileal resection or disease
- Cystic fibrosis
- Diabetes mellitus

## Clinical Manifestations

Gallstones may be silent, producing no pain and only mild GI symptoms. Such stones may be detected incidentally during surgery or evaluation for unrelated problems.

The patient with gallbladder disease resulting from gallstones may develop two types of symptoms: those due to disease of the gallbladder itself and those due to obstruction of the bile passages by a gallstone. The symptoms may be acute or chronic. Epigastric distress, such as fullness, abdominal distention, and vague pain in the right upper quadrant of the abdomen, may occur. This distress may follow a meal rich in fried or fatty foods.

### Pain and Biliary Colic

If a gallstone obstructs the cystic duct, the gallbladder becomes distended, inflamed, and eventually infected (acute cholecystitis). The patient develops a fever and may have a palpable abdominal mass. The patient may have biliary colic with excruciating upper right abdominal pain that radiates to the back or right shoulder. Biliary colic is usually associated with nausea and vomiting, and it is noticeable several hours after a heavy meal. The patient moves about restlessly, unable to find a comfortable position. In some patients, the pain is constant rather than colicky.

Such a bout of biliary colic is caused by contraction of the gallbladder, which cannot release bile because of obstruction by the stone. When distended, the fundus of the gallbladder comes in contact with the abdominal wall in the region of the right ninth and tenth costal cartilages. This produces marked tenderness in the right upper quadrant on deep inspiration and prevents full inspiratory excursion.

The pain of acute cholecystitis may be so severe that analgesics are required. The use of morphine has traditionally been avoided because of concern that it could cause spasm of the sphincter of Oddi, and meperidine (Demerol) has been used instead. This is controversial, because morphine is the preferred analgesic agent for management of acute pain, and some metabolites of meperidine are toxic to the central nervous system (CNS). Furthermore, all opioids stimulate the sphincter of Oddi to some degree (Porth & Matfin, 2009).

If the gallstone is dislodged and no longer obstructs the cystic duct, the gallbladder drains and the inflammatory process subsides after a relatively short time. If the gallstone continues to obstruct the duct, abscess, necrosis, and perforation with generalized peritonitis may result.

### Jaundice

Jaundice occurs in a few patients with gallbladder disease, usually with obstruction of the common bile duct. The bile, which is no longer carried to the duodenum, is absorbed by the blood and gives the skin and mucous membranes a yellow color. This is frequently accompanied by marked pruritus (itching) of the skin.

### Changes in Urine and Stool Color

The excretion of the bile pigments by the kidneys gives the urine a very dark color. The feces, no longer colored with bile pigments, are grayish, like putty, or clay-colored.

### Vitamin Deficiency

Obstruction of bile flow interferes with absorption of the fat-soluble vitamins A, D, E, and K. Patients may exhibit deficiencies of these vitamins if biliary obstruction has been prolonged. For example, a patient may have bleeding caused by vitamin K deficiency (vitamin K is necessary for normal blood clotting).

## Assessment and Diagnostic Findings

Table 40-1 identifies various procedures and their diagnostic uses.

### Abdominal X-Ray

If gallbladder disease is suspected, an abdominal x-ray may be obtained to exclude other causes of symptoms. However, only 15% to 20% of gallstones are calcified sufficiently to be visible on such x-ray studies.

### Ultrasonography

Ultrasonography has replaced cholecystography (discussed later) as the diagnostic procedure of choice because it is rapid and accurate and can be used in patients with liver dysfunction and jaundice. It does not expose patients to ionizing radiation. The procedure is most accurate if the patient fasts overnight so that the gallbladder is distended. Ultrasonography can detect calculi in the gallbladder or a dilated common bile duct with 95% accuracy.

**Table 40-1 STUDIES USED IN THE DIAGNOSIS OF BILIARY TRACT AND PANCREATIC DISEASE**

| Studies | Diagnostic Uses |
|---|---|
| Cholecystogram, cholangiogram | To visualize gallbladder and bile duct |
| Celiac axis arteriography | To visualize liver and pancreas |
| Laparoscopy | To visualize anterior surface of liver, gallbladder, and mesentery through a trocar |
| Ultrasonography | To show size of abdominal organs and presence of masses |
| Helical computed tomography (CT scans) and magnetic resonance imaging (MRI) | To detect neoplasms; diagnose cysts, pseudocysts, abscess, and hematomas |
| Endoscopic retrograde cholangiopancreatography (ERCP) | To visualize biliary structures and pancreas via endoscopy |
| Endoscopic ultrasound (EUS) | To identify small tumors and to facilitate fine-needle aspiration biopsy of tumors or lymph nodes for diagnosis |
| Serum alkaline phosphatase | In absence of bone disease, to measure biliary tract obstruction |
| Gamma-glutamyl (GGT), gamma-glutamyl trans-peptidase (GGTP), lactate dehydrogenase (LDH) | Markers for biliary stasis; also elevated in alcohol abuse |
| Cholesterol levels | Elevated in biliary obstruction; decreased in parenchymal liver disease |

### Radionuclide Imaging or Cholescintigraphy

Cholescintigraphy is used successfully in the diagnosis of acute cholecystitis or blockage of a bile duct. In this procedure, a radioactive agent is administered intravenously. It is taken up by the hepatocytes and excreted rapidly through the biliary tract. The biliary tract is then scanned, and images of the gallbladder and biliary tract are obtained. This test is more expensive than ultrasonography, takes longer to perform, exposes the patient to radiation, and cannot detect gallstones. It is often used when ultrasonography is not conclusive.

### Cholecystography

Although cholecystography has been replaced by ultrasonography as the test of choice, it is still used if ultrasound equipment is not available or if the ultrasound results are inconclusive. Oral cholangiography may be performed to detect gallstones and to assess the ability of the gallbladder to fill, concentrate its contents, contract, and empty. If the patient is not allergic to iodine or seafood, an iodide-containing contrast agent that is excreted by the liver and concentrated in the gallbladder is administered 10 to 12 hours before the x-ray study. The normal gallbladder fills with this radiopaque substance. If gallstones are present, they appear as shadows on the x-ray film.

Oral cholecystography is likely to continue to be used as part of the evaluation of the few patients who have been treated with gallstone **dissolution therapy** or lithotripsy.

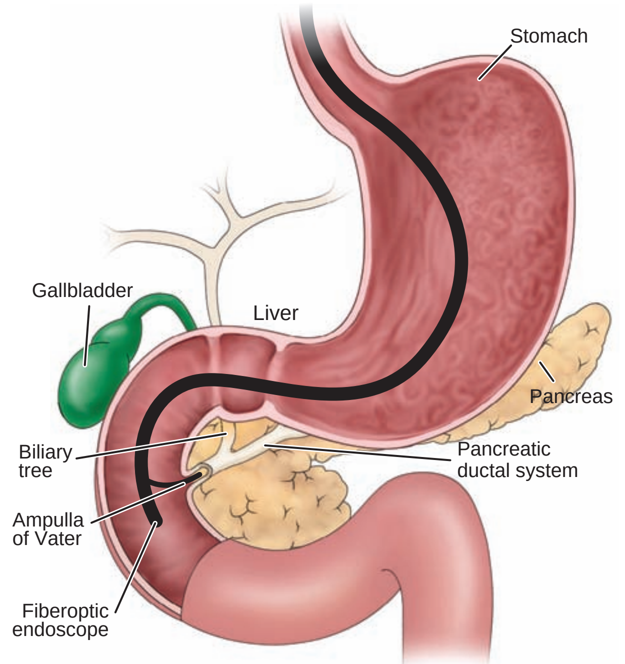



**Figure 40-3** Endoscopic retrograde cholangiopancreatography (ERCP). A fiberoptic duodenoscope, with side-viewing apparatus, is inserted into the duodenum. The ampulla of Vater is catheterized, and the biliary tree is injected with contrast agent. The pancreatic ductal system is also assessed, if indicated. This procedure is of special value in visualizing neoplasms of the ampulla area and extracting a biopsy specimen.

### Endoscopic Retrograde Cholangiopancreatography

**Endoscopic retrograde cholangiopancreatography (ERCP)** permits direct visualization of structures that previously could be seen only during laparotomy. The examination of the hepatobiliary system is carried out via a side-viewing flexible fiberoptic endoscope inserted through the esophagus to the descending duodenum (Fig. 40-3). Multiple position changes are required to pass the endoscope during the procedure, beginning in the left semiprone position.

Fluoroscopy and multiple x-rays are used during ERCP to evaluate the presence and location of ductal stones. Careful insertion of a catheter through the endoscope into the common bile duct is the most important step in sphincterotomy (division of the muscles of the biliary sphincter) for gallstone extraction via this technique (see later discussion).

#### Nursing Implications

The procedure requires a cooperative patient to permit insertion of the endoscope without damage to the GI tract structures, including the biliary tree. Before the procedure, the patient is given an explanation of the procedure and his or her role in it. The patient takes nothing by mouth for several hours before the procedure. Moderate sedation is used, and the sedated patient must be monitored closely. It may be necessary to administer medications, such as glucagon or anticholinergics, to make cannulation easier by decreasing duodenal peristalsis. The nurse observes closely for signs of respiratory and central nervous system depression, hypotension, oversedation, and vomiting (if glucagon is administered). During ERCP, the nurse monitors intravenous (IV) fluids, administers medications, and positions the patient.

After the procedure, the nurse monitors the patient's condition, observing vital signs and monitoring for signs of perforation or infection. The nurse also monitors the patient for side effects of any medications received during the procedure and for return of the gag and cough reflexes after the use of local anesthetics.

### Percutaneous Transhepatic Cholangiography

Percutaneous transhepatic cholangiography involves the injection of dye directly into the biliary tract. Because of the relatively large concentration of dye that is introduced into the biliary system, including the hepatic ducts within the liver, the entire length of the common bile duct, the cystic duct, and the gallbladder is outlined clearly.

This procedure can be carried out even in the presence of liver dysfunction and jaundice. It is useful for (1) distinguishing jaundice caused by liver disease (hepatocellular jaundice) from that caused by biliary obstruction, (2) investigating the GI symptoms of a patient whose gallbladder has been removed, (3) locating stones within the bile ducts, and (4) diagnosing cancer involving the biliary system.

This sterile procedure is performed under moderate sedation on a patient who has been fasting; the patient receives local anesthesia and moderate sedation. Coagulation parameters and platelet count should be normal to minimize the risk of bleeding. Broad-spectrum antibiotics are administered during the procedure because of the high prevalence of bacterial colonization from obstructed biliary systems. After infiltration with a local anesthetic agent has occurred,

a flexible needle is inserted into the liver from the right side in the midclavicular line immediately beneath the right costal margin. Successful entry of a duct is noted when bile is aspirated or on injection of a contrast agent. Ultrasound can be used to guide puncture of the duct. Bile is aspirated and samples are sent for bacteriology and cytology. A water-soluble contrast agent is injected to fill the biliary system. The fluoroscopy table is tilted and the patient is repositioned to allow x-rays to be taken in multiple projections. Delayed x-ray views can identify abnormalities of more distant ducts and determine the length of a stricture or multiple strictures. Before the needle is removed, as much dye and bile as possible are aspirated to forestall subsequent leakage into the needle tract and eventually into the peritoneal cavity, thus minimizing the risk of bile peritonitis.

*NURSING ALERT*

**Although the complication rate after this procedure is low, the nurse must closely observe the patient for symptoms of bleeding, peritonitis, and septicemia. The nurse assesses the patient for pain and indications of these complications and reports them promptly to the physician. Antibiotic agents are often prescribed to minimize the risk of sepsis and septic shock.**

## Medical Management

The major objectives of medical therapy are to reduce the incidence of acute episodes of gallbladder pain and cholecystitis by supportive and dietary management and, if possible, to remove the cause of cholecystitis by pharmacologic therapy, endoscopic procedures, or surgical intervention. Although nonsurgical approaches eliminate risks associated with surgery, these approaches are associated with persistent symptoms or recurrent stone formation. Most of the nonsurgical approaches, including lithotripsy and dissolution of gallstones, provide only temporary solutions to gallstone problems and are infrequently used in the United States. In some instances, other treatment approaches may be indicated; these are described later.

Removal of the gallbladder **(cholecystectomy)** through traditional surgical approaches was the standard treatment for more than 100 years. It has largely been replaced by **laparoscopic cholecystectomy** (removal of the gallbladder through a small incision through the umbilicus). As a result, surgical risks have decreased, along with the length of hospital stay and the long recovery period required after standard surgical cholecystectomy. In relatively rare instances, a standard surgical procedure may be necessary.

### Nutritional and Supportive Therapy

Approximately 80% of the patients with acute gallbladder inflammation achieve remission with rest, IV fluids, nasogastric suction, analgesia, and antibiotic agents. Unless the patient's condition deteriorates, surgical intervention is delayed just until the acute symptoms subside (usually within a few days). At this time, the patient should undergo a laparoscopic cholecystectomy (Goldman & Ausiello, 2008).

The diet required immediately after an episode is usually limited to low-fat liquids. These can include powdered supplements high in protein and carbohydrate stirred into skim milk. Cooked fruits, rice or tapioca, lean meats, mashed potatoes, non–gas-forming vegetables, bread, coffee, or tea may be added as tolerated. The patient should avoid eggs, cream, pork, fried foods, cheese, rich dressings, gas-forming vegetables, and alcohol. It is important to remind the patient that fatty foods may induce an episode of cholecystitis. Dietary management may be the major mode of therapy in patients who have had only dietary intolerance to fatty foods and vague GI symptoms (Dudek, 2006).

### Pharmacologic Therapy

Ursodeoxycholic acid (UDCA [URSO, Actigall]) and chenodeoxycholic acid (chenodiol or CDCA [Chenix]) have been used to dissolve small, radiolucent gallstones composed primarily of cholesterol. UDCA has fewer side effects than chenodiol and can be administered in smaller doses to achieve the same effect. It acts by inhibiting the synthesis and secretion of cholesterol, thereby desaturating bile. Treatment with UDCA can reduce the size of existing stones, dissolve small stones, and prevent new stones from forming. Six to 12 months of therapy are required in many patients to dissolve stones, and monitoring of the patient for recurrence of symptoms or the occurrence of side effects (eg, GI symptoms, pruritus, headache) is required during this time. The effective dose of medication depends on body weight. This method of treatment is generally indicated for patients who refuse surgery or for whom surgery is considered too risky.

Patients with significant, frequent symptoms; cystic duct occlusion; or pigment stones are not candidates for therapy with UDCA. Laparoscopic or open cholecystectomy is more appropriate for symptomatic patients with acceptable operative risk.

### Nonsurgical Removal of Gallstones

#### Dissolving Gallstones

Several methods have been used to dissolve gallstones by infusion of a solvent (mono-octanoin or methyl tertiary butyl ether [MTBE]) into the gallbladder. The solvent can be infused through the following routes: through a tube or catheter inserted percutaneously directly into the gallbladder; through a tube or drain inserted through a T-tube tract to dissolve stones not removed at the time of surgery; endoscopically with ERCP; or via a transnasal biliary catheter.

In the latter procedure, the catheter is introduced through the mouth and inserted into the common bile duct. The upper end of the tube is then rerouted from the mouth to the nose and left in place. This enables the patient to eat and drink normally while passage of stones is monitored or chemical solvents are infused to dissolve the stones. This method of dissolution of stones is not widely used.

#### Stone Removal by Instrumentation

Several nonsurgical methods are used to remove stones that were not removed at the time of cholecystectomy or have become lodged in the common bile duct (Fig. 40-4A,B). A catheter and instrument with a basket attached are threaded through the T-tube tract or fistula formed at the time of T-tube insertion; the basket is used to retrieve and remove the stones lodged in the common bile duct.

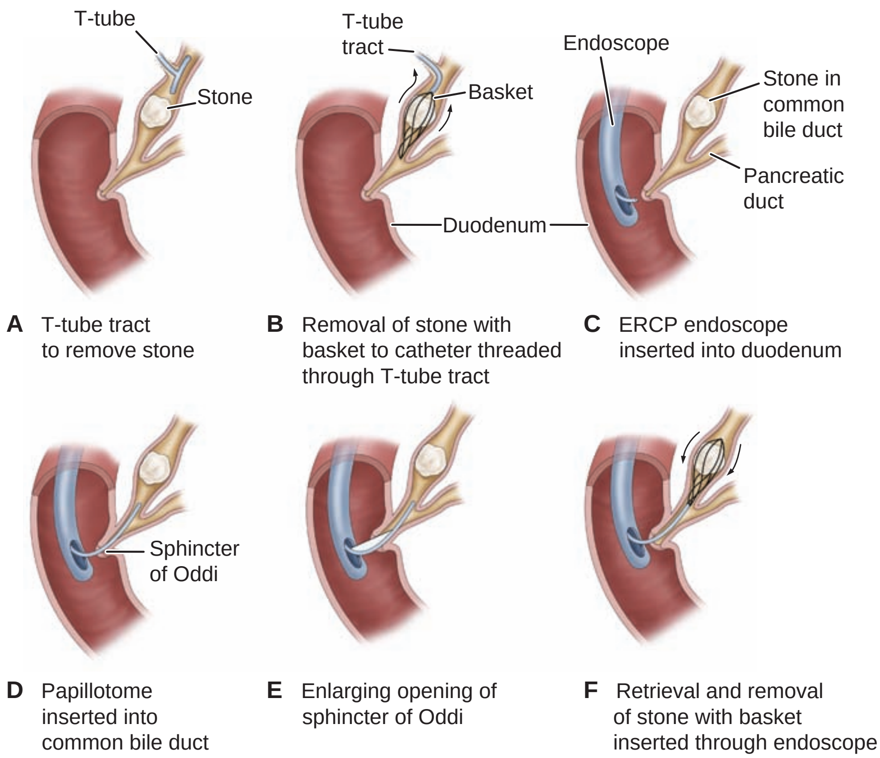



**Figure 40-4** Nonsurgical techniques for removing gallstones.

A second procedure involves the use of the ERCP endoscope (Fig. 40-4C). After the endoscope is inserted, a cutting instrument is passed through the endoscope into the ampulla of Vater of the common bile duct. It may be used to cut the submucosal fibers, or papilla, of the sphincter of Oddi, enlarging the opening, which may allow the lodged stones to pass spontaneously into the duodenum. Another instrument with a small basket or balloon at its tip may be inserted through the endoscope to retrieve the stones (Fig. 40-4D–F). The patient is observed closely for bleeding, perforation, and the development of pancreatitis or sepsis.

The ERCP procedure is particularly useful in diagnosis and treatment of patients who have symptoms after biliary tract surgery, patients with intact gallbladders, and patients for whom surgery is particularly hazardous.

#### Intracorporeal Lithotripsy

Stones in the gallbladder or common bile duct may be fragmented by means of laser pulse technology. A laser pulse is directed under fluoroscopic guidance with the use of devices that can distinguish between stones and tissue. The laser pulse produces rapid expansion and disintegration of plasma on the stone surface, resulting in a mechanical shock wave. Electrohydraulic lithotripsy uses a probe with two electrodes that deliver electric sparks in rapid pulses, creating expansion of the liquid environment surrounding the gallstones. This results in pressure waves that cause stones to fragment. This technique can be used percutaneously with a basket or balloon catheter system or by direct visualization through an endoscope. Repeated procedures may be necessary because of stone size, local anatomy, bleeding, or technical difficulty. A nasobiliary tube can be inserted to allow for biliary decompression and to prevent stone impaction in the common bile duct. This approach allows time for improvement in the patient's clinical condition until gallstones are cleared endoscopically, percutaneously, or surgically.

#### Extracorporeal Shock Wave Lithotripsy

Extracorporeal shock wave therapy (lithotripsy or ESWL) has been used for nonsurgical fragmentation of gallstones. **Lithotripsy,** a noninvasive procedure, uses repeated shock waves directed at the gallstones in the gallbladder or common bile duct to fragment the stones. The waves are transmitted to the body through a fluid-filled bag or by immersing the patient in a water bath. After the stones are gradually broken up, the stone fragments can be spontaneously passed from the gallbladder or common bile duct, removed by endoscopy, or dissolved with oral bile acid or solvents. Because the procedure requires no incision and no hospitalization, patients are usually treated as outpatients, but usually several sessions are necessary. This procedure has largely been replaced by laparoscopic cholecystectomy. ESWL is used in some centers for a small percentage of suitable patients (those with common bile duct stones who may not be surgical candidates), sometimes in combination with dissolution therapy.

### *Surgical Management*

Surgical treatment of gallbladder disease and gallstones is carried out to relieve persistent symptoms, to remove the cause of biliary colic, and to treat acute cholecystitis. Surgery may be delayed until the patient's symptoms have subsided, or it may be performed as an emergency procedure, if necessitated by the patient's condition.

### Preoperative Measures

Chest x-ray, electrocardiogram (ECG), and liver function tests may be performed in addition to x-ray studies of the gallbladder. Vitamin K may be administered if the prothrombin level is low. Nutritional requirements are considered, and, if the nutritional status is suboptimal, it may be necessary to provide IV glucose with protein supplements to aid wound healing and help prevent liver damage.

Preparation for gallbladder surgery is similar to that for any upper abdominal laparotomy or laparoscopy. Instructions and explanations are given before surgery with regard to turning and deep breathing. Postoperative pneumonia and atelectasis can be avoided by deep-breathing exercises and frequent turning. The patient should be informed that drainage tubes and a nasogastric tube and suction might be required during the immediate postoperative period if an open cholecystectomy is performed.

### Laparoscopic Cholecystectomy

Laparoscopic cholecystectomy (Fig. 40-5) has dramatically changed the approach to the management of cholecystitis. It has become the new standard for therapy of symptomatic gallstones. Approximately 700,000 patients in the United States require surgery each year for removal of the gallbladder, and 80% to 90% of them are candidates for laparoscopic cholecystectomy (Feldman, et al., 2006). If the common bile duct is thought to be obstructed by a gallstone, an ERCP with sphincterotomy may be performed to explore the duct before laparoscopy.

Before the procedure, the patient is informed that an open abdominal procedure may be necessary, and general anesthesia is administered. Laparoscopic cholecystectomy is performed through a small incision or puncture made through the abdominal wall at the umbilicus. The abdominal cavity is insufflated with carbon dioxide (pneumoperitoneum) to assist in inserting the laparoscope and to aid in visualizing the abdominal structures. The fiberoptic scope is inserted through the small umbilical incision. Several additional punctures or small incisions are made in the abdominal wall to introduce other surgical instruments into the operative field. A camera attached to the laparoscope permits the surgeon to view the intra-abdominal field and biliary system on a television monitor. After the cystic duct is dissected, the common bile duct can be visualized by ultrasound or cholangiography to evaluate the anatomy and identify stones. The cystic artery is dissected free and clipped. The gallbladder is separated from the hepatic bed and removed from the abdominal cavity after bile and small stones are aspirated. Stone forceps also can be used to remove or crush larger stones.

With the laparoscopic procedure, the patient does not experience the paralytic ileus that occurs with open abdominal surgery and has less postoperative abdominal pain. The patient is often discharged from the hospital on the same day of surgery or within 1 or 2 days and resumes full activity and employment within 1 week after the surgery.

Conversion to a traditional abdominal surgical procedure may be necessary if problems are encountered during the laparoscopic procedure; this occurs in 2.2% of cases in the United States and 3.6% to 8.2% of cases internationally. Conversion to an open procedure occurs if there is inflammation in and around the gallbladder, making safe dissection of the porta hepatis difficult (Feldman, et al., 2006).

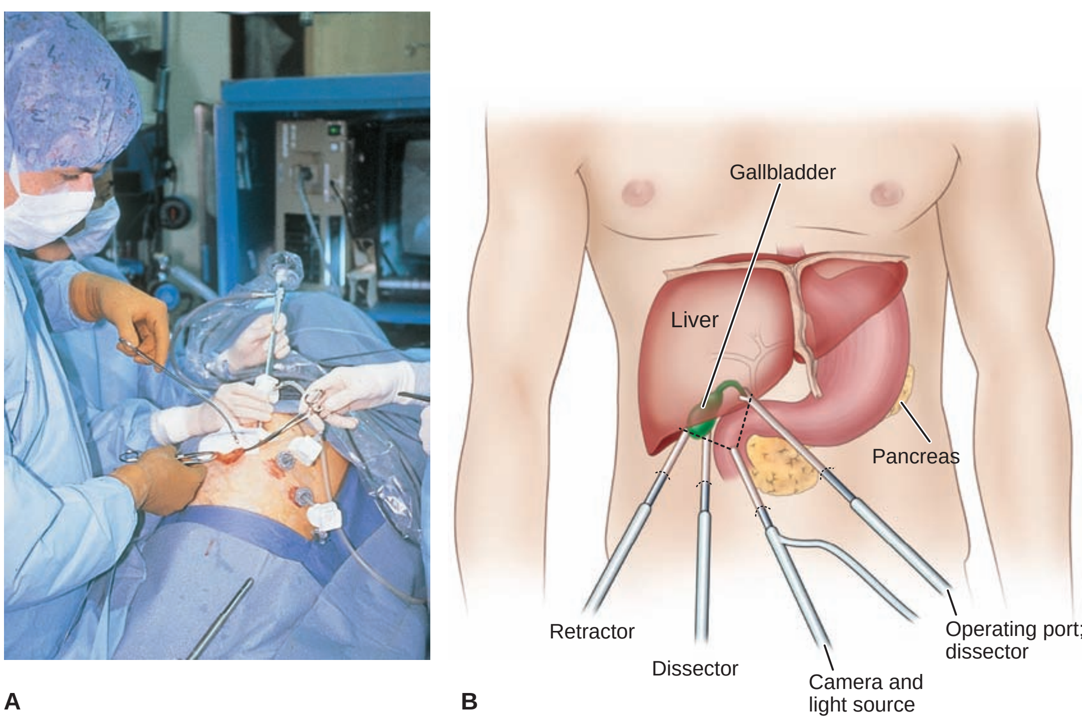



**Figure 40-5** **A,** In laparoscopic cholecystectomy, the surgeon makes four small incisions (less than one half inch each) in the abdomen **(B)** and inserts a laparoscope with a miniature camera through the umbilical incision. The camera apparatus displays the gallbladder and adjacent tissues on a screen, allowing the surgeon to visualize the sections of the organ for removal.

(The porta hepatis is the fissure of the liver where the portal vein and the hepatic artery enter and the hepatic ducts exit the liver.) Careful screening of patients and identification of those at low risk for complications limit the frequency of conversion to an open abdominal procedure. However, with increasing use of laparoscopic procedures, the number of such conversions may increase.

The most serious complication after laparoscopic cholecystectomy is a bile duct injury, which may be identified and corrected at the time of the procedure. Patients with a postoperative bile leak may not develop symptoms until several days after the procedure, and some have an even more prolonged period before injury to the bile duct becomes apparent (Massoumi, Kiyici & Hertan, 2007). A bile leak may result in fluid collections, which can usually be managed by endoscopic stent placement. Bile peritonitis, a rare complication, may result in serious illness or death.

Because of the short hospital stay with uncomplicated laparoscopic cholecystectomies, it is important to provide written and verbal instructions about managing postoperative pain and reporting signs and symptoms of intra-abdominal complications, including loss of appetite, vomiting, pain, distention of the abdomen, and temperature elevation. Although recovery from laparoscopic cholecystectomy is rapid, patients are drowsy afterward. The patient must have assistance at home during the first 24 to 48 hours. If pain occurs in the right shoulder or scapular area (from migration of the carbon dioxide used to insufflate the abdominal cavity during the procedure), the nurse may recommend a heating pad for 15 to 20 minutes hourly.

#### Cholecystectomy

In cholecystectomy, the gallbladder is removed through an abdominal incision (usually right subcostal) after the cystic duct and artery are ligated. The procedure is performed for acute and chronic cholecystitis. In some patients, a drain is placed close to the gallbladder bed and brought out through a puncture wound if there is a bile leak. The drain type is chosen based on the physician's preference. A small leak should close spontaneously in a few days, with the drain preventing accumulation of bile. Usually only a small amount of serosanguineous fluid drains in the initial 24 hours after surgery; afterward, the drain is removed. The drain is typically maintained if there is excess oozing or bile leakage. Insertion of a T-tube into the common bile duct during the open procedure is now uncommon; it is used only in the setting of a complication (ie, retained common bile duct stone). Bile duct injury is a serious complication of cholecystectomy, but it occurs less frequently than with the laparoscopic approach, which has largely replaced traditional surgical cholecystectomy.

#### Mini-Cholecystectomy

Mini-cholecystectomy is a surgical procedure in which the gallbladder is removed through a small incision. If needed, the surgical incision is extended to remove larger gallbladder stones. Drains may or may not be used. The cost savings resulting from the short hospital stay have been identified as a major reason for pursuing this type of procedure. The procedure is controversial because it limits exposure to all the involved biliary structures.

#### Choledochostomy

**Choledochostomy** is reserved for the patient with acute cholecystitis who may be too ill to undergo a surgical procedure. It involves making an incision in the common duct, usually for removal of stones (choledochostomy). After the stones have been evacuated, a tube is usually inserted into the duct for drainage of bile until edema subsides. This tube is connected to gravity drainage tubing; the patient is monitored closely, and a laparoscopic cholecystectomy is planned for a future date after acute inflammation has resolved.

#### Surgical Cholecystostomy

**Cholecystostomy** is performed when the patient's condition precludes more extensive surgery or when an acute inflammatory reaction is severe. The gallbladder is surgically opened, stones and the bile or the purulent drainage are removed, and a drainage tube is secured with a purse-string suture. The drainage tube is connected to a drainage system to prevent bile from leaking around the tube or escaping into the peritoneal cavity. After recovery from the acute episode, the patient may return for subsequent laparoscopic cholecystectomy. Despite its lower risk, surgical cholecystostomy has a high mortality rate (reported to be as high as 20% to 30%) because of the underlying disease process.

#### Percutaneous Cholecystostomy

Percutaneous cholecystostomy has been used in the treatment and diagnosis of acute cholecystitis in patients who are poor risks for any surgical procedure or for general anesthesia. These may include patients with sepsis or severe cardiac, renal, pulmonary, or liver failure. Under local anesthesia, a fine needle is inserted through the abdominal wall and liver edge into the gallbladder under the guidance of ultrasound or computed tomography (CT). Bile is aspirated to ensure adequate placement of the needle, and a catheter is inserted into the gallbladder to decompress the biliary tract. Almost immediate relief of pain and resolution of signs and symptoms of sepsis and cholecystitis have been reported with this procedure. Antibiotic agents are administered before, during, and after the procedure.

### *Gerontologic Considerations*

Surgical intervention for disease of the biliary tract is the most common operative procedure performed in the elderly. Cholesterol saturation of bile increases with age because of increased hepatic secretion of cholesterol and decreased bile acid synthesis.

Although the incidence of gallstones increases with age, the elderly patient may not exhibit the typical symptoms of fever, pain, chills, and jaundice. Symptoms of biliary tract disease in the elderly may be accompanied or preceded by those of septic shock, which include oliguria, hypotension, changes in mental status, tachycardia, and tachypnea.

Although surgery in the elderly presents a risk because of preexisting associated diseases, the mortality rate from serious complications of biliary tract disease itself is also high. The risk of death and complications is increased in the elderly patient who undergoes emergency surgery for life-threatening disease of the biliary tract. Despite chronic illness in many elderly patients, elective cholecystectomy is

usually well tolerated and can be carried out with low risk if expert assessment and care are provided before, during, and after the surgical procedure.

Because of recent changes in reimbursement for health care expenses, there has been a decrease in the number of elective surgical procedures performed, including cholecystectomies. As a result, patients requiring the procedure are seen in later stages of disease. At the same time, patients undergoing surgery are increasingly older than 60 years of age and may have complicated acute cholecystitis. The higher risk of complications and shorter hospital stay make it essential that older patients and their family members receive specific information about signs and symptoms of complications and measures to prevent them.

# NURSING PROCESS

## The Patient Undergoing Surgery for Gallbladder Disease

### Assessment

The patient who is to undergo surgical treatment of gallbladder disease is often admitted to the hospital or same-day surgery unit on the morning of surgery. Preadmission testing is often completed a week or longer before admission. At that time, the nurse instructs the patient about the need to avoid smoking, to enhance pulmonary recovery postoperatively, and to avoid respiratory complications. It also is important to instruct the patient to avoid the use of aspirin and other agents (over-the-counter medications and herbal remedies) that can alter coagulation and other biochemical processes.

Assessment should focus on the patient's respiratory status. If a traditional surgical approach is planned, the high abdominal incision required during surgery may interfere with full respiratory excursion. The nurse notes a history of smoking, previous respiratory problems, shallow respirations, a persistent or ineffective cough, and the presence of adventitious breath sounds. Nutritional status is evaluated through a dietary history and a general examination performed at the time of preadmission testing. The nurse also reviews previously obtained laboratory results to obtain information about the patient's nutritional status.

### Diagnosis

#### *Nursing Diagnoses*

Based on all the assessment data, the major postoperative nursing diagnoses for the patient undergoing surgery for gallbladder disease may include the following:

- Acute pain and discomfort related to surgical incision
- Impaired gas exchange related to the high abdominal surgical incision (if traditional surgical cholecystectomy was performed)
- Impaired skin integrity related to altered biliary drainage after surgical intervention (if a T-tube was inserted because of retained stones in the common bile duct or another drainage device was employed)
- Imbalanced nutrition, less than body requirements, related to inadequate bile secretion
- Deficient knowledge about self-care activities related to incision care, dietary modifications (if needed), medications, and reportable signs or symptoms (eg, fever, bleeding, vomiting)

#### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications may include the following:

- Bleeding
- GI symptoms (may be related to biliary leak or injury to the bowel)

### Planning and Goals

The goals for the patient include relief of pain, adequate ventilation, intact skin and improved biliary drainage, optimal nutritional intake, absence of complications, and understanding of self-care routines.

### Postoperative Nursing Interventions

After recovery from anesthesia, the patient is placed in the low Fowler's position. Fluids may be administered intravenously, and nasogastric suction (a nasogastric tube was probably inserted immediately before surgery for a nonlaparoscopic procedure) may be instituted to relieve abdominal distention. Water and other fluids are administered within hours after laparoscopic procedures. A soft diet is started after bowel sounds return, which is usually the next day if the laparoscopic approach is used.

#### *Relieving Pain*

The location of the subcostal incision in nonlaparoscopic gallbladder surgery often causes the patient to avoid turning and moving, to splint the affected site, and to take shallow breaths to prevent pain. Because full expansion of the lungs and gradually increased activity are necessary to prevent postoperative complications, the nurse administers analgesic agents as prescribed to relieve the pain and to promote well-being in addition to helping the patient turn, cough, breathe deeply, and ambulate as indicated. Use of a pillow or binder over the incision may reduce pain during these maneuvers.

#### *Improving Respiratory Status*

Patients undergoing biliary tract surgery are especially prone to pulmonary complications, as are all patients with upper abdominal incisions. Therefore, the nurse reminds the patient to take deep breaths and cough every hour to expand the lungs fully and prevent atelectasis. The early and consistent use of incentive spirometry also helps improve respiratory function. Early ambulation prevents pulmonary complications as well as other complications, such as thrombophlebitis. Pulmonary complications are more likely to occur in elderly patients, obese patients, and those with preexisting pulmonary disease.

#### *Maintaining Skin Integrity and Promoting Biliary Drainage*

In patients who have undergone a cholecystostomy or choledochostomy, the drainage tube must be connected immediately to a drainage receptacle. The nurse should fasten the tubing to the dressings or to the patient's gown, with enough leeway for the patient to move without dislodging

or kinking the tube. Because a drainage system remains attached when the patient is ambulating, the drainage bag may be placed in a bathrobe pocket or fastened so that it is below the waist or common duct level. If a Penrose drain is used, the nurse changes the dressings as required.

After these surgical procedures, the patient is observed for indications of infection, leakage of bile into the peritoneal cavity, and obstruction of bile drainage. If bile is not draining properly, an obstruction is probably causing bile to be forced back into the liver and bloodstream. Because jaundice may result, the nurse should assess the color of the sclerae. The nurse should note and report right upper quadrant abdominal pain, nausea and vomiting, bile drainage around any drainage tube, clay-colored stools, and a change in vital signs.

Bile may continue to drain from the drainage tract in considerable quantities for some time, necessitating frequent changes of the outer dressings and protection of the skin from irritation (bile is corrosive to the skin).

To prevent total loss of bile, the physician may want the drainage tube or collection receptacle elevated above the level of the abdomen so that the bile drains externally only if pressure develops in the duct system. Every 24 hours, the nurse measures the bile collected and records the amount, color, and character of the drainage. After several days of drainage, the tube may be clamped for 1 hour before and after each meal to deliver bile to the duodenum to aid in digestion. Within 7 to 14 days, the drainage tube is removed. The patient who goes home with a drainage tube in place requires instruction and reassurance about the function and care of the tube.

In all patients with biliary drainage, the nurse (or the patient, if at home) observes the color of stools daily. Urine and stool specimens may be sent to the laboratory for examination for bile pigments. In this way, it is possible to determine whether the bile pigment is disappearing from the blood and is draining again into the duodenum. Maintaining a careful record of fluid intake and output is important.

#### *Improving Nutritional Status*

The nurse encourages the patient to eat a diet that is low in fats and high in carbohydrates and proteins immediately after surgery. At the time of hospital discharge, there are usually no special dietary instructions other than to maintain a nutritious diet and avoid excessive fats. Fat restriction usually is lifted in 4 to 6 weeks, when the biliary ducts dilate to accommodate the volume of bile once held by the gallbladder and when the ampulla of Vater again functions effectively. After this time, when the patient eats fat, adequate bile will be released into the GI tract to emulsify the fats and allow their digestion. This is in contrast to the condition before surgery, when fats may not have been digested completely or adequately and flatulence may have occurred. One purpose of gallbladder surgery is to allow a normal diet.

#### *Monitoring and Managing Potential Complications*

Bleeding may occur as a result of inadvertent puncture or injury to a major blood vessel. Postoperatively, the nurse closely monitors vital signs and inspects the surgical incisions and any drains for bleeding. The nurse also assesses the patient for increased tenderness and rigidity of the abdomen. If these signs and symptoms occur, they are reported to the surgeon. The nurse instructs the patient and family to report any change in the color of stools, because this may indicate complications. GI symptoms, although not common, may occur with manipulation of the intestines during surgery.

After laparoscopic cholecystectomy, the nurse assesses the patient for anorexia, vomiting, pain, abdominal distension, and temperature elevation. These may indicate infection or disruption of the GI tract and should be reported to the surgeon promptly. Because the patient is discharged soon after laparoscopic surgery, the patient and family are instructed verbally and in writing about the importance of reporting these symptoms promptly.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The nurse instructs the patient about the medications that are prescribed (vitamins, anticholinergics, and antispasmodics) and their actions. It also is important to inform the patient and family about symptoms that should be reported to the physician, including jaundice, dark urine, pale-colored stools, pruritus, and signs of inflammation and infection, such as pain or fever.

Some patients report one to three bowel movements a day, which is a result of a continual trickle of bile through the choledochoduodenal junction after cholecystectomy. Usually, such frequency diminishes over a period of a few weeks to several months.

If a patient is discharged from the hospital with a drainage tube still in place, the patient and family need instructions about its management. The nurse instructs them in proper care of the drainage tube and the importance of reporting promptly any changes in the amount or characteristics of drainage. Assistance in securing the appropriate dressings reduces the patient's anxiety about going home with the drain or tube still in place. See Chart 40-2 for additional details.

**CONTINUING CARE.** With sufficient support at home, most patients recover quickly from a cholecystectomy. However, elderly or frail patients and those who live alone may require a referral for home care. During home visits, the nurse assesses the patient's physical status, especially wound healing, and progress toward recovery. Assessing the patient for adequacy of pain relief and pulmonary exercises is also important. If the patient has a drainage system in place, the nurse assesses it for patency and appropriate management by the patient and family. Assessing for signs of infection and teaching the patient about the signs and symptoms of infection are also important nursing interventions. The patient's understanding of the therapeutic regimen (medications, gradual return to normal activities) is assessed, and previous teaching is reinforced. The nurse emphasizes the importance of keeping follow-up appointments and reminds the patient and family of the importance of participating in health promotion activities and recommended health screening.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports decrease in pain
   a. Splints abdominal incision to decrease pain

CHART 40-2

PATIENT EDUCATION

*Managing Self-Care After Laparoscopic Cholecystectomy*

**Resuming Activity**

- Begin light exercise (walking) immediately.
- Take a shower or bath after 1 or 2 days.
- Drive a car after 3 or 4 days.
- Avoid lifting objects exceeding 5 pounds after surgery, usually for 1 week.
- Resume sexual activity when desired.

**Caring for the Wound**

- Check puncture site daily for signs of infection.
- Wash puncture site with mild soap and water.
- Allow special adhesive strips on the puncture site to fall off. Do not pull them off.

**Resuming Eating**

- Resume your normal diet.
- If you had fat intolerance before surgery, gradually add fat back into your diet in small increments.

**Managing Pain**

- You may experience pain or discomfort in your right shoulder from the gas used to inflate your abdominal area during surgery. Sitting upright in bed or a chair, walking, or use of a heating pad may ease the discomfort.
- Take analgesics as needed and as prescribed. Report to surgeon if pain is unrelieved even with analgesic use.

**Managing Follow-Up Care**

- Make an appointment with your surgeon for 7 to 10 days after discharge.
- Call your surgeon if you experience any signs or symptoms of infection at or around the puncture site: redness, tenderness, swelling, heat, or drainage.
- Call your surgeon if you experience a fever of 37.7°C (100°F) or more for 2 consecutive days.
- Call your surgeon if you develop nausea, vomiting, or abdominal pain.

    b. Avoids foods that cause pain
    c. Uses postoperative analgesia as prescribed
2. Demonstrates appropriate respiratory function
    a. Achieves full respiratory excursion, with deep inspiration and expiration
    b. Coughs effectively, using pillow to splint abdominal incision
    c. Uses postoperative analgesia as prescribed
    d. Exercises as prescribed (eg, turns, ambulates)
3. Exhibits normal skin integrity around biliary drainage site (if applicable)
    a. Is free of fever, abdominal pain, change in vital signs, and presence of bile, foul-smelling drainage, or pus around drainage tube
    b. Demonstrates correct management of drainage tube (if applicable)
    c. Identifies signs and symptoms of biliary obstruction to be noted and reported
    d. Has serum bilirubin level within normal range
4. Obtains relief from dietary intolerance
    a. Maintains adequate dietary intake and avoids foods that cause gastrointestinal symptoms
    b. Reports decreased or absent nausea, vomiting, diarrhea, flatulence, and abdominal discomfort
5. Absence of complications
    a. Has normal vital signs (blood pressure, pulse, respiratory rate and pattern, and temperature)
    b. Reports absence of bleeding from GI tract and from biliary drainage tube or catheter (if present) and no evidence of bleeding in stool
    c. Reports return of appetite and no evidence of vomiting, abdominal distention, or pain
    d. Lists symptoms that should be reported to surgeon promptly and demonstrates an understanding of self-care, including wound care

## DISORDERS OF THE PANCREAS

**Pancreatitis** (inflammation of the pancreas) is a serious disorder. The most basic classification system used to describe or categorize the various stages and forms of pancreatitis divides the disorder into acute and chronic forms. Acute pancreatitis can be a medical emergency associated with a high risk of life-threatening complications and mortality, whereas chronic pancreatitis often goes undetected until 80% to 90% of the exocrine and endocrine tissue is destroyed. Acute pancreatitis does not usually lead to chronic pancreatitis unless complications develop. However, chronic pancreatitis can be characterized by acute episodes.

Although the mechanisms causing pancreatic inflammation are unknown, pancreatitis is commonly described as autodigestion of the pancreas. It is believed that the pancreatic duct becomes temporarily obstructed, accompanied by hypersecretion of the exocrine enzymes of the pancreas. These enzymes enter the bile duct, where they are activated and, together with bile, back up (reflux) into the pancreatic duct, causing pancreatitis.

### *Acute Pancreatitis*

Acute pancreatitis ranges from a mild, self-limited disorder to a severe, rapidly fatal disease that does not respond to any treatment. Approximately 185,000 cases of acute pancreatitis occur in the United States each year, of which 150,000 are the result of cholelithiasis or sustained alcohol abuse (Zinner & Ashley, 2007). Mild acute pancreatitis is characterized by edema and inflammation confined to the pancreas. Minimal organ dysfunction is present, and return to normal function usually occurs within 6 months. Although this is considered the milder form of pancreatitis, the

patient is acutely ill and at risk for hypovolemic shock, fluid and electrolyte disturbances, and sepsis. A more widespread and complete enzymatic digestion of the gland characterizes severe acute pancreatitis. Enzymes damage the local blood vessels, and bleeding and thrombosis can occur. The tissue may become necrotic, with damage extending into the retroperitoneal tissues. Local complications include pancreatic cysts or abscesses and acute fluid collections in or near the pancreas. Patients who develop systemic complications with organ failure, such as pulmonary insufficiency with hypoxia, shock, renal failure, and GI bleeding, are also characterized as having severe acute pancreatitis.

## Gerontologic Considerations

Acute pancreatitis affects people of all ages, but the mortality rate associated with acute pancreatitis increases with advancing age. In addition, the pattern of complications changes with age. Younger patients tend to develop local complications; the incidence of multiple organ failure increases with age, possibly as a result of progressive decreases in physiologic function of major organs with increasing age. Close monitoring of major organ function (ie, lungs, kidneys) is essential, and aggressive treatment is necessary to reduce mortality from acute pancreatitis in the elderly.

## Pathophysiology

Self-digestion of the pancreas by its own proteolytic enzymes, principally trypsin, causes acute pancreatitis. Eighty percent of patients with acute pancreatitis have biliary tract disease or a history of long-term alcohol abuse. These patients usually have had undiagnosed chronic pancreatitis before their first episode of acute pancreatitis. Gallstones enter the common bile duct and lodge at the ampulla of Vater, obstructing the flow of pancreatic juice or causing a reflux of bile from the common bile duct into the pancreatic duct, thus activating the powerful enzymes within the pancreas. Normally, these remain in an inactive form until the pancreatic secretions reach the lumen of the duodenum. Activation of the enzymes can lead to vasodilation, increased vascular permeability, necrosis, erosion, and hemorrhage (Zinner & Ashley, 2007).

Other less common causes of pancreatitis include bacterial or viral infection, with pancreatitis occasionally developing as a complication of mumps virus. Spasm and edema of the ampulla of Vater, caused by duodenitis, can probably produce pancreatitis. Blunt abdominal trauma, peptic ulcer disease, ischemic vascular disease, hyperlipidemia, hypercalcemia, and the use of corticosteroids, thiazide diuretics, oral contraceptives, and other medications have also been associated with an increased incidence of pancreatitis. Acute pancreatitis may develop after surgery on or near the pancreas or after instrumentation of the pancreatic duct. Acute idiopathic pancreatitis accounts for up to 10% of the cases of acute pancreatitis. Some experts postulate that these cases may be related to occult microlithiasis (small stones in the bile) (Zinner & Ashley, 2007). In addition, there is a small incidence of hereditary pancreatitis.

The overall mortality rate of patients with acute pancreatitis is high (2% to 10%) because of shock, anoxia, hypotension, or fluid and electrolyte imbalances. This mortality rate may also be related to the 10% to 30% of patients with severe acute disease characterized by pancreatic and peripancreatic necrosis (Zinner & Ashley, 2007). Attacks of acute pancreatitis may result in complete recovery, may recur without permanent damage, or may progress to chronic pancreatitis. The patient who is admitted to the hospital with a diagnosis of pancreatitis is acutely ill and needs expert nursing and medical care.

### Chart 40-3 • *Criteria for Predicting Severity of Pancreatitis**

**Criteria on Admission to Hospital**

Age >55 years
WBC >16,000 mm$^3$
Serum glucose >200 mg/dL (>11.1 mmol/L)
Serum LDH >350 IU/L (>350 U/L)
AST >250 U/mL (120 U/L)

**Criteria Within 48 Hours of Hospital Admission**

Fall in hematocrit >10% (>0.10)
BUN increase >5 mg/dL (>1.7 mmol/L)
Serum calcium <8 mg/dL (<2.0 mmol/L)
Base deficit >4 mEq/L (>4 mmol/L)
Fluid retention or sequestration >6 L
$PO_2$ <60 mm Hg

Two or fewer signs, 1% mortality; 3 or 4 signs, 15% mortality; 5 or 6 signs, 40% mortality; >6 signs, 100% mortality.

*Note: The more risk factors a patient has, the greater the severity and likelihood of complications or death.

The severity of acute alcoholic pancreatitis and its outcomes can be predicted based on clinical and laboratory data (Chart 40-3).

## Clinical Manifestations

Severe abdominal pain is the major symptom of pancreatitis that causes the patient to seek medical care. Abdominal pain and tenderness and back pain result from irritation and edema of the inflamed pancreas. Increased tension on the pancreatic capsule and obstruction of the pancreatic ducts also contribute to the pain. Typically, the pain occurs in the midepigastrium. Pain is frequently acute in onset, occurring 24 to 48 hours after a very heavy meal or alcohol ingestion, and it may be diffuse and difficult to localize. It is generally more severe after meals and is unrelieved by antacids. Pain may be accompanied by abdominal distention; a poorly defined, palpable abdominal mass; decreased peristalsis; and vomiting that fails to relieve the pain or nausea.

The patient appears acutely ill. Abdominal guarding is present. A rigid or boardlike abdomen may develop and is generally an ominous sign, usually indicating peritonitis. Ecchymosis (bruising) in the flank or around the umbilicus may indicate severe pancreatitis. Nausea and vomiting are common in acute pancreatitis. The emesis is usually gastric in origin but may also be bile stained. Fever, jaundice, mental confusion, and agitation may also occur.

Hypotension is typical and reflects hypovolemia and shock caused by the loss of large amounts of protein-rich fluid into the tissues and peritoneal cavity. In addition to

hypotension, the patient may develop tachycardia, cyanosis, and cold, clammy skin. Acute renal failure is common.

Respiratory distress and hypoxia are common, and the patient may develop diffuse pulmonary infiltrates, dyspnea, tachypnea, and abnormal blood gas values. Myocardial depression, hypocalcemia, hyperglycemia, and disseminated intravascular coagulation may also occur with acute pancreatitis.

## Assessment and Diagnostic Findings

The diagnosis of acute pancreatitis is based on a history of abdominal pain, the presence of known risk factors, physical examination findings, and diagnostic findings. Serum amylase and lipase levels are used in making the diagnosis of acute pancreatitis, although their elevation can be attributed to many other causes (Feldman, et al., 2006). In most cases, serum amylase and lipase levels are elevated within 24 hours of the onset of the symptoms. Serum amylase usually returns to normal within 48 to 72 hours, but serum lipase levels may remain elevated for a longer period, often days longer than amylase. Urinary amylase levels also become elevated and remain elevated longer than serum amylase levels. The white blood cell count is usually elevated; hypocalcemia is present in many patients and correlates well with the severity of pancreatitis. Transient hyperglycemia and glucosuria and elevated serum bilirubin levels occur in some patients with acute pancreatitis.

X-ray studies of the abdomen and chest may be obtained to differentiate pancreatitis from other disorders that can cause similar symptoms and to detect pleural effusions. Ultrasound and contrast-enhanced CT scans are used to identify an increase in the diameter of the pancreas and to detect pancreatic cysts, abscesses, or pseudocysts.

Hematocrit and hemoglobin levels are used to monitor the patient for bleeding. Peritoneal fluid, obtained through paracentesis or peritoneal lavage, may contain increased levels of pancreatic enzymes. ERCP is rarely used in the diagnostic evaluation of acute pancreatitis, because the patient is acutely ill; however, it may be valuable in the treatment of gallstone pancreatitis.

## Medical Management

Management of acute pancreatitis is directed toward relieving symptoms and preventing or treating complications. All oral intake is withheld to inhibit stimulation of the pancreas and its secretion of enzymes. Parenteral nutrition plays an important role in the nutritional support of patients with severe acute pancreatitis, particularly in those who are debilitated and those with a prolonged paralytic ileus (more than 48 to 72 hours) (Zinner & Ashley, 2007). Ongoing research has shown positive outcomes with the use of enteral feedings. The current recommendation is that, whenever possible, the enteral route should be used to meet nutritional needs in patients with pancreatitis. This strategy also has been found to prevent infectious complications, safely and cost effectively (DiMagno & DiMagno, 2007; Zinner & Ashley, 2007). Enteral feedings should be started early in the course of acute pancreatitis. Patients who do not tolerate enteral feeding require parenteral nutrition. Nasogastric suction may be used to relieve nausea and vomiting and to decrease painful abdominal distention and paralytic ileus. Research data do not support the routine use of nasogastric tubes to remove gastric secretions in an effort to limit pancreatic secretion. Histamine-2 ($H_2$) antagonists such as cimetidine (Tagamet) and ranitidine (Zantac) may be prescribed to decrease pancreatic activity by inhibiting secretion of gastric acid. Proton pump inhibitors such as pantoprazole (Protonix) may be used for patients who do not tolerate $H_2$ antagonists or for whom this therapy is ineffective.

### *Pain Management*

Adequate administration of analgesia is essential during the course of acute pancreatitis to provide sufficient pain relief and to minimize restlessness, which may stimulate pancreatic secretion further. Pain relief may require parenteral opioids such as morphine, fentanyl (Sublimaze), or hydromorphone (Dilaudid) (Hauser, Pardi & Poterucha, 2006). The use of morphine was avoided in the past because of concern that it could cause painful spasms of the sphincter of Oddi and worsen pancreatitis; however, all opioids stimulate this sphincter to some degree. There is no clinical evidence to support the use of meperidine for pain relief in pancreatitis, and, in fact, accumulation of its metabolites can cause CNS irritability and possibly seizures. The current recommendation for pain management is the use of opioids, with assessment for their effectiveness and altering therapy if pain is not controlled or increased (Wolfe, Davis, Farraye, et al., 2006). More research is needed to identify the best option for pain management in the patient with acute pancreatitis (Hauser, et al., 2006). Antiemetic agents may be prescribed to prevent vomiting.

### *Intensive Care*

Correction of fluid and blood loss and low albumin levels is necessary to maintain fluid volume and prevent renal failure. The patient is usually acutely ill and is monitored in the intensive care unit, where hemodynamic monitoring and arterial blood gas monitoring are initiated. Antibiotic agents may be prescribed if infection is present. The role of prophylactic antibiotics is controversial and still under study. Insulin may be required if hyperglycemia occurs. Intensive insulin therapy (continuous infusion) in the critically ill patient has undergone much study and has shown promise in terms of positive patient outcomes when compared with intermittent insulin dosing. Glycemic control with normal or near normal blood glucose levels improves patient outcomes.

### *Respiratory Care*

Aggressive respiratory care is indicated because of the high risk of elevation of the diaphragm, pulmonary infiltrates and effusion, and atelectasis. Hypoxemia occurs in a significant number of patients with acute pancreatitis, even with normal x-ray findings. Respiratory care may range from close monitoring of arterial blood gases to use of humidified oxygen to intubation and mechanical ventilation (see Chapter 25 for further discussion).

### *Biliary Drainage*

Placement of biliary drains (for external drainage) and stents (indwelling tubes) in the pancreatic duct through endoscopy has been performed to reestablish drainage of the

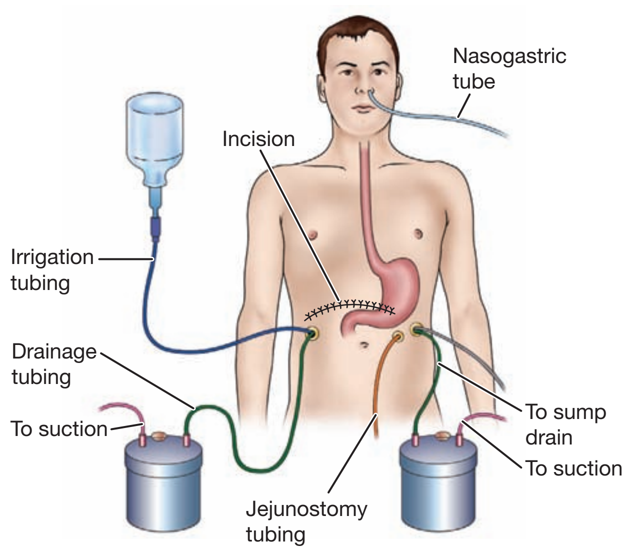



**Figure 40-6** Multiple sump tubes are used after pancreatic surgery. Triple-lumen tubes consist of ports that provide tubing for irrigation, air venting, and drainage.

pancreas. This has resulted in decreased pain and increased weight gain.

### *Surgical Intervention*

Although surgery is often risky because the acutely ill patient is a poor surgical risk, it may be performed to assist in the diagnosis of pancreatitis (diagnostic laparotomy), to establish pancreatic drainage, or to resect or débride a necrotic pancreas. The patient who undergoes pancreatic surgery may have multiple drains in place postoperatively, as well as a surgical incision that is left open for irrigation and repacking every 2 to 3 days to remove necrotic debris (Fig. 40-6).

### *Postacute Management*

Antacids may be used after acute pancreatitis begins to resolve. Oral feedings that are low in fat and protein are initiated gradually. Caffeine and alcohol are eliminated from the diet. If the episode of pancreatitis occurred during treatment with thiazide diuretics, corticosteroids, or oral contraceptives, these medications are discontinued. Follow-up may include ultrasound, x-ray studies, or ERCP to determine whether the pancreatitis is resolving and to assess for abscesses and pseudocysts. ERCP may also be used to identify the cause of acute pancreatitis if it is in question and for endoscopic sphincterotomy and removal of gallstones from the common bile duct.

## Nursing Management

### *Relieving Pain and Discomfort*

Because the pathologic process responsible for pain is autodigestion of the pancreas, the objectives of therapy are to relieve pain and decrease secretion of pancreatic enzymes. The pain of acute pancreatitis is often very severe, necessitating the liberal use of analgesics. The current recommendation for pain management in this population is parenteral opioids, including morphine, hydromorphone, or fentanyl via patient-controlled analgesia or bolus (Hauser, et al., 2006; Wolfe, et al., 2006). In critically ill patients, a continuous infusion may be needed. Because most opioids stimulate spasm of the sphincter of Oddi to some degree, consensus has not been reached on the most effective agent. Ensuring patient comfort, regardless of the opioid prescribed, is the most essential aspect of care. The nurse frequently assesses the pain and the effectiveness of the pharmacologic (and nonpharmacologic) interventions. Changes may be needed in the regimen for pain management based on the achievement of pain control. Pain assessment tools (see Chapter 13) are available for the nurse to ensure an accurate rating of pain. Nonpharmacologic interventions such as proper positioning, music, distraction, and imagery may be effective in reducing pain when used along with medications.

In addition, oral feedings are withheld to decrease the secretion of secretin. Parenteral fluids and electrolytes are prescribed to restore and maintain fluid balance. Nasogastric suction may be used to relieve nausea and vomiting or to treat abdominal distention and paralytic ileus. The nurse provides frequent oral hygiene and care to decrease discomfort from the nasogastric tube and relieve dryness of the mouth.

The acutely ill patient is maintained on bed rest to decrease the metabolic rate and reduce the secretion of pancreatic and gastric enzymes. If the patient experiences increasing severity of pain, the nurse reports this to the physician because the patient may be experiencing hemorrhage of the pancreas or the dose of analgesic may be inadequate.

The patient with acute pancreatitis often has a clouded sensorium because of severe pain, fluid and electrolyte disturbances, and hypoxia. Therefore, the nurse provides frequent and repeated but simple explanations about the need for withholding fluids, maintenance of gastric suction, and bed rest.

### *Improving Breathing Pattern*

The nurse maintains the patient in a semi-Fowler's position to decrease pressure on the diaphragm by a distended abdomen and to increase respiratory expansion. Frequent changes of position are necessary to prevent atelectasis and pooling of respiratory secretions. Pulmonary assessment, including monitoring of pulse oximetry or arterial blood gases, is essential to detect changes in respiratory status so that early treatment can be initiated. The nurse instructs the patient in techniques of coughing and deep breathing and in the use of incentive spirometry to improve respiratory function and assists the patient to perform these activities every hour.

### *Improving Nutritional Status*

Oral food or fluid intake is not permitted. However, it is important to assess the patient's nutritional status and to note factors that alter the patient's nutritional requirements (eg, temperature elevation, surgery, drainage). Laboratory test results and daily weights are useful to monitor the nutritional status.

Enteral or parenteral nutrition may be prescribed. In addition to administering enteral or parenteral nutrition, the nurse monitors serum glucose levels every 4 to 6 hours. As the acute symptoms subside, oral feedings are gradually reintroduced.

Between acute attacks, the patient receives a diet that is high in carbohydrates and low in fats and proteins. The patient should avoid heavy meals and alcoholic beverages.

#### Maintaining Skin Integrity

The patient is at risk for skin breakdown because of poor nutritional status, enforced bed rest, and restlessness, which may result in pressure ulcers and breaks in tissue integrity. In addition, the patient who has undergone surgery may have multiple drains or an open surgical incision and is at risk for skin breakdown and infection. The nurse carefully assesses the wound, drainage sites, and skin for signs of infection, inflammation, and breakdown. The nurse carries out wound care as prescribed and takes precautions to protect intact skin from contact with drainage. Consultation with a **wound-ostomy-continence (WOC) nurse** (formerly referred to as a wound care specialist or enterostomal therapist) is often helpful in identifying appropriate skin care devices and protocols. It is important to turn the patient every 2 hours; use of specialty beds may be indicated to prevent skin breakdown.

#### Monitoring and Managing Potential Complications

Fluid and electrolyte disturbances are common complications because of nausea, vomiting, movement of fluid from the vascular compartment to the peritoneal cavity, diaphoresis, fever, and the use of gastric suction. The nurse assesses the patient's fluid and electrolyte status by noting skin turgor and moistness of mucous membranes. The nurse weighs the patient daily and carefully measures fluid intake and output, including urine output, nasogastric secretions, and diarrhea. In addition, it is important to assess for other factors that may affect fluid and electrolyte status, including increased body temperature and wound drainage. The nurse assesses the patient for ascites and measures abdominal girth daily if ascites is suspected.

Fluids are administered intravenously and may be accompanied by infusion of blood or blood products to maintain the blood volume and to prevent or treat hypovolemic shock. It is important to keep emergency medications readily available because of the risk of circulatory collapse and shock. The nurse promptly reports decreased blood pressure and reduced urine output, which indicate hypovolemia and shock or renal failure. Low serum calcium and magnesium levels may occur and require prompt treatment.

Pancreatic necrosis is a major cause of morbidity and mortality in patients with acute pancreatitis because of resulting hemorrhage, septic shock, and multiple organ failure. The patient may undergo diagnostic procedures for confirmation of pancreatic necrosis, for surgical débridement, or for insertion of multiple drains. The patient with pancreatic necrosis is usually critically ill and requires expert medical and nursing management, including hemodynamic monitoring in the intensive care unit.

In addition to carefully monitoring vital signs and other signs and symptoms, the nurse is responsible for administering prescribed fluids, medications, and blood products; assisting with supportive management, such as use of a ventilator; preventing additional complications; and providing physical and psychological care.

Shock and multiple organ failure may occur with acute pancreatitis. Hypovolemic shock may occur as a result of hypovolemia and sequestering of fluid in the peritoneal cavity. Hemorrhagic shock may occur with hemorrhagic pancreatitis. Septic shock may occur with bacterial infection of the pancreas. Cardiac dysfunction may occur as a result of fluid and electrolyte disturbances, acid–base imbalances, and release of toxic substances into the circulation.

The nurse closely monitors the patient for early signs of neurologic, cardiovascular, renal, and respiratory dysfunction. The nurse must be prepared to respond quickly to rapid changes in the patient's status, treatments, and therapies. In addition, it is important to inform the family about the status and progress of the patient and to allow them to spend time with the patient. (Management of shock is discussed in detail in Chapter 15.)

#### Promoting Home and Community-Based Care

**Teaching Patients Self-Care**

The patient who has survived an episode of acute pancreatitis has been acutely ill. A prolonged period is needed to regain strength and return to the previous level of activity. The patient is often still weak and debilitated for weeks or months after an acute episode of pancreatitis. Because of the severity of the acute illness, the patient may not recall many of the explanations and instructions given during the acute phase. Teaching often needs to be repeated and reinforced. The nurse instructs the patient about the factors implicated in the onset of acute pancreatitis and about the need to avoid high-fat foods, heavy meals, and alcohol. It is important to give the patient and family verbal and written instructions about signs and symptoms of acute pancreatitis and possible complications that should be reported promptly to the physician.

If acute pancreatitis is a result of biliary tract disease, such as gallstones and gallbladder disease, additional explanations are needed about required dietary modifications. If the pancreatitis is a result of alcohol abuse, the nurse reinforces the need to avoid all alcohol.

**Continuing Care**

A referral for home care is often indicated. This enables the nurse to assess the patient's physical and psychological status and adherence to the therapeutic regimen. The nurse also assesses the home situation and reinforces instructions about fluid and nutrition intake and avoidance of alcohol. After the acute attack has subsided, some patients may be inclined to return to their previous drinking habits. The nurse provides specific information about resources and support groups that may be of assistance in avoiding alcohol in the future. Referral to Alcoholics Anonymous or other appropriate support groups is essential. See the accompanying plan of nursing care in Chart 40-4 for the patient with acute pancreatitis.

## Chronic Pancreatitis

Chronic pancreatitis is an inflammatory disorder characterized by progressive destruction of the pancreas. As cells are replaced by fibrous tissue with repeated attacks of pancreatitis,

CHART 40-4

## PLAN OF NURSING CARE
### *Care of the Patient With Acute Pancreatitis*

**NURSING DIAGNOSIS:** Acute pain and discomfort related to edema, distention of the pancreas, and peritoneal irritation
**GOAL:** Relief of pain and discomfort

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Administer morphine, fentanyl, or hydromorphone frequently, as prescribed, to achieve level of pain acceptable to patient based on patient's level of pain and discomfort. | 1. Morphine, fentanyl, and hydromorphone act by depressing the central nervous system and thereby increasing the patient's pain threshold. Meperidine (Demerol) is avoided because it has failed acute pain studies and it possesses toxic metabolites. | • Reports relief of pain.<br>• Moves and turns without increasing pain and discomfort.<br>• Rests comfortably and sleeps for increasing periods.<br>• Reports less frequent episodes of pain, discomfort, and cramping.<br>• Experiences enhanced pain relief.<br>• Reports increased feelings of well-being and security with the health care team. |
| 2. Using a pain scale, assess pain level before and after administration of analgesic. | 2. Assessment and control of pain are important because restlessness increases body metabolism, which stimulates the secretion of pancreatic and gastric enzymes. | |
| 3. Report unrelieved pain or increasing intensity of pain. | 3. Pain may increase pancreatic enzymes and may also indicate pancreatic hemorrhage. | |
| 4. Assist the patient to assume positions of comfort; turn and reposition every 2 hours. | 4. Frequent turning relieves pressure and assists in preventing pulmonary and vascular complications. | |
| 5. Use nonpharmacologic interventions for relieving pain (eg, relaxation, focused breathing, diversion). | 5. Use of nonpharmacologic methods will enhance the effects of analgesics. Gate control theory suggests that cutaneous stimulation closes the pain pathways. | |
| 6. Listen to patient's expression of pain experience. | 6. Demonstration of caring can help to decrease anxiety. | |

**NURSING DIAGNOSIS:** Acute pain and discomfort related to excess stimulation of pancreatic secretions
**GOAL:** Relief of pain related to stimulation of the pancreas

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Administer anticholinergic medications as prescribed. | 1. Anticholinergic medications reduce gastric and pancreatic secretion. | • Reports relief of pain, discomfort, and abdominal cramping.<br>• Consumes no fluid and food during acute phase.<br>• Maintains bed rest.<br>• Identifies rationale for fluid and dietary restrictions and use of nasogastric drainage.<br>• Cooperates with insertion of nasogastric tube and suction. |
| 2. Withhold oral intake. | 2. Pancreatic secretion is increased by food and fluid intake. | |
| 3. Maintain the patient on bed rest. | 3. Bed rest decreases body metabolism and thus reduces pancreatic and gastric secretions. | |
| 4. Maintain continuous nasogastric drainage if paralytic ileus or nausea and vomiting, abdominal distention are present.<br>a. Measure gastric secretions at specified intervals.<br>b. Observe and record color and viscosity of gastric secretions.<br>c. Ensure that the nasogastric tube is patent to permit free drainage. | 4. Nasogastric suction relieves nausea, vomiting, and abdominal distention. Decompression of the intestines (if intestinal intubation is used) also assists in relieving respiratory distress. | |

**NURSING DIAGNOSIS:** Discomfort related to nasogastric tube
**GOAL:** Relief of discomfort associated with nasogastric intubation used to treat ileus, vomiting, distention

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Use water-soluble lubricant around external nares. | 1. Prevents irritation of nares. | • Exhibits intact skin and tissue of nares at site of nasogastric tube insertion.<br>• Reports no pain or irritation of nares or oropharynx. |
| 2. Turn patient at intervals; avoid pressure or tension on nasogastric tube. | 2. Relieves pressure of tube on esophageal and gastric mucosa. | |

*Continued*

CHART 40-4

PLAN OF NURSING CARE

## Care of the Patient With Acute Pancreatitis (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Provide oral hygiene and gargling solutions without alcohol.<br>4. Explain rationale for use of nasogastric drainage | 3. Relieves dryness and irritation of oropharynx.<br>4. Assists patient to cooperate with the drainage, nasogastric tube, and suction. | • Exhibits moist, clean mucous membranes of mouth and nasopharynx.<br>• States that thirst is relieved by oral hygiene.<br>• Identifies rationale for nasogastric tube and suction. |

**NURSING DIAGNOSIS:** Imbalanced nutrition: less than body requirements related to inadequate dietary intake, impaired pancreatic secretions, increased nutritional needs secondary to acute illness, and increased body temperature
**GOAL:** Improvement in nutritional status

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess current nutritional status and increased metabolic requirements.<br>2. Monitor serum glucose levels and administer insulin as prescribed.<br>3. Administer intravenous fluid and electrolytes, enteral or parenteral nutrition as prescribed.<br>4. Provide high-carbohydrate, low-protein, low-fat diet when tolerated.<br>5. Instruct patient to eliminate alcohol and refer to Alcoholics Anonymous if indicated.<br>6. Counsel patient to avoid excessive use of coffee and spicy foods.<br>7. Monitor daily weights. | 1. Alteration in pancreatic secretions interferes with normal digestive processes. Acute illness, infection, and fever increase metabolic needs.<br>2. Impairment of endocrine function of the pancreas leads to increased serum glucose levels.<br>3. Parenteral administration of fluids and electrolytes, and enteral or parenteral nutrients are essential to provide fluids, calories, electrolytes, and nutrients when oral intake is prohibited.<br>4. These foods increase caloric intake without stimulating pancreatic secretions beyond the ability of the pancreas to respond.<br>5. Alcohol intake produces further damage to pancreas and precipitates attacks of acute pancreatitis.<br>6. Coffee and spicy foods increase pancreatic and gastric secretions.<br>7. This provides a baseline and a means to measure weight gain or weight loss. | • Maintains normal body weight.<br>• Demonstrates no additional weight loss.<br>• Maintains normal serum glucose levels.<br>• Reports decreasing episodes of vomiting and diarrhea.<br>• Reports return of normal stool characteristics and bowel pattern.<br>• Consumes foods high in carbohydrates, low in fat and protein.<br>• Explains rationale for high-carbohydrate, low-fat, low-protein diet.<br>• Eliminates alcohol from diet.<br>• Explains rationale for limiting coffee intake and avoiding spicy foods.<br>• Participates in Alcoholics Anonymous or other counseling approach.<br>• Returns to and maintains desirable weight. |

**NURSING DIAGNOSIS:** Ineffective breathing pattern related to splinting from severe pain, pulmonary infiltrates, pleural effusion, and atelectasis
**GOAL:** Improvement in respiratory function

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess respiratory status (rate, pattern, breath sounds), pulse oximetry, and arterial blood gases.<br>2. Maintain semi-Fowler's position.<br>3. Instruct and encourage patient to take deep breaths and to cough every hour.<br>4. Assist patient to turn and change position every 2 hours. | 1. Acute pancreatitis produces retroperitoneal edema, elevation of the diaphragm, pleural effusion, and inadequate lung ventilation. Intra-abdominal infection and labored breathing increase the body's metabolic demands, which further decreases pulmonary reserve and leads to respiratory failure.<br>2. Decreases pressure on diaphragm and allows greater lung expansion.<br>3. Taking deep breaths and coughing will clear the airways and reduce atelectasis.<br>4. Changing position frequently assists aeration and drainage of all lobes of the lungs. | • Demonstrates normal respiratory rate and pattern and full lung expansion.<br>• Demonstrates normal breath sounds and absence of adventitious breath sounds.<br>• Demonstrates normal arterial blood gases and pulse oximetry.<br>• Maintains semi-Fowler's position when in bed.<br>• Changes position in bed frequently.<br>• Coughs and takes deep breaths at least every hour.<br>• Demonstrates normal body temperature.<br>• Exhibits no signs or symptoms of respiratory infection or impairment.<br>• Is alert and responsive to environment. |

*Continued on following page*

CHART 40-4

PLAN OF NURSING CARE

## *Care of the Patient With Acute Pancreatitis* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 5. Reduce the excessive metabolism of the body.<br>a. Administer antibiotics as prescribed.<br>b. Place patient in an air-conditioned room.<br>c. Administer nasal oxygen as required for hypoxia.<br>d. Use a hypothermia blanket if necessary. | 5. Pancreatitis produces a severe peritoneal and retroperitoneal reaction that causes fever, tachycardia, and accelerated respirations. Placing the patient in an air-conditioned room and supporting the patient with oxygen therapy decrease the workload of the respiratory system and the tissue utilization of oxygen. Reduction of fever and pulse rate decreases the metabolic demands on the body. | |

**COLLABORATIVE PROBLEM:** Fluid and electrolyte disturbances, hypovolemia, shock
**GOAL:** Improvement in fluid and electrolyte status, prevention of hypovolemia and shock

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess fluid and electrolyte status (skin turgor, mucous membranes, urine output, vital signs, hemodynamic parameters). | 1. The amount and type of fluid and electrolyte replacement are determined by the status of the blood pressure, the laboratory evaluations of serum electrolyte and blood urea nitrogen levels, the urinary volume, and the assessment of the patient's condition. | • Exhibits moist mucous membranes and normal skin turgor.<br>• Exhibits normal blood pressure without evidence of postural (orthostatic) hypotension.<br>• Excretes adequate urine volume.<br>• Exhibits normal, not excessive, thirst.<br>• Maintains normal pulse and respiratory rate.<br>• Remains alert and responsive.<br>• Exhibits normal arterial pressures and blood gases.<br>• Exhibits normal electrolyte levels.<br>• Exhibits no signs or symptoms of calcium deficit (eg, tetany, carpopedal spasm).<br>• Exhibits no additional losses of fluids and electrolytes through vomiting, diarrhea, or diaphoresis.<br>• Reports stabilization of weight.<br>• Demonstrates no increase in abdominal girth.<br>• Demonstrates no fluid wave on palpation of the abdomen.<br>• Demonstrates stable organ function without manifestations of failure. |
| 2. Assess sources of fluid and electrolyte loss (vomiting, diarrhea, nasogastric drainage, excessive diaphoresis). | 2. Electrolyte losses occur from nasogastric suctioning, severe diaphoresis, emesis, and as a result of the patient's being in a fasting state. | |
| 3. Combat shock if present.<br>a. Administer corticosteroids as prescribed if patient does not respond to conventional treatment.<br>b. Evaluate the amount of urinary output. Attempt to maintain this at 50 mL/h. | 3. Extensive acute pancreatitis may cause peripheral vascular collapse and shock. Blood and plasma may be lost into the abdominal cavity, and, therefore, there is a decreased blood and plasma volume. The toxins from the bacteria of a necrotic pancreas may cause shock. | |
| 4. Administer blood products, fluids, and electrolytes (sodium, potassium, chloride) as prescribed. | 4. Patients with hemorrhagic pancreatitis lose large amounts of blood and plasma, which decreases effective circulation and blood volume. | |
| 5. Administer plasma and blood products as prescribed. | 5. Replacement with blood, plasma or albumin assists in ensuring effective circulating blood volume. | |
| 6. Keep a supply of intravenous calcium gluconate readily available. | 6. Calcium may be prescribed to prevent or treat tetany, which may result from calcium losses into retroperitoneal (peripancreatic) exudate. | |
| 7. Assess abdomen for ascites formation:<br>a. Measure abdominal girth daily.<br>b. Weigh patient daily.<br>c. Palpate abdomen for fluid wave. | 7. During acute pancreatitis, plasma may be lost into the abdominal cavity, which diminishes the blood volume. | |
| 8. Monitor for manifestations of multiple organ failure: neurologic, cardiovascular, renal, and respiratory dysfunction. | 8. All body systems may fail if pancreatitis is severe and treatment is ineffective. | |

pressure within the pancreas increases. The result is obstruction of the pancreatic and common bile ducts and the duodenum. Additionally, there is atrophy of the epithelium of the ducts, inflammation, and destruction of the secreting cells of the pancreas.

Alcohol consumption in Western societies and malnutrition worldwide are the major causes of chronic pancreatitis. The median age of patients diagnosed with chronic pancreatitis is 37 to 40 years. Frequently, at that age, patients already report a long history of alcohol abuse. Excessive and prolonged consumption of alcohol accounts for approximately 70% to 80% of all cases of chronic pancreatitis (Zinner & Ashley, 2007). The incidence of pancreatitis is 50 times greater in people with alcoholism than in those who do not abuse alcohol. Long-term alcohol consumption causes hypersecretion of protein in pancreatic secretions, resulting in protein plugs and calculi within the pancreatic ducts. Alcohol also has a direct toxic effect on the cells of the pancreas. Damage to these cells is more likely to occur and to be more severe in patients whose diets are poor in protein content and either very high or very low in fat.

Smoking is another factor in the development of chronic pancreatitis. Because heavy drinkers usually smoke, it is difficult to separate the effects of the alcohol abuse and smoking (Lankisch, 2007).

## Clinical Manifestations

Chronic pancreatitis is characterized by recurring attacks of severe upper abdominal and back pain, accompanied by vomiting. Attacks are often so painful that opioids, even in large doses, do not provide relief. The risk of opioid dependence is increased in pancreatitis because of the chronic nature and severity of the pain. As the disease progresses, recurring attacks of pain are more severe, more frequent, and of longer duration. Some patients experience continuous severe pain, and others have dull, nagging constant pain. Periods of well-being sometimes follow the episodes of pain (Wolfe, et al., 2006). In fact, in some patients, chronic pancreatitis is painless. The natural history of abdominal pain (character, timing, severity) is variable, and many studies have documented a decrease in pain ("burnout") over time in a majority of patients (Dominguez-Muñoz & Malfertheiner, 2005).

Weight loss is a major problem in chronic pancreatitis: More than 80% of patients experience significant weight loss, which is usually caused by decreased dietary intake secondary to anorexia or fear that eating will precipitate another attack (Wolfe, et al., 2006). Malabsorption occurs late in the disease, when as little as 10% of pancreatic function remains (Dominguez-Muñoz & Malfertheiner, 2005). As a result, digestion, especially of proteins and fats, is impaired. The stools become frequent, frothy, and foul-smelling because of impaired fat digestion, which results in stools with a high fat content. This is referred to as **steatorrhea.** As the disease progresses, calcification of the gland may occur, and calcium stones may form within the ducts.

## Assessment and Diagnostic Findings

ERCP is the most useful study in the diagnosis of chronic pancreatitis. It provides details about the anatomy of the pancreas and the pancreatic and biliary ducts. It is also helpful in obtaining tissue for analysis and differentiating pancreatitis from other conditions, such as carcinoma. Various imaging procedures, including magnetic resonance imaging (MRI), CT scans, and ultrasound, are used in the diagnostic evaluation of patients with suspected pancreatic disorders. A CT scan or ultrasound study is also helpful to detect pancreatic cysts.

A glucose tolerance test evaluates pancreatic islet cell function and provides necessary information for making decisions about surgical resection of the pancreas. An abnormal glucose tolerance test may indicate the presence of diabetes associated with pancreatitis. Acute exacerbations of chronic pancreatitis may result in increased serum amylase levels. Steatorrhea is best confirmed by laboratory analysis of fecal fat content (Dominguez-Muñoz & Malfertheiner, 2005).

## Medical Management

The management of chronic pancreatitis depends on its probable cause in each patient. Treatment is directed toward preventing and managing acute attacks, relieving pain and discomfort, and managing exocrine and endocrine insufficiency of pancreatitis.

### *Nonsurgical Management*

Nonsurgical approaches may be indicated for the patient who refuses surgery, who is a poor surgical risk, or whose disease and symptoms do not warrant surgical intervention. Endoscopy to remove pancreatic duct stones, correct strictures, and drain cysts may be effective in selected patients to manage pain and relieve obstruction (Zinner & Ashley, 2007).

Management of abdominal pain and discomfort is similar to that of acute pancreatitis; however, the focus is usually on the use of nonopioid methods to manage pain. Antioxidants that may relieve pain and improve reported quality of life are being studied (Kirk, White, McKie, et al., 2006). Researchers have proposed that yoga may be an effective nonpharmacologic method for pain reduction and for relief of other coexisting symptoms of chronic pancreatitis (Sareen & Kumari, 2006). Persistent, unrelieved pain is often the most difficult aspect of management (Zinner & Ashley, 2007). The physician, nurse, and dietitian emphasize to the patient and family the importance of avoiding alcohol and foods that have produced abdominal pain and discomfort in the past. The health care team stresses to the patient that no other treatment is likely to relieve pain if the patient continues to consume alcohol.

Diabetes mellitus resulting from dysfunction of the pancreatic islet cells is treated with diet, insulin, or oral antidiabetic agents. The hazard of severe hypoglycemia with alcohol consumption is stressed to the patient and family. Pancreatic enzyme replacement is indicated for the patient with malabsorption and steatorrhea.

### *Surgical Management*

Chronic pancreatitis is not often managed by surgery. However, surgery may be indicated to relieve persistent abdominal pain and discomfort, restore drainage of pancreatic secretions, and reduce the frequency of acute attacks of pancreatitis and hospitalization (Zinner & Ashley, 2007).

The type of surgery performed depends on the anatomic and functional abnormalities of the pancreas, including the location of disease within the pancreas, the presence of diabetes, exocrine insufficiency, biliary stenosis, and pseudocysts of the pancreas. Other considerations for surgery selection include the patient's likelihood for continued use of alcohol and the likelihood that the patient will be able to manage the endocrine or exocrine changes that are expected after surgery.

**Pancreaticojejunostomy** (also referred to as Roux-en-Y), with a side-to-side anastomosis or joining of the pancreatic duct to the jejunum, allows drainage of the pancreatic secretions into the jejunum. Pain relief occurs within 6 months in more than 85% of the patients who undergo this procedure, but pain returns in a substantial number of patients as the disease progresses (Zinner & Ashley, 2007).

Other surgical procedures may be performed for different degrees and types of underlying disorders. These procedures include revision of the sphincter of the ampulla of Vater, internal drainage of a pancreatic cyst into the stomach (see later discussion), insertion of a stent, and wide resection or removal of the pancreas. A Whipple resection (pancreaticoduodenectomy) can be carried out to relieve the pain of chronic pancreatitis. In an effort to provide permanent pain relief and avoid endocrine and exocrine insufficiency that ensue with major resections of the pancreas, surgeons have designed new procedures that combine limited resection of the head of the pancreas with a pancreaticojejunostomy. These procedures, known as the Beger or Frey operations, remove most of the head of the pancreas except for a shell of pancreatic tissue posteriorly (Bayless & Diehl, 2005; Zinner & Ashley, 2007).

When chronic pancreatitis develops as a result of gallbladder disease, surgery is performed to explore the common duct and remove the stones; usually, the gallbladder is removed at the same time. In addition, an attempt is made to improve the drainage of the common bile duct and the pancreatic duct by dividing the sphincter of Oddi, a muscle that is located at the ampulla of Vater (this surgical procedure is known as a sphincterotomy). A T-tube usually is placed in the common bile duct, requiring a drainage system to collect the bile postoperatively. Nursing care after such surgery is similar to that indicated after other biliary tract surgery.

Approximately two thirds of all patients with chronic pancreatitis can be managed with endoscopic or laparoscopic intervention (Wolfe, et al., 2006). Endoscopic and laparoscopic procedures such as distal pancreatectomy, longitudinal decompression of the pancreatic duct, nerve denervation, and stenting have been performed in patients with jaundice or recurrent inflammation and are being refined. Minimally invasive procedures to treat chronic pancreatitis may prove to be successful adjuncts in the management of this complex disorder (Beger & Bettina, 2007; Wolfe, et al., 2006).

Patients who undergo surgery for chronic pancreatitis may experience weight gain and improved nutritional status; this may result from reduction in pain associated with eating rather than from correction of malabsorption. However, morbidity and mortality after these surgical procedures are high because of the poor physical condition of the patient before surgery and the concomitant presence of cirrhosis. Even after undergoing these surgical procedures, the patient is likely to continue to have pain and impaired digestion secondary to pancreatitis, unless alcohol is avoided completely.

## Pancreatic Cysts

As a result of the local necrosis that occurs at the time of acute pancreatitis, collections of fluid may form close to the pancreas. These fluid collections become walled off by fibrous tissue and are called pancreatic pseudocysts. They are the most common type of pancreatic cyst. Less common cysts occur as a result of congenital anomalies or secondary to chronic pancreatitis or trauma to the pancreas.

Diagnosis of pancreatic cysts and pseudocysts is made by ultrasound, CT scan, and ERCP. ERCP may be used to define the anatomy of the pancreas and evaluate the patency of pancreatic drainage. Pancreatic pseudocysts may be of considerable size. When pancreatic pseudocysts enlarge, they impinge on and displace the adjacent stomach or the colon because of the location of pseudocysts behind the posterior peritoneum. Eventually, through pressure or secondary infection, they produce symptoms and require drainage.

Drainage into the GI tract or through the skin and abdominal wall may be established. In the latter instance, the drainage is likely to be profuse and destructive to tissue because of the enzyme contents. Hence, steps (including application of skin ointment) must be taken to protect the skin near the drainage site from excoriation. A suction apparatus may be used to continuously aspirate digestive secretions from the drainage tract so that skin contact with the digestive enzymes is avoided. Expert nursing attention is required to ensure that the suction tube does not become dislodged and suction is not interrupted. Consultation with a WOC nurse is indicated to identify appropriate strategies for maintaining drainage and protecting the skin.

## Cancer of the Pancreas

Pancreatic cancer is the fourth leading cause of cancer death in men in the United States and the fifth leading cause of cancer death in women. It is very rare before the age of 45 years, and the majority of patients present in or beyond the sixth decade of life (Feldman, et al., 2006; Zinner & Ashley, 2007). The incidence of pancreatic cancer increases with age, peaking in the seventh and eighth decades for both men and women (American Cancer Society, 2009). The frequency of pancreatic cancer has decreased slightly over the past 25 years among non-Caucasian men. There is a slight male preponderance, and in the United States, incidence is highest in African American males (Zinner & Ashley, 2007). Cigarette smoking, exposure to industrial chemicals or toxins in the environment, and a diet high in fat, meat, or both are associated with pancreatic cancer, although their roles are not completely clear. The risk of pancreatic cancer increases as the extent of cigarette smoking increases. Diabetes mellitus, chronic pancreatitis, and hereditary pancreatitis are also associated with

pancreatic cancer. The pancreas can also be the site of metastasis from other tumors.

Cancer may develop in the head, body, or tail of the pancreas; clinical manifestations vary depending on the site and whether functioning insulin-secreting pancreatic islet cells are involved. Approximately 70% of pancreatic cancers originate in the head of the pancreas and give rise to a distinctive clinical picture (Zinner & Ashley, 2007). Functioning islet cell tumors, whether benign (adenoma) or malignant (carcinoma), are responsible for the syndrome of hyperinsulinism. The symptoms are typically nonspecific, and patients usually do not seek medical attention until late in the disease. Only about 7% of cases are diagnosed in early stages; 80% to 85% of patients have advanced, unresectable tumor when first detected. As a result, pancreatic carcinoma has only a 5% survival rate at 5 years regardless of the stage of disease at diagnosis or treatment (American Cancer Society, 2009).

## Clinical Manifestations

Pain, jaundice, or both are present in more than 80% of patients and, along with weight loss, are considered classic signs of pancreatic carcinoma (Hauser, et al., 2006). However, they often do not appear until the disease is far advanced. Other signs include rapid, profound, and progressive weight loss as well as vague upper or midabdominal pain or discomfort that is unrelated to any GI function and is often difficult to describe. Such discomfort radiates as a boring pain in the midback and is unrelated to posture or activity. It is often progressive and severe, requiring the use of opioids. It is often more severe at night and is accentuated when lying supine. Relief may be obtained by sitting up and leaning forward.

Malignant cells from pancreatic cancer are often shed into the peritoneal cavity, increasing the likelihood of metastasis. The formation of ascites is common. An important sign, if it is present, is the onset of symptoms of insulin deficiency: glucosuria, hyperglycemia, and abnormal glucose tolerance. Therefore, diabetes may be an early sign of carcinoma of the pancreas. Meals often aggravate epigastric pain, which usually occurs before the appearance of jaundice and pruritus.

## Assessment and Diagnostic Findings

Spiral (helical) CT is more than 85% to 90% accurate in the diagnosis and staging of pancreatic cancer and is currently the most useful preoperative imaging technique. MRI may also be used. ERCP is also used in the diagnosis of pancreatic carcinoma. Endoscopic ultrasound (EUS) is useful in identifying small tumors and in performing fine-needle aspiration biopsy of the primary tumor or lymph nodes (Hauser, et al., 2006). Cells obtained during ERCP are sent to the laboratory for analysis. GI x-ray findings may demonstrate deformities in adjacent organs caused by the impinging pancreatic mass.

A histologic diagnosis is not usually required in patients who are candidates for surgery. The tissue diagnosis is made at the time of the surgical procedure. Percutaneous fine-needle aspiration biopsy of the pancreas, which is used to diagnose pancreatic tumors, is also used to confirm the diagnosis in patients whose tumors are not resectable so that a palliative plan of care can be determined. This may eliminate the stress and postoperative pain of ineffective surgery. In this procedure, a needle is inserted through the anterior abdominal wall into the pancreatic mass, guided by CT, ultrasound, ERCP, or other imaging techniques. The aspirated material is examined for malignant cells. Although percutaneous biopsy is a valuable diagnostic tool, it has some potential drawbacks: a false-negative result if small tumors are missed and the risk of seeding of cancer cells along the needle track. Low-dose radiation to the site may be used before the biopsy to reduce this risk.

Percutaneous transhepatic cholangiography is another procedure that may be performed to identify obstructions of the biliary tract by a pancreatic tumor. Several tumor markers (eg, cancer antigen [CA] 19-9, carcinoembryonic antigen [CEA], DU-PAN-2) may be used in the diagnostic workup, but they are nonspecific for pancreatic carcinoma. These tumor markers are useful as indicators of disease progression.

Angiography, CT scans, and laparoscopy may be performed to determine whether the tumor can be removed surgically. Intraoperative ultrasonography has been used to determine whether there is metastatic disease to other organs.

## Medical Management

If the tumor is resectable and localized (typically tumors in the head of the pancreas), the surgical procedure to remove it is usually extensive (see later discussion). However, total excision of the lesion often is not possible for two reasons: (1) extensive growth of tumor before diagnosis and (2) probable widespread metastases (especially to the liver, lungs, and bones). More often, treatment is limited to palliative measures.

Although pancreatic tumors may be resistant to standard radiation therapy, the patient may be treated with radiation and chemotherapy (5-fluorouracil [5-FU, Adrucil], leucovorin [Wellcovorin], and gemcitabine [Gemzar]). Currently, gemcitabine is the standard of care for patients with metastatic pancreatic cancer (Feldman, et al., 2006). At present, newer biologic agents, including farnesyl transferase inhibitors and monoclonal antibodies, are under study for the treatment of metastatic pancreatic cancer (Feldman, et al., 2006; Zinner & Ashley, 2007). If the patient undergoes surgery, intraoperative radiation therapy (IORT) may be used to deliver a high dose of radiation to the tumor with minimal injury to other tissues; this may also be helpful in relief of pain. Interstitial implantation of radioactive sources has also been used, although the rate of complications is high. A large biliary stent inserted percutaneously or by endoscopy may be used to relieve jaundice.

## Nursing Management

Pain management and attention to nutritional requirements are important nursing measures that improve the level of patient comfort. Skin care and nursing measures are directed toward relief of pain and discomfort associated with jaundice, anorexia, and profound weight loss. Specialty mattresses are beneficial and protect bony prominences from pressure. Pain associated with pancreatic cancer may be severe and may require liberal use of opioids;

patient-controlled analgesia should be considered for the patient with severe, escalating pain.

Because of the poor prognosis and likelihood of short survival, end-of-life preferences are discussed and honored. If appropriate, the nurse refers the patient to hospice care. (See Chapters 16 and 17 for care of the patient with cancer and end-of-life care, respectively.)

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

The specific teaching for the patient and family varies with the stage of disease and the treatment choices made by the patient. If the patient elects to receive chemotherapy, the nurse focuses teaching on prevention of side effects and complications of the agents used. If surgery is performed to relieve obstruction and establish biliary drainage, teaching addresses management of the drainage system and monitoring for complications. The nurse instructs the family about changes in the patient's status that should be reported to the physician.

**Continuing Care**

A referral for home care is indicated to help the patient and family deal with the physical problems and discomforts associated with pancreatic cancer and the psychological impact of the disease. The home care nurse assesses the patient's physical status, fluid and nutritional status, skin integrity, and the adequacy of pain management. The nurse teaches the patient and family strategies to prevent skin breakdown and relieve pain, pruritus, and anorexia. It is important to discuss and arrange palliative care (hospice services) in an effort to relieve patient discomfort, assist with care, and comply with the patient's end-of-life decisions and wishes.

## *Tumors of the Head of the Pancreas*

Sixty percent to 80% of pancreatic tumors occur in the head of the pancreas (Zinner & Ashley, 2007). Tumors in this region of the pancreas obstruct the common bile duct where the duct passes through the head of the pancreas to join the pancreatic duct and empty at the ampulla of Vater into the duodenum. The tumors producing the obstruction may arise from the pancreas, the common bile duct, or the ampulla of Vater.

### Clinical Manifestations

The obstructed flow of bile produces jaundice, clay-colored stools, and dark urine. Malabsorption of nutrients and fat-soluble vitamins may result if the tumor obstructs the entry of bile to the GI tract. Abdominal discomfort or pain and pruritus may be noted, along with anorexia, weight loss, and malaise. If these signs and symptoms are present, cancer of the head of the pancreas is suspected.

The jaundice of this disease must be differentiated from that due to a biliary obstruction caused by a gallstone in the common duct. Jaundice caused by a gallstone is usually intermittent and appears typically in obese patients, who are most often women, and who have had previous symptoms of gallbladder disease.

### Assessment and Diagnostic Findings

Diagnostic studies may include duodenography, angiography by hepatic or celiac artery catheterization, pancreatic scanning, percutaneous transhepatic cholangiography, ERCP, and percutaneous needle biopsy of the pancreas. Results of a biopsy of the pancreas may aid in the diagnosis.

### Medical Management

Before extensive surgery can be performed, a fairly long period of preparation is often necessary, because the patient's nutritional status and physical condition are often quite compromised. Various liver and pancreatic function studies are performed. A diet high in protein along with pancreatic enzymes is often prescribed. Preoperative preparation includes adequate hydration, correction of prothrombin deficiency with vitamin K, and treatment of anemia to minimize postoperative complications. Parenteral nutrition and blood component therapy are frequently required.

A biliary-enteric shunt may be performed to relieve the jaundice and, perhaps, to provide time for a thorough diagnostic evaluation. Total pancreatectomy (removal of the pancreas) may be performed if there is no evidence of direct extension of the tumor to adjacent tissues or regional lymph nodes. A pancreaticoduodenectomy (Whipple's procedure or resection) is used for potentially resectable cancer of the head of the pancreas (Fig. 40-7). This procedure involves removal of the gallbladder, a portion of the stomach, duodenum, proximal jejunum, head of the pancreas, and distal common bile duct. Reconstruction involves anastomosis of the remaining pancreas and stomach to the jejunum (Hauser, et al., 2006). The result is removal of the tumor, allowing flow of bile into the jejunum. If the tumor cannot be excised, the jaundice may be relieved by diverting the bile flow into the jejunum by anastomosing the jejunum to the gallbladder, a procedure known as **cholecystojejunostomy.**

The postoperative management of patients who have undergone a pancreatectomy or a pancreaticoduodenectomy is similar to the management of patients after extensive gastrointestinal or biliary surgery. The patient's physical status is often suboptimal, increasing the risk of postoperative complications. Hemorrhage, vascular collapse, and hepatorenal failure remain the major postoperative complications. The mortality rate associated with these procedures has decreased because of advances in nutritional support and improved surgical techniques. A nasogastric tube with suction and parenteral nutrition allow the GI tract to rest while promoting adequate nutrition.

### Nursing Management

Preoperatively and postoperatively, nursing care is directed toward promoting patient comfort, preventing complications, and assisting the patient to return to and maintain as normal and comfortable a life as possible. The nurse closely monitors the patient in the intensive care unit after surgery; in the immediate postoperative period, multiple IV and arterial lines are used for fluid and blood replacement and hemodynamic monitoring, and a mechanical ventilator may be used. It is important to note and report changes in vital

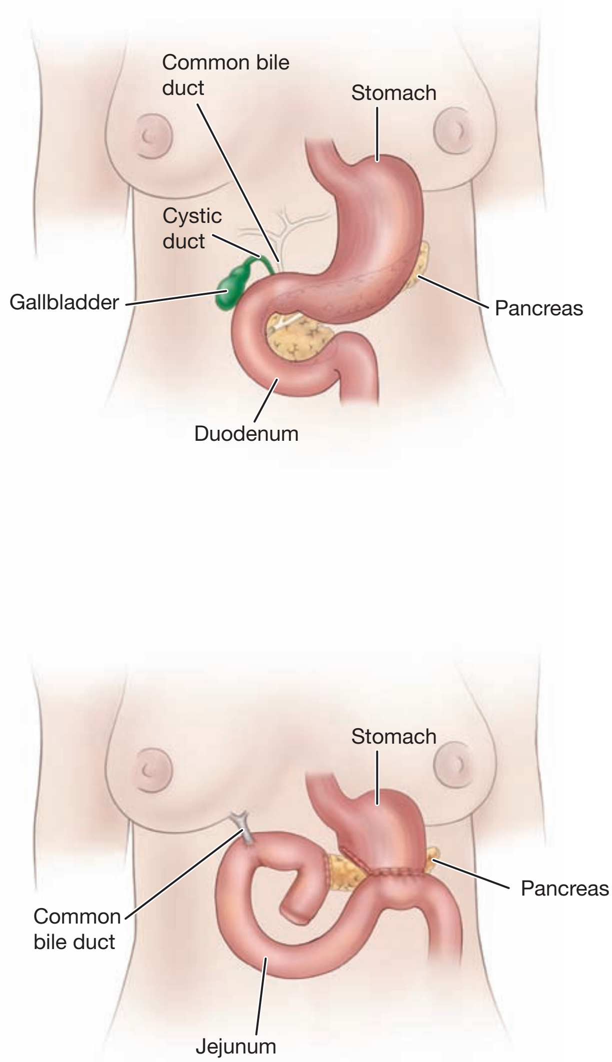



**Figure 40-7** Pancreatoduodenectomy (Whipple's procedure or resection). End result of resection of carcinoma of the head of the pancreas or the ampulla of Vater. The common duct is sutured to the side of the jejunum (choledochojejunostomy), and the remaining portion of the pancreas and the end of the stomach are sutured to the side of the jejunum.

signs, arterial blood gases and pressures, pulse oximetry, laboratory values, and urine output. The nurse must also consider the patient's compromised nutritional status and risk of bleeding. Depending on the type of surgical procedure performed, malabsorption syndrome and diabetes mellitus are likely; the nurse must address these issues during acute and long-term patient care.

Although the patient's physiologic status is the focus of the health care team in the immediate postoperative period, the patient's psychological and emotional states must be considered, along with that of the family. The patient has undergone a major high-risk surgery and is critically ill; anxiety and depression may affect recovery. The immediate and long-term outcomes of this extensive surgical resection are uncertain, and the patient and family require emotional support and understanding in the critical and stressful preoperative and postoperative periods.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The patient who has undergone this extensive surgery requires careful and thorough preparation for self-care at home. The nurse instructs the patient and family about the need for modifications in the diet because of malabsorption and hyperglycemia resulting from the surgery. It is important to instruct the patient and family about the continuing need for pancreatic enzyme replacement, a low-fat diet, and vitamin supplementation.

The nurse teaches the patient and family strategies to relieve pain and discomfort, along with strategies to manage drains, if present, and to care for the surgical incision. The patient and family members may require instruction about use of patient-controlled analgesia, parenteral nutrition, wound care, skin care, and management of drainage. It is important to describe, verbally and in writing, the signs and symptoms of complications and to teach the patient and family about indicators of complications that should be reported promptly.

Discharge of the patient to a long-term care or rehabilitation facility may be warranted after surgery as extensive as pancreatectomy or pancreaticoduodenectomy, particularly if the patient's preoperative status was not optimal. Information about the teaching that has been provided is shared with the long-term care staff so that instructions can be clarified and reinforced. During the recovery or long-term phase of care, the patient and family receive further instructions about self-care in the home.

#### Continuing Care

A referral for home care may be indicated when the patient returns home. The home care nurse assesses the patient's physical and psychological status and the ability of the patient and family to manage needed care. The home care nurse provides needed physical care and monitors the adequacy of pain management. In addition, it is important to assess the patient's nutritional status and monitor the use of enteral or parenteral nutrition, if used. The nurse discusses the use of hospice services with the patient and family and makes a referral if indicated.

## *Pancreatic Islet Tumors*

The pancreas contains the islets (islands) of Langerhans, small nests of cells that secrete hormones directly into the bloodstream and therefore are part of the endocrine system. The hormone insulin is essential for the metabolism of glucose. Diabetes mellitus (see Chapter 41) is the result of deficient insulin secretion. At least two types of tumors of the pancreatic islet cells are known: those that secrete insulin (insulinoma) and those in which insulin secretion is not increased (nonfunctioning islet cell cancer). Insulinomas produce hypersecretion of insulin and cause an excessive rate of glucose metabolism. The resulting hypoglycemia may produce symptoms of weakness, mental confusion, and seizures. These symptoms may be relieved almost immediately by oral or IV administration of glucose. The 5-hour glucose tolerance test is helpful to diagnose insulinoma and to distinguish this diagnosis from other causes of hypoglycemia.

### Surgical Management

If a tumor of the islet cells has been diagnosed, surgical treatment with removal of the tumor is usually recommended (Zinner & Ashley, 2007). The tumors may be benign adenomas or they may be malignant. Complete removal usually results in almost immediate relief of symptoms. In some patients, symptoms may be produced by simple hypertrophy of this tissue rather than a tumor of the islet cells. In such cases, a partial pancreatectomy (removal of the tail and part of the body of the pancreas) is performed.

### Nursing Management

In preparing the patient for surgery, the nurse must be alert for symptoms of hypoglycemia and be ready to administer glucose as prescribed if symptoms occur. Postoperatively, the nursing management is the same as after other upper abdominal surgical procedures, with special emphasis on monitoring serum glucose levels. Patient teaching is determined by the extent of surgery and alterations in pancreatic function.

## Hyperinsulinism

Hyperinsulinism is caused by overproduction of insulin by the pancreatic islets. Symptoms resemble those of excessive doses of insulin and are attributable to the same mechanism: an abnormal reduction in blood glucose levels. Clinically it is characterized by episodes during which the patient experiences unusual hunger, nervousness, sweating, headache, and faintness; in severe cases, seizures and episodes of unconsciousness may occur. The findings at the time of surgery or at autopsy may indicate hyperplasia (overgrowth) of the islets of Langerhans or a benign or malignant tumor involving the islets that is capable of producing large amounts of insulin (see preceding discussion). Occasionally, tumors of nonpancreatic origin produce an insulin-like material that can cause severe hypoglycemia and may be responsible for seizures coinciding with blood glucose levels that are too low to sustain normal brain function (ie, lower than 30 mg/dL [1.6 mmol/L]).

All the symptoms that accompany spontaneous hypoglycemia are relieved by the oral or parenteral administration of glucose. Surgical removal of the hyperplastic or neoplastic tissue from the pancreas is the only successful method of treatment. About 15% of patients with spontaneous or functional hypoglycemia eventually develop diabetes mellitus.

## Ulcerogenic Tumors

Some tumors of the islets of Langerhans are associated with hypersecretion of gastric acid that produces ulcers in the stomach, duodenum, and jejunum. This is referred to as **Zollinger-Ellison syndrome.** The hypersecretion is so excessive that even after partial gastric resection enough acid is produced to cause further ulceration. If a marked tendency to develop gastric and duodenal ulcers is noted, an ulcerogenic tumor of the islets of Langerhans is considered.

These tumors, which may be benign or malignant, are treated by excision, if possible. Frequently, however, removal is not possible because of extension beyond the pancreas. In many patients, a total gastrectomy may be necessary to reduce the secretion of gastric acid sufficiently to prevent further ulceration. This procedure is also indicated to treat gastric carcinoid tumors that may arise from the effect of prolonged hypersecretion of gastric acids (Zinner & Ashley, 2007).

## CRITICAL THINKING EXERCISES

**1** A 72-year-old woman has confirmed cholelithiasis. She also has many other chronic medical conditions, including coronary artery disease, heart failure, and chronic obstructive pulmonary disease. She has been evaluated for treatment by her internist and a surgeon. Surgical treatment of her cholelithiasis is inappropriate for her at this time. What options exist for this patient? How would you educate and prepare her for nonsurgical interventions? What will her likely outcome be with this treatment approach? What are possible adverse effects of nonsurgical treatment?

**2** A 44-year-old man is admitted to your unit with a diagnosis of pancreatitis. He had an ultrasound performed, and several large gallstones were identified. He reports severe epigastric pain (rates it at 9 on a 10-point scale) and nausea. He has a nasogastric tube in place because of several episodes of vomiting. What is the cause of this patient's pancreatitis? What medications and laboratory tests would you expect to see prescribed for this patient? What physical assessment findings will you see? What issues would be of high priority in caring for this patient during his hospital stay? What multisystem complications might arise that would necessitate this patient's transfer to an intensive care unit? What issues would be of high priority in preparing him for hospital discharge?

EBP **3** A 68-year-old woman has undergone a Whipple procedure. For what immediate postoperative complications must you be alert? What assessment strategies are used to monitor for the development of complications? Describe two evidence-based preventive interventions for postoperative care. What type of nutritional interventions might you expect? What education is needed prior to the patient's hospital discharge? What follow-up will be necessary?

EBP **4** A 35-year-old woman is scheduled for a laparoscopic cholecystectomy. She is being discharged on the day of surgery. What information should you collect regarding the patient's home situation before she is discharged? What information should you provide about expectations for postoperative pain and other complications, and what instructions should you provide to the patient about pharmacologic and nonpharmacologic pain management strategies? What is the evidence base for the pain management strategies you provide, and what is the strength of that evidence?

**5** Compare and contrast the nursing care of a 46-year-old patient with a diagnosis of acute pancreatitis with that of a 64-year-old patient with a diagnosis of chronic pancreatitis. Explain the rationale for differences in care for patients with these two diagnoses.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint on line resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Gastroenterological Association, www.gastro.org
National Digestive Diseases Information Clearing House, www.niddk.nih.gov
National Endocrine Society, www.endo-society.org
National Pancreas Foundation, www.pancreasfoundation.org



chapter 41

# Assessment and Management of Patients With Diabetes Mellitus

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Differentiate between type 1 and type 2 diabetes.
2. Describe etiologic factors associated with diabetes.
3. Relate the clinical manifestations of diabetes to the associated pathophysiologic alterations.
4. Identify the diagnostic and clinical significance of blood glucose test results.
5. Explain the dietary modifications used for management of people with diabetes.
6. Describe the relationships among diet, exercise, and medication (ie, insulin or oral antidiabetic agents) for people with diabetes.
7. Develop a plan for teaching insulin self-management.
8. Identify the role of oral antidiabetic agents in diabetic therapy.
9. Differentiate between hyperglycemia with diabetic ketoacidosis and hyperosmolar nonketotic syndrome.
10. Describe management strategies for a person with diabetes to use during "sick days."
11. Describe the major macrovascular, microvascular, and neuropathic complications of diabetes and the self-care behaviors that are important in their prevention.
12. Identify the teaching aids and community support groups available for people with diabetes.

## GLOSSARY

**continuous glucose monitoring system (CGMS):** a device worn for 72 hours that continuously monitors blood glucose levels; the data are downloaded and analyzed for blood glucose patterns for that time period; presently used diagnostically to elicit patterns and tailor treatment
**continuous subcutaneous insulin infusion, insulin pump:** a small device that delivers insulin on a 24-hour basis as basal insulin; it is also programmed by the patient to deliver a bolus dose before eating a meal in an attempt to mimic normal pancreatic function
**diabetes mellitus:** a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both
**diabetic ketoacidosis (DKA):** a metabolic derangement in type 1 diabetes that results from a deficiency of insulin; highly acidic ketone bodies are formed, resulting in acidosis; usually requires hospitalization for treatment and is usually caused by nonadherence to the insulin regimen, concurrent illness, or infection
**fasting plasma glucose (FPG):** blood glucose determination obtained in the laboratory after fasting for more than 8 hours
**gestational diabetes mellitus (GDM):** any degree of glucose intolerance with its onset during pregnancy
**glycated hemoglobin (glycosylated hemoglobin, Hgb $A_{1C}$ or A1C):** a long-term measure of glucose control that is a result of glucose attaching to hemoglobin for the life of the red blood cell (120 days).

## GLOSSARY *(Continued)*

The goal of diabetes therapy is a normal to near-normal level of glycated hemoglobin, the same as in the nondiabetic population
**hyperglycemia:** elevated blood glucose level; fasting level greater than 110 mg/dL (6.1 mmol/L); 2-hour postprandial level greater than 140 mg/dL (7.8 mmol/L)
**hyperglycemic hyperosmolar nonketotic syndrome (HHNS):** a metabolic disorder of type 2 diabetes resulting from a relative insulin deficiency initiated by an intercurrent illness that raises the demand for insulin; associated with polyuria and severe dehydration
**hypoglycemia:** low blood glucose level (less than 60 mg/dL [less than 2.7 mmol/L])
**impaired fasting glucose (IFG), impaired glucose tolerance (IGT):** a metabolic stage intermediate between normal glucose homeostasis and diabetes; now referred to as prediabetes
**insulin:** a hormone secreted by the beta cells of the islets of Langerhans of the pancreas that is necessary for the metabolism of carbohydrates, proteins, and fats; a deficiency of insulin results in diabetes mellitus
**islet cell transplantation:** an investigational procedure in which purified islet cells from cadaver donors are injected into the portal vein of the liver, with the goal of having these cells secrete insulin and cure type 1 diabetes
**ketone:** a highly acidic substance formed when the liver breaks down free fatty acids in the absence of insulin; the result is diabetic ketoacidosis
**medical nutrition therapy (MNT):** nutritional therapy prescribed by the physician for management of diabetes
**nephropathy:** a long-term complication of diabetes in which the kidney cells are damaged; characterized by microalbuminuria in early stages and progressing to end-stage renal disease
**neuropathy:** a long-term complication of diabetes resulting from damage to the nerve cell
**prediabetes:** impaired glucose metabolism in which blood glucose concentrations fall between normal levels and those considered diagnostic for diabetes; includes IFG and IGT, not clinical entities in their own right but risk factors for future diabetes and cardiovascular disease
**retinopathy:** a long-term complication of diabetes in which the microvascular system of the eye is damaged
**self-monitoring of blood glucose (SMBG):** a method of capillary blood glucose testing in which the patient pricks his or her finger and applies a drop of blood to a test strip that is read by a meter
**sulfonylurea:** a classification of oral antidiabetic medication for treating type 2 diabetes; stimulates insulin secretion and insulin action
**thiazolidinedione:** a class of oral antidiabetic medications that reduce insulin resistance in target tissues, enhancing insulin action without directly stimulating insulin secretion
**type 1 diabetes:** a metabolic disorder characterized by an absence of insulin production and secretion from autoimmune destruction of the beta cells of the islets of Langerhans in the pancreas; formerly called insulin-dependent, juvenile, or type I diabetes
**type 2 diabetes:** a metabolic disorder characterized by the relative deficiency of insulin production and a decreased insulin action and increased insulin resistance; Formerly called non–insulin-dependent, adult-onset, or type II diabetes

**Diabetes mellitus** is a group of metabolic diseases characterized by increased levels of glucose in the blood (**hyperglycemia**) resulting from defects in insulin secretion, insulin action, or both (American Diabetes Association [ADA], 2009a). Normally, a certain amount of glucose circulates in the blood. The major sources of this glucose are absorption of ingested food in the gastrointestinal tract and formation of glucose by the liver from food substances.

# DIABETES

## Epidemiology

Diabetes is becoming more common in the United States. From 1980 through 2002, the number of Americans with diabetes more than doubled and increased in all age groups. Currently, it is estimated that more than 23 million people in the United States have diabetes, although almost one third of these cases are undiagnosed. The number of people newly diagnosed with diabetes increases by about 1 million people per year (Centers for Disease Control and Prevention [CDC], 2008). By 2030, the number of cases is expected to exceed 30 million. In 2000, the worldwide estimate of the prevalence of diabetes was 171 million people, and by 2030, this is expected to increase to more than 360 million (World Health Organization, 2008). Diabetes is especially prevalent in the elderly; as many as 50% of people older than 65 years of age have some degree of glucose intolerance. People 65 years and older account for almost 40% of people with diabetes.

Minority populations are disproportionately affected by diabetes. From 1980 through 2002, the age-adjusted prevalence of diabetes increased among all gender and race groups, but compared to Caucasians, African Americans and members of other racial and ethnic groups (Native Americans and persons of Hispanic origin) are more likely to develop diabetes, are at greater risk for many of the complications, and have higher death rates due to diabetes (CDC, 2008). Chart 41-1 summarizes risk factors for diabetes mellitus.

### CHART 41-1 *Risk Factors for Diabetes Mellitus*

- Family history of diabetes (ie, parents or siblings with diabetes)
- Obesity (ie, ≥20% over desired body weight or BMI ≥27 kg/m$^2$)
- Race/ethnicity (eg, African Americans, Hispanic Americans, Native Americans, Asian Americans, Pacific Islanders)
- Age ≥45 y
- Previously identified impaired fasting glucose or impaired glucose tolerance
- Hypertension (≥140/90 mm Hg)
- HDL cholesterol level ≤35 mg/dL (0.90 mmol/L) and/or triglyceride level ≥250 mg/dL (2.8 mmol/L)
- History of gestational diabetes or delivery of babies over 9 lb

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Diabetes has far-reaching and devastating physical, social, and economic consequences, including the following:

- In the United States, diabetes is the leading cause of nontraumatic amputations, blindness in working-age adults, and end-stage renal disease (CDC, 2008).
- Diabetes is the third leading cause of death from disease, primarily because of the high rate of cardiovascular disease (myocardial infarction, stroke, and peripheral vascular disease) among people with diabetes.
- Hospitalization rates for people with diabetes are 2.4 times greater for adults and 5.3 times greater for children than for the general population.

The economic cost of diabetes continues to increase because of increasing health care costs and an aging population. Half of all people who have diabetes and are older than 65 years of age are hospitalized each year, and severe and life-threatening complications often contribute to the increased rates of hospitalization. Costs related to diabetes are estimated to be almost $174 billion annually, including direct medical care expenses and indirect costs attributable to disability and premature death (ADA, 2008a).

## Classification

The major classifications of diabetes are type 1 diabetes, type 2 diabetes, gestational diabetes, and diabetes mellitus associated with other conditions or syndromes (ADA, 2009a). The different types of diabetes mellitus vary in cause, clinical course, and treatment (Table 41-1). The classification system is dynamic in two ways. First, research findings suggest many differences among individuals within each category. Second, except for people with type 1 diabetes, patients may move from one category to another. For example, a woman with gestational diabetes may, after delivery, move into the type 2 category. **Prediabetes** is classified as **impaired glucose tolerance (IGT)** or **impaired fasting glucose (IFG)** and refers to a condition in which blood glucose concentrations fall between normal levels and those considered diagnostic for diabetes.

## Pathophysiology

**Insulin** is secreted by beta cells, which are one of four types of cells in the islets of Langerhans in the pancreas. Insulin is an anabolic, or storage, hormone. When a person eats a meal, insulin secretion increases and moves glucose from the blood into muscle, liver, and fat cells. In those cells, insulin

- Transports and metabolizes glucose for energy
- Stimulates storage of glucose in the liver and muscle (in the form of glycogen)
- Signals the liver to stop the release of glucose
- Enhances storage of dietary fat in adipose tissue
- Accelerates transport of amino acids (derived from dietary protein) into cells

Insulin also inhibits the breakdown of stored glucose, protein, and fat.

During fasting periods (between meals and overnight), the pancreas continuously releases a small amount of insulin (basal insulin); another pancreatic hormone called glucagon (secreted by the alpha cells of the islets of Langerhans) is released when blood glucose levels decrease and stimulates the liver to release stored glucose. The insulin

**Table 41-1 CLASSIFICATION OF DIABETES MELLITUS AND RELATED GLUCOSE INTOLERANCES**

| Current Classification | Clinical Characteristics and Clinical Implications |
|---|---|
| Type 1 (5–10% of all diabetes) (Previously classified as juvenile diabetes, juvenile-onset diabetes, ketosis-prone diabetes, brittle diabetes, and insulin-dependent diabetes mellitus [IDDM]) | Onset any age, but usually young (<30 y)<br>Usually thin at diagnosis; recent weight loss<br>Etiology includes genetic, immunologic, and environmental factors (eg, virus)<br>Often have islet cell antibodies<br>Often have antibodies to insulin even before insulin treatment<br>Little or no endogenous insulin<br>Need insulin to preserve life<br>Ketosis prone when insulin absent<br>Acute complication of hyperglycemia: diabetic ketoacidosis |
| Type 2 (90–95% of all diabetes: obese—80% of type 2; nonobese—20% of type 2) (Previously classified as adult-onset diabetes, maturity-onset diabetes, ketosis-resistant diabetes, stable diabetes, and non–insulin-dependent diabetes [NIDDM]) | Onset any age, usually over 30 y<br>Usually obese at diagnosis<br>Causes include obesity, heredity, and environmental factors<br>No islet cell antibodies<br>Decrease in endogenous insulin, or increased with insulin resistance<br>Most patients can control blood glucose through weight loss if obese<br>Oral antidiabetic agents may improve blood glucose levels if dietary modification and exercise are unsuccessful<br>May need insulin on a short-term or long-term basis to prevent hyperglycemia<br>Ketosis uncommon, except in stress or infection<br>Acute complication: hyperglycemic hyperosmolar nonketotic syndrome |
| Diabetes mellitus associated with other conditions or syndromes (Previously classified as secondary diabetes) | Accompanied by conditions known or suspected to cause the disease: pancreatic diseases, hormonal abnormalities, medications such as corticosteroids and estrogen-containing preparations<br>Depending on the ability of the pancreas to produce insulin, the patient may require treatment with oral antidiabetic agents or insulin |
| Gestational diabetes | Onset during pregnancy, usually in the second or third trimester<br>Due to hormones secreted by the placenta, which inhibit the action of insulin<br>Above-normal risk for perinatal complications, especially macrosomia (abnormally large babies)<br>Treated with diet and, if needed, insulin to strictly maintain normal blood glucose levels<br>Occurs in about 2–5% of all pregnancies<br>Glucose intolerance transitory but may recur:<br>• In subsequent pregnancies<br>• 30–40% will develop overt diabetes (usually type 2) within 10 years (especially if obese)<br>Risk factors include obesity, age older than 30 years, family history of diabetes, previous large babies (>9 lb)<br>Screening tests (glucose challenge test) should be performed on all pregnant women between 24- and 28-weeks gestation<br>Should be screened for diabetes periodically |
| Prediabetes (Previously classified as previous abnormality of glucose tolerance [PrevAGT]) | Previous history of hyperglycemia (eg, during pregnancy or illness)<br>Current normal glucose metabolism<br>Impaired glucose tolerance or impaired fasting glucose screening after age 40 years if there is a family history of diabetes or if symptomatic<br>Encourage ideal body weight, because loss of 10–15 lb may improve glycemic control |

and the glucagon together maintain a constant level of glucose in the blood by stimulating the release of glucose from the liver.

Initially, the liver produces glucose through the breakdown of glycogen (glycogenolysis). After 8 to 12 hours without food, the liver forms glucose from the breakdown of noncarbohydrate substances, including amino acids (gluconeogenesis).

### *Type 1 Diabetes*

**Type 1 diabetes** affects approximately 5% to 10% of people with the disease; it is characterized by an acute onset, usually before 30 years of age (CDC, 2008). Type 1 diabetes is characterized by destruction of the pancreatic beta cells. Combined genetic, immunologic, and possibly environmental (eg, viral) factors are thought to contribute to beta-cell destruction. Although the events that lead to beta-cell destruction are not fully understood, it is generally accepted that a genetic susceptibility is a common underlying factor in the development of type 1 diabetes. People do not inherit type 1 diabetes itself but rather a genetic predisposition, or tendency, toward development of type 1 diabetes. This genetic tendency has been found in people with certain human leukocyte antigen (HLA) types. There is also evidence of an autoimmune response in type 1 diabetes. This is an abnormal response in which antibodies are directed against normal tissues of the body, responding to these tissues as if they were foreign. Autoantibodies against islet cells and against endogenous (internal) insulin have been detected in people at the time of diagnosis and even several years before the development of clinical signs of type 1 diabetes. In addition to genetic and immunologic components, environmental factors, such as viruses or toxins, that may initiate destruction of the beta cell are being investigated.

Regardless of the specific cause, the destruction of the beta cells results in decreased insulin production, unchecked glucose production by the liver, and fasting

hyperglycemia. In addition, glucose derived from food cannot be stored in the liver but instead remains in the bloodstream and contributes to postprandial (after meals) hyperglycemia. If the concentration of glucose in the blood exceeds the renal threshold for glucose, usually 180 to 200 mg/dL (9.9 to 11.1 mmol/L), the kidneys may not reabsorb all of the filtered glucose; the glucose then appears in the urine (glycosuria). When excess glucose is excreted in the urine, it is accompanied by excessive loss of fluids and electrolytes. This is called osmotic diuresis.

Because insulin normally inhibits glycogenolysis (breakdown of stored glucose) and gluconeogenesis (production of new glucose from amino acids and other substrates), these processes occur in an unrestrained fashion in people with insulin deficiency and contribute further to hyperglycemia. In addition, fat breakdown occurs, resulting in an increased production of **ketone** bodies, which are the byproducts of fat breakdown.

*NURSING ALERT*

**Ketone bodies are acids that disturb the acid–base balance of the body when they accumulate in excessive amounts. The resulting diabetic ketoacidosis (DKA) may cause signs and symptoms such as abdominal pain, nausea, vomiting, hyperventilation, a fruity breath odor, and, if left untreated, altered level of consciousness, coma, and death. Initiation of insulin treatment, along with fluid and electrolytes as needed, is essential to treat hyperglycemia and DKA and rapidly improves the metabolic abnormalities.**

### Type 2 Diabetes

**Type 2 diabetes** affects approximately 90% to 95% of people with the disease (CDC, 2008). It occurs more commonly among people who are older than 30 years of age and obese (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2005), although its incidence is rapidly increasing in younger people because of the growing epidemic of obesity in children, adolescents, and young adults (CDC, 2008). The two main problems related to insulin in type 2 diabetes are insulin resistance and impaired insulin secretion. Insulin resistance refers to a decreased tissue sensitivity to insulin. Normally, insulin binds to special receptors on cell surfaces and initiates a series of reactions involved in glucose metabolism. In type 2 diabetes, these intracellular reactions are diminished, making insulin less effective at stimulating glucose uptake by the tissues and at regulating glucose release by the liver (Fig. 41-1). The exact mechanisms that lead to insulin resistance and impaired insulin secretion in type 2 diabetes are unknown, although genetic factors are thought to play a role.

To overcome insulin resistance and to prevent the buildup of glucose in the blood, increased amounts of insulin must be secreted to maintain the glucose level at a normal or slightly elevated level. This is called metabolic syndrome, which includes hypertension, hypercholesterolemia, and abdominal obesity. However, if the

**Physiology ■■■ Pathophysiology**

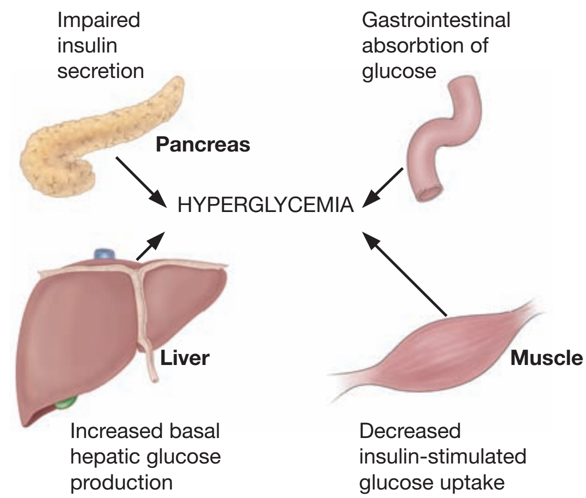



**Figure 41-1** Pathogenesis of type 2 diabetes.

beta cells cannot keep up with the increased demand for insulin, the glucose level rises and type 2 diabetes develops.

Despite the impaired insulin secretion that is characteristic of type 2 diabetes, there is enough insulin present to prevent the breakdown of fat and the accompanying production of ketone bodies. Therefore, DKA does not typically occur in type 2 diabetes. However, uncontrolled type 2 diabetes may lead to another acute problem—hyperglycemic hyperosmolar nonketotic syndrome (see later discussion).

Because type 2 diabetes is associated with a slow, progressive glucose intolerance, its onset may go undetected for many years. If the patient experiences symptoms, they are frequently mild and may include fatigue, irritability, polyuria, polydipsia, poorly healing skin wounds, vaginal infections, or blurred vision (if glucose levels are very high).

For most patients (approximately 75%), type 2 diabetes is detected incidentally (eg, when routine laboratory tests or ophthalmoscopic examinations are performed). One consequence of undetected diabetes is that long-term diabetes complications (eg, eye disease, peripheral neuropathy, peripheral vascular disease) may have developed before the actual diagnosis of diabetes is made (ADA, 2009a), signifying that the blood glucose has been elevated for a time before diagnosis.

### Gestational Diabetes

**Gestational diabetes mellitus (GDM)** is any degree of glucose intolerance with its onset during pregnancy. Hyperglycemia develops during pregnancy because of the secretion of placental hormones, which causes insulin resistance. Gestational diabetes occurs in as many as 14% of pregnant women and increases their risk for hypertensive disorders during pregnancy (ADA, 2009a).

Women who are considered to be at high risk for GDM and who should be screened by blood glucose testing at their

first prenatal visit are those with marked obesity, a personal history of GDM, glycosuria, or a strong family history of diabetes. High-risk ethnic groups include Hispanic Americans, Native Americans, Asian Americans, African Americans, and Pacific Islanders. If these high-risk women do not have GDM at initial screening, they should be retested between 24 and 28 weeks of gestation. All women of average risk should be tested at 24 to 28 weeks of gestation. Testing is not specifically recommended for women identified as being at low risk. Low-risk women are those who meet all of the following criteria: age younger than 25 years, normal weight before pregnancy, member of an ethnic group with low prevalence of GDM, no history of abnormal glucose tolerance, no known history of diabetes in first-degree relatives, and no history of poor obstetric outcome (ADA, 2009a). Women considered to be at high risk or average risk should have either an oral glucose tolerance test (OGTT) or a glucose challenge test (GCT) followed by OGTT in women who exceed the glucose threshold value of 140 mg/dL (7.8 mmol/L) (ADA, 2009a).

Initial management includes dietary modification and blood glucose monitoring. If hyperglycemia persists, insulin is prescribed. Goals for blood glucose levels during pregnancy are 105 mg/dL (5.8 mmol/L) or less before meals and 130 mg/dL (7.2 mmol/L) or less 2 hours after meals (ADA, 2009a).

After delivery, blood glucose levels in women with GDM usually return to normal. However, many women who have had GDM develop type 2 diabetes later in life. For this reason, a woman who has had GDM should be counseled to maintain her ideal body weight and to exercise regularly to reduce her risk for type 2 diabetes (Kitzmiller, Dang-Kilduff & Taslimi, 2007).

## Prevention

In 2002 the Diabetes Prevention Program Research Group reported that type 2 diabetes can be prevented with appropriate changes in lifestyle. Persons at high risk for type 2 diabetes (BMI 24 or greater, fasting and postprandial plasma glucose levels elevated but not to levels diagnostic of diabetes) received either standard lifestyle recommendations plus metformin, standard lifestyle recommendations plus placebo, or an intensive program of lifestyle modifications. The 16-lesson curriculum of the intensive program of lifestyle modifications focused on weight reduction of greater than 7% of initial body weight and physical activity of moderate intensity. It also included behavior modification strategies designed to help patients achieve the goals of weight reduction and participation in exercise. The lifestyle intervention group had a 58% lower incidence of diabetes and the metformin group had a 31% lower incidence of diabetes compared to the placebo group. These findings were found in both genders and all racial and ethnic groups. These findings demonstrate that type 2 diabetes can be prevented or delayed in persons at high risk for the disease.

## Clinical Manifestations

Clinical manifestations depend on the patient's level of hyperglycemia. Classic clinical manifestations of all types of diabetes include the "three Ps": polyuria, polydipsia, and polyphagia. Polyuria (increased urination) and polydipsia (increased thirst) occur as a result of the excess loss of fluid associated with osmotic diuresis. Patients also experience polyphagia (increased appetite) that results from the catabolic state induced by insulin deficiency and the breakdown of proteins and fats. Other symptoms include fatigue and weakness, sudden vision changes, tingling or numbness in hands or feet, dry skin, skin lesions or wounds that are slow to heal, and recurrent infections. The onset of type 1 diabetes may also be associated with sudden weight loss or nausea, vomiting, or abdominal pains, if DKA has developed.

## Assessment and Diagnostic Findings

An abnormally high blood glucose level is the basic criterion for the diagnosis of diabetes. **Fasting plasma glucose (FPG),** random plasma glucose, and glucose level 2 hours after receiving glucose (2-hour postload) may be used. The OGTT and the intravenous (IV) glucose tolerance test are no longer recommended for routine clinical use. See Chart 41-2 for the ADA's diagnostic criteria for diabetes mellitus (ADA, 2009a).

In addition to the assessment and diagnostic evaluation performed to diagnose diabetes, ongoing specialized assessment of patients with known diabetes and evaluation for complications in patients with newly diagnosed diabetes are important components of care. Parameters that should be regularly assessed are discussed in Chart 41-3.

### Chart 41-2 • *Criteria for the Diagnosis of Diabetes Mellitus*

1. Symptoms of diabetes plus casual plasma glucose concentration equal to or greater than 200 mg/dL (11.1 mmol/L). Casual is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss.

**or**

2. Fasting plasma glucose greater than or equal to 126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 hours.

**or**

3. Two-hour postload glucose equal to or greater than 200 mg/dL (11.1 mmol/L) during an oral glucose tolerance test. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.

In the absence of unequivocal hyperglycemia with acute metabolic decompensation, these criteria should be confirmed by repeat testing on a different day. The third measure is not recommended for routine clinical use.

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CHART 41-3

### Assessing the Patient With Diabetes

**History**

- Symptoms related to the diagnosis of diabetes:
  - Symptoms of hyperglycemia
  - Symptoms of hypoglycemia
    - Frequency, timing, severity, and resolution
- Results of blood glucose monitoring
- Status, symptoms, and management of chronic complications of diabetes:
  - Eye; kidney; nerve; genitourinary and sexual, bladder, and gastrointestinal
  - Cardiac; peripheral vascular; foot complications associated with diabetes
- Adherence to/ability to follow prescribed dietary management plan
- Adherence to prescribed exercise regimen
- Adherence to/ability to follow prescribed pharmacologic treatment (insulin or oral antidiabetic agents)
- Use of tobacco, alcohol, and prescribed and over-the-counter medications/drugs
- Lifestyle, cultural, psychosocial, and economic factors that may affect diabetes treatment
- Effects of diabetes or its complications on functional status (eg, mobility, vision)

**Physical Examination**

- Blood pressure (sitting and standing to detect orthostatic changes)
- Body mass index (height and weight)
- Fundoscopic examination and visual acuity
- Foot examination (lesions, signs of infection, pulses)
- Skin examination (lesions and insulin-injection sites)
- Neurologic examination
  - Vibratory and sensory examination using monofilament
  - Deep tendon reflexes
- Oral examination

**Laboratory Examination**

- $HgbA_{1C}$ (A1C)
- Fasting lipid profile
- Test for microalbuminuria
- Serum creatinine level
- Urinalysis
- Electrocardiogram

**Need for Referrals**

- Ophthalmology
- Podiatry
- Dietitian
- Diabetes educator
- Others if indicated

### *Gerontologic Considerations*

Elevated blood glucose levels appear to be age related and occur in both men and women throughout the world. Elevated blood glucose levels commonly appear in the fifth decade of life and increase in frequency with advancing age. Approximately 10% to 30% of elderly people have age-related hyperglycemia, not counting those with overt diabetes. What causes age-related changes in carbohydrate metabolism is not known. Possibilities include poor diet, physical inactivity, a decrease in the lean body mass in which ingested carbohydrate may be stored, altered insulin secretion, and increase in fat tissue, which increases insulin resistance (ADA, 2009b).

## Medical Management

The main goal of diabetes treatment is to normalize insulin activity and blood glucose levels to reduce the development of vascular and neuropathic complications. The Diabetes Control and Complications Trial (DCCT), a 10-year prospective clinical trial conducted from 1983 to 1993, demonstrated the importance of achieving blood glucose control in the normal, nondiabetic range. This landmark trial demonstrated that intensive glucose control dramatically reduced the development and progression of complications such as **retinopathy, nephropathy,** and **neuropathy.** Intensive treatment is defined as three or four insulin injections per day or **continuous subcutaneous insulin infusion, insulin pump** therapy plus frequent blood glucose monitoring and weekly contacts with diabetes educators. The American Diabetes Association now recommends that all patients with diabetes strive for glucose control to reduce their risk of complications (ADA, 2009b).

Intensive therapy must be initiated with caution and must be accompanied by thorough education of the patient and family and by responsible behavior of the patient. Careful screening of patients is a key step in initiating intensive therapy.

A study conducted in the United Kingdom demonstrated a decrease in complications among patients with type 2 diabetes receiving intensive therapy compared to those receiving conventional therapy (United Kingdom Prospective Diabetes Study Group [UKPDS], 1998; see also ADA, 2009b).

The results of the DCCT and UKPDS have been supported by follow-up studies, including the Epidemiology of Diabetes Interventions and Complications (EDIC) study (Nathan, Cleary, Backlund, et al., 2005). Therefore, the therapeutic goal for diabetes management is to achieve normal blood glucose levels (euglycemia) without hypoglycemia while maintaining a high quality of life. Diabetes management has five components: nutritional therapy, exercise, monitoring, pharmacologic therapy, and education. Diabetes management involves constant assessment and modification of the treatment plan by health professionals and daily adjustments in therapy by the patient. Although the health care team directs the treatment, it is the individual patient who must manage the complex therapeutic regimen. For this reason, patient and family education is an

essential component of diabetes treatment and is as important as all other components of the regimen.

### Nutritional Therapy

Nutrition, meal planning, and weight control are the foundation of diabetes management. The most important objectives in the dietary and nutritional management of diabetes are control of total caloric intake to attain or maintain a reasonable body weight, control of blood glucose levels, and normalization of lipids and blood pressure to prevent heart disease. Success in this area alone is often associated with reversal of hyperglycemia in type 2 diabetes. However, achieving these goals is not always easy. Because **medical nutrition therapy** (MNT, nutritional management) of diabetes is complex, a registered dietitian who understands diabetes management has the major responsibility for designing and teaching this aspect of the therapeutic plan. Nurses and all other members of the health care team must be knowledgeable about nutritional therapy and supportive of patients who need to implement nutritional and lifestyle changes. Nutritional management of diabetes includes the following goals (ADA, 2008b).

1. To achieve and maintain
   - Blood glucose levels in the normal range or as close to normal as is safely possible
   - A lipid and lipoprotein profile that reduces the risk for vascular disease
   - Blood pressure levels in the normal range or as close to normal as is safely possible
2. To prevent, or at least slow, the rate of development of the chronic complications of diabetes by modifying nutrient intake and lifestyle
3. To address individual nutrition needs, taking into account personal and cultural preferences and willingness to change
4. To maintain the pleasure of eating by only limiting food choices when indicated by scientific evidence.

For obese patients with diabetes (especially those with type 2 diabetes), weight loss is the key to treatment. (It is also a major factor in preventing diabetes.) In general, overweight is considered to be a body mass index (BMI) of 25 to 29; obesity is defined as 20% above ideal body weight or a BMI equal to or greater than 30 (National Institutes of Health, 2000). BMI is a weight-to-height ratio calculated by dividing body weight (in kilograms) by the square of the height (in meters). Calculation of BMI is discussed in Chapter 5. Obese patients who have type 2 diabetes and who require insulin or oral agents to control blood glucose levels may be able to reduce or eliminate the need for medication through weight loss. A weight loss as small as 5% to 10% of total weight may significantly improve blood glucose levels (ADA, 2009b). For obese patients with diabetes who do not take insulin or sulfonylureas, consistent meal content or timing is important but not as critical. Rather, decreasing the overall caloric intake assumes more importance. However, meals should not be skipped. Pacing food intake throughout the day places more manageable demands on the pancreas.

Consistently following a meal plan is one of the most challenging aspects of diabetes management. It may be more realistic to restrict calories only moderately. For patients who have lost weight, maintaining the weight loss may be difficult. To help these patients incorporate new dietary habits into their lifestyles, diet education, behavioral therapy, group support, and ongoing nutrition counseling are encouraged.

#### Meal Planning and Related Teaching

The meal plan must consider the patient's food preferences, lifestyle, usual eating times, and ethnic and cultural background. For patients who require insulin to help control blood glucose levels, maintaining as much consistency as possible in the amount of calories and carbohydrates ingested at each meal is essential. In addition, consistency in the approximate time intervals between meals, with the addition of snacks if necessary, helps prevent hypoglycemic reactions and maintain overall blood glucose control. For patients who can master the insulin-to-carbohydrate calculations, lifestyle can be more flexible and diabetes control more predictable. For those using intensive insulin therapy, there may be greater flexibility in the timing and content of meals by allowing adjustments in insulin dosage for changes in eating and exercise habits. Advances in insulin management (new insulin analogues, insulin algorithms, insulin pumps) permit greater flexibility of schedules than was previously possible. This contrasts with the older concept of maintaining a constant dose of insulin, which required strict scheduling of meals to match the actions and duration of the insulin.

The first step in preparing a meal plan is a thorough review of the patient's diet history to identify his or her eating habits and lifestyle. This includes a thorough assessment of the patient's need for weight loss, gain, or maintenance. In most instances, people with type 2 diabetes require weight reduction.

In teaching about meal planning, clinical dietitians use various educational tools, materials, and approaches. Initial education addresses the importance of consistent eating habits, the relationship of food and insulin, and the provision of an individualized meal plan. In-depth follow-up education then focuses on management skills, such as eating at restaurants, reading food labels, and adjusting the meal plan for exercise, illness, and special occasions. The nurse plays an important role in communicating pertinent information to the dietitian and reinforcing the patient's understanding.

Certain aspects of meal planning, such as the food exchange system, may be difficult to learn. This may be related to limitations in the patient's intellectual level or to emotional issues, such as difficulty accepting the diagnosis of diabetes or feelings of deprivation and undue restriction in eating. In any case, it helps to emphasize that using the exchange system (or any food classification system) provides a new way of thinking about food rather than a new way of eating. It is also important to simplify information as much as possible and to provide opportunities for the patient to practice and repeat activities and information.

***Caloric Requirements.*** Calorie-controlled diets are planned by first calculating a person's energy needs and caloric requirements based on age, gender, height, and weight. An activity element is then factored in to provide

the actual number of calories required for weight maintenance. To promote a 1- to 2-pound weight loss per week, 500 to 1000 calories are subtracted from the daily total. The calories are distributed into carbohydrates, proteins, and fats, and a meal plan is then developed, taking into account the patient's lifestyle and food preferences.

In contrast to the priority for the obese person with type 2 diabetes, the priority for a young patient with type 1 diabetes should be a diet with enough calories to maintain normal growth and development. Some patients may be underweight at the onset of type 1 diabetes because of rapid weight loss from severe hyperglycemia. The goal initially may be to provide a higher-calorie diet to regain lost weight and blood glucose control.

***Caloric Distribution.*** A meal plan for diabetes focuses on the percentages of calories that come from carbohydrates, proteins, and fats.

*Carbohydrates.* The caloric distribution currently recommended is higher in carbohydrates than in fat and protein. In general, carbohydrate foods have the greatest effect on blood glucose levels because they are more quickly digested than other foods and are converted into glucose rapidly. However, research into the appropriateness of a higher-carbohydrate diet in patients with decreased glucose tolerance is ongoing, and recommendations may change accordingly. Currently, the ADA and the American Dietetic Association recommend that for all levels of caloric intake, 50% to 60% of calories should be derived from carbohydrates, 20% to 30% from fat, and the remaining 10% to 20% from protein. The majority of the selections for carbohydrates should come from whole grains. These recommendations are also consistent with those of the American Heart Association and American Cancer Society.

Carbohydrates consist of sugars (eg, sucrose) and starches (eg, rice, pasta, bread). Low glycemic index diets (described later) may reduce postprandial glucose levels. Therefore, the nutrition guidelines recommend that all carbohydrates should be eaten in moderation to avoid high postprandial blood glucose levels (ADA, 2008b).

Foods high in carbohydrates, such as sucrose (concentrated sweets), are not totally eliminated from the diet but should be eaten in moderation (up to 10% of total calories), because they are typically high in fat and lack vitamins, minerals, and fiber.

*Fats.* The recommendations regarding fat content of the diabetic diet include both reducing the total percentage of calories from fat sources to less than 30% of total calories and limiting the amount of saturated fats to 10% of total calories. Additional recommendations include limiting the total intake of dietary cholesterol to less than 300 mg/day. This approach may help reduce risk factors such as increased serum cholesterol levels, which are associated with the development of coronary artery disease, the leading cause of death and disability among people with diabetes (ADA, 2008c).

*Protein.* The meal plan may include the use of some nonanimal sources of protein (eg, legumes, whole grains), to help reduce saturated fat and cholesterol intake. In addition, the amount of protein intake may be reduced in patients with early signs of renal disease.

*Fiber.* Increased fiber in the diet may improve blood glucose levels, decrease the need for exogenous insulin, and lower total cholesterol and low-density lipoprotein levels in the blood (ADA, 2008b).

There are two types of dietary fibers: soluble and insoluble. Soluble fiber—in foods such as legumes, oats, and some fruits—plays more of a role in lowering blood glucose and lipid levels than does insoluble fiber, although the clinical significance of this effect is probably small (ADA, 2008b). Soluble fiber slows stomach emptying and the movement of food through the upper digestive tract. The potential glucose-lowering effect of fiber may be caused by the slower rate of glucose absorption from foods that contain soluble fiber. Insoluble fiber is found in whole-grain breads and cereals and in some vegetables. This type of fiber along with soluble fiber increases satiety, which is helpful for weight loss. At least 25 g of fiber should be ingested daily.

One risk involved in suddenly increasing fiber intake is that it may require adjusting the dosage of insulin or oral agents to prevent hypoglycemia. Other problems may include abdominal fullness, nausea, diarrhea, increased flatulence, and constipation if fluid intake is inadequate. If fiber is added to or increased in the meal plan, it should be done gradually and in consultation with a dietitian. The exchange lists (ADA, 2008b) serve as an excellent guide for increasing fiber intake. Fiber-rich food choices within the vegetable, fruit, and starch/bread exchanges are highlighted in the lists.

***Food Classification Systems.*** To teach diet principles and to help in meal planning, several systems have been developed in which foods are organized into groups with common characteristics, such as number of calories, composition of foods (ie, amount of protein, fat, or carbohydrate in the food), or effect on blood glucose levels. Several of these are listed here.

*Exchange Lists.* A commonly used tool for nutritional management is the exchange lists for meal planning (ADA, 2008b). There are six main exchange lists: bread/starch, vegetable, milk, meat, fruit, and fat. Foods within one group (in the portion amounts specified) contain equal numbers of calories and are approximately equal in grams of protein, fat, and carbohydrate. Meal plans can be based on a recommended number of choices from each exchange list. Foods on one list may be interchanged with one another, allowing for variety while maintaining as much consistency as possible in the nutrient content of foods eaten. Table 41-2 presents three sample lunch menus that are interchangeable in terms of carbohydrate, protein, and fat content.

Exchange list information on combination foods such as pizza, chili, and casseroles, as well as convenience foods, desserts, snack foods, and fast foods, is available from the American Diabetes Association (see Resources). Some food manufacturers and restaurants publish exchange lists that describe their products.

*Nutrition Labels.* Food manufacturers are required to have the nutrition content of foods listed on package labels, and reading food labels is an important skill for patients to learn and use when food shopping. The label includes information about how many grams of carbohydrate are in a serving

**Table 41-2 SELECTED SAMPLE MENUS FROM EXCHANGE LISTS**

| Exchanges | Sample Lunch #1 | Sample Lunch #2 | Sample Lunch #3 |
|---|---|---|---|
| 2 starch | 2 slices bread | Hamburger bun | 1 cup cooked pasta |
| 3 meat | 2 oz sliced turkey and 1 oz lowfat cheese | 3 oz lean beef patty | 3 oz boiled shrimp |
| 1 vegetable | Lettuce, tomato, onion | Green salad | ½ cup plum tomatoes |
| 1 fat | 1 tsp mayonnaise | 1 tbsp salad dressing | 1 tsp olive oil |
| 1 fruit | 1 medium apple | 1¼ cup watermelon | 1¼ cup fresh strawberries |
| "Free" items (optional) | Unsweetened iced tea<br>Mustard, pickle, hot pepper | Diet soda<br>1 tbsp catsup, pickle, onions | Ice water with lemon<br>Garlic, basil |

of food. This information can be used to determine how much medication is needed. For example, a patient who takes premeal insulin may use the algorithm, 1 unit of insulin for 15 g of carbohydrate. Patients can also be taught to have a "carbohydrate budget" per meal (eg, 45 to 60 g).

Carbohydrate counting is a nutritional tool used for blood glucose management because carbohydrates are the main nutrients in food that influence blood glucose levels. This method provides flexibility in food choices, can be less complicated to understand than the diabetic food exchange list, and allows more accurate management with multiple daily injections (insulin before each meal). However, if carbohydrate counting is not used with other meal-planning techniques, weight gain can result. A variety of methods are used to count carbohydrates. When developing a diabetic meal plan using carbohydrate counting, all food sources should be considered.

Once digested, 100% of carbohydrates are converted to glucose. Approximately 50% of protein foods (meat, fish, and poultry) are also converted to glucose, but this has minimal effect on blood glucose levels.

Carbohydrate counting consists of counting grams of carbohydrates. If target goals are not reached by counting carbohydrates alone, protein is factored into the calculations. This is especially true if the meal consists only of meat, fish, and nonstarchy vegetables.

Although carbohydrate counting is now commonly used for blood glucose management with type 1 and type 2 diabetes, it is not a perfect system. All carbohydrates affect the blood glucose level to different degrees, regardless of equivalent serving size. When carbohydrate counting is used, reading labels on food items is the key to success. Knowing what the "carbohydrate budget" for the meal is and knowing how many grams of carbohydrate are in a serving of a food, the patient can calculate the amount in one serving.

*Healthy Food Choices.* An alternative to counting grams of carbohydrate is measuring servings or choices. This method is used more often by people with type 2 diabetes. It is similar to the food exchange list and emphasizes portion control of total servings of carbohydrate at meals and snacks. One carbohydrate serving is equivalent to 15 g of carbohydrate. Examples of one serving are an apple 2 inches in diameter and one slice of bread. Vegetables and meat are counted as one third of a carbohydrate serving. This system works well for those who have difficulty with the other complicated systems.

*Food Guide Pyramid.* The Food Guide Pyramid (ie, MyPyramid) is another tool used to develop meal plans. It is commonly used for patients with type 2 diabetes who have a difficult time following a calorie-controlled diet. The 2005 food pyramid consists of the following food groups: (1) grains, (2) vegetables, (3) fruits, (4) milk and other dairy products, and (5) meats and beans. Oils and other high-fat foods comprise another food group on the pyramid (see Chapter 5). Foods (starches, fruits, and vegetables) that are lowest in calories and fat and highest in fiber should make up the basis of the diet. For those with diabetes, as well as for the general population, 50% to 60% of the daily caloric intake should be from these three groups. Foods higher in fat (particularly saturated fat) should account for a smaller percentage of the daily caloric intake. Fats, oils, and sweets should be used sparingly to obtain weight and blood glucose control and to reduce the risk for cardiovascular disease. Reliance on the MyPyramid may result in fluctuations in blood glucose levels, however, because high-carbohydrate foods may be grouped with low-carbohydrate foods. The pyramid is appropriately used only as a first-step teaching tool for patients who are learning how to control food portions and how to identify which foods contain carbohydrate, protein, and fat.

*Glycemic Index.* One of the main goals of diet therapy in diabetes is to avoid sharp, rapid increases in blood glucose levels after food is eaten. The term glycemic index is used to describe how much a given food increases the blood glucose level compared with an equivalent amount of glucose. The effects of use of the glycemic index on blood glucose levels and on long-term patient outcomes are unclear, but it may be beneficial (ADA, 2008b). Although more research is necessary, the following guidelines may be helpful when making dietary recommendations:

- Combining starchy foods with protein-containing and fat-containing foods tends to slow their absorption and lower the glycemic response.
- In general, eating foods that are raw and whole results in a lower glycemic response than eating chopped, puréed, or cooked foods.
- Eating whole fruit instead of drinking juice decreases the glycemic response, because fiber in the fruit slows absorption.
- Adding foods with sugars to the diet may result in a lower glycemic response if these foods are eaten with foods that are more slowly absorbed.

Patients can create their own glycemic index by monitoring their blood glucose level after ingestion of a particular food. This can help improve blood glucose control through individualized manipulation of the diet. Many

patients who use frequent monitoring of blood glucose levels can use this information to adjust their insulin doses in accordance with variations in food intake.

### Other Dietary Concerns

***Alcohol Consumption.*** Patients with diabetes do not need to give up alcoholic beverages entirely, but they and health care professionals must be aware of the potential adverse effects of alcohol specific to diabetes. Alcohol is absorbed before other nutrients and does not require insulin for absorption. Large amounts can be converted to fats, increasing the risk for DKA. In general, the same precautions regarding the use of alcohol by people without diabetes should be applied to patients with diabetes. Moderation is recommended. A major danger of alcohol consumption by the patient with diabetes is hypoglycemia, especially for patients who take insulin or insulin secretagogues (medications that increase the secretion of insulin by the pancreas). Alcohol may decrease the normal physiologic reactions in the body that produce glucose (gluconeogenesis). Therefore, if a patient with diabetes consumes alcohol on an empty stomach, there is an increased likelihood of hypoglycemia. In addition, excessive alcohol intake may impair the patient's ability to recognize and treat hypoglycemia or to follow a prescribed meal plan to prevent hypoglycemia. To reduce the risk of hypoglycemia, the patient should be cautioned to consume food along with the alcohol; however, carbohydrate consumed with alcohol may raise blood glucose (ADA, 2008b).

Alcohol consumption may lead to excessive weight gain (from the high caloric content of alcohol), hyperlipidemia, and elevated glucose levels (especially with mixed drinks and liqueurs). Patient teaching regarding alcohol intake must emphasize moderation in the amount of alcohol consumed. Moderate intake is considered to be one alcoholic beverage per day for women and two per day for men. Lower-calorie or less sweet drinks (eg, light beer, dry wine) and food intake along with alcohol consumption are advised. Especially for patients with type 2 diabetes who wish to control their weight, it is important to incorporate the calories from alcohol into the overall meal plan.

***Sweeteners.*** Use of artificial sweeteners is acceptable, especially if it assists in overall dietary adherence. Moderation in the amount of sweetener used is encouraged to avoid potential adverse effects. There are two main types of sweeteners: nutritive and nonnutritive. The nutritive sweeteners contain calories, and the nonnutritive sweeteners have few or no calories in the amounts normally used.

Nutritive sweeteners include fructose (fruit sugar), sorbitol, and xylitol, all of which provide calories in amounts similar to those in sucrose (table sugar). They cause less elevation in blood sugar levels than sucrose does and are often used in "sugar-free" foods. Sweeteners containing sorbitol may have a laxative effect.

Nonnutritive sweeteners have minimal or no calories. They are used in food products and are also available for table use. They produce minimal or no elevation in blood glucose levels and have been approved by the U.S. Food and Drug Administration (FDA) as safe for people with diabetes. Nonnutritive sweeteners include saccharin, aspartame (NutraSweet), acesulfame-K (Sunnette), and sucralose (Splenda) (ADA, 2009b).

***Misleading Food Labels.*** Foods labeled "sugarless" or "sugar-free" may still provide calories equal to those of the equivalent sugar-containing products if they are made with nutritive sweeteners. Therefore, these foods should not be considered "free" foods to be eaten in unlimited quantity, because they can elevate blood glucose levels. Foods labeled "dietetic" are not necessarily reduced-calorie foods. Patients are advised that foods labeled "dietetic" may still contain significant amounts of sugar or fat.

It is important that patients read the labels of "health foods"—especially snacks—because they often contain carbohydrates (eg, honey, brown sugar, corn syrup) and saturated vegetable fats (eg, coconut or palm oil), hydrogenated vegetable fats, or animal fats, which may be contraindicated in people with elevated blood lipid levels.

## Exercise

Exercise is extremely important in diabetes management because of its effects on lowering blood glucose and reducing cardiovascular risk factors. Exercise lowers blood glucose levels by increasing the uptake of glucose by body muscles and by improving insulin utilization. It also improves circulation and muscle tone. Resistance (strength) training, such as weight lifting, can increase lean muscle mass, thereby increasing the resting metabolic rate. These effects are useful in diabetes in relation to losing weight, easing stress, and maintaining a feeling of well-being. Exercise also alters blood lipid concentrations, increasing levels of high-density lipoproteins and decreasing total cholesterol and triglyceride levels. This is especially important for people with diabetes because of their increased risk of cardiovascular disease (Nathan, et al., 2005).

### Exercise Recommendations

Ideally, a person with diabetes should exercise at the same time (preferably when blood glucose levels are at their peak) and in the same amount each day. Regular daily exercise, rather than sporadic exercise, should be encouraged. Exercise recommendations must be altered as necessary for patients with diabetic complications such as retinopathy, autonomic neuropathy, sensorimotor neuropathy, and cardiovascular disease (ADA, 2009b). Increased blood pressure associated with exercise may aggravate diabetic retinopathy and increase the risk of a hemorrhage into the vitreous or retina. Patients with ischemic heart disease risk triggering angina or a myocardial infarction, which may be silent. Avoiding trauma to the lower extremities is especially important in patients with numbness related to neuropathy.

In general, a slow, gradual increase in the exercise period is encouraged. For many patients, walking is a safe and beneficial form of exercise that requires no special equipment (except for proper shoes) and can be performed anywhere. People with diabetes should discuss an exercise program with their health care providers and undergo a careful medical evaluation with appropriate diagnostic studies before beginning program (ADA, 2009b).

For patients who are older than 30 years and who have two or more risk factors for heart disease, an exercise stress

test is recommended. Risk factors for heart disease include hypertension, obesity, high cholesterol levels, abnormal resting electrocardiogram (ECG), sedentary lifestyle, smoking, male gender, and a family history of heart disease. An abnormal stress test may indicate cardiac ischemia. Typically, an abnormal stress test is followed up with a cardiac catheterization and, in some cases, with an intervention such as angioplasty, stent replacement, or cardiac surgery.

### Exercise Precautions

Patients who have blood glucose levels exceeding 250 mg/dL (14 mmol/L) and who have ketones in their urine should not begin exercising until the urine test results are negative for ketones and the blood glucose level is closer to normal. Exercising with elevated blood glucose levels increases the secretion of glucagon, growth hormone, and catecholamines. The liver then releases more glucose, and the result is an increase in the blood glucose level (ADA, 2009b).

The physiologic decrease in circulating insulin that normally occurs with exercise cannot occur in patients treated with insulin. Initially, patients who require insulin should be taught to eat a 15-g carbohydrate snack (a fruit exchange) or a snack of complex carbohydrates with a protein before engaging in moderate exercise to prevent unexpected hypoglycemia. The exact amount of food needed varies from person to person and should be determined by blood glucose monitoring.

Another potential concern for patients who take insulin is hypoglycemia that occurs many hours after exercise. To avoid postexercise hypoglycemia, especially after strenuous or prolonged exercise, the patient may need to eat a snack at the end of the exercise session and at bedtime and monitor the blood glucose level more frequently. Patients who are capable, knowledgeable, and responsible can learn to adjust their own insulin doses by working closely with a diabetes educator. Others need specific instructions on what to do when they exercise.

Patients taking insulin and participating in extended periods of exercise should test their blood glucose levels before, during, and after the exercise period, and they should snack on carbohydrates as needed to maintain blood glucose levels (ADA, 2006a). Other participants or observers should be aware that the person exercising has diabetes, and they should know what assistance to give if severe hypoglycemia occurs.

In obese people with type 2 diabetes, exercise in addition to dietary management both improves glucose metabolism and enhances loss of body fat. Exercise coupled with weight loss improves insulin sensitivity and may decrease the need for insulin or oral antidiabetic agents (ADA, 2006a). Eventually, the patient's glucose tolerance may return to normal. Patients with type 2 diabetes who are not taking insulin or an oral agent may not need extra food before exercise.

General precautions for exercise in diabetes are presented in Chart 41-4.

### Gerontologic Considerations

Physical activity that is consistent and realistic is beneficial to elderly people with diabetes. Physical fitness in the elderly population with diabetes may lead to improved glycemic control, decreased risk for chronic vascular disease, and an improved quality of life (ADA, 2006a). Advantages of exercise in this population include a decrease in hyperglycemia, a general sense of well-being, and better use of ingested calories, resulting in weight reduction. Because there is an increased incidence of cardiovascular problems in the elderly, a physical examination and exercise stress test may be warranted before an exercise program is initiated. A pattern of gradual, consistent exercise, including resistance exercise, should be planned that does not exceed the patient's physical capacity. Physical impairment due to other chronic diseases must also be considered. In some cases, a physical therapy evaluation may be indicated, with the goal of determining exercises specific to the patient's needs and abilities. Tools such as the "Armchair Fitness" video may be helpful. For more information about age-related changes that affect diabetes management, see Chart 41-5.

**CHART 41-4 PATIENT EDUCATION**
***General Precautions for Exercise in People With Diabetes***

- Use proper footwear and, if appropriate, other protective equipment.
- Avoid exercise in extreme heat or cold.
- Inspect feet daily after exercise.
- Avoid exercise during periods of poor metabolic control.

## Monitoring Glucose Levels and Ketones

Blood glucose monitoring is a cornerstone of diabetes management, and **self-monitoring of blood glucose (SMBG)** levels has dramatically altered diabetes care.

### Self-Monitoring of Blood Glucose

Using frequent SMBG and learning how to respond to the results enable people with diabetes to adjust their treatment regimen to obtain optimal blood glucose control. This allows for detection and prevention of hypoglycemia and hyperglycemia and plays a crucial role in normalizing blood glucose levels, which in turn may reduce the risk of long-term diabetic complications.

Various methods for SMBG are available. Most involve obtaining a drop of blood from the fingertip, applying the blood to a special reagent strip, and allowing the blood to stay on the strip for the amount of time specified by the manufacturer (usually 5 to 30 seconds). The meter gives a digital readout of the blood glucose value. The meters available for SMBG offer various features and benefits such as monthly averages, tracking of events like exercise and food consumption, and downloading capacity. Some meters are biosensors that can use blood obtained from alternative test sites, such as the forearm. They have a special lancing device that is useful for patients who have painful fingertips or experience pain with fingersticks.

Because laboratory methods measure plasma glucose, most blood glucose monitors approved for patients' use in the home and some test strips calibrate blood glucose readings to plasma values. Plasma glucose values are 10% to 15% higher than whole blood glucose values, and it is

CHART 41-5

GERONTOLOGIC CONSIDERATIONS

## *Age-Related Changes That May Affect Diabetes and Its Management*

**Sensory Changes**

Decreased vision
Decreased smell
Taste changes
Decreased proprioception
Diminished thirst

**Gastrointestinal Changes**

Dental problems
Appetite changes
Delayed gastric emptying
Decreased bowel motility

**Activity/exercise Pattern Changes**

More sedentary

**Renal Function Changes**

Decreased function
Decreased drug clearance

**Affective/cognitive Changes**

Medications/meals omitted or taken erratically

**Socioeconomic Factors**

Fad diets
Loneliness/living alone
Lack of money/lack of support system

**Chronic Diseases**

Hypertension
Arthritis
Neoplasms
Acute/chronic infections

**Potential Drug Interactions**

Use of another person's medications
Consulting multiple physicians for different illnesses
Alcohol use/abuse

crucial for patients with diabetes to know whether their monitor and strips provide whole blood or plasma results.

Methods for SMBG must match the skill level of patients. Factors affecting SMBG performance include visual acuity, fine motor coordination, cognitive ability, comfort with technology and willingness to use it, and cost. Some meters can be used by patients with visual impairments that have audio components to assist in performing the test and obtaining the result. In addition, meters are available to check both blood glucose and blood ketone levels by those who are particularly susceptible to DKA. Most insurance companies cover some or all of the costs of meters and strips.

A potential hazard of all methods of SMBG is that the patient may obtain and report erroneous blood glucose values as a result of using incorrect techniques. Some common sources of error include improper application of blood (eg, drop too small), damage to the reagent strips caused by heat or humidity, use of outdated strips, and improper meter cleaning and maintenance.

Nurses play an important role in providing initial teaching about SMBG techniques. Equally important is evaluating the techniques of patients who are experienced in self-monitoring. Every 6 to 12 months, patients should conduct a comparison of their meter result with a simultaneous laboratory-measured blood glucose level in their physician's office and have their technique observed. The accuracy of the meter and strips can also be assessed with control solutions specific to that meter whenever a new vial of strips is used and whenever the validity of the reading is in doubt.

***Candidates for Self-Monitoring of Blood Glucose.*** SMBG is a useful tool for managing self-care for everyone with diabetes. It is a key component of treatment for any intensive insulin therapy regimen (ie, two to four injections per day or use of an insulin pump) and for diabetes management during pregnancy. It is also recommended for patients with the following conditions:

- Unstable diabetes (severe swings from very high to very low blood glucose levels within a 24-hour day)
- A tendency to develop severe ketosis or hypoglycemia
- Hypoglycemia without warning symptoms

For patients not taking insulin, SMBG is helpful for monitoring the effectiveness of exercise, diet, and oral antidiabetic agents. It can also help motivate patients to continue with treatment. For patients with type 2 diabetes, SMBG is recommended during periods of suspected hyperglycemia (eg, illness) or hypoglycemia (eg, unusual increased activity levels) and when the medication or dosage of medication is modified (ADA, 2009b).

***Frequency of Self-Monitoring of Blood Glucose.*** For most patients who require insulin, SMBG is recommended two to four times daily (usually before meals and at bedtime). For patients who take insulin before each meal, SMBG is required at least three times daily before meals to determine each dose (ADA, 2009b). Those not receiving insulin may be instructed to assess their blood glucose levels at least two or three times per week, including a 2-hour postprandial test. For all patients, testing is recommended whenever hypoglycemia or hyperglycemia is suspected, with changes in medications, activity, or diet, and with stress or illness.

***Responding to Self-Monitoring of Blood Glucose Results.*** Patients are asked to keep a record or logbook of blood glucose levels so that they can detect patterns. Testing is done at the peak action time of the medication to evaluate the need for dosage adjustments. To evaluate basal insulin and determine bolus insulin doses, testing is performed before meals. To determine bolus doses of regular or rapid-acting insulin (lispro [Humalog], aspart [Novolog], or glulisine [Apidra]), testing is done 2 hours after meals. Patients with type 2 diabetes are encouraged to test daily before and 2 hours after the largest meal of the day until stabilized. Thereafter, testing should be done periodically before and after meals. Patients who take insulin at bedtime or who use an insulin infusion pump should also test at 3 AM once a

week to document that the blood glucose level is not decreasing during the night. If the patient is unwilling or cannot afford to test frequently, then once or twice a day may be sufficient if the time of testing is varied (eg, before breakfast one day and before lunch the next day).

A tendency to discontinue SMBG is more likely to occur if the patient does not receive instruction about using the results to alter the treatment regimen, if positive reinforcement is not given, and if costs of testing increase. At the very least, the patient should be given parameters for contacting the physician. Patients using intensive insulin therapy regimens may be instructed in the use of algorithms (rules or decision trees) for changing the insulin doses based on patterns of values greater or less than the target range and the amount of carbohydrate to be consumed. Baseline patterns should be established by SMBG for 1 to 2 weeks.

#### Using a Continuous Glucose Monitoring System

A **continuous glucose monitoring system (CGMS)** can be used to continuously monitor blood glucose levels (Fig. 41-2). A sensor attached to an infusion set, which is similar to an insulin pump infusion set, is inserted subcutaneously in the abdomen and connected to the device worn on a belt. After 72 hours, the data from the device are downloaded, and blood glucose readings are analyzed. Although the CGMS cannot be used for making decisions about specific insulin doses, it can be used to determine whether treatment is adequate over a 24-hour period. This device will be refined in the future so that it can be used by patients to make daily treatment decisions.

#### Testing for Glycated Hemoglobin

**Glycated hemoglobin** (also referred to as **glycosylated hemoglobin, HgbA$_{1C}$, or A1C**) is a blood test that reflects average blood glucose levels over a period of approximately 2 to 3 months (ADA, 2009b). When blood glucose levels are elevated, glucose molecules attach to hemoglobin in red blood cells. The longer the amount of glucose in the blood remains above normal, the more glucose binds to hemoglobin and the higher the glycated hemoglobin level becomes. This complex (hemoglobin attached to the glucose) is permanent and lasts for the life of an individual red blood cell, approximately 120 days. If near-normal blood glucose levels are maintained, with only occasional increases, the overall value will not be greatly elevated. However, if the blood glucose values are consistently high, then the test result is also elevated. If the patient reports mostly normal SMBG results but the glycated hemoglobin is high, there may be errors in the methods used for glucose monitoring, errors in recording results, or frequent elevations in glucose levels at times during the day when the patient is not usually monitoring blood sugar levels. Normal values typically range from 4% to 6% and indicate consistently near-normal blood glucose concentrations. The target range for people with diabetes is less than 7% (ADA, 2009b).

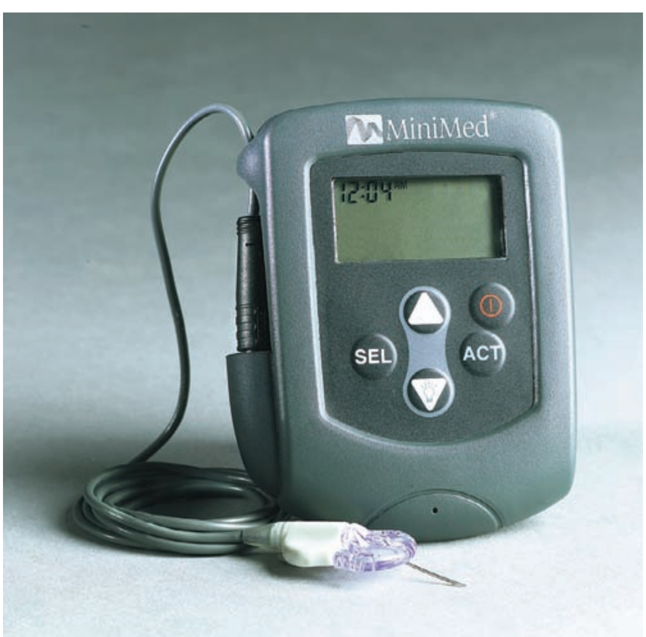



**Figure 41-2** MiniMed CGMS System Gold Continuous Glucose Monitoring System. (Courtesy of Medtronic Diabetes.)

#### Testing for Ketones

Ketones (or ketone bodies) are byproducts of fat breakdown, and they accumulate in the blood and urine. Ketones in the urine signal that there is a deficiency of insulin and control of type 1 diabetes is deteriorating. The risk of DKA is high. When there is almost no effective insulin available, the body starts to break down stored fat for energy. Urine testing is the most common method used for self-testing of ketone bodies by patients. A meter that enables testing of blood for ketones is available.

Most commonly, the patient uses a urine dipstick (Ketostix or Chemstrip uK) to detect ketonuria. The reagent pad on the strip turns purple when ketones are present. (One of the ketone bodies is called acetone, and this term is frequently used interchangeably with the term ketones.) Other strips are available for measuring both urine glucose and ketones (Keto-Diastix or Chemstrip uGK). Large amounts of ketones may depress the color response of the glucose test area.

Urine ketone testing should be performed whenever patients with type 1 diabetes have glycosuria or persistently elevated blood glucose levels (more than 240 mg/dL or 13.2 mmol/L for two testing periods in a row) and during illness, in pregnancy with preexisting diabetes, and in gestational diabetes (ADA, 2009b).

### *Pharmacologic Therapy*

As previously stated, insulin is secreted by the beta cells of the islets of Langerhans and works to lower the blood glucose level after meals by facilitating the uptake and utilization of glucose by muscle, fat, and liver cells. In the absence of adequate insulin, pharmacologic therapy is essential.

#### Insulin Therapy

In type 1 diabetes, exogenous insulin must be administered for life because the body loses the ability to produce insulin. In type 2 diabetes, insulin may be necessary on a long-term basis to control glucose levels if meal planning and oral agents are ineffective. In addition, some patients in whom type 2 diabetes is usually controlled by meal planning alone

or by meal planning and an oral antidiabetic agent may require insulin temporarily during illness, infection, pregnancy, surgery, or some other stressful event. In many cases, insulin injections are administered two or more times daily to control the blood glucose level. Because the insulin dose required by the individual patient is determined by the level of glucose in the blood, accurate monitoring of blood glucose levels is essential; thus, SMBG is a cornerstone of insulin therapy.

***Preparations.*** A number of insulin preparations are available. They vary according to three main characteristics: time course of action, species (source), and manufacturer.

*Time Course of Action.* Insulins may be grouped into several categories based on the onset, peak, and duration of action (Table 41-3). Human insulin preparations have a shorter duration of action than insulin from animal sources because the presence of animal proteins triggers an immune response that results in the binding of animal insulin, which slows its availability.

Rapid-acting insulins produce a more rapid effect that is of shorter duration than regular insulin. Because of their rapid onset, the patient should be instructed to eat no more than 5 to 15 minutes after injection. Because of the short duration of action of these insulin analogues, patients with type 1 diabetes and some patients with type 2 or gestational diabetes also require a long-acting insulin (basal insulin) to maintain glucose control. Basal insulin is necessary to maintain blood glucose levels irrespective of meals. A constant level of insulin is required at all times. Intermediate-acting insulins function as basal insulins but may have to be split into two injections to achieve 24-hour coverage.

Short-acting insulins are called regular insulin (marked R on the bottle). Regular insulin is a clear solution and is usually administered 20 to 30 minutes before a meal, either alone or in combination with a longer-acting insulin. Regular insulin is the only insulin approved for IV use.

Intermediate-acting insulins are called NPH insulin (neutral protamine Hagedorn) or Lente insulin. Intermediate-acting insulins, which are similar in their time course of action, appear white and cloudy. If NPH or Lente insulin is taken alone, it is not crucial that it be taken 30 minutes before the meal. However, it is important that patients eat some food around the time of the onset and peak of these insulins.

"Peakless" basal or very long-acting insulins are approved by the FDA for use as a basal insulin—that is, the insulin is absorbed very slowly over 24 hours and can be given once a day. Because the insulin is in a suspension with a pH of 4, it cannot be mixed with other insulins because this would cause precipitation. It was originally approved to be given once a day at bedtime; however, it has now been approved to be given once a day at any time of the day but must be given at the same time each day to prevent overlap of action. Many patients fall asleep, forgetting to take their bedtime insulin or may be wary of taking insulin before going to sleep. Having these patients take their insulin in the morning ensures that the dose is taken.

**NURSING ALERT**

**When administering insulin, it is very important to read the label carefully and to be sure that the correct type of insulin is administered. It is also important to avoid mistaking Lantus insulin for Lente insulin and vice versa.**

The nurse should emphasize which meals—and snacks—are being "covered" by which insulin doses. In general, the rapid-acting and short-acting insulins are expected to cover the increase in glucose levels after meals, immediately after the injection; the intermediate-acting insulins are expected to cover subsequent meals; and the long-acting insulins provide a relatively constant level of insulin and act as a basal insulin.

*Species (Source).* In the past, all insulins were obtained from beef (cow) and pork (pig) pancreases. Human insulins are now widely available. They are produced by recombinant

**Table 41-3 CATEGORIES OF INSULIN**

| Time Course | Agent | Onset | Peak | Duration | Indications |
|---|---|---|---|---|---|
| Rapid-acting | Lispro (Humalog)<br>Aspart (Novolog)<br>Glulisine (Apidra) | 10–15 min<br>5–15 min<br>5–15 min | 1 h<br>40–50 min<br>30–60 min | 2–4 h<br>2–4 h<br>2 h | Used for rapid reduction of glucose level, to treat postprandial hyperglycemia, and/or to prevent nocturnal hypoglycemia |
| Short-acting | Regular (Humalog R, Novolin R, Iletin II Regular) | ½–1 h | 2–3 h | 4–6 h | Usually administered 20–30 min before a meal; may be taken alone or in combination with longer-acting insulin |
| Intermediate-acting | NPH (neutral protamine Hagedorn)<br>(Humulin N, Iletin II Lente, Iletin II NPH, Novolin L [Lente], Novolin N [NPH]) | 2–4 h<br>3–4 h | 4–12 h<br>4–12 h | 16–20 h<br>16–20 h | Usually taken after food |
| Very long-acting | Glargine (Lantus)<br>Detemir (Levemir) | 1 h | Continuous (no peak) | 24 h | Used for basal dose |

DNA technology and have largely replaced insulin from animal sources. These insulins are preferable to animal source insulins because they are not antigenic and do not depend on sufficient animal sources. Human insulin preparations have a shorter duration of action than insulin from animal sources because the presence of animal proteins triggers an immune response that results in the binding of animal insulin, which slows its availability.

***Insulin Regimens.*** Insulin regimens vary from one to four injections per day. Usually there is a combination of a short-acting insulin and a longer-acting insulin. The normally functioning pancreas continuously secretes small amounts of insulin during the day and night. In addition, whenever blood glucose increases after ingestion of food, there is a rapid burst of insulin secretion in proportion to the glucose-raising effect of the food. The goal of all but the simplest, one-injection insulin regimens is to mimic this normal pattern of insulin secretion in response to food intake and activity patterns. Table 41-4 describes several insulin regimens and the advantages and disadvantages of each.

There are two general approaches to insulin therapy: conventional and intensive (described in detail below). The patient can learn to use SMBG results and carbohydrate counting to vary the insulin doses. This allows more flexibility in timing and content of meals and exercise periods. However, complex insulin regimens require a strong level of commitment, intensive education, and close follow-up by the health care team.

The patient should be very involved in the decision regarding which insulin regimen to use. The patient should compare the potential benefits of different regimens with the potential costs (eg, time involved, number of injections or fingersticks for glucose testing, amount of record keeping). There are no set guidelines as to which insulin regimen should be used for which patient. It must not be assumed that elderly patients should automatically be given a simplified regimen. Likewise, it must not be assumed that all people want to be involved in a complex treatment regimen. The nurse plays an important role in educating the patient about the various approaches to insulin therapy. The nurse should refer the patient to a diabetes specialist or a diabetes education center, if available, for further training and education in the insulin treatment regimens.

*Conventional Regimen.* One approach is to simplify the insulin regimen as much as possible, with the aim of avoiding the acute complications of diabetes (hypoglycemia and symptomatic hyperglycemia). With this type of simplified regimen (eg, one or more injections of a mixture of short-acting and intermediate-acting insulins per day), the patient should not vary meal patterns and activity levels. The simplified regimen would be appropriate for the terminally ill, the frail elderly with limited self-care abilities, or patients who are completely unwilling or unable to engage in the self-management activities that are part of a more complex insulin regimen.

*Intensive Regimen.* The second approach is to use a more complex insulin regimen to achieve as much control over blood glucose levels as is safe and practical. A more complex insulin regimen allows the patient more flexibility to change the insulin doses from day to day in accordance with changes in eating and activity patterns, with stress and illness, and as needed for variations in the prevailing glucose level.

Although the DCCT Research Group (1993) found that intensive treatment (three or four injections of insulin per day) reduced the risk of complications, not all people with diabetes are candidates for very tight control of blood glucose. The DCCT also found that the risk of severe hypoglycemia was increased threefold in patients receiving intensive treatment (ADA, 2009b). Patients who have received a kidney transplant because of nephropathy and chronic renal failure should follow an intensive insulin regimen to preserve function of the new kidney.

Those who are not candidates include those with:

- Nervous system disorders rendering them unaware of hypoglycemic episodes (eg, those with autonomic neuropathy)
- Recurring severe hypoglycemia
- Irreversible diabetic complications, such as blindness or end-stage renal disease
- Cerebrovascular or cardiovascular disease
- Ineffective self-care skills

### *Complications of Insulin Therapy*

*Local Allergic Reactions.* A local allergic reaction (redness, swelling, tenderness, and induration or a 2- to 4-cm wheal) may appear at the injection site 1 to 2 hours after the insulin administration. These reactions, which usually occur during the beginning stages of therapy and disappear with continued use of insulin, are becoming rare because of the increased use of human insulins. The physician may prescribe an antihistamine to be taken 1 hour before the injection if such a local reaction occurs.

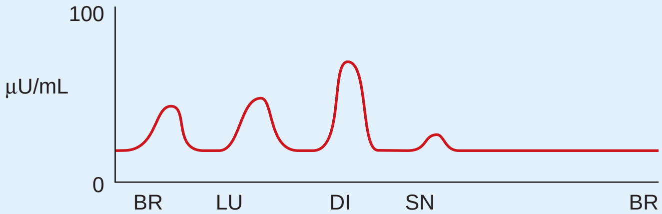
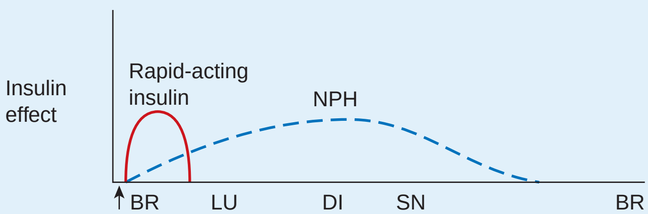
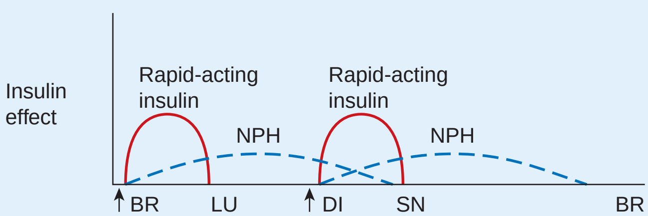
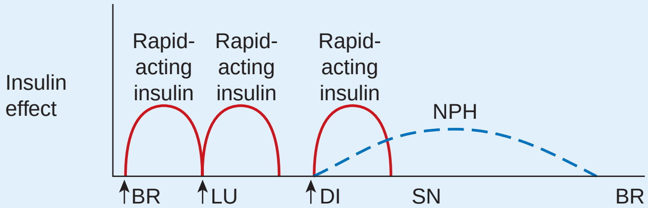
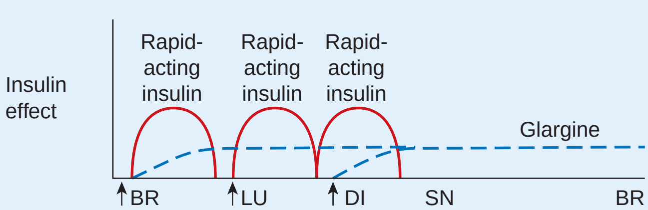
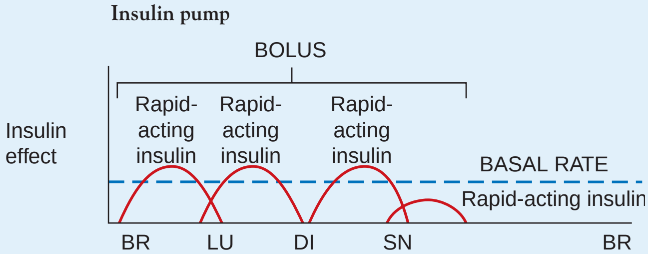
*Systemic Allergic Reactions.* Systemic allergic reactions to insulin are rare. When they do occur, there is an immediate local skin reaction that gradually spreads into generalized urticaria (hives). These rare reactions are occasionally associated with generalized edema or anaphylaxis. The treatment is desensitization, with small doses of insulin administered in gradually increasing amounts using a desensitization kit.

*Insulin Lipodystrophy.* Lipodystrophy refers to a localized reaction, in the form of either lipoatrophy or lipohypertrophy, occurring at the site of insulin injections. Lipoatrophy is loss of subcutaneous fat; it appears as slight dimpling or more serious pitting of subcutaneous fat. The use of human insulin has almost eliminated this disfiguring complication.

Lipohypertrophy, the development of fibrofatty masses at the injection site, is caused by the repeated use of an injection site. If insulin is injected into scarred areas, absorption may be delayed. This is one reason that rotation of injection sites is so important. Patients should avoid injecting insulin into these areas until the hypertrophy disappears.

*Resistance to Injected Insulin.* Most patients have some degree of insulin resistance at one time or another. This may occur for various reasons, the most common being obesity, which can be overcome by weight loss. Clinical insulin resistance has been defined as a daily insulin requirement of

**Table 41-4 INSULIN REGIMENS**

| Schematic Representation | Description | Advantages | Disadvantages |
|---|---|---|---|
| **Normal pancreas**   | Insulin release increases when blood glucose levels rise and continues at a low steady rate between meals. | | |
| **One injection per day**   | Before breakfast:<br>• NPH or<br>• NPH with rapid acting insulin | Simple regimen | Difficult to control fasting blood glucose if effects of NPH do not last<br>Afternoon hypoglycemia may result from attempts to control fasting glucose level by increasing NPH dose |
| **Two injections per day–mixed**   | Before breakfast and dinner:<br>• NPH or<br>• NPH with rapid-acting insulin or<br>• Premixed (rapid-acting insulin) insulin | Simplest regimen that attempts to mimic normal pancreas | Need relatively fixed schedule of meals and exercise<br>Cannot independently adjust NPH or regular if premixed insulin is used |
| **Three or four injections per day**     | Rapid-acting insulin before each meal with:<br>• NPH at dinner or<br>• NPH at bedtime or<br>• Glargine one or two times per day | More closely mimics normal pancreas than two-injection regimen<br>Each premeal dose of regular insulin decided independently<br>More flexibility with meals and exercise | Requires more injections than other regimens<br>Requires multiple blood glucose tests on a daily basis<br>Requires intensive education and follow-up |
| **Insulin pump**   | Uses ONLY rapid-acting, (Lispro, Aspart, or Apidra) insulin infused at continuous, low rate called *basal rate* (commonly 0.5–1.5 units/h) and premeal *bolus doses* activated by pump wearer | Most closely mimics normal pancreas<br>Decreases unpredictable peaks of intermediate-acting and long-acting insulins<br>Increases meal and exercise flexibility | Requires intensive training and frequent follow-up<br>Potential for mechanical problems<br>Requires multiple blood glucose tests on a daily basis<br>Potential increase in expenses (depending on insurance coverage) |

BR, breakfast; LU, lunch; DI, dinner; SN, snack; REG, regular; ↑ indicates insulin injections.
Rapid acting insulin; lispro, aspart, or glulisine [Apidra]

200 units or more. In most patients with diabetes who take insulin, immune antibodies develop and bind the insulin, thereby decreasing the insulin available for use. All animal insulins, and human insulins to a lesser degree, cause antibody production in humans.

Very few resistant patients develop high levels of antibodies. Many of these patients have a history of insulin therapy interrupted for several months or longer. Treatment consists of administering a more concentrated insulin preparation, such as U500, which is available by special order. Occasionally, prednisone is needed to block the production of antibodies. This may be followed by a gradual reduction in the insulin requirement. Therefore, patients must monitor their blood for hypoglycemia.

*Morning Hyperglycemia.* An elevated blood glucose level on arising in the morning is caused by an insufficient level of insulin, which may be caused by several factors: the dawn phenomenon, the Somogyi effect, or insulin waning. The dawn phenomenon is characterized by a relatively normal blood glucose level until approximately 3 AM, when blood glucose levels begin to rise. The phenomenon is thought to result from nocturnal surges in growth hormone secretion, which create a greater need for insulin in the early morning hours in patients with type 1 diabetes. It must be distinguished from insulin waning (the progressive increase in blood glucose from bedtime to morning) and from the Somogyi effect (nocturnal hypoglycemia followed by rebound hyperglycemia). Insulin waning is frequently seen if the evening NPH dose is administered before dinner; it is prevented by moving the evening dose of NPH insulin to bedtime.

It may be difficult to tell from a patient's history which of these causes is responsible for morning hyperglycemia. To determine the cause, the patient must be awakened once or twice during the night to test blood glucose levels. Testing at bedtime, at 3 AM, and on awakening provides information that can be used to make adjustments in insulin to avoid morning hyperglycemia. Table 41-5 summarizes the differences among insulin waning, the dawn phenomenon, and the Somogyi effect.

***Methods of Insulin Delivery.*** Methods of insulin delivery include traditional subcutaneous injections, insulin pens, jet injectors, and insulin pumps. See the nursing management section for discussion of traditional subcutaneous injections.

*Insulin Pens.* Insulin pens use small (150- to 300-unit) prefilled insulin cartridges that are loaded into a penlike holder. A disposable needle is attached to the device for insulin injection. Insulin is delivered by dialing in a dose or pushing a button for every 1- or 2-unit increment administered. People using these devices still need to insert the needle for each injection (Fig. 41-3); however, they do not need to carry insulin bottles or draw up insulin before each injection. These devices are most useful for patients who need to inject only one type of insulin at a time (eg, premeal rapid-acting insulin three times a day and bedtime NPH insulin) or who can use the premixed insulins. These pens are convenient for those who administer insulin before dinner if eating out or traveling. They are also useful for patients with impaired manual dexterity, vision, or cognitive function, which makes the use of traditional syringes difficult.

**Table 41-5 CAUSES OF MORNING HYPERGLYCEMIA**

| Characteristic | Treatment |
|---|---|
| **Insulin Waning** | |
| Progressive rise in blood glucose from bedtime to morning | Increase evening (predinner or bedtime) dose of intermediate-acting or long-acting insulin, or institute a dose of insulin before the evening meal if one is not already part of the treatment regimen. |
| **Dawn Phenomenon** | |
| Relatively normal blood glucose until about 3 AM, when the level begins to rise | Change time of injection of evening intermediate-acting insulin from dinnertime to bedtime. |
| **Somogyi Effect** | |
| Normal or elevated blood glucose at bedtime, a decrease at 2–3 AM to hypoglycemic levels, and a subsequent increase caused by the production of counterregulatory hormones | Decrease evening (predinner or bedtime) dose of intermediate-acting insulin, or increase bedtime snack. |

*Jet Injectors.* As an alternative to needle injections, jet injection devices deliver insulin through the skin under pressure in an extremely fine stream. These devices are more expensive and require thorough training and supervision when first used. In addition, patients should be cautioned

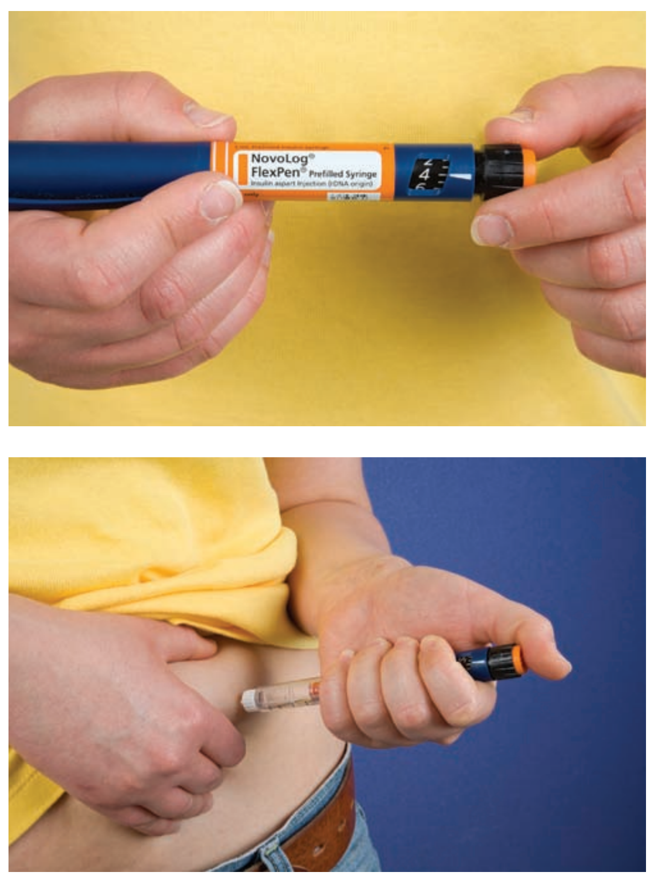



**Figure 41-3** Prefilled insulin syringe.



**Figure 41-4** MiniMed Paradigm real-time insulin pump and continuous glucose monitoring system. (Courtesy of Medtronic Diabetes.)

that absorption rates, peak insulin activity, and insulin levels may be different when changing to a jet injector. (Insulin administered by jet injector is usually absorbed faster.) Use of jet injectors has been associated with bruising in some patients.

*Insulin Pumps.* Continuous subcutaneous insulin infusion involves the use of small, externally worn devices (insulin pumps) that closely mimic the functioning of the normal pancreas (ADA, 2009b). Insulin pumps contain a 3-mL syringe attached to a long (24- to 42-in), thin, narrow-lumen tube with a needle or Teflon catheter attached to the end (Fig. 41-4). The patient inserts the needle or catheter into subcutaneous tissue (usually on the abdomen) and secures it with tape or a transparent dressing. The needle or catheter is changed at least every 3 days. The pump is then worn either on a belt or in a pocket. Some women keep the pump tucked into the front or side of the bra or wear it on a garter belt on the thigh.

When an insulin pump is used, insulin is delivered by subcutaneous infusion at a basal rate (eg, 0.5 to 2.0 units/h). When a meal is consumed, the patient calculates a dose of insulin to metabolize the meal by counting the total amount of carbohydrate for the meal using a predetermined insulin-to-carbohydrate ratio; for example, a ratio of 1 unit of insulin for every 15 g of carbohydrate would require 3 units for a meal with 45 g of carbohydrate. This allows flexibility of meal timing and content.

Possible disadvantages of insulin pumps are unexpected disruptions in the flow of insulin from the pump that may occur if the tubing or needle becomes occluded, if the supply of insulin runs out, or if the battery is depleted, increasing the risk of DKA. Effective teaching to produce knowledgeable patients minimizes this risk. Another disadvantage is the potential for infection at needle insertion sites. Hypoglycemia may occur with insulin pump therapy; however, this is usually related to the lowered blood glucose levels many patients achieve rather than to a specific problem with the pump itself. The tight diabetes control associated with use of an insulin pump may increase the incidence of hypoglycemia unawareness because of the very gradual decline in serum glucose level, from more than 70 mg/dL (3.9 mmol/L) to less than 60 mg/dL (3.3 mmol/L).

Some patients find that wearing the pump for 24 hours each day is inconvenient. However, the pump can easily be disconnected, per patient preference, for limited periods, such as for showering, exercise, or sexual activity.

Candidates for the insulin pump must be willing to assess their blood glucose level several times daily. In addition, they must be psychologically stable and open about having diabetes, because the insulin pump is often a visible sign to others and a constant reminder to patients that they have diabetes. Most important, patients using insulin pumps must have extensive education in the use of the pump and in self-management of blood glucose and insulin doses. They must work closely with a team of health care professionals who are experienced in insulin pump therapy—specifically, a diabetologist/endocrinologist, a dietitian, and a certified diabetes educator.

The most common risk of insulin pump therapy is ketoacidosis, which can occur if there is an occlusion in the infusion set or tubing. Because only rapid-acting insulin is used in the pump, any interruption in the flow of insulin may rapidly cause the patient to be without insulin. The patient should be taught to administer insulin by manual injection if an insulin interruption is suspected (eg, no response in blood glucose level after a meal bolus).

Many insurance companies cover the cost of pump therapy. If not, the extra expense of the pump and associated supplies may be a deterrent for some patients. Medicare covers insulin pump therapy for patients with type 1 diabetes.

Insulin pumps have been used in patients with type 2 diabetes whose beta-cell function has diminished and who require insulin. Patients with a hectic lifestyle often do well with an insulin pump. There is no risk of DKA when there is an interruption of the flow of insulin in people with type 2 diabetes wearing an insulin pump.

*Future Insulin Delivery.* Research into mechanical delivery of insulin has involved implantable insulin pumps that can be externally programmed according to blood glucose test results. Clinical trials with these devices are continuing. In addition, there is research into the development of implantable devices that both measure the blood glucose level and deliver insulin as needed. Methods of administering insulin by the oral route (oral spray or capsule) and skin patch are undergoing intensive study.

*Transplantation of Pancreatic Cells.* Transplantation of the whole pancreas or a segment of the pancreas is being performed on a limited population (mostly patients with diabetes who are receiving a kidney transplantation simultaneously). One main issue is weighing the risks of antirejection medications against the advantages of pancreas transplantation. Implantation of insulin-producing pancreatic islet cells is another approach under investigation. This latter approach involves a less extensive surgical procedure and a potentially lower incidence of immunogenic problems (ADA, 2006b). However, thus far, independence from exogenous insulin has been limited to 2 years after transplantation of islet cells. Results of recent studies of patients with

**islet cell transplants** using less toxic antirejection drugs have shown some promise (NIDDK, 2007).

### Oral Antidiabetic Agents

Oral antidiabetic agents may be effective for patients who have type 2 diabetes that cannot be treated effectively with MNT and exercise alone. In the United States, oral antidiabetic agents include first-generation and second-generation **sulfonylureas,** biguanides, alpha-glucosidase inhibitors, non-sulfonylurea insulin secretogogues (meglitinides and phenylalanine derivatives), **thiazolidinediones** (glitazones), and dipeptide-peptidase-4 (DPP-4) inhibitors (Table 41-6). Sulfonylureas and meglitinides are considered insulin secretagogues because their action increases the secretion of insulin by the pancreatic beta cells.

Patients must understand that oral agents are prescribed as an addition to (not as a substitute for) other treatment modalities, such as MNT and exercise. Use of oral antidiabetic medications may need to be halted temporarily and insulin prescribed if hyperglycemia develops that is attributable to infection, trauma, or surgery.

In time, oral antidiabetic agents may no longer be effective in controlling diabetes because of decline in function of beta cells. In such cases, the patient is treated with insulin. Approximately half of all patients who initially use oral antidiabetic agents eventually require insulin. This is referred to as a secondary failure. Primary failure occurs when the blood glucose level remains high 1 month after initial medication use.

Because mechanisms of action vary (Fig. 41-5), effects may be enhanced with the use of multidose, multiple medications. Use of multiple medications with different mechanisms of action is very common today. A combination of oral agents with insulin, usually glargine at bedtime, has also been used frequently as a treatment for some patients with type 2 diabetes.

### Other Pharmacologic Therapy

Two new medications became available in 2005 for use in the pharmacologic management of diabetes. Both are injectable medications; neither is a substitute for insulin if insulin is required to control diabetes.

Pramlintide (Symlin), a synthetic analogue of human amylin, a hormone that is secreted by the beta cells of the pancreas, has recently been approved for treatment of both type 1 and type 2 diabetes. It is used to control hyperglycemia in adults who have not achieved acceptable levels of glucose control despite the use of insulin at mealtimes. It is used with insulin, not in place of insulin. Although pramlintide is not yet widely used, it is anticipated that it will be useful to minimize fluctuations in daily glucose levels and provide better glucose control. Risks associated with pramlintide include hypoglycemia; therefore, a source of glucose must be available if hypoglycemia occurs. Pramlintide must be injected into the abdomen or thigh because of variable absorption rates if it is injected into the arm. It should not be injected close to an insulin injection site. Caution must be exercised in preparing and administering pramlintide to avoid errors in dosing. Patients are instructed to monitor their blood glucose level before each meal, 2 hours afterward, and at bedtime during the initial period of use of pramlintide.

Exenatide (Byetta) is another medication approved for the treatment of type 2 diabetes in combination with metformin or sulfonylureas. It is derived from a hormone that is produced in the small intestine and has been found to be deficient in type 2 diabetes. It is normally released after food is ingested to delay gastric emptying and enhance insulin secretion, resulting in dampening of the rise in blood glucose levels after meals and a feeling of satiety. The return of the blood glucose level to normal results in decreased production of the hormone. Hypoglycemia is not a side effect of exenatide if adjustments are made in the sulfonylurea dose. Exenatide has been shown to result in weight loss because of the increased satiety produced. Exenatide must be injected twice a day within 1 hour before breakfast and dinner. It is not a substitute for insulin in patients who require insulin to control their diabetes.

## Nursing Management

Nursing management of patients with diabetes can involve treatment of a wide variety of physiologic disorders, depending on the patient's health status and whether the patient is newly diagnosed or seeking care for an unrelated health problem. Nursing management of patients with DKA and hyperglycemic hyperosmolar nonketotic syndrome and of those with diabetes as a secondary diagnosis is discussed in subsequent sections of this chapter.

Because all patients with diabetes must master the concepts and skills necessary for long-term management and avoidance of potential complications of diabetes, a solid educational foundation is necessary for competent self-care and is an ongoing focus of nursing care.

### *Providing Patient Education*

Diabetes mellitus is a chronic illness that requires a lifetime of special self-management behaviors. Because MNT, physical activity, and physical and emotional stress affect diabetic control, patients must learn to balance a multitude of factors.

#### Developing a Diabetic Teaching Plan

Changes in the health care system as a whole have had a major impact on diabetes education and training. Patients with new-onset type 1 diabetes are hospitalized for much shorter periods or may be managed completely on an outpatient basis. Patients with new-onset type 2 diabetes are rarely hospitalized for initial care. There has been a proliferation of outpatient diabetes education and training programs, with increasing support of third-party reimbursement. All encounters with patients with diabetes are opportunities for reinforcement of self-management skills, regardless of the setting.

Many hospitals employ nurses who specialize in diabetes education and management and who are certified by the National Certification Board of Diabetes Educators as Certified Diabetes Educators (CDEs). However, because of the large number of patients with diabetes who are admitted to every unit of a hospital for reasons other than diabetes or its complications, staff nurses play a vital role in identifying patients with diabetes, assessing self-care skills, providing

**Table 41-6 ORAL ANTIDIABETIC AGENTS**

| Generic (Trade) Name | Action/Indications | Side Effects | Implications |
|---|---|---|---|
| **First-Generation Sulfonylureas** | | | |
| Acetohexamide (Dymelor)<br>Chlorpropamide (Diabinese)<br>Tolazamide (Tolinase)<br>Tolbutamide (Orinase) | Used infrequently in U.S. today<br>Used in type 2 diabetes to control blood glucose levels<br>Stimulate beta cells of the pancreas to secrete insulin; may improve binding between insulin and insulin receptors or increase the number of insulin receptors | Hypoglycemia<br>Mild GI symptoms<br>Weight gain<br>Drug–drug interactions (NSAIDs, warfarin, sulfonamides)<br>Sulfa allergy<br>Skin reactions | Monitor patient for hypoglycemia<br>Monitor blood glucose and urine ketone levels to assess effectiveness of therapy<br>Patients at high risk for hypoglycemia: advanced age, renal insufficiency<br>When taken with beta-adrenergic blocking agents may mask usual warning signs and symptoms of hypoglycemia<br>Instruct patients to avoid use of alcohol<br>Check for interactions with other medications |
| **Second-Generation Sulfonylureas** | | | |
| Glipizide (Glucotrol, Glucotrol XL)<br>Glyburide (Micronase, Glynase, Dia-Beta)<br>Glimepiride (Amaryl) | Stimulate beta cells of the pancreas to secrete insulin; may improve binding between insulin and insulin receptors or increase the number of insulin receptors<br>Used in type 2 diabetes to control blood glucose levels<br>Have more potent effects than first-generation sulfonylureas<br>May be used in combination with metformin or insulin to improve glucose control | Hypoglycemia<br>Mild GI symptoms<br>Weight gain<br>Drug–drug interactions (NSAIDs, warfarin, sulfonamides)<br>Sulfa allergy | Monitor patient for hypoglycemia<br>Monitor blood glucose and urine ketone levels to assess effectiveness of therapy<br>Patients at high risk for hypoglycemia: advanced age, renal insufficiency<br>When taken with beta-adrenergic blocking agents, may mask usual warning signs and symptoms of hypoglycemia<br>Instruct patients to avoid use of alcohol |
| **Biguanides** | | | |
| Metformin (Glucophage, Glucophage XL, Fortamet)<br>Metformin with glyburide (Glucovance) | Inhibit production of glucose by the liver<br>Increase body tissues' sensitivity to insulin<br>Decrease hepatic synthesis of cholesterol<br>Used in type 2 diabetes to control blood glucose levels | Lactic acidosis<br>Hypoglycemia if metformin is used in combination with insulin or other antidiabetic agents<br>Drug–drug interaction<br>GI disturbances<br>Contraindicated in patients with impaired renal or liver function, respiratory insufficiency, severe infection, or alcohol abuse | Monitor for lactic acidosis and hypoglycemia<br>Monitor renal function<br>Patients taking metformin are at increased risk of acute renal failure and lactic acidosis with use of iodinated contrast material for diagnostic studies; metformin should be stopped 48 h prior to and for 48 h after use of contrast agent or until renal function is evaluated and normal<br>Check for interactions with other medications |
| **Alpha-Glucosidase Inhibitors** | | | |
| Acarbose (Precose)<br>Miglitol (Glyset) | Delay absorption of complex carbohydrates in the intestine and slow entry of glucose into systemic circulation<br>Do not increase insulin secretion<br>Used in type 2 diabetes to control blood glucose levels<br>Can be used alone or in combination with sulfonylureas, metformin, or insulin to improve glucose control | Hypoglycemia (risk increased if used with insulin or other antidiabetic agents)<br>GI side effects (abdominal discomfort or distention, diarrhea, flatulence)<br>Drug–drug interactions | Must be taken with first bite of food to be effective<br>Monitor for GI side effects (diarrhea, abdominal distention)<br>Monitor for blood glucose levels to assess effectiveness of therapy<br>Monitor liver function studies every 3 mo for 1 y, then periodically<br>Contraindicated in patients with GI or renal dysfunction, or cirrhosis<br>**Alert: Hypoglycemia must be treated with glucose, not sucrose** |

*Continued on following page*

**Table 41-6 ORAL ANTIDIABETIC AGENTS (Continued)**

| Generic (Trade) Name | Action/Indications | Side Effects | Implications |
|---|---|---|---|
| **Non-Sulfonylurea Insulin Secretagogues** | | | |
| Repaglinide (Prandin) categorized as a meglitinide<br>Nateglinide (Starlix) categorized as a D-phenylalanine derivative | Stimulate pancreas to secrete insulin<br>Used in type 2 diabetes to control blood glucose levels<br>Can be used alone or in combination with metformin or thiazolidinediones to improve glucose control | Hypoglycemia/weight gain less likely than sulfonylureas<br>Drug–drug interactions (with ketoconazole, fluconazole, erythromycin, rifampin, isoniazid) | Monitor blood glucose levels to assess effectiveness of therapy<br>Has rapid action and short half-life<br>Should be taken only if able to eat a meal immediately<br>Teach patients symptoms of hypoglycemia<br>Monitor patients with impaired liver function and renal impairment<br>Has no effect on plasma lipids<br>Is taken before each meal<br>Check for interactions with other medications |
| **Thiazolidinediones (or glitazones)** | | | |
| Pioglitazone (Actos)<br>Rosiglitazone (Avandia) | Sensitize body tissue to insulin; stimulate insulin receptor sites to lower blood glucose and improve action of insulin<br>May be used alone or in combination with sulfonylurea, metformin, or insulin | Hypoglycemia (risk increased with use of insulin or other antidiabetic agents)<br>Anemia<br>Weight gain, edema<br>Decrease effectiveness of oral contraceptives<br>Possible liver dysfunction<br>Drug–drug interactions<br>Hyperlipidemia (has variable effect on lipids; pioglitazone may be preferred choice in patients with lipid abnormalities)<br>Impaired platelet function | Monitor blood glucose levels to assess effectiveness of therapy<br>Monitor liver function tests<br>Arrange dietary teaching to establish weight control program<br>Instruct patient taking oral contraceptives about increased risk of pregnancy |
| **Dipeptidyl Peptidase-4 (DPP-4) Inhibitor** | | | |
| Sitagliptin (Januvia)<br>Vildagliptin (Galvus) | Increase and prolongs the action of incretin, a hormone that increases insulin release and decreases glucagon levels, with the result of improved glucose control | Upper respiratory infection<br>Stuffy or runny nose and sore throat<br>Headache<br>Stomach discomfort and diarrhea<br>Hypoglycemia, if used with sulfonylurea | Usually administered once a day<br>Used alone or with other oral antidiabetic agents<br>Instruct patient about signs and symptoms of hypoglycemia and other adverse effects to report<br>Monitor renal function |

basic education, reinforcing the teaching provided by the specialist, and referring patients for follow-up care after discharge. Diabetes patient education programs that have been peer-reviewed by the ADA as meeting National Standards for Diabetes Education can be reimbursed for education.

***Organizing Information.*** There are various strategies for organizing and prioritizing the vast amount of information that must be taught to patients with diabetes. In addition, many hospitals and outpatient diabetes centers have devised written guidelines, care plans, and documentation forms (often based on ADA guidelines) that may be used to document and evaluate teaching. One approach is to organize education using the seven tips for managing diabetes identified and developed by the American Association of Diabetes Educators (AADE, 2005): healthy eating, being active, monitoring, taking medication, problem solving, healthy coping, and reducing risks. The AADE can be contacted for additional information about assessment and documentation of outcomes of this approach to teaching.

Another general approach is to organize information and skills into two main types: basic, initial, or "survival" skills and information, and in-depth (advanced) or continuing education.

*Teaching Survival Skills*. Survival skills must be taught to all patients with newly diagnosed type 1 or type 2 diabetes and all patients receiving insulin for the first time. This basic information is literally what patients must know to survive (eg, to avoid severe hypoglycemic or acute hyperglycemic complications after discharge). An outline of survival information includes the following:

1. Simple pathophysiology
   a. Basic definition of diabetes (having a high blood glucose level)
   b. Normal blood glucose ranges and target blood glucose levels
   c. Effect of insulin and exercise (decrease glucose)
   d. Effect of food and stress, including illness and infections (increase glucose)
   e. Basic treatment approaches

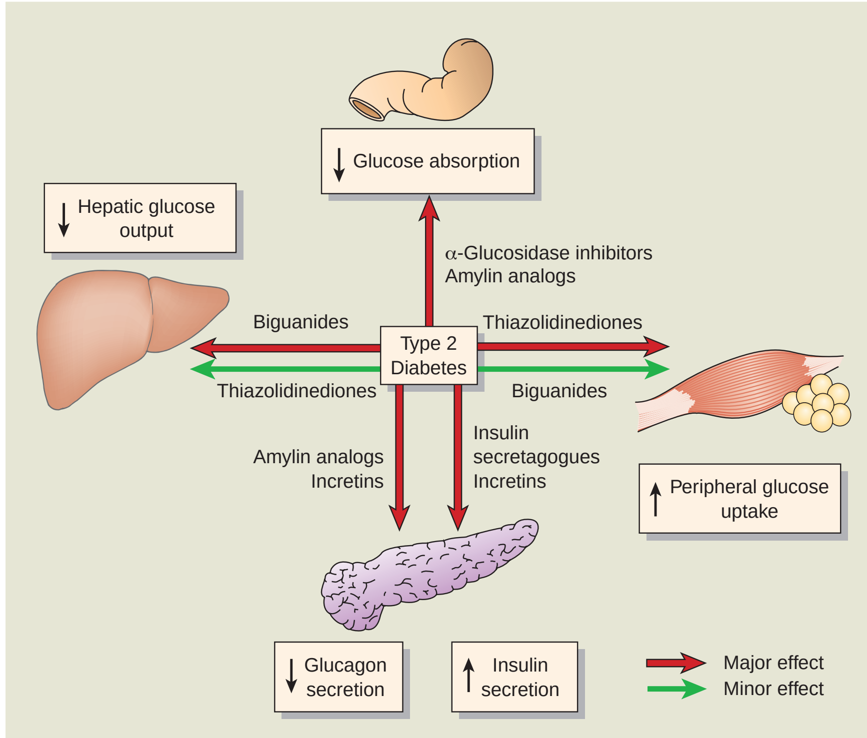



**Figure 41-5** Action sites of hypoglycemic agents and mechanisms of lowering blood glucose in type 2 diabetes. The incretins are the dipeptidyl peptidase-4 (DPP-4) inhibitors and glucagon-like peptide-1 (GLP-1) agonists.

2. Treatment modalities
   a. Administration of insulin and oral antidiabetes medications
   b. Meal planning (food groups, timing of meals)
   c. Monitoring of blood glucose and urine ketones
3. Recognition, treatment, and prevention of acute complications
   a. Hypoglycemia
   b. Hyperglycemia
4. Pragmatic information
   a. Where to buy and store insulin, syringes, and glucose monitoring supplies
   b. When and how to contact the physician

For patients with newly diagnosed type 2 diabetes, emphasis is initially placed on meal planning and exercise. Those who are starting to take oral sulfonylureas or insulin secretagogues need to know about detecting, preventing, and treating hypoglycemia. If diabetes has gone undetected for many years, the patient may already be experiencing some chronic diabetic complications. Therefore, for some patients with newly diagnosed type 2 diabetes, basic diabetes teaching must include information on preventive skills, such as foot care and eye care (eg, planning yearly or more frequent complete [dilated eye] examinations by an ophthalmologist, understanding that retinopathy is largely asymptomatic until advanced stages).

Patients also need to realize that once they master the basic skills and information, further diabetes education must be pursued. Acquiring in-depth and advanced diabetes knowledge occurs throughout the patient's lifetime, both formally through programs of continuing education and informally through experience and sharing of information with other people with diabetes.

*Planning In-Depth and Continuing Education.* This education involves teaching more detailed information related to survival skills (eg, learning to vary food choices and insulin, preparing for travel) as well as learning preventive measures for avoiding long-term diabetic complications. Preventive measures include foot care, eye care, general hygiene (eg, skin care and oral hygiene), and risk factor management (eg, blood pressure control and blood glucose normalization).

More advanced continuing education may include alternative methods for insulin delivery, such as the insulin pump, and algorithms or rules for evaluating and adjusting insulin doses. The degree of advanced diabetes education to be provided depends on the patient's interest and ability. However, learning preventive measures (especially foot care and eye care) is mandatory for early detection and treatment to reduce the occurrence of amputations and blindness in patients with diabetes.

### Assessing Readiness to Learn

Before initiating diabetes education, the nurse assesses the patient's (and family's) readiness to learn. When patients are first diagnosed with diabetes (or first told of their need for insulin), they often go through various stages of the grieving process. These stages may include shock and denial, anger, depression, negotiation, and acceptance. The amount of time it takes for the patient and family members to work through the grieving process varies from patient to patient. They may experience helplessness, guilt, altered body image, loss of self-esteem, and concern about the future. The nurse must assess the patient's coping strategies and reassure the patient and family that feelings of depression and shock are normal (Chart 41-6).

Asking the patient and family about their major concerns or fears is an important way to learn about any

CHART 41-6

NURSING RESEARCH PROFILE

### *Psychological Impact of Diabetes in Women*

Penckofer, S., Ferrans, C. & Velsor-Friedrich, B. (2007). The psychological impact of living with diabetes: Women's day-to-day experiences. *The Diabetes Educator, 33*(4), 680–690.

**Purpose**

Diabetes is a leading cause of heart disease and cardiovascular-related deaths among women; further, depression is often associated with diabetes. Depression may serve as a barrier for women with diabetes to obtain treatment to ensure control of diabetes or to follow the recommended treatment regimen. In an effort to gain an understanding of how psychological issues influence diabetes management, this study was undertaken. Its specific purpose was to identify the feelings experienced by women with diabetes and the impact these feeling have on the quality of life.

**Design**

A descriptive, exploratory design using a focus groups approach for data collection was undertaken. Four focus groups were conducted by professional moderators. The sessions were audiotaped and transcriptions were analyzed. Forty-one women with type 2 diabetes participated; their mean age was 55.6 years. Guidelines for focus groups published by the American Diabetes Association were used. A moderator guide was used to explore depression, anger, and anxiety.

**Findings**

Five major themes were identified: (1) struggling with health challenges, (2) challenges in relationships, (3) worrying about the present and the future, (4) multiple responsibilities for self and others, and (5) choosing to take a break from caring for their diabetes. Struggling with health situations was the most prevalent theme. The difficulty of carrying on a normal life in the context of experiencing hypoglycemia and complications promoted angry feelings.

**Nursing Implications**

The incidence of depression is high in people with diabetes and more so in women than in men. The burden to take on self-care responsibilities while being responsible for others may result in anger. The findings support the need to address the psychological impact of having diabetes on treatment. Tending to the psychological component of diabetes and its effect on patients and families is important because of the potential negative effect of unresolved psychological issues on overall health and prevention of long-term complications.

misinformation that may be contributing to anxiety. Some common misconceptions regarding diabetes and its treatment are listed in Table 41-7. Simple, direct information should be provided to dispel misconceptions. More information can be provided once the patient masters survival skills.

Nurses whose patients are in the hospital rarely have the luxury of waiting until the patient feels ready to learn; short hospital stays necessitate initiation of survival skill education as early as possible. This gives the patient the opportunity to practice skills with supervision by the nurse before discharge. Follow-up by home health nurses is often necessary for reinforcement of survival skills.

The nurse evaluates the patient's social situation for factors that may influence the diabetes treatment and education plan, such as

- Low literacy level (may be evaluated while assessing for visual deficits by having the patient read from teaching materials)
- Limited financial resources or lack of health insurance
- Presence or absence of family support
- Typical daily schedule (the patient is asked about timing and number of usual daily meals, work and exercise schedule, plans for travel)
- Neurologic deficits caused by stroke, other neurologic disorders, or other disabling conditions, obtained from the patient's health history and physical assessment (the patient is assessed for aphasia or decreased ability to follow simple commands)

#### Teaching Experienced Patients

Nurses should continue to assess the skills and self-care behaviors of patients who have had diabetes for many years, because it is estimated that as many as 50% of patients make errors in self-care. Assessment of these patients must include direct observation of skills, not just the patient's self-report of self-care behaviors. In addition, these patients must be fully aware of preventive measures related to foot care, eye care, and risk factor management. Those experiencing long-term diabetic complications for the first time may go through the grieving process again. Some patients may have a renewed interest in diabetes self-care in the hope of delaying further complications. Others may be overwhelmed by feelings of guilt and depression. The patient is encouraged to discuss feelings and fears related to complications. Meanwhile, the nurse provides appropriate information regarding diabetic complications.

#### Determining Teaching Methods

Maintaining flexibility with regard to teaching approaches is important. Teaching skills and information in a logical sequence is not always the most helpful method for patients. For example, many patients fear self-injection. Before they learn how to prepare, purchase, store, and mix insulins, they should be taught to insert the needle and inject insulin (or practice with saline solution).

Various tools can be used to complement teaching. Many of the companies that manufacture products for diabetes self-care also provide booklets and videotapes to assist in patient teaching. Teaching/educational materials are also available from the AADE and the ADA. It is important to use a variety of written handouts that match the patient's learning needs (including different languages, low-literacy information, large print) and reading level and to ensure that these materials are technically accurate. Patients can continue learning about diabetes care by participating in

**Table 41-7 MISCONCEPTIONS RELATED TO INSULIN TREATMENT**

| Misconception | Response |
|---|---|
| Once insulin injections are started (for treatment of type 2 diabetes), they can never be discontinued | During periods of acute stress (eg, illness, infection, surgery) or when receiving certain medications that cause elevations in blood glucose, some patients with type 2 diabetes require insulin. If the diabetes had previously been well controlled with diet alone or diet with oral antidiabetic agents, the patient should be able to resume previous methods for control of diabetes after the stress is resolved.<br>In addition, insulin is sometimes used to control blood glucose levels in obese type 2 diabetic patients who have been unsuccessful at weight loss. If the patient can lose weight after insulin therapy is initiated, the insulin doses may be tapered and the patient may be able to switch to diet and exercise alone or with oral antidiabetic agents for control of blood glucose.<br>(For patients with type 1 diabetes, insulin is needed on an ongoing basis. For thin patients with type 2 diabetes, once insulin has to be started, it is usually required permanently.) |
| If increasing doses of insulin are needed to control the blood glucose, the diabetes must be getting "worse" | Explain to the patient that unlike other medications that are given in standard doses, there is not a standard dose of insulin that is effective for all patients. Rather, the dose must be adjusted according to blood glucose test results. If the initial insulin dose prescribed for the patient does not adequately decrease the glucose level, the patient may assume that he or she has a "bad" case of diabetes or that the diabetes is getting worse. It is important to instruct patients that many different factors may affect the ability of insulin to lower the glucose, including obesity, puberty, pregnancy, illness, and certain medications.<br>In addition, to avoid hypoglycemia, physicians frequently initiate insulin therapy with smaller dosages than will eventually be needed. The doses are then increased in small increments until blood glucose levels are in the desired range. |
| Insulin causes blindness (or other diabetic complications) | If the patient has a diabetic acquaintance in whom the initiation of insulin therapy happened to coincide with the onset of diabetic complications, the patient may view insulin as the cause of complications such as blindness or amputation. In these situations, the acquaintance probably had type 2 diabetes that was no longer controllable with diet and oral hypoglycemic agents. It must be explained to the patient that factors such as elevated blood glucose (and not insulin therapy) contribute to some of the diabetic complications. Further, emphasize that insulin is a natural hormone that is present in every person's body, helps control blood glucose levels, and definitely does *not* cause long-term complications of diabetes. |
| Insulin must be injected directly into the vein | When patients first learn that one area used for insulin injections is on the arm, they may envision inserting the needle directly into a vein in the antecubital area, as in blood withdrawal. The patient must be reassured that insulin is injected into the fat tissue on the *back* of the arm (or on the abdomen, thigh, or hip) and that the needle is much shorter than that used for venipuncture. |
| There is extreme danger in injecting insulin if there are any air bubbles in the syringe | Patients may have a fear of dying if air bubbles are injected with a syringe. (This may be related to the misconception that insulin is injected directly into the vein.) Reassure patients that the main danger in having air bubbles in the insulin syringe is that the amount of insulin being injected is less than the required dose. It is often difficult to remove every small "champagne" bubble from the syringe. Thus, patients should be reassured that injection of insulin when these bubbles are present does not cause any harm. |
| Insulin always causes people to have bad (hypoglycemic) reactions | First, make sure that patients are aware that low blood sugar reactions are often related to an imbalance with the insulin, food, and activity and can often be avoided. Thus, before starting on insulin, patients should discuss their usual schedule of meals and activities as well as the content of meals with the health care team. Make sure that patients are aware that various different insulins and insulin schedules can be used to try to allow patients to maintain some of their usual lifestyle habits. Reassure patients that avoiding hypoglycemic reactions is a high priority for the diabetes team. In addition, tell patients of the importance of reporting any hypoglycemic reactions to the health care team immediately so that early adjustments can be made in the insulin dosage. Focus early insulin education on treatment and prevention of hypoglycemia. |
| People who take insulin must travel only where there is a refrigerator to store the insulin | Insulin bottles in use may be kept at room temperature. Therefore, for most business trips or vacations, keeping the insulin in a purse or briefcase (or special diabetes supply case) is acceptable. If a prolonged trip is planned (more than 2 to 3 months), patients may want to consult the pharmacist or insulin manufacturer for suggestions. Most importantly, emphasize with patients that taking insulin should never deter them from pursuing activities they enjoy. |

Pearce, M. A., Rosenberg, C. S. & Davidson, M. B. (2003). Patient education. In Davidson, M. B. (Ed.). *Diabetes mellitus: Diagnosis and treatment* (4th ed.). New York: Churchill Livingstone. Reprinted with permission from Elsevier Science.

activities sponsored by local hospitals and diabetes organizations. In addition, magazines and Web sites with information on diabetes management are available (see Resources).

### Teaching Patients to Self-Administer Insulin

Insulin injections are self-administered into the subcutaneous tissue with the use of special insulin syringes. Basic information includes explanations of the equipment, insulins, and syringes and how to mix insulin.

***Storing Insulin.*** Whether insulin is the short-acting or the long-acting preparation, vials not in use, including spare vials, should be refrigerated. Extremes of temperature should be avoided; insulin should not be allowed to freeze and should not be kept in direct sunlight or in a hot car. The insulin vial in use should be kept at room temperature to reduce local irritation at the injection site, which may occur if cold insulin is injected. If a vial of insulin will be used up within 1 month, it may be kept at room temperature. The patient should be instructed to always have a spare vial of the type or types of insulin he or she uses (ADA, 2004). Cloudy insulins should be thoroughly mixed by gently inverting the vial or rolling it between the hands before drawing the solution into a syringe or a pen.

Bottles of intermediate-acting insulin should also be inspected for flocculation, which is a frosted, whitish coating

inside the bottle. This occurs most commonly with human insulins that are exposed to extremes of temperature. If a frosted, adherent coating is present, some of the insulin is bound, and it should not be used.

***Selecting Syringes.*** Syringes must be matched with the insulin concentration (eg, U-100). Currently, three sizes of U-100 insulin syringes are available:

- 1-mL syringes that hold 100 units
- 0.5-mL syringes that hold 50 units
- 0.3-mL syringes that hold 30 units

The concentration of insulin used in the United States is U-100; that is, there are 100 units per milliliter (or cubic centimeter). Small syringes allow patients who require small amounts of insulin to measure and draw up the amount of insulin accurately. Patients who require large amounts of insulin use larger syringes. There is a U-500 (500 units/mL) concentration of insulin available by special order for patients who have severe insulin resistance and require massive doses of insulin.

Most insulin syringes have a disposable 27- to 29-gauge needle that is approximately 0.5 inch long. The smaller syringes are marked in 1-unit increments and may be easier to use for patients with visual deficits and those taking very small doses of insulin. The 1-mL syringes are marked in 1- and 2-unit increments. A small disposable insulin needle (31 gauge, 8 mm long) is available for very thin patients and children.

***Mixing Insulins.*** When rapid-acting or short-acting insulins are to be given simultaneously with longer-acting insulins, they are usually mixed together in the same syringe; the longer-acting insulins must be mixed thoroughly before drawing into the syringe. The most important issue is that patients be consistent in how they prepare their insulin injections from day to day.

There are varying opinions regarding which type of insulin (short-acting or longer-acting) should be drawn up into the syringe first when they are going to be mixed, but the ADA recommends that the regular insulin be drawn up first. Again, the most important issues are (1) that patients be consistent in technique, so as not to draw up the wrong dose in error or the wrong type of insulin, and (2) that patients not inject one type of insulin into the bottle containing a different type of insulin (ADA, 2004). Injecting cloudy insulin into a vial of clear insulin contaminates the entire vial of clear insulin and alters its action.

For patients who have difficulty mixing insulins, several options are available: they may use a premixed insulin, they may have prefilled syringes prepared (see Fig. 41-3), or they may take 2 injections. Premixed insulins are available in several different ratios of NPH insulin to regular insulin. The ratio of 70/30 (70% NPH and 30% regular insulin in one bottle) is most common; this combination is available as Novolin 70/30 (Novo-Nordisk) and Humulin 70/30 (Lilly). Combinations with a ratio of 75% NPL (neutral protamine lispro) and 25% insulin lispro are also available (ADA, 2004). NPL is used only in the mix with Humalog; its action is the same as NPH. The appropriate initial dosage of premixed insulin must be calculated so that the ratio of NPH to regular insulin most closely approximates the separate doses needed.

For patients who can inject insulin but who have difficulty drawing up a single or mixed dose, syringes may be prefilled with the help of home care nurses or family and friends. A 3-week supply of insulin syringes may be prepared and kept in the refrigerator. The prefilled syringes should be stored with the needle in an upright position to avoid clogging of the needle (ADA, 2004); they should be mixed thoroughly before the insulin is injected.

***Withdrawing Insulin.*** Most (if not all) of the printed materials available on insulin dose preparation instruct patients to inject air into the bottle of insulin equivalent to the number of units of insulin to be withdrawn. The rationale for this is to prevent the formation of a vacuum inside the bottle, which would make it difficult to withdraw the proper amount of insulin.

***Selecting and Rotating the Injection Site.*** The four main areas for injection are the abdomen, upper arms (posterior surface), thighs (anterior surface), and hips (Fig. 41-6). Insulin is absorbed faster in some areas of the body than others. The speed of absorption is greatest in the abdomen and decreases progressively in the arm, thigh, and hip, respectively.

Systematic rotation of injection sites within an anatomic area is recommended to prevent localized changes in fatty tissue (lipodystrophy). In addition, to promote consistency in insulin absorption, the patient should be encouraged to use all available injection sites within one area rather than randomly rotating sites from area to area (ADA, 2004). For example, some patients almost exclusively use the abdominal area, administering each injection 0.5 to 1 inch away from the previous injection. Another approach to rotation is always to use the same area at the same time of day. For example, patients may inject morning doses into the abdomen and evening doses into the arms or legs.

A few general principles apply to all rotation patterns. First, the patient should try not to use the same site more than once in 2 to 3 weeks. In addition, if the patient is planning to exercise, insulin should not be injected into

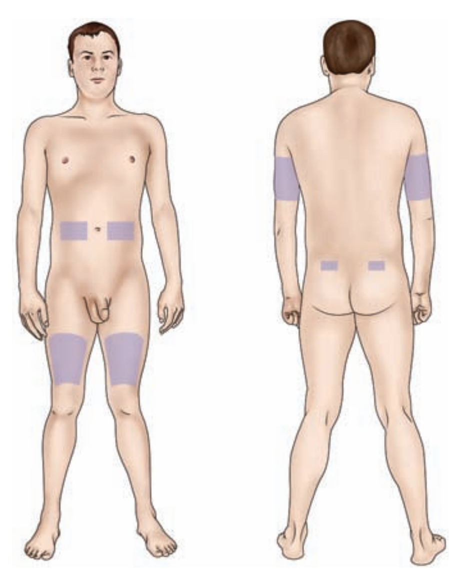


**Figure 41-6** Suggested areas for insulin injection.

the limb that will be exercised because this will cause the drug to be absorbed faster, which may result in hypoglycemia.

In the past, patients were taught to rotate injections from one area to the next (eg, injecting once in the right arm, then once in the right abdomen, then once in the right thigh). Patients who still use this system must be taught to avoid repeated injections into the same site within an area. However, as previously stated, it is preferable for patients to use the same anatomic area at the same time of day consistently; this reduces day-to-day variation in blood glucose levels caused by different absorption rates.

***Preparing the Skin.*** Use of alcohol to cleanse the skin is not recommended, but patients who have learned this technique often continue to use it. They should be cautioned to allow the skin to dry after cleansing with alcohol. If the skin is not allowed to dry before the injection, the alcohol may be carried into the tissues, resulting in a localized reddened area and a burning sensation.

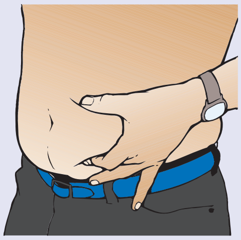
***Inserting the Needle.*** There are varying approaches to inserting the needle for insulin injections. The correct technique is based on the need for the insulin to be injected into the subcutaneous tissue (Chart 41-7). Injection that is too deep (eg, intramuscular) or too shallow may affect the rate of absorption of the insulin. For a normal or overweight person, a 90-degree angle is the best insertion angle. Aspiration (inserting the needle and then pulling back on the plunger to assess for blood being drawn into the syringe) is generally not recommended with self-injection of insulin. Many patients who have been using insulin for an extended

CHART 41-7

**PATIENT EDUCATION**

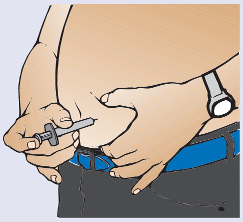
***Self-Injection of Insulin***

1. With one hand, stabilize the skin by spreading it or pinching up a large area.



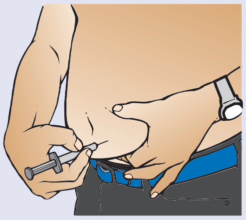
Pinching the skin

2. Pick up syringe with the other hand and hold it as you would a pencil. Insert needle straight into the skin.*



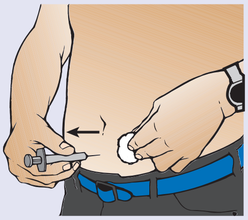
Inserting the needle into the skin

3. To inject the insulin, push the plunger all the way in.



Injecting the insulin

4. Pull needle straight out of skin. Press cotton ball over injection site for several seconds.



Removing the needle and holding cotton ball over site

5. Use disposable syringe *only once* and discard into hard plastic container (with a tight-fitting top) such as an empty bleach or detergent container.† Follow state regulations for disposal of syringes and needles.



Disposing of syringe

*Some patients may be taught to insert the needle at a 45-degree angle.

†Although some studies suggest that reusing disposable syringes may be safe, it is recommended that this be done only in the absence of poor personal hygiene, an acute concurrent illness, open wounds on the hands, or decreased resistance to infection.

period have eliminated this step from their insulin injection routine with no apparent adverse effects.

***Disposing of Syringes and Needles.*** Insulin syringes and pens, needles, and lancets should be disposed of according to local regulations. If community disposal programs are unavailable, used sharps should be placed in a puncture-resistant container. The patient should contact local trash authorities for instructions about proper disposal of filled containers, which should not be mixed with containers to be recycled.

### *Promoting Home and Community-Based Care*

#### Promoting Self-Care

If problems exist with glucose control or with the development of preventable complications, it is the nurse's responsibility to assess the reasons for the patient's ineffective management of the treatment regimen. It should not be assumed that problems with diabetes management are related to the patient's willful decision to ignore self-management. The patient may have forgotten or never learned certain information. The problem may be correctable simply through providing complete information and ensuring that the patient understands the information. The focus of diabetes education should be patient empowerment. Patient education should address behavior change, self-efficacy, and health beliefs. Chart 41-8 details how to evaluate the effectiveness of self-injection of insulin education.

If knowledge deficit is not the problem, certain physical or emotional factors may be impairing the patient's ability to perform self-care skills. For example, decreased visual acuity may impair the patient's ability to administer insulin accurately, measure the blood glucose level, or inspect the skin and feet. In addition, decreased joint mobility (especially in the elderly) or preexisting disability may impair the patient's ability to inspect the bottom of the feet. Denial of the diagnosis or depression may impair the patient's ability to carry out multiple daily self-care measures. The patient whose family, personal, or work problems may be of higher priority may benefit from assistance in establishing priorities. It is also important to assess the patient for infection or emotional stress, which may lead to elevated blood glucose levels despite adherence to the treatment regimen.

The following approaches are helpful for promoting self-care management skills:

- Address any underlying factors (eg, knowledge deficit, self-care deficit, illness) that may affect diabetic control.
- Simplify the treatment regimen if it is too difficult for the patient to follow.
- Adjust the treatment regimen to meet patient requests (eg, adjust diet or insulin schedule to allow increased flexibility in meal content or timing).
- Establish a specific plan or contract with each patient with simple, measurable goals.
- Provide positive reinforcement of self-care behaviors performed instead of focusing on behaviors that were neglected (eg, positively reinforce blood glucose tests that were performed instead of focusing on the number of missed tests).
- Help the patient identify personal motivating factors rather than focusing on wanting to please physicians or nurses.
- Encourage the patient to pursue life goals and interests, and discourage an undue focus on diabetes.

#### Continuing Care

The degree to which patients interact with health care providers to obtain ongoing care depends on many factors. Age, socioeconomic level, existing complications, type of diabetes, and comorbid conditions all may dictate the frequency of follow-up visits. Many patients with diabetes are seen by home health nurses for diabetes education, wound care, insulin preparation, or assistance with glucose monitoring. Even patients who achieve excellent glucose control and have no complications can expect to see their primary health care provider at least twice a year for ongoing evaluation and should receive routine nutrition updates. In addition, the nurse should remind the patient to participate in recommended health promotion activities (eg, immunizations) and age-appropriate health screenings (eg, pelvic examinations, mammograms).

In addition, participation in support groups is encouraged for patients who have had diabetes for many years as well as for those who are newly diagnosed. Such participation may help the patient and family cope with changes in lifestyle that occur with the onset of diabetes and its complications. People who participate in support groups often share valuable information and experiences and learn from others. Support groups provide an opportunity for discussion of strategies to deal with diabetes and its management and to clarify and verify information with nurses or other health care professionals. Participation in support groups may also promote healthy activities.

# ACUTE COMPLICATIONS OF DIABETES

There are three major acute complications of diabetes related to short-term imbalances in blood glucose levels: hypoglycemia, DKA, and hyperglycemic hyperosmolar nonketotic syndrome, which is also called hyperglycemic hyperosmolar syndrome or state.

## *Hypoglycemia (Insulin Reactions)*

**Hypoglycemia** occurs when the blood glucose falls to less than 50 to 60 mg/dL (2.7 to 3.3 mmol/L), because of too much insulin or oral hypoglycemic agents, too little food, or excessive physical activity. Hypoglycemia may occur at any time of the day or night. It often occurs before meals, especially if meals are delayed or snacks are omitted. For example, midmorning hypoglycemia may occur when the morning regular insulin is peaking, whereas hypoglycemia that occurs in the late afternoon coincides with the peak of the morning NPH or Lente insulin. Middle-of-the-night hypoglycemia may occur because of peaking evening or predinner NPH or Lente insulins, especially in patients who have not eaten a bedtime snack.

## Chart 41-8 • *Outcome Criteria for Determining Effectiveness of Self-Injection of Insulin Education*

### Equipment

**Insulin**

1. Identifies information on label of insulin bottle:
   - Type (eg, NPH, regular, 70/30)
   - Species (human, biosynthetic, pork)
   - Manufacturer (Lilly, Novo Nordisk)
   - Concentration (eg, U-100)
   - Expiration date
2. Checks appearance of insulin:
   - Clear or milky white
   - Checks for flocculation (clumping, frosted appearance)
3. Identifies where to purchase and store insulin:
   - Indicates approximately how long bottle will last (1,000 units per bottle U-100 insulin)
   - Indicates how long opened bottles can be used

**Syringes**

1. Identifies concentration (U-100) marking on syringe
2. Identifies size of syringe (eg, 100-unit, 50-unit, 30-unit)
3. Describes appropriate disposal of used syringe

### Preparation and Administration of Insulin Injection

1. Draws up correct amount and type of insulin
2. Properly mixes two insulins if necessary
3. Inserts needle and injects insulin
4. Describes site rotation:
   - Demonstrates injection with all anatomic areas to be used
   - Describes pattern for rotation, such as using abdomen only or using certain areas at the same time of day
   - Describes system for remembering site locations, such as horizontal pattern across the abdomen as if drawing a dotted line

### Knowledge of Insulin Action

1. Lists prescription:
   - Type and dosage of insulin
   - Timing of insulin injections
2. Describes approximate time course of insulin action:
   - Identifies longing and short-acting insulins by name
   - States approximate time delay until onset of insulin action
   - Identifies need to delay food until 5 to 15 min after injection of rapid-acting insulin (lispro, aspart, glulisine [Apidra])
   - Knows that longer time delays are safe when blood glucose level is high, and time delays may need to be shortened when blood glucose level is low

### Incorporation of Insulin Injections Into Daily Schedule

1. Recites proper order of premeal diabetes activities:
   - May use mnemonic device such as the word "tie," which helps the patient remember the order of activities ("t" = test [blood glucose], "i" = insulin injection, "e" = eat)
   - Describes daily schedule, such as test, insulin, eat before breakfast and dinner; test and eat, before lunch and bedtime
2. Describes information regarding hypoglycemia:
   - Symptoms: shakiness, sweating, nervousness, hunger, weakness
   - Causes: too much insulin, too much exercise, not enough food
   - Treatment: 15 g concentrated carbohydrate, such as two or three glucose tablets, 1 tube glucose gel, 0.5 cup juice
   - After initial treatment, follow with snack including starch and protein, such as cheese and crackers, milk and crackers, half sandwich
3. Describes information regarding prevention of hypoglycemia:
   - Avoids delays in meal timing
   - Eats a meal or snack approximately every 4 to 5 h (while awake)
   - Does not skip meals
   - Increases food intake before exercise if blood glucose level is <100 mg/dL
   - Checks blood glucose regularly
   - Identifies safe modification of insulin doses consistent with management plan
   - Carries a form of fast-acting sugar at all times
   - Wears a medical identification bracelet
   - Teaches family, friends, coworkers about signs and treatment of hypoglycemia
   - Has family, roommates, traveling companions learn to use injectable glucagon for severe hypoglycemic reactions
4. Maintains regular follow-up for evaluation of diabetes control:
   - Keeps written record of blood glucose, insulin doses, hypoglycemic reactions, variations in diet
   - Keeps all appointments with health professionals
   - Sees health care provider regularly (usually two to four times per year)
   - States how to contact health care provider in case of emergency
   - States when to call health care provider to report variations in blood glucose levels

## Gerontologic Considerations

In elderly patients with diabetes, hypoglycemia is a particular concern for many reasons:

- Elderly people frequently live alone and may not recognize the symptoms of hypoglycemia.
- With decreasing renal function, it takes longer for oral hypoglycemic agents to be excreted by the kidneys.
- Skipping meals may occur because of decreased appetite or financial limitations.
- Decreased visual acuity may lead to errors in insulin administration.

## Clinical Manifestations

The clinical manifestations of hypoglycemia may be grouped into two categories: adrenergic symptoms and central nervous system (CNS) symptoms.

In mild hypoglycemia, as the blood glucose level falls, the sympathetic nervous system is stimulated, resulting in a surge of epinephrine and norepinephrine. This causes symptoms

such as sweating, tremor, tachycardia, palpitation, nervousness, and hunger.

In moderate hypoglycemia, the drop in blood glucose level deprives the brain cells of needed fuel for functioning. Signs of impaired function of the CNS may include inability to concentrate, headache, lightheadedness, confusion, memory lapses, numbness of the lips and tongue, slurred speech, impaired coordination, emotional changes, irrational or combative behavior, double vision, and drowsiness. Any combination of these symptoms (in addition to adrenergic symptoms) may occur with moderate hypoglycemia.

In severe hypoglycemia, CNS function is so impaired that the patient needs the assistance of another person for treatment of hypoglycemia. Symptoms may include disoriented behavior, seizures, difficulty arousing from sleep, or loss of consciousness.

## Assessment and Diagnostic Findings

Symptoms of hypoglycemia may occur suddenly and vary considerably from person to person. To some degree, this may be related to the actual level to which the blood glucose falls or to the rate at which it falls. For example, patients who usually have a blood glucose level in the hyperglycemic range (eg, 200 mg/dL or greater) may feel hypoglycemic (adrenergic) symptoms when their blood glucose falls rapidly to 120 mg/dL (6.6 mmol/L) or less. Conversely, patients who frequently have a glucose level in the low range of normal (eg, 80 to 100 mg/dL) may be asymptomatic when the blood glucose falls slowly to less than 50 mg/dL (2.7 mmol/L).

Decreased hormonal (adrenergic) response to hypoglycemia may also contribute to lack of symptoms of hypoglycemia. This occurs in some patients who have had diabetes for many years. It may be related to autonomic neuropathy, a chronic diabetic complication (see later discussion). As the blood glucose level falls, the normal surge in adrenalin does not occur, and the usual adrenergic symptoms, such as sweating and shakiness, do not take place. The hypoglycemia may not be detected until moderate or severe CNS impairment occurs. Affected patients must perform SMBG on a frequent regular basis, especially before driving or engaging in other potentially dangerous activities.

## Management

### Treating with Carbohydrates

Immediate treatment must be given when hypoglycemia occurs. The usual recommendation is for 15 g of a fast-acting concentrated source of carbohydrate such as the following, given orally:

- Three or four commercially prepared glucose tablets
- 4 to 6 oz of fruit juice or regular soda
- 6 to 10 hard candies
- 2 to 3 teaspoons of sugar or honey

It is not necessary to add sugar to juice, even if it is labeled as unsweetened juice: the fruit sugar in juice contains enough carbohydrate to raise the blood glucose level. Adding table sugar to juice may cause a sharp increase in the blood glucose level, and patients may experience hyperglycemia for hours after treatment.

The blood glucose level should be retested in 15 minutes and retreated if it is less than 70 to 75 mg/dL (3.8 to 4 mmol/L). If the symptoms persist for longer than 10 to 15 minutes after initial treatment, the treatment is repeated even if blood glucose testing is not possible. Once the symptoms resolve, a snack containing protein and starch (eg, milk or cheese and crackers) is recommended unless the patient plans to eat a regular meal or snack within 30 to 60 minutes.

### Initiating Emergency Measures

In emergency situations, for adults who are unconscious and cannot swallow, an injection of glucagon 1 mg can be administered either subcutaneously or intramuscularly. Glucagon is a hormone produced by the alpha cells of the pancreas that stimulates the liver to breakdown glycogen, the stored glucose. Injectable glucagon is packaged as a powder in 1-mg vials and must be mixed with a diluent immediately before being injected. After injection of glucagon, the patient may take as long as 20 minutes to regain consciousness. A concentrated source of carbohydrate followed by a snack should be given to the patient on awakening to prevent recurrence of hypoglycemia (because the duration of the action of 1 mg of glucagon is brief—its onset is 8 to 10 minutes, and its action lasts 12 to 27 minutes) and to replenish liver stores of glucose. Some patients experience nausea after the administration of glucagon. If this occurs, the patient should be turned to the side to prevent aspiration in case the patient vomits.

Glucagon is sold by prescription only and should be part of the emergency supplies available to patients with diabetes who require insulin. Family members, friends, neighbors, and coworkers should be instructed in the use of glucagon, especially for patients who have little or no warning of hypoglycemic episodes. Patients should be instructed to notify their physician after severe hypoglycemia has occurred and been treated.

In hospitals and emergency departments, for patients who are unconscious or cannot swallow, 25 to 50 mL of 50% dextrose in water ($D_{50}W$) may be administered IV. The effect is usually seen within minutes. The patient may complain of a headache and of pain at the injection site. Assuring patency of the IV line used for injection of 50% dextrose is essential because hypertonic solutions such as 50% dextrose are very irritating to veins.

### Providing Patient Education

Hypoglycemia is prevented by a consistent pattern of eating, administering insulin, and exercising. Between-meal and bedtime snacks may be needed to counteract the maximum insulin effect. In general, the patient should cover the time of peak activity of insulin by eating a snack and by taking additional food when physical activity is increased. Routine blood glucose tests are performed so that changing insulin requirements may be anticipated and the dosage adjusted. Because unexpected hypoglycemia can occur, all patients treated with insulin should wear an identification bracelet or tag stating that they have diabetes.

Patients and family members must be instructed to recognize the symptoms of hypoglycemia. Family members in particular must be made aware that any subtle (but unusual)

change in behavior may be an indication of hypoglycemia. They should be taught to encourage and even insist that the person with diabetes assess blood glucose levels if hypoglycemia is suspected. When some patients are hypoglycemic, they become very resistant to testing or eating and become angry at family members who are trying to treat the hypoglycemia. Family members must be taught to persevere and to understand that the hypoglycemia can cause irrational behavior.

Autonomic neuropathy or beta-blockers such as propranolol (Inderal) to treat hypertension or cardiac dysrhythmias may mask the typical symptoms of hypoglycemia. It is very important that these patients perform blood glucose tests on a frequent and regular basis. Patients who have type 2 diabetes and who take oral sulfonylurea agents may also develop hypoglycemia, which can be prolonged and severe; this is a particular risk for elderly patients.

It is important that patients with diabetes, especially those receiving insulin, learn to carry some form of simple sugar with them at all times (ADA, 2008b). There are many different commercially prepared glucose tablets and gels that the patient may find convenient to carry. If the patient has a hypoglycemic reaction and does not have any of the recommended emergency foods available, he or she should eat any available food (preferably a carbohydrate food).

Patients are advised to refrain from eating high-calorie, high-fat dessert foods (eg, cookies, cakes, doughnuts, ice cream) to treat hypoglycemia because their high fat content may slow the absorption of the glucose and resolution of the hypoglycemic symptoms. The patient may subsequently eat more of the foods when symptoms do not resolve rapidly, which may cause very high blood glucose levels for several hours and may contribute to weight gain.

Patients who feel unduly restricted by their meal plan may view hypoglycemic episodes as a time to reward themselves with desserts. It may be more prudent to teach these patients to incorporate occasional desserts into the meal plan. This may make it easier for them to limit their treatment of hypoglycemic episodes to simple (low-calorie) carbohydrates such as juice or glucose tablets.

## Diabetic Ketoacidosis

DKA is caused by an absence or markedly inadequate amount of insulin. This deficit in available insulin results in disorders in the metabolism of carbohydrate, protein, and fat. The three main clinical features of DKA are

- Hyperglycemia
- Dehydration and electrolyte loss
- Acidosis

### Pathophysiology

Without insulin, the amount of glucose entering the cells is reduced, and production and release of glucose by the liver (gluconeogenesis) is increased, leading to hyperglycemia (Fig. 41-7). In an attempt to rid the body of the excess glucose, the kidneys excrete the glucose along with water and electrolytes (eg, sodium, potassium). This osmotic diuresis, which is characterized by excessive urination (polyuria),

**Physiology ■■■ Pathophysiology**

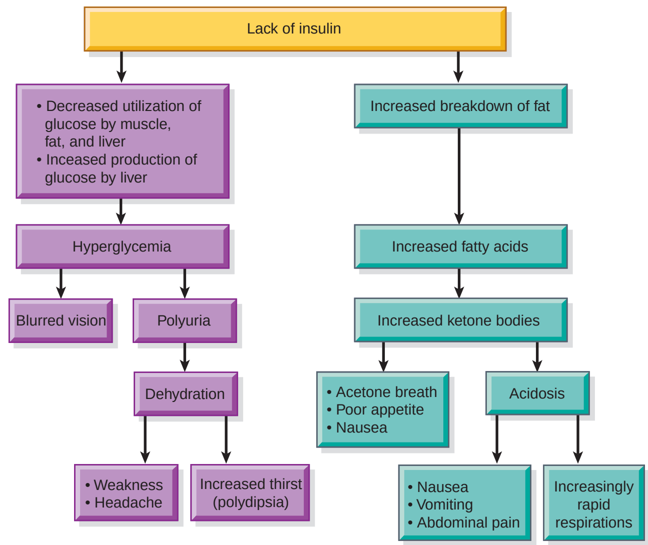



**Figure 41-7** Abnormal metabolism that causes signs and symptoms of diabetic ketoacidosis. (Redrawn from Pearce, M. A., Rosenberg, C. S. & Davidson, M. D. (2003). Patient education. In Davidson, M. B. (Ed.). *Diabetes mellitus: Diagnosis and treatment.* New York: Churchill Livingstone.)

leads to dehydration and marked electrolyte loss. Patients with severe DKA may lose up to 6.5 L of water and up to 400 to 500 mEq each of sodium, potassium, and chloride over a 24-hour period.

Another effect of insulin deficiency or deficit is the breakdown of fat (lipolysis) into free fatty acids and glycerol. The free fatty acids are converted into ketone bodies by the liver. Ketone bodies are acids; their accumulation in the circulation due to lack of insulin leads to metabolic acidosis.

Three main causes of DKA are decreased or missed dose of insulin, illness or infection, and undiagnosed and untreated diabetes (DKA may be the initial manifestation of diabetes). An insulin deficit may result from an insufficient dosage of insulin prescribed or from insufficient insulin being administered by the patient. Errors in insulin dosage may be made by patients who are ill and who assume that if they are eating less or if they are vomiting, they must decrease their insulin doses. (Because illness, especially infections, can cause increased blood glucose levels, the patient does not need to decrease the insulin dose to compensate for decreased food intake when ill and may even need to increase the insulin dose.)

Other potential causes of decreased insulin include patient error in drawing up or injecting insulin (especially in patients with visual impairments), intentional skipping of insulin doses (especially in adolescents with diabetes who are having difficulty coping with diabetes or other aspects of their lives), or equipment problems (eg, occlusion of insulin pump tubing). Illness and infections are associated with insulin resistance. In response to physical (and emotional) stressors, there is an increase in the level of "stress"

**CHART 41-9** PATIENT EDUCATION

**Guidelines to Follow During Periods of Illness ("Sick Day Rules")**

- Take insulin or oral antidiabetic agents as usual.
- Test blood glucose and test urine ketones every 3 to 4 h.
- Report elevated glucose levels (>300 mg/dL [16.6 mmol/L] or as otherwise specified) or urine ketones to your health care provider.
- If you take insulin, you may need supplemental doses of regular insulin every 3 to 4 h.
- If you cannot follow your usual meal plan, substitute soft foods (eg, 1/3 cup regular gelatin, 1 cup cream soup, 1/2 cup custard, 3 squares graham crackers) six to eight times per day.
- If vomiting, diarrhea, or fever persists, take liquids (eg, 1/2 cup regular cola or orange juice, 1/2 cup broth, 1 cup Gatorade) every 1/2 to 1 hour to prevent dehydration and to provide calories.
- Report nausea, vomiting, and diarrhea to your health care provider, because extreme fluid loss may be dangerous.
- If you are unable to retain oral fluids, you may require hospitalization to avoid diabetic ketoacidosis and possibly coma.

hormones—glucagon, epinephrine, norepinephrine, cortisol, and growth hormone. These hormones promote glucose production by the liver and interfere with glucose utilization by muscle and fat tissue, counteracting the effect of insulin. If insulin levels are not increased during times of illness and infection, hyperglycemia may progress to DKA (ADA, 2006c).

## Prevention

For prevention of DKA related to illness, "sick day" rules for managing their diabetes when ill (Chart 41-9) should be reviewed. The most important concept in this is to never eliminate insulin doses when nausea and vomiting occur. Instead, the patient should take the usual insulin dose (or previously prescribed special "sick day" doses) and then attempt to consume frequent small portions of carbohydrates (including foods usually avoided, such as juices, regular sodas, and gelatin). Drinking fluids every hour is important to prevent dehydration. Blood glucose and urine ketones must be assessed every 3 to 4 hours.

If the patient cannot take fluids without vomiting, or if elevated glucose or ketone levels persist, the physician must be contacted. Patients are taught to have foods available for use on sick days. In addition, a supply of urine test strips (for ketone testing) and blood glucose test strips should be available. The patient must know how to contact his or her physician 24 hours a day. These materials should be assembled in a "sick day" kit.

After the acute phase of DKA has resolved, the nurse should assess for underlying causes of DKA. If there are psychological reasons for the patient's deliberately missing insulin doses, the patient and family may be referred for evaluation and counseling or therapy.

## Clinical Manifestations

The hyperglycemia of DKA leads to polyuria and polydipsia (increased thirst). In addition, the patient may experience blurred vision, weakness, and headache. Patients with marked intravascular volume depletion may have orthostatic hypotension (drop in systolic blood pressure of 20 mm Hg or more on changing from a reclining to a standing position). Volume depletion may also lead to frank hypotension with a weak, rapid pulse.

The ketosis and acidosis of DKA lead to gastrointestinal symptoms such as anorexia, nausea, vomiting, and abdominal pain. The abdominal pain and physical findings on examination can be so severe that they resemble an acute abdominal disorder that requires surgery. The patient may have acetone breath (a fruity odor), which occurs with elevated ketone levels. In addition, hyperventilation (with very deep, but not labored, respirations) may occur. These Kussmaul respirations represent the body's attempt to decrease the acidosis, counteracting the effect of the ketone buildup. In addition, mental status in DKA varies widely. The patient may be alert, lethargic, or comatose.

## Assessment and Diagnostic Findings

Blood glucose levels may vary between 300 and 800 mg/dL (16.6 to 44.4 mmol/L). Some patients have lower glucose values, and others have values of 1000 mg/dL (55.5 mmol/L) or higher (usually depending on the degree of dehydration). The severity of DKA is not necessarily related to the blood glucose level. Evidence of ketoacidosis is reflected in low serum bicarbonate (0 to 15 mEq/L) and low pH (6.8 to 7.3) values. A low partial pressure of carbon dioxide ($PCO_2$; 10 to 30 mm Hg) reflects respiratory compensation (Kussmaul respirations) for the metabolic acidosis. Accumulation of ketone bodies (which precipitates the acidosis) is reflected in blood and urine ketone measurements.

Sodium and potassium concentrations may be low, normal, or high, depending on the amount of water loss (dehydration). Despite the plasma concentration, there has been a marked total body depletion of these (and other) electrolytes and they will need to be replaced.

Increased levels of creatinine, blood urea nitrogen (BUN), and hematocrit may also be seen with dehydration. After rehydration, continued elevation in the serum creatinine and BUN levels suggests underlying renal insufficiency.

## Management

In addition to treating hyperglycemia, management of DKA is aimed at correcting dehydration, electrolyte loss, and acidosis.

### *Rehydration*

In dehydrated patients, rehydration is important for maintaining tissue perfusion. In addition, fluid replacement enhances the excretion of excessive glucose by the kidneys. The patient may need as much as 6 to 10 L of IV fluid to replace fluid losses caused by polyuria, hyperventilation, diarrhea, and vomiting.

Initially, 0.9% sodium chloride (normal saline) solution is administered at a rapid rate, usually 0.5 to 1 L/h for 2 to 3 hours. Half-strength normal saline (0.45%) solution (also known as hypotonic saline solution) may be used for patients with hypertension or hypernatremia and those at risk for heart failure. After the first few hours, half-strength normal saline solution is the fluid of choice for continued rehydration, provided the blood pressure is stable and the sodium level is not low. Moderate to high rates of infusion (200 to 500 mL/h) may be needed for several more hours. When the blood glucose level reaches 300 mg/dL (16.6 mmol/L) or less, the IV solution may be changed to dextrose 5% in water ($D_5W$) to prevent a precipitous decline in the blood glucose level (Fowler, 2009).

Monitoring of fluid volume status involves frequent measurements of vital signs (including monitoring for orthostatic changes in blood pressure and heart rate), lung assessment, and monitoring of intake and output. Initial urine output lags behind IV fluid intake as dehydration is corrected. Plasma expanders may be necessary to correct severe hypotension that does not respond to IV fluid treatment. Monitoring for signs of fluid overload is especially important for patients who are older, have renal impairment, or are at risk for heart failure.

#### Restoring Electrolytes

The major electrolyte of concern during treatment of DKA is potassium. Although the initial plasma concentration of potassium may be low, normal, or even high, there is a major loss of potassium from body stores and an intracellular-to-extracellular shift of potassium. Furthermore, the serum level of potassium decreases as potassium reenters the cells during the course of treatment of DKA; therefore, the serum potassium level must be monitored frequently. Some of the factors related to treating DKA that reduce the serum potassium concentration include rehydration, which leads to increased plasma volume and subsequent decreases in the concentration of serum potassium. Rehydration also leads to increased urinary excretion of potassium. Insulin administration enhances the movement of potassium from the extracellular fluid into the cells.

Cautious but timely potassium replacement is vital to avoid dysrhythmias that may occur with hypokalemia. As much as 40 mEq/h may be needed for several hours. Because extracellular potassium levels decrease during DKA treatment, potassium must be infused even if the plasma potassium level is normal.

Frequent (every 2 to 4 hours initially) ECGs and laboratory measurements of potassium are necessary during the first 8 hours of treatment. Potassium replacement is withheld only if hyperkalemia is present or if the patient is not urinating.

> **NURSING ALERT**
>
> **Because a patient's serum potassium level may drop quickly as a result of rehydration and insulin treatment, potassium replacement must begin once potassium levels drop to normal.**

#### Reversing Acidosis

Ketone bodies (acids) accumulate as a result of fat breakdown. The acidosis that occurs in DKA is reversed with insulin, which inhibits fat breakdown, thereby stopping acid buildup. Insulin is usually infused intravenously at a slow, continuous rate (eg, 5 units/h). Hourly blood glucose values must be measured. IV fluid solutions with higher concentrations of glucose, such as normal saline (NS) solution (eg, $D_5NS$, $D_5$·45NS), are administered when blood glucose levels reach 250 to 300 mg/dL (13.8 to 16.6 mmol/L) to avoid too rapid a drop in the blood glucose level (ie, hypoglycemia) during treatment.

Regular insulin, the only type of insulin approved for IV use, may be added to IV solutions. The nurse must convert hourly rates of insulin infusion (frequently prescribed as units per hour) to IV drip rates. For example, if 100 units of regular insulin are mixed into 500 mL of 0.9% NS, then 1 unit of insulin equals 5 mL; therefore, an initial insulin infusion rate of 5 units/h would equal 25 mL/h. The insulin is often infused separately from the rehydration solutions to allow frequent changes in the rate and content of the latter.

Insulin must be infused continuously until subcutaneous administration of insulin can be resumed. Any interruption in administration may result in the reaccumulation of ketone bodies and worsening acidosis. Even if blood glucose levels are decreasing and returning to normal, the insulin drip must not be stopped until subcutaneous insulin therapy has been started. Rather, the rate or concentration of the dextrose infusion should be increased. Blood glucose levels are usually corrected before the acidosis is corrected. Therefore, IV insulin may be continued for 12 to 24 hours, until the serum bicarbonate level increases (to at least 15 to 18 mEq/L) and until the patient can eat. In general, bicarbonate infusion to correct severe acidosis is avoided during treatment of DKA because it precipitates further, sudden (and potentially fatal) decreases in serum potassium levels. Continuous insulin infusion is usually sufficient for reversal of DKA (ADA, 2006c).

> **NURSING ALERT**
>
> **When mixing the insulin drip, it is important to flush the insulin solution through the entire IV infusion set and to discard the first 50 mL of fluid. Insulin molecules adhere to the inner surface of IV infusion sets; therefore, the initial fluid may contain a decreased concentration of insulin.**

## Hyperglycemic Hyperosmolar Nonketotic Syndrome

**Hyperglycemic hyperosmolar nonketotic syndrome (HHNS)** is a serious condition in which hyperosmolarity and hyperglycemia predominate, with alterations of the sensorium (sense of awareness). At the same time, ketosis is usually minimal or absent. The basic biochemical defect is lack of effective insulin (ie, insulin resistance). Persistent hyperglycemia causes osmotic diuresis, which results in losses of water and electrolytes. To maintain osmotic equilibrium, water shifts from the intracellular fluid space to the

**Table 41-8 COMPARISON OF DIABETIC KETOACIDOSIS (DKA) AND HYPERGLYCEMIC HYPEROSMOLAR NONKETOTIC SYNDROME (HHNS)**

| Characteristics | DKA | HHNS |
|---|---|---|
| Patients most commonly affected | Can occur in type 1 or type 2 diabetes; more common in type 1 diabetes | Can occur in type 1 or type 2 diabetes; more common in type 2 diabetes, especially elderly patients with type 2 diabetes |
| Precipitating event | Omission of insulin; physiologic stress (infection, surgery, CVA, MI) | Physiologic stress (infection, surgery, CVA, MI) |
| Onset | Rapid (<24 h) | Slower (over several days) |
| Blood glucose levels | Usually >250 mg/dL (>13.9 mmol/L) | Usually >600 mg/dL (>33.3 mmol/L) |
| Arterial pH level | <7.3 | Normal |
| Serum and urine ketones | Present | Absent |
| Serum osmolality | 300–350 mOsm/L | >350 mOsm/L |
| Plasma bicarbonate level | <15 mEq/L | Normal |
| BUN and creatinine levels | Elevated | Elevated |
| Mortality rate | <5% | 10–40% |

BUN, blood urea nitrogen; CVA, cerebrovascular accident; MI, myocardial infarction.

extracellular fluid space. With glycosuria and dehydration, hypernatremia and increased osmolarity occur. Table 41-8 compares DKA and HHNS.

HHNS occurs most often in older people (50 to 70 years of age) who have no known history of diabetes or who have type 2 diabetes. HHNS often can be traced to a precipitating event such as an acute illness (eg, pneumonia, cerebrovascular accident [CVA]), medications that exacerbate hyperglycemia (eg, thiazides), or treatments such as dialysis. The history includes days to weeks of polyuria with adequate fluid intake. What distinguishes HHNS from DKA is that ketosis and acidosis generally do not occur in HHNS, partly because of differences in insulin levels. In DKA, no insulin is present, and this promotes the breakdown of stored glucose, protein, and fat, which leads to the production of ketone bodies and ketoacidosis. In HHNS, the insulin level is too low to prevent hyperglycemia (and subsequent osmotic diuresis), but it is high enough to prevent fat breakdown. Patients with HHNS do not have the ketosis-related gastrointestinal symptoms that lead them to seek medical attention. Instead, they may tolerate polyuria and polydipsia until neurologic changes or an underlying illness (or family members or others) prompts them to seek treatment. Because of possible delays in therapy, hyperglycemia, dehydration, and hyperosmolarity may be more severe in HHNS.

## Clinical Manifestations

The clinical picture of HHNS is one of hypotension, profound dehydration (dry mucous membranes, poor skin turgor), tachycardia, and variable neurologic signs (eg, alteration of sensorium, seizures, hemiparesis). The mortality rate ranges from 10% to 40%, usually related to an underlying illness, the vulnerability of the elderly patient, and the severity of HHNS.

## Assessment and Diagnostic Findings

Diagnostic assessment includes a range of laboratory tests, including blood glucose, electrolytes, BUN, complete blood count, serum osmolality, and arterial blood gas analysis. The blood glucose level is usually 600 to 1200 mg/dL, and the osmolality exceeds 350 mOsm/kg. Electrolyte and BUN levels are consistent with the clinical picture of severe dehydration. Mental status changes, focal neurologic deficits, and hallucinations are common secondary to the cerebral dehydration that results from extreme hyperosmolality. Postural hypotension accompanies the dehydration.

## Management

The overall approach to the treatment of HHNS is similar to that of DKA: fluid replacement, correction of electrolyte imbalances, and insulin administration. Because patients with HHNS are typically older, close monitoring of volume and electrolyte status is important for prevention of fluid overload, heart failure, and cardiac dysrhythmias. Fluid treatment is started with 0.9% or 0.45% NS, depending on the patient's sodium level and the severity of volume depletion. Central venous or hemodynamic pressure monitoring guides fluid replacement. Potassium is added to IV fluids when urinary output is adequate and is guided by continuous ECG monitoring and frequent laboratory determinations of potassium.

Extremely elevated blood glucose concentrations decrease as the patient is rehydrated. Insulin plays a less important role in the treatment of HHNS because it is not needed for reversal of acidosis, as in DKA. Nevertheless, insulin is usually administered at a continuous low rate to treat hyperglycemia, and replacement IV fluids with dextrose are administered (as in DKA) after the glucose level has decreased to the range of 250 to 300 mg/dL (13.8 to 16.6 mmol/L) (ADA, 2008d; Fowler, 2009).

Other therapeutic modalities are determined by the underlying illness and the results of continuing clinical and laboratory evaluation. It may take 3 to 5 days for neurologic symptoms to clear, and treatment of HHNS usually continues well after metabolic abnormalities have resolved. After recovery from HHNS, many patients can control their diabetes with MNT alone or with MNT and oral antidiabetic medications. Insulin may not be needed once the acute hyperglycemic complication is resolved. Frequent SBGM is important in prevention of recurrence of HHNS.

## NURSING PROCESS

### The Patient With Diabetic Ketoacidosis or Hyperglycemic Hyperosmolar Nonketotic Syndrome

#### Assessment

For the patient with DKA, the nurse monitors the ECG for dysrhythmias indicating abnormal potassium levels. Vital signs (especially blood pressure and pulse), arterial blood gases, breath sounds, and mental status are assessed every hour and recorded on a flow sheet. Neurologic status checks are included as part of the hourly assessment as cerebral edema can be a severe and sometimes fatal outcome.

For the patient with HHNS, the nurse assesses vital signs, fluid status, and laboratory values. Fluid status and urine output are closely monitored because of the high risk of renal failure secondary to severe dehydration. Because HHNS tends to occur in older patients, the physiologic changes that occur with aging should be considered. Careful assessment of cardiovascular, pulmonary, and renal function throughout the acute and recovery phases of HHNS is important.

#### Diagnosis

*Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include the following:

- Risk for fluid volume deficit related to polyuria and dehydration
- Fluid and electrolyte imbalance related to fluid loss or shifts
- Deficient knowledge about diabetes self-care skills or information
- Anxiety related to loss of control, fear of inability to manage diabetes, misinformation related to diabetes, fear of diabetes complications

*Collaborative Problems/Potential Complications*

Based on assessment data, potential complications may include the following:

- Fluid overload, pulmonary edema, and heart failure
- Hypokalemia
- Hyperglycemia and ketoacidosis
- Hypoglycemia
- Cerebral edema

#### Planning and Goals

The major goals for the patient may include maintenance of fluid and electrolyte balance, optimal control of blood glucose levels, ability to perform diabetes survival skills and self-care activities, and absence of complications.

#### Nursing Interventions

*Maintaining Fluid and Electrolyte Balance*

Intake and output are measured. IV fluids and electrolytes are administered as prescribed, and oral fluid intake is encouraged when it is permitted. Laboratory values of serum electrolytes (especially sodium and potassium) are monitored. Vital signs are monitored hourly for signs of dehydration (tachycardia, orthostatic hypotension) along with assessment of breath sounds, level of consciousness, presence of edema, and cardiac status (ECG rhythm strips).

*Increasing Knowledge About Diabetes Management*

The development of DKA or HHNS suggests the need for the nurse to carefully assess the patient's understanding of and adherence to the diabetes management plan. Further, factors that may have led to the development of DKA or HHNS are explored with the patient and family. If the patient's blood glucose monitoring, dietary intake, use of antidiabetes (insulin or oral agents) medications, and exercise patterns differ from those identified in the diabetes management plan, their relationship to the development of DKS or HHNS is discussed, along with early manifestations of DKA or HHNS. If other factors, such as trauma, illness, surgery, or stress, are implicated, appropriate strategies to respond to these and similar situations in the future are described so that the patient can respond in the future without developing life-threatening complications. It may be necessary to reteach survival skills to patients who may not be able to recall them. If the patient has omitted insulin or oral antidiabetes agents that have been prescribed, it is important to explore the reasons for doing so and address those issues to prevent future recurrence and readmissions for treatment of these complications.

If the patient has not previously been diagnosed with diabetes, the opportunity is used to teach the patient about the need for maintaining blood glucose at a normal level and learning about diabetes management and survival skills.

*Monitoring and Managing Potential Complications*

**FLUID OVERLOAD.** Fluid overload can occur because of the administration of a large volume of fluid at a rapid rate, which is often required to treat patients with DKA or HHNS. This risk is increased in elderly patients and in those with preexisting cardiac or renal disease. To avoid fluid overload and resulting heart failure and pulmonary edema, the nurse monitors the patient closely during treatment by measuring vital signs and intake and output at frequent intervals. Central venous pressure monitoring and hemodynamic monitoring may be initiated to provide additional measures of fluid status. Physical examination focuses on assessment of cardiac rate and rhythm, breath sounds, venous distention, skin turgor, and urine output. The nurse monitors fluid intake and keeps careful records of IV and other fluid intake, along with urine output measurements.

**HYPOKALEMIA.** As previously described, hypokalemia is a potential complication during the treatment of DKA as potassium is lost from body stores. Low serum potassium levels may result from rehydration, increased urinary excretion of potassium, and movement of potassium from the extracellular fluid into the cells with insulin administration.

Prevention of hypokalemia includes cautious replacement of potassium; however, before its administration, it is important to ensure that a patient's kidneys are functioning. Because of the adverse effects of hypokalemia on cardiac function, monitoring of the cardiac rate, cardiac rhythm, ECG, and serum potassium levels is essential.

**CEREBRAL EDEMA.** Although the cause of cerebral edema is unknown, rapid correction of hyperglycemia, resulting in fluid shifts, is thought to be the cause. Cerebral edema, which occurs more often in children than in adults, can be prevented by gradual reduction in the blood glucose level (ADA, 2006c). An hourly flow sheet is used to enable close monitoring of the blood glucose level, serum electrolyte levels, urine output, mental status, and neurologic signs. Precautions are taken to minimize activities that could increase intracranial pressure.

#### *Teaching Patients Self-Care*

The patient is taught survival skills, including treatment modalities (diet, insulin administration, monitoring of blood glucose, and, for type 1 diabetes, monitoring of urine ketones); recognition, treatment, and prevention of DKA and HHNS. Teaching addresses those factors leading to DKA or HHNS. Follow-up education is arranged with a home care nurse and dietitian or an outpatient diabetes education center. This is particularly important for patients who have experienced DKA or HHNS because of the need to address factors that led to its occurrence. The importance of self-monitoring and of monitoring and follow-up by primary health care providers is reinforced, and the patient is reminded about the importance of keeping follow-up appointments.

### Evaluation

#### *Expected Outcomes*

1. Achieves fluid and electrolyte balance
    a. Demonstrates intake and output balance
    b. Exhibits electrolyte values within normal limits
    c. Exhibits vital signs that remain stable, with resolution of orthostatic hypotension and tachycardia
2. Demonstrates knowledge about DKA and HHNS
    a. Identifies factors leading to DKA and HHNS
    b. Describes signs and symptoms of DKA and HHNS
    c. Describes short-term and long-term consequences of DKA and HHNS
    d. Identifies strategies to prevent the development of DKA and HHNS
    e. States when contact with health care provider is needed to treat early signs of DKS and HHNS
3. Absence of complications
    a. Exhibits normal cardiac rate and rhythm and normal breath sounds
    b. Exhibits no jugular venous distention
    c. Exhibits blood glucose and urine ketone levels within target range
    d. Exhibits no manifestations of hypoglycemia or hyperglycemia
    e. Shows improved mental status without signs of cerebral edema

## LONG-TERM COMPLICATIONS OF DIABETES

There has been a steady decline in the number of deaths attributable to ketoacidosis and infection in patients with diabetes but an alarming increase in the number of deaths from cardiovascular and renal complications. Long-term complications, which are becoming more common as more people live longer with diabetes, can affect almost every organ system of the body and are a major cause of disability. The general categories of long-term diabetic complications are macrovascular disease, microvascular disease, and neuropathy.

The specific causes and pathogenesis of each type of complication are still being investigated. However, it appears that increased levels of blood glucose may play a role in neuropathic disease, microvascular complications, and risk factors contributing to macrovascular complications. Hypertension may also be a major contributing factor, especially in macrovascular and microvascular diseases.

Long-term complications are seen in both type 1 and type 2 diabetes but usually do not occur within the first 5 to 10 years after diagnosis. However, evidence of these complications may be present at the time of diagnosis of type 2 diabetes, because patients may have had undiagnosed diabetes for many years. Renal (microvascular) disease is more prevalent in patients with type 1 diabetes, and cardiovascular (macrovascular) complications are more prevalent in older patients with type 2 diabetes.

### *Macrovascular Complications*

Diabetic macrovascular complications result from changes in the medium to large blood vessels. Blood vessel walls thicken, sclerose, and become occluded by plaque that adheres to the vessel walls. Eventually, blood flow is blocked. These atherosclerotic changes tend to occur more often and at an earlier age in patients with diabetes. Coronary artery disease, cerebrovascular disease, and peripheral vascular disease are the three main types of macrovascular complications that occur frequently in the diabetic population.

Myocardial infarction (MI) is twice as common in men with diabetes and three times as common in women with diabetes, compared to people without diabetes. There is also an increased risk for complications resulting from MI and an increased likelihood of a second MI. Coronary artery disease may account for 50% to 60% of all deaths among patients with diabetes. The typical ischemic symptoms may be absent in patients with diabetes. Therefore, the patient may not experience the early warning signs of decreased coronary blood flow and may have "silent" MIs, which may be discovered only as changes on the ECG. However, ECG changes may not be apparent. This lack of ischemic symptoms may be secondary to autonomic neuropathy (see later discussion). Cardiac disease is discussed in detail in Chapter 28.

Cerebral blood vessels are similarly affected by accelerated atherosclerosis. Occlusive changes or the formation of an embolus elsewhere in the vasculature that lodges in a

cerebral blood vessel can lead to transient ischemic attacks and strokes. People with diabetes have twice the risk of developing cerebrovascular disease, and an increased risk of death from CVA. In addition, recovery from a stroke may be impaired in patients who have elevated blood glucose levels at the time of and immediately after a stroke. Because symptoms of CVA may be similar to symptoms of acute diabetic complications (HHNS or hypoglycemia), it is very important to assess the blood glucose level (and treat abnormal levels) rapidly in patients with these symptoms, so that testing and treatment of CVA (stroke) can be initiated promptly if indicated.

Atherosclerotic changes in the large blood vessels of the lower extremities are responsible for the increased incidence (two to three times higher than in nondiabetic people) of occlusive peripheral arterial disease in patients with diabetes. Signs and symptoms of peripheral vascular disease include diminished peripheral pulses and intermittent claudication (pain in the buttock, thigh, or calf during walking). The severe form of arterial occlusive disease in the lower extremities is largely responsible for the increased incidence of gangrene and subsequent amputation in patients with diabetes. Neuropathy and impairments in wound healing also play a role in diabetic foot disease (see later discussion).

### Role of Diabetes in Macrovascular Diseases

Researchers continue to investigate the relationship between diabetes and macrovascular diseases. The main feature unique to diabetes is elevated blood glucose; however, a direct link has not been found between hyperglycemia and atherosclerosis. Although it may be tempting to attribute the increased prevalence of macrovascular diseases to the increased prevalence of certain risk factors (eg, obesity, increased triglyceride levels, hypertension) in patients with diabetes, there is a higher-than-expected rate of macrovascular diseases among patients with diabetes compared with patients without diabetes who have the same risk factors (ADA, 2009b). Therefore, diabetes itself is seen as an independent risk factor for accelerated atherosclerosis. Other potential factors that may play a role in diabetes-related atherosclerosis include platelet and clotting factor abnormalities, decreased flexibility of red blood cells, decreased oxygen release, changes in the arterial wall related to hyperglycemia, and possibly hyperinsulinemia.

### Management

The focus of management is aggressive modification and reduction of risk factors. This involves prevention and treatment of the commonly accepted risk factors for atherosclerosis. MNT and exercise are important in managing obesity, hypertension, and hyperlipidemia. In addition, the use of medications to control hypertension and hyperlipidemia is indicated. Smoking cessation is essential. Control of blood glucose levels may reduce triglyceride concentrations and can significantly reduce the incidence of complications.

When macrovascular complications do occur, patients may require increased amounts of insulin or may need to switch from oral antidiabetic agents to insulin during illnesses.

## Microvascular Complications

Diabetic microvascular disease (or microangiopathy) is characterized by capillary basement membrane thickening. The basement membrane surrounds the endothelial cells of the capillary. Researchers believe that increased blood glucose levels react through a series of biochemical responses to thicken the basement membrane to several times its normal thickness. Two areas affected by these changes are the retina and the kidneys.

### DIABETIC RETINOPATHY

Diabetic retinopathy is the leading cause of blindness among people between 20 and 74 years of age in the United States; it occurs in both type 1 and type 2 diabetes (ADA, 2009b; CDC, 2008).

People with diabetes are subject to many visual complications (Table 41-9). The eye pathology referred to as diabetic retinopathy is caused by changes in the small blood vessels in the retina, the area of the eye that receives images and sends information about the images to the brain (Fig. 41-8). The retina is richly supplied with blood vessels of all

**Table 41-9 OCULAR COMPLICATIONS OF DIABETES**

| Eye Disorder | Characteristics |
|---|---|
| **Retinopathy** | Deterioration of the small blood vessels that nourish the retina. |
| Background | Early stage, asymptomatic retinopathy. Blood vessels within the retina develop microaneurysms that leak fluid, causing swelling and forming deposits (exudates). In some cases, macular edema causes distorted vision. |
| Preproliferative | Represents increased destruction of retinal blood vessels. |
| Proliferative | Abnormal growth of new blood vessels on the retina. New vessels rupture, bleeding into the vitreous and blocking light. Ruptured blood vessels in the vitreous form scar tissue, which can pull on and detach the retina. |
| **Cataracts** | Opacity of the lens of the eye; cataracts occur at an earlier age in patients with diabetes. |
| **Lens Changes** | The lens of the eye can swell when blood glucose levels are elevated. For some patients, visual changes related to lens swelling may be the first symptoms of diabetes. It may take up to 2 months of improved blood glucose control before hyperglycemic swelling subsides and vision stabilizes. Therefore, patients are advised not to change eyeglass prescriptions during the 2 months after discovery of hyperglycemia. |
| **Extraocular Muscle Palsy** | This may occur as a result of diabetic neuropathy. The involvement of various cranial nerves responsible for ocular movements may lead to double vision. This usually resolves spontaneously. |
| **Glaucoma** | Results from occlusion of the outflow channels by new blood vessels. Glaucoma may occur with slightly higher frequency in the diabetic population. |

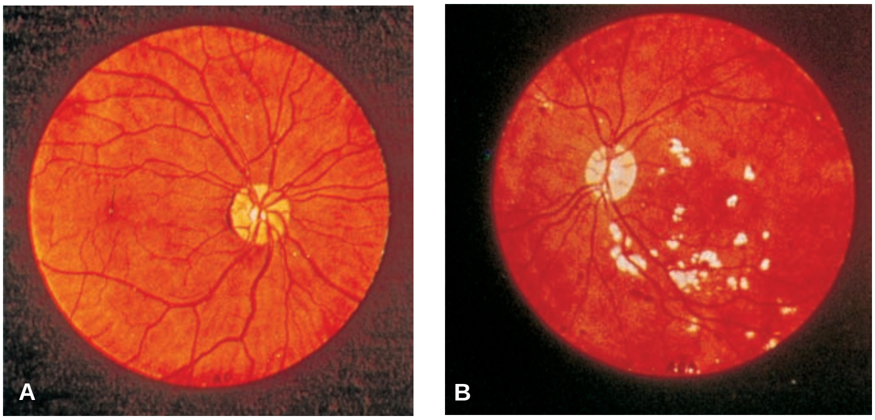



**Figure 41-8** Diabetic retinopathy. **A,** In the fundus photograph of a normal eye, the light circular area over which a number of blood vessels converge is the optic disk, where the optic nerve meets the back of the eye. **B,** The fundus photograph of a patient with diabetic retinopathy shows characteristic waxy-looking retinal lesions, microaneurysms of the vessels, and hemorrhages. (Courtesy of American Optometric Association.)

kinds: small arteries and veins, arterioles, venules, and capillaries. Retinopathy has three main stages: nonproliferative (background), preproliferative, and proliferative.

Almost all patients with type 1 diabetes and more than 60% of patients with type 2 diabetes have some degree of retinopathy after 20 years (ADA, 2009b). Changes in the microvasculature include microaneurysms, intraretinal hemorrhage, hard exudates, and focal capillary closure. Although most patients do not develop visual impairment, it can be devastating if it occurs. A complication of nonproliferative retinopathy, macular edema, occurs in approximately 10% of people with type 1 or type 2 diabetes and may lead to visual distortion and loss of central vision (ADA, 2008e).

An advanced form of background retinopathy, preproliferative retinopathy, is considered to be a precursor to the more serious proliferative retinopathy. In preproliferative retinopathy, there are more widespread vascular changes and loss of nerve fibers. Epidemiologic evidence suggests that 10% to 50% of patients with preproliferative retinopathy will develop proliferative retinopathy within a short time (possibly as little as 1 year). As with background retinopathy, if visual changes occur during the preproliferative stage, they are usually caused by macular edema.

Proliferative retinopathy represents the greatest threat to vision and is characterized by the proliferation of new blood vessels growing from the retina into the vitreous. These new vessels are prone to bleeding. The visual loss associated with proliferative retinopathy is caused by this vitreous hemorrhage, retinal detachment, or both. The vitreous is normally clear, allowing light to be transmitted to the retina. When there is a hemorrhage, the vitreous becomes clouded and cannot transmit light, resulting in loss of vision. Another consequence of vitreous hemorrhage is that resorption of the blood in the vitreous leads to the formation of fibrous scar tissue. This scar tissue may place traction on the retina, resulting in retinal detachment and subsequent visual loss.

## Clinical Manifestations

Retinopathy is a painless process. In nonproliferative and preproliferative retinopathy, blurry vision secondary to macular edema occurs in some patients, although many patients are asymptomatic. Even patients with a significant degree of proliferative retinopathy and some hemorrhaging may not experience major visual changes. However, symptoms indicative of hemorrhaging include floaters or cobwebs in the visual field, sudden visual changes including spotty or hazy vision, or complete loss of vision.

## Assessment and Diagnostic Findings

Diagnosis is by direct visualization of the retina through dilated pupils with an ophthalmoscope or with a technique known as fluorescein angiography. Fluorescein angiography can document the type and activity of the retinopathy. Dye is injected into an arm vein and is carried to various parts of the body through the blood, but especially through the vessels of the retina of the eye. This technique allows an ophthalmologist, using special instruments, to see the retinal vessels in bright detail and gives useful information that cannot be obtained with just an ophthalmoscope.

Side effects of this diagnostic procedure may include nausea during the dye injection; yellowish, fluorescent discoloration of the skin and urine lasting 12 to 24 hours; and occasionally allergic reactions, usually manifested by hives or itching. However, the diagnostic procedure is generally safe.

## Medical Management

The first focus of management of retinopathy is on primary and secondary prevention. The DCCT study (1993) demonstrated that in patients without preexisting retinopathy, maintenance of blood glucose to a normal or near-normal level in type 1 diabetes through intensive insulin therapy and patient education decreased the risk of retinopathy by 76%, compared with conventional therapy. The progression of retinopathy was decreased by 54% in patients with very mild to moderate nonproliferative retinopathy at the time of initiation of treatment. Similarly, the UKPDS study (1998) demonstrated that better control of blood glucose levels in patients with type 2 diabetes led to reduced risk of retinopathy.

Other strategies that may slow the progression of diabetic retinopathy include control of hypertension, control of blood glucose, and cessation of smoking.

For advanced cases of diabetic retinopathy, the main treatment is argon laser photocoagulation. The laser treatment

destroys leaking blood vessels and areas of neovascularization. For patients who are at increased risk for hemorrhage, panretinal photocoagulation may significantly reduce the rate of progression to blindness. Panretinal photocoagulation involves the systematic application of multiple (more than 1000) laser burns throughout the retina (except in the macular region). This stops the widespread growth of new vessels and hemorrhaging of damaged vessels. The role of "mild" panretinal photocoagulation (with only one-third to one-half as many laser burns) in the early stages of proliferative retinopathy or in patients with preproliferative changes is being investigated. For patients with macular edema, focal photocoagulation is used to apply smaller laser burns to specific areas of microaneurysms in the macular region. This may reduce the rate of visual loss from macular edema by 50% (ADA, 2008e).

Photocoagulation treatments are usually performed on an outpatient basis, and most patients can return to their usual activities by the next day. Limitations may be placed on activities involving weight bearing or bearing down. In most cases, the treatment does not cause intense pain, although patients may report varying degrees of discomfort. Usually an anesthetic eye drop is all that is needed during the treatment. A few patients may experience slight visual loss, loss of peripheral vision, or impairments in adaptation to the dark. However, the risk of slight visual changes from the laser treatment itself is much less than the potential for loss of vision from progression of retinopathy.

A major hemorrhage into the vitreous may occur, with the vitreous fluid becoming mixed with blood, preventing light from passing through the eye; this can cause blindness. A vitrectomy is a surgical procedure in which vitreous humor filled with blood or fibrous tissue is removed with a special drill-like instrument and replaced with saline or another liquid. A vitrectomy is performed for patients who already have visual loss and in whom the vitreous hemorrhage has not cleared on its own after 6 months. The purpose is to restore useful vision; recovery to near-normal vision is not usually expected.

## Nursing Management

Nursing management of patients with diabetic retinopathy or other eye disorders involves implementing the individual plan of care and providing patient education. Education focuses on prevention through regular ophthalmologic examinations and blood glucose control and self-management of eye care regimens. The effectiveness of early diagnosis and prompt treatment is emphasized in teaching the patient and family. If vision loss occurs, nursing care must also address the patient's adjustment to impaired vision and use of adaptive devices for diabetes self-care as well as activities of daily living. Nursing care for patients with low vision or loss of vision is discussed in detail in Chapter 58.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Because the course of the retinopathy may be long and stressful, patient teaching is essential. In teaching and counseling patients, it is important to stress the following:

- Retinopathy may appear after many years of diabetes, and its appearance does not necessarily mean that the diabetes is on a downhill course.
- The odds for maintaining vision are in the patient's favor, especially with adequate control of glucose levels and blood pressure.
- Frequent eye examinations allow for the detection and prompt treatment of retinopathy.

A patient's response to vision loss depends on personality, self-concept, and coping mechanisms. Acceptance of blindness occurs in stages; some patients may learn to accept blindness in a rather short period, and others may never do so. An important issue in teaching patients is that several complications of diabetes occur simultaneously. For example, a patient who is blind due to diabetic retinopathy may also have peripheral neuropathy and may experience impairment of manual dexterity and tactile sensation. To prevent further losses, glycemic control remains a priority.

#### Continuing Care

The importance of careful diabetes management is emphasized as one means of slowing the progression of visual changes. The patient is reminded of the need to see an ophthalmologist regularly. If eye changes are progressive and unrelenting, the patient should be prepared for inevitable blindness. Therefore, consideration is given to making referrals for teaching the patient Braille and for training him or her with guide (ie, service) dogs. Referral to state agencies should be made to ensure that the patient receives services for the blind. Family members are also taught how to assist the patient to remain as independent as possible despite decreasing visual acuity.

Referral for home care may be indicated for some patients, particularly those who live alone, those who are not coping well, and those who have other health problems or complications of diabetes that may interfere with their ability to perform self-care. During home visits, the nurse can assess the patient's home environment and his or her ability to manage diabetes despite visual impairments. Medical management and nursing care of patients with visual disturbances are discussed in detail in Chapter 58.

## NEPHROPATHY

Nephropathy, or renal disease secondary to diabetic microvascular changes in the kidney, is a common complication of diabetes (ADA, 2008f, 2009b). In the United States each year, people with diabetes account for almost 50% of new cases of end-stage renal disease (ESRD) and about 25% of those require dialysis or transplantation. About 20% to 30% of people with type 1 or type 2 diabetes develop nephropathy, but fewer of those with type 2 diabetes progress to ESRD. Native American, Latino, African American, Asian American, and Pacific Island people with type 2 diabetes are at greater risk for ESRD than non-Latino whites (ADA, 2009b).

Patients with type 1 diabetes frequently show initial signs of renal disease after 10 to 15 years; patients with type 2 diabetes develop renal disease within 10 years after the diagnosis of diabetes. Many patients with type 2 diabetes have

had diabetes for many years before the diabetes is diagnosed and treated. Therefore, they may have evidence of nephropathy at the time of diagnosis (ADA, 2008f). If blood glucose levels are elevated consistently for a significant period of time, the kidney's filtration mechanism is stressed, allowing blood proteins to leak into the urine. As a result, the pressure in the blood vessels of the kidney increases. It is thought that this elevated pressure serves as the stimulus for the development of nephropathy. Various medications and diets are being tested to prevent these complications.

The DCCT (1993) results showed that intensive treatment of type 1 diabetes with a goal of achieving a hemoglobin $A_{1C}$ level as close to the nondiabetic range as possible reduced the occurrence of early signs of nephropathy. Similarly, the UKPDS study (1998) demonstrated a reduced incidence of overt nephropathy in patients with type 2 diabetes who controlled their blood glucose levels.

## Clinical Manifestations

Most of the signs and symptoms of renal dysfunction in patients with diabetes are similar to those seen in patients without diabetes (see Chapter 44). In addition, as renal failure progresses, the catabolism (breakdown) of both exogenous and endogenous insulin decreases, and frequent hypoglycemic episodes may result. Insulin needs change as a result of changes in the catabolism of insulin, changes in diet related to the treatment of nephropathy, and changes in insulin clearance that occur with decreased renal function. The stress of renal disease affects self-esteem, family relationships, marital relations, and virtually all aspects of daily life. As renal function decreases, patients commonly have multiple-system failure (eg, declining visual acuity, impotence, foot ulcerations, heart failure, nocturnal diarrhea).

## Assessment and Diagnostic Findings

Albumin is one of the most important blood proteins that leaks into the urine. Although small amounts may leak undetected for years, its leakage into the urine is among the earliest signs that can be detected. Clinical nephropathy eventually develops in more than 85% of people with microalbuminuria but in fewer than 5% of people without microalbuminuria. The urine should be checked annually for the presence of microalbumin. If the microalbuminuria exceeds 30 mg/24 hours on two consecutive random urine tests, a 24-hour urine sample should be obtained and tested. If results are positive, treatment is indicated (see later discussion).

In addition, tests for serum creatinine and BUN levels should be conducted annually. Diagnostic testing for cardiac or other systemic disorders may also be required with progression of other complications, and caution is indicated if contrast agents are used with these tests. Contrast agents and dyes used for some diagnostic tests may not be easily cleared by the damaged kidney, and the potential benefits of these diagnostic tests must be weighed against their potential risks.

Hypertension often develops in patients (with and without diabetes) who are in the early stages of renal disease. However, hypertension occurs in as many as 50% of all people with diabetes (for unknown reasons). Therefore, this symptom may or may not be due to renal disease; other diagnostic criteria must also be present.

## Management

In addition to achieving and maintaining near-normal blood glucose levels, management for all patients with diabetes should include careful attention to the following:

- Control of hypertension (the use of angiotensin-converting enzyme [ACE] inhibitors, such as captopril [Capoten]), because control of hypertension may also decrease or delay the onset of early proteinuria
- Prevention or vigorous treatment of urinary tract infections
- Avoidance of nephrotoxic substances (eg, antibiotics, other selected medications)
- Adjustment of medications as renal function changes
- Low-sodium diet
- Low-protein diet

If the patient has already developed microalbuminuria and its level exceeds 30 mg/24 hours on two consecutive tests, an ACE inhibitor should be prescribed. ACE inhibitors lower blood pressure and reduce microalbuminuria, thereby protecting the kidney. Alternatively, angiotensin-receptor blocking (ARB) agents may be prescribed. This preventive strategy should be part of the standard of care for all people with diabetes. Carefully designed low-protein diets also appear to reverse early leakage of small amounts of protein from the kidney.

In chronic or end-stage renal failure, two types of treatment are available: dialysis (hemodialysis or peritoneal dialysis) and transplantation from a relative or a cadaver. Hemodialysis for patients with diabetes is similar to that for patients without the disease (see Chapter 44). Because hemodialysis creates additional stress on patients with cardiovascular disease, it may not be appropriate for some patients.

Continuous ambulatory peritoneal dialysis is being used by an increasing number of patients with diabetes, mainly because of the independence it allows. In addition, insulin can be mixed into the dialysate, which may result in better blood glucose control and end the need for insulin injections. In some cases, they may require higher doses of insulin because the dialysate contains glucose. Major risks of peritoneal dialysis are infection and peritonitis. The mortality rate for patients with diabetes undergoing dialysis is higher than that for patients without diabetes undergoing dialysis and is closely related to the severity of cardiovascular problems.

Renal disease is frequently accompanied by advancing retinopathy that may require laser treatments and surgery. Severe hypertension also worsens eye disease because of the additional stress it places on the blood vessels. Patients being treated with hemodialysis who require eye surgery may be changed to peritoneal dialysis and have their hypertension aggressively controlled for several weeks before surgery to prevent bleeding and damage to the retina. The rationale for this change is that hemodialysis requires anticoagulants that can increase the risk of bleeding after the surgery, and peritoneal dialysis minimizes pressure changes in the eyes.

The success rate for kidney transplantation in patients with diabetes has improved. In medical centers performing large numbers of transplantations, the chances are 75% to 80% that the transplanted kidney will continue to function in patients with diabetes for at least 5 years. Like the

original kidneys, transplanted kidneys can eventually be damaged if blood glucose levels are consistently high after the transplantation. Therefore, monitoring blood glucose levels frequently and adjusting insulin levels in patients with diabetes are essential for long-term success of kidney transplantation.

## Diabetic Neuropathies

Diabetic neuropathy refers to a group of diseases that affect all types of nerves, including peripheral (sensorimotor), autonomic, and spinal nerves. The disorders appear to be clinically diverse and depend on the location of the affected nerve cells. The prevalence increases with the age of the patient and the duration of the disease and may be as high as 50% in patients who have had diabetes for 25 years (NIDDK, 2008a).

The etiology of neuropathy may involve elevated blood glucose levels over a period of years. The DCCT results (1993) showed that control of blood glucose levels to normal or near-normal levels decreased the incidence of neuropathy by 60%. The pathogenesis of neuropathy may be attributed to either a vascular or metabolic mechanism or both. Capillary basement membrane thickening and capillary closure may be present. In addition, there may be demyelinization of the nerves, which is thought to be related to hyperglycemia. Nerve conduction is disrupted when there are aberrations of the myelin sheaths.

The two most common types of diabetic neuropathy are sensorimotor polyneuropathy and autonomic neuropathy. Sensorimotor polyneuropathy is also called peripheral neuropathy. Cranial mononeuropathies—those affecting the oculomotor nerve—also occur in diabetes, especially in the elderly.

### Peripheral Neuropathy

Peripheral neuropathy most commonly affects the distal portions of the nerves, especially the nerves of the lower extremities; it affects both sides of the body symmetrically and may spread in a proximal direction.

#### Clinical Manifestations

Although approximately half of patients with diabetic neuropathy do not have symptoms, initial symptoms may include paresthesias (prickling, tingling, or heightened sensation) and burning sensations (especially at night). As the neuropathy progresses, the feet become numb. In addition, a decrease in proprioception (awareness of posture and movement of the body and of position and weight of objects in relation to the body) and a decreased sensation of light touch may lead to an unsteady gait. Decreased sensations of pain and temperature place patients with neuropathy at increased risk for injury and undetected foot infections. Deformities of the foot may also occur; neuropathy-related joint changes produce Charcot joints. These joint deformities result from the abnormal weight distribution on joints resulting from lack of proprioception.

On physical examination, a decrease in deep tendon reflexes and vibratory sensation is found. For patients who have few or no symptoms of neuropathy, these physical findings may be the only indication of neuropathic changes. For patients with signs or symptoms of neuropathy, it is important to rule out other possible causes, including alcohol-induced and vitamin-deficiency neuropathies.

#### Management

The results of the DCCT study (1993) demonstrated that intensive insulin therapy and control of blood glucose levels delay the onset and slow the progression of neuropathy. Pain, particularly of the lower extremities, is a disturbing symptom in some people with neuropathy secondary to diabetes. In some cases, neuropathic pain spontaneously resolves within 6 months; for others, pain persists for many years. Various approaches to pain management can be tried. These include analgesics (preferably nonopioid); tricyclic antidepressants; antiseizure medications (phenytoin [Dilantin], carbamazepine [Tegretol], or gabapentin [Neurontin]); mexiletine (Mexitil, an antiarrhythmic); and transcutaneous electrical nerve stimulation (TENS).

Duloxetine (Cymbalta), an antidepressant medication, has been approved for treatment of peripheral diabetic neuropathy.

### Autonomic Neuropathies

Neuropathy of the autonomic nervous system results in a broad range of dysfunctions affecting almost every organ system of the body (NIDDK, 2008a).

#### Clinical Manifestations

Three manifestations of autonomic neuropathy are related to the cardiac, gastrointestinal, and renal systems. Cardiovascular symptoms range from a fixed, slightly tachycardic heart rate and orthostatic hypotension to silent, or painless, myocardial ischemia and infarction. Delayed gastric emptying may occur with the typical gastrointestinal symptoms of early satiety, bloating, nausea, and vomiting. “Diabetic” constipation or diarrhea (especially nocturnal diarrhea) may occur as a result. In addition, there may be unexplained wide swings in blood glucose levels related to inconsistent absorption of the glucose from ingested foods secondary to the inconsistent gastric emptying.

Urinary retention, a decreased sensation of bladder fullness, and other urinary symptoms of neurogenic bladder result from autonomic neuropathy. The patient with a neurogenic bladder is predisposed to development of urinary tract infections because of the inability to empty the bladder completely. This is especially true of patients with poorly controlled diabetes because hyperglycemia impairs resistance to infection.

**Hypoglycemic Unawareness**

Autonomic neuropathy that affects the adrenal medulla is responsible for diminished or absent adrenergic symptoms of hypoglycemia. Patients may report that they no longer feel the typical shakiness, sweating, nervousness, and palpitations associated with hypoglycemia. Frequent blood glucose monitoring is recommended for these patients. Their inability to detect and treat these warning signs of hypoglycemia puts them at risk for development of dangerously low blood glucose levels. Therefore, their goals for blood glucose levels may need to be adjusted to reduce the risk for hypoglycemia. Patients and families need to be taught to recognize subtle

and atypical symptoms of hypoglycemia, such as numbness around the mouth and impaired ability to concentrate.

#### Sudomotor Neuropathy

The neuropathic condition called sudomotor neuropathy refers to a decrease or absence of sweating (anhidrosis) of the extremities, with a compensatory increase in upper body sweating. Dryness of the feet increases the risk for the development of foot ulcers.

#### Sexual Dysfunction

Sexual dysfunction, especially erectile dysfunction in men, is a complication of diabetes. The effects of autonomic neuropathy on female sexual functioning are not well documented. Reduced vaginal lubrication has been mentioned as a possible neuropathic effect. Other possible changes in sexual function in women with diabetes include decreased libido and lack of orgasm. Vaginal infection, which increases in incidence in women with diabetes, may be associated with decreased lubrication and vaginal pruritus (itching) and tenderness. Urinary tract infections and vaginitis may also affect sexual function.

Impotence (inability of the penis to become rigid and sustain an erection adequate for penetration) occurs with greater frequency in men with diabetes than in other men of the same age. Some men with autonomic neuropathy have normal erectile function and can experience orgasm but do not ejaculate normally. Retrograde ejaculation occurs; seminal fluid is propelled backward through the posterior urethra and into the urinary bladder. Examination of the urine confirms the diagnosis because of the large number of active sperm present. Fertility counseling may be necessary for couples attempting conception.

Diabetic neuropathy is not the only cause of impotence in men with diabetes. Medications such as antihypertensive agents, psychological factors, and other medical conditions (eg, vascular insufficiency) that may affect other men also play a role in impotence in men with diabetes (see Chapter 49).

### Management

Management strategies for autonomic neuropathy focus on alleviating symptoms and on modification and management of risk factors. The prognosis for painless cardiac ischemia is poor. However, detection is important so that education about avoiding strenuous exercise can be provided. Orthostatic hypotension may respond to a diet high in sodium, discontinuation of medications that impede autonomic nervous system responses, use of sympathomimetics and other agents (eg, caffeine) that stimulate an autonomic response, mineralocorticoid therapy, and use of lower-body elastic garments that maximize venous return and prevent pooling of blood in the extremities.

Treatment of delayed gastric emptying includes a low-fat diet, frequent small meals, frequent blood glucose monitoring, and use of agents that increase gastric motility (eg, metoclopramide [Reglan], bethanechol [Myotonachol]). Treatment of diabetic diarrhea may include bulk-forming laxatives or antidiarrheal agents. Constipation is treated with a high-fiber diet and adequate hydration; medications, laxatives, and enemas may be necessary if constipation is severe. Management of sexual dysfunction in women and men is discussed in Chapters 47 and 49, respectively.

Treatment of sudomotor dysfunction focuses on education about skin care and heat intolerance.

## Foot and Leg Problems

Between 50% and 75% of lower extremity amputations are performed on people with diabetes. More than 50% of these amputations are thought to be preventable, provided patients are taught foot care measures and practice them on a daily basis (ADA, 2009b). Complications of diabetes that contribute to the increased risk of foot problems and infections include the following:

- Neuropathy: Sensory neuropathy leads to loss of pain and pressure sensation, and autonomic neuropathy leads to increased dryness and fissuring of the skin (secondary to decreased sweating). Motor neuropathy results in muscular atrophy, which may lead to changes in the shape of the foot.
- Peripheral vascular disease: Poor circulation of the lower extremities contributes to poor wound healing and the development of gangrene.
- Immunocompromise: Hyperglycemia impairs the ability of specialized leukocytes to destroy bacteria. Therefore, in poorly controlled diabetes, there is a lowered resistance to certain infections.

The typical sequence of events in the development of a diabetic foot ulcer begins with a soft tissue injury of the foot, formation of a fissure between the toes or in an area of dry skin, or formation of a callus (Fig. 41-9). Patients with an insensitive foot do not feel injuries, which may be thermal (eg, from using heating pads, walking barefoot on hot concrete, testing bath water with the foot), chemical (eg, burning the foot while using caustic agents on calluses, corns, or bunions), or traumatic (eg, injuring skin while cutting nails, walking with an undetected foreign object in the shoe, or wearing ill-fitting shoes and socks).



**Figure 41-9** Neuropathic ulcers occur on pressure points in areas with diminished sensation in diabetic polyneuropathy. Because pain is absent, the ulcer may go unnoticed.

If the patient is not in the habit of thoroughly inspecting both feet on a daily basis, the injury or fissure may go unnoticed until a serious infection has developed. Drainage, swelling, redness of the leg (from cellulitis), or gangrene may be the first sign of foot problems that the patient notices. Treatment of foot ulcers involves bed rest, antibiotics, and débridement. In addition, controlling glucose levels, which tend to increase when infections occur, is important for promoting wound healing. When peripheral vascular disease is present, foot ulcers may not heal because of the decreased ability of oxygen, nutrients, and antibiotics to reach the injured tissue. Amputation may be necessary to prevent the spread of infection, particularly if it involves the bone (osteomyelitis).

Foot assessment and foot care instructions are most important when caring for patients who are at high risk for foot infections. Some of the high-risk characteristics include:

- Duration of diabetes more than 10 years
- Age older than 40 years
- History of smoking
- Decreased peripheral pulses
- Decreased sensation
- Anatomic deformities or pressure areas (eg, bunions, calluses, hammer toes)
- History of previous foot ulcers or amputation

## Management

Teaching proper foot care is a nursing intervention that can prevent costly and painful complications that result in disability (Chart 41-10). Preventive foot care begins with careful daily assessment of the feet, which should be inspected on a daily basis for any redness, blisters, fissures, calluses, ulcerations, changes in skin temperature, or development of foot deformities (hammer toes, bunions). Visual impairment or decreased joint mobility (especially in the elderly) requires use of a mirror to inspect the bottoms of both feet or the help of a family member in foot inspection. The interior surfaces of shoes should also be inspected for any rough spots or foreign objects (NIDDK, 2008b).

In addition to the daily visual and manual inspection of the feet, the feet should be examined during every health care visit or at least once per year (more often if there is an increase in risk) by a podiatrist, physician, or nurse (ADA, 2009b). All patients should be assessed for neuropathy and undergo evaluation of neurologic status by an experienced examiner using a monofilament device (Fig. 41-10). Pressure areas, such as calluses, or thick toenails should be treated by a podiatrist in addition to routine trimming of nails.

Additional aspects of preventive foot care that are taught to patients and families include the following:

- Properly bathing, drying, and lubricating the feet, taking care not to allow moisture (water or lotion) to accumulate between the toes
- Wearing closed-toed shoes that fit well. A podiatrist can provide the patient with inserts (orthotics) to remove pressure from pressure points on the foot. New shoes should be broken in slowly (ie, worn for 1 to 2 hours initially, with gradual increases in the length of time worn) to avoid blister formation. Patients with bony deformities may need custom-made shoes with extra width or depth. High-risk behaviors, such as walking barefoot, using heating pads on the feet, wearing open-toed shoes, soaking the feet, and shaving calluses, should be avoided.
- Trimming toenails straight across and filing sharp corners to follow the contour of the toe. If the patient has

**CHART 41-10 PATIENT EDUCATION**
### *Foot Care Tips*

1. Take care of your diabetes.
   - Work with your health care team to keep your blood glucose level within a normal range.
2. Inspect your feet every day.
   - Look at your bare feet every day for cuts, blisters, red spots, and swelling.
   - Use a mirror to check the bottoms of your feet or ask a family member for help if you have trouble seeing.
   - Check for changes in temperature.
3. Wash your feet every day.
   - Wash your feet in warm, not hot, water.
   - Dry your feet well. Be sure to dry between the toes.
   - Do not soak your feet.
   - Do not check water temperature with your feet; use a thermometer or elbow.
4. Keep the skin soft and smooth.
   - Rub a thin coat of skin lotion over the tops and bottoms of your feet, but not between your toes.
5. Smooth corns and calluses gently.
   - Use a pumice stone to smooth corns and calluses.
6. Trim your toenails each week or when needed.
   - Trim your toenails straight across and file the edges with an emery board or nail file.
7. Wear shoes and socks at all times.
   - Never walk barefoot.
   - Wear comfortable shoes that fit well and protect your feet.
   - Feel inside your shoes before putting them on each time to make sure the lining is smooth and there are no objects inside.
8. Protect your feet from hot and cold.
   - Wear shoes at the beach or on hot pavement.
   - Wear socks at night if your feet get cold.
9. Keep the blood flowing to your feet.
   - Put your feet up when sitting.
   - Wiggle your toes and move your ankles up and down for 5 minutes, 2 or 3 times a day.
   - Do not cross your legs for long periods of time.
   - Do not smoke.
10. Check with your health care provider.
    - Have your health care provider check your bare feet and find out whether you are likely to have serious foot problems. Remember that you may not feel the pain of an injury.
    - Call your health care provider right away if a cut, sore, blister, or bruise on your foot does not begin to heal after one day.
    - Follow your health care provider's advice about foot care.
    - Do not self-medicate or use home remedies or over-the-counter agents to treat foot problems.

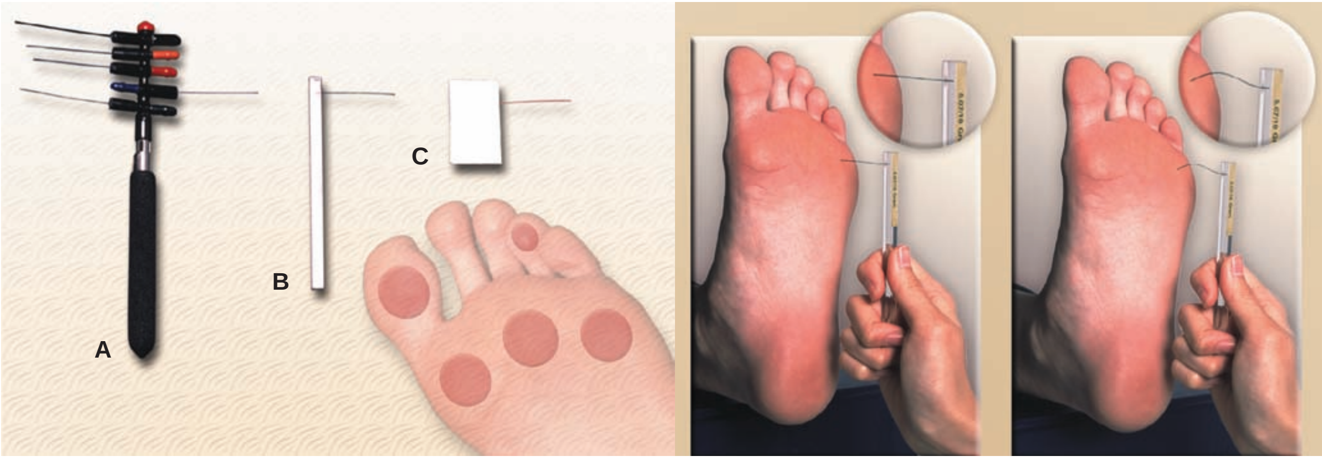



**Figure 41-10** The monofilament test is used to assess the sensory threshold in patients with diabetes. The test instrument—a monofilament—is gently applied to about five pressure points on the foot (as shown in image on *left*). **A,** Example of a monofilament used for advanced quantitative assessment. **B,** Semmes-Weinstein monofilament used by clinicians. **C,** Disposable monofilament used by patients. The examiner applies the monofilament to the test area to determine whether the patient feels the device. (Adapted with permission from Cameron, B. L. (2002). Making diabetes management routine. *American Journal of Nursing, 102*(2), 26–32.)

visual deficits, is unable to reach the feet because of disability, or has thickened toenails, a podiatrist should cut the nails.

- Reducing risk factors, such as smoking and elevated blood lipids, that contribute to peripheral vascular disease.
- Avoiding home remedies, over-the-counter agents, and self-medicating to treat foot problems.

Blood glucose control is important for avoiding decreased resistance to infections and for preventing diabetic neuropathy.

## SPECIAL ISSUES IN DIABETES CARE

### Patients With Diabetes Who Are Undergoing Surgery

During periods of physiologic stress, such as surgery, blood glucose levels tend to increase, because levels of stress hormones (epinephrine, norepinephrine, glucagon, cortisol, and growth hormone) increase. If hyperglycemia is not controlled during surgery, the resulting osmotic diuresis may lead to excessive loss of fluids and electrolytes. Patients with type 1 diabetes also risk developing ketoacidosis during periods of stress.

Hypoglycemia is also a concern in patients with diabetes who are undergoing surgery. For example, this is a special concern during the preoperative period if surgery is delayed beyond the morning in a patient who received a morning injection of intermediate-acting insulin.

There are various approaches to managing glucose control during the perioperative period. Frequent blood glucose monitoring is essential throughout the preoperative and postoperative periods, regardless of the method used for glucose control. Examples of these approaches are described in Chart 41-11. The use of IV insulin and dextrose has become widespread with the increased availability of meters for intraoperative glucose monitoring.

During the postoperative period, patients with diabetes must also be closely monitored for cardiovascular complications because of the increased prevalence of atherosclerosis, wound infections, and skin breakdown (especially in patients with decreased sensation in the extremities due to neuropathy). Maintaining adequate nutrition and blood glucose control promote wound healing.

### Management of Hospitalized Patients With Diabetes

At any one time, 10% to 20% of hospitalized general medical-surgical patients have diabetes. This number may increase as elderly patients make up an increasing proportion of the hospitalized population. Often diabetes is not the primary medical diagnosis, yet problems with control of diabetes frequently result from changes in the patient's normal routine or from surgery or illness. During the course of treatment for the primary medical diagnosis, blood glucose control may worsen. In addition, the only opportunity for some patients with diabetes to update their knowledge about diabetes self-care and prevention of complications may be during hospitalization. It is important for nurses caring for patients with diabetes to focus attention on the diabetes as well as the primary health issue. Control of blood glucose levels is important because hyperglycemia impairs resistance to certain infections and impedes wound healing.

#### Self-Care Issues

For patients who are actively involved in diabetes self-management (especially insulin dose adjustment), relinquishing control over meal timing, insulin timing, and insulin dosage can be particularly difficult and anxiety provoking. The patient may fear hypoglycemia and express much concern over possible delays in receiving attention from the nurse if hypoglycemic symptoms occur or may disagree with a planned dose of insulin.

## Chart 41-11 • *Approaches to Management of Glucose Control During the Perioperative Period*

- Monitor blood glucose levels frequently (every 1 to 2 h).
- For patients taking insulin
  1. The morning of surgery, all subcutaneous insulin doses are withheld, unless the blood glucose level is elevated (eg, >200 mg/dL [11.1 mmol/L]), in which case a small dose of subcutaneous regular insulin may be prescribed. The blood glucose level is controlled during surgery with the IV infusion of regular insulin, which is balanced by an infusion of dextrose. The insulin and dextrose infusion rates are adjusted according to frequent (hourly) capillary glucose determinations. After surgery, the insulin infusion may be continued until the patient can eat. If IV insulin is discontinued, subcutaneous regular insulin may be administered at set intervals (every 4–6 h), or intermediate-acting insulin may be administered every 12 h with supplemental regular insulin as necessary until the patient is eating and the usual pattern of insulin dosing is resumed.
     - Carefully monitor the insulin infusion rate and blood glucose levels in a patient with diabetes who is receiving IV insulin. IV insulin has a much shorter duration of action than subcutaneous insulin. If the infusion is interrupted or discontinued, hyperglycemia will develop rapidly (within 1 h in type 1 diabetes and within a few hours in type 2 diabetes).
     - Ensure that subcutaneous insulin is administered 30 min before the IV insulin infusion is discontinued.
  2. One half to two thirds of the patient's usual morning dose of insulin (either intermediate-acting insulin alone or both short-act and intermediate-acting insulins) is administered subcutaneously in the morning before surgery. The remainder is then administered after surgery.
  3. The patient's usual daily dose of subcutaneous insulin is divided into four equal doses of regular insulin. These are then administered at 6-h intervals. The last two approaches do not provide the control achieved by IV administration of insulin and dextrose.
- Patients with type 2 diabetes who do not usually take insulin may require insulin during the perioperative period to control blood glucose elevations. Patients who are taking metformin may be instructed to discontinue the oral agent 24 to 48 h before surgery, if possible. Some of these patients may resume their usual regimen of diet and oral agent during the recovery period. Other patients (whose diabetes is probably not well controlled with diet and an oral antidiabetic agent before surgery) need to continue with insulin injections after discharge.
- For patients with type 2 diabetes who are undergoing minor surgery but who do not normally take insulin, glucose levels may remain stable provided no dextrose is infused during the surgery. After surgery, these patients may require small doses of regular insulin until the usual diet and oral agent are resumed.

It is important for the nurse to acknowledge the patient's concerns and involve the patient in the plan of care as much as possible. If the patient disagrees with certain aspects of the nursing or medical care related to diabetes, the nurse must communicate this to other members of the health care team. Nurses and other health care providers must pay particular attention to patients who are successful in managing self-care; they should assess these patients' self-care management skills and encourage them to continue if their performance is correct and effective.

Hospitalization of a patient with diabetes should be considered an opportunity to evaluate the patient's self-care skills and to reinforce teaching that might be needed. The nurse observes the patient preparing and injecting the insulin, monitoring blood glucose, and performing foot care. (Simply questioning the patient about these skills without actually observing performance of the skills is not sufficient.) The patient's knowledge about diet can be assessed with the help of a dietitian through direct questioning and review of the patient's menu choices. The patient's understanding about signs and symptoms, treatment, and prevention of hypoglycemia and hyperglycemia is assessed, along with knowledge of risk factors for macrovascular disease, including hypertension, increased lipids, and smoking. In addition, the patient is asked the date of his or her last eye examination (including dilation of the pupils). Teaching about these issues is critical.

### Hyperglycemia During Hospitalization

Hyperglycemia may occur in hospitalized patients as a result of the original illness that led to the need for hospitalization. A number of other factors may contribute to hyperglycemia; examples include:

- Changes in the usual treatment regimen (eg, increased food, decreased insulin, decreased activity)
- Medications (eg, corticosteroids such as prednisone, which are used in the treatment of a variety of inflammatory disorders)
- IV dextrose, which may be part of the maintenance fluids or may be used for the administration of antibiotics and other medications, without adequate insulin therapy
- Overly vigorous treatment of hypoglycemia
- Inappropriate withholding of insulin or inappropriate use of "sliding scales"
- Mismatched timing of meals and insulin (eg, postmeal hyperglycemia may occur if short-acting insulin is administered immediately before or even after a meal)

Nursing actions to correct some of these factors are important for avoiding hyperglycemia. Assessment of the patient's usual home routine is important. The nurse should try to approximate as much as possible the home schedule of insulin, meals, and activities. Monitoring blood glucose levels has been identified by the ADA as an additional "vital sign" essential in assessment of patients (ADA, 2009b). The results of blood glucose monitoring provide information needed to obtain orders for extra doses of insulin (at times when insulin is usually taken), an important nursing function. Insulin doses must not be withheld when blood glucose levels are normal.

Short-acting insulin is usually needed to avoid postprandial hyperglycemia (even in patients with normal premeal glucose levels), and NPH insulin does not peak until many hours after the dose is given. IV antibiotics should be mixed

CHART 41-12 **NURSING RESEARCH PROFILE**

***Hypoglycemia in Hospitalized Patients With Diabetes***

Anthony, M. (2007). Treatment of hypoglycemia in hospitalized adults, A descriptive study. *The Diabetes Educator, 33*(4), 709–715.

**Purpose**

Diabetes mellitus is a primary or secondary reason for over 24 million days spent in the hospital. The goal of achieving normal blood glucose levels is a challenge in hospitalized patients but has the potential to improve patient outcomes. This goal may, however, result in increased risk of hypoglycemia in patients with diabetes who are hospitalized. The purpose of this study was to describe the treatment of hypoglycemia in two Midwestern hospitals to determine patterns and adherence to policies and procedures.

**Design**

A retrospective chart audit was conducted on 210 patients who had experienced hypoglycemia while hospitalized. The purpose of the audit was to examine adherence to five steps identified in hospital policies and procedures for treatment of hypoglycemia. The five steps were: (1) administer 15 g of carbohydrates, (2) retest blood glucose in 15 minutes, (3) retest in 1 hour, (4) notify the physician, and (5) document the event in the patient's record. A checklist of expected behaviors was derived from the practice manual and used as the evaluation tool.

**Findings**

A total of 484 episodes of hypoglycemia in 105 patients at two hospitals were analyzed. Hypoglycemia was defined as a blood glucose level of less than 70 mg/dL. Adherence to practice guidelines for treatment of hypoglycemia was low. There was not one case where all five steps were followed. The adherence ranged from 2.1% for the 1-hour retest to a high of 70.9% for documentation.

**Nursing Implications**

Nursing policy and procedures are put in place to ensure that a standard of care is followed for patient safety. The treatment of hypoglycemia is an important patient safety issue because severe hypoglycemia can threaten the patient's well-being and lead to seizures, coma, or a fall. Following guidelines provides for the treatment of the condition and a return of blood glucose levels to normal without causing hyperglycemia. Although it is possible that all five steps of the guidelines were taken but not documented, if actions are not documented it is assumed that the actions were not taken. The findings indicate that staff education is needed to increase the likelihood that important guidelines are followed to improve patient safety and prevent catastrophic outcomes.

in normal saline (if possible) to avoid excess infusion of dextrose (especially in patients who are eating). It is important to avoid overly vigorous treatment of hypoglycemia, which may lead to hyperglycemia.

## Hypoglycemia During Hospitalization

Hypoglycemia in hospitalized patients is usually the result of too much insulin or delays in eating (Chart 41-12). Specific examples include:

- Overuse of "sliding scale" regular insulin, particularly as a supplement to regularly scheduled, twice-daily short-acting and intermediate-acting insulins
- Lack of change in insulin dosage when dietary intake is changed (eg, in the patient taking nothing by mouth [NPO])
- Overly vigorous treatment of hyperglycemia (eg, giving too-frequent successive doses of regular insulin before the time of peak insulin activity is reached), resulting in a cumulative effect
- Delayed meal after administration of lispro, aspart, or glulisine [Apidra] insulin (the patient should eat within 5 to 15 minutes after insulin administration)

Treatment of hypoglycemia should be based on the established hospital protocol. If the initial treatment does not increase the glucose level adequately, the same treatment may be repeated after 15 minutes. The nurse must assess the pattern of glucose values and avoid giving doses of insulin that repeatedly lead to hypoglycemia. Successive doses of subcutaneous regular insulin should be administered no more frequently than every 3 to 4 hours. For patients receiving NPH or Lente insulin before breakfast and dinner, the nurse must use caution in administering supplemental doses of regular insulin at lunch and bedtime. Hypoglycemia may occur when two insulins peak at similar times (eg, morning NPH peaks with lunchtime regular insulin and may lead to late-afternoon hypoglycemia; dinnertime NPH peaks with bedtime regular insulin and may lead to nocturnal hypoglycemia). To avoid hypoglycemic reactions caused by delayed food intake, the nurse should arrange for snacks to be given to the patient if meals are going to be delayed because of procedures, physical therapy, or other activities.

## Common Alterations in Diet

Dietary modifications commonly prescribed during hospitalization require special consideration for patients who have diabetes (ADA, 2008b).

### *Nothing by Mouth*

For patients who must be NPO in preparation for diagnostic or surgical procedures, the nurse must ensure that the usual insulin dosage has been changed. These changes may include eliminating the rapid-acting insulin and giving a decreased amount (eg, half the usual dose) of intermediate-acting NPH or Lente insulin. Another approach is to use frequent (every 3 to 4 hours) dosing of rapid-acting insulin only. IV dextrose may be administered to provide calories and to avoid hypoglycemia.

Even without food, glucose levels may increase as a result of hepatic glucose production, especially in patients with type 1 diabetes and lean patients with type 2 diabetes. Furthermore, in type 1 diabetes, elimination of the insulin dose may lead to the development of DKA. Therefore, administration of insulin to patients with type 1 diabetes who are NPO is an important nursing action.

For patients with type 2 diabetes who are taking insulin, DKA does not usually develop when insulin doses are eliminated because the patient's pancreas produces some insulin. Therefore, skipping the insulin dose altogether (when the patient is receiving IV dextrose) may be safe; however, close monitoring of blood glucose levels is essential.

For patients who are NPO for extended periods (24 hours), glucose testing and insulin administration should be performed at regular intervals, usually four times per day. Insulin regimens for the patient who is NPO for an extended period may include NPH insulin every 12 hours (with rapid-acting insulin added to the NPH, depending on the results of glucose testing) or rapid-acting insulin only every 4 to 6 hours. These patients should receive dextrose infusions to provide some calories and limit ketosis.

To prevent the problems that result from the need to withhold food, diagnostic tests and procedures and surgery should be scheduled early in the morning if possible.

### Clear Liquid Diet

When the diet is advanced to include clear liquids, patients with diabetes receive more simple carbohydrate foods, such as juice and gelatin desserts, than are usually included in the diabetic diet. It is important for hospitalized patients to maintain their nutritional status as much as possible to promote healing. Therefore, the use of reduced-calorie substitutes such as diet soda or diet gelatin desserts would not be appropriate when the only source of calories is clear liquids. Simple carbohydrates, if eaten alone, cause a rapid rise in blood glucose levels; therefore, it is important to try to match peak times of insulin effect with peaks in the blood glucose concentration. If the patient receives insulin at regular intervals while NPO, the scheduled times for glucose tests and insulin injections must match meal times.

### Enteral Tube Feedings

Tube feeding formulas contain more simple carbohydrates and less protein and fat than the typical meal plan for diabetes. This results in increased levels of glucose in patients with diabetes who are receiving tube feedings. It is important that insulin doses be administered at regular intervals (eg, NPH every 12 hours or regular insulin every 4 to 6 hours) when continuous tube feedings are administered. If insulin is administered at routine (prebreakfast and predinner) times, hypoglycemia during the day may result (because the patient receives more insulin without more calories); and hyperglycemia may occur during the night if feedings continue but insulin action decreases.

A common cause of hypoglycemia in patients receiving both continuous tube feedings and insulin is inadvertent or purposeful discontinuation of the feeding. The nurse must discuss with the medical team any plans for temporarily discontinuing the tube feeding (eg, when the patient is away from the unit). Planning ahead may allow for alterations to be made in the insulin dose or for administration of IV dextrose. In addition, if problems with the tube feeding develop unexpectedly (eg, the patient pulls out the tube, the tube clogs, the feeding is discontinued when residual gastric contents are found), the nurse must notify the physician, assess blood glucose levels more frequently, and administer IV dextrose if indicated.

### Parenteral Nutrition

Patients receiving parenteral nutrition may receive both IV insulin (added to the parenteral nutrition container) and subcutaneous intermediate-acting or short-acting insulins. If the patient is receiving continuous parenteral nutrition, the blood glucose level should be monitored and insulin administered at regular intervals. If the parenteral nutrition is infused over a limited number of hours, subcutaneous insulin should be administered so that peak times of insulin action coincide with times of parenteral nutrition infusion.

## Hygiene

Nurses caring for hospitalized patients with diabetes must focus attention on oral hygiene and skin care. Because these patients are at increased risk for periodontal disease, it is important for the nurse to assist the patient with daily dental care. The patient may also require assistance in keeping the skin clean and dry, especially in areas of contact between two skin surfaces (eg, groin, axilla, under the breasts), where chafing and fungal infections tend to occur.

Careful assessment of the skin, especially at pressure points and on the lower extremities, is important. The skin is assessed for dryness, cracks, skin breakdown, and redness. The patient is asked about symptoms of neuropathy, such as tingling and pain or numbness of the feet. Deep tendon reflexes are assessed.

As with any patient confined to bed, nursing care must emphasize the prevention of skin breakdown at pressure points. The heels are particularly susceptible to breakdown because of loss of sensation of pain and pressure associated with sensory neuropathy.

Feet should be cleaned, dried, lubricated with lotion (but not between the toes), and inspected frequently. If the patient is in the supine position, pressure on the heels can be alleviated by elevating the lower legs on a pillow, with the heels positioned over the edge of the pillow. When the patient is seated in a chair, the feet should be positioned so that pressure is not placed on the heels. If the patient has an ulcer on one foot, it is important to provide preventive care to the unaffected foot as well as special care of the affected foot.

As always, every opportunity should be taken to teach the patient about diabetes self-management, including daily oral, skin, and foot care. Female patients should also be instructed about measures for the avoidance of vaginal infections, which occur more frequently when blood glucose levels are elevated. Patients often take their cues from nurses and realize the importance of daily personal hygiene if this is emphasized during their hospitalization.

## Stress

Physiologic stress, such as infections and surgery, contributes to hyperglycemia and may precipitate DKA or HHNS. Emotional stress related to hospitalization for any reason can also have a negative impact on diabetic control. An increase in stress hormones leads to an increase in glucose levels, especially if intake of food and insulin remains unchanged. In addition, during periods of emotional stress,

people with diabetes may alter their usual pattern of meals, exercise, and medication. This can contribute to hyperglycemia or even hypoglycemia (eg, in the patient taking insulin or oral antidiabetic agents who stops eating in response to stress).

People with diabetes must be made aware of the potential deterioration in diabetic control that can accompany emotional stress. They must be encouraged to follow the diabetes treatment plan as much as possible during times of stress. In addition, learning strategies for minimizing stress and coping with stress when it does occur are important aspects of diabetes education. Healthy coping is one of the seven steps to managing diabetes identified by the AADE (2007).

## Gerontologic Considerations

Because people with diabetes are living longer, both type 1 and type 2 diabetes are being seen more frequently in elderly patients hospitalized for various reasons. Regardless of the type or duration of diabetes, the goals of diabetes treatment may need to be altered when caring for hospitalized elderly patients. The focus is on quality-of-life issues, such as maintaining independent functioning and promoting general well-being.

Some of the barriers to learning and self-care during hospital stays and in preparing patients for discharge include decreased vision, hearing loss, memory deficits, decreased mobility and fine motor coordination, increased tremors, depression and isolation, decreased financial resources, and limitations related to disabilities and other medical disorders. Assessing these barriers is important in planning diabetes treatment and educational activities. Presenting brief, simplified instructions with ample opportunity for practice of skills is important. The use of special devices such as a magnifier for the insulin syringe, an insulin pen, or a mirror for foot inspection is helpful. Frequent evaluation of self-care skills (insulin administration, blood glucose monitoring, foot care, diet planning) is essential, especially in patients with deteriorating vision and memory.

If appropriate, family members may be called on to assist with diabetes survival skills, and referral to community resources may be made. It is preferable to teach the patient or family members to test blood glucose at home; the choice of meter should be tailored to the patient's visual and cognitive status and dexterity.

> *NURSING ALERT*
>
> **Careful monitoring for diabetes complications must not be neglected in elderly patients. Hypoglycemia is especially dangerous, because it may go undetected and result in falls. Dehydration is a concern in patients who have chronically elevated blood glucose levels. Assessment for long-term complications, especially eye and foot problems, is important. Avoiding blindness and amputation through early detection and treatment of retinopathy and foot ulcers may mean the difference between placement in a long-term care facility and continued independent living for the elderly person with diabetes.**

## Monitoring and Managing Potential Complications

Assessment for hypoglycemia and hyperglycemia involves frequent blood glucose monitoring (usually prescribed before meals and at bedtime) and monitoring for signs and symptoms of hypoglycemia or prolonged hyperglycemia (including DKA or HHNS), as described previously. Inadequate control of blood glucose levels may hinder recovery from the primary health problem. Blood glucose levels are monitored, and insulin is administered as prescribed. It is important for the nurse to ensure that prescribed insulin dosage is modified as needed to compensate for changes in the patient's schedule or eating pattern. Treatment is given for hypoglycemia (with oral glucose) or hyperglycemia (with supplemental regular insulin no more often than every 3 to 4 hours). Blood glucose records are assessed for patterns of hypoglycemia and hyperglycemia at the same time of day, and findings are reported to the physician for modification in insulin orders. In the patient with prolonged elevations in blood glucose, laboratory values and the patient's physical condition are monitored for signs and symptoms of DKA or HHNS.

## Promoting Home and Community-Based Case

### *Teaching Patients Self-Care*

Even if the patient has had diabetes for many years, it is important to assess his or her knowledge and adherence to the plan of care. A new plan of care may need to be devised using concepts mentioned earlier. The nurse also reminds the patient and family about the importance of health promotion activities and recommended health screening.

### *Continuing Care*

A patient who is hospitalized may require referral for home care. The home care nurse can use this opportunity to assess the patient's knowledge about diabetes management and the patient's and family's ability to carry out that management. The nurse reinforces the teaching provided in the hospital, clinic, office, or diabetes education center and assesses the home care environment to determine its adequacy for self-care and safety.

# CRITICAL THINKING EXERCISES

**1** A 35-year-old pregnant woman with type 2 diabetes is admitted to the hospital for an elective Caesarean section. What modifications in her diabetes care are needed before, during, and after her Caesarean section? How would her care differ if she had type 1 diabetes?

EBP **2** A 25-year-old patient is newly diagnosed with type 1 diabetes. His physician has discussed intensive insulin therapy with him, although the patient indicates that he needs more information about the advantages and disadvantages of intensive therapy before he can make a decision about therapy. What is the evidence base for intensive insulin therapy and the strength of that evidence?

How would you present information to him about the advantages and disadvantages of intensive therapy?

**3** You are the nurse in a diabetes education center with many patients with type 1 and type 2 diabetes. Identify strategies you would use to provide diabetes education for the following patients: (1) a patient who has managed her diabetes well for 20 years, but has recently been prescribed insulin for the first time, (2) a patient who has cerebral palsy that affects her lower extremities and one hand, (3) a patient who speaks very little English, and (4) a patient who is angry and resentful that he has developed diabetes.

**4** You are providing discharge instructions for a 55-year-old executive being discharged from the hospital after carotid endarterectomy and cardiac artery bypass surgery. He indicates that although he has had diabetes for 10 years, he has only "a little diabetes" because until recently he has not required insulin. He is a smoker and travels extensively. Develop a teaching plan for this patient and identify the priorities of teaching for him.

**5** A 68-year-old woman who was found at home unresponsive by her neighbors is admitted to the emergency department with possible diabetic ketoacidosis. She is well known to the emergency department personnel because of repeated episodes of hypoglycemia in the past. Compare the pathophysiology and signs and symptoms of diabetic ketoacidosis and hypoglycemia. How would assessment, medical management, and nursing care for these two disorders compare? What would be your priorities for patient teaching once she has recovered from the acute medical problem?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

## REFERENCES AND SELECTED READINGS

**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

### Books


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## RESOURCES

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American Diabetes Association, www.diabetes.org
American Dietetic Association, www.eatright.org
American Foundation for the Blind, www.afb.org
Armchair Fitness Series, CC-M Productions, Inc. 7755 16th Street, NW, District of Columbia, Washington, 20012. http://armchairfitness.stores.yahoo.net/index.html.
Centers for Disease Control and Prevention, www.cdc.gov/diabetes/pubs/factsheet.htm
Juvenile Diabetes Research Foundation International, www.jdrf.org
MedicAlert Foundation International, www.medicalert.org
National Diabetes Information Clearinghouse, www.niddk.nih.gov
National Library Services for the Blind and Physically Handicapped (NLSBPH), www.loc.gov/nls/



# chapter 42

# Assessment and Management of Patients With Endocrine Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the functions of each of the endocrine glands and their hormones.
2. Identify the diagnostic tests used to determine alterations in function of each of the endocrine glands.
3. Compare hypothyroidism and hyperthyroidism: their causes, clinical manifestations, management, and nursing interventions.
4. Develop a plan of nursing care for the patient undergoing thyroidectomy.
5. Compare hyperparathyroidism and hypoparathyroidism: their causes, clinical manifestations, management, and nursing interventions.
6. Compare Addison's disease with Cushing's syndrome: their causes, clinical manifestations, management, and nursing interventions.
7. Describe nursing management of patients with adrenal insufficiency.
8. Use the nursing process as a framework for care of patients with Cushing's syndrome.
9. Identify the teaching needs of patients requiring corticosteroid therapy.

## GLOSSARY

**acromegaly:** disease process resulting from excessive secretion of somatotropin; causes progressive enlargement of peripheral body parts
**addisonian crisis:** acute adrenocortical insufficiency; characterized by hypotension, cyanosis, fever, nausea/vomiting, and classic signs of shock; precipitated by stress or abrupt withdrawal of therapeutic glucocorticoids
**Addison's disease:** chronic adrenocortical insufficiency secondary to destruction of the adrenal glands
**adrenalectomy:** surgical removal of one or both adrenal glands
**adrenocorticotropic hormone (ACTH):** hormone secreted by the anterior pituitary, essential for growth and development
**adrenogenital syndrome:** masculinization in women, feminization in men, or premature sexual development in children; result of abnormal secretion of adrenocortical hormones, especially androgens
**androgens:** hormones secreted by the adrenal cortex; stimulate activity of accessory male sex organs and development of male sex characteristics
**basal metabolic rate:** chemical reactions occurring when the body is at rest
**calcitonin:** hormone secreted by the parafollicular cells of the thyroid gland; participates in calcium regulation
**Chvostek's sign:** spasm of the facial muscles produced by sharply tapping over the facial nerve in front of the parotid gland and anterior to the ear; suggestive of latent tetany in patients with hypocalcemia
**corticosteroids:** hormones produced by the adrenal cortex or their synthetic equivalents; also referred to as adrenal-cortical hormone and adrenocorticosteroid; consist of glucocorticoids, mineralocorticoids, and androgens
**cretinism:** stunted body growth and mental development appearing during the first year of life as a result of congenital hypothyroidism
**Cushing's syndrome:** group of symptoms produced by an excess of free circulating cortisol from the adrenal cortex; characterized by truncal obesity, "moon face," acne, abdominal striae, and hypertension

## GLOSSARY *(Continued)*

**diabetes insipidus:** condition in which abnormally large volumes of dilute urine are excreted as a result of deficient production of vasopressin
**dwarfism:** generalized limited growth resulting from insufficient secretion of growth hormone during childhood
**endocrine:** secreting internally; hormonal secretion of a ductless gland
**euthyroid:** state of normal thyroid hormone production
**exocrine:** secreting externally; hormonal secretion from excretory ducts
**exophthalmos:** abnormal protrusion of one or both eyeballs
**glucocorticoids:** steroid hormones secreted by the adrenal cortex in response to ACTH; produce a rise of liver glycogen and blood glucose
**goiter:** enlargement of the thyroid gland; usually caused by an iodine-deficient diet
**Graves' disease:** a form of hyperthyroidism; characterized by a diffuse goiter and exophthalmos
**hormones:** chemical transmitter substances produced in one organ or part of the body and carried by the bloodstream to other cells or organs on which they have a specific regulatory effect; produced mainly by endocrine glands
**hypophysectomy:** removal or destruction of all or part of the pituitary gland
**mineralocorticoid:** steroid of the adrenal cortex
**myxedema:** severe hypothyroidism characterized by an accumulation of mucopolysaccharides in interstitial tissues, a masklike expression, puffy eyelids, loss of eyebrow hair, thick lips, and a broad tongue
**negative feedback:** regulating mechanism in which an increase or decrease in the level of a substance decreases or increases the function of the organ producing the substance
**oxytocin:** hormone secreted by the posterior pituitary; causes myometrial contraction at term and milk release during lactation
**pheochromocytoma:** chromaffin cell tumor, usually benign, located in the adrenal medulla; characterized by secretion of catecholamines resulting in hypertension, severe headache, profuse sweating, visual blurring, anxiety, and nausea
**syndrome of inappropriate antidiuretic hormone (SIADH) secretion:** excessive secretion of antidiuretic hormone (ADH) from the pituitary gland despite low serum osmolality level
**thyroidectomy:** surgical removal of all or part of the thyroid gland
**thyroiditis:** inflammation of the thyroid gland; may lead to chronic hypothyroidism or may resolve spontaneously
**thyroid-stimulating hormone:** released from the pituitary gland; causes stimulation of the thyroid, resulting in release of T3 and T4
**thyroid storm:** severe life-threatening hyperthyroidism precipitated by stress; characterized by high fever, extreme tachycardia, and altered mental state
**thyrotoxicosis:** condition produced by excessive endogenous or exogenous thyroid hormone
**thyroxine ($T_4$):** thyroid hormone; active iodine compound formed and stored in the thyroid; deiodinated in peripheral tissues to form triiodothyronine; maintains body metabolism in a steady state
**triiodothyronine ($T_3$):** thyroid hormone; formed and stored in the thyroid; released in smaller quantities, biologically more active and with faster onset of action than $T_4$; widespread effect on cellular metabolism
**Trousseau's sign:** carpopedal spasm induced when blood flow to the arm is occluded using a blood pressure cuff or tourniquet, causing ischemia to the distal nerves; suggestive sign for latent tetany in hypocalcemia
**vasopressin:** ADH secreted by the posterior pituitary; causes contraction of smooth muscle, particularly blood vessels

The endocrine system plays a vital role in growth and development, the metabolism of energy, muscle and adipose tissue distribution, sexual development, fluid and electrolyte balance, and inflammation and immune responses (Porth & Matfin, 2009). This interconnected network of glands is closely linked with the nervous and immune systems regulating the functions of multiple body organs. Disorders of the endocrine system are common and are manifested as hyperfunction and hypofunction.

Nursing interventions are essential in the management of patients with endocrine disorders. This chapter focuses on the anatomy and physiology of the endocrine system; the most common endocrine disorders of the pituitary, thyroid, parathyroid, and adrenal glands; clinical manifestations; diagnostic studies; medical management; and nursing interventions. The unique endocrine and exocrine functions of the pancreas, pancreatic function, and associated pancreatic disorders are discussed in Chapters 40 and 41, and reproductive structures, including the ovaries and testes, are discussed in Chapters 46 and 49.

# ASSESSMENT OF THE ENDOCRINE SYSTEM

## *Anatomic and Physiologic Overview*

The **endocrine** system involves the release of chemical substances known as **hormones** to regulate and integrate body functions. Generally, these hormones are produced by the endocrine glands, but some are also produced by other tissues. The gastrointestinal (GI) mucosa produces hormones (eg, gastrin, enterogastrone, secretin, cholecystokinin) that are important in the digestive process; the kidneys produce erythropoietin, a hormone that stimulates the bone marrow to produce red blood cells; and the white blood cells produce cytokines (hormonelike proteins) that actively participate in inflammatory and immune responses.

The immune system and the nervous system have unique relationships with the endocrine system. Chemicals such as neurotransmitters (eg, epinephrine) released by the nervous system can also function as hormones when needed. The immune system responds to the introduction of foreign agents by means of chemical messengers (cytokines), which are hormonelike proteins, while it is also subject to regulation by adrenal corticosteroid hormones (Porth & Matfin, 2009).

### Glands of the Endocrine System

The endocrine system is composed of several glands: the pituitary, the thyroid gland, parathyroid glands, adrenal glands, pancreatic islets, ovaries, and testes (Fig. 42-1). Unlike the **exocrine** glands, most hormones secreted from endocrine glands are released directly into the bloodstream. Exocrine glands, such as sweat glands, secrete their products through ducts onto epithelial surfaces or into the GI tract.

### Function and Regulation of Hormones

Hormones help regulate organ function in concert with the nervous system. This dual regulatory system, in which rapid action by the nervous system is balanced by slower hormonal action, permits precise control of organ functions in

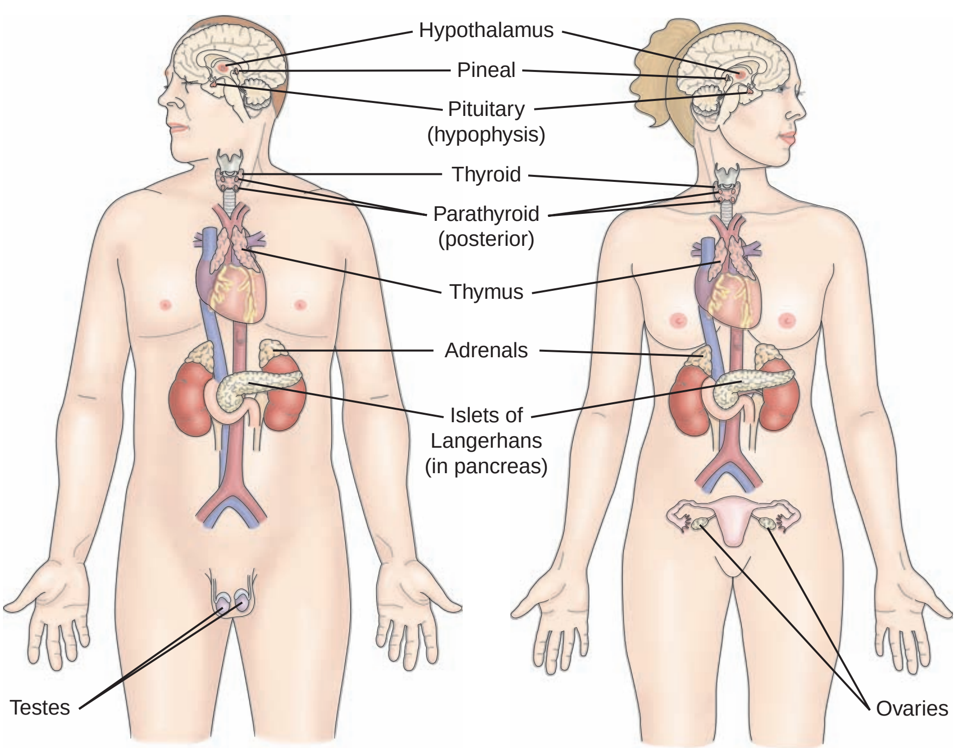



**Figure 42-1** Major hormone-secreting glands of the endocrine system.

**Table 42-1 MAJOR ACTION AND SOURCE OF SELECTED HORMONES**

| Source | Hormone | Major Action |
|---|---|---|
| Hypothalamus | Releasing and inhibiting hormones<br>Corticotropin-releasing hormone (CRH)<br>Thyrotropin-releasing hormone (TRH)<br>Growth hormone–releasing hormone (GHRH)<br>Gonadotropin–releasing hormone (GnRH) | Controls the release of pituitary hormones |
| | Somatostatin | Inhibits growth hormone and thyroid-stimulating hormone |
| Anterior pituitary | Growth hormone (GH) | Stimulates growth of bone and muscle, promotes protein synthesis and fat metabolism, decreases carbohydrate metabolism |
| | Adrenocorticotropic hormone (ACTH) | Stimulates synthesis and secretion of adrenal cortical hormones |
| | Thyroid-stimulating hormone (TSH) | Stimulates synthesis and secretion of thyroid hormone |
| | Follicle-stimulating hormone (FSH) | Female: stimulates growth of ovarian follicle, ovulation<br>Male: stimulates sperm production |
| | Luteinizing hormone (LH) | Female: stimulates development of corpus luteum, release of oocyte, production of estrogen and progesterone<br>Male: stimulates secretion of testosterone, development of interstitial tissue of testes |
| | Prolactin | Prepares female breast for breast-feeding |
| Posterior pituitary | Antidiuretic hormone (ADH) | Increases water reabsorption by kidney |
| | Oxytocin | Stimulates contraction of pregnant uterus, milk ejection from breasts after childbirth |
| Adrenal cortex | Mineralocorticosteroids, mainly aldosterone | Increase sodium absorption, potassium loss by kidney |
| | Glucocorticoids, mainly cortisol | Affect metabolism of all nutrients; regulates blood glucose levels, affects growth, has anti-inflammatory action, and decreases effects of stress |
| | Adrenal androgens, mainly dehydroepiandrosterone (DHEA) and androstenedione | Have minimal intrinsic androgenic activity; they are converted to testosterone and dihydrotestosterone in the periphery |
| Adrenal medulla | Epinephrine<br>Norepinephrine | Serve as neurotransmitters for the sympathetic nervous system |
| Thyroid (follicular cells) | Thyroid hormones: triiodothyronine ($T_3$), thyroxine ($T_4$) | Increase the metabolic rate; increase protein and bone turnover; increase responsiveness to catecholamines; necessary for fetal and infant growth and development |
| Thyroid C cells | Calcitonin | Lowers blood calcium and phosphate levels |
| Parathyroid glands | Parathormone (PTH, parathyroid hormone) | Regulates serum calcium |
| Pancreatic islet cells | Insulin | Lowers blood glucose by facilitating glucose transport across cell membranes of muscle, liver, and adipose tissue |
| | Glucagon | Increases blood glucose concentration by stimulation of glycogenolysis and glyconeogenesis |
| | Somatostatin | Delays intestinal absorption of glucose |
| Kidney | 1,25-Dihydroxyvitamin D | Stimulates calcium absorption from the intestine |
| | Renin | Activates renin–angiotensin–aldosterone system |
| | Erythropoietin | Increases red blood cell production |
| Ovaries | Estrogen | Affects development of female sex organs and secondary sex characteristics |
| | Progesterone | Influences menstrual cycle; stimulates growth of uterine wall; maintains pregnancy |
| Testes | Androgens, mainly testosterone | Affect development of male sex organs and secondary sex characteristics; aid in sperm production |

Reproduced with permission from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

response to varied changes within and outside the body. Table 42-1 lists the major hormones, their target tissues, and some of their properties.

The endocrine glands are composed of secretory cells arranged in minute clusters known as acini. No ducts are present, but the glands have a rich blood supply, so the hormones they produce enter the bloodstream rapidly. In the healthy physiologic state, hormone concentration in the bloodstream is maintained at a relatively constant level. **Negative feedback** is the mechanism for regulating hormone concentration in the bloodstream. When the hormone concentration increases, further production of that hormone is inhibited. Conversely, when the hormone concentration decreases, the rate of production of that hormone increases.

Hormones are generally transported in body fluids, and the amount of specific hormones circulating at any given time depends on the body's needs. Hormones are special in that particular ones may affect different tissues in various ways or that several may be necessary for the regulation of a certain body function.

## Classification and Action of Hormones

Hormones are classified into four categories according to their structure: (1) amines and amino acids (eg, epinephrine, norepinephrine, and thyroid hormones); (2) peptides, polypeptides, proteins, and glycoproteins (eg, thyrotropin-releasing hormone, follicle-stimulating hormone, and growth hormone); (3) steroids (eg, corticosteroids); and (4) fatty acid derivatives (eg, eicosanoid, retinoids) (Porth &

Matfin, 2009). These different classes of hormones act on the target tissues by different mechanisms.

Hormones can alter the function of the target tissue by interacting with chemical receptors located either on the cell membrane or in the interior of the cell. For example, *peptide and protein hormones* interact with receptor sites on the cell surface, resulting in stimulation of the intracellular enzyme adenyl cyclase. This causes increased production of cyclic 3′,5′-adenosine monophosphate (cyclic AMP). The cyclic AMP inside the cell alters enzyme activity. Thus, cyclic AMP is the "second messenger" that links the peptide hormone at the cell surface to a change in the intracellular environment. Some protein and peptide hormones also act by changing membrane permeability and act within seconds or minutes. The mechanism of action for *amine hormones* is similar to that for peptide hormones.

*Steroid hormones*, because of their smaller size and higher lipid solubility, penetrate cell membranes and interact with intracellular receptors. The steroid–receptor complex modifies cell metabolism and the formation of messenger ribonucleic acid (mRNA) from deoxyribonucleic acid (DNA). The mRNA then stimulates protein synthesis within the cell. Steroid hormones require several hours to exert their effects, because they exert their action by the modification of protein synthesis.

Although most hormones released by endocrine glands can be transported to distant target sites for action, some hormones and hormonelike substances never enter the bloodstream. Some hormones act locally in the area where they are released; this is called paracrine action (eg, the effect of sex hormones on the ovaries). Others may act on the actual cells from which they were released; this is called autocrine action (eg, the effect of insulin from pancreatic beta cells on those cells) (Porth & Matfin, 2009).

## Assessment

### Health History

Although specific endocrine disorders are often accompanied by specific clinical symptoms, more general manifestations may also occur. Some common signs and symptoms of endocrine imbalances include changes in energy level, tolerance to heat or cold, weight, fat and fluid distribution, secondary sexual characteristics, sexual dysfunction, memory, concentration, sleep patterns, and mood. The health history should include information regarding (1) the severity of these changes, (2) the length of time the patient has experienced these changes, (3) the way in which these changes have affected the patient's ability to carry out activities of daily living, and (4) the effect of the changes on the patient's self-perception. Specific symptoms of various endocrine disorders are discussed with each disorder. Possible genetics-related issues may also be important (Chart 42-1).

CHART 42-1 GENETICS IN NURSING PRACTICE

**Metabolic Disorders**

Some examples of metabolic and endocrine disorders influenced by genetic factors include the following:

- Alpha-1 antitrypsin deficiency
- Cystic fibrosis
- Diabetes mellitus type 1 and type 2
- Hereditary hemochromatosis
- Multiple endocrine neoplasia (MEN) type I and type II
- Von Hippel-Lindau syndrome
- Wilson's disease

#### Nursing Assessments

**Family History Assessment**

- Assess family history for relatives with early-onset hepatic, pancreatic, or endocrine disease.
- Inquire about family members with diabetes and their ages at onset.
- Assess family history of other related genetic conditions such as cystic fibrosis, alpha-1 antitrypsin deficiency, and hereditary hemochromatosis.

**Patient Assessment**

- Assess for physical symptoms such as mucosal neuromas, hypertrophied lips, skeletal abnormalities, and marfanoid appearance.
- Assess for signs of arthritis and bronze pigmentation of the skin (hereditary hemochromatosis).

#### Management Issues Specific to Genetics

- Inquire whether DNA mutation testing has been performed on any affected family member.
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, and availability of genetic testing and gene-based interventions.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed genetics-related metabolic and endocrine conditions.
- Participate in management and coordination of care of patients with genetic conditions and people predisposed to develop or pass on a genetic condition.

#### Genetics Resources for Nurses and Their Patients on the Web

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Clinics**—a listing of common genetics disorders with clinical summaries and genetic counseling and testing information, www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/projects/omim

### Physical Assessment

The physical examination should include vital signs, a visual head-to-toe assessment, and tactile examination. Findings should be compared with previous findings if available. Changes in physical characteristics such as appearance of facial hair in women, "moon face," "buffalo hump," exophthalmos, edema, thinning of the skin, obesity of the trunk, thinness of the extremities, increased size of the feet and hands, and edema may signify disorders of the thyroid, adrenal cortex, or pituitary gland. Exophthalmos and other eye symptoms may occur with hyperthyroidism and Graves' disease. Alteration in skin texture is associated with hypofunction and hyperfunction of the thyroid gland. Elevated blood pressure may occur with hyperfunction of the adrenal cortex or tumor of the adrenal medulla. Decreased blood pressure may occur with hypofunction of the adrenal cortex. Behavioral changes such as agitation, nervousness, a flat affect, or a lack of concern about personal appearance may also be present.

## *Diagnostic Evaluation*

A variety of diagnostic studies are used to evaluate the endocrine system. The most common tests are discussed in this section.

Blood tests are used to determine hormone blood levels. Knowing the serum levels of a specific hormone may provide information about whether there is hypofunction or hyperfunction of the endocrine system and the site of dysfunction. Other blood tests are used to detect autoantibodies or to assess the effect of the hormone on other substances (eg, the effect of insulin on blood glucose levels). Radioimmunoassays are radioisotope-labeled antigen tests used to measure the levels of hormones or other substances.

Urine tests may be used to measure the amount of hormones or the end products of hormones excreted by the kidneys. One-time specimens are obtained, or in some disorders 24-hour urine specimens are collected to measure hormones or their metabolites. For example, urinary levels of free catecholamines (norepinephrine, epinephrine, and dopamine) may be measured in patients with suspected tumors of the adrenal medulla **(pheochromocytoma).** Urine tests have several disadvantages, such as the inability of patients to urinate at scheduled intervals and the effect of some medications or disease states on the test results (Porth & Matfin, 2009).

*Stimulation tests* can determine how an endocrine gland responds to the administration of stimulating hormones that are normally produced or released by the hypothalamus or pituitary gland. If the endocrine gland responds to this stimulation, the specific disorder may be in the hypothalamus or pituitary. Failure of the endocrine gland to respond to this stimulation helps identify the problem as being in the endocrine gland itself.

*Suppression tests* may be used to determine whether negative feedback mechanisms that normally control secretion of hormones from the hypothalamus or pituitary gland are intact. They test the effect of administration of an exogenous dose of the hormone on the endogenous secretion of the hormone or on the secretion of stimulation hormones from the hypothalamus or pituitary gland.

Imaging studies include radioactive scanning, magnetic resonance imaging (MRI), computed tomography (CT), ultrasonography, positron emission tomography (PET), and dual-energy x-ray absorptiometry (DEXA).

Genetic screening is increasingly becoming more available. DNA testing is expected to lead to the identification of specific genes associated with endocrine disorders, selective targeting for drug development, and increased understanding of the function of the endocrine system (Porth & Matfin, 2009). Genetic screening is used to determine the presence of a gene mutation that may predispose an individual to a certain condition. The use of genetic screening must be considered carefully by the physician and patient.

# THE PITUITARY GLAND

## *Anatomic and Physiologic Overview*

The pituitary gland, or hypophysis, is commonly referred to as the master gland because of the influence it has on secretion of hormones by other endocrine glands (Fig. 42-2) (Porth & Matfin, 2009). The round structure, about 1.27 cm (1/2 inch) in diameter, is located on the inferior aspect of the brain. The pituitary gland is divided into anterior and posterior lobes. It is controlled by the hypothalamus, an adjacent area of the brain that is connected to the pituitary by the pituitary stalk.

### Anterior Pituitary

The major hormones of the anterior pituitary gland are follicle-stimulating hormone (FSH), luteinizing hormone (LH), prolactin, **adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone (TSH),** and growth hormone (GH) (also referred to as somatotropin). The secretion of these major hormones is controlled by releasing factors secreted by the hypothalamus. These releasing factors reach the anterior pituitary by way of the bloodstream in a special circulation called the pituitary portal blood system. Other hormones include melanocyte-stimulating hormone and beta-lipotropin; the function of lipotropin is poorly understood.

The hormones released by the anterior pituitary enter the general circulation and are transported to their target organs. The main function of TSH, ACTH, FSH, and LH is the release of hormones from other endocrine glands. Prolactin acts on the breast to stimulate milk production. Hormones that stimulate other organs and tissues are discussed in conjunction with their target organs.

GH is a protein hormone that increases protein synthesis in many tissues, increases the breakdown of fatty acids in adipose tissue, and increases the glucose level in the blood. These actions of GH are essential for normal growth, although other hormones, such as thyroid hormone and insulin, are required as well. Stress, exercise, and low blood glucose levels increase the secretion of GH. The half-life of GH activity in the blood is 20 to 30 minutes; the hormone is largely inactivated in the liver.

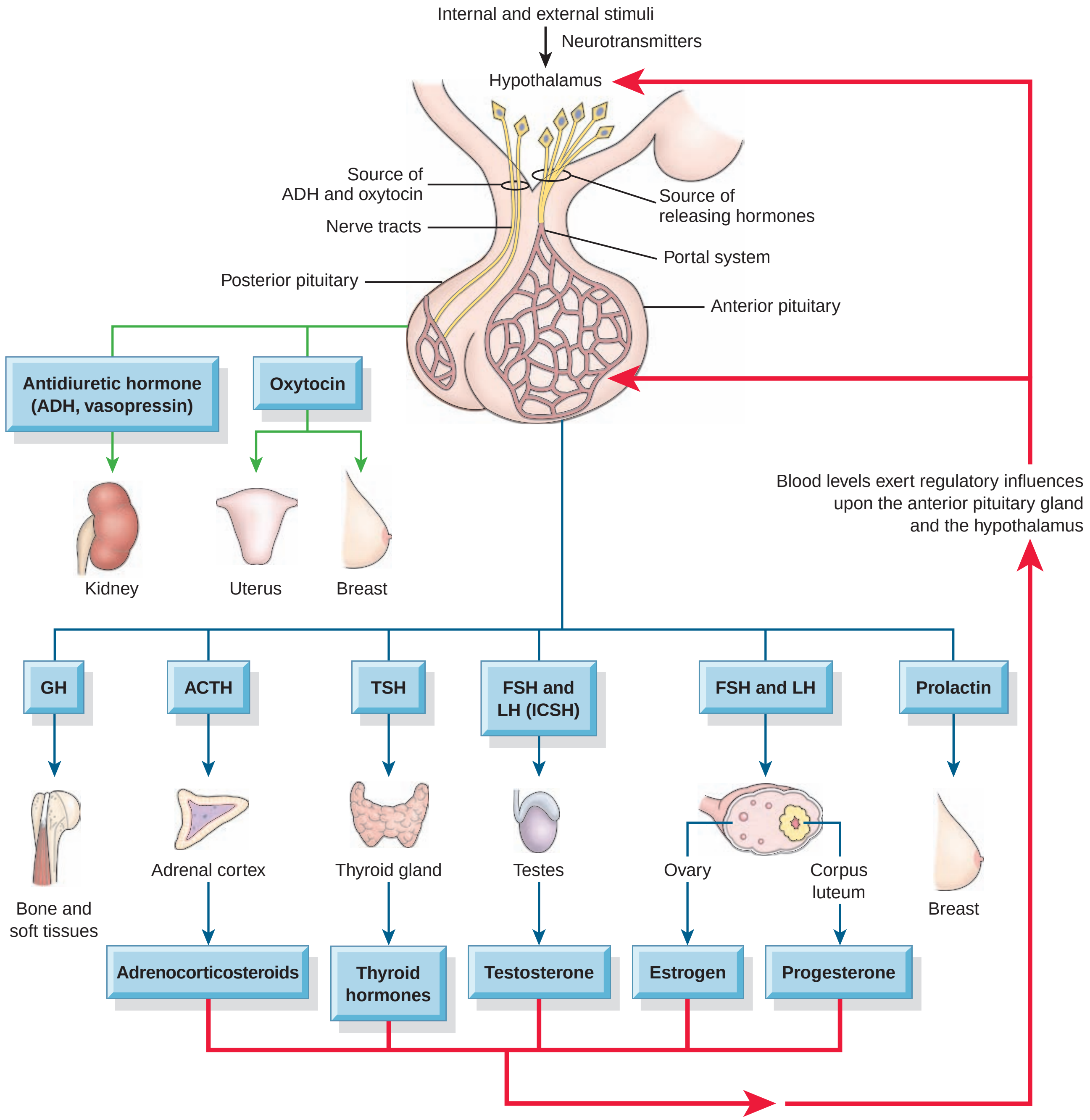



**Figure 42-2** The pituitary gland, the relationship of the brain to pituitary action, and the hormones secreted by the anterior and posterior pituitary lobes. ACTH, adrenocorticotropic hormone; ADH, antidiuretic hormone; FSH, follicle-stimulating hormone; GH, growth hormone; ICSH, interstitial cell-stimulating hormone; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

## Posterior Pituitary

The important hormones secreted by the posterior lobe of the pituitary gland are **vasopressin,** also called antidiuretic hormone (ADH), and **oxytocin.** These hormones are synthesized in the hypothalamus and travel from the hypothalamus to the posterior pituitary gland for storage. Vasopressin controls the excretion of water by the kidney; its secretion is stimulated by an increase in the osmolality of the blood or by a decrease in blood pressure. Oxytocin secretion is stimulated during pregnancy and at childbirth. It facilitates milk ejection during lactation and increases the force of uterine contractions during labor and delivery.

## Pathophysiology

Abnormalities of pituitary function are caused by oversecretion or undersecretion of any of the hormones produced or released by the gland. Abnormalities of the anterior and posterior portions of the gland may occur independently.

Hypofunction of the pituitary gland (hypopituitarism) can result from disease of the pituitary gland itself or disease of the hypothalamus; the result is essentially the same. Hypopituitarism can result from radiation therapy to the head and neck area. The total destruction of the pituitary gland by trauma, tumor, or vascular lesion removes all stimuli that are normally received by the thyroid, the gonads, and the adrenal glands. The result is extreme weight loss, emaciation, atrophy of all endocrine glands and organs, hair loss, impotence, amenorrhea, hypometabolism, and hypoglycemia. Coma and death occur if the missing hormones are not replaced.

### Anterior Pituitary

Oversecretion (hypersecretion) of the anterior pituitary gland most commonly involves ACTH or GH and results in **Cushing's syndrome** or **acromegaly,** respectively. Acromegaly, an excess of GH in adults, results in bone and soft tissue deformities and enlargement of the viscera without an increase in height. It occurs in approximately 3 cases per 1 million people per year (Melmed, 2006). Oversecretion of GH results in gigantism in children; a person may be 7 or even 8 feet tall. Conversely, insufficient secretion of GH during childhood results in generalized limited growth and **dwarfism** (Porth & Matfin, 2009). Undersecretion (hyposecretion) commonly involves all of the anterior pituitary hormones and is termed *panhypopituitarism*. In this condition, the thyroid gland, the adrenal cortex, and the gonads atrophy (shrink) because of loss of the trophic-stimulating hormones. Hypopituitarism may result from destruction of the anterior lobe of the pituitary gland. Postpartum pituitary necrosis (Sheehan's syndrome) is another uncommon cause of failure of the anterior pituitary. It is more likely to occur in women with severe blood loss, hypovolemia, and hypotension at the time of delivery.

### Posterior Pituitary

The most common disorder related to posterior lobe dysfunction is **diabetes insipidus,** a condition in which abnormally large volumes of dilute urine are excreted as a result of deficient production of vasopressin.

# Specific Disorders of the Pituitary Gland

## PITUITARY TUMORS

Pituitary tumors are usually benign and may be primary or secondary (Porth & Matfin, 2009). Functionality is also important. Functional tumors secrete pituitary hormones, whereas nonfunctional tumors do not. The location and effects of these tumors on hormone production by target organs can have life-threatening effects. Three principal types of pituitary tumors represent an overgrowth of (1) eosinophilic cells, (2) basophilic cells, or (3) chromophobic cells (ie, cells with no affinity for either eosinophilic or basophilic stains).

### Clinical Manifestations

Eosinophilic tumors that develop early in life result in gigantism. The affected person may be more than 7 feet tall and large in all proportions, yet so weak and lethargic that he or she can hardly stand. If the disorder begins during adult life, the excessive skeletal growth occurs only in the feet, the hands, the superciliary ridge, the molar eminences, the nose, and the chin, giving rise to the clinical picture called acromegaly. However, enlargement involves all tissues and organs of the body (Melmed, 2006). Many of these patients suffer from severe headaches and visual disturbances because the tumors exert pressure on the optic nerves (Porth & Matfin, 2009). Assessment of central vision and visual fields may reveal loss of color discrimination, diplopia (double vision), or blindness in a portion of a field of vision. Decalcification of the skeleton, muscular weakness, and endocrine disturbances, similar to those occurring in patients with hyperthyroidism, also are associated with this type of tumor.

Basophilic tumors give rise to Cushing's syndrome with features largely attributable to hyperadrenalism, including masculinization and amenorrhea in females, truncal obesity, hypertension, osteoporosis, and polycythemia.

Chromophobic tumors represent 90% of pituitary tumors. These tumors usually produce no hormones but destroy the rest of the pituitary gland, causing hypopituitarism. People with this disease are often obese and somnolent and exhibit fine, scanty hair; dry, soft skin; a pasty complexion; and small bones. They also experience headaches, loss of libido, and visual defects progressing to blindness. Other signs and symptoms include polyuria, polyphagia, a lowering of the **basal metabolic rate,** and a subnormal body temperature.

### Assessment and Diagnostic Findings

Diagnostic evaluation requires a careful history and physical examination, including assessment of visual acuity and visual fields. CT and MRI are used to diagnose the presence and extent of pituitary tumors. Serum levels of pituitary hormones may be obtained along with measurements of hormones of target organs (eg, thyroid, adrenal) to assist in diagnosis.

### Medical Management

Surgical removal of the pituitary tumor **(hypophysectomy)** through a transsphenoidal approach is the usual treatment. Stereotactic radiation therapy, which requires use of a neurosurgery-type stereotactic frame, may be used to deliver external beam radiation therapy precisely to the pituitary tumor with minimal effect on normal tissue (see Chapter 16). Other treatments include conventional radiation therapy, bromocriptine (Parlodel, a dopamine antagonist), and octreotide (Sandostatin, a synthetic analogue of GH). These medications inhibit the production or release of GH and may bring about marked improvement of symptoms. Octreotide and lanreotide (Somatuline Depot, a somatostatin analogue) may also be used preoperatively to improve the patient's clinical condition and to shrink the tumor (Melmed, 2006).

#### *Surgical Management*

Hypophysectomy is the treatment of choice in patients with Cushing's syndrome resulting from excessive production of ACTH by a pituitary tumor. Hypophysectomy may also be performed on occasion as a palliative measure to relieve

bone pain secondary to metastasis of malignant lesions of the breast and prostate.

Several approaches are used to remove or destroy the pituitary gland, including surgical removal by transfrontal, subcranial, or oronasal–transsphenoidal approaches; irradiation; and cryosurgery. (The transsphenoidal approach and the nursing management of a patient undergoing cranial surgery are discussed in Chapter 61.) Features or symptoms of acromegaly are unaffected by surgical removal of the tumor.

The absence of the pituitary gland alters the function of many body systems. Menstruation ceases and infertility occurs after total or near-total ablation of the pituitary gland. Replacement therapy with corticosteroids and thyroid hormone is necessary; therefore, patient teaching is imperative (see later discussion).

# DIABETES INSIPIDUS

Diabetes insipidus (DI) is a disorder of the posterior lobe of the pituitary gland that is characterized by a deficiency of ADH (vasopressin). Excessive thirst (polydipsia) and large volumes of dilute urine characterize the disorder. It may occur secondary to head trauma, brain tumor, or surgical ablation or irradiation of the pituitary gland. It may also occur with infections of the central nervous system (meningitis, encephalitis, tuberculosis) or with tumors (eg, metastatic disease, lymphoma of the breast or lung). Another cause of DI is failure of the renal tubules to respond to ADH; this nephrogenic form may be related to hypokalemia, hypercalcemia, and a variety of medications (eg, lithium, demeclocycline [Declomycin]).

## Clinical Manifestations

Without the action of ADH on the distal nephron of the kidney, an enormous daily output of very dilute, waterlike urine with a specific gravity of 1.001 to 1.005 occurs. The urine contains no abnormal substances such as glucose or albumin. Because of the intense thirst, the patient tends to drink 2 to 20 L of fluid daily and craves cold water. In the hereditary form of DI, the primary symptoms may begin at birth. In adults, the onset of DI may be insidious or abrupt.

The disease cannot be controlled by limiting fluid intake, because the high-volume loss of urine continues even without fluid replacement. Attempts to restrict fluids cause the patient to experience an insatiable craving for fluid and to develop hypernatremia and severe dehydration.

## Assessment and Diagnostic Findings

The fluid deprivation test is carried out by withholding fluids for 8 to 12 hours or until 3% to 5% of the body weight is lost. The patient is weighed frequently during the test. Plasma and urine osmolality studies are performed at the beginning and end of the test. The inability to increase the specific gravity and osmolality of the urine is characteristic of DI. The patient continues to excrete large volumes of urine with low specific gravity and experiences weight loss, increasing serum osmolality, and elevated serum sodium levels. The patient's condition needs to be monitored frequently during the test, and the test is terminated if tachycardia, excessive weight loss, or hypotension develops.

Other diagnostic procedures include concurrent measurements of plasma levels of ADH and plasma and urine osmolality as well as a trial of desmopressin (synthetic vasopressin) therapy and intravenous (IV) infusion of hypertonic saline solution. If the diagnosis is confirmed and the cause (eg, head injury) is not obvious, the patient is carefully assessed for tumors that may be causing the disorder.

## Medical Management

The objectives of therapy are (1) to replace ADH (which is usually a long-term therapeutic program), (2) to ensure adequate fluid replacement, and (3) to identify and correct the underlying intracranial pathology. Nephrogenic causes require different management approaches.

### *Pharmacologic Therapy*

Desmopressin (DDAVP), a synthetic vasopressin without the vascular effects of natural ADH, is particularly valuable because it has a longer duration of action and fewer adverse effects than other preparations previously used to treat the disease. It is administered intranasally; the patient sprays the solution into the nose through a flexible calibrated plastic tube. One or two administrations daily (ie, every 12 to 24 hours) usually control the symptoms (Tierney, McPhee & Papadakis, 2005). Vasopressin causes vasoconstriction; thus, it must be used cautiously in patients with coronary artery disease.

Intramuscular administration of ADH, vasopressin tannate in oil, is used if the intranasal route is not possible. The medication is administered every 24 to 96 hours. The vial of medication should be warmed or shaken vigorously before administration. The injection is administered in the evening so that maximum results are obtained during sleep. Abdominal cramps are a side effect of this medication. Rotation of injection sites is necessary to prevent lipodystrophy.

Clofibrate (Atromid-S), a hypolipidemic agent, has been found to have an antidiuretic effect on patients with DI who have some residual hypothalamic vasopressin. Chlorpropamide (Diabinese) and thiazide diuretics are also used in mild forms of the disease because they potentiate the action of vasopressin. Hyperglycemia is possible.

If the DI is renal in origin, the previously described treatments are ineffective. Thiazide diuretics, mild salt depletion, and prostaglandin inhibitors (ibuprofen [Advil, Motrin], indomethacin [Indocin], and aspirin) are used to treat the nephrogenic form of DI.

## Nursing Management

The nurse must teach the patient and family about follow-up care and emergency measures and provide specific verbal and written instructions, including the actions and side effects of all medications. In addition to demonstrating correct medication administration, the nurse should observe return demonstrations. It is necessary to provide information regarding the signs and symptoms of hyponatremia. Finally, the nurse should advise wearing a medical identification bracelet and carrying medication and information about DI at all times.

## SYNDROME OF INAPPROPRIATE ANTIDIURETIC HORMONE SECRETION

The **syndrome of inappropriate antidiuretic hormone (SIADH) secretion** includes excessive ADH secretion from the pituitary gland even in the face of subnormal serum osmolality. Patients cannot excrete a dilute urine, retain fluids, and develop a sodium deficiency known as dilutional hyponatremia. SIADH is often of nonendocrine origin; for instance, the syndrome may occur in patients with bronchogenic carcinoma in which malignant lung cells synthesize and release ADH. SIADH has also occurred in patients with severe pneumonia, pneumothorax, and other disorders of the lungs, as well as malignant tumors that affect other organs (Porth & Matfin, 2009).

Disorders of the central nervous system, such as head injury, brain surgery or tumor, and infection, are thought to produce SIADH by direct stimulation of the pituitary gland. Some medications (eg, vincristine [Oncovin], phenothiazines, tricyclic antidepressants, thiazide diuretics) and nicotine have been implicated in SIADH; they either directly stimulate the pituitary gland or increase the sensitivity of renal tubules to circulating ADH.

Interventions include the elimination of the underlying cause, if possible, and restricting fluid intake. Because retained water is excreted slowly through the kidneys, the extracellular fluid volume contracts and the serum sodium concentration gradually increases toward normal. Diuretics such as furosemide (Lasix) may be used along with fluid restriction if severe hyponatremia is present.

Close monitoring of fluid intake and output, daily weight, urine and blood chemistries, and neurologic status is indicated for the patient at risk for SIADH. Supportive measures and explanations of procedures and treatments assist the patient in managing this disorder.

## THE THYROID GLAND

The thyroid gland is a butterfly-shaped organ located in the lower neck, anterior to the trachea (Fig. 42-3). It consists of two lateral lobes connected by an isthmus. The gland is about 5 cm long and 3 cm wide and weighs about 30 g. The blood flow to the thyroid is very high (about 5 mL/min per gram of thyroid tissue), approximately five times the blood flow to the liver. This reflects the high metabolic activity of the thyroid gland. The thyroid gland produces three hormones: **thyroxine ($T_4$), triiodothyronine ($T_3$),** and **calcitonin**.

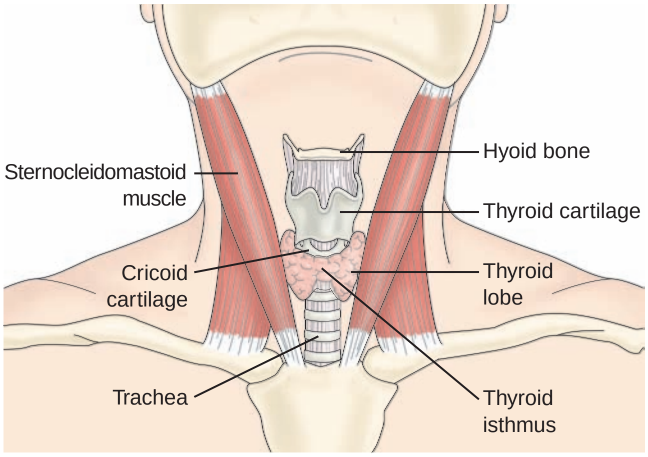



**Figure 42-3** The thyroid gland and surrounding structures.

## *Anatomic and Physiologic Overview*

Various hormones and chemicals are responsible for normal thyroid function. Key among them are thyroid hormone, calcitonin, and iodine.

### Thyroid Hormone

$T_4$ and $T_3$, which are referred to collectively as thyroid hormone, are two separate hormones produced by the thyroid gland. Both are amino acids that contain iodine molecules bound to the amino acid structure; $T_4$ contains four iodine atoms in each molecule, and $T_3$ contains three. These hormones are synthesized and stored bound to proteins in the cells of the thyroid gland until needed for release into the bloodstream. About 75% of bound thyroid hormone is bound to thyroxine-binding globulin (TBG); the remaining bound thyroid hormone is bound to thyroid-binding prealbumin and albumin.

#### *Synthesis of Thyroid Hormone*

Iodine is essential to the thyroid gland for synthesis of its hormones. The major use of iodine in the body is by the thyroid, and the major derangement in iodine deficiency is alteration of thyroid function. Iodide is ingested in the diet and absorbed into the blood in the GI tract. The thyroid gland is extremely efficient at taking up iodide from the blood and concentrating it within the cells, where iodide ions are converted to iodine molecules, which react with tyrosine (an amino acid) to form the thyroid hormones.

#### *Regulation of Thyroid Hormone*

The secretion of $T_3$ and $T_4$ by the thyroid gland is controlled by TSH (also called thyrotropin) from the anterior pituitary gland. TSH controls the rate of thyroid hormone release through a negative feedback mechanism. In turn, the level of thyroid hormone in the blood determines the release of TSH. If the thyroid hormone concentration in the blood decreases, the release of TSH increases, which causes increased output of $T_3$ and $T_4$. The term **euthyroid** refers to thyroid hormone production that is within normal limits.

Thyrotropin-releasing hormone (TRH), secreted by the hypothalamus, exerts a modulating influence on the release of TSH from the pituitary. Environmental factors, such as a decrease in temperature, may lead to increased secretion of TRH, resulting in elevated secretion of thyroid hormones. Figure 42-4 shows the hypothalamic–pituitary–thyroid axis, which regulates thyroid hormone production.

#### *Function of Thyroid Hormone*

The primary function of thyroid hormone is to control cellular metabolic activity. $T_4$, a relatively weak hormone, maintains body metabolism in a steady state. $T_3$ is about five

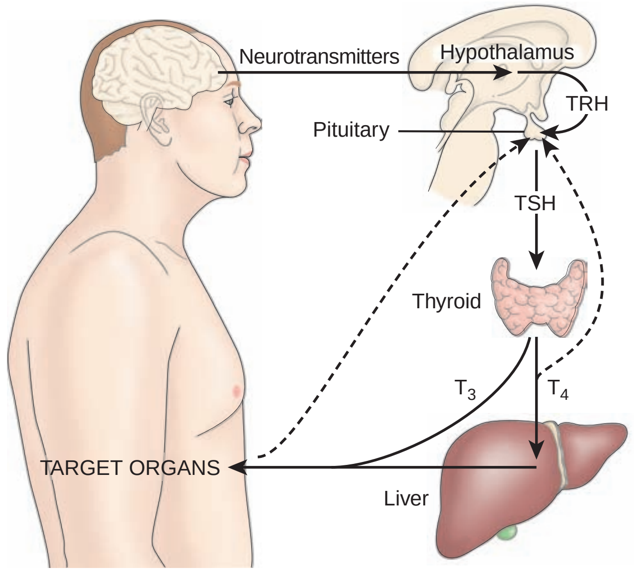



**Figure 42-4** The hypothalamic–pituitary–thyroid axis. Thyroid-releasing hormone (TRH) from the hypothalamus stimulates the pituitary gland to secrete thyroid-stimulating hormone (TSH). TSH stimulates the thyroid to produce thyroid hormone (triiodothyronine [$T_3$] and thyroxine [$T_4$]). High circulating levels of $T_3$ and $T_4$ inhibit further TSH secretion and thyroid hormone production through a negative feedback mechanism (*dashed lines*).

times as potent as $T_4$ and has a more rapid metabolic action. These hormones accelerate metabolic processes by increasing the level of specific enzymes that contribute to oxygen consumption and altering the responsiveness of tissues to other hormones. The thyroid hormones influence cell replication and are important in brain development. Thyroid hormone is also necessary for normal growth. The thyroid hormones, through their widespread effects on cellular metabolism, influence every major organ system.

### Calcitonin

Calcitonin, or thyrocalcitonin, is another important hormone secreted by the thyroid gland. It is secreted in response to high plasma levels of calcium, and it reduces the plasma level of calcium by increasing its deposition in bone.

## Pathophysiology

Inadequate secretion of thyroid hormone during fetal and neonatal development results in stunted physical and mental growth **(cretinism)** because of general depression of metabolic activity. In adults, hypothyroidism manifests as lethargy, slow mentation, and generalized slowing of body functions.

Oversecretion of thyroid hormones (hyperthyroidism) is manifested by a greatly increased metabolic rate. Many of the other characteristics of hyperthyroidism result from the increased response to circulating catecholamines (epinephrine and norepinephrine). Oversecretion of thyroid hormones is usually associated with an enlarged thyroid gland known as a **goiter.** Goiter also commonly occurs with iodine deficiency. In this latter condition, lack of iodine results in low levels of circulating thyroid hormones, which causes increased release of TSH; the elevated TSH causes overproduction of thyroglobulin (a precursor of $T_3$ and $T_4$) and hypertrophy of the thyroid gland.

## Assessment and Diagnostic Findings

### Physical Examination

The thyroid gland is inspected and palpated routinely in all patients. Inspection begins with identification of landmarks. The lower neck region between the sternocleidomastoid muscles is inspected for swelling or asymmetry. The patient is instructed to extend the neck slightly and swallow. Thyroid tissue rises normally with swallowing. The thyroid is then palpated for size, shape, consistency, symmetry, and the presence of tenderness (Bickley, 2007).

The clinician may examine the thyroid from an anterior or a posterior position. In the posterior position, both hands encircle the patient's neck. The thumbs rest on the nape of the neck, while the index and middle fingers palpate for the thyroid isthmus and the anterior surfaces of the lateral lobes. When palpable, the isthmus is perceived as firm and of a rubber-band consistency.

The left lobe is examined by positioning the patient so that the neck flexes slightly forward and to the left. The thyroid cartilage is then displaced to the left with the fingers of the right hand. This maneuver displaces the left lobe deep into the sternocleidomastoid muscle, where it can be more easily palpated. The left lobe is then palpated by placing the left thumb deep into the posterior area of the sternocleidomastoid muscle, while the index and middle fingers exert opposite pressure in the anterior portion of the muscle. Having the patient swallow during the maneuver may assist the examiner to locate the thyroid as it ascends in the neck. The procedure is reversed to examine the right lobe. The isthmus is the only portion of the thyroid that is normally palpable. If a patient has a very thin neck, two thin, smooth, nontender lobes may also be palpable.

If palpation discloses an enlarged thyroid gland, both lobes are auscultated using the diaphragm of the stethoscope. Auscultation identifies the localized audible vibration of a bruit. This is indicative of increased blood flow through the thyroid gland associated with hyperthyroidism and necessitates referral to a physician. Other abnormal findings that require referral for further evaluation may include a soft texture (Graves' disease), firmness (Hashimoto's thyroiditis or malignancy), and tenderness (thyroiditis) (Table 42-2) (Bickley, 2007).

### Laboratory and Diagnostic Studies

Assessment measures in addition to palpation and auscultation include thyroid function tests, such as laboratory measurement of thyroid hormones, thyroid scanning, biopsy, and ultrasonography. The most widely used tests are serum immunoassay for TSH and free $T_4$ (Tierney, et al., 2005). Measurement of TSH has a sensitivity of 98% and specificity of greater than 92% (U.S. Department of Health & Human Services [USDHHS], 2006). Free $T_4$ levels correlate with metabolic status; they are elevated in hyperthyroidism and decreased in

**Table 42-2 SUMMARY OF FINDINGS ON PHYSICAL EXAMINATION OF THE THYROID GLAND**

| Physical Finding | Differential Diagnosis | Special Features |
|---|---|---|
| Single nodule | Autonomously functioning adenoma | Opposite lobe not palpable |
| | Adenoma or adenomatous nodule | Rubbery, firm; tenderness suggests recent hemorrhage or infarction |
| | Cancer | Usually hard; may have associated lymph node enlargement or vocal cord palsy |
| | Hyperplasia secondary to unilobar agenesis | Opposite lobe not palpable |
| Multiple nodules | Multinodular goiter | Firm lobes or irregular surface may be misinterpreted as multiple nodules |
| | Hashimoto's thyroiditis | |
| Diffuse goiter | Graves' disease | Bruit or thrill; pyramidal lobe |
| | Hashimoto's thyroiditis | Irregular surface; pyramidal lobe; rubbery or firm; occasionally tender; fibrous variant may be hard |
| | Thyroid lymphoma | Rapidly growing goiter, particularly in setting of preexisting Hashimoto's thyroiditis |
| | Multinodular goiter | Nodules may be hidden within gland and may become apparent with thyroid hormone suppression |
| Tenderness | Subacute thyroiditis | Unilateral or bilateral; tenderness often severe |
| | Hemorrhagic or infarcted adenoma | Discrete nodule with tenderness |
| | Hashimoto's thyroiditis | Mild tenderness |
| | Cancer | Irregular, firm thyroid nodule with chronic tenderness |

hypothyroidism. Ultrasound, CT, and MRI may be used to clarify or confirm the results of other diagnostic studies.

### *Thyroid Tests*

#### Serum Thyroid-Stimulating Hormone

Measurement of the serum TSH concentration is the single best screening test of thyroid function in outpatients because of its high sensitivity. The ability to detect minute changes in serum TSH makes it possible to distinguish subclinical thyroid disease from euthyroid states in patients with low or high normal values. Measurement of TSH is also used for monitoring thyroid hormone replacement therapy and for differentiating between disorders of the thyroid gland itself and disorders of the pituitary or hypothalamus. Current recommendations suggest TSH screening for all adults beginning at 35 years of age and every 5 years thereafter (USDHHS, 2006).

#### Serum Free $T_4$

The test most commonly used to confirm an abnormal TSH result is free $T_4$. It is a direct measurement of free (unbound) thyroxine, the only metabolically active fraction of $T_4$. The range of free $T_4$ in serum is normally 0.9 to 1.7 ng/dL (11.5 to 21.8 pmol/L). When measured by the dialysis method, free $T_4$ is not affected by variations in protein binding and is the procedure of choice for monitoring the changes in $T_4$ secretion during treatment of hyperthyroidism.

#### Serum $T_3$ and $T_4$

Measurement of total $T_3$ or $T_4$ includes protein-bound and free hormone levels that occur in response to TSH secretion. $T_4$ is 70% bound to TBG; $T_3$ is bound less firmly. Only 0.03% of $T_4$ and 0.3% of $T_3$ are unbound. Serious systemic illnesses, medications (eg, oral contraceptives, corticosteroids, phenytoin, salicylates) and protein wasting as a result of nephrosis or use of androgens may interfere with accurate test results. Normal range for $T_4$ is 4.5 to 11.5 μg/dL (58.5 to 150 nmol/L). Although serum $T_3$ and $T_4$ levels generally increase or decrease together, the $T_3$ level appears to be a more accurate indicator of hyperthyroidism, which causes a greater increase in $T_3$ than in $T_4$ levels. The normal range for serum $T_3$ is 70 to 220 ng/dL (1.15 to 3.10 nmol/L).

#### $T_3$ Resin Uptake Test

The $T_3$ resin uptake test is an indirect measure of unsaturated TBG. Its purpose is to determine the amount of thyroid hormone bound to TBG and the number of available binding sites. This provides an index of the amount of thyroid hormone already present in the circulation. Normally, TBG is not fully saturated with thyroid hormone, and additional binding sites are available to combine with radioiodine-labeled $T_3$ added to the blood specimen. The normal $T_3$ uptake value is 25% to 35% (relative uptake fraction, 0.25 to 0.35), which indicates that about one third of the available sites of TBG are occupied by thyroid hormone. If the number of free or unoccupied binding sites is low, as in hyperthyroidism, the $T_3$ uptake is greater than 35% (0.35). If the number of available sites is high, as occurs in hypothyroidism, the test result is less than 25% (0.25).

$T_3$ uptake is useful in the evaluation of thyroid hormone levels in patients who have received diagnostic or therapeutic doses of iodine. The test results may be altered by the use of estrogens, androgens, salicylates, phenytoin, anticoagulants, or corticosteroids.

#### Thyroid Antibodies

Autoimmune thyroid diseases include both hypothyroid and hyperthyroid conditions. Results of testing by immunoassay techniques for antithyroid antibodies are positive in chronic autoimmune thyroid disease (90%), Hashimoto's thyroiditis (100%), Graves' disease (80%), and other organ-specific autoimmune diseases, such as lupus erythematosus and rheumatoid arthritis. Antithyroid antibody titers are normally present in 5% to 10% of the population and increase with age.

#### Radioactive Iodine Uptake

The radioactive iodine uptake test measures the rate of iodine uptake by the thyroid gland. The patient is administered a tracer dose of iodine 123 ($^{123}I$) or another

radionuclide, and a count is made over the thyroid gland with a scintillation counter, which detects and counts the gamma rays released from the breakdown of $^{123}I$ in the thyroid. It measures the proportion of the administered dose that is present in the thyroid gland at a specific time after its administration. It is a simple test and provides reliable results. It is affected by the patient's intake of iodide or thyroid hormone; therefore, a careful preliminary clinical history is essential in evaluating results. Normal values vary from one geographic region to another and with the intake of iodine. Patients with hyperthyroidism exhibit a high uptake of the $^{123}I$ (in some patients, as high as 90%), whereas patients with hypothyroidism exhibit a very low uptake.

**Fine-Needle Aspiration Biopsy**

Use of a small-gauge needle to sample the thyroid tissue for biopsy is a safe and accurate method of detecting malignancy. It is often the initial test for evaluation of thyroid masses. Results are reported as (1) negative (benign), (2) positive (malignant), (3) indeterminate (suspicious), and (4) inadequate (nondiagnostic).

**Thyroid Scan, Radioscan, or Scintiscan**

In a thyroid scan, a scintillation detector or gamma camera moves back and forth across the area to be studied in a series of parallel tracks, and a visual image is made of the distribution of radioactivity in the area being scanned. Although $^{123}I$ has been the most commonly used isotope, technetium 99m ($^{99m}Tc$) pertechnetate, thallium, and americium are also used.

Scans are helpful in determining the location, size, shape, and anatomic function of the thyroid gland, particularly when thyroid tissue is substernal or large. Identifying areas of increased function ("hot" areas) or decreased function ("cold" areas) can assist in diagnosis. Although most areas of decreased function do not represent malignancies, lack of function increases the likelihood of malignancy, particularly if only one nonfunctioning area is present. Scanning of the entire body, to obtain the total body profile, may be carried out in a search for a functioning thyroid metastasis (ie, a lesion that produces thyroid hormones).

**Serum Thyroglobulin**

Thyroglobulin (Tg) can be measured reliably in the serum by radioimmunoassay. Clinically, it is used to detect persistence or recurrence of thyroid carcinoma.

*Nursing Implications*

When thyroid tests are scheduled, it is necessary to determine whether the patient has taken medications or agents that contain iodine, because these may alter the test results. Iodine-containing medications include contrast agents and those used to treat thyroid disorders. Less obvious sources of iodine are topical antiseptics, multivitamin preparations, and food supplements frequently found in health food stores; cough syrups; and amiodarone (Cordarone), an antiarrhythmic agent. Other medications that may affect test results are estrogens, salicylates, amphetamines, chemotherapeutic agents, antibiotics, corticosteroids, and mercurial diuretics. The nurse asks the patient about the use of these medications and notes their use on the laboratory requisition. Chart 42-2 gives a partial list of agents that may interfere with accurate testing of thyroid gland function.

CHART 42-2 PHARMACOLOGY

***Partial List of Medications That May Alter Thyroid Test Results***

| | |
|---|---|
| Estrogens | Opioids |
| Sulfonylureas | Androgens |
| Corticosteroids | Salicylates |
| Iodine | Lithium |
| Propranolol | Amiodarone |
| Cimetidine | Clofibrate |
| 5-Fluorouracil | Furosemide |
| Phenytoin | Diazepam |
| Heparin | Danazol |
| Chloral hydrate | Dopamine antagonists |
| X-ray contrast agents | Propylthiouracil |

# Specific Disorders of the Thyroid Gland

## HYPOTHYROIDISM

Hypothyroidism results from suboptimal levels of thyroid hormone. Thyroid deficiency can affect all body functions and can range from mild, subclinical forms to **myxedema,** an advanced form. The most common cause of hypothyroidism in adults is autoimmune thyroiditis (Hashimoto's disease), in which the immune system attacks the thyroid gland. Symptoms of hyperthyroidism may later be followed by those of hypothyroidism and myxedema. Hypothyroidism also commonly occurs in patients with previous hyperthyroidism that has been treated with radioiodine or antithyroid medications or thyroidectomy. The condition occurs most frequently in older women. In addition, there is an increased incidence of thyroid cancer in men who have undergone radiation therapy for head and neck cancer. Therefore, testing of thyroid function is recommended for all patients who receive such treatment. Other causes of hypothyroidism are presented in Chart 42-3.

**Chart 42-3 • *Causes of Hypothyroidism***

- Autoimmune disease (Hashimoto's thyroiditis, post-Graves' disease)
- Atrophy of thyroid gland with aging
- Therapy for hyperthyroidism
  - Radioactive iodine ($^{131}I$)
  - Thyroidectomy
- Medications
  - Lithium
  - Iodine compounds
  - Antithyroid medications
- Radiation to head and neck for treatment of head and neck cancers, lymphoma
- Infiltrative diseases of the thyroid (amyloidosis, scleroderma, lymphoma)
- Iodine deficiency and iodine excess

More than 95% of patients with hypothyroidism have primary or thyroidal hypothyroidism, which refers to dysfunction of the thyroid gland itself. If the cause of the thyroid dysfunction is failure of the pituitary gland, the hypothalamus, or both, the hypothyroidism is known as central hypothyroidism. If the cause is entirely a pituitary disorder, it may be referred to as pituitary or secondary hypothyroidism. If the cause is a disorder of the hypothalamus resulting in inadequate secretion of TSH due to decreased stimulation of TRH, it is referred to as hypothalamic or tertiary hypothyroidism. If thyroid deficiency is present at birth, it is referred to as cretinism. In such instances, the mother may also have thyroid deficiency.

The term *myxedema* refers to the accumulation of mucopolysaccharides in subcutaneous and other interstitial tissues. Although myxedema occurs in long-standing hypothyroidism, the term is used appropriately only to describe the extreme symptoms of severe hypothyroidism.

## Clinical Manifestations

Extreme fatigue makes it difficult for the person to complete a full day's work or participate in usual activities. Reports of hair loss, brittle nails, and dry skin are common, and numbness and tingling of the fingers may occur. On occasion, the voice may become husky, and the patient may complain of hoarseness. Menstrual disturbances such as menorrhagia or amenorrhea occur, in addition to loss of libido. Hypothyroidism affects women five times more frequently than men and occurs most often between 40 and 70 years of age. The prevalence of the disease increases with increasing age.

Severe hypothyroidism results in a subnormal body temperature and pulse rate. The patient usually begins to gain weight even without an increase in food intake, although he or she may be cachectic. The skin becomes thickened because of an accumulation of mucopolysaccharides in the subcutaneous tissues. The hair thins and falls out, and the face becomes expressionless and masklike. The patient often complains of being cold even in a warm environment.

At first, the patient may be irritable and may complain of fatigue, but as the condition progresses, the emotional responses are subdued. The mental processes become dulled, and the patient appears apathetic. Speech is slow, the tongue enlarges, the hands and feet increase in size, and deafness may occur. The patient frequently complains of constipation.

Advanced hypothyroidism may produce personality and cognitive changes characteristic of dementia. Inadequate ventilation and sleep apnea can occur with severe hypothyroidism. Pleural effusion, pericardial effusion, and respiratory muscle weakness may also occur.

Severe hypothyroidism is associated with an elevated serum cholesterol level, atherosclerosis, coronary artery disease, and poor left ventricular function. The patient with advanced hypothyroidism is hypothermic and abnormally sensitive to sedatives, opioids, and anesthetic agents, which must be administered with extreme caution.

Patients with unrecognized hypothyroidism who are undergoing surgery are at increased risk for intraoperative hypotension, postoperative heart failure, and altered mental status.

Myxedema coma is a rare life-threatening condition. It is the decompensated state of severe hypothyroidism in which the patient is hypothermic and unconscious (Kwaku & Burman, 2007). This condition may develop with undiagnosed hypothyroidism and may be precipitated by infection or other systemic disease or by use of sedatives or opioid analgesic agents. The condition occurs most often among elderly women in the winter months and appears to be precipitated by cold. However, the disorder can affect any age group.

In myxedema coma, the patient may initially show signs of depression, diminished cognitive status, lethargy, and somnolence (Kwaku & Burman, 2007). Increasing lethargy may progress to stupor. The patient's respiratory drive is depressed, resulting in alveolar hypoventilation, progressive carbon dioxide retention, narcosis, and coma. These symptoms, along with cardiovascular collapse and shock, require aggressive and intensive supportive and hemodynamic therapy if the patient is to survive. Although there has been a decline in mortality rates over the past two decades due to early intervention and improved therapies, the mortality rate (20% to 25%) remains high even with vigorous treatment (Kwaku & Burman, 2007).

*NURSING ALERT*

**In all patients with hypothyroidism, the effects of analgesic agents, sedatives, and anesthetic agents are prolonged; special caution is necessary in administering these agents to elderly patients because of concurrent changes in liver and renal function.**

## Medical Management

The primary objective in the management of hypothyroidism is to restore a normal metabolic state by replacing the missing hormone.

### Pharmacologic Therapy

Synthetic levothyroxine (Synthroid or Levothroid) is the preferred preparation for treating hypothyroidism and suppressing nontoxic goiters. Its dosage is based on the patient's serum TSH concentration. Desiccated thyroid is used infrequently today, because it often results in transient elevated serum concentrations of $T_3$, with occasional symptoms of hyperthyroidism. If replacement therapy is adequate, the symptoms of myxedema disappear and normal metabolic activity is resumed.

#### Prevention of Cardiac Dysfunction

Any patient who has had hypothyroidism for a long period is almost certain to have elevated serum cholesterol, atherosclerosis, and coronary artery disease. As long as metabolism is subnormal and the tissues, including the myocardium, require relatively little oxygen, a reduction in blood supply is tolerated without overt symptoms of coronary artery disease. When thyroid hormone is administered, the oxygen demand increases, but oxygen delivery cannot be increased unless, or until, the atherosclerosis improves. This occurs very slowly, if at all. The occurrence of angina is the signal that the oxygen needs of the myocardium exceed its blood supply. Angina or dysrhythmias can occur

when thyroid replacement is initiated because thyroid hormones enhance the cardiovascular effects of catecholamines.

**NURSING ALERT**

**The nurse must monitor for myocardial ischemia or infarction, which can occur in response to therapy in patients with severe, long-standing hypothyroidism or myxedema coma. The nurse must also be alert for signs of angina, especially during the early phase of treatment; if detected, it must be reported and treated at once to avoid a fatal myocardial infarction.**

Obviously, if angina or dysrhythmias occur, thyroid hormone administration must be discontinued immediately. Later, when it can be resumed safely, it should be prescribed cautiously at a lower dosage and under the close observation of the physician and the nurse.

#### Prevention of Medication Interactions

Precautions must be taken during the course of therapy because thyroid hormones may interact with other medications. Thyroid hormones may increase blood glucose levels, which may necessitate adjustment in the dosage of insulin or oral antidiabetic agents in patients with diabetes. Thyroid hormones may also increase the pharmacologic effects of digitalis glycosides, anticoagulant agents, and indomethacin (Indocin). Phenytoin (Dilantin) and tricyclic antidepressant agents may increase the effects of thyroid hormone. Bone loss and osteoporosis may also occur with thyroid therapy.

Even in small doses, hypnotic and sedative agents may induce profound somnolence, lasting far longer than anticipated and leading to narcosis (stuporlike condition). Furthermore, they are likely to cause respiratory depression, which can easily be fatal because of decreased respiratory reserve and alveolar hypoventilation. The dose of these medications should be one half or one third of that typically prescribed for patients of similar age and weight with normal thyroid function.

### *Supportive Therapy*

In severe hypothyroidism and myxedema coma, management includes maintaining vital functions. Arterial blood gases may be measured to determine carbon dioxide retention and to guide the use of assisted ventilation to combat hypoventilation. Oxygen saturation levels should be monitored using pulse oximetry. Fluids are administered cautiously because of the danger of water intoxication. Application of external heat (eg, heating pads) is avoided, because it increases oxygen requirements and may lead to vascular collapse. If hypoglycemia is evident, concentrated glucose may be prescribed to provide glucose without precipitating fluid overload. If myxedema has progressed to myxedema coma, thyroid hormone (usually levothyroxine [Synthyroid]) is administered intravenously until consciousness is restored. Treatment then continues with oral thyroid hormone therapy. Because of an associated adrenocortical insufficiency, corticosteroid therapy may be necessary.

## Nursing Management

Nursing care of the patient with hypothyroidism and myxedema is summarized in the plan of nursing care in Chart 42-4.

**NURSING ALERT**

**Medications are administered to the patient with hypothyroidism with extreme caution because of the potential for altered metabolism and excretion as well as depressed metabolic rate and respiratory status.**

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The patient and family require education and support to manage this complex disorder at home. Oral and written instructions should be provided regarding the following:

- Desired actions and side effects of medications
- Correct medication administration
- Importance of continuing to take the medications as prescribed even after symptoms improve
- When to seek medical attention
- Importance of nutrition and diet to promote weight loss and normal bowel patterns
- Importance of periodic follow-up testing

The patient and family should be informed that many of the symptoms observed during the course of the disorder will disappear with effective treatment (Chart 42-5).

#### Continuing Care

If indicated, a referral is made for home care. The home care nurse monitors the patient's recovery and ability to cope with the recent changes, along with the patient's physical and cognitive status and the patient's and family's understanding of the instructions provided before hospital discharge. The home care nurse documents and reports to the patient's primary health care provider subtle signs and symptoms that may indicate either inadequate or excessive thyroid hormone.

## Gerontologic Considerations

The prevalence of hypothyroidism increases with age, most often among women. The higher prevalence of hypothyroidism among elderly people may be related to alterations in immune function with age and complicated by multiple comorbidities. Screening of TSH levels is recommended for women older than 50 years of age who have one or more symptoms, because they are at high risk for hypothyroidism (USDHHS, 2006). It is estimated that approximately 10% of women 65 years of age and 15% of those older than 75 years of age experience hypothyroidism (Singer, 2006).

Most patients with primary hypothyroidism present with long-standing mild to moderate hypothyroidism. Subclinical disease is common among older women and can be asymptomatic or mistaken for other medical conditions. Subtle symptoms of hypothyroidism, such as fatigue, muscle aches, and mental confusion, may be attributed to the normal aging process by patients, families, and health care

CHART 42-4

**PLAN OF NURSING CARE**

## Care of the Patient With Hypothyroidism

**NURSING DIAGNOSIS:** Activity intolerance related to fatigue and depressed cognitive process
**GOAL:** Increased participation in activities and increased independence

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Promote independence in self-care activities. | 1. Encouragement needed in fatigued, often depressed patient | • Participates in self-care activities<br>• Reports decreased level of fatigue<br>• Displays interest and awareness in environment<br>• Participates in activities and events in environment<br>• Participates in family events and activities<br>• Reports no chest pain, increased fatigue, or breathlessness with increased level of activity |
| a. Space activities to promote rest and exercise as tolerated. | a. Encourages activities while allowing time for adequate rest | |
| b. Assist with self-care activities when patient is fatigued. | b. Permits patient to participate to the extent possible in self-care activities | |
| c. Provide stimulation through conversation and nonstressful activities. | c. Promotes interest without overly stressing the patient | |
| d. Monitor patient's response to increasing activities | d. Guards against over- and under-exertion by the patient | |

**NURSING DIAGNOSIS:** Risk for imbalanced body temperature
**GOAL:** Maintenance of normal body temperature

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Provide extra layer of clothing or extra blanket. | 1. Minimizes heat loss | • Experiences relief of discomfort and cold intolerance<br>• Maintains baseline body temperature<br>• Reports adequate feeling of warmth and lack of chilling<br>• Uses extra layer of clothing or extra blanket<br>• Explains rationale for avoiding external heat source |
| 2. Avoid and discourage use of external heat source (eg, heating pads, electric or warming blankets). | 2. Reduces risk of peripheral vasodilation and vascular collapse | |
| 3. Monitor patient's body temperature and report decreases from patient's baseline value. | 3. Detects decreased body temperature and onset of myxedema coma | |
| 4. Protect from exposure to cold and drafts. | 4. Increases patient's level of comfort and decreases further heat loss | |

**NURSING DIAGNOSIS:** Constipation related to depressed gastrointestinal function
**GOAL:** Return of normal bowel function

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage increased fluid intake within limits of fluid restriction. | 1. Promotes passage of soft stools | • Reports normal bowel function<br>• Identifies and consumes foods high in fiber<br>• Drinks recommended amount of fluid each day<br>• Participates in gradually increasing exercises<br>• Uses laxatives as prescribed and avoids excessive dependence on laxatives and enemas |
| 2. Provide foods high in fiber. | 2. Increases bulk of stools and more frequent bowel movements | |
| 3. Instruct patient about foods with high water content. | 3. Provides rationale for patient to increase fluid intake | |
| 4. Monitor bowel function. | 4. Permits detection of constipation and return to normal bowel pattern | |
| 5. Encourage increased mobility within patient's exercise tolerance. | 5. Promotes evacuation of the bowel | |
| 6. Encourage patient to use laxatives and enemas sparingly. | 6. Minimizes patient's dependence on laxatives and enemas and encourages normal pattern of bowel evacuation | |

**NURSING DIAGNOSIS:** Deficient knowledge about the therapeutic regimen for lifelong thyroid replacement therapy
**GOAL:** Knowledge and acceptance of the prescribed therapeutic regimen

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Explain rationale for thyroid hormone replacement. | 1. Provides rationale for patient to use thyroid hormone replacement as prescribed | • Describes therapeutic regimen correctly<br>• Explains rationale for thyroid hormone replacement<br>• Identifies positive outcomes of thyroid hormone replacement |
| 2. Describe desired effects of medication to patient. | 2. Provides encouragement to patient by identifying improved physical status and well-being that will occur with thyroid hormone therapy and return to a euthyroid state | |

*Continued on following page*

CHART 42-4

**PLAN OF NURSING CARE**

## Care of the Patient With Hypothyroidism (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Assist patient to develop schedule and checklist to ensure self-administration of thyroid replacement. | 3. Increases chances that medication will be taken as prescribed | • Administers medication to self as prescribed |
| 4. Describe signs and symptoms of over- and underdose of medication. | 4. Serves as check for patient to determine if therapeutic goals are met | • Identifies adverse side effects that should be reported promptly to physician: recurrence of symptoms of hypothyroidism and occurrence of symptoms of hyperthyroidism |
| 5. Explain the necessity for long-term follow-up to patient and family | 5. Increases likelihood that hypo- or hyperthyroidism will be detected and treated | • Restates need for periodic/long-term follow-up visits to physician |

**NURSING DIAGNOSIS:** Ineffective breathing pattern related to depressed ventilation
**GOAL:** Improved respiratory status and maintenance of normal breathing pattern

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor respiratory rate, depth, pattern, pulse oximetry, and arterial blood gases. | 1. Identifies patient's baseline to monitor further changes and evaluate effectiveness of interventions | • Shows improved respiratory status and maintenance of normal breathing pattern<br>• Demonstrates normal respiratory rate, depth, and pattern |
| 2. Encourage deep breathing, coughing, and use of incentive spirometry. | 2. Prevents atelectasis and promotes adequate ventilation | • Takes deep breaths, coughs, and uses incentive spirometry when encouraged |
| 3. Administer medications (hypnotics and sedatives) with caution. | 3. Patients with hypothyroidism are very susceptible to respiratory depression with use of hypnotics and sedatives. | • Demonstrates normal breath sounds without adventitious sounds on auscultation |
| 4. Maintain patent airway through suction and ventilatory support if indicated (see Chapter 25 for care of patients requiring mechanical ventilation). | 4. Use of an artificial airway and ventilatory support may be necessary with respiratory depression. | • Explains rationale for cautious use of medications<br>• Cooperates with suction procedure and ventilator support when necessary |

**NURSING DIAGNOSIS:** Disturbed thought processes related to depressed metabolism and altered cardiovascular and respiratory status
**GOAL:** Improved thought processes

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Orient patient to time, place, date, and events around him or her. | 1. Provides reality orientation to patient | • Shows improved cognitive functioning<br>• Identifies time, place, date, and events correctly |
| 2. Provide stimulation through conversation and nonthreatening activities. | 2. Provides stimulation within patient's level of tolerance for stress | • Responds when stimulated<br>• Responds spontaneously as treatment becomes effective |
| 3. Explain to patient and family that change in cognitive and mental functioning is a result of disease process. | 3. Reassures patient and family about the cause of the cognitive changes and that a positive outcome is possible with appropriate treatment | • Interacts spontaneously with family and environment |
| 4. Monitor cognitive and mental processes and response of these to medication and other therapy. | 4. Permits evaluation of the effectiveness of treatment | • Explains that change in mental and cognitive processes is a result of disease processes<br>• Takes medications as prescribed to prevent decrease in cognitive processes |

**COLLABORATIVE PROBLEM:** Myxedema and myxedema coma
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor patient for increasing severity of signs and symptoms of hypothyroidism:<br>a. Decreased level of consciousness; dementia<br>b. Decreased vital signs (blood pressure, respiratory rate, temperature, pulse rate)<br>c. Increasing difficulty in awakening or arousing patient | 1. Extreme hypothyroidism may lead to myxedema, myxedema coma, and slowing of all body systems if untreated. | • Exhibits reversal of myxedema and myxedema coma<br>• Responds appropriately to questions and surroundings<br>• Vital signs return to normal or near-normal ranges<br>• Respiratory status improves with adequate spontaneous ventilatory effort |

*Continued*

CHART 42-4

PLAN OF NURSING CARE

*Care of the Patient With Hypothyroidism (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Assist in ventilatory support if respiratory depression and failure occur. | 2. Ventilatory support is necessary to maintain adequate oxygenation and maintenance of airway. | • Reports no episodes of angina or other indicators of cardiac insufficiency<br>• Experiences minimal or no complications caused by immobility |
| 3. Administer prescribed medications (eg, thyroxine) with extreme caution. | 3. The slow metabolism and atherosclerosis of myxedema may result in angina with administration of thyroxine. | |
| 4. Turn and reposition patient at intervals. | 4. Minimizes risks associated with immobility | |
| 5. Avoid use of hypnotic, sedative, and analgesic agents. | 5. Altered metabolism of these agents greatly increases the risks of their use in myxedema. | |

providers; therefore, these symptoms require close attention (Dominguez, Bevilacqua, DiBella, et al., 2008). In addition, signs and symptoms of hypothyroidism in elderly people are often atypical, and manifestations of hypothyroidism and hyperthyroidism may blur. Patients may have few or no symptoms until dysfunction is severe. Depression, apathy, and decreased mobility or activity may be the major initial symptoms and may be accompanied by significant weight loss. Constipation affects one fourth of elderly patients.

In elderly patients with mild to moderate hypothyroidism, thyroid hormone replacement is individually tailored and must be started with low dosages and increased gradually to prevent serious cardiovascular and neurologic side effects. Angina, for example, may occur with rapid thyroid replacement in the presence of coronary artery disease secondary to the hypothyroid state. Heart failure and tachydysrhythmias may worsen during the transition from the hypothyroid state to the normal metabolic state. Dementia may become more apparent during early thyroid hormone replacement in elderly patients.

Elderly patients with severe hypothyroidism and atherosclerosis may become confused and agitated if their metabolic rate is increased too quickly. Marked clinical improvement follows the administration of hormone replacement; such medication must be continued for life, even though signs of hypothyroidism disappear within 3 to 12 weeks.

Myxedema and myxedema coma usually occur exclusively in patients older than 50 years of age (Kwaku & Burman, 2007). The high mortality rate of myxedema coma mandates immediate IV administration of high doses of thyroid hormone as well as supportive care.

Elderly patients require periodic follow-up monitoring of serum TSH levels, because poor compliance with therapy may occur or the patient may take the medications erratically. A careful history can identify the need for further teaching about the importance of the medication.

CHART 42-5

HOME CARE CHECKLIST

*The Patient With Hypothyroidism (Myxedema)*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of hypothyroidism on the body. | ✔ | ✔ |
| • State precipitating factors and interventions for complications (hyperthyroidism, myxedema coma). | ✔ | ✔ |
| • Explain the purpose, dose, route, schedule, side effects, and precautions of prescribed medication (synthetic thyroid hormone). | ✔ | ✔ |
| • State that compliance with medical regimen is lifelong. | ✔ | ✔ |
| • State the need to avoid extreme cold temperature until condition is stable. | ✔ | ✔ |
| • State importance of regular follow-up visits with health care provider. | ✔ | ✔ |
| • Identify dietary strategies to promote weight reduction and prevent constipation (high fiber, low calorie, adequate fluid intake). | ✔ | ✔ |
| • State potential for menstrual irregularities and potential for pregnancy for women. | ✔ | ✔ |
| • State the importance of avoiding infection. | ✔ | ✔ |
| • Identify changes in personality as related to hypothyroidism. | ✔ | ✔ |
| • Identify areas of activity limitations and impact on lifestyle. | ✔ | ✔ |

## HYPERTHYROIDISM

Hyperthyroidism is the second most prevalent endocrine disorder, after diabetes mellitus. **Graves' disease,** the most common type of hyperthyroidism, results from an excessive output of thyroid hormones caused by abnormal stimulation of the thyroid gland by circulating immunoglobulins (Porth & Matfin, 2009). It affects women eight times more frequently than men, with onset usually between the second and fourth decades (Tierney, et al., 2005). The disorder may appear after an emotional shock, stress, or an infection, but the exact significance of these relationships is not understood. Other common causes of hyperthyroidism include thyroiditis and excessive ingestion of thyroid hormone.

### Clinical Manifestations

Patients with well-developed hyperthyroidism exhibit a characteristic group of signs and symptoms (sometimes referred to as **thyrotoxicosis**). The presenting symptom is often nervousness. These patients are often emotionally hyperexcitable, irritable, and apprehensive; they cannot sit quietly; they suffer from palpitations; and their pulse is abnormally rapid at rest as well as on exertion. They tolerate heat poorly and perspire unusually freely. The skin is flushed continuously, with a characteristic salmon color, and is likely to be warm, soft, and moist. However, patients may report dry skin and diffuse pruritus. A fine tremor of the hands may be observed. Patients may exhibit ophthalmopathy, such as **exophthalmos** (bulging eyes), which produces a startled facial expression. Despite treatment, these ocular changes are not always reversible. Patients should be informed that smoking has been shown to aggravate ocular changes (Asvold, Bjoro, Nilsen, et al., 2007).

Other manifestations include an increased appetite and dietary intake, progressive weight loss, abnormal muscular fatigability and weakness (difficulty in climbing stairs and rising from a chair), amenorrhea, and changes in bowel function. The pulse rate ranges constantly between 90 and 160 bpm; the systolic, but characteristically not the diastolic, blood pressure is elevated; atrial fibrillation may occur; and cardiac decompensation in the form of heart failure is common, especially in elderly patients. Osteoporosis and fracture are also associated with hyperthyroidism.

Cardiac effects may include sinus tachycardia or dysrhythmias, increased pulse pressure, and palpitations; these changes may be related to increased sensitivity to catecholamines or to changes in neurotransmitter turnover. Myocardial hypertrophy and heart failure may occur if the hyperthyroidism is severe and untreated.

The course of the disease may be mild, characterized by remissions and exacerbations, and terminate with spontaneous recovery in a few months or years. Conversely, it may progress relentlessly, with the untreated person becoming emaciated, intensely nervous, delirious, and even disoriented; eventually, the heart fails.

Symptoms of hyperthyroidism may occur with the release of excessive amounts of thyroid hormone as a result of inflammation after irradiation of the thyroid or destruction of thyroid tissue by tumor. Such symptoms may also occur with excessive administration of thyroid hormone for treatment of hypothyroidism. Long-standing use of thyroid hormone in the absence of close monitoring may be a cause of symptoms of hyperthyroidism. It is also likely to result in premature osteoporosis, particularly in women.

### Assessment and Diagnostic Findings

The thyroid gland invariably is enlarged to some extent. It is soft and may pulsate; a thrill often can be palpated, and a bruit is heard over the thyroid arteries. These are signs of greatly increased blood flow through the thyroid gland. In advanced cases, the diagnosis is made on the basis of the symptoms, a decrease in serum TSH, increased free $T_4$, and an increase in radioactive iodine uptake.

### Medical Management

Appropriate treatment of hyperthyroidism depends on the underlying cause and often consists of a combination of therapies, including antithyroid agents, radioactive iodine, and surgery. Treatment of hyperthyroidism is directed toward reducing thyroid hyperactivity to relieve symptoms and preventing complications. Use of radioactive iodine is the most common form of treatment for Graves' disease in North America. Beta-adrenergic blocking agents (eg, propranolol [Inderal]) are used as adjunctive therapy for symptomatic relief, particularly in transient thyroiditis (Cooper, 2005). Surgical removal of most of the thyroid gland is a nonpharmacologic alternative.

No treatment for thyrotoxicosis is without side effects, and all three treatments (radioactive iodine therapy, antithyroid medications, and surgery) share the same complications: relapse or recurrent hyperthyroidism and permanent hypothyroidism. The rate of relapse increases in patients who have had very severe disease, a long history of dysfunction, ocular and cardiac symptoms, large goiter, or relapse after previous treatment. The relapse rate after radioactive iodine therapy depends on the dose used in treatment. Patients receiving a lower dose of radioactive iodine are more likely to require subsequent treatment than those treated with a higher dose. The remission rate achieved with a single dose of radioactive iodine is 80% (Reid & Wheeler, 2005, Brent, 2008).

#### *Pharmacologic Therapy*

Two forms of pharmacotherapy are available for treating hyperthyroidism and controlling excessive thyroid activity: (1) use of irradiation by administration of the radioisotope iodine 131 ($^{131}I$) for destructive effects on the thyroid gland and (2) antithyroid medications that interfere with the synthesis of thyroid hormones and other agents that control manifestations of hyperthyroidism.

#### *Radioactive Iodine Therapy*

The goal of radioactive iodine therapy ($^{131}I$) is to destroy the overactive thyroid cells. Almost all the iodine that enters and is retained in the body becomes concentrated in the thyroid gland. Therefore, the radioactive isotope of iodine is concentrated in the thyroid gland, where it destroys thyroid cells without jeopardizing other radiosensitive tissues. Over a period of several weeks, thyroid cells exposed to the radioactive iodine are destroyed, resulting in reduction of the hyperthyroid state and inevitably hypothyroidism.

## Chart 42-6 • *Thyroid Storm (Thyrotoxic Crisis, Thyrotoxicosis)*

Thyroid storm (thyrotoxic crisis) is a form of severe hyperthyroidism, usually of abrupt onset. Untreated, it is almost always fatal, but with proper treatment the mortality rate is reduced substantially. The patient with thyroid storm or crisis is critically ill and requires astute observation and aggressive and supportive nursing care during and after the acute stage of illness.

### Clinical Manifestations

Thyroid storm is characterized by:
- High fever (hyperpyrexia) above 38.5°C (101.3°F)
- Extreme tachycardia (more than 130 bpm)
- Exaggerated symptoms of hyperthyroidism with disturbances of a major system—for example, gastrointestinal (weight loss, diarrhea, abdominal pain) or cardiovascular (edema, chest pain, dyspnea, palpitations)
- Altered neurologic or mental state, which frequently appears as delirium psychosis, somnolence, or coma

Life-threatening thyroid storm is usually precipitated by stress, such as injury, infection, thyroid and nonthyroid surgery, tooth extraction, insulin reaction, diabetic ketoacidosis, pregnancy, digitalis intoxication, abrupt withdrawal of antithyroid medications, extreme emotional stress, or vigorous palpation of the thyroid. These factors can precipitate thyroid storm in the partially controlled or completely untreated patient with hyperthyroidism. Current methods of diagnosis and treatment for hyperthyroidism have greatly decreased the incidence of thyroid storm, making it uncommon today.

### Management

Immediate objectives are reduction of body temperature and heart rate and prevention of vascular collapse. Measures to accomplish these objectives include:
- A hypothermia mattress or blanket, ice packs, a cool environment, hydrocortisone, and acetaminophen (Tylenol). Salicylates (eg, aspirin) are not used because they displace thyroid hormone from binding proteins and worsen the hypermetabolism.
- Humidified oxygen is administered to improve tissue oxygenation and meet the high metabolic demands. Arterial blood gas levels or pulse oximetry may be used to monitor respiratory status.
- Intravenous fluids containing dextrose are administered to replace liver glycogen stores that have been decreased in the hyperthyroid patient.
- PTU or methimazole is administered to impede formation of thyroid hormone and block conversion of $T_4$ to $T_3$, the more active form of thyroid hormone.
- Hydrocortisone is prescribed to treat shock or adrenal insufficiency.
- Iodine is administered to decrease output of $T_4$ from the thyroid gland. For cardiac problems such as atrial fibrillation, dysrhythmias, and heart failure, sympatholytic agents may be administered. Propranolol, combined with digitalis, has been effective in reducing severe cardiac symptoms.

The patient is instructed about what to expect with this tasteless, colorless radioiodine, which may be administered by the radiologist. Typically, a single dose is needed (Reid & Wheeler, 2005). About 95% of patients are cured by one dose of radioactive iodine. The additional 5% require two doses; rarely is a third dose necessary. Use of an ablative dose of radioactive iodine initially causes an acute release of thyroid hormone from the thyroid gland and may cause increased symptoms. The patient is observed for signs of **thyroid storm** (Chart 42-6), a life-threatening condition manifested by cardiac dysrhythmias, fever, and neurologic impairment (Harris, 2007). Propranolol (Inderal) is useful in controlling these symptoms.

After treatment with radioactive iodine, the patient is monitored closely until the euthyroid state is reached. In 3 to 4 weeks, symptoms of hyperthyroidism subside. Close follow-up is required to evaluate thyroid function, because the incidence of hypothyroidism after this form of treatment is very high. Approximately 20% of patients become hypothyroid within 2 years after treatment, and another 3% to 5% of patients each year thereafter (Reid & Wheeler, 2005). Thyroid hormone replacement is necessary; small doses are usually prescribed, with the dose gradually increased over a period of months (up to about 1 year) until the free $T_4$ and TSH levels stabilize within normal ranges.

Radioactive iodine has been used to treat toxic adenomas, multinodular goiter, and most varieties of thyrotoxicosis (rarely with permanent success). It is preferred for treating patients beyond the childbearing years who have diffuse toxic goiter. Radioactive iodine is contraindicated during pregnancy (because it crosses the placenta) and while breast-feeding (because it is secreted in breast milk) to prevent hypothyroidism in the fetus (Cooper, Doherty, Haugen, et al., 2006). Pregnancy should be postponed for at least 6 months after treatment.

A major advantage of treatment with radioactive iodine is that it avoids many of the side effects associated with antithyroid medications. However, some patients and their families fear medications that are radioactive. For this reason, patients may elect to take antithyroid medications rather than radioactive iodine.

#### *Antithyroid Medications*

Antithyroid medications are summarized in Table 42-3. The objective of pharmacotherapy is to inhibit one or more stages in thyroid hormone synthesis or hormone release. Antithyroid agents block the utilization of iodine by interfering with the iodination of tyrosine and the coupling of iodotyrosines in the synthesis of thyroid hormones. This prevents the synthesis of thyroid hormone. Most commonly, propylthiouracil (PTU) or methimazole (Tapazole) is used until the patient is euthyroid (ie, neither hyperthyroid nor hypothyroid). These medications block extrathyroidal conversion of $T_4$ to $T_3$.

The therapeutic dose is determined on the basis of clinical criteria, including changes in pulse rate, pulse pressure, body weight, size of the goiter, and results of laboratory studies of thyroid function. Because antithyroid

**Table 42-3 PHARMACOLOGIC AGENTS USED TO TREAT HYPERTHYROIDISM**

| Agent | Action | Nursing Considerations |
|---|---|---|
| Propylthiouracil (PTU) | Blocks synthesis of hormones (conversion of $T_3$ to $T_4$) | Monitor cardiac parameters.<br>Observe for conversion to hypothyroidism.<br>Must be given by mouth.<br>Watch for rash, nausea, vomiting, agranulocytosis, lupus syndrome. |
| Methimazole | Blocks synthesis of thyroid hormone | More toxic than PTU.<br>Watch for rash and other symptoms as for PTU. |
| Sodium iodide | Suppresses release of thyroid hormone | Given 1 h after PTU or methimazole.<br>Watch for edema, hemorrhage, gastrointestinal upset. |
| Potassium iodide | Suppresses release of thyroid hormone | Discontinue for rash.<br>Watch for signs of toxic iodinism. |
| Saturated solution of potassium iodide (SSKI) | Suppresses release of thyroid hormone | Mix with juice or milk.<br>Give by straw to prevent staining of teeth. |
| Dexamethasone | Suppresses release of thyroid hormone | Monitor input and output.<br>Monitor glucose.<br>May cause hypertension, nausea, vomiting, anorexia, infection. |
| Beta-blocker (eg, propranolol) | Beta-adrenergic blocking agent | Monitor cardiac status.<br>Hold for bradycardia or decreased cardiac output.<br>Use with caution in patients with heart failure. |

Adapted from Morton, P. G. & Fontaine, D. K. (2009). *Critical care nursing: A holistic approach*. Philadelphia: Lippincott Williams & Wilkins.

medications do not interfere with release or activity of previously formed thyroid hormones, it may take several weeks until relief of symptoms occurs. At that time, the maintenance dose is established, and a gradual withdrawal of the medication over the next several months follows.

Toxic complications of antithyroid medications are relatively uncommon; nevertheless, the importance of periodic follow-up is emphasized, because medication sensitization, fever, rash, urticaria, or even agranulocytosis and thrombocytopenia (decrease in granulocytes and platelets) may develop. With any sign of infection, especially pharyngitis and fever or the occurrence of mouth ulcers, the patient is advised to stop the medication, notify the physician immediately, and undergo hematologic studies. Rash, arthralgias, and fever occur in 1% to 5% of patients (Reid & Wheeler, 2005). Agranulocytosis, the most serious toxic side effect, occurs in approximately 0.5% of patients. Its incidence is higher in patients older than 40 years of age. It usually occurs within the first 3 months but may occur up to 1 year after therapy is started.

Patients taking antithyroid medications are instructed not to use decongestants for nasal stuffiness, because these agents are poorly tolerated. PTU is the treatment of choice during pregnancy. Once the thyrotoxicity is under control, the dose is decreased to prevent fetal hypothyroidism. Antithyroid medications are contraindicated in late pregnancy, because they may produce goiter and cretinism in the fetus (Cooper, 2005).

Another goal of therapy is to reduce the amount of thyroid tissue, with resulting decreased thyroid hormone production. Thyroid hormone is occasionally administered with antithyroid medications to put the thyroid gland at rest. In this approach, hypothyroidism from excess antithyroid medication is avoided, as is stimulation of the thyroid gland by TSH. Levothyroxine sodium (Synthroid) is the most common thyroid hormone preparation used. It takes approximately 10 days of its administration to achieve full effect. Liothyronine sodium (Cytomel) has a more rapid onset, and its action is of short duration. Antithyroid medications may also be used to normalize thyroid function before radioactive iodine is administered, to suppress symptoms of thyrotoxicosis that may occur with this therapy (Cooper, 2005).

Relapse usually occurs within the first 3 to 6 months after medication is stopped. Thereafter, the rate of recurrence decreases and stabilizes after 1 to 2 years, for an overall recurrence rate of approximately 50% to 60% (Cooper, 2005). Discontinuation of antithyroid medications before therapy is complete usually results in relapse within 6 months. The incidence of relapse with subtotal thyroidectomy is 19% at 18 months; an incidence of hypothyroidism of 25% has been reported at 18 months after surgery. The risk of these complications illustrates the importance of long-term follow-up of patients treated for hyperthyroidism. It is important that the possibility of relapse be discussed so that a treatment strategy will be in place if relapse occurs.

### Adjunctive Therapy

Iodine or iodide compounds, once the only therapy available for patients with hyperthyroidism, are no longer used as the sole method of treatment. Such compounds decrease the release of thyroid hormones from the thyroid gland and reduce the vascularity and size of the thyroid. Compounds such as potassium iodide (KI), Lugol's solution, and saturated solution of potassium iodide (SSKI) may be used in combination with antithyroid agents or beta-adrenergic blockers to prepare the patient with hyperthyroidism for surgery. These agents reduce the activity of the thyroid hormone and the vascularity of the thyroid gland, making the surgical procedure safer (Brent, 2008). Solutions of iodine and iodide compounds are more palatable in milk or fruit juice and are administered through a straw to prevent staining of the teeth. These compounds reduce the metabolic rate more rapidly than antithyroid medications do, but their action does not last as long.

**NURSING ALERT**

**Patients receiving iodide medications should be observed for the development of goiter and should be cautioned against use of iodide-containing over-the-counter medications that can increase the response to iodide therapy. Cough medications, expectorants, bronchodilators, and salt substitutes may contain iodide and should be avoided.**

Beta-adrenergic blocking agents are important in controlling the sympathetic nervous system effects of hyperthyroidism. For example, propranolol is used to control nervousness, tachycardia, tremor, anxiety, and heat intolerance. The patient continues taking propranolol until the free $T_4$ is within the normal range and the TSH level approaches normal.

### Surgical Management

Surgery to remove thyroid tissue was once the primary method of treating hyperthyroidism. Today, surgery is reserved for special circumstances—for example, in pregnant women who are allergic to antithyroid medications, in patients with large goiters, or in patients who are unable to take antithyroid agents. Surgery for treatment of hyperthyroidism is performed soon after the thyroid function has returned to normal (4 to 6 weeks).

The surgical removal of about five sixths of the thyroid tissue (subtotal thyroidectomy) reliably results in a prolonged remission in most patients with exophthalmic goiter. Its use today is reserved for patients with obstructive symptoms, for pregnant women in the second trimester, and for patients with a need for rapid normalization of thyroid function. Before surgery, PTU is administered until signs of hyperthyroidism have disappeared. A beta-adrenergic blocking agent (eg, propranolol) may be used to reduce the heart rate and other signs and symptoms of hyperthyroidism; however, this does not create a euthyroid state. Iodine (Lugol's solution or KI) may be prescribed in an effort to reduce blood loss; however, the effectiveness of this treatment is unknown. Medications that may prolong clotting (eg, aspirin) are stopped several weeks before surgery to reduce the risk for postoperative bleeding. Patients receiving iodine medication must be monitored for evidence of iodine toxicity (iodism), which requires immediate withdrawal of the medication. Symptoms of iodism include swelling of the buccal mucosa, excessive salivation, coryza, and skin eruptions.

## Gerontologic Considerations

Although hyperthyroidism is much less common in elderly people than hypothyroidism, patients older than 60 years of age account for 10% to 15% of the cases of thyrotoxicosis. They often develop atypical signs and symptoms of endocrine disorders, including thyrotoxicosis. The only presenting manifestations may be anorexia and weight loss, absence of ocular signs, or isolated atrial fibrillation. (New or worsening heart failure or angina is more likely to occur in elderly than in younger patients.) These signs and symptoms may mask the underlying thyroid disease. Elderly patients also tend to have symptoms for longer periods of time and commonly present with vague and nonspecific signs and symptoms, making disorders difficult to detect (Dominguez, et al., 2008). Symptoms such as tachycardia, fatigue, mental confusion, weight loss, change in bowel habits, and depression can be attributed to age and other illnesses that are common in elderly people. In addition, patients may report cardiovascular symptoms and difficulty climbing stairs or rising from a chair because of muscle weakness. Elderly patients may have only a single manifestation (eg, anorexia, weight loss) of thyroid disease.

Spontaneous remission of hyperthyroidism is rare in elderly patients. Measurement of TSH is indicated in elderly patients who have unexplained physical or mental deterioration. The use of radioactive iodine is generally recommended for treatment of thyrotoxicosis in elderly patients unless an enlarged thyroid gland is pressing on the airway. The hypermetabolic state of thyrotoxicosis must be controlled by antithyroid medications before radioactive iodine is administered, because radiation therapy may precipitate thyroid storm by increasing the release of hormone from the thyroid gland. Thyroid storm, if it occurs, has a mortality rate of 10% in elderly patients.

Long-term use of antithyroid medications is not generally recommended for elderly patients because of the increased incidence of side effects, such as granulocytopenia, and the need for frequent monitoring. The dosage of other medications used to treat other chronic illnesses in elderly patients may need to be modified because of the altered rate of metabolism in hyperthyroidism. In addition, antithyroid medications are considered to be less effective in the treatment of toxic nodular goiter, the most common cause of thyrotoxicosis in the elderly.

Use of beta-adrenergic blocking agents (eg, propranolol) may be indicated to decrease the cardiovascular and neurologic signs and symptoms of thyrotoxicosis. These agents must be used with extreme caution in elderly patients to minimize adverse effects on cardiac function that may produce heart failure.

## NURSING PROCESS

### The Patient With Hyperthyroidism

#### Assessment

The health history and examination focus on symptoms related to accelerated or exaggerated metabolism. These include the patient's and family's reports of irritability and increased emotional reaction and the impact these changes have had on the patient's interactions with family, friends, and coworkers. The history includes other stressors and the patient's ability to cope with stress.

The nurse assesses the patient's nutritional status and the presence of symptoms. Symptoms related to excessive nervous system output and changes in vision and appearance of the eyes are noted. The nurse periodically assesses and monitors the patient's cardiac status, including heart rate, blood pressure, heart sounds, and peripheral pulses.

Because emotional changes are associated with hyperthyroidism, the patient's emotional state and psychological

status are evaluated, as well as such symptoms as irritability, anxiety, sleep disturbances, apathy, and lethargy, all of which may occur with hyperthyroidism. The family may also provide information about recent changes in the patient's emotional status.

## Diagnosis

### *Nursing Diagnoses*

Based on all the assessment data, the major nursing diagnoses of the patient with hyperthyroidism may include the following:

- Imbalanced nutrition, less than body requirements, related to exaggerated metabolic rate, excessive appetite, and increased GI activity
- Ineffective coping related to irritability, hyperexcitability, apprehension, and emotional instability
- Low self-esteem related to changes in appearance, excessive appetite, and weight loss
- Altered body temperature

### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications may include the following:

- Thyrotoxicosis or thyroid storm
- Hypothyroidism

## Planning and Goals

The goals for the patient may be improved nutritional status, improved coping ability, improved self-esteem, maintenance of normal body temperature, and absence of complications.

## Nursing Interventions

### *Improving Nutritional Status*

Hyperthyroidism affects all body systems, including the GI system. The appetite is increased but may be satisfied by several well-balanced meals of small size, even up to six meals a day. Foods and fluids are selected to replace fluid lost through diarrhea and diaphoresis and to control the diarrhea that results from increased peristalsis. Rapid movement of food through the GI tract may result in nutritional imbalance and further weight loss. To reduce diarrhea, highly seasoned foods and stimulants such as coffee, tea, cola, and alcohol are discouraged. High-calorie, high-protein foods are encouraged. A quiet atmosphere during mealtime may aid digestion. Weight and dietary intake are recorded to monitor nutritional status.

### *Enhancing Coping Measures*

The patient with hyperthyroidism needs reassurance that the emotional reactions being experienced are a result of the disorder and that with effective treatment those symptoms will be controlled. Because of the negative effect these symptoms have on family and friends, they too need reassurance that the symptoms are expected to disappear with treatment.

It is important to use a calm, unhurried approach with the patient. Stressful experiences are minimized; therefore, if hospitalized, the patient is not placed in a room with very ill or talkative patients. The environment is kept quiet and uncluttered. Noises, such as loud music, conversation, and equipment alarms, are minimized. The nurse encourages relaxing activities if they do not overstimulate the patient.

If thyroidectomy is planned, the patient needs to know that pharmacologic therapy is necessary to prepare the thyroid gland for surgical treatment. The nurse instructs and reminds the patient to take the medications as prescribed. Because of hyperexcitability and shortened attention span, the patient may require repetition of this information and written instructions.

### *Improving Self-Esteem*

The patient with hyperthyroidism is likely to experience changes in appearance, appetite, and weight. These factors, along with the patient's inability to cope well with family and the illness, may result in loss of self-esteem. The nurse conveys an understanding of the patient's concern about these problems and promotes use of effective coping strategies. The patient and family need to know that these changes are a result of the thyroid dysfunction and are, in fact, out of the patient's control.

If changes in appearance are very disturbing to the patient, mirrors may be covered or removed. In addition, the nurse reminds family members and personnel to avoid bringing these changes to the patient's attention. The nurse explains to the patient and family that most of these changes are expected to disappear with effective treatment.

If the patient experiences ocular changes secondary to hyperthyroidism, eye care and protection may be necessary. The patient may need instructions about instillation of eye drops or ointment prescribed to soothe the eyes and protect the exposed cornea. The patient should also be discouraged from smoking.

The patient may be embarrassed by the need to eat large meals. Therefore, the nurse arranges for the patient to eat alone if desired and avoids commenting on the patient's large dietary intake while making sure that the patient receives sufficient food.

### *Maintaining Normal Body Temperature*

The patient with hyperthyroidism frequently finds a normal room temperature too warm because of an exaggerated metabolic rate and increased heat production. If the patient is hospitalized, the nurse maintains the environment at a cool, comfortable temperature and changes bedding and clothing as needed. Cool baths and cool or cold fluids are encouraged, because they may provide relief.

### *Monitoring and Managing Potential Complications*

The nurse closely monitors the patient with hyperthyroidism for signs and symptoms that may be indicative of thyroid storm. Cardiac and respiratory function are assessed by measuring vital signs and cardiac output, electrocardiographic (ECG) monitoring, arterial blood gases, and pulse oximetry. Assessment continues after treatment is initiated because of the potential effects of treatment on cardiac function. Oxygen is administered to prevent hypoxia, to improve tissue oxygenation, and to meet the high metabolic demands. IV fluids may be necessary to maintain blood glucose levels and to replace lost fluids. Antithyroid medications (PTU or methimazole) may be prescribed to reduce

thyroid hormone levels. In addition, propranolol and digitalis may be prescribed to treat cardiac symptoms. If shock develops, treatment strategies must be implemented (see Chapter 15).

Hypothyroidism is likely to occur with any of the treatments used for hyperthyroidism. Therefore, the nurse periodically monitors the patient. Most patients report a greatly improved sense of well-being after treatment of hyperthyroidism, and some fail to continue to take prescribed thyroid replacement therapy. Therefore, part of patient and family teaching is instruction about the importance of continuing therapy indefinitely after discharge and a discussion of the consequences of failing to take medication.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The nurse teaches the patient with hyperthyroidism how and when to take prescribed medication and provides instruction about the essential role of the medication in the broader therapeutic plan. Because of the hyperexcitability and decreased attention span associated with hyperthyroidism, the nurse provides a written plan for the patient to use at home. The type and amount of information given depend on the patient's stress and anxiety levels. The patient and family members receive verbal and written information about the actions and possible side effects of the medications. The nurse identifies adverse effects that should be reported if they occur (Chart 42-7).

If a total or subtotal thyroidectomy is anticipated, the patient needs information about what to expect. This information is repeated as the time of surgery approaches. The nurse also advises the patient to avoid stressful situations that may precipitate thyroid storm.

**CONTINUING CARE.** Referral for home care, if indicated, allows the home care nurse to assess the home and family environment and the patient's and family's understanding of the importance of adhering to the therapeutic regimen and the recommended follow-up monitoring. The nurse reinforces to the patient and family the importance of long-term follow-up because of the risk of hypothyroidism after thyroidectomy or treatment with antithyroid medications or radioactive iodine. The nurse also assesses the patient for changes indicating return to normal thyroid function and signs and symptoms of hyperthyroidism and hypothyroidism. Furthermore, the nurse reminds the patient and family about the importance of health promotion activities and recommended health screening.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Improves nutritional status
   a. Reports adequate dietary intake and decreased hunger
   b. Identifies high-calorie, high-protein foods; identifies foods to be avoided
   c. Avoids use of alcohol and other stimulants
   d. Stops smoking
   e. Reports decreased episodes of diarrhea
2. Demonstrates effective coping methods in dealing with family, friends, and coworkers
   a. Explains reasons for irritability and emotional instability
   b. Avoids stressful situations, events, and people
   c. Participates in relaxing, nonstressful activities
3. Achieves increased self-esteem
   a. Verbalizes feelings about self and illness
   b. Describes feelings of frustration and loss of control
   c. Describes reasons for increased appetite

CHART 42-7 HOME CARE CHECKLIST
**The Patient With Hyperthyroidism**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of hyperthyroidism on the body. | ✔ | ✔ |
| • State precipitating factors and interventions for complications (hypothyroidism, thyroid storm). | ✔ | ✔ |
| • State the purpose, dose, route, schedule, side effects, and precautions of prescribed medications (propylthiouracil, radioactive iodine). | ✔ | ✔ |
| • State the need to contact health care provider before taking over-the-counter medications. | ✔ | ✔ |
| • State need for regular follow-up visits with health care provider. | ✔ | ✔ |
| • Identify the need for planned rest periods and methods to improve sleep patterns. | ✔ | ✔ |
| • Identify the need for increased dietary intake until weight stabilizes. | ✔ | ✔ |
| • Identify areas of physical and emotional stress. | ✔ | ✔ |
| • State that emotional lability is part of disease process. | ✔ | ✔ |
| • Describe the potential benefits and risks of surgical intervention or radioactive iodine therapy. | ✔ | ✔ |
| • Identify potential for menstrual irregularities, increased risk for osteoporosis, and potential for pregnancy for women. | ✔ | ✔ |
| • State need to wear medical identification and carry medical information card. | ✔ | ✔ |
| • Identify rationale for smoking cessation and take steps to stop smoking. | ✔ | |

4. Maintains normal body temperature
5. Absence of complications
   a. Has serum thyroid hormone and TSH levels within normal limits
   b. Identifies signs and symptoms of thyroid storm and hypothyroidism
   c. Has vital signs and results of ECG, arterial blood gases, and pulse oximetry within normal limits
   d. States importance of regular follow-up and lifelong maintenance of prescribed therapy

## THYROIDITIS

**Thyroiditis,** inflammation of the thyroid gland, can be acute, subacute, or chronic. Each type of thyroiditis is characterized by inflammation, fibrosis, or lymphocytic infiltration of the thyroid gland. Several forms of thyroiditis are characterized by autoimmune damage to the thyroid. The various forms of thyroiditis may cause thyrotoxicosis, hypothyroidism, or both (Bindra & Braunstein, 2006).

### Acute Thyroiditis

Acute thyroiditis is a rare disorder caused by infection of the thyroid gland by bacteria, fungi, mycobacteria, or parasites. *Staphylococcus aureus* and other staphylococci are the most common causes. Infection typically causes anterior neck pain and swelling, fever, dysphagia, and dysphonia. Pharyngitis or pharyngeal pain is often present. Examination may reveal warmth, erythema (redness), and tenderness of the thyroid gland. Treatment of acute thyroiditis includes antimicrobial agents and fluid replacement. Surgical incision and drainage may be needed if an abscess is present.

### Subacute Thyroiditis

Subacute thyroiditis may be subacute granulomatous thyroiditis (de Quervain's thyroiditis) or painless thyroiditis (silent thyroiditis or subacute lymphocytic thyroiditis). Subacute granulomatous thyroiditis is an inflammatory disorder of the thyroid gland that predominantly affects women between the ages of 40 and 50 years (Bindra & Braunstein, 2006). The condition is usually associated with a viral respiratory infection and has a summer peak incidence that coincides with coxsackievirus groups A and B and echovirus infections. Signs and symptoms include myalgias, pharyngitis, low-grade fever, and fatigue. These progress to a painful swelling in the anterior neck that lasts 1 to 2 months and then disappears spontaneously without residual effect. The thyroid enlarges symmetrically and may be painful. The overlying skin is often reddened and warm. Swallowing may be difficult and uncomfortable. Irritability, nervousness, insomnia, and weight loss—manifestations of hyperthyroidism—are common, and many patients experience chills and fever as well. There is no thrill or bruit found on physical examination of the thyroid gland in hyperthyroidism with subacute thyroiditis. The absence of this sign assists in the differentiation of hyperthyroidism associated with subacute thyroiditis and hyperthyroidism associated with Graves' disease (Bindra & Braunstein, 2006).

Treatment is directed toward control of the inflammation. In general, nonsteroidal anti-inflammatory drugs are used to relieve neck pain. Acetylsalicylic acid (aspirin) is avoided if symptoms of hyperthyroidism occur, because aspirin displaces thyroid hormone from its binding sites and increases the amount of circulating hormone. Beta-blocking agents (eg, propranolol [Inderal]) may be used to control symptoms of hyperthyroidism. Antithyroid agents, which block the synthesis of $T_3$ and $T_4$, are not effective because the associated thyrotoxicosis results from the release of stored thyroid hormones rather than from their increased synthesis. In cases that are more severe and do not respond to treatment within 5 weeks, oral corticosteroids may be prescribed to reduce swelling and relieve pain. However, corticosteroids do not usually affect the underlying cause (Bindra & Braunstein, 2006). In some cases, temporary hypothyroidism may develop and may necessitate thyroid hormone therapy. Follow-up monitoring is necessary to document the patient's return to a euthyroid state.

Painless thyroiditis (subacute lymphocytic thyroiditis) often occurs in the postpartum period and is thought to be an autoimmune process. Symptoms of hyperthyroidism or hypothyroidism are possible. Treatment is directed at symptoms, and yearly follow-up is recommended to determine the patient's need for treatment of subsequent hypothyroidism.

### Chronic Thyroiditis (Hashimoto's Disease)

Chronic thyroiditis, which occurs most frequently in women between the ages of 30 and 50 years, has been termed Hashimoto's disease, or chronic lymphocytic thyroiditis. In contrast to acute thyroiditis, the chronic forms usually are not accompanied by pain, pressure symptoms, or fever, and thyroid activity usually is normal or low rather than increased. Cell-mediated immunity may play a significant role in the pathogenesis of chronic thyroiditis, and there may be a genetic predisposition to it. Diagnosis is based on the histologic appearance of the inflamed thyroid gland. Patients with Hashimoto's disease should also be evaluated for primary thyroid lymphoma if they present with a rapidly growing nodule, because they are 60 to 80 times more likely to develop this condition than the general population (Bindra & Braunstein, 2006). If untreated, the disease runs a slow, progressive course, leading eventually to hypothyroidism. Indications for treatment include goiter or clinical hypothyroidism.

The objective of treatment is to reduce the size of the thyroid gland and prevent hypothyroidism. Thyroid hormone therapy is prescribed to reduce thyroid activity and the production of thyroglobulin. If hypothyroid symptoms are present, thyroid hormone therapy is prescribed. Surgery may be required if pressure symptoms persist.

## THYROID TUMORS

Tumors of the thyroid gland are classified on the basis of being benign or malignant, the presence or absence of associated thyrotoxicosis, and the diffuse or irregular quality of the glandular enlargement. If the enlargement is sufficient to cause a visible swelling in the neck, the tumor is referred to as a goiter.

All grades of goiter are encountered, from those that are barely visible to those producing disfigurement. Some are

symmetric and diffuse; others are nodular. Some are accompanied by hyperthyroidism, in which case they are described as toxic; others are associated with a euthyroid state and are called nontoxic goiters.

## Endemic (Iodine-Deficient) Goiter

The most common type of goiter, once encountered chiefly in geographic regions where the natural supply of iodine is deficient (eg, the Great Lakes areas of the United States), is the so-called simple or colloid goiter. In addition to being caused by an iodine deficiency, simple goiter may be caused by an intake of large quantities of goitrogenic substances in patients with unusually susceptible glands. These substances include excessive amounts of iodine or lithium, which is used in treating bipolar disorders.

Simple goiter represents a compensatory hypertrophy of the thyroid gland, caused by stimulation by the pituitary gland. The pituitary gland produces thyrotropin or TSH, a hormone that controls the release of thyroid hormone from the thyroid gland. Its production increases if there is subnormal thyroid activity, as when insufficient iodine is available for production of the thyroid hormone. Such goiters usually cause no symptoms, except for the swelling in the neck, which may result in tracheal compression when excessive.

Many goiters of this type recede after the iodine imbalance is corrected. Supplementary iodine, such as SSKI, is prescribed to suppress the pituitary's thyroid-stimulating activity. When surgery is recommended, the risk of postoperative complications is minimized by ensuring a preoperative euthyroid state through treatment with antithyroid medications and iodide to reduce the size and vascularity of the goiter.

Providing children in iodine-poor regions with iodine compounds can prevent simple or endemic goiter. Although the introduction of iodized salt has been the single most effective means of preventing goiter in at-risk populations, the World Health Organization (2007) is exploring alternative strategies to ensure iodine intake because of the health risks associated with excessive salt intake.

## Nodular Goiter

Some thyroid glands are nodular because of areas of hyperplasia (overgrowth). No symptoms may arise as a result of this condition, but not uncommonly these nodules slowly increase in size, with some descending into the thorax, where they cause local pressure symptoms. Some nodules become malignant, and some are associated with a hyperthyroid state. Therefore, the patient with many thyroid nodules may eventually require surgery.

## Thyroid Cancer

Cancer of the thyroid is much less prevalent than other forms of cancer; however, it accounts for 90% of endocrine malignancies. According to the American Cancer Society (2009), more than 37,000 new cases of thyroid cancer are diagnosed each year, with one fourth of the cases occurring in men and three fourths in women. About 1600 people die annually from this malignancy. There are several types of cancer of the thyroid gland; the type determines the course and prognosis (Table 42-4).

External radiation of the head, neck, or chest in infancy and childhood increases the risk of thyroid carcinoma. The incidence of thyroid cancer appears to increase 5 to 40 years after irradiation. Consequently, people who underwent radiation treatment or were otherwise exposed to radiation as children should consult a physician, request an isotope thyroid scan as part of the evaluation, follow recommended treatment of abnormalities of the gland, and continue with annual checkups (Chart 42-8).

### *Assessment and Diagnostic Findings*

Lesions that are single, hard, and fixed on palpation or associated with cervical lymphadenopathy suggest malignancy. Thyroid function tests may be helpful in evaluating thyroid nodules and masses; however, results are rarely

**Table 42-4 TYPES OF THYROID CANCERS**

| Type of Thyroid Cancer | Incidence (%) | Characteristics |
|---|---|---|
| Papillary adenocarcinoma | 70 | Most common and least aggressive<br>Asymptomatic nodule in a normal gland<br>Starts in childhood or early adult life, remains localized<br>Metastasizes along the lymphatics if untreated<br>More aggressive in the elderly |
| Follicular adenocarcinoma | 15 | Appears after 40 y of age<br>Encapsulated; feels elastic or rubbery on palpation<br>Spreads through the bloodstream to bone, liver, and lung<br>Prognosis is not as favorable as for papillary adenocarcinoma |
| Medullary | 5 | Appears after 50 y of age<br>Occurs as part of multiple endocrine neoplasia (MEN)<br>Hormone-producing tumor causing endocrine dysfunction symptoms<br>Metastasizes by lymphatics and bloodstream<br>Moderate survival rate |
| Anaplastic | 5 | 50% of anaplastic thyroid carcinomas occur in patients older than 60 y<br>Hard, irregular mass that grows quickly and spreads by direct invasion to adjacent tissues<br>May be painful and tender<br>Survival for patients with anaplastic cancer is usually less than 6 mo |
| Thyroid lymphoma | 5 | Appears after age 40 y<br>May have history of goiter, hoarseness, dyspnea, pain, and pressure<br>Good prognosis |

## Chart 42-8 • *Radiation-Induced Thyroid Damage and Cancer*

The thyroid gland has a very efficient mechanism to remove iodine from the bloodstream and concentrate or "trap" it for subsequent synthesis of thyroid hormone. The effectiveness of this mechanism to concentrate iodide is reflected in a concentration of iodide 20 to 40 times the concentration of iodide in the plasma.

If milk and other food sources become contaminated with radioactivity as a result of a nuclear detonation or a nuclear power plant incident or mishap, the radioactive iodide would become concentrated in the thyroid gland at a very high concentration and would irradiate the thyroid gland, increasing the risk for thyroid gland cancer. Therefore, in communities exposed to increased radioactivity, attempts have been made to block the uptake of radioactive iodide by flooding or saturating the thyroid gland with nonradioactive iodide.

Administration of potassium iodide (KI) or other iodide preparations as soon as possible after exposure almost completely inhibits thyroid absorption of the radioactive iodide and promotes rapid excretion of any that is absorbed. In 2001, the Food and Drug Administration issued a statement recommending KI administration in advance of exposure to radioactive iodine—that is, when exposure is imminent (Thyroid Carcinoma Task Force, 2001).

conclusive. Needle biopsy of the thyroid gland is used as an outpatient procedure to make a diagnosis of thyroid cancer, to differentiate cancerous thyroid nodules from noncancerous nodules, and to stage the cancer if detected. The procedure is safe and usually requires only a local anesthetic agent. However, patients who undergo the procedure are monitored closely, because cancerous tissues may be missed during the procedure. A second type of aspiration or biopsy uses a large-bore needle rather than the fine needle used in standard biopsy; it may be used when the results of the standard biopsy are inconclusive or with rapidly growing tumors. Additional diagnostic studies include ultrasound, MRI, CT, thyroid scans, radioactive iodine uptake studies, and thyroid suppression tests.

### *Medical Management*

The treatment of choice for thyroid carcinoma is surgical removal. Total or near-total **thyroidectomy** is performed if possible. Modified neck dissection or more extensive radical neck dissection is performed if there is lymph node involvement.

Efforts are made to spare parathyroid tissue to reduce the risk of postoperative hypocalcemia and tetany. After surgery, ablation procedures are carried out with radioactive iodine to eradicate residual thyroid tissue if the tumor is radiosensitive. Radioactive iodine also maximizes the chance of discovering thyroid metastasis at a later date if total-body scans are carried out.

After surgery, thyroid hormone is administered in suppressive doses to lower the levels of TSH to a euthyroid state (Cooper, et al., 2006). If the remaining thyroid tissue is inadequate to produce sufficient thyroid hormone, thyroxine is required permanently.

Several routes are available for administering radiation to the thyroid or tissues of the neck, including oral administration of radioactive iodine and external administration of radiation therapy. The patient who receives external sources of radiation therapy is at risk for mucositis, dryness of the mouth, dysphagia, redness of the skin, anorexia, and fatigue (see Chapter 16). Chemotherapy is infrequently used to treat thyroid cancer.

Patients whose thyroid cancer is detected early and who are appropriately treated usually do very well. Patients who have had papillary cancer, the most common and least aggressive tumor, have a 10-year survival rate greater than 90%. Long-term survival is also common in follicular cancer, a more aggressive form of thyroid cancer (Tierney, et al., 2005). However, continued thyroid hormone therapy and periodic follow-up and diagnostic testing are important to ensure the patient's well-being (Cooper, et al., 2006).

Postoperatively, the patient is instructed to take exogenous thyroid hormone to prevent hypothyroidism. Later follow-up includes clinical assessment for recurrence of nodules or masses in the neck and signs of hoarseness, dysphagia, or dyspnea. Total-body scans are performed 2 to 4 months after surgery to detect residual thyroid tissue or metastatic disease. Thyroid hormones are stopped for about 6 weeks before the tests. Care must be taken to avoid iodine-containing foods and contrast agents. A repeat scan is performed 1 year after the initial surgery. If measurements are stable, a final scan is obtained in 3 to 5 years.

Free $T_4$, TSH, and serum calcium and phosphorus levels are monitored to determine whether the thyroid hormone supplementation is adequate and to note whether calcium balance is maintained.

Although local and systemic reactions to radiation may occur and may include neutropenia or thrombocytopenia, these complications are rare when radioactive iodine is used. Patients who undergo surgery that is combined with radioactive iodine have a higher survival rate than those who undergo surgery alone. Patient teaching emphasizes the importance of taking prescribed medications and following recommendations for follow-up monitoring. The patient who is undergoing radiation therapy is also instructed in how to assess and manage side effects of treatment.

### *Nursing Management*

Important preoperative goals are to gain the patient's confidence and reduce anxiety. Often, the patient's home life has become tense because of his or her restlessness, irritability, and nervousness secondary to hyperthyroidism. Efforts are necessary to protect the patient from such tension and stress to avoid precipitating thyroid storm. If the patient reports increased stress when with family or friends, suggestions are made to limit contact with them. Quiet and relaxing forms of recreation or occupational therapy may be helpful.

#### Providing Preoperative Care

The nurse instructs the patient about the importance of eating a diet high in carbohydrates and proteins. A high daily caloric intake is necessary because of the increased metabolic activity and rapid depletion of glycogen reserves. Supplementary vitamins, particularly thiamine and ascorbic

acid, may be prescribed. The patient is reminded to avoid tea, coffee, cola, and other stimulants.

The nurse also informs the patient about the purpose of preoperative tests, if they are to be performed, and explains what preoperative preparations to expect. This information should help to reduce the patient's anxiety about the surgery. In addition, special efforts are made to ensure a good night's rest before surgery, although many patients are admitted to the hospital on the day of surgery.

Preoperative teaching includes demonstrating to the patient how to support the neck with the hands after surgery to prevent stress on the incision. This involves raising the elbows and placing the hands behind the neck to provide support and reduce strain and tension on the neck muscles and the surgical incision.

**Providing Postoperative Care**

The nurse periodically assesses the surgical dressings and reinforces them if necessary. When the patient is in a recumbent position, the nurse observes the sides and the back of the neck as well as the anterior dressing for bleeding. In addition to monitoring the pulse and blood pressure for any indication of internal bleeding, it is important to be alert for complaints of a sensation of pressure or fullness at the incision site. Such symptoms may indicate subcutaneous hemorrhage and hematoma formation and should be reported.

Difficulty in respiration can occur as a result of edema of the glottis, hematoma formation, or injury to the recurrent laryngeal nerve. This complication requires that an airway be inserted. Therefore, a tracheostomy set is kept at the bedside at all times, and the surgeon is summoned at the first indication of respiratory distress. If the respiratory distress is caused by hematoma, surgical evacuation is required.

The intensity of pain is assessed, and analgesic agents are administered as prescribed for pain. The nurse should anticipate apprehension in the patient and should inform the patient that oxygen will assist breathing. When moving and turning the patient, the nurse carefully supports the patient's head and avoids tension on the sutures. The most comfortable position is the semi-Fowler's position, with the head elevated and supported by pillows.

IV fluids are administered during the immediate postoperative period. Water may be given by mouth as soon as nausea subsides. Usually, there is a little difficulty in swallowing; initially, cold fluids and ice may be taken better than other fluids. Often, patients prefer a soft diet to a liquid diet in the immediate postoperative period.

The patient is advised to talk as little as possible to reduce edema to the vocal cords; however, when the patient does speak, any voice changes are noted, which might indicate injury to the recurrent laryngeal nerve, which lies just behind the thyroid next to the trachea. An overbed table is provided for access to frequently used items so the patient avoids turning his or her head. The table can also be used to support a humidifier when vapor-mist inhalations are prescribed for the relief of excessive mucus accumulation.

The patient is usually permitted out of bed as soon as possible and is encouraged to eat foods that are easily swallowed. A high-calorie diet may be prescribed to promote weight gain. Sutures or skin clips are usually removed on the second day. The patient is usually discharged from the hospital on the day of surgery or soon afterward if the postoperative course is uncomplicated.

**Monitoring and Managing Potential Complications**

Hemorrhage, hematoma formation, edema of the glottis, and injury to the recurrent laryngeal nerve are complications that have been reviewed previously in this chapter. Occasionally in thyroid surgery, the parathyroid glands are injured or removed, producing a disturbance in calcium metabolism. As the blood calcium level falls, hyperirritability of the nerves occurs, with spasms of the hands and feet and muscle twitching (see Chapter 14). This group of symptoms is termed tetany, and the nurse must immediately report its appearance, because laryngospasm, although rare, may occur and obstruct the airway. Tetany of this type is usually treated with IV calcium gluconate. This calcium abnormality is usually temporary after thyroidectomy unless all parathyroid tissue was removed.

**Promoting Home and Community-Based Care**

The patient is usually discharged within 1 or 2 days. Therefore, the patient and family need to be knowledgeable about the signs and symptoms of the complications that may occur and those that should be reported. Strategies are suggested for managing postoperative pain at home and for increasing humidification. The nurse explains to the patient and family the need for rest, relaxation, and nutrition. The patient is permitted to resume his or her former activities and responsibilities completely once recovered from surgery.

If indicated, a referral to home care is made. The home care nurse assesses the patient's recovery from surgery. The nurse also assesses the surgical incision and reinforces instruction about limiting activities that put strain on the incision and sutures. Family responsibilities and factors relating to the home environment that produce emotional tension have often been implicated as precipitating causes of thyrotoxicosis. A home visit provides an opportunity to evaluate these factors and to suggest ways to improve the home and family environment. The nurse instructs the patients about the importance of follow-up visits to the physician or the clinic for monitoring of thyroid status.

# THE PARATHYROID GLANDS

## *Anatomic and Physiologic Overview*

The parathyroid glands (normally four) are situated in the neck and embedded in the posterior aspect of the thyroid gland (Fig. 42-5). Parathormone (parathyroid hormone), the protein hormone produced by the parathyroid glands, regulates calcium and phosphorus metabolism. Increased secretion of parathormone results in increased calcium absorption from the kidney, intestine, and bones, which raises the blood calcium level. Some actions of this hormone are increased by the presence of vitamin D. Parathormone also tends to lower the blood phosphorus level. The serum level of ionized calcium regulates the output of parathormone. Increased serum calcium results in decreased parathormone secretion, creating a negative feedback system.

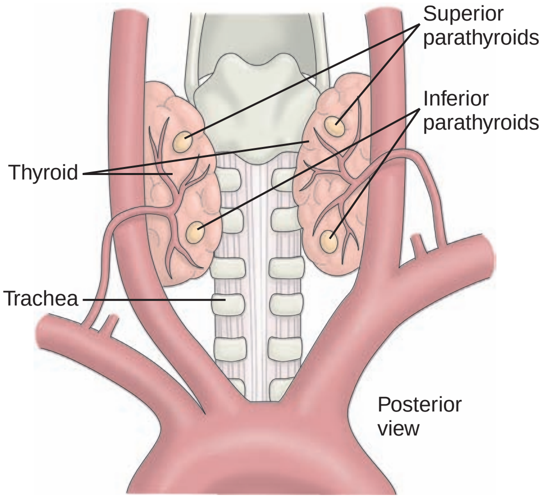



**Figure 42-5** The parathyroid glands are located behind the thyroid gland. The parathyroids may be embedded in the thyroid tissue.

## Pathophysiology

Excess parathormone can result in markedly increased levels of serum calcium, a potentially life-threatening situation. When the product of serum calcium and serum phosphorus (calcium × phosphorus) rises, calcium phosphate may precipitate in various organs of the body (eg, the kidneys) and cause tissue calcification.

# Specific Disorders of the Parathyroid Glands

## HYPERPARATHYROIDISM

Hyperparathyroidism, which is caused by overproduction of parathormone by the parathyroid glands, is characterized by bone decalcification and the development of renal calculi (kidney stones) containing calcium.

Primary hyperparathyroidism occurs two to four times more often in women than in men and is most common in people between 60 and 70 years of age. Its incidence is approximately 25 cases per 100,000 (Suliburk & Perrier, 2007). The disorder is rare in children younger than 15 years of age, but its incidence increases 10-fold between the ages of 15 and 65 years. Half of the people diagnosed with hyperparathyroidism do not have symptoms.

Secondary hyperparathyroidism, with manifestations similar to those of primary hyperparathyroidism, occurs in patients who have chronic renal failure and so-called renal rickets as a result of phosphorus retention, increased stimulation of the parathyroid glands, and increased parathormone secretion.

### Clinical Manifestations

The patient may have no symptoms or may experience signs and symptoms resulting from involvement of several body systems. Apathy, fatigue, muscle weakness, nausea, vomiting, constipation, hypertension, and cardiac dysrhythmias may occur. All these signs and symptoms are attributable to the increased concentration of calcium in the blood. Psychological effects may vary from irritability and neurosis to psychoses caused by the direct action of calcium on the brain and nervous system. An increase in calcium produces a decrease in the excitation potential of nerve and muscle tissue.

The formation of stones in one or both kidneys, related to the increased urinary excretion of calcium and phosphorus, is one of the important complications of hyperparathyroidism and occurs in 55% of patients with primary hyperparathyroidism. Renal damage results from the precipitation of calcium phosphate in the renal pelvis and parenchyma, which causes renal calculi (kidney stones), obstruction, pyelonephritis, and renal failure.

Musculoskeletal symptoms accompanying hyperparathyroidism may be caused by demineralization of the bones or by bone tumors composed of benign giant cells resulting from overgrowth of osteoclasts. The patient may develop skeletal pain and tenderness, especially of the back and joints; pain on weight bearing; pathologic fractures; deformities; and shortening of body stature. Bone loss attributable to hyperparathyroidism increases the risk of fracture.

The incidence of peptic ulcer and pancreatitis is increased with hyperparathyroidism and may be responsible for many of the GI symptoms that occur.

### Assessment and Diagnostic Findings

Primary hyperparathyroidism is diagnosed by persistent elevation of serum calcium levels and an elevated concentration of parathormone. Radioimmunoassays for parathormone are sensitive and differentiate primary hyperparathyroidism from other causes of hypercalcemia in more than 90% of patients with elevated serum calcium levels. An elevated serum calcium level alone is a nonspecific finding, because serum levels may be altered by diet, medications, and renal and bone changes. Bone changes may be detected on x-ray or bone scans in advanced disease. The double-antibody parathyroid hormone test is used to distinguish between primary hyperparathyroidism and malignancy as a cause of hypercalcemia. Ultrasound, MRI, thallium scan, and fine-needle biopsy have been used to evaluate the function of the parathyroids and to localize parathyroid cysts, adenomas, or hyperplasia.

### Medical Management

#### *Surgical Management*

The recommended treatment for primary hyperparathyroidism is the surgical removal of abnormal parathyroid tissue (parathyroidectomy) (Rodgers, Lew & Solorzano, 2008; Suliburk & Perrier, 2007). In the past, the standard parathyroidectomy involved a bilateral neck exploration under general anesthesia. Today, minimally invasive parathyroidectomy techniques allow for unilateral neck exploration using local anesthesia; these are performed on an outpatient basis. In some cases only the removal of a single diseased gland is necessary, reducing morbidity rates associated with surgery. For asymptomatic patients who have only mildly elevated serum calcium concentrations and normal renal function, surgery may be delayed and the patient monitored closely for worsening of hypercalcemia, bone deterioration, renal impairment, or the development of kidney stones.

Surgery is recommended for asymptomatic patients who meet the following criteria: (1) younger than 50 years of age, (2) unable or unlikely to participate in follow-up care, (3) serum calcium level more than 1.0 mg/dL (0.25 mmol/L) above normal reference range, (4) urinary calcium level greater than 400 mg/day (10 mmol/day), (5) a 30% or greater decrease in renal function, or (6) with complaints of primary hyperparathyroidism, including nephrocalcinosis, osteoporosis, or a severe psychoneurologic disorder (AACE/AAES Task Force on Primary Hyperparathyroidism, 2005).

However, according to several authors, these criteria are too conservative; there is little evidence to support long-term medical management of asymptomatic patients who do not meet these criteria (Rodgers, et al., 2008; Suliburk & Perrier, 2007).

#### *Hydration Therapy*

Because kidney involvement is possible, patients with hyperparathyroidism are at risk for renal calculi. Therefore, a daily fluid intake of 2000 mL or more is encouraged to help prevent calculus formation. Cranberry juice is suggested, because it may lower the urinary pH. It can be added to other juices or to ginger ale for variety. Cranberry extract tablets are an alternative to reduce urinary pH. The patient is instructed to report other manifestations of renal calculi, such as abdominal pain and hematuria. Thiazide diuretics are avoided, because they decrease the renal excretion of calcium and further elevate serum calcium levels. Because of the risk of hypercalcemic crisis (see later discussion), the patient is instructed to avoid dehydration and to seek immediate health care if conditions that commonly produce dehydration (eg, vomiting, diarrhea) occur.

#### *Mobility*

Mobility of the patient, with walking or use of a rocking chair for those with limited mobility, is encouraged as much as possible, because bones that are subjected to normal stress give up less calcium. Bed rest increases calcium excretion and the risk for renal calculi. Oral phosphates lower the serum calcium level in some patients; long-term use is not recommended because of the risk of ectopic calcium phosphate deposition in soft tissues.

#### *Diet and Medications*

Nutritional needs are met, but the patient is advised to avoid a diet with restricted or excess calcium. If the patient has a coexisting peptic ulcer, prescribed antacids and protein feedings are necessary. Because anorexia is common, efforts are made to improve the appetite. Prune juice, stool softeners, and physical activity, along with increased fluid intake, help offset constipation, which is common postoperatively.

### Nursing Management

The insidious onset and chronic nature of hyperparathyroidism and its diverse and commonly vague symptoms may result in depression and frustration. The family may have considered the patient's illness to be psychosomatic. An awareness of the course of the disorder and an understanding approach by the nurse may help the patient and family deal with their reactions and feelings.

The nursing management of the patient undergoing parathyroidectomy is essentially the same as that of a patient undergoing thyroidectomy. However, the previously described precautions about airway patency, dehydration, immobility, and diet are particularly important in the patient who is awaiting or recovering from parathyroidectomy. Although not all parathyroid tissue is removed during surgery in an effort to control the calcium–phosphorus balance, the nurse closely monitors the patient to detect symptoms of tetany (which may be an early postoperative complication). Most patients quickly regain function of the remaining parathyroid tissue and experience only mild, transient postoperative hypocalcemia. In patients with significant bone disease or bone changes, a more prolonged period of hypocalcemia should be anticipated. The nurse reminds the patient and family about the importance of follow-up to ensure return of serum calcium levels to normal (Chart 42-9).

### Complications: Hypercalcemic Crisis

Acute hypercalcemic crisis can occur with extreme elevation of serum calcium levels. Serum calcium levels greater than 15 mg/dL (3.7 mmol/L) result in neurologic, cardiovascular, and renal symptoms that can be life-threatening. Treatment includes rehydration with large volumes of IV fluids, diuretic agents to promote renal excretion of excess calcium, and phosphate therapy to correct hypophosphatemia and decrease serum calcium levels by promoting calcium deposition in bone and reducing the gastrointestinal absorption of calcium. Cytotoxic agents (eg, mithramycin), calcitonin, and dialysis may be used in emergency situations to decrease serum calcium levels quickly.

*NURSING ALERT*

**The patient in acute hypercalcemic crisis requires close monitoring for life-threatening complications and prompt treatment to reduce serum calcium levels.**

A combination of calcitonin and corticosteroids has been administered in emergencies to reduce the serum calcium level by increasing calcium deposition in bone. Other agents that may be administered to decrease serum calcium levels include bisphosphonates (eg, etidronate [Didronel], pamidronate [Aredia]).

Expert assessment and care are required to minimize complications and reverse the life-threatening hypercalcemia. Medications are administered with care, and attention is given to fluid balance to promote return of normal fluid and electrolyte balance. Supportive measures are necessary for the patient and family. (See Chapters 14 and 16 for further discussion of hypercalcemic crisis.)

## HYPOPARATHYROIDISM

The most common cause of hypoparathyroidism is inadequate secretion of parathormone after interruption of the blood supply or surgical removal of parathyroid gland tissue during thyroidectomy, parathyroidectomy, or radical neck dissection. These small glands are easily overlooked and can be removed inadvertently during thyroid surgery. Atrophy

CHART 42-9

**HOME CARE CHECKLIST**
*The Patient With Hyperparathyroidism*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of hyperparathyroidism on the body. | ✔ | ✔ |
| • State precipitating factors and interventions for complications. | ✔ | ✔ |
| • State importance of regular follow-up visits with health care provider. | ✔ | ✔ |
| • Describe potential benefits and risks of parathyroidectomy. | ✔ | ✔ |
| • State the purpose, dose, route, schedule, side effects, and precautions of prescribed medications (loop diuretics, phosphate, calcitonin, mithramycin). | ✔ | ✔ |
| • State the need to contact health care provider before taking over-the-counter medication containing calcium. | ✔ | ✔ |
| • State need to take pain medications on a scheduled basis. | ✔ | ✔ |
| • Describe nonpharmacologic methods of pain management. | ✔ | ✔ |
| • Identify safety hazards and methods of injury prevention. | ✔ | ✔ |
| • Identify areas of activity limitations and impact on lifestyle. | ✔ | ✔ |
| • State need for increased fluid intake and diet low in calcium and vitamin D. | ✔ | ✔ |

of the parathyroid glands of unknown cause is a less common cause of hypoparathyroidism.

Deficiency of parathormone results in increased blood phosphate (hyperphosphatemia) and decreased blood calcium (hypocalcemia) levels. In the absence of parathormone, there is decreased intestinal absorption of dietary calcium and decreased resorption of calcium from bone and through the renal tubules. Decreased renal excretion of phosphate causes hypophosphaturia, and low serum calcium levels result in hypocalciuria.

## Clinical Manifestations

Hypocalcemia causes irritability of the neuromuscular system and contributes to the chief symptom of hypoparathyroidism—tetany. Tetany is a general muscle hypertonia, with tremor and spasmodic or uncoordinated contractions occurring with or without efforts to make voluntary movements. Symptoms of latent tetany are numbness, tingling, and cramps in the extremities, and the patient complains of stiffness in the hands and feet. In overt tetany, the signs include bronchospasm, laryngeal spasm, carpopedal spasm (flexion of the elbows and wrists and extension of the carpophalangeal joints and dorsiflexion of the feet), dysphagia, photophobia, cardiac dysrhythmias, and seizures. Other symptoms include anxiety, irritability, depression, and even delirium. ECG changes and hypotension also may occur.

## Assessment and Diagnostic Findings

A positive Trousseau's sign or a positive Chvostek's sign suggests latent tetany. **Trousseau's sign** is positive when carpopedal spasm is induced by occluding the blood flow to the arm for 3 minutes with a blood pressure cuff. **Chvostek's sign** is positive when a sharp tapping over the facial nerve just in front of the parotid gland and anterior to the ear causes spasm or twitching of the mouth, nose, and eye (see Chapter 14).

The diagnosis of hypoparathyroidism often is difficult because of the vague symptoms, such as aches and pains. Therefore, laboratory studies are especially helpful. Tetany develops at serum calcium levels of 5 to 6 mg/dL (1.2 to 1.5 mmol/L) or lower. Serum phosphate levels are increased, and x-rays of bone show increased density. Calcification is detected on x-rays of the subcutaneous or paraspinal basal ganglia of the brain.

## Medical Management

The goal of therapy is to increase the serum calcium level to 9 to 10 mg/dL (2.2 to 2.5 mmol/L) and to eliminate the symptoms of hypoparathyroidism and hypocalcemia. When hypocalcemia and tetany occur after a thyroidectomy, the immediate treatment is administration of IV calcium gluconate. If this does not decrease neuromuscular irritability and seizure activity immediately, sedative agents such as pentobarbital may be administered.

Parenteral parathormone can be administered to treat acute hypoparathyroidism with tetany. However, the high incidence of allergic reactions to injections of parathormone limits its use to acute episodes of hypocalcemia. The patient receiving parathormone is monitored closely for allergic reactions and changes in serum calcium levels.

Because of neuromuscular irritability, the patient with hypocalcemia and tetany requires an environment that is free of noise, drafts, bright lights, or sudden movement. Tracheostomy or mechanical ventilation may become necessary, along with bronchodilating medications, if the patient develops respiratory distress.

Therapy for chronic hypoparathyroidism is determined after serum calcium levels are obtained. A diet high in calcium and low in phosphorus is prescribed. Although milk, milk products, and egg yolk are high in calcium, they are restricted because they also contain high levels of phosphorus. Spinach also is avoided because it contains oxalate, which would form insoluble calcium substances. Oral tablets of calcium salts, such as calcium gluconate, may be used to supplement the diet. Aluminum hydroxide gel or aluminum carbonate (Gelusil, Amphojel) also is administered after

CHART 42-10 HOME CARE CHECKLIST
**The Patient With Hypoparathyroidism**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of hypoparathyroidism on the body. | ✔ | ✔ |
| • State precipitating factors and interventions for complications (seizure, cardiac dysrhythmias, cardiac arrest). | ✔ | ✔ |
| • State necessary actions for seizure activity. | | ✔ |
| • State importance of regular follow-up visits with health care provider. | ✔ | ✔ |
| • State purpose, dose, route, schedule, side effects, and precautions of prescribed medications (calcium, phosphate binders). | ✔ | ✔ |
| • State need to alternate activity and rest periods. | ✔ | ✔ |
| • Identify areas of activity limitations and impact on lifestyle. | ✔ | ✔ |
| • Identify foods high in calcium and vitamin D, low in phosphorus. | ✔ | ✔ |

meals to bind phosphate and promote its excretion through the GI tract.

Variable dosages of a vitamin D preparation—dihydrotachysterol (AT 10 or Hytakerol), ergocalciferol (vitamin D), or cholecalciferol (vitamin D)—are usually required and enhance calcium absorption from the GI tract.

### Nursing Management

Nursing management of the patient with possible acute hypoparathyroidism includes the following:

- Care of postoperative patients who have undergone thyroidectomy, parathyroidectomy, or radical neck dissection is directed toward detecting early signs of hypocalcemia and anticipating signs of tetany, seizures, and respiratory difficulties.
- Calcium gluconate is kept at the bedside with equipment necessary for emergency IV administration. If the patient requiring administration of calcium gluconate has a cardiac disorder, is subject to dysrhythmias, or is receiving digitalis, the calcium gluconate is administered slowly and cautiously.
- Calcium and digitalis increase systolic contraction and also potentiate each other; this can produce potentially fatal dysrhythmias. Consequently, the cardiac patient requires continuous cardiac monitoring and careful assessment.

An important aspect of nursing care is teaching about medications and diet therapy. The patient needs to know the reason for high calcium and low phosphate intake and the symptoms of hypocalcemia and hypercalcemia; he or she should know to contact the physician immediately if these symptoms occur (Chart 42-10).

## THE ADRENAL GLANDS

### *Anatomic and Physiologic Overview*

Each person has two adrenal glands, one attached to the upper portion of each kidney (Porth & Matfin, 2009). Each adrenal gland is, in reality, two endocrine glands with separate, independent functions. The adrenal medulla at the center of the gland secretes catecholamines, and the outer portion of the gland, the adrenal cortex, secretes steroid hormones (Fig. 42-6). The secretion of hormones from the adrenal cortex is regulated by the hypothalamic–pituitary–adrenal axis. The hypothalamus secretes corticotropin-releasing hormone (CRH), which stimulates the pituitary gland to secrete ACTH, which in turn stimulates

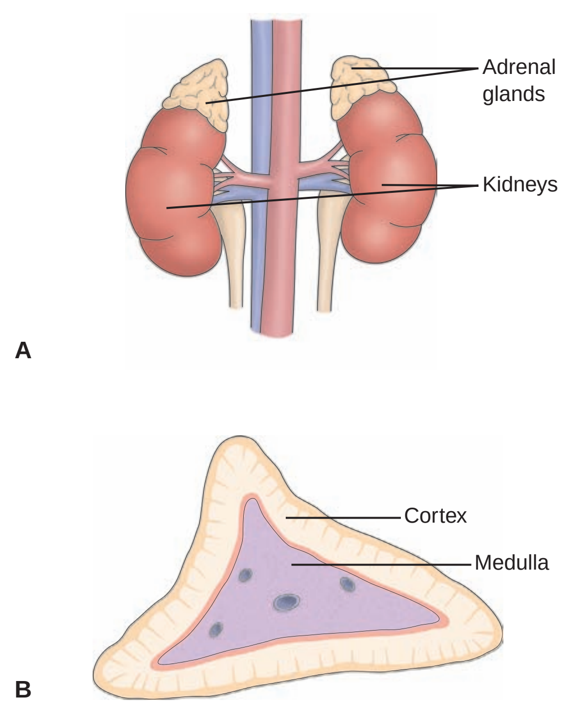



**Figure 42-6** **A,** The adrenal glands sit on top of the kidneys. **B,** Each gland is composed of an outer cortex and an inner medulla. Each area secretes specific hormones. The adrenal medulla secretes catecholamines—epinephrine and norepinephrine; the adrenal cortex secretes glucocorticoids, mineralocorticoids, and sex hormones. Adapted from Porth, C. (2006). *Essentials of pathophysiology: Concepts of altered health states* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins.

the adrenal cortex to secrete glucocorticoid hormone (cortisol). Increased levels of the adrenal hormone then inhibit the production or secretion of CRH and ACTH. This system is an example of a negative feedback mechanism.

## Adrenal Medulla

The adrenal medulla functions as part of the autonomic nervous system. Stimulation of preganglionic sympathetic nerve fibers, which travel directly to the cells of the adrenal medulla, causes release of the catecholamine hormones epinephrine and norepinephrine. About 90% of the secretion of the human adrenal medulla is epinephrine (also called adrenaline). Catecholamines regulate metabolic pathways to promote catabolism of stored fuels to meet caloric needs from endogenous sources. The major effects of epinephrine release are to prepare to meet a challenge (fight-or-flight response). Secretion of epinephrine causes decreased blood flow to tissues that are not needed in emergency situations, such as the GI tract, and increased blood flow to tissues that are important for effective fight or flight, such as cardiac and skeletal muscle. Catecholamines also induce the release of free fatty acids, increase the basal metabolic rate, and elevate the blood glucose level.

## Adrenal Cortex

A functioning adrenal cortex is necessary for life; adrenocortical secretions make it possible for the body to adapt to stress of all kinds. The three types of steroid hormones produced by the adrenal cortex are **glucocorticoids,** the prototype of which is hydrocortisone; **mineralocorticoids,** mainly aldosterone; and sex hormones, mainly **androgens** (male sex hormones). Without the adrenal cortex, severe stress would cause peripheral circulatory failure, circulatory shock, and prostration. Survival in the absence of a functioning adrenal cortex is possible only with nutritional, electrolyte, and fluid replacement and appropriate replacement with exogenous adrenocortical hormones.

### *Glucocorticoids*

The glucocorticoids are so named because they have an important influence on glucose metabolism: Increased hydrocortisone secretion results in elevated blood glucose levels. However, the glucocorticoids have major effects on the metabolism of almost all organs of the body. Glucocorticoids are secreted from the adrenal cortex in response to the release of ACTH from the anterior lobe of the pituitary gland. This system represents an example of negative feedback. The presence of glucocorticoids in the blood inhibits the release of CRH from the hypothalamus and also inhibits ACTH secretion from the pituitary. The resultant decrease in ACTH secretion causes diminished release of glucocorticoids from the adrenal cortex.

Glucocorticoids (in the form of **corticosteroids**) are administered frequently to inhibit the inflammatory response to tissue injury and to suppress allergic manifestations. Their side effects include the development of diabetes mellitus, osteoporosis, peptic ulcer, increased protein breakdown resulting in muscle wasting and poor wound healing, and redistribution of body fat. Large amounts of exogenously administered glucocorticoids in the blood inhibit the release of ACTH and endogenous glucocorticoids. Because of this, the adrenal cortex can atrophy. If exogenous glucocorticoid administration is discontinued suddenly, adrenal insufficiency results because of the inability of the atrophied cortex to respond adequately.

### *Mineralocorticoids*

Mineralocorticoids exert their major effects on electrolyte metabolism. They act principally on the renal tubular and GI epithelium to cause increased sodium ion absorption in exchange for excretion of potassium or hydrogen ions. ACTH only minimally influences aldosterone secretion. It is primarily secreted in response to the presence of angiotensin II in the bloodstream. Angiotensin II is a substance that elevates the blood pressure by constricting arterioles. Its concentration is increased when renin is released from the kidney in response to decreased perfusion pressure. The resultant increased aldosterone levels promote sodium reabsorption by the kidney and the GI tract, which tends to restore blood pressure to normal. The release of aldosterone is also increased by hyperkalemia. Aldosterone is the primary hormone for the long-term regulation of sodium balance.

### *Adrenal Sex Hormones (Androgens)*

Androgens, the third major type of steroid hormones produced by the adrenal cortex, exert effects similar to those of male sex hormones. The adrenal gland may also secrete small amounts of some estrogens, or female sex hormones. ACTH controls the secretion of adrenal androgens. When secreted in normal amounts, the adrenal androgens probably have little effect, but when secreted in excess, as in certain inborn enzyme deficiencies, masculinization may result. This is termed the **adrenogenital syndrome.**

# *Specific Disorders of the Adrenal Glands*

## PHEOCHROMOCYTOMA

Pheochromocytoma is a tumor that is usually benign and originates from the chromaffin cells of the adrenal medulla. In 90% of patients (Porth & Matfin, 2009), the tumor arises in the medulla; in the remaining patients, it occurs in the extra-adrenal chromaffin tissue located in or near the aorta, ovaries, spleen, or other organs. Pheochromocytoma may occur at any age, but its peak incidence is between 40 and 50 years of age affecting men and women equally. Ten percent of the tumors are bilateral, and 10% are malignant. Because of the high incidence of pheochromocytoma in family members of affected people, the patient's family members should be alerted and screened for this tumor. Pheochromocytoma may occur in the familial form as part of multiple endocrine neoplasia type 2; therefore, it should be considered a possibility in patients who have medullary thyroid carcinoma and parathyroid hyperplasia or tumor.

Pheochromocytoma is the cause of high blood pressure in 0.1% of patients with hypertension. Although it is uncommon, it is one form of hypertension that is usually cured by surgery; however, without detection and treatment, it is usually fatal.

## Clinical Manifestations

The nature and severity of symptoms of functioning tumors of the adrenal medulla depend on the relative proportions of epinephrine and norepinephrine secretion. The typical triad of symptoms is headache, diaphoresis, and palpitations in the patient with hypertension. Approximately 8% of patients are completely asymptomatic. Hypertension and other cardiovascular disturbances are common. The hypertension may be intermittent or persistent. However, only half of patients with pheochromocytoma have sustained or persistent hypertension. If the hypertension is sustained, it may be difficult to distinguish from other causes of hypertension. Other symptoms may include tremor, headache, flushing, and anxiety. Hyperglycemia may result from conversion of liver and muscle glycogen to glucose due to epinephrine secretion; insulin may be required to maintain normal blood glucose levels.

The clinical picture in the paroxysmal form of pheochromocytoma is usually characterized by acute, unpredictable attacks lasting seconds or several hours. Symptoms usually begin abruptly and subside slowly. During these attacks, the patient is extremely anxious, tremulous, and weak. The patient may experience headache, vertigo, blurring of vision, tinnitus, air hunger, and dyspnea. Other symptoms include polyuria, nausea, vomiting, diarrhea, abdominal pain, and a feeling of impending doom. Palpitations and tachycardia are common (Porth & Matfin, 2009). Blood pressures exceeding 250/150 mm Hg have been recorded. Such blood pressure elevations are life-threatening and can cause severe complications, such as cardiac dysrhythmias, dissecting aneurysm, stroke, and acute renal failure. Postural hypotension (decrease in systolic blood pressure, lightheadedness, dizziness on standing) occurs in 70% of patients with untreated pheochromocytoma.

## Assessment and Diagnostic Findings

Pheochromocytoma is suspected if signs of sympathetic nervous system overactivity occur in association with marked elevation of blood pressure. These signs can be associated with the "five H's": hypertension, headache, hyperhidrosis (excessive sweating), hypermetabolism, and hyperglycemia. The presence of these signs is highly predictive of pheochromocytoma. Paroxysmal symptoms of pheochromocytoma commonly develop in the fifth decade of life.

Measurements of urine and plasma levels of catecholamines and metanephrine (MN), a catecholamine metabolite, are the most direct and conclusive tests for overactivity of the adrenal medulla. A new test for detecting pheochromocytoma has recently been developed that measures free MN in plasma by high-pressure liquid chromatography and electrochemical detection. A negative test result virtually excludes pheochromocytoma. However, increased levels of at least one catecholamine or MN can occur in 10% of patients with essential hypertension.

Measurements of catecholamine metabolites (MN and vanillylmandelic acid [VMA]) or free catecholamines have been extensively used in the clinical setting. In most cases, pheochromocytoma can be diagnosed or confirmed based on a properly collected 24-hour urine sample. Levels can be as high as two times the normal limit. A 24-hour specimen of urine is collected for determination of free catecholamines, MN, and VMA; the use of combined tests increases the diagnostic accuracy of testing. A number of medications and foods, such as coffee and tea (including decaffeinated varieties), bananas, chocolate, vanilla, and aspirin, may alter the results of these tests; therefore, careful instructions to avoid restricted items must be given to the patient. Urine collected over a 2- or 3-hour period after an attack of hypertension can be assayed for catecholamine content.

The total plasma catecholamine (epinephrine and norepinephrine) concentration is measured with the patient supine and at rest for 30 minutes. To prevent elevation of catecholamine levels resulting from the stress of venipuncture, a butterfly needle, scalp vein needle, or venous catheter may be inserted 30 minutes before the blood specimen is obtained.

Factors that may elevate catecholamine concentrations must be controlled to obtain valid results; these factors include consumption of coffee or tea (including decaffeinated varieties), use of tobacco, emotional and physical stress, and use of many prescription and over-the-counter medications (eg, amphetamines, nose drops or sprays, decongestant agents, bronchodilators).

Normal plasma values of epinephrine are 100 pg/mL (590 pmol/L); normal values of norepinephrine are generally less than 100 to 550 pg/mL (590 to 3240 pmol/L). Values of epinephrine greater than 400 pg/mL (2180 pmol/L) or norepinephrine values greater than 2000 pg/mL (11,800 pmol/L) are considered diagnostic of pheochromocytoma. Values that fall between normal levels and those diagnostic of pheochromocytoma indicate the need for further testing.

A clonidine suppression test may be performed if the results of plasma and urine tests of catecholamines are inconclusive. Clonidine (Catapres) is a centrally acting antiadrenergic medication that suppresses the release of neurogenically mediated catecholamines. The suppression test is based on the principle that catecholamine levels are normally increased through the activity of the sympathetic nervous system. In pheochromocytoma, increased catecholamine levels result from the diffusion of excess catecholamines into the circulation, bypassing normal storage and release mechanisms. Therefore, in patients with pheochromocytoma, clonidine does not suppress the release of catecholamines.

Imaging studies, such as CT, MRI, and ultrasonography, may also be carried out to localize the pheochromocytoma and to determine whether more than one tumor is present. Use of $^{131}$I-metaiodobenzylguanidine (MIBG) scintigraphy may be required to determine the location of the pheochromocytoma and to detect metastatic sites outside the adrenal gland. MIBG is a specific isotope for catecholamine-producing tissue. It has been helpful in identifying tumors not detected by other tests or procedures. MIBG scintigraphy is a noninvasive, safe procedure that has increased the accuracy of diagnosis of adrenal tumors.

Other diagnostic studies may focus on evaluating the function of other endocrine glands because of the association of pheochromocytoma in some patients with other endocrine tumors.

## Medical Management

During an episode or attack of hypertension, tachycardia, anxiety, and the other symptoms of pheochromocytoma, bed rest with the head of the bed elevated is prescribed to promote an orthostatic decrease in blood pressure.

### *Pharmacologic Therapy*

The patient may be moved to the intensive care unit for close monitoring of ECG changes and careful administration of alpha-adrenergic blocking agents (eg, phentolamine [Regitine]) or smooth muscle relaxants (eg, sodium nitroprusside [Nipride]) to lower the blood pressure quickly.

Phenoxybenzamine (Dibenzyline), a long-acting alpha-blocker, may be used after the blood pressure is stable to prepare the patient for surgery. Calcium channel blockers such as nifedipine (Procardia) are usually well tolerated by patients and have reduced perioperative fluid requirements. They are also useful for prevention of cardiovascular complications, because they prevent catecholamine-induced coronary vasospasm and myocarditis. Beta-adrenergic blocking agents such as propranolol (Inderal) may be used in patients with cardiac dysrhythmias and in those not responsive to alpha-blockers. Alpha-adrenergic and beta-adrenergic blocking agents must be used with caution, because patients with pheochromocytoma may have increased sensitivity to them. Still other medications that may be used preoperatively are catecholamine synthesis inhibitors, such as alpha-methyl-*p*-tyrosine (metyrosine [Demser]). These are occasionally used if adrenergic blocking agents do not reduce the effects of catecholamines.

### *Surgical Management*

The definitive treatment of pheochromocytoma is surgical removal of the tumor, usually with **adrenalectomy.** Bilateral adrenalectomy may be necessary if tumors are present in both adrenal glands. Patient preparation includes control of blood pressure and blood volumes; usually this is carried out over 4 to 7 days. Nifedipine (Procardia) and nicardipine (Cardene) may be used safely without causing undue hypotension. For episodes of severe hypertension, nifedipine is a fast and effective treatment, because the capsules can be pierced and chewed. The patient needs to be well hydrated before, during, and after surgery to prevent hypotension.

Manipulation of the tumor during surgical excision may cause release of stored epinephrine and norepinephrine, with marked increases in blood pressure and changes in heart rate. Therefore, use of sodium nitroprusside (Nipride) and alpha-adrenergic blocking agents may be required during and after surgery. Exploration of other possible tumor sites is frequently undertaken to ensure removal of all tumor tissue. As a result, the patient is subject to the stress and effects of a long surgical procedure, which may increase the risk of hypertension postoperatively.

Corticosteroid replacement is required if bilateral adrenalectomy has been necessary. Corticosteroids may also be required for the first few days or weeks after removal of a single adrenal gland. IV administration of corticosteroids (methylprednisolone sodium succinate [Solu-Medrol]) may begin on the evening before surgery and continue during the early postoperative period to prevent adrenal insufficiency. Oral preparations of corticosteroids (prednisone) are prescribed after the acute stress of surgery diminishes.

Hypotension and hypoglycemia may occur in the postoperative period because of the sudden withdrawal of excessive amounts of catecholamines. Therefore, careful attention is directed toward monitoring and treating these changes. Blood pressure is expected to return to normal with treatment; however, one third of patients continue to be hypertensive after surgery. This may result if not all pheochromocytoma tissue was removed, if pheochromocytoma recurs, or if the blood vessels were damaged by severe and prolonged hypertension. Several days after surgery, urine and plasma levels of catecholamines and their metabolites are measured to determine whether the surgery was successful.

## Nursing Management

The patient who has undergone surgery to treat pheochromocytoma has experienced a stressful preoperative and postoperative course and may remain fearful of repeated attacks. Although it is usually expected that all pheochromocytoma tissue has been removed, there is a possibility that other sites were undetected and that attacks may recur. The patient is monitored for several days in the intensive care unit with special attention given to ECG changes, arterial pressures, fluid and electrolyte balance, and blood glucose levels. Several IV lines are inserted for administration of fluids and medications.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

During the preoperative and postoperative phases of care, the nurse informs the patient about the importance of follow-up monitoring to ensure that pheochromocytoma does not recur undetected. After adrenalectomy, use of corticosteroids may be needed. Therefore, the nurse instructs the patient about their purpose, the medication schedule, and the risks of skipping doses or stopping their administration abruptly.

It is important to teach the patient and family how to measure the patient's blood pressure and when to notify the physician about changes in blood pressure. In addition, the nurse provides verbal and written instructions about the procedure for collecting 24-hour urine specimens to monitor urine catecholamine levels.

#### Continuing Care

A follow-up visit from a home care nurse may be indicated to assess the patient's postoperative recovery, surgical incision, and compliance with the medication schedule. This may help reinforce previous teaching about management and monitoring. The home care nurse also obtains blood pressure measurements and assists the patient in preventing or dealing with problems that may result from long-term use of corticosteroids.

Because of the risk of recurrence of hypertension, periodic checkups are required, especially in young patients and in those whose families have a history of pheochromocytoma. The patient is scheduled for periodic follow-up

appointments to observe for return of normal blood pressure and plasma and urine levels of catecholamines.

# ADRENOCORTICAL INSUFFICIENCY (ADDISON'S DISEASE)

**Addison's disease,** or adrenocortical insufficiency, occurs when adrenal cortex function is inadequate to meet the patient's need for cortical hormones. Autoimmune or idiopathic atrophy of the adrenal glands is responsible for the vast majority of cases. Other causes include surgical removal of both adrenal glands and infection of the adrenal glands. Tuberculosis and histoplasmosis are the most common infections that destroy adrenal gland tissue. Although autoimmune destruction has replaced tuberculosis as the principal cause of Addison's disease, tuberculosis should be considered in the diagnostic workup because of its increasing incidence. Inadequate secretion of ACTH from the pituitary gland also results in adrenal insufficiency because of decreased stimulation of the adrenal cortex.

Therapeutic use of corticosteroids is the most common cause of adrenocortical insufficiency (Porth & Matfin, 2009). Symptoms of adrenocortical insufficiency may also result from the sudden cessation of exogenous adrenocortical hormonal therapy, which suppresses the body's normal response to stress and interferes with normal feedback mechanisms. Treatment with daily administration of corticosteroids for 2 to 4 weeks may suppress function of the adrenal cortex; therefore, adrenal insufficiency should be considered in any patient who has been treated with corticosteroids.

## Clinical Manifestations

Addison's disease is characterized by muscle weakness; anorexia; GI symptoms; fatigue; emaciation; dark pigmentation of the mucous membranes and the skin, especially of the knuckles, knees, and elbows; hypotension; and low blood glucose, low serum sodium, and high serum potassium levels. Mental status changes such as depression, emotional lability, apathy, and confusion are present in 60% to 80% of patients. In severe cases, the disturbance of sodium and potassium metabolism may be marked by depletion of sodium and water and severe, chronic dehydration.

With disease progression and acute hypotension, **addisonian crisis** develops. This condition is characterized by cyanosis and the classic signs of circulatory shock: pallor, apprehension, rapid and weak pulse, rapid respirations, and low blood pressure. In addition, the patient may complain of headache, nausea, abdominal pain, and diarrhea and may show signs of confusion and restlessness. Even slight overexertion, exposure to cold, acute infection, or a decrease in salt intake may lead to circulatory collapse, shock, and death if untreated. The stress of surgery or dehydration resulting from preparation for diagnostic tests or surgery may precipitate an addisonian or hypotensive crisis.

## Assessment and Diagnostic Findings

Although the clinical manifestations presented appear specific, the onset of Addison's disease usually occurs with nonspecific symptoms. The diagnosis is confirmed by laboratory test results. Combined measurements of early-morning serum cortisol and plasma ACTH are performed to differentiate primary adrenal insufficiency from secondary adrenal insufficiency and from normal adrenal function. Patients with primary insufficiency have a greatly increased plasma ACTH level (more than 22.0 pmol/L) and a serum cortisol concentration lower than the normal range (less than 165 nmol/L) or in the low-normal range. Other laboratory findings include decreased levels of blood glucose (hypoglycemia) and sodium (hyponatremia), an increased serum potassium concentration (hyperkalemia), and an increased white blood cell count (leukocytosis).

The diagnosis is confirmed by low levels of adrenocortical hormones in the blood or urine and decreased serum cortisol levels. If the adrenal cortex is destroyed, baseline values are low, and ACTH administration fails to cause the normal increase in plasma cortisol and urinary 17-hydroxycorticosteroids. If the adrenal gland is normal but not stimulated properly by the pituitary, a normal response to repeated doses of exogenous ACTH is seen, but no response occurs after the administration of metyrapone (Metopirone), which stimulates endogenous ACTH.

## Medical Management

Immediate treatment is directed toward combating circulatory shock: restoring blood circulation, administering fluids and corticosteroids, monitoring vital signs, and placing the patient in a recumbent position with the legs elevated. Hydrocortisone (Solu-Cortef) is administered by IV, followed by 5% dextrose in normal saline. Vasopressor amines may be required if hypotension persists.

Antibiotics may be administered if infection has precipitated adrenal crisis in a patient with chronic adrenal insufficiency. In addition, the patient is assessed closely to identify other factors, stressors, or illnesses that led to the acute episode.

Oral intake may be initiated as soon as tolerated. IV fluids are gradually decreased after oral fluid intake is adequate to prevent hypovolemia. If the adrenal gland does not regain function, the patient needs lifelong replacement of corticosteroids and mineralocorticoids to prevent recurrence of adrenal insufficiency. During stressful procedures or significant illnesses, additional supplementary therapy with glucocorticoids is required to prevent addisonian crisis. In addition, the patient may need to supplement dietary intake with added salt during gastrointestinal losses of fluids through vomiting and diarrhea.

## Nursing Management

### *Assessing the Patient*

The health history and examination focus on the presence of symptoms of fluid imbalance and on the patient's level of stress. The nurse should monitor the blood pressure and pulse rate as the patient moves from a lying, sitting, and standing position to assess for inadequate fluid volume. A decrease in systolic pressure (20 mm Hg or more) may indicate depletion of fluid volume, especially if accompanied by symptoms. The skin should be assessed for changes in color and turgor, which could indicate chronic adrenal insufficiency and hypovolemia. The patient is assessed for change in weight, muscle weakness, fatigue, and any illness or stress that may have precipitated the acute crisis.

### Monitoring and Managing Addisonian Crisis

The patient at risk is monitored for signs and symptoms indicative of addisonian crisis, which can include shock; hypotension; rapid, weak pulse; rapid respiratory rate; pallor; and extreme weakness (see Chapter 15). Physical and psychological stressors such as cold exposure, overexertion, infection, and emotional distress should be avoided.

The patient with addisonian crisis requires immediate treatment with IV administration of fluid, glucose, and electrolytes, especially sodium; replacement of missing steroid hormones; and vasopressors. The nurse anticipates and meets the patient's needs to promote return to a precrisis state.

### Restoring Fluid Balance

The nurse encourages the patient to consume foods and fluids that assist in restoring and maintaining fluid and electrolyte balance. Along with the dietitian, the nurse helps the patient select foods high in sodium during GI disturbances and in very hot weather.

The nurse instructs the patient and family to administer hormone replacement as prescribed and to modify the dosage during illness and other stressful situations. Written and verbal instructions are provided about the administration of mineralocorticoid (Florinef) or corticosteroid (prednisone) as prescribed.

### Improving Activity Tolerance

Until the patient's condition is stabilized, the nurse takes precautions to avoid unnecessary activity and stress that could precipitate another hypotensive episode. Efforts are made to detect signs of infection or the presence of other stressors. Explaining the rationale for minimizing stress during the acute crisis assists the patient to increase activity gradually.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

Because of the need for lifelong replacement of adrenal cortex hormones to prevent addisonian crises, the patient and family members receive explicit verbal and written instructions about the rationale for replacement therapy and proper dosage. In addition, they are instructed about how to modify the medication dosage and increase salt intake in times of illness, very hot weather, and other stressful situations. The patient also learns how to modify diet and fluid intake to help maintain fluid and electrolyte balance.

The patient and family are frequently prescribed preloaded, single-injection syringes of corticosteroid for use in emergencies. Specific instructions about how and when to use the injection are also provided. It is important to instruct the patient to inform other health care providers, such as dentists, about the use of corticosteroids; to wear a medical alert bracelet; and to carry information at all times about the need for corticosteroids. If the patient with Addison's disease requires surgery, careful administration of fluids and corticosteroids is necessary before, during, and after surgery to prevent addisonian crisis.

The patient and family need to know the signs of excessive or insufficient hormone replacement. The development of edema or weight gain may signify too high a dose of hormone; postural hypotension and weight loss frequently signify too low a dose (Chart 42-11).

CHART 42-11

HOME CARE CHECKLIST

***The Patient With Adrenal Insufficiency (Addison's Disease)***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of adrenal insufficiency on the body. | ✔ | ✔ |
| • State warning signs of adrenal crisis and need for emergency care. | ✔ | ✔ |
| • Explain components of an emergency kit and indications for their use; demonstrate how to use them. | ✔ | ✔ |
| • State strategies for dealing with stress and avoiding adrenal crisis. | ✔ | ✔ |
| • State the purpose, dose, route, schedule, side effects, and precautions of prescribed medications (corticosteroid replacement). | ✔ | ✔ |
| • State that compliance with medical regimen is lifelong. | ✔ | ✔ |
| • State importance of regular follow-up visits with health care provider. | ✔ | ✔ |
| • Recognize the need for dosage adjustment during times of stress. | ✔ | ✔ |
| • State need to wear medical alert identification and carry medical information card. | ✔ | ✔ |
| • State need to notify health care providers about disease before treatment or procedure. | ✔ | ✔ |
| • State need to avoid strenuous activity in hot, humid weather. | ✔ | ✔ |
| • State need for increased fluid intake and salt with excessive perspiration. | ✔ | ✔ |
| • State need for high-carbohydrate, high-protein diet with adequate sodium intake. | ✔ | ✔ |
| • Identify needed activity limitations and impact on lifestyle. | ✔ | ✔ |

**Continuing Care**

Although most patients can return to their job and family responsibilities soon after hospital discharge, others cannot do so because of concurrent illnesses or incomplete recovery from the episode of adrenal insufficiency. In these circumstances, a referral for home care enables the home care nurse to assess the patient's recovery, monitor hormone replacement, and evaluate stress in the home. The nurse assesses the patient's and family's knowledge about medication therapy and dietary modifications. A home visit also allows the nurse to assess the patient's plans for follow-up visits to the clinic or physician's office. The nurse reminds the patient and family about the importance of participating in health promotion activities and health screening.

## CUSHING'S SYNDROME

Cushing's syndrome results from excessive, rather than deficient, adrenocortical activity (Porth & Matfin, 2009). Cushing's syndrome is commonly caused by use of corticosteroid medications and is infrequently the result of excessive corticosteroid production secondary to hyperplasia of the adrenal cortex. However, overproduction of endogenous corticosteroids may be caused by several mechanisms, including a tumor of the pituitary gland that produces ACTH and stimulates the adrenal cortex to increase its hormone secretion despite production of adequate amounts. Primary hyperplasia of the adrenal glands in the absence of a pituitary tumor is less common. Another less common cause of Cushing's syndrome is the ectopic production of ACTH by malignancies; bronchogenic carcinoma is the most common type. Regardless of the cause, the normal feedback mechanisms that control the function of the adrenal cortex become ineffective, and the usual diurnal pattern of cortisol is lost. The signs and symptoms of Cushing's syndrome are primarily a result of oversecretion of glucocorticoids and androgens (sex hormones), although mineralocorticoid secretion also may be affected (Porth & Matfin, 2009).

### Clinical Manifestations

When overproduction of the adrenal cortical hormone occurs, arrest of growth, obesity, and musculoskeletal changes occur along with glucose intolerance. The classic picture of Cushing's syndrome in the adult is that of central-type obesity, with a fatty "buffalo hump" in the neck and supraclavicular areas, a heavy trunk, and relatively thin extremities. The skin is thin, fragile, and easily traumatized; ecchymoses (bruises) and striae develop. The patient complains of weakness and lassitude. Sleep is disturbed because of altered diurnal secretion of cortisol.

Excessive protein catabolism occurs, producing muscle wasting and osteoporosis. Kyphosis, backache, and compression fractures of the vertebrae may result. Retention of sodium and water occurs as a result of increased mineralocorticoid activity, producing hypertension and heart failure.

The patient develops a "moon-faced" appearance and may experience increased oiliness of the skin and acne. There is increased susceptibility to infection. Hyperglycemia or overt diabetes may develop. The patient may also report weight gain, slow healing of minor cuts, and bruises.

Women between the ages of 20 and 40 years are five times more likely than men to develop Cushing's syndrome. In females of all ages, virilization may occur as a result of excess androgens. Virilization is characterized by the appearance of masculine traits and the recession of feminine traits. There is an excessive growth of hair on the face (hirsutism), the breasts atrophy, menses cease, the clitoris enlarges, and the voice deepens. Libido is lost in men and women.

Changes occur in mood and mental activity, and psychosis may develop. Distress and depression are common and are increased by the severity of the physical changes that occur with this syndrome. If Cushing's syndrome is a consequence of pituitary tumor, visual disturbances may occur because of pressure of the growing tumor on the optic chiasm. Chart 42-12 summarizes the changes associated with Cushing's syndrome.

### Assessment and Diagnostic Findings

An overnight dexamethasone suppression test is the most widely used and most sensitive screening test for diagnosis of pituitary and adrenal causes of Cushing's syndrome. It can be performed on an outpatient basis. Dexamethasone (1 mg) is administered orally at 11 PM, and a plasma cortisol level is obtained at 8 AM the next morning. Suppression of cortisol to less than 5 mg/dL indicates that the hypothalamic–pituitary–adrenal axis is functioning properly. Stress, obesity, depression, and medications such as antiseizure agents, estrogen (during pregnancy or as oral medications), and rifampin (Rifadin) can falsely elevate cortisol levels. Nighttime salivary cortisol levels show promise in screening for Cushing's syndrome (Gross, Mindea, Pick, et al., 2007).

Indicators of Cushing's syndrome include an increase in serum sodium and blood glucose levels and a decrease in serum potassium, a reduction in the number of blood eosinophils, and disappearance of lymphoid tissue. Measurements of plasma and urinary cortisol levels are obtained. Several blood samples may be collected to determine whether the normal diurnal variation in plasma levels is present; this variation is frequently absent in adrenal dysfunction. If several blood samples are required, they must be collected at the times specified, and the time of collection must be noted on the requisition slip. Other diagnostic studies include a 24-hour urinary free cortisol level and a low-dose dexamethasone suppression test. Low-dose suppression tests are similar to the overnight test but vary in dosage and timing.

Measurement of plasma ACTH by radioimmunoassay is used in conjunction with the high-dose suppression test to distinguish pituitary tumors from ectopic sites of ACTH production as the cause of Cushing's syndrome. Elevation of both ACTH and cortisol indicates pituitary or hypothalamic disease. A low ACTH with a high cortisol level indicates adrenal disease. CT, ultrasound, or MRI may be performed to localize adrenal tissue and detect tumors of the adrenal gland.

### Medical Management

If Cushing's syndrome is caused by pituitary tumors rather than tumors of the adrenal cortex, treatment is directed at the pituitary gland. Surgical removal of the tumor by transsphenoidal hypophysectomy (see Chapter 61) is the

### Chart 42-12 • *Clinical Manifestations of Cushing's Syndrome*

**Ophthalmic**

Cataracts
Glaucoma

**Cardiovascular**

Hypertension
Heart failure

**Endocrine/Metabolic**

Truncal obesity
Moon face
Buffalo hump
Sodium retention
Hypokalemia
Metabolic alkalosis
Hyperglycemia
Menstrual irregularities
Impotence
Negative nitrogen balance
Altered calcium metabolism
Adrenal suppression

**Immune Function**

Decreased inflammatory responses
Impaired wound healing
Increased susceptibility to infections

**Skeletal**

Osteoporosis
Spontaneous fractures
Aseptic necrosis of femur
Vertebral compression fractures

**Gastrointestinal**

Peptic ulcer
Pancreatitis

**Muscular**

Myopathy
Muscle weakness

**Dermatologic**

Thinning of skin
Petechiae
Ecchymoses
Striae
Acne

**Psychiatric**

Mood alterations
Psychoses



This woman with Cushing's syndrome has several classic signs, including facial hair, buffalo hump, and moon face. From Rubin, E. & Farber, J. L. (2005). *Pathology* (4th ed.). Philadelphia: Lippincott Williams & Wilkins.

treatment of choice and has an 80% success rate. Radiation of the pituitary gland also has been successful, although it may take several months for control of symptoms. Adrenalectomy is the treatment of choice in patients with primary adrenal hypertrophy.

Postoperatively, symptoms of adrenal insufficiency may begin to appear 12 to 48 hours after surgery because of reduction of the high levels of circulating adrenal hormones. Temporary replacement therapy with hydrocortisone may be necessary for several months, until the adrenal glands begin to respond normally to the body's needs. If both adrenal glands have been removed (bilateral adrenalectomy), lifetime replacement of adrenal cortex hormones is necessary.

Adrenal enzyme inhibitors (eg, metyrapone [Metopirone], aminoglutethimide [Cytadren], mitotane [Lysodren], and ketoconazole [Nizoral]) may be used to reduce hyperadrenalism if the syndrome is caused by ectopic ACTH secretion by a tumor that cannot be eradicated. Close monitoring is necessary, because symptoms of inadequate adrenal function may result and side effects of the medications may occur.

If Cushing's syndrome is a result of the administration of corticosteroids, an attempt is made to reduce or taper the medication to the minimum dosage needed to treat the underlying disease process (eg, autoimmune or allergic disease, rejection of a transplanted organ). Frequently, alternate-day therapy decreases the symptoms of Cushing's syndrome and allows recovery of the adrenal glands' responsiveness to ACTH.

## NURSING PROCESS

### The Patient With Cushing's Syndrome

#### Assessment

The health history and examination focus on the effects on the body of high concentrations of adrenal cortex hormones and on the inability of the adrenal cortex to respond to changes in cortisol and aldosterone levels. The history includes information about the patient's level of activity and ability to carry out routine and self-care activities. The skin is observed and assessed for trauma, infection, breakdown, bruising, and edema. Changes in physical appearance are noted, and the patient's responses to these changes are elicited. The nurse assesses the patient's mental function, including mood, responses to questions, awareness of environment, and level of depression. The family is often a good source of information about gradual changes in the patient's physical appearance as well as emotional status.

#### Diagnosis

*Nursing Diagnoses*

Based on all the assessment data, the major nursing diagnoses of the patient with Cushing's syndrome include the following:

- Risk for injury related to weakness
- Risk for infection related to altered protein metabolism and inflammatory response
- Self-care deficit related to weakness, fatigue, muscle wasting, and altered sleep patterns
- Impaired skin integrity related to edema, impaired healing, and thin and fragile skin
- Disturbed body image related to altered physical appearance, impaired sexual functioning, and decreased activity level
- Disturbed thought processes related to mood swings, irritability, and depression

### *Collaborative Problems/Potential Complications*

Potential complications may include the following:

- Addisonian crisis
- Adverse effects of adrenocortical activity

## Planning and Goals

The major goals for the patient include decreased risk of injury, decreased risk of infection, increased ability to carry out self-care activities, improved skin integrity, improved body image, improved mental function, and absence of complications.

## Nursing Interventions

### *Decreasing Risk of Injury*

Establishing a protective environment helps prevent falls, fractures, and other injuries to bones and soft tissues. The patient who is very weak may require assistance from the nurse in ambulating to avoid falling or bumping into sharp corners of furniture. Foods high in protein, calcium, and vitamin D are recommended to minimize muscle wasting and osteoporosis. Referral to a dietitian may assist the patient in selecting appropriate foods that are also low in sodium and calories.

### *Decreasing Risk of Infection*

The patient should avoid unnecessary exposure to others with infections. The nurse frequently assesses the patient for subtle signs of infection, because the anti-inflammatory effects of corticosteroids may mask the common signs of inflammation and infection.

### *Preparing the Patient for Surgery*

The patient is prepared for adrenalectomy, if indicated, and the postoperative course (see later discussion). If Cushing's syndrome is a result of a pituitary tumor, a transsphenoidal hypophysectomy may be performed (see Chapter 61). Diabetes mellitus and peptic ulcer are common in patients with Cushing's syndrome. Therefore, insulin therapy and medication to treat peptic ulcer are initiated if needed. Before, during, and after surgery, blood glucose monitoring and assessment of stools for blood are carried out to monitor for these complications. If the patient has other symptoms of Cushing's syndrome, these are considered in the preoperative preparation. For example, if the patient has experienced weight gain, special instruction is given about postoperative breathing exercises.

### *Encouraging Rest and Activity*

Although the patient with Cushing's syndrome experiences insomnia, weakness, fatigue, and muscle wasting, the nurse should encourage moderate activity to prevent complications of immobility and promote increased self-esteem. It is important to help the patient plan and space rest periods throughout the day and promote a relaxing, quiet environment for rest and sleep.

### *Promoting Skin Integrity*

Meticulous skin care is necessary to avoid traumatizing the patient's fragile skin. Use of adhesive tape is avoided, because it can irritate the skin and tear the fragile tissue when the tape is removed. The nurse frequently assesses the skin and bony prominences and encourages and assists the patient to change positions frequently to prevent skin breakdown.

### *Improving Body Image*

If treated successfully, the major physical changes associated with Cushing's syndrome disappear in time. The patient may benefit from discussion of the effect the changes have had on his or her self-concept and relationships with others. Weight gain and edema may be modified by a low-carbohydrate, low-sodium diet, and a high protein intake may reduce some of the other bothersome symptoms.

### *Improving Thought Processes*

Explanations to the patient and family members about the cause of emotional instability are important in helping them cope with the mood swings, irritability, and depression that may occur. Psychotic behavior may occur in a few patients and should be reported. The nurse encourages the patient and family members to verbalize their feelings and concerns.

### *Monitoring and Managing Potential Complications*

**ADDISONIAN CRISIS.** The patient with Cushing's syndrome whose symptoms are treated by withdrawal of corticosteroids, by adrenalectomy, or by removal of a pituitary tumor is at risk for adrenal hypofunction and addisonian crisis. If high levels of circulating adrenal hormones have suppressed the function of the adrenal cortex, atrophy of the adrenal cortex is likely. If the circulating hormone level is decreased rapidly because of surgery or abrupt cessation of corticosteroid agents, manifestations of adrenal hypofunction and addisonian crisis may develop. Therefore, the patient with Cushing's syndrome should be assessed for signs and symptoms of addisonian crisis as previously discussed. If addisonian crisis occurs, the patient is treated for circulatory collapse and shock (see Chapter 15).

**ADVERSE EFFECTS OF ADRENOCORTICAL ACTIVITY.** The nurse assesses fluid and electrolyte status by monitoring laboratory values and daily weights. Because of the increased risk of glucose intolerance and hyperglycemia, blood glucose monitoring is initiated. The nurse reports elevated blood glucose levels to the physician so that treatment can be prescribed if indicated.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient and family should be informed that acute adrenal insufficiency and underlying symptoms will recur if corticosteroid therapy is stopped abruptly without medical supervision. The patient should be instructed to always have an adequate supply of the corticosteroid medication to avoid running out (see Therapeutic Uses of Corticosteroids).

The nurse stresses the need for dietary modifications to ensure adequate calcium intake without increasing the risks for hypertension, hyperglycemia, and weight gain. The patient and family can be taught to monitor blood pressure, blood glucose levels, and weight. Patients should be advised to wear a medical alert bracelet and to notify other health care providers (eg, dentist) about their condition (Chart 42-13).

CHART 42-13 HOME CARE CHECKLIST
### *The Patient With Cushing's Syndrome*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State present and potential effects of Cushing's syndrome on the body. | ✔ | ✔ |
| • Identify signs and symptoms of excessive and insufficient adrenal hormone. | ✔ | ✔ |
| • State the relationship between adrenal hormones, emotional state, and stress. | ✔ | ✔ |
| • Identify methods for managing labile emotions. | ✔ | ✔ |
| • Describe protective skin care measures and use of protective devices and practices. | ✔ | ✔ |
| • State the importance of regular follow-up visits with primary health care provider. | ✔ | ✔ |
| • State the purpose, dose, route, schedule, side effects, and precautions for prescribed medications (adrenocortical inhibitors). | ✔ | ✔ |
| • Identify need to wear medical alert identification and carry medical information card. | ✔ | ✔ |
| • State importance of compliance with medical regimen. | ✔ | ✔ |
| • State the need to contact health care provider before taking over-the-counter medications. | ✔ | ✔ |
| • Identify foods high in potassium and low in sodium, calories, and carbohydrates. | ✔ | ✔ |
| • Identify areas of activity limitations and impact on lifestyle. | ✔ | ✔ |

**CONTINUING CARE.** The need for follow-up depends on the origin and duration of the disease and its management. The patient who has been treated by adrenalectomy or removal of a pituitary tumor requires close monitoring to ensure that adrenal function has returned to normal and to ensure adequacy of circulating adrenal hormones. The patient who requires continued corticosteroid therapy is monitored to ensure understanding of the medications and the need for a dosage that treats the underlying disorder while minimizing the side effects. Home care referral may be indicated to ensure a safe environment that minimizes stress and risk of falls and other side effects. The home care nurse assesses the patient's physical and psychological status and reports changes to the physician. The nurse also assesses the patient's understanding of the medication regimen and his or her compliance with the regimen and reinforces previous teaching about the medications and the importance of taking them as prescribed. The nurse emphasizes the importance of regular medical follow-up, the side effects and toxic effects of medications, and the need to wear medical identification with Addison's and Cushing's disease. In addition, the nurse reminds the patient and family about the importance of health promotion activities and recommended health screening, including bone mineral density testing.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Decreases risk of injury
   a. Is free of fractures or soft tissue injuries
   b. Is free of ecchymotic areas
2. Decreases risk of infection
   a. Experiences no temperature elevation, redness, pain, or other signs of infection or inflammation
   b. Avoids contact with others who have infections
3. Increases participation in self-care activities
   a. Plans activities and exercises to allow alternating periods of rest and activity
   b. Reports improved well-being
   c. Is free of complications of immobility
4. Attains/maintains skin integrity
   a. Has intact skin, without evidence of breakdown or infection
   b. Exhibits decreased edema in extremities and trunk
   c. Changes position frequently and inspects bony prominences daily
5. Achieves improved body image
   a. Verbalizes feelings about changes in appearance, sexual function, and activity level
   b. States that physical changes are a result of excessive corticosteroids
6. Exhibits improved mental functioning
7. Exhibits absence of complications
   a. Exhibits normal vital signs and weight and is free of symptoms of addisonian crisis
   b. Identifies signs and symptoms of adrenocortical hypofunction that should be reported and measures to take in case of severe illness and stress
   c. Identifies strategies to minimize complications of Cushing's syndrome
   d. Complies with recommendations for follow-up appointments and health screening

## PRIMARY ALDOSTERONISM

The principal action of aldosterone is to conserve body sodium. Under the influence of this hormone, the kidneys excrete less sodium and more potassium and hydrogen. Excessive production of aldosterone, which occurs in some patients with functioning tumors of the adrenal gland, causes a distinctive pattern of biochemical changes and a corresponding

set of clinical manifestations that are diagnostic of this condition.

## Clinical Manifestations

Patients with aldosteronism exhibit a profound decline in the serum levels of potassium (hypokalemia) and hydrogen ions (alkalosis), as demonstrated by an increase in pH and serum bicarbonate concentration. The serum sodium level is normal or elevated, depending on the amount of water reabsorbed with the sodium. Hypertension is the most prominent and almost universal sign of aldosteronism and is present in up to 10% of individuals with hypertension (Mulatero, Dluhy, Giacchetti, et al., 2005).

Hypokalemia is responsible for the variable muscle weakness, cramping, and fatigue in patients with aldosteronism, as well as an inability on the part of the kidneys to acidify or concentrate the urine. Accordingly, the urine volume is excessive, leading to polyuria. Serum, by contrast, becomes abnormally concentrated, contributing to excessive thirst (polydipsia) and arterial hypertension. A secondary increase in blood volume and possible direct effects of aldosterone on nerve receptors, such as the carotid sinus, are other factors that result in hypertension.

Hypokalemic alkalosis may decrease the ionized serum calcium level and predispose the patient to tetany and paresthesias. Trousseau's and Chvostek's signs may be used to assess neuromuscular irritability before overt paresthesia and tetany occur. Glucose intolerance may occur, because hypokalemia interferes with insulin secretion from the pancreas.

## Assessment and Diagnostic Findings

In addition to a high or normal serum sodium level and a low serum potassium level, diagnostic studies indicate high serum aldosterone and low serum renin levels. The measurement of the aldosterone excretion rate after salt loading is a useful diagnostic test for primary aldosteronism. The renin–aldosterone stimulation test and bilateral adrenal venous sampling are useful in differentiating the cause of primary aldosteronism. Antihypertensive medication may be discontinued up to 2 weeks before testing.

## Medical Management

Treatment of primary aldosteronism usually involves surgical removal of the adrenal tumor through adrenalectomy. Hypokalemia resolves for all patients after surgery, but hypertension may persist. Spironolactone (Aldactone) may be prescribed to control hypertension.

Adrenalectomy is performed through an incision in the flank or the abdomen. In general, the postoperative care resembles that for other abdominal surgery. However, the patient is susceptible to fluctuations in adrenocortical hormones and requires administration of corticosteroids, fluids, and other agents to maintain blood pressure and prevent acute complications. If the adrenalectomy is bilateral, replacement of corticosteroids will be lifelong; if one adrenal gland is removed, replacement therapy may be temporarily necessary because of suppression of the remaining adrenal gland by high levels of adrenal hormones. A normal serum glucose level is maintained with insulin, appropriate IV fluids, and dietary modifications.

## Nursing Management

Nursing management in the postoperative period includes frequent assessment of vital signs to detect early signs and symptoms of adrenal insufficiency and crisis or hemorrhage. Explaining all treatments and procedures, providing comfort measures, and providing rest periods can reduce the patient's stress and anxiety level.

# *Corticosteroid Therapy*

Corticosteroids are used extensively for adrenal insufficiency and are also widely used in suppressing inflammation and autoimmune reactions, controlling allergic reactions, and reducing the rejection process in transplantation. Commonly used corticosteroid preparations are listed in Table 42-5. Their anti-inflammatory and antiallergy actions make corticosteroids effective in treating rheumatic or connective tissue diseases, such as rheumatoid arthritis and systemic lupus erythematosus. They are also frequently used in the treatment of asthma, multiple sclerosis, and other autoimmune disorders.

High doses appear to allow patients to tolerate high degrees of stress. Such antistress action may be caused by the ability of corticosteroids to aid circulating vasopressor substances in keeping the blood pressure elevated; other effects, such as maintenance of the serum glucose level, also may keep blood pressure elevated.

**Table 42-5 COMMONLY USED CORTICOSTEROID PREPARATIONS**

| Generic Names | Trade Names |
|---|---|
| Hydrocortisone | Cortisol, Cortef, Hydrocortone, Solu-Cortef |
| Cortisone | Cortone, Cortate, Cortogen |
| Dexamethasone | Decadron, Dexameth, Deronil, Delalone, Dexasone, Dexone, Hexadrol |
| Prednisone | Meticorten, Deltasone, Orasone, Panasol, Novo-prednisone |
| Prednisolone | Meticortelone, Delta-Cortef, Prelone, Predalone |
| Methylprednisolone | Medrol, Solu-Medrol, Meprolone |
| Triamcinolone | Aristocort, Kenacort, Kenalog, Cenocort, Azmacort, Aristospan |
| Beclomethasone | Beconase, Beclovent, Vanceril, Vancenase, Propaderm |
| Betamethasone | Celestone, Betameth, Betnesol, Betnelan |

## Side Effects

Although the synthetic corticosteroids are safer for some patients because of relative freedom from mineralocorticoid activity, most natural and synthetic corticosteroids produce similar kinds of side effects. The dose required for anti-inflammatory and antiallergy effects also produces metabolic effects, pituitary and adrenal gland suppression, and changes in the function of the central nervous system. Therefore, although corticosteroids are highly effective therapeutically, they may also be very dangerous. Dosages of these medications are frequently altered to allow high concentrations when necessary and then tapered in an attempt to avoid undesirable effects. This requires that patients be observed closely for side effects and that the dose be reduced when high doses are no longer required. Suppression of the adrenal cortex may persist up to 1 year after a course of corticosteroids of only 2 weeks' duration.

## Therapeutic Uses of Corticosteroids

The dosage of corticosteroids is determined by the nature and chronicity of the illness as well as the patient's other medical conditions. Rheumatoid arthritis, bronchial asthma, and multiple sclerosis are chronic disorders that corticosteroids do not cure; however, these medications may be useful when other measures do not provide adequate control of symptoms. In addition, corticosteroids may be used to treat acute exacerbations of these disorders.

In such situations, the adverse effects of corticosteroids are weighed against the patient's current condition. These medications may be used for a period but then are gradually reduced or tapered as the symptoms subside. The nurse plays an important role in providing encouragement and understanding during times when the patient is experiencing (or is apprehensive about experiencing) recurrence of symptoms while taking smaller doses.

### Treatment of Acute Conditions

Acute flare-ups and crises are treated with large doses of corticosteroids. Examples include emergency treatment for bronchial obstruction in status asthmaticus and for septic shock from septicemia caused by gram-negative bacteria. Other measures, such as anti-infective agents or medications, are also used with corticosteroids to treat shock and other major symptoms. At times, corticosteroids are continued past the acute flare-up stage to prevent serious complications.

### Ophthalmologic Treatment

Outer eye infections can be treated by topical application of corticosteroid eye drops, because the agents do not cause systemic toxicity. However, long-term application can cause an increase in intraocular pressure, which leads to glaucoma in some patients. In addition, prolonged use of corticosteroids can sometimes lead to cataract formation.

### Dermatologic Disorders

Topical administration of corticosteroids in the form of creams, ointments, lotions, and aerosols is especially effective in many dermatologic disorders. It may be more effective in some conditions to use occlusive dressings around the affected part to achieve maximum absorption of the medication. Penetration and absorption are also increased if the medication is applied when the skin is hydrated or moist (eg, immediately after bathing).

Absorption of topical agents varies with body location. For example, absorption is greater through the layers of skin on the scalp, face, and genital area than on the forearm; as a result, use of topical agents on these sites increases the risk of side effects. The availability of over-the-counter topical corticosteroids increases the risk of side effects in patients who are unaware of their potential risks. Excessive use of these agents, especially on large surface areas of inflamed skin, can lead to decreased therapeutic effects and increased side effects.

## Dosage

Attempts have been made to determine the best time to administer pharmacologic doses of steroids. If symptoms have been controlled on a 6-hour or 8-hour program, a once-daily or every-other-day schedule may be implemented. In keeping with the natural secretion of cortisol, the best time of day for the total corticosteroid dose is in the early morning, between 7 AM and 8 AM. Large-dose therapy at 8 AM., when the adrenal gland is most active, produces maximal suppression of the gland. A large 8 AM dose is more physiologic because it allows the body to escape effects of the steroids from 4 PM to 6 AM, when serum levels are normally low, hence minimizing cushingoid effects. If symptoms of the disorder being treated are suppressed, alternate-day therapy is helpful in reducing pituitary–adrenal suppression in patients requiring prolonged therapy. Some patients report discomfort associated with symptoms of their primary illness on the second day; therefore, it is important to explain to patients that this regimen is necessary to minimize side effects and suppression of adrenal function.

## Tapering

Corticosteroid dosages are reduced gradually (tapered) to allow normal adrenal function to return and to prevent steroid-induced adrenal insufficiency. Up to 1 year or longer after use of corticosteroids, the patient is still at risk for adrenal insufficiency in times of stress. For example, if surgery for any reason is necessary, the patient is likely to require IV corticosteroids during and after surgery to reduce the risk of acute adrenal crisis. Patients receiving corticosteroids must have an adequate supply of medication on hand, so that they do not miss a scheduled dose and increase their risk of adrenal insufficiency. Table 42-6 provides an overview of the effects of corticosteroid therapy and their nursing implications.

**Table 42-6 SIDE EFFECTS OF CORTICOSTEROID THERAPY AND IMPLICATIONS FOR NURSING PRACTICE**

| Side Effects | Collaborative Interventions |
|---|---|
| **Cardiovascular Effects** | |
| Hypertension | Monitor for elevated blood pressure. |
| Thrombophlebitis | Assess for signs and symptoms of deep venous thrombosis: redness, warmth, tenderness, and edema of an extremity. |
| Thromboembolism | Remind patient to avoid positions and situations that restrict blood flow (eg, crossing legs, prolonged sitting in same position). |
| Accelerated atherosclerosis | Encourage foot and leg exercises when recumbent. |
| | Encourage low sodium intake. |
| | Encourage limited intake of fat. |
| **Immunologic Effects** | |
| Increased risk of infection and masking of signs of infection | Assess for subtle signs of infection and inflammation. |
| | Encourage patient to avoid exposure to others with upper respiratory infection. |
| | Monitor patient for fungal infections. |
| | Encourage hand washing. |
| **Ophthalmologic Changes** | |
| Glaucoma | Encourage frequent eye examinations. |
| Corneal lesions | Refer patient to ophthalmologist if changes in visual acuity are detected. |
| **Musculoskeletal Effects** | |
| Muscle wasting | Encourage high protein intake. |
| Poor wound healing | Encourage high protein intake and vitamin C supplementation. |
| Osteoporosis with vertebral compression fractures, pathologic fractures of long bones, aseptic necrosis of head of the femur | Encourage diet high in calcium and vitamin D or calcium and vitamin D supplementation if indicated. |
| | Take measures to avoid falls and other trauma. |
| | Use caution in moving and turning patient. |
| | Encourage postmenopausal women on corticosteroids to consider bone mineral density testing and treatment, if indicated. |
| | Instruct patient to rise slowly from bed or chair to avoid falling due to postural hypotension. |
| **Metabolic Effects** | |
| Alterations in glucose metabolism | Monitor blood glucose levels at periodic intervals. |
| Steroid withdrawal syndrome | Instruct patient about medications, diet, and exercise prescribed to control blood glucose level. |
| | Report signs of adrenal insufficiency. |
| | Administer corticosteroids and mineralocorticoids as prescribed. |
| | Monitor fluid and electrolyte balance. |
| | Administer fluids and electrolytes as prescribed. |
| | Instruct patient about importance of taking corticosteroids as prescribed without abruptly stopping therapy. |
| | Encourage patient to obtain and wear a medical identification bracelet. |
| | Advise patient to notify all health care providers (eg, dentist) about need for corticosteroid therapy. |
| **Changes in Appearance** | |
| Moon face | Encourage low-calorie, low-sodium diet. |
| Weight gain | Assure patient that most changes in appearance are temporary and will disappear if and when corticosteroid therapy is no longer necessary. |
| Acne | |

## CRITICAL THINKING EXERCISES

**1** A 72-year-old man has been diagnosed with hyperparathyroidism. He is scheduled for a minimally invasive parathyroidectomy in 1 week. How would you explain this disorder to the patient? Describe what he and his family can expect postoperatively. Describe the nursing role preoperatively and postoperatively. Discuss the importance of nutrition and activity as related to this disorder.

**2** A 40-year-old woman is seen in the emergency department for severe nausea, vomiting, tachycardia, and agitation. Her eyes appear to bulge. She is diagnosed with severe hyperthyroidism and thyroid storm. What factors could have precipitated her condition? What is the significance of the bulging eyes? What nursing precautions should be taken? How would you explain this condition to the patient, and what information would you provide to the family to assist them in understanding her symptoms? What diagnostic tests are likely to be performed? Describe the treatment for this condition.

EBP **3** A 50-year-old woman of Japanese descent is undergoing testing for thyroid disease because of symptoms of hyperthyroidism. Her physician has suggested that she receive treatment with radioactive iodine (RAI). Information the patient found on the Internet has convinced her that RAI is not safe or necessary to treat her disorder. Her grandparents lived in Nagasaki during World War II, and she recalls stories of horrible effects of the radiation on her grandfather and other relatives. Only her grandmother survived the atomic blast.

If untreated, the patient's condition can lead to serious complications. How would you address this patient's concerns and assist her in making an informed decision about treatment? What sources of information would you

use, and how would you evaluate the available evidence about the effectiveness and possible adverse effects of RAI?

**4** A 50-year-old woman is recovering from acute adrenal insufficiency. Corticosteroid therapy has been prescribed, and she will be required to take it for the rest of her life. What instructions should you provide regarding precautions to take related to corticosteroid therapy? How can the patient and family prevent a reoccurrence of this disorder?

**5** A 24-year-old man is scheduled for diagnostic testing for possible pheochromocytoma. Identify the major signs and symptoms of pheochromocytoma and their cause. If pheochromocytoma is diagnosed and the patient is scheduled for an adrenalectomy, what preoperative and postoperative nursing care would you anticipate? What teaching, if any, would you provide to the patient's family?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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American Thyroid Association, Inc., www.thyroid.org
Cushing's Support and Research Foundation, http://csrf.net
The Endocrine Society, www.endo-society.org
National Adrenal Disease Foundation, www.nadf.us
National Cancer Institute, Cancer Net for Health Professionals, www.nci.nih.gov
The Thyroid Society for Education and Research, www.the-thyroid-society.org

unit 9

# Urinary Tract Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Involuntary Urine Loss During Physical Exertion and Ineffective Bladder Emptying



**Mrs. Lopez** is a 38-year-old woman with no significant past medical history. She has three children. During her annual physical examination, she tells the women's health nurse practitioner that when she jogs, coughs, or sneezes, she experiences an involuntary loss of small amounts of urine. The patient's urinalysis is normal. On physical examination, the nurse finds that Mrs. Lopez has a moderate cystocele and that her bladder feels mildly distended, although she had just voided to provide a urine sample. The nurse catheterizes Mrs. Lopez to check for postvoid residual urine and obtains 120 mL of clear urine.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **STRESS URINARY INCONTINENCE**—Loss of less than 50 mL of urine occurring with increased abdominal pressure | **PELVIC MUSCLE EXERCISES**—Strengthening and training the levator ani and urogenital muscles through voluntary, repetitive contraction to decrease stress, urge, or mixed types of urinary incontinence | **SYMPTOM CONTROL**—Personal actions to minimize perceived changes in physical and emotional functioning |
| **URINARY RETENTION**—Incomplete emptying of the bladder | **URINARY BLADDER TRAINING**—Improving bladder function for those with urge incontinence by increasing the bladder's ability to hold urine and the patient's ability to suppress urination | **URINARY CONTINENCE**—Control of elimination of urine from the bladder |
| **RISK FOR INFECTION**—At increased risk for being invaded by pathogenic organisms | **URINARY CATHETERIZATION: INTERMITTENT**—Regular periodic use of a catheter to empty the bladder<br>**INFECTION PROTECTION**—Prevention and early detection of infection in a patient at risk | **INFECTION SEVERITY**—Severity of infection and associated symptoms |


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chapter 43

# Assessment of Renal and Urinary Tract Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the anatomy and physiology of the renal and urinary systems.
2. Discuss the role of the kidneys in regulating fluid and electrolyte balance, acid–base balance, and blood pressure.
3. Describe the diagnostic studies used to determine upper and lower urinary tract function.
4. Identify the assessment parameters used for determining the status of upper and lower urinary tract function.
5. Initiate education and preparation for patients undergoing assessment of the urinary system.

## GLOSSARY

**aldosterone:** hormone synthesized and released by the adrenal cortex; causes the kidneys to reabsorb sodium

**antidiuretic hormone:** hormone secreted by the posterior pituitary gland; causes the kidneys to reabsorb more water; also called vasopressin

**anuria:** total urine output less than 50 mL in 24 hours

**bacteriuria:** bacteria in the urine; bacterial count higher than 100,000 colonies/mL

**creatinine:** endogenous waste product of muscle energy metabolism

**diuresis:** increased formation and secretion of urine

**dysuria:** painful or difficult urination

**frequency:** voiding more frequently than every 3 hours

**glomerular filtration:** plasma filtered at the glomerulus into the kidney tubules

**glomerulus:** tuft of capillaries forming part of the nephron through which filtration occurs

**hematuria:** red blood cells in the urine

**micturition:** urination or voiding

**nephron:** structural and functional unit of the kidney responsible for urine formation

**nocturia:** awakening at night to urinate

**oliguria:** total urine output less than 500 mL in 24 hours

**proteinuria:** protein in the urine

**pyuria:** white blood cells in the urine

**renal clearance:** volume of plasma that the kidneys can clear of a specific solute (eg, creatinine); expressed in milliliters per minute

**renal glycosuria:** recurring or persistent excretion of glucose in the urine

**specific gravity:** reflects the weight of particles dissolved in the urine; expression of the degree of concentration of the urine

**tubular reabsorption:** movement of a substance from the kidney tubule into the blood in the peritubular capillaries or vasa recta

**tubular secretion:** movement of a substance from the blood in the peritubular capillaries or vasa recta into the kidney tubule

**urea nitrogen:** nitrogenous end product of protein metabolism

## Chart 43-1 • *Functions of the Kidney*

- Urine formation
- Excretion of waste products
- Regulation of electrolytes
- Regulation of acid–base balance
- Control of water balance
- Control of blood pressure
- Renal clearance
- Regulation of red blood cell production
- Synthesis of vitamin D to active form
- Secretion of prostaglandins
- Regulates calcium and phosphorus balance

Function of the renal and urinary systems is essential to life. The primary purpose of the renal and urinary systems is to maintain the body's state of homeostasis by carefully regulating fluid and electrolytes, removing wastes, and providing other functions (Chart 43-1). Dysfunction of the kidneys and lower urinary tract is common and may occur at any age and with varying degrees of severity. Assessment of upper and lower urinary tract function is part of every health examination and necessitates an understanding of the anatomy and physiology of the urinary system as well as the effects of changes in the system on other physiologic functions.

# Anatomic and Physiologic Overview

## Anatomy of the Renal and Urinary Tract Systems

The renal and urinary systems include the kidneys, ureters, bladder, and urethra. Urine is formed by the kidney and flows through the other structures to be eliminated from the body.

### Kidneys

The kidneys are a pair of bean-shaped, brownish-red structures located retroperitoneally (behind and outside the peritoneal cavity) on the posterior wall of the abdomen—from the 12th thoracic vertebra to the third lumbar vertebra in the adult (Fig. 43-1A). The average adult kidney weighs approximately 113 to 170 g (about 4.5 oz) and is 10 to 12 cm long, 6 cm wide, and 2.5 cm thick (Porth & Matfin, 2009). The right kidney is slightly lower than the left due to the location of the liver.

Externally, the kidneys are well protected by the ribs and by the muscles of the abdomen and back. Internally, fat deposits surround each kidney, providing protection against jarring. The kidneys and surrounding fat are suspended from the abdominal wall by renal fascia made of connective tissue. The fibrous connective tissue, blood vessels, and lymphatics surrounding each kidney are known as the renal capsule. An adrenal gland lies on top of each kidney. The kidneys and adrenals are independent in function, blood supply, and innervation.

The renal parenchyma is divided into two parts: the cortex and the medulla (Fig. 43-1B). The medulla, which is approximately 5 cm wide, is the inner portion of the kidney. It contains the loops of Henle, the vasa recta, and the collecting ducts of the juxtamedullary nephrons. The collecting ducts from both the juxtamedullary and the cortical nephrons connect to the renal pyramids, which are triangular and are situated with the base facing the concave surface of the kidney and the point (papilla) facing the hilum, or pelvis. Each kidney contains approximately 8 to 18 pyramids. The pyramids drain into minor calices, which drain into major calices that open directly into the renal pelvis. The renal pelvis is the beginning of the collecting system and is composed of structures that are designed to collect and transport urine. Once the urine leaves the renal pelvis, the composition or amount of urine does not change.

The cortex, which is approximately 1 cm wide, is located farthest from the center of the kidney and around the

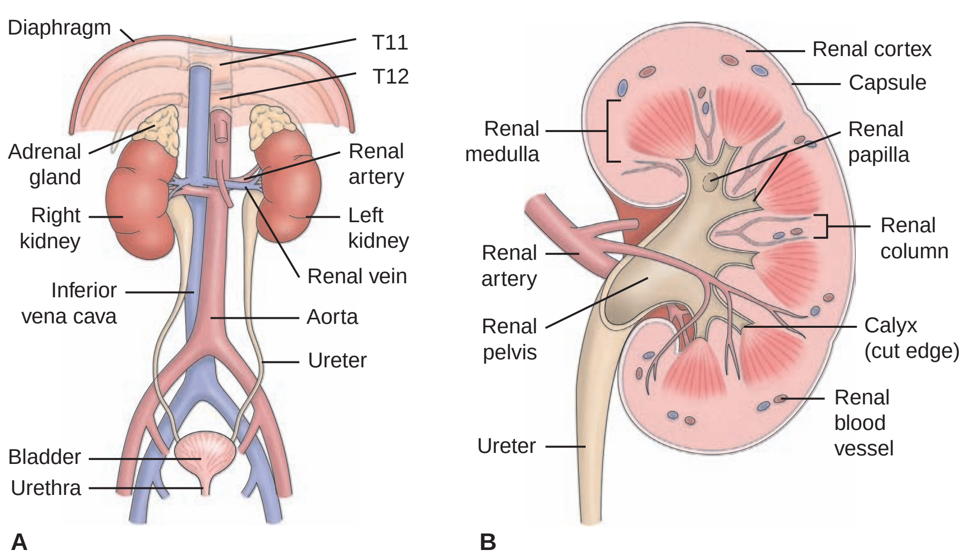



**Figure 43-1** **A**, Kidneys, ureters, and bladder. **B,** Internal structure of the kidney. Redrawn from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health status* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

outermost edges. It contains the **nephrons** (the functional units of the kidney), which are discussed below.

### Blood Supply to the Kidneys

The hilum is the concave portion of the kidney through which the renal artery enters and the ureters and renal vein exit. The kidneys receive 20% to 25% of the total cardiac output, which means that all of the body's blood circulates through the kidneys approximately 12 times per hour. The renal artery (arising from the abdominal aorta) divides into smaller and smaller vessels, eventually forming the afferent arterioles. Each afferent arteriole branches to form a **glomerulus,** which is the capillary bed responsible for glomerular filtration. Blood leaves the glomerulus through the efferent arteriole and flows back to the inferior vena cava through a network of capillaries and veins.

### Nephrons

Each kidney has 1 million nephrons that are located within the renal parenchyma and are responsible for the initial formation of urine. The large number of nephrons allows for adequate renal function even if the opposite kidney is damaged or becomes nonfunctional. If the total number of functioning nephrons is less then 20% of normal, renal replacement therapy needs to be considered.

There are two types of nephrons. The cortical nephrons, which make up 80% to 85% of the total number, are located in the outermost part of the cortex, and the juxtamedullary nephrons, which make up the remaining 15% to 20%, are located deeper in the cortex. The juxtamedullary nephrons are distinguished by long loops of Henle and are surrounded by long capillary loops called vasa recta that dip into the medulla of the kidney. The length of the tubular component of the nephron is directly related to its ability to concentrate urine.

Nephrons are made up of two basic components: a filtering element composed of an enclosed capillary network (the glomerulus) and the attached tubule (Fig. 43-2). The glomerulus is a unique network of capillaries suspended between the afferent and efferent blood vessels, which are enclosed in an epithelial structure called Bowman's capsule. The glomerular membrane is composed of three filtering layers: the capillary endothelium, the basement membrane, and the epithelium. This membrane normally allows filtration of fluid and small molecules yet limits passage of larger molecules, such as blood cells and albumin. Pressure changes and the permeability of the glomerular membrane of Bowman's capsule facilitate the passage of fluids and various substances from the blood vessels, filling the space within Bowman's capsule with this filtered solution.

The tubular component of the nephron begins in the Bowman's capsule. The filtrate created in the Bowman's capsule travels first into the proximal tubule, then the loop of Henle, the distal tubule, and either the cortical or medullary collecting ducts. The structural arrangement of the tubule allows the distal tubule to lie in close proximity to where the afferent and efferent arteriole respectively enter and leave the glomerulus. The distal tubular cells located in this area, known as the macula densa, function with the adjacent afferent arteriole and create what is known as the juxtaglomerular apparatus. This is the site of renin production. Renin is a hormone directly involved in the control of arterial blood pressure; it is essential for proper functioning of the glomerulus (see later discussion).

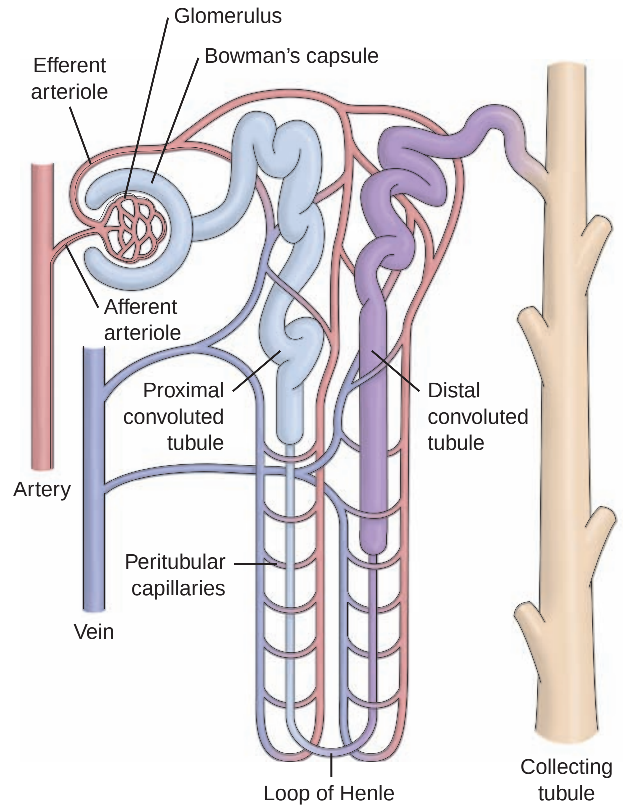



**Figure 43-2** Representation of a nephron. Each kidney has about 1 million nephrons of two types: cortical and juxtamedullary. Cortical nephrons are located in the cortex of the kidney; juxtamedullary nephrons are adjacent to the medulla.

The tubular component consists of the Bowman's capsule, the proximal tubule, the descending and ascending limbs of the loop of Henle, and the cortical and medullary collecting ducts. This portion of the nephron is responsible for making adjustments in the filtrate based on the body's needs. Changes are continually made as the filtrate travels through the tubules until it enters the collecting system and is expelled from the body (see Fig. 43-2).

## *Ureters, Bladder, and Urethra*

The urine formed in the nephrons flows into the renal pelvis and then into the ureters, which are long fibromuscular tubes that connect each kidney to the bladder. These narrow tubes, each 24 to 30 cm long, originate at the lower portion of the renal pelvis and terminate in the trigone of the bladder wall.

The left ureter is slightly shorter than the right ureter. The lining of the ureters is made up of transitional cell epithelium called urothelium. The urothelium prevents reabsorption of urine. The movement of urine from each renal pelvis through the ureter into the bladder is facilitated by peristaltic contraction of the smooth muscles in the ureter wall. There are three narrowed areas of each ureter: the ureteropelvic junction, the ureteral segment near the sacroiliac junction,

and the ureterovesical junction. These three areas of the ureters have a propensity for obstruction by renal calculi (kidney stones) or stricture. Obstruction of the ureteropelvic junction is the most serious because of its close proximity to the kidney and the risk of associated kidney dysfunction.

The urinary bladder is a muscular, hollow sac located just behind the pubic bone. The capacity of the adult bladder is 400 to 500 mL (Bickley, 2007). The bladder is characterized by its central, hollow area, called the vesicle, which has two inlets (the ureters) and one outlet (the urethra). The area surrounding the bladder neck is called the urethrovesical junction. The angling of the ureterovesical junction is the primary means of providing antegrade, or downward, movement of urine, also referred to as efflux of urine. This angling prevents vesicoureteral reflux (retrograde, or backward, movement of urine) from the bladder, up the ureter, toward the kidney.

The wall of the bladder contains four layers. The outermost layer is the adventitia, which is made up of connective tissue. Immediately beneath the adventitia is a smooth muscle layer known as the detrusor. Beneath the detrusor is a submucosal layer of loose connective tissue that serves as an interface between the detrusor and the innermost layer, a mucosal lining. The inner layer contains specialized transitional cell epithelium, a membrane that is impermeable to water and prevents reabsorption of urine stored in the bladder. The bladder neck contains bundles of involuntary smooth muscle that form a portion of the urethral sphincter known as the internal sphincter. An important portion of the sphincteric mechanism that helps maintain continence is the external urinary sphincter at the anterior urethra, the segment most distal from the bladder (Porth & Matfin, 2009). During voiding **(micturition),** increased intravesical pressure keeps the ureterovesical junction closed and keeps urine within the ureters. As soon as micturition is completed, intravesical pressure returns to its normal low baseline value, allowing efflux of urine to resume. Therefore, the only time that the bladder is completely empty is in the last seconds of micturition, before efflux of urine resumes.

The urethra arises from the base of the bladder: In the male, it passes through the penis; in the female, it opens just anterior to the vagina. In the male, the prostate gland, which lies just below the bladder neck, surrounds the urethra posteriorly and laterally.

## Function of the Renal and Urinary Tract Systems

CONCEPTS IN ACTION

### *Urine Formation*

The healthy human body is composed of approximately 60% water. Water balance is regulated by the kidneys and results in the formation of urine. Urine is formed in the nephrons through a complex three-step process: **glomerular filtration**, **tubular reabsorption,** and **tubular secretion** (Fig. 43-3). The various substances normally filtered by the glomerulus, reabsorbed by the tubules, and excreted in the urine include sodium, chloride, bicarbonate, potassium, glucose, urea, creatinine, and uric acid. Within the tubule, some of these substances are selectively reabsorbed into the blood. Others are secreted from the blood into the filtrate as it travels down the tubule.

**Physiology ■■■ Pathophysiology**

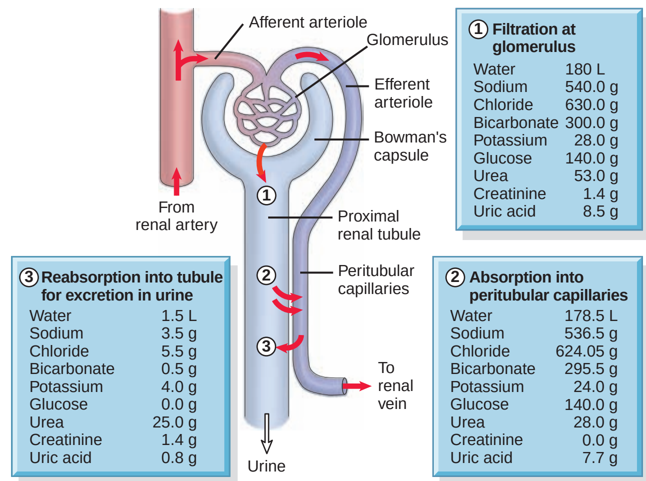



**Figure 43-3** Urine is formed in the nephrons in a three-step process: filtration, reabsorption, and excretion. Water, electrolytes, and other substances, such as glucose and creatinine, are filtered by the glomerulus; varying amounts of these substances are reabsorbed in the renal tubule or excreted in the urine. Approximate normal volumes of these substances during the steps of urine formation are shown at the top. Wide variations may occur in these values depending on diet.

Amino acids and glucose are usually filtered at the level of the glomerulus and reabsorbed so that neither is excreted in the urine. Normally, glucose does not appear in the urine. However, **renal glycosuria** (recurring or persistent excretion of glucose in the urine) occurs if the amount of glucose in the blood and glomerular filtrate exceeds the amount that the tubules are able to reabsorb. Renal glycosuria occurs in diabetes, the most common condition that causes the blood glucose level to exceed the kidney's reabsorption capacity. Renal glycosuria is also common in pregnancy.

Protein molecules also are not usually found in the urine; however, low-molecular-weight proteins (globulins and albumin) may periodically be excreted in small amounts. Protein in the urine is referred to as **proteinuria.**

#### Glomerular Filtration

The normal blood flow through the kidneys is about 1200 mL/min. As blood flows into the glomerulus from an afferent arteriole, filtration occurs. The filtered fluid, also known as filtrate or ultrafiltrate, then enters the renal tubules. Under normal conditions, about 20% of the blood passing through the glomeruli is filtered into the nephron, amounting to about 180 L/day of filtrate. The filtrate normally consists of water, electrolytes, and other small molecules, because water and small molecules are allowed to pass, whereas larger molecules stay in the bloodstream. Efficient filtration depends on adequate blood flow that maintains a consistent pressure through the glomerulus. Many factors can alter this blood flow and pressure, including hypotension, decreased oncotic pressure in the blood, and increased pressure in the renal tubules from an obstruction.

### Tubular Reabsorption and Tubular Secretion

The second and third steps of urine formation occur in the renal tubules. In tubular reabsorption, a substance moves from the filtrate back into the peritubular capillaries or vasa recta. In tubular secretion, a substance moves from the peritubular capillaries or vasa recta into tubular filtrate. Of the 180 L (45 gallons) of filtrate that the kidneys produce each day, 99% is reabsorbed into the bloodstream, resulting in the formation of 1 L to 2 L of urine each day. Although most reabsorption occurs in the proximal tubule, reabsorption occurs along the entire tubule. Reabsorption and secretion in the tubule frequently involve passive and active transport and may require the use of energy. Filtrate becomes concentrated in the distal tubule and collecting ducts under hormonal influence and becomes urine, which then enters the renal pelvis.

#### Antidiuretic Hormone

**Antidiuretic hormone (ADH),** also known as vasopressin, is a hormone that is secreted by the posterior portion of the pituitary gland in response to changes in osmolality of the blood. With decreased water intake, blood osmolality tends to increase, stimulating ADH release. ADH then acts on the kidney, increasing reabsorption of water and thereby returning the osmolality of the blood to normal. With excess water intake, the secretion of ADH by the pituitary is suppressed; therefore, less water is reabsorbed by the kidney tubule. This latter situation leads to increased urine volume **(diuresis).**

A dilute urine with a fixed specific gravity (about 1.010) or fixed osmolality (about 300 mOsm/L) indicates an inability to concentrate and dilute the urine, a common early sign of kidney disease.

#### Osmolarity and Osmolality

Osmolarity refers to the ratio of solute to water. The regulation of salt and water is paramount for control of the extracellular volume and both serum and urine osmolarity. Controlling either the amount of water or the amount of solute can change osmolarity. Osmolarity and ionic composition are maintained by the body within very narrow limits. As little as a 1% to 2% change in the serum osmolarity can cause a conscious desire to drink and conservation of water by the kidneys (Goertz, 2006).

The degree of dilution or concentration of the urine is also measured in terms of osmolality, the number of osmoles (the standard unit of osmotic pressure) dissolved per kilogram of solution. The filtrate in the glomerular capillary normally has the same osmolality as the blood, 280 to 300 mOsm/kg. Serum and urine osmolality and osmolarity are discussed in more detail in Chapter 14.

#### Regulation of Water Excretion

Regulation of the amount of water excreted is an important function of the kidney. With high fluid intake, a large volume of dilute urine is excreted. Conversely, with a low fluid intake, a small volume of concentrated urine is excreted. A person normally ingests about 1300 mL of oral liquids and 1000 mL of water in food per day. Of the fluid ingested, approximately 900 mL is lost through the skin and lungs (called insensible loss), 50 mL through sweat, and 200 mL through feces. It is important to consider all fluid gained and lost when evaluating total fluid status. Daily weight measurements are a reliable means of determining overall fluid status. One pound equals approximately 500 mL, so a weight change of as little as 1 lb could suggest an overall fluid gain or loss of 500 mL.

#### Regulation of Electrolyte Excretion

When the kidneys are functioning normally, the volume of electrolytes excreted per day is equal to the amount ingested. For example, the average American daily diet contains 6 to 8 g each of sodium chloride (salt) and potassium chloride, and approximately the same amounts are excreted in the urine.

The regulation of sodium volume excreted depends on **aldosterone,** a hormone synthesized and released from the adrenal cortex. With increased aldosterone in the blood, less sodium is excreted in the urine, because aldosterone fosters renal reabsorption of sodium. Release of aldosterone from the adrenal cortex is largely under the control of angiotensin II. Angiotensin II levels are in turn controlled by renin, an enzyme that is released from specialized cells in the kidneys (Fig. 43-4). This complex system is activated when pressure in the renal arterioles falls below normal levels, as occurs with shock, dehydration, or decreased sodium chloride delivery to the tubules. Activation of this system increases the retention of water and expansion of the intravascular fluid volume, thereby maintaining enough pressure within the glomerulus to ensure adequate filtration.

The regulation of serum sodium and potassium are discussed in detail in Chapter 14.

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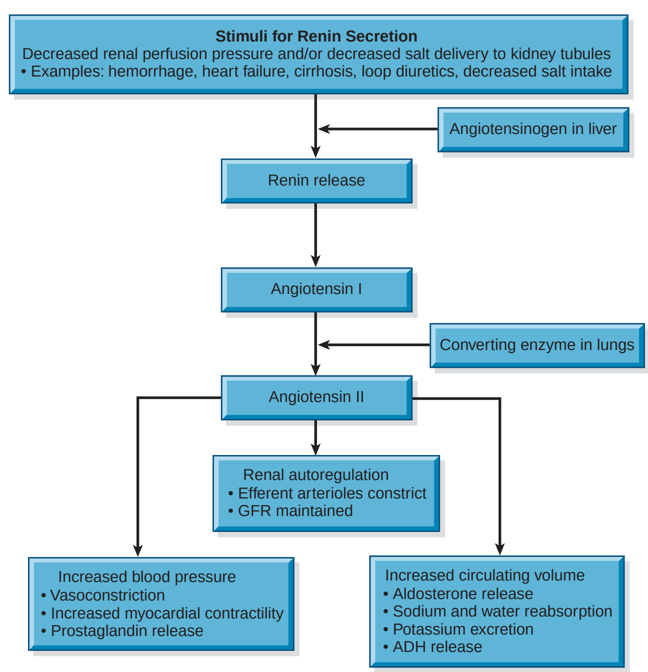



**Figure 43-4** The renin–angiotensin system. ADH, antidiuretic hormone; GFR, glomerular filtration rate.

### Regulation of Acid–Base Balance

The normal serum pH is about 7.35 to 7.45 and must be maintained within this narrow range for optimal physiologic function. The kidney performs two major functions to assist in this balance. The first is to reabsorb and return to the body's circulation any bicarbonate from the urinary filtrate; the second is to excrete acid in the urine. Because bicarbonate is a small ion, it is freely filtered at the glomerulus. The renal tubules actively reabsorb most of the bicarbonate in the urinary filtrate. To replace any lost bicarbonate, the renal tubular cells generate new bicarbonate through a variety of chemical reactions. This newly generated bicarbonate is then reabsorbed by the tubules and returned to the body.

The body's acid production is the result of catabolism, or breakdown, of proteins, which produces acid compounds, in particular phosphoric and sulfuric acids. The normal daily diet also includes a certain amount of acid materials. Unlike carbon dioxide ($CO_2$), phosphoric and sulfuric acids cannot be eliminated by the lungs. Because accumulation of these acids in the blood lowers pH (making the blood more acidic) and inhibits cell function, they must be excreted in the urine. A person with normal kidney function excretes about 70 mEq of acid each day. The kidney is able to excrete some of this acid directly into the urine until the urine pH reaches 4.5, which is 1000 times more acidic than blood.

However, more acid usually needs to be eliminated from the body than can be secreted directly as free acid in the urine. These excess acids are bound to chemical buffers so that they can be excreted in the urine. Two important chemical buffers are phosphate ions and ammonia ($NH_3$). When buffered with acid, ammonia becomes ammonium ($NH_4$). Phosphate is present in the glomerular filtrate, and ammonia is produced by the cells of the renal tubules and secreted into the tubular fluid. Through the buffering process, the kidney is able to excrete large quantities of acid in a bound form, without further lowering the pH of the urine.

### Autoregulation of Blood Pressure

Regulation of blood pressure is an important function of the kidney. Specialized vessels of the kidney, called the vasa recta, constantly monitor blood pressure as blood begins its passage into the kidney. When the vasa recta detect a decrease in blood pressure, specialized juxtaglomerular cells called denta cells, near the afferent arteriole, distal tubule, and efferent arteriole secrete the hormone renin. Renin converts angiotensinogen to angiotensin I, which is then converted to angiotensin II, the most powerful vasoconstrictor known; angiotensin II causes the blood pressure to increase (Goshorn, 2005). The adrenal cortex secretes aldosterone in response to stimulation by the pituitary gland, which occurs in response to poor perfusion or increasing serum osmolality. The result is an increase in blood pressure. When the vasa recta recognize the increase in blood pressure, renin secretion stops. Failure of this feedback mechanism is one of the primary causes of hypertension (see Fig. 43-4).

### Renal Clearance

**Renal clearance** refers to the ability of the kidneys to clear solutes from the plasma. A 24-hour collection of urine is the primary test of renal clearance used to evaluate how well the kidney performs this important excretory function. Renal clearance depends on several factors: how quickly the substance is filtered across the glomerulus, how much of the substance is reabsorbed along the tubules, and how much of the substance is secreted into the tubules. It is possible to measure the renal clearance of any substance, but the one measure that is particularly useful is the creatinine clearance.

**Creatinine** is an endogenous waste product of skeletal muscle that is filtered at the glomerulus, passed through the tubules with minimal change, and excreted in the urine. Hence, creatinine clearance is a good measure of the glomerular filtration rate (GFR). To calculate creatinine clearance, a 24-hour urine specimen is collected. Midway through the collection, the serum creatinine level is measured. The following formula is then used to calculate the creatinine clearance:

$$\frac{(\text{Volume of urine [mL/min]} \times \text{urine creatinine [mL/dL]})}{\text{Serum creatinine (mg/dL)}}$$

The adult GFR can vary from a normal of approximately 125 mL/min (1.67 to 2.0 mL/sec) to a high of 200 mL/min (Porth & Matfin, 2009). Creatinine clearance is an excellent measure of renal function; as renal function declines, creatinine clearance decreases.

### Regulation of Red Blood Cell Production

When the kidneys detect a decrease in the oxygen tension in renal blood flow, they release erythropoietin. Erythropoietin is a glycoprotein from the kidney that stimulates the bone marrow to produce red blood cells (RBCs) that carry oxygen throughout the body.

### Vitamin D Synthesis

The kidneys are also responsible for the final conversion of inactive vitamin D to its active form, 1,25-dihydroxycholecalciferol. Vitamin D is necessary for maintaining normal calcium balance in the body.

### Secretion of Prostaglandins

The kidneys also produce prostaglandin E and prostacyclin, which have a vasodilatory effect and are important in maintaining renal blood flow.

### Excretion of Waste Products

The kidneys eliminate the body's metabolic waste products. The major waste product of protein metabolism is urea, of which about 25 to 30 g are produced and excreted daily. All of this urea must be excreted in the urine; otherwise, it accumulates in body tissues. Other waste products of metabolism that must be excreted are creatinine, phosphates, and sulfates. Uric acid, formed as a waste product of purine metabolism, is also eliminated in the urine. The kidneys serve as the primary mechanism for excreting drug metabolites.

### Urine Storage

The bladder is the reservoir for urine. Both filling and emptying of the bladder are mediated by coordinated sympathetic and parasympathetic nervous system control mechanisms involving the detrusor muscle and the bladder outlet.

Conscious awareness of bladder filling occurs as a result of sympathetic neuronal pathways that travel via the spinal cord to the level of T10 through T12, where peripheral, hypogastric nerve innervation allows for continued bladder filling. As bladder filling continues, stretch receptors in the bladder wall are activated, coupled with the desire to void. This information from the detrusor muscle is relayed back to the cerebral cortex via the parasympathetic pelvic nerves at the level of S1 through S4 (Porth & Matfin, 2009). Overall bladder pressure remains low due to the bladder's compliance (ability to expand or collapse) as urine volume changes.

Bladder compliance is due in part to the smooth muscle lining of the bladder and collagen deposits within the wall of the bladder, as well as to neuronal mechanisms that inhibit the detrusor muscle from contracting (specifically, adrenergic receptors that mediate relaxation). To maintain adequate kidney filtration rates, bladder pressure during filling must remain lower than 40 cm $H_2O$. This low pressure allows the urine to freely leave the renal pelvis and enter the ureters. The sensation of bladder fullness is transmitted to the central nervous system when the bladder has reached about 150 to 200 mL in adults, and an initial desire to void occurs. A marked sense of fullness and discomfort with a strong desire to void usually occurs when the bladder reaches its functional capacity 300 mL to 500 mL of urine (Bickley, 2007). Neurologic changes to the bladder at the level of the supraspinal nerves, the spinal nerves, or the bladder wall itself can cause abnormally high volumes (up to 2000 mL) of urine to be stored due to a decreased or absent urge to void.

Under normal circumstances with average fluid intake of approximately 1 to 2 L/day, the bladder should be able to store urine for periods of 2 to 4 hours at a time during the day. At night, the release of vasopressin in response to decreased fluid intake causes a decrease in the production of urine and makes it more concentrated. This phenomenon usually allows the bladder to continue filling for periods of 6 to 8 hours in adolescents and adults, making them able to sleep for longer periods before needing to void. In older people, decreasing bladder compliance and decreased vasopressin levels often cause **nocturia** (the need to wake up during the night to urinate).

### *Bladder Emptying*

Micturition (voiding) normally occurs approximately eight times in a 24-hour period. It is activated via the micturition reflex arc within the sympathetic and parasympathetic nervous systems, which causes a coordinated sequence of events. Initiation of voiding occurs when the efferent pelvic nerve, which originates in the S1 to S4 area, stimulates the bladder to contract, resulting in complete relaxation of the striated urethral sphincter. This is followed by a decrease in urethral pressure, contraction of the detrusor muscle, opening of the vesicle neck and proximal urethra, and flow of urine. This coordinated effort by the parasympathetic system is mediated by muscarinic and, to a lesser extent, cholinergic receptors within the detrusor muscle. The pressure generated in the bladder during micturition is about 20 to 40 cm $H_2O$ in females. It is somewhat higher and more variable in males 45 years of age and older due to the normal hyperplasia of the cells of the middle lobes of the prostate gland, which surround the proximal urethra. Any obstruction of the bladder outlet, such as in advanced benign prostatic hyperplasia (BPH), results in a high voiding pressure. High voiding pressures make it more difficult to start urine flow and maintain it.

If the spinal pathways from the brain to the urinary system are destroyed (eg, after a spinal cord injury), reflex contraction of the bladder is maintained, but voluntary control over the process is lost. In both situations, the detrusor muscle can contract and expel urine, but the contractions are generally insufficient to empty the bladder completely, so residual urine (urine left in the bladder after voiding) remains. Normally, residual urine amounts to no more than 50 mL in the middle-aged adult and less than 50 to 100 mL in the older adult.

## Gerontologic Considerations

Upper and lower urinary tract function changes with age (Stanley, Blair & Beare, 2005). The GFR decreases, starting between 35 and 40 years of age, and a yearly decline of about 1 mL/min continues thereafter. The elderly are more susceptible to acute and chronic renal failure due to the structural and functional changes in the kidney. Examples include sclerosis of the glomerulus and renal vasculature, decreased blood flow, decreased GFR, altered tubular function, and acid–base imbalance. Although renal function usually remains adequate, renal reserve is decreased and may reduce the kidneys' ability to respond effectively to drastic or sudden physiologic changes. This steady decrease in glomerular filtration, combined with the use of multiple medications in which metabolites are cleared by the kidneys, puts the older person at higher risk for adverse drug effects and drug–drug interactions (Stanley, et al., 2005).

The elderly are more prone to develop hypernatremia and fluid volume deficit, because increasing age is also associated with diminished osmotic stimulation of thirst (Stanley, et al., 2005). Thirst is defined as one's awareness of the desire to drink. The sense of thirst is so protective that hypernatremia almost never occurs in adults younger than 60 years of age.

Structural or functional abnormalities that occur with aging may also prevent complete emptying of the bladder. This may be due to decreased bladder wall contractility; secondary to myogenic or neurogenic factors; or related to bladder outlet obstruction, such as in BPH or after prostatectomy (Ostaszkiewicz, 2007). Vaginal and urethral tissues atrophy (become thinner) in aging women due to decreased estrogen levels. This causes decreased blood supply to the urogenital tissues, resulting in urethral and vaginal irritation and urinary incontinence.

Urinary incontinence is the most common reason for admission to skilled nursing facilities. Many older people and their families are unaware that urinary incontinence stems from many causes. The nurse needs to inform the patient and family that, with appropriate evaluation, urinary incontinence can often be managed at home, and in many cases it can be eliminated. Many treatments are available for urinary incontinence in the elderly, including noninvasive, behavioral interventions that the patient or caregiver can carry out (Palmer & Newman, 2007). Treatment

modalities for urinary incontinence are described in further detail in Chapter 45.

Preparation of the elderly patient for diagnostic tests must be managed carefully to prevent dehydration, which might precipitate renal failure in a patient with marginal renal function. Limitations in mobility may affect an elderly patient's ability to void adequately or to consume an adequate volume of fluids. The patient may limit fluid intake to minimize the frequency of voiding or the risk of incontinence. Teaching the patient and family about the dangers of an inadequate fluid intake is an important role of the nurse caring for the elderly incontinent patient.

# Assessment of the Renal and Urinary Tract Systems

## Health History

Obtaining a urologic health history requires excellent communication skills, because many patients are embarrassed or uncomfortable discussing genitourinary function or symptoms (Bickley, 2007; Weber & Kelley, 2007). It is important to use language the patient can understand and to avoid medical jargon. It is also important to review risk factors, particularly for those patients who are at high risk. For example, the nurse needs to be aware that multiparous women delivering their children vaginally have a high risk for stress urinary incontinence, which, if severe enough, can also lead to urge incontinence. Elderly women and people with neurologic disorders such as diabetic neuropathy, multiple sclerosis (MS), or Parkinson's disease often have incomplete emptying of the bladder and urinary stasis, which may result in urinary tract infection or increasing bladder pressure, leading to overflow incontinence, hydronephrosis, pyelonephritis, or chronic kidney disease (Burrows-Hudson, 2005). Risk factors for specific disorders and kidney and lower urinary tract dysfunction are summarized in Table 43-1 and discussed in Chapters 44 and 45.

When obtaining the health history, the nurse should inquire about the following:

- The patient's chief concern or reason for seeking health care, the onset of the problem, and its effect on the patient's quality of life
- The location, character, and duration of pain, if present, and its relationship to voiding; factors that precipitate pain, and those that relieve it
- History of urinary tract infections, including past treatment or hospitalization for urinary tract infection
- Fever or chills
- Previous renal or urinary diagnostic tests or use of indwelling urinary catheters
- **Dysuria** and when during voiding (ie, at initiation or at termination of voiding) it occurs
- Hesitancy, straining, or pain during or after urination
- Urinary incontinence (stress incontinence, urge incontinence, overflow incontinence, or functional incontinence)
- Hematuria or change in color or volume of urine
- Nocturia and its date of onset
- Renal calculi (kidney stones), passage of stones or gravel in urine

**Table 43-1 RISK FACTORS FOR SELECTED RENAL OR UROLOGIC DISORDERS**

| Risk Factor | Possible Renal or Urologic Disorder |
|---|---|
| Childhood diseases: "strep throat" impetigo, nephrotic syndrome | Chronic kidney disease |
| Advanced age | Incomplete emptying of bladder, leading to urinary tract infection |
| Instrumentation of urinary tract, cystoscopy, catheterization | Urinary tract infection, incontinence |
| Immobilization | Kidney stone formation |
| Occupational, recreational, or environmental exposure to chemicals (plastics, pitch, tar, rubber) | Acute renal failure |
| Diabetes mellitus | Chronic kidney disease, neurogenic bladder |
| Hypertension | Renal insufficiency, chronic renal failure |
| Multiple sclerosis | Incontinence, neurogenic bladder |
| Parkinson's disease | Incontinence |
| Systemic lupus erythematosus | Nephritis, chronic kidney disease |
| Gout, hyperparathyroidism, Crohn's disease, ileostomy | Kidney stone formation |
| Sickle cell anemia, multiple myeloma | Chronic kidney disease |
| Benign prostatic hyperplasia | Obstruction to urine flow, leading to frequency, oliguria, anuria |
| Radiation therapy to pelvis | Cystitis, fibrosis of ureter, or fistula in urinary tract |
| Recent pelvic surgery | Inadvertent trauma to ureters or bladder |
| Pregnancy | Proteinuria, frequent voiding |
| Obstetric injury, tumors | Incontinence |
| Spinal cord injury | Neurogenic bladder, urinary tract infection, incontinence |

- Female patients: number and type (vaginal or cesarean) of deliveries; use of forceps; vaginal infection, discharge, or irritation; contraceptive practices
- History of **anuria** (decreased urine production) or other renal problem
- Presence or history of genital lesions or sexually transmitted diseases
- Use of tobacco, alcohol, or recreational drugs
- Any prescription and over-the-counter medications (including those prescribed for renal or urinary problems)

### Common Symptoms

Dysfunction of the kidney can produce a complex array of symptoms throughout the body. Pain, changes in voiding, and gastrointestinal symptoms are particularly suggestive of urinary tract disease.

#### Pain

Genitourinary pain is usually caused by distention of some portion of the urinary tract as a result of obstructed urine flow or inflammation and swelling of tissues. Severity of pain is related to the sudden onset rather than the extent of distention.

Table 43-2 lists the various types of genitourinary pain, characteristics of the pain, associated signs and symptoms,

**Table 43-2 IDENTIFYING CHARACTERISTICS OF GENITOURINARY PAIN**

| Type | Location | Character | Associated Signs and Symptoms | Possible Etiology |
|---|---|---|---|---|
| Kidney | Costovertebral angle, may extend to umbilicus | Dull constant ache; if sudden distention of capsule, pain is severe, sharp, stabbing, and colicky in nature | Nausea and vomiting, diaphoresis, pallor, signs of shock | Acute obstruction, kidney stone, blood clot, acute pyelonephritis, trauma |
| Bladder | Suprapubic area | Dull, continuous pain, may be intense with voiding, may be severe if bladder full | Urgency, pain at end of voiding, painful straining | Overdistended bladder, infection, interstitial cystitis; tumor |
| Ureteral | Costovertebral angle, flank, lower abdominal area, testis, or labium | Severe, sharp, stabbing pain, colicky in nature | Nausea and vomiting, paralytic ileus | Ureteral stone, edema or stricture, blood clot |
| Prostatic | Perineum and rectum | Vague discomfort, feeling of fullness in perineum, vague back pain | Suprapubic tenderness, obstruction to urine flow; frequency, urgency, dysuria, nocturia | Prostatic cancer, acute or chronic prostatitis |
| Urethral | Male: along penis to meatus; female: urethra to meatus | Pain variable, most severe during and immediately after voiding | Frequency, urgency, dysuria, nocturia, urethral discharge | Irritation of bladder neck, infection of urethra, trauma, foreign body in lower urinary tract |

and possible causes. However, kidney disease does not always involve pain. It tends to be diagnosed because of other symptoms that cause a patient to seek health care, such as pedal edema, shortness of breath, and changes in urine elimination (Stanley, et al., 2005).

### Changes in Voiding

**Micturition** is normally a painless function that occurs approximately eight times in a 24-hour period. The average person voids 1 to 2 L of urine in 24 hours, although this amount varies depending on fluid intake, sweating, environmental temperature, vomiting, or diarrhea. Common problems associated with voiding include **frequency,** urgency, dysuria, hesitancy, incontinence, enuresis, polyuria, **oliguria,** and hematuria. These problems and others are described in Table 43-3. Increased urinary urgency and frequency coupled with decreasing urine volumes strongly suggest urine retention. Depending on the acuity of the onset of these symptoms, immediate bladder emptying via catheterization and evaluation may be necessary to prevent kidney dysfunction.

**Table 43-3 PROBLEMS ASSOCIATED WITH CHANGES IN VOIDING**

| Problem | Definition | Possible Etiology |
|---|---|---|
| Frequency | Frequent voiding—more than every 3 h | Infection, obstruction of lower urinary tract leading to residual urine and overflow, anxiety, diuretics, benign prostatic hyperplasia, urethral stricture, diabetic neuropathy |
| Urgency | Strong desire to void | Infection, chronic prostatitis, urethritis, obstruction of lower urinary tract leading to residual urine and overflow, anxiety, diuretics, benign prostatic hyperplasia, urethral stricture, diabetic neuropathy |
| Dysuria | Painful or difficult voiding | Lower urinary tract infection, inflammation of bladder or urethra, acute prostatitis, stones, foreign bodies, tumors in bladder |
| Hesitancy | Delay, difficulty in initiating voiding | Benign prostatic hyperplasia, compression of urethra, outlet obstruction, neurogenic bladder |
| Nocturia | Excessive urination at night | Decreased renal concentrating ability, heart failure, diabetes mellitus, incomplete bladder emptying, excessive fluid intake at bedtime, nephrotic syndrome, cirrhosis with ascites |
| Incontinence | Involuntary loss of urine | External urinary sphincter injury, obstetric injury, lesions of bladder neck, detrusor dysfunction, infection, neurogenic bladder, medications, neurologic abnormalities |
| Enuresis | Involuntary voiding during sleep | Delay in functional maturation of central nervous system (bladder control usually achieved by 5 y of age), obstructive disease of lower urinary tract, genetic factors, failure to concentrate urine, urinary tract infection, psychological stress |
| Polyuria | Increased volume of urine voided | Diabetes mellitus, diabetes insipidus, use of diuretics, excess fluid intake, lithium toxicity, some forms of kidney disease (hypercalcemic and hypokalemic nephropathy) |
| Oliguria | Urine output less than 500 mL/day | Acute or chronic renal failure (see Chapter 44), inadequate fluid intake |
| Anuria | Urine output less than 50 mL/day | Acute or chronic renal failure (see Chapter 44), complete obstruction |
| Hematuria | Red blood cells in the urine | Cancer of genitourinary tract, acute glomerulonephritis, renal stones, renal tuberculosis, blood dyscrasia, trauma, extreme exercise, rheumatic fever, hemophilia, leukemia, sickle cell trait or disease |
| Proteinuria | Abnormal amounts of protein in the urine | Acute and chronic renal disease, nephrotic syndrome, vigorous exercise, heat stroke, severe heart failure, diabetic nephropathy, multiple myeloma |

### Gastrointestinal Symptoms

Gastrointestinal signs and symptoms are often associated with urologic conditions because of shared autonomic and sensory innervation and renointestinal reflexes (see Table 43-3). The proximity of the right kidney to the colon, duodenum, head of the pancreas, common bile duct, liver, and gallbladder may cause gastrointestinal disturbances. The proximity of the left kidney to the colon (splenic flexure), stomach, pancreas, and spleen may also result in intestinal symptoms. The most common signs and symptoms are nausea, vomiting, diarrhea, abdominal discomfort, and abdominal distention. Urologic symptoms can mimic such disorders as appendicitis, peptic ulcer disease, and cholecystitis; this can make diagnosis difficult, especially in the elderly, who have decreased neurologic innervation to this area (Goshorn, 2005).

### Unexplained Anemia

Gradual kidney dysfunction can be insidious in its presentation, although fatigue is a common symptom. Fatigue, shortness of breath, and exercise intolerance all result from the condition known as "anemia of chronic disease." Although historically hematocrit has been the blood test of choice when assessing a patient for anemia, use of the hemoglobin level rather than hematocrit is currently recommended, because that measurement is a better assessment of the oxygen transport ability of the blood.

### *Past Health, Family, and Social History*

Data collection about previous health problems or diseases provides the health care team with useful information for evaluating the patient's current urinary status. People with diabetes who have consistent hypertension and those with primary hypertension are at risk for renal dysfunction. Older men are at risk for prostatic enlargement, which causes urethral obstruction and can result in urinary tract infections and renal failure. People with a family history of urinary tract problems are at increased risk for renal disorders. Genetics may also influence renal conditions (Chart 43-2).

It is also important to assess the patient's psychosocial status, level of anxiety, perceived threats to body image, available support systems, and sociocultural patterns.

## Physical Assessment

Several body systems can affect upper and lower urinary tract dysfunction, and conversely that dysfunction can affect several end organs; therefore, a head-to-toe assessment is indicated. Areas of emphasis include the abdomen, suprapubic region, genitalia, lower back, and lower extremities.

The kidneys are not usually palpable. However, palpation of the kidneys may detect an enlargement that could prove to be very important (Bickley, 2007). The correct technique for palpation is illustrated in Figure 43-5. It

CHART 43-2 GENETICS IN NURSING PRACTICE

## *Renal and Urinary Tract Disorders*

Various conditions that affect the renal system and urinary tract function are influenced by genetic factors. Some examples of these genetic disorders are:

- Alport syndrome
- Congenital absence of the vas deferens (caused by *CFTR* gene mutation for cystic fibrosis)
- Cystic, dysplastic kidneys
- Fabry disease
- Familial Wilms' tumor
- Focal and segmental glomerulosis
- Horseshoe kidney
- Polycystic kidney (autosomal dominant gene)
- Nephrosis of later onset
- Renal cystic disease in tuberous sclerosis complex

### Nursing Assessments

**Family History**

- Inquire about other family members with renal and/or urinary tract malformations.
- Ask about family history of kidney disease with onset in third to fifth decade (polycystic kidney, autosomal dominant gene).
- Identify family history of male infertility and cystic fibrosis (congenital absence of vas deferens).
- Be alert for family members with history of early-onset renal (Wilms' tumor) or other cancers.

**Physical Assessment**

- Be alert for signs and symptoms of renal disease at an early age (hematuria, hypertension, abdominal mass).
- Assess for clinical findings suggesting that renal disease is a component of a genetic syndrome (eg, seizures, mental retardation, skin involvement).

### Management Issues Specific to Genetics

- Inquire whether DNA mutation or other genetic testing has been performed on an affected family member.
- If indicated, refer for genetic counseling and evaluation so that the family can discuss concerns regarding inheritance, risks to other family members, availability of genetic testing, and gene-based interventions.
- Offer appropriate genetics information and resources (eg, Genetic Alliance Web site).
- Provide support to families newly diagnosed with gene-related renal and/or kidney disease.

### Genetics Resources for Nurses and Their Patients on the Web

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Clinics**—a listing of common genetic disorders with up-to-date clinical summaries and genetic counseling and testing information, www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/projects/omim



**Figure 43-5** Technique for palpating the right kidney (*top*). Place one hand under the patient's back with the fingers under the lower rib. Place the palm of the other hand anterior to the kidney with fingers above the umbilicus. Push the hand on top forward as the patient inhales deeply. The left kidney (*bottom*) is palpated similarly by reaching over to the patient's left side and placing the right hand beneath the patient's lower left rib. From Weber, J. & Kelley, J. (2007). *Health assessment in nursing* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins.

may be possible to palpate the smooth, rounded lower pole of the kidney between the hands. The right kidney is easier to detect, because it is somewhat lower than the left one. In obese patients, palpation of the kidneys is more difficult.

Renal dysfunction may produce tenderness over the costovertebral angle, which is the angle formed by the lower border of the 12th, or bottom, rib and the spine (Fig. 43-6). The abdomen (just slightly to the right and left of the midline in both upper quadrants) is auscultated to assess for bruits (low-pitched murmurs that indicate renal artery stenosis or an aortic aneurysm). The abdomen is also assessed for the presence of ascites (accumulation of fluid in the peritoneal cavity), which may occur with kidney as well as liver dysfunction.

To check for residual urine, the bladder should be percussed after the patient voids. Percussion of the bladder begins at the midline just above the umbilicus and proceeds downward. The sound changes from tympanic to dull when percussing over the bladder. The bladder, which can be palpated only if it is moderately distended, feels like a smooth, firm, round mass rising out of the abdomen, usually at midline (Fig. 43-7). Dullness to percussion of the bladder after voiding indicates incomplete bladder emptying (Bickley, 2007; Weber & Kelley, 2007).

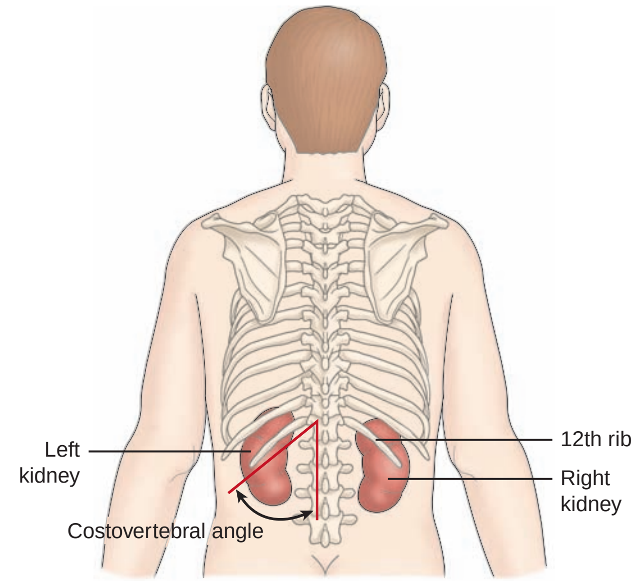



**Figure 43-6** Location of the costovertebral angle.

In older men, BPH or prostatitis can cause difficulty with urination (Stanley, et al., 2005). Because the signs and symptoms of prostate cancer can mimic those of

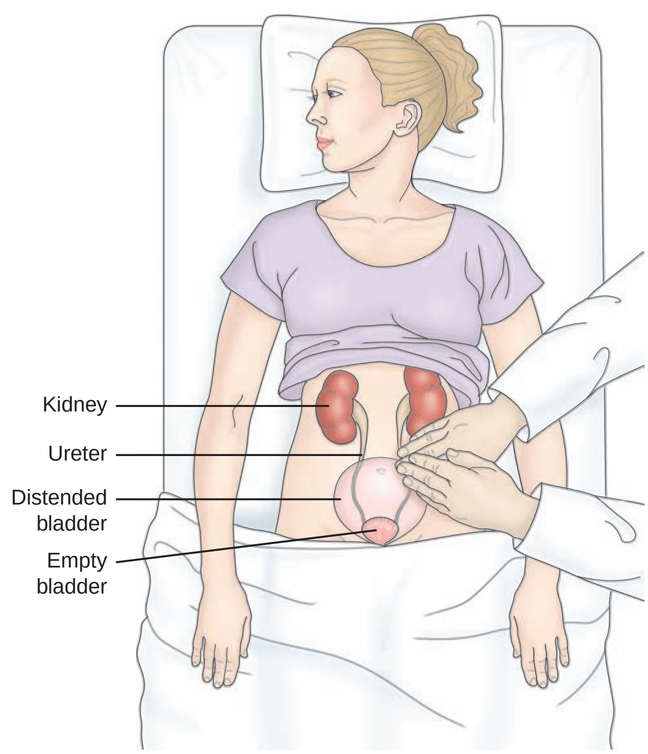



**Figure 43-7** Palpation of the bladder.

BPH, the prostate gland is palpated by digital rectal examination (DRE) as part of the yearly physical examination in men 40 years of age and older (see Chapter 49). In addition, a blood specimen is obtained to test the prostate-specific antigen (PSA) level annually; the results of the DRE and PSA are then correlated. Blood is drawn for PSA before the DRE, because manipulation of the prostate can cause the PSA level to increase temporarily. The inguinal area is examined for enlarged nodes, an inguinal or femoral hernia, and varicocele (varicose veins of the spermatic cord).

In women, the vulva, urethral meatus, and vagina are examined (Bickley, 2007; Weber & Kelley, 2007). The urethra is palpated for diverticula, and the vagina is assessed for adequate estrogen effect and any of five types of herniation. Urethrocele is the bulging of the anterior vaginal wall into the urethra. Cystocele is the herniation of the bladder wall into the vaginal vault. Pelvic prolapse is bulging of the cervix into the vaginal vault. Enterocele is herniation of the bowel into the posterior vaginal wall. Rectocele is herniation of the rectum into the vaginal wall. These prolapses are graded depending on the degree of herniation (see Chapter 47 for more information).

The woman is asked to cough and perform a Valsalva maneuver to assess the urethra's system of muscular and ligament support. If urine leakage occurs, the index and middle fingers of the examiner's gloved hand are used to support either side of the urethra as the woman is asked to repeat the Valsalva maneuver; this is called the Marshall-Boney maneuver. If this produces urinary leakage, referral is suggested.

The patient is assessed for edema and changes in body weight. Edema may be observed, particularly in the face and dependent parts of the body, such as the ankles and sacral areas, and suggests fluid retention. An increase in body weight commonly accompanies edema. A 1-kg weight gain equals approximately 1000 mL of fluid (1 lb is approximately 500 mL).

The deep tendon reflexes of the knee are examined for quality and symmetry. This is an important part of testing for neurologic causes of bladder dysfunction, because the sacral area, which innervates the lower extremities, is the same peripheral nerve area responsible for urinary continence. The gait pattern of the person with bladder dysfunction is also noted, as well as the patient's ability to walk toe-to-heel. These tests evaluate possible supraspinal causes for urinary incontinence.

## Diagnostic Evaluation

A comprehensive health history is used to determine the appropriate laboratory and diagnostic tests. The following sections review some of the tests that might be used.

Most patients undergoing urologic testing or imaging studies are apprehensive, even those who have had these tests in the past. Patients frequently feel discomfort and embarrassment about such a private and personal function as voiding. Voiding in the presence of others can frequently cause guarding, a natural reflex that inhibits voiding due to situational anxiety. Because the outcomes of these studies determine the plan of care, the nurse must help the patient relax by providing as much privacy and explanation about the procedure as possible (Chart 43-3). In addition, Chart 43-4 provides a plan of care for patients undergoing diagnostic testing.

### Urinalysis and Urine Culture

The urinalysis provides important clinical information about kidney function and helps diagnose other diseases, such as diabetes. The urine culture determines whether bacteria are present in the urine, as well as their strains and concentration. Urine culture and sensitivity also identify the antimicrobial therapy that is best suited for the particular strains identified, taking into consideration the antibiotics that have the best rate of resolution in that particular geographic region. Appropriate evaluation of any abnormality can assist in detecting serious underlying diseases.

#### Components

Urine examination includes the following:

- Urine color (Table 43-4)
- Urine clarity and odor
- Urine pH and specific gravity
- Tests to detect protein, glucose, and ketone bodies in the urine (proteinuria, renal glycosuria, and ketonuria, respectively)
- Microscopic examination of the urine sediment after centrifugation to detect RBCs **(hematuria),** white blood cells **(pyuria),** casts (cylindruria), crystals (crystalluria), and bacteria **(bacteriuria)**

Researchers are working on additional noninvasive tests that can be performed on urine to detect conditions such as bladder cancer. For example, urine telomerase activity levels have been found to be sensitive and specific to detect bladder cancer in men (Sanchini, Gunelli, Nanni, et al., 2005). More research is needed before these tests are acceptable for routine use in patients.

#### Significance of Findings

Several abnormalities, such as hematuria and proteinuria, produce no symptoms but may be detected during a routine urinalysis using a dipstick. Normally, about 1 million RBCs pass into the urine daily, which is equivalent to one to three RBCs per high-power field. Hematuria (more than three RBCs per high-power field) can develop from an abnormality anywhere along the genitourinary tract and is more common in women than in men. Common causes include acute infection (cystitis, urethritis, or prostatitis), renal calculi, and neoplasm. Other causes include systemic disorders, such as bleeding disorders; malignant lesions; and medications, such as warfarin (Coumadin) and heparin (Heparin Sodium). Although hematuria may initially be detected using a dipstick test, further microscopic evaluation is necessary (Tierney & Henderson, 2005).

Proteinuria may be a benign finding, or it may signify serious disease (Burrows-Hudson, 2005). Occasional loss of

CHART 43-3 PATIENT EDUCATION

**Before and After Urodynamic Testing**

- A physician or nurse will conduct an in-depth interview. Questions related to your urologic symptoms and voiding habits will be asked.
- You will be asked to describe sensations felt during the procedure.
- During the procedure, you might be asked to change positions (eg, from supine to sitting or standing).
- You may be asked to cough or perform the Valsalva maneuver (bear down) during the procedure.
- You will probably need to have one or two urethral catheters inserted so that bladder pressure and bladder filling can be measured. Another catheter may be placed in the rectum or vagina to measure abdominal pressure.
- You may also have electrodes (surface, wire, or needle) placed in the perianal area for electromyography (EMG). This may be uncomfortable initially during insertion and later during position changes.
- Your bladder will be filled through the urethral catheter one or more times during the procedure.
- After the procedure, you may experience urinary frequency, urgency, or dysuria from the urethral catheters. Avoid caffeinated, carbonated, and alcoholic beverages after the procedure because these can further irritate the bladder. These symptoms usually decrease or subside by the day after the procedure.
- You might notice a slight hematuria (blood-tinged urine) right after the procedure (especially in men with benign prostatic hyperplasia). Drinking fluids will help to clear the hematuria.
- If the urinary meatus is irritated, a warm sitz bath may be helpful.
- Be alert for signs of a urinary tract infection after the procedure. Contact your physician if you experience fever, chills, lower back pain, or continued dysuria and hematuria.
- If you receive an antibiotic medication before the procedure, you should continue taking the complete course of medication after the procedure. This is a measure to prevent infection.

up to 150 mg/day of protein in the urine, primarily albumin and Tamm-Horsfall protein (also known as uromodulin), is considered normal and usually does not require further evaluation. A dipstick examination, which can detect from 30 to 1000 mg/dL of protein, should be used as a screening test only, because urine concentration, pH, hematuria, and radiocontrast materials all affect the results. Because dipstick analysis does not detect protein concentrations of less than 30 mg/dL, the test cannot be used for early detection of diabetic nephropathy. Microalbuminuria (excretion of 20 to 200 mg/dL of protein in the urine) is an early sign of diabetic nephropathy. Common benign causes of transient proteinuria are fever, strenuous exercise, and prolonged standing.

Causes of persistent proteinuria include glomerular diseases, malignancies, collagen diseases, diabetes mellitus, preeclampsia, hypothyroidism, heart failure, exposure to heavy metals, and use of medications, such as nonsteroidal anti-inflammatory drugs (NSAIDs) and angiotensin-converting enzyme (ACE) inhibitors (Karch, 2008).

## Specific Gravity

**Specific gravity** measures the density of a solution compared to the density of water, which is 1.000. Specific gravity is altered by the presence of blood, protein, and casts in the urine. The normal range of urine specific gravity is 1.010 to 1.025.

Methods for determination of specific gravity include the following:

- Multiple-test dipstick (most common method), with a specific reagent area for specific gravity
- Urinometer (least accurate method), in which urine is placed in a small cylinder and the urinometer is floated in the urine; a specific gravity reading is obtained at the meniscus level of the urine
- Refractometer, an instrument used in a laboratory setting, which measures differences in the speed of light passing through air and the urine sample

Urine specific gravity depends largely on hydration status. When fluid intake decreases, specific gravity normally increases. With high fluid intake, specific gravity decreases. In patients with kidney disease, urine specific gravity does not vary with fluid intake, and the patient's urine is said to have a fixed specific gravity. Disorders or conditions that cause decreased urine specific gravity include diabetes insipidus, glomerulonephritis, and severe renal damage. Those that can cause increased specific gravity include diabetes mellitus, nephritis, and fluid deficit.

## Osmolality

Osmolality is the most accurate measurement of the kidney's ability to dilute and concentrate urine. It measures the number of solute particles in a kilogram of water. Serum and urine osmolality are measured simultaneously to assess the body's fluid status. In healthy adults serum osmolality is 280 to 300 mOsm/kg, and normal urine osmolality is 200 to 800 mOsm/kg (Goertz, 2006). For a 24-hour urine sample, the normal value is 300 to 900 mOsm/kg.

## Renal Function Tests

Renal function tests are used to evaluate the severity of kidney disease and to assess the status of the patient's kidney function. These tests also provide information about the effectiveness of the kidney in carrying out its excretory function. Renal function test results may be within normal limits until the GFR is reduced to less than 50% of normal. Renal function can be assessed most accurately if several tests are performed and their results are analyzed together. Common tests of renal function include renal concentration tests, creatinine clearance, and

CHART 43-4

## PLAN OF NURSING CARE

### *Care of the Patient Undergoing Diagnostic Testing of the Renal–Urologic System*

**NURSING DIAGNOSIS:** Deficient knowledge about procedures and diagnostic tests
**GOAL:** Patient demonstrates increased understanding of the procedure and tests and expected behaviors

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess patient's level of understanding of planned diagnostic tests. | 1. Provides basis for teaching and gives indication of patient's perception of tests |
| 2. Provide a description of tests in language the patient can understand. | 2. Understanding what is expected enhances patient compliance and cooperation. |
| 3. Assess patient's understanding of test results after their completion. | 3. Apprehension may interfere with patient's ability to understand information and results provided by health care team. |
| 4. Reinforce information provided to patient about test results and implications for follow-up care. | 4. Provides opportunity for patient to clarify information and anticipate follow-up care. |

**Expected Outcomes**

- States rationale for planned diagnostic tests and what tasks and behaviors are expected during the procedure
- Complies with urine collection, fluid modifications, or other procedures required for diagnostic evaluation
- Restates in own words results of diagnostic tests
- Asks for clarification of terms and procedures
- Explains rationale for follow-up care
- Participates in follow-up care

**NURSING DIAGNOSIS:** Acute pain related to infection, edema, obstruction, or bleeding along urinary tract or related to invasive diagnostic tests
**GOAL:** Patient reports decrease in pain and absence of discomfort

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess level of pain: dysuria, burning on urination, abdominal or flank pain, bladder spasm. | 1. Provides baseline for evaluation of pain relief strategies and progression of dysfunction |
| 2. Encourage fluid intake (unless contraindicated). | 2. Promotes dilute urine and flushing of the lower urinary tract |
| 3. Encourage warm sitz baths. | 3. Relieves local discomfort and promotes relaxation |
| 4. Report increased pain to physician. | 4. May indicate progression or recurrence of dysfunction, or untoward signs (eg, bleeding, calculi) |
| 5. Administer analgesic and antispasmodic agents for pain and spasm as prescribed. | 5. Prescribed to relieve pain or spasm |
| 6. Assess voiding patterns and hygiene practices and provide instructions about recommended voiding patterns and hygienic practices. | 6. Delayed emptying of the bladder and poor hygiene may contribute to pain secondary to renal or urinary tract dysfunction. |

**Expected Outcomes**

- Reports decreasing levels of pain
- Reports absence of local symptoms
- States ability to start and stop urinary stream without discomfort
- Consumes increased fluid intake if indicated
- Uses sitz bath as indicated
- Identifies signs and symptoms to be reported to the health care provider
- Takes medications as prescribed
- Does not delay in emptying bladder
- Uses appropriate hygienic measures, avoids use of bubble bath, uses appropriate hygiene after bowel movements

**NURSING DIAGNOSIS:** Fear related to potential alteration in renal function and embarrassment secondary to discussion of urinary function and invasion of genitalia
**GOAL:** Patient appears relaxed and reports decreased fear and anxiety

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess patient's level of fear and apprehension. | 1. A high level of fear or apprehension can interfere with learning and cooperation. |
| 2. Explain all procedures and tests to patient. | 2. Knowledge about what is expected helps reduce fear and apprehension. |
| 3. Provide privacy and respect patient's modesty by closing doors and keeping patient covered. Keep urinal and bedpan covered and out of sight. | 3. Communicates that you are aware of and accept patient's need for privacy and modesty |
| 4. Use correct terminology in a factual manner when questioning patient about urinary tract dysfunction. | 4. Conveys that you are comfortable discussing patient's urinary dysfunction and symptoms with patient |
| 5. Assess patient's fears about perceived changes associated with tests and other procedures. | 5. May uncover fears and misconceptions of the patient that can be alleviated by correct understanding |
| 6. Instruct patient in relaxation techniques. | 6. Promotes relaxation and assists patient in coping with uncertainty about outcomes |

**Expected Outcomes**

- Appears relaxed with a low level of fear or apprehension
- States rationale for tests and procedures in a calm, relaxed manner
- Maintains usual privacy and modesty
- Discusses own urinary tract dysfunction using correct terminology without overt indications of embarrassment or discomfort
- Relates fears and concerns
- Demonstrates correct understanding of procedures and possible outcomes
- Appears relaxed with low level of fear and apprehension

**Table 43-4 CHANGES IN URINE COLOR AND POSSIBLE CAUSES**

| Urine Color | Possible Cause |
|---|---|
| Colorless to pale yellow | Dilute urine due to diuretics, alcohol consumption, diabetes insipidus, glycosuria, excess fluid intake, renal disease |
| Yellow to milky white | Pyuria, infection, vaginal cream |
| Bright yellow | Multiple vitamin preparations |
| Pink to red | Hemoglobin breakdown, red blood cells, gross blood, menses, bladder or prostate surgery, beets, blackberries, medications (phenytoin, [Dilantin], rifampin [Rifadin], phenothiazine [Mellaril], cascara [Sagrada], senna products) |
| Blue, blue green | Dyes, methylene blue, Pseudomonas species organisms, medications (amitriptyline [Amitriptyline HCL], triamterine [Dyrenium]) |
| Orange to amber | Concentrated urine due to dehydration, fever, bile, excess bilirubin or carotene, medications (pyridium [Phenazopyridium HCL], nitrofurantoin [Furadantin]) |
| Brown to black | Old red blood cells, urobilinogen, bilirubin, melanin, porphyrin, extremely concentrated urine due to dehydration, medications (cascara, metronidazole [Flagyl], iron preparations, quinine [Quinine Sulfate], senna products, methyldopa [Aldomet], nitrofurantoin) |

serum creatinine and blood **urea nitrogen** levels. Table 43-5 describes the purpose and gives the normal range for each test. Other tests for evaluating renal function that may be helpful include serum electrolyte levels (see Chapter 14).

## Diagnostic Imaging

### *Kidney, Ureter, and Bladder Studies*

An x-ray study of the abdomen or kidneys, ureters, and bladder (KUB) may be performed to delineate the size, shape, and position of the kidneys and to reveal urinary system abnormalities (Labus, 2008).

### *General Ultrasonography*

Ultrasonography is a noninvasive procedure that uses sound waves passed into the body through a transducer to detect abnormalities of internal tissues and organs. Abnormalities such as fluid accumulation, masses, congenital malformations, changes in organ size, and obstructions can be identified. During the test, the lower abdomen and genitalia may need to be exposed. Ultrasonography requires a full bladder; therefore, fluid intake should be encouraged before the procedure. Because of its sensitivity, ultrasonography has replaced many other tests as the initial diagnostic procedure (Burrows-Hudson, 2005).

### *Bladder Ultrasonography*

Bladder ultrasonography is a noninvasive method of measuring urine volume in the bladder. It may be indicated for urinary frequency, inability to void after removal of an indwelling urinary catheter, measurement of postvoiding residual urine volume, inability to void postoperatively, or assessment of the need for catheterization during the initial stages of an intermittent catheterization training program. Portable, battery-operated devices are available for bedside use. The scan head is placed on the patient's abdomen and

**Table 43-5 RENAL FUNCTION TESTS**

| Test | Purpose | Normal Values | | |
|---|---|---|---|---|
| **Renal Concentration Tests** | | | | |
| Specific gravity | Evaluates ability of kidneys to concentrate solutes in urine. | 1.010–1.025 | | |
| Urine osmolality | Concentrating ability is lost early in kidney disease; hence, these test findings may disclose early defects in renal function. | 300–900 mOsm/kg/24 h, 50–1200 mOsm/kg random sample | | |
| **24-Hour Urine Test** | | | | |
| Creatinine clearance | Detects and evaluates progression of renal disease. Test measures volume of blood cleared of endogenous creatinine in 1 min, which provides an approximation of the glomerular filtration rate. Sensitive indicator of renal disease used to follow progression of renal disease. | Measured in mL/min/1.73 m$^2$ | | |
| | | **Age** | **Male** | **Female** |
| | | Under 30 | 88–146 | 81–134 |
| | | 30–40 | 82–140 | 75–128 |
| | | 40–50 | 75–133 | 69–122 |
| | | 50–60 | 68–126 | 64–116 |
| | | 60–70 | 61–120 | 58–110 |
| | | 70–80 | 55–113 | 52–105 |
| **Serum Tests** | | | | |
| Creatinine level | Measures effectiveness of renal function. Creatinine is end product of muscle energy metabolism. In normal function, level of creatinine, which is regulated and excreted by the kidneys, remains fairly constant in body. | 0.6–1.2 mg/dL (50–110 mmol/L) | | |
| Urea nitrogen (blood urea nitrogen [BUN]) | Serves as index of renal function. Urea is nitrogenous end product of protein metabolism. Test values are affected by protein intake, tissue breakdown, and fluid volume changes. | 7–18 mg/dL<br>Patients >60 yrs: 8–20 mg/dL | | |
| BUN-to-creatinine ratio | Evaluates hydration status. An elevated ratio is seen in hypovolemia; a normal ratio with an elevated BUN and creatinine is seen with intrinsic renal disease. | About 10:1 | | |

directed toward the bladder. The device automatically calculates and displays urine volume.

### Computed Tomography and Magnetic Resonance Imaging

Computed tomography (CT) scans and magnetic resonance imaging (MRI) are noninvasive techniques that provide excellent cross-sectional views of the anatomy of the kidney and urinary tract (Labus, 2008). They are used to evaluate genitourinary masses, nephrolithiasis, chronic renal infections, renal or urinary tract trauma, metastatic disease, and soft tissue abnormalities. Occasionally, an oral or intravenous (IV) radiopaque contrast agent is used in CT scanning to enhance visualization.

#### Preparation for Magnetic Resonance Imaging

Patient preparation should include teaching relaxation techniques and informing the patient that he or she will be able to communicate with the staff by means of a microphone located inside the scanner. Many MRI suites provide headphones so that patients can listen to the music of their choice during the procedure. Nursing care guidelines for patient preparation and test precautions for any imaging procedure that requires a contrast agent (contrast medium) are explained in Chart 43-5.

Before the patient enters the room where the MRI is to be performed, all metal objects and credit cards (the magnetic field can erase them) are removed. This includes medication patches (eg, nicotine and nitroglycerine) that have a metal backing, which can cause burns if they are not removed. No metal objects (eg, oxygen tanks, ventilators, stethoscopes) may be brought into the MRI room. The magnetic field is so strong that any metal-containing items will be pulled toward the magnet, causing severe injury and possible death. A patient history is obtained to determine the presence of any metal objects (eg, aneurysm clips, orthopedic hardware, pacemakers, artificial heart valves, intrauterine devices). These objects could malfunction, be dislodged, or heat up as they absorb energy. Cochlear implants are inactivated by MRI; therefore, other imaging procedures are considered. A sedative may be prescribed, because claustrophobia is a problem for some patients.

Prior to MRI of the urinary system the patient needs to be informed to avoid alcohol, caffeine-containing beverages, and smoking for at least 2 hours and food for at least 1 hour prior to the scan. Patients should continue taking their usual medication, except for iron supplements, which can interfere with the imaging (Labus, 2008).

### Chart 43-5 • *Patient Care During Urologic Testing With Contrast Agents*

For some patients, contrast agents are nephrotoxic and allergenic. The following guidelines can help the nurse and other health care providers respond quickly in the event of a problem.

**Nursing Actions for Room Preparation**

- Have emergency equipment and medications available in case the patient has an anaphylactic reaction to the contrast agent. Emergency supplies include epinephrine, corticosteroids, vasopressors, oxygen, and airway and suction equipment.

**Nursing Actions for Patient Preparation**

- Obtain the patient's allergy history with emphasis on allergy to iodine, shellfish, and other seafood, because many contrast agents contain iodine.
- Notify physician and radiologist if the patient is allergic or suspected to be allergic to iodine.
- Obtain health history. Contrast agents should be used with caution in older patients and patients who have diabetes mellitus, multiple myeloma, renal insufficiency, or volume depletion.
- Inform the patient that he or she may experience a temporary feeling of warmth, flushing of the face, and an unusual flavor (similar to that of seafood) in the mouth when the contrast agent is infused.
- Monitor patient closely for allergic reaction and monitor urine output.

### Nuclear Scans

Nuclear scans require injection of a radioisotope (a technetium 99m–labeled compound or iodine 123 [$^{123}$I] hippurate) into the circulatory system; the isotope is then monitored as it moves through the blood vessels of the kidneys. A scintillation camera is placed behind the kidney with the patient in a supine, prone, or seated position. Hypersensitivity to the radioisotope is rare. The technetium scan provides information about kidney perfusion. The $^{123}$I-hippurate renal scan provides information about kidney function, such as GFR.

Nuclear scans are used to evaluate acute and chronic renal failure, renal masses, and blood flow before and after kidney transplantation. The radioisotope is injected at a specified time to achieve the proper concentration in the kidneys. After the procedure is completed, the patient is encouraged to drink fluids to promote excretion of the radioisotope by the kidneys.

### Intravenous Urography

IV urography includes various tests such as excretory urography, intravenous pyelography (IVP), and infusion drip pyelography. A radiopaque contrast agent is administered by IV. An IVP shows the kidneys, ureter, and bladder via x-ray imaging as the dye moves through the upper and then the lower urinary system. A nephrotomogram may be carried out as part of the study to visualize different layers of the kidney and the diffuse structures within each layer and to differentiate solid masses or lesions from cysts in the kidneys or urinary tract.

IV urography may be used as the initial assessment of many suspected urologic conditions, especially lesions in the kidneys and ureters. It also provides an approximate estimate of renal function. After the contrast agent (sodium diatrizoate or meglumine diatrizoate) is administered by IV, multiple x-rays are obtained to visualize drainage structures in the upper and lower urinary systems.

Infusion drip pyelography requires IV infusion of a large volume of a dilute contrast agent to opacify the renal

parenchyma and fill the urinary tract. This examination method is useful when prolonged opacification of the drainage structures is desired so that tomograms (body-section radiography) can be made. Images are obtained at specified intervals after the start of the infusion. These images show the filled and distended collecting system. The patient preparation is the same as for excretory urography, except that fluids are not restricted.

### Retrograde Pyelography

In retrograde pyelography, catheters are advanced through the ureters into the renal pelvis by means of cystoscopy. A contrast agent is then injected. Retrograde pyelography is usually performed if IV urography provides inadequate visualization of the collecting systems. It may also be used before extracorporeal shock wave lithotripsy and in patients with urologic cancer who need follow-up and have an allergy to IV contrast agents. Possible complications include infection, hematuria, and perforation of the ureter. Retrograde pyelography is used infrequently because of improved techniques in excretory urography.

### Cystography

Cystography aids in evaluating vesicoureteral reflux (backflow of urine from the bladder into one or both ureters) and in assessing for bladder injury. A catheter is inserted into the bladder, and a contrast agent is instilled to outline the bladder wall. The contrast agent may leak through a small bladder perforation stemming from bladder injury, but such leakage is usually harmless. Cystography can also be performed with simultaneous pressure recordings inside the bladder.

### Voiding Cystourethrography

Voiding cystourethrography uses fluoroscopy to visualize the lower urinary tract and assess urine storage in the bladder. It is commonly used as a diagnostic tool to identify vesicoureteral reflux. A urethral catheter is inserted, and a contrast agent is instilled into the bladder. When the bladder is full and the patient feels the urge to void, the catheter is removed, and the patient voids.

### Renal Angiography

A renal angiogram, or renal arteriogram, provides an image of the renal arteries. The femoral (or axillary) artery is pierced with a needle, and a catheter is threaded up through the femoral and iliac arteries into the aorta or renal artery. A contrast agent is injected to opacify the renal arterial supply. Angiography is used to evaluate renal blood flow in suspected renal trauma, to differentiate renal cysts from tumors, and to evaluate hypertension. It is used preoperatively for renal transplantation. Before the procedure, a laxative may be prescribed to evacuate the colon so that unobstructed x-rays can be obtained. Injection sites (groin for femoral approach or axilla for axillary approach) may be shaved. The peripheral pulse sites (radial, femoral, and dorsalis pedis) are marked for easy access during postprocedural assessment. The patient is informed that there may be a brief sensation of warmth along the course of the vessel when the contrast agent is injected.

After the procedure, vital signs are monitored until stable. If the axillary artery was the injection site, blood pressure measurements are taken on the opposite arm. The injection site is examined for swelling and hematoma. Peripheral pulses are palpated, and the color and temperature of the involved extremity are noted and compared with those of the uninvolved extremity. Cold compresses may be applied to the injection site to decrease edema and pain. Possible complications include hematoma formation, arterial thrombosis or dissection, false aneurysm formation, and altered renal function.

## Urologic Endoscopic Procedures

Endourology, or urologic endoscopic procedures, can be performed in one of two ways: using a cystoscope inserted into the urethra, or percutaneously, through a small incision.

The cystoscopic examination is used to directly visualize the urethra and bladder. The cystoscope, which is inserted through the urethra into the bladder, has an optical lens system that provides a magnified, illuminated view of the bladder (Fig. 43-8). The use of a high-intensity light and interchangeable lenses allows excellent visualization and permits still and motion pictures to be taken. The cystoscope is manipulated to allow complete visualization of the urethra and bladder as well as the ureteral orifices and prostatic urethra. Small ureteral catheters can be passed through the cystoscope for assessment of the ureters and the pelvis of each kidney.

The cystoscope also allows the urologist to obtain a urine specimen from each kidney to evaluate its function. Cup forceps can be inserted through the cystoscope for biopsy. Calculi may be removed from the urethra, bladder, and ureter using cystoscopy. If a lower tract cystoscopy is performed, the patient is usually conscious, and the procedure is usually no more uncomfortable than a catheterization. To

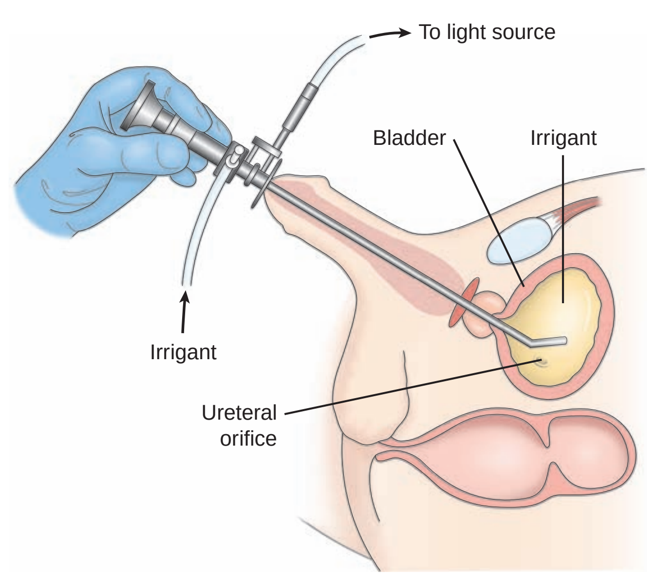



**Figure 43-8** Cystoscopic examination. A rigid or semirigid cystoscope is introduced into the bladder. The upper cord is an electric line for the light at the distal end of the cystoscope. The lower tubing leads from a reservoir of sterile irrigant that is used to inflate the bladder.

minimize posttest urethral discomfort, viscous lidocaine is administered several minutes before the study. If the cystoscopy includes examination of the upper tracts, a sedative may be administered before the procedure. General anesthesia is usually administered to ensure that there are no involuntary muscle spasms when the scope is being passed through the ureters or kidney.

The nurse describes the procedure to the patient and family to prepare them and to allay their fears. If an upper cystoscopy is to be performed, the patient is usually restricted to nothing by mouth (NPO) for several hours beforehand.

Postprocedural management is directed at relieving any discomfort resulting from the examination. Some burning on voiding, blood-tinged urine, and urinary frequency from trauma to the mucous membranes can be expected. Moist heat to the lower abdomen and warm sitz baths are helpful in relieving pain and relaxing the muscles.

After a cystoscopic examination, the patient with obstructive pathology may experience urine retention if the instruments used during the examination caused edema. The nurse carefully monitors the patient with prostatic hyperplasia for urine retention. Warm sitz baths and antispasmodic medication, such as flavoxate (Urispas), may be prescribed to relieve temporary urine retention caused by poor relaxation of the urinary sphincter; however, intermittent catheterization may be necessary for a few hours after the examination. The nurse monitors the patient for signs and symptoms of urinary tract infection. Because edema of the urethra secondary to local trauma may obstruct urine flow, the patient is also monitored for signs and symptoms of obstruction.

## Biopsy

### *Renal and Ureteral Brush Biopsy*

Brush biopsy techniques provide specific information when abnormal x-ray findings of the ureter or renal pelvis raise questions about whether a defect is a tumor, a stone, a blood clot, or an artifact. First, a cystoscopic examination is conducted. Then, a ureteral catheter is introduced, followed by a biopsy brush that is passed through the catheter. The suspected lesion is brushed back and forth to obtain cells and surface tissue fragments for histologic analysis.

After the procedure, IV fluids may be administered to help clear the kidneys and prevent clot formation. Urine may contain blood (usually clearing in 24 to 48 hours) from oozing at the brushing site. Postoperative renal colic occasionally occurs and responds to analgesic agents.

### *Kidney Biopsy*

Biopsy of the kidney is used to help diagnose and evaluate the extent of kidney disease. Indications for biopsy include unexplained acute renal failure, persistent proteinuria or hematuria, transplant rejection, and glomerulopathies. A small section of renal cortex is obtained either percutaneously (needle biopsy) or by open biopsy through a small flank incision. Before the biopsy is carried out, coagulation studies are conducted to identify any risk of postbiopsy bleeding. Contraindications to kidney biopsy include bleeding tendencies, uncontrolled hypertension, a solitary kidney, and morbid obesity (Morton, Fontaine, Hudak, et al., 2005).

#### Procedure

The patient may be prescribed a fasting regimen 6 to 8 hours before the test. An IV line is established. A urine specimen is obtained and saved for comparison with the postbiopsy specimen.

If a needle biopsy is to be performed, the patient is instructed to breathe in and hold that breath (to prevent the kidney from moving) while the needle is being inserted. The sedated patient is placed in a prone position with a sandbag under the abdomen. The skin at the biopsy site is infiltrated with a local anesthetic agent. The biopsy needle is introduced just inside the renal capsule of the outer quadrant of the kidney. The location of the needle may be confirmed by fluoroscopy or by ultrasound, in which case a special probe is used.

With open biopsy, a small incision is made over the kidney, allowing direct visualization. Preparation for an open biopsy is similar to that for any major abdominal surgery.

## CRITICAL THINKING EXERCISES

EBP **1** Two days after major surgery your patient complains of lower abdominal pain. Describe the assessment techniques appropriate to evaluate the pain. Review the possible causes, describe the actions you would take and the rationale for each action, and identify the evidence base that supports the actions. What criteria would you use to evaluate the strength of the evidence?

**2** A 46-year-old patient with a history of smoking is admitted to the hospital for evaluation of urinary dysfunction and is scheduled for a urinary system MRI. Explain why the MRI is indicated for this patient and what, if any, precautions must be taken because the patient is trying to stop smoking. What nursing observations and assessments are indicated because of the history of smoking? What patient teaching is appropriate before the MRI?

EBP **3** You make a home visit to an elderly female patient who is incontinent. Identify assessments and possible interventions you would use to evaluate and manage the incontinence. Identify the evidence for the assessments and nursing interventions you chose and the strength of that evidence.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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*Asterisk indicates nursing research.*

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## RESOURCES

American Association of Kidney Patients, www.aakp.org
American Urological Association, www.auafoundation.org
National Kidney Foundation, www.kidney.org
National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, www.niddk.nih.gov



chapter 44

# Management of Patients With Renal Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the key factors associated with the development of renal disorders.
2. Differentiate between the causes of chronic kidney disease and acute and chronic renal failure.
3. Compare and contrast the pathophysiology, clinical manifestations, medical management, and nursing management for patients with renal disorders.
4. Describe the nursing management of patients with acute and chronic renal failure.
5. Compare and contrast the renal replacement therapies including hemodialysis, peritoneal dialysis, and kidney transplantation.
6. Describe the nursing management of the hospitalized patient on dialysis.
7. Develop a postoperative plan of nursing care and teaching plan for the patient undergoing kidney surgery and transplantation.

## GLOSSARY

**acute nephritic syndrome:** type of renal failure with glomerular inflammation
**acute renal failure:** sudden rapid deterioration of kidney function that is sometimes reversible
**acute tubular necrosis:** type of acute renal failure in which there is actual damage to the kidney tubules
**anuria:** total urine output less than 50 mL in 24 hours
**arteriovenous fistula:** type of vascular access for dialysis; created by surgically connecting an artery to a vein
**arteriovenous graft:** type of surgically created vascular access for dialysis by which a piece of biologic, semibiologic, or synthetic graft material connects the patient's artery to a vein
**azotemia:** abnormal concentration of nitrogenous wastes in the blood
**chronic kidney disease:** chronic progressive and irreversible diseases of the kidneys
**continuous ambulatory peritoneal dialysis:** method of peritoneal dialysis whereby a patient manually performs four or five complete exchanges or cycles throughout the day

## GLOSSARY *(Continued)*

**continuous cyclic peritoneal dialysis:** method of peritoneal dialysis in which a peritoneal dialysis machine (cycler) automatically performs exchanges, usually while the patient sleeps
**continuous renal replacement therapy:** variety of methods used to replace normal kidney function by circulating the patient's blood through a filter and returning it to the patient
**dialysate:** solution that circulates through the dialyzer in hemodialysis and through the peritoneal membrane in peritoneal dialysis
**dialyzer:** "artificial kidney" or dialysis machine; contains a semipermeable membrane through which particles of a certain size can pass
**diffusion:** movement of solutes (waste products) from an area of higher concentration to an area of lower concentration
**effluent:** term used to describe the drained fluid from a peritoneal dialysis exchange
**end-stage renal disease:** final stage of renal failure that results in retention of uremic waste products and the need for renal replacement therapies
**exchange (peritoneal dialysis):** complete cycle of peritoneal dialysis includes fill, dwell, and drain phases
**glomerulonephritis:** inflammation of the glomerular capillaries
**hemodialysis:** procedure during which a patient's blood is circulated through a dialyzer to remove waste products and excess fluid
**interstitial nephritis:** inflammation within the renal tissue
**nephrosclerosis:** hardening of the renal arteries
**nephrotic syndrome**: type of renal failure with increased glomerular permeability and massive proteinuria
**nephrotoxic:** any substance, medication, or action that destroys kidney tissue
**osmosis:** movement of water through a semipermeable membrane from an area of lower solute concentration to an area of higher solute concentration
**peritoneal dialysis:** procedure that uses the lining of the patient's peritoneal cavity as the semipermeable membrane for exchange of fluid and solutes
**peritonitis:** inflammation of the peritoneal membrane (lining of the peritoneal cavity)
**pyelonephritis:** inflammation of the renal pelvis
**ultrafiltration:** process whereby water is removed from the blood by means of a pressure gradient between the patient's blood and the dialysate
**uremia:** an excess of urea and other nitrogenous wastes in the blood
**urinary casts:** proteins secreted by damaged kidney tubules

The renal system helps regulate the body's internal environment and is essential for the maintenance of life. Nurses working in any clinical setting may encounter patients with various renal disorders and thus need to be knowledgeable about these disorders. This chapter provides an overview of electrolyte imbalances that are common in patients with renal disorders. The main causes of kidney disease are discussed, together with management strategies to prevent damage and preserve renal function. Chronic kidney disease and acute and chronic renal failure are discussed, as is the care of patients with other renal conditions who require dialysis, transplantation, and kidney surgery.

## FLUID AND ELECTROLYTE IMBALANCES IN RENAL DISORDERS

Patients with renal disorders commonly experience fluid and electrolyte imbalances and require careful assessment and close monitoring for signs of potential problems. The patient whose fluid intake exceeds the ability of the kidneys to excrete fluid is said to have fluid overload. If fluid intake is inadequate, the patient is said to be volume depleted and may show signs and symptoms of fluid volume deficit. The fluid intake and output (I&O) record, a key monitoring tool, is used to document important fluid parameters, including the amount of fluid taken in (orally or parenterally), the volume of urine excreted, and other fluid losses (diarrhea, vomiting, diaphoresis). Patient weight is also important, and documenting trends in weight is a key assessment strategy essential for determining the daily fluid allowance and indicating signs of fluid overload or deficit.

*NURSING ALERT*

**The most accurate indicator of fluid loss or gain in an acutely ill patient is weight. An accurate daily weight must be obtained and recorded. A 1-kg weight gain is equal to 1000 mL of retained fluid.**

### Clinical Manifestations

The signs and symptoms of common fluid and electrolyte disturbances that can occur in patients with renal disorders and their general management strategies are listed in Table 44-1. The nurse continually assesses, monitors, and informs appro-

**Table 44-1 COMMON FLUID AND ELECTROLYTE DISTURBANCES IN RENAL DISORDERS**

| Disturbance | Manifestations | General Management Strategies |
|---|---|---|
| Fluid volume deficit | Acute weight loss ≥5%, decreased skin turgor, dry mucous membranes, oliguria or anuria, increased hematocrit, blood urea nitrogen (BUN) level increased out of proportion to creatinine level, hypothermia | Fluid challenge, fluid replacement orally or parenterally |
| Fluid volume excess | Acute weight gain ≥5%, edema, crackles, shortness of breath, decreased BUN, decreased hematocrit, distended neck veins | Fluid and sodium restriction, diuretics, dialysis |
| Sodium deficit | Nausea, malaise, lethargy, headache, abdominal cramps, apprehension, seizures | Diet, normal saline or hypertonic saline solutions |
| Sodium excess | Dry, sticky mucous membranes, thirst, rough dry tongue, fever, restlessness, weakness, disorientation | Fluids, diuretics, dietary restriction |
| Potassium deficit | Anorexia, abdominal distention, paralytic ileus, muscle weakness, ECG changes, dysrhythmias | Diet, oral or parenteral potassium replacement therapy |
| Potassium excess | Diarrhea, colic, nausea, irritability, muscle weakness, ECG changes | Dietary restriction, diuretics, IV glucose, insulin and sodium bicarbonate, cation-exchange resin, calcium gluconate, dialysis |
| Calcium deficit | Abdominal and muscle cramps, stridor, carpopedal spasm, hyperactive reflexes, tetany, positive Chvostek's or Trousseau's sign, tingling of fingers and around mouth, ECG changes | Diet, oral or parenteral calcium salt replacement |
| Calcium excess | Deep bone pain, flank pain, muscle weakness, depressed deep tendon reflexes, constipation, nausea and vomiting, confusion, impaired memory, polyuria, polydipsia, ECG changes | Fluid replacement, etidronate, pamidronate, mithramycin, calcitonin, glucocorticoids, phosphate salts |
| Bicarbonate deficit | Headache, confusion, drowsiness, increased respiratory rate and depth, nausea and vomiting, warm flushed skin | Bicarbonate replacement, dialysis |
| Bicarbonate excess | Depressed respirations, muscle hypertonicity, dizziness, tingling of fingers and toes | Fluid replacement if volume depleted; ensure adequate chloride |
| Protein deficit | Chronic weight loss, emotional depression, pallor, fatigue, soft flabby muscles | Diet, dietary supplements, hyperalimentation, albumin |
| Magnesium deficit | Dysphagia, muscle cramps, hyperactive reflexes, tetany, positive Chvostek's or Trousseau's sign, tingling of fingers, dysrhythmias, vertigo | Diet, oral or parenteral magnesium replacement therapy |
| Magnesium excess | Facial flushing, nausea and vomiting, sensation of warmth, drowsiness, depressed deep tendon reflexes, muscle weakness, respiratory depression, cardiac arrest | Calcium gluconate, mechanical ventilation, dialysis |
| Phosphorus deficit | Deep bone pain, flank pain, muscle weakness and pain, paresthesia, apprehension, confusion, seizures | Diet, oral or parenteral phosphorus supplementation therapy |
| Phosphorus excess | Tetany, tingling of fingers and around mouth, muscle spasms, soft tissue calcification | Diet restriction, phosphate binders, normal saline solution, IV dextrose solution, and insulin |

priate members of the health care team if the patient exhibits any of these signs. Management strategies for fluid and electrolyte disturbances in renal disease are discussed in greater depth later in this chapter (see also Chapter 14).

### Gerontologic Considerations

With aging, the kidney is less able to respond to acute fluid and electrolyte changes. Elderly patients may develop atypical and nonspecific signs and symptoms of disturbed renal function and fluid and electrolyte imbalances. A fluid balance deficit in the elderly can lead to constipation, falls, medication toxicity, urinary tract and respiratory tract infections, delirium, seizures, electrolyte imbalances, hyperthermia, and delayed wound healing (Mentes, 2006). Recognition of acute changes in fluid and electrolytes is further hampered by their association with preexisting disorders and the misconception that they are normal changes of aging.

# RENAL DISORDERS

## *Chronic Kidney Disease*

**Chronic kidney disease** (CKD) is an umbrella term that describes kidney damage or a decrease in the glomerular filtration rate (GFR) for 3 or more months (Thomas-Hawkins & Zazworsky, 2005). CKD is associated with decreased quality of life, increased health care expenditures, and premature death. Untreated CKD can result in **end-stage renal disease (ESRD)** and necessitate renal replacement therapy (dialysis or kidney transplantation). Risk factors include cardiovascular disease, diabetes, hypertension, and obesity. Recent research reported that 16.8% of the U.S. population aged 20 years and older have CKD (Centers for Disease Control and Prevention [CDC], 2007).

Diabetes is the primary cause of CKD. Between 25% and 40% of patients with type 1 diabetes and 5% to 40% of those with type 2 diabetes develop kidney damage (Thomas & Atkins, 2006). Diabetes is the leading cause of renal failure in patients starting renal replacement therapy. The second leading cause is hypertension, followed by glomerulonephritis and **pyelonephritis;** polycystic, hereditary, or congenital disorders; and renal cancers (U.S. Renal Data System [USRDS], 2007).

### Pathophysiology

In the early stages of CKD there can be significant damage to the kidneys without signs or symptoms. The pathophysiology of CKD is not yet clearly understood, but the damage to the kidneys is thought to be caused by prolonged acute inflammation that is not organ specific and thus has subtle systemic manifestations.

### Stages of Chronic Kidney Disease

CKD has been classified into five stages by the National Kidney Foundation (NKF) (Chart 44-1). Stage 5 results when the kidneys cannot remove the body's metabolic wastes or perform their regulatory functions and renal replacement therapies are required to sustain life. Screening and early intervention are important, as not all patients progress to stage 5 CKD. Patients with CKD are at increased risk for cardiovascular disease, the leading cause of morbidity and mortality (Thomas & Atkins, 2006). Treatment of hypertension, anemia, and hyperglycemia and detection of proteinuria all help to slow disease progression and improve patient outcomes (Compton, 2007).

**Chart 44-1 • *Stages of Chronic Kidney Disease***

Stages are based on the glomerular filtration rate (GFR). The normal GFR is 125 mL/min/1.73 $m^2$.

**Stage 1**

GFR ≥ 90 mL/min/1.73 $m^2$
Kidney damage with normal or increased GFR

**Stage 2**

GFR = 60–89 mL/min/1.73 $m^2$
Mild decrease in GFR

**Stage 3**

GFR = 30–59 mL/min/1.73 $m^2$
Moderate decrease in GFR

**Stage 4**

GFR = 15–29 mL/min/1.73 $m^2$
Severe decrease in GFR

**Stage 5**

GFR < 15 mL/min/1.73 $m^2$
Kidney failure (end-stage renal disease [ESRD])

### Clinical Manifestations

Elevated serum creatinine levels indicate underlying kidney disease; as the creatinine level increases, symptoms of chronic kidney disease begin. Anemia, due to decreased erythropoietin production by the kidney; metabolic acidosis; and abnormalities in calcium and phosphorus herald the development of CKD. Fluid retention, evidenced by both edema and congestive heart failure, develops. As the disease progresses, abnormalities in electrolytes occur, heart failure worsens, and hypertension becomes more difficult to control.

### Assessment and Diagnostic Findings

The GFR is the amount of plasma filtered through the glomeruli per unit of time. Creatinine clearance is a measure of the amount of creatinine the kidneys are able to clear in a 24-hour period. Normal values differ in men and women. Calculation of GFR, an important assessment perimeter in CKD, is discussed in Chapter 43.

### Medical Management

The management of patients with CKD includes treatment of the underlying causes. Regular clinical and laboratory assessment is important to keep the blood pressure (BP) below 130/80 mm Hg. Medical management also includes early referral for initiation of renal replacement therapies as indicated by the patient's renal status. Prevention of

complications is accomplished by controlling cardiovascular risk factors; treating hyperglycemia; treating anemia; smoking cessation, weight loss, and exercise programs as needed; and reduction in salt and alcohol intake.

### Gerontologic Considerations

Changes in kidney function with normal aging increase the susceptibility of elderly patients to kidney dysfunction and renal failure (Miller, 2009). In addition, the incidence of systemic diseases, such as atherosclerosis, hypertension, heart failure, diabetes, and cancer, increases with advancing age, predisposing older adults to renal disease associated with these disorders. Therefore, acute problems need to be prevented if possible or recognized and treated quickly to avoid kidney damage. Thus, nurses in all settings need to be alert for signs and symptoms of renal dysfunction in elderly patients.

Elderly patients frequently take multiple prescription and over-the-counter medications. Because alterations in renal blood flow, glomerular filtration, and renal clearance increase the risk for medication-associated changes in renal function, precautions are indicated with all medications. When elderly patients undergo extensive diagnostic tests or when new medications (eg, diuretic agents) are added, precautions must be taken to prevent dehydration, which can compromise marginal renal function and lead to renal failure (Mentes, 2006).

## Nephrosclerosis

**Nephrosclerosis** (hardening of the renal arteries) is most often due to prolonged hypertension and diabetes. Nephrosclerosis is a major cause of CKD and ESRD secondary to many disorders.

### Pathophysiology

There are two forms of nephrosclerosis: malignant (accelerated) and benign. Malignant nephrosclerosis is often associated with significant hypertension (diastolic blood pressure higher than 130 mm Hg). It usually occurs in young adults and twice as often in men compared to women. Damage is caused by decreased blood flow to the kidney resulting in patchy necrosis of the renal parenchyma. Over time, fibrosis occurs and glomeruli are destroyed.

The disease process progresses rapidly. Without dialysis, more than half of patients die from **uremia** (an excess of urea and other nitrogenous wastes in the blood) in a few years. Benign nephrosclerosis can be found in older adults, associated with atherosclerosis and hypertension.

### Assessment and Diagnostic Findings

Symptoms are rare early in the disease, even though the urine usually contains protein and occasional casts. Renal insufficiency and associated signs and symptoms occur late in the disease.

### Medical Management

Treatment of nephrosclerosis is aggressive antihypertensive therapy. An angiotensin-converting enzyme (ACE) inhibitor, alone or in combination with other antihypertensive medications, significantly reduces its incidence (Munar & Singh, 2007). See Chapter 32 for additional information on hypertension.

## Primary Glomerular Diseases

Diseases that destroy the glomerulus of the kidney are the third most common cause of stage 5 CKD. In these disorders, the glomerular capillaries are primarily involved. Antigen–antibody complexes form in the blood and become trapped in the glomerular capillaries (the filtering portion of the kidney), inducing an inflammatory response. Immunoglobulin G (IgG), the major immunoglobulin (antibody) found in the blood, can be detected in the glomerular capillary walls. The major clinical manifestations of glomerular injury include proteinuria, hematuria, decreased GFR, decreased excretion of sodium, edema, and hypertension (Chart 44-2).

### ACUTE NEPHRITIC SYNDROME

The **acute nephritic syndrome** is the clinical manifestation of glomerular inflammation (Porth & Matfin, 2009). **Glomerulonephritis** is an inflammation of the glomerular capillaries that can occur in acute and chronic forms.

#### Pathophysiology

Primary glomerular diseases include postinfectious glomerulonephritis, rapidly progressive glomerulonephritis, membrane proliferative glomerulonephritis, and membranous glomerulonephritis. Postinfectious causes are group A beta-hemolytic streptococcal infection of the throat that precedes the onset of glomerulonephritis by 2 to 3 weeks (Fig. 44-1). It may also follow impetigo (infection of the skin) and acute viral infections (upper respiratory tract infections, mumps, varicella zoster virus, Epstein-Barr virus, hepatitis B, and human immunodeficiency virus [HIV] infection). In some patients, antigens outside the body (eg, medications, foreign serum) initiate the process, resulting in antigen–antibody complexes being deposited in the glomeruli. In other patients, the kidney tissue itself serves as the inciting antigen.

**Chart 44-2 • *Terms Typically Used When Describing Glomerular Disease***

Primary: Disease is mainly in glomeruli
Secondary: Glomerular diseases that are the consequence of systemic disease
Idiopathic: Cause is unknown
Acute: Occurs over days or weeks
Chronic: Occurs over months or years
Rapidly progressing: Constant loss of renal function with minimal chance of recovery
Diffuse: Involves all glomeruli
Focal: Involves some glomeruli
Segmental: Involves portions of individual glomeruli
Membranous: Evidence of thickened glomerular capillary walls
Proliferative: Number of glomerular cells involved is increasing

**Physiology ■■■ Pathophysiology**

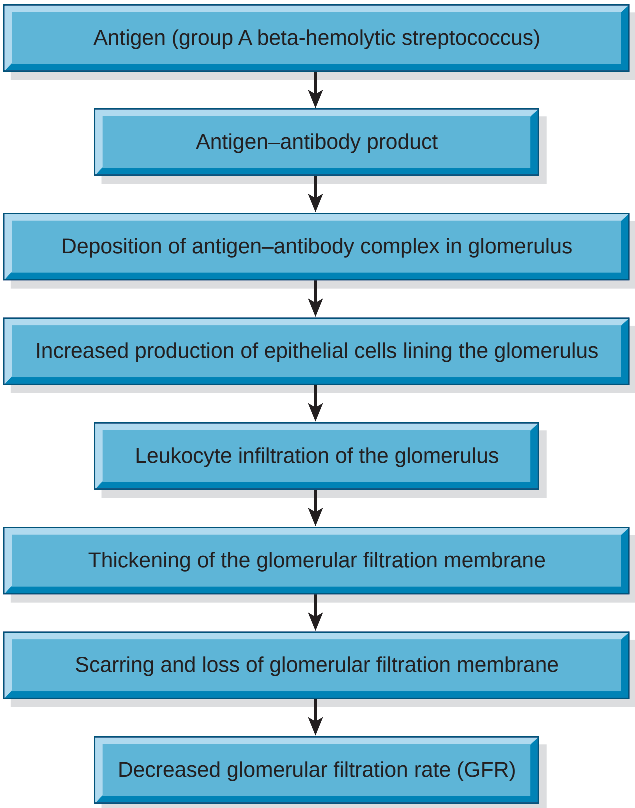



**Figure 44-1** Sequence of events in acute nephritic syndrome.

## Clinical Manifestations

The primary presenting features of an acute glomerular inflammation are hematuria, edema, **azotemia**, an abnormal concentration of nitrogenous wastes in the blood, and proteinuria or excess protein in the urine (Porth & Matfin, 2009). The hematuria may be microscopic (identifiable only through microscopic examination) or macroscopic (visible to the eye). The urine may appear cola-colored because of red blood cells (RBCs) and protein plugs or casts; RBC casts indicate glomerular injury. Glomerulonephritis may be mild and the hematuria discovered incidentally through a routine urinalysis, or the disease may be severe, with acute renal failure (ARF) and oliguria.

Some degree of edema and hypertension is present in most patients. Marked proteinuria due to the increased permeability of the glomerular membrane may also occur, with associated pitting edema, hypoalbuminemia, hyperlipidemia, and fatty casts in the urine. Blood urea nitrogen (BUN) and serum creatinine levels may increase as urine output decreases. In addition, anemia may be present.

In the more severe form of the disease, patients also complain of headache, malaise, and flank pain. Elderly patients may experience circulatory overload with dyspnea, engorged neck veins, cardiomegaly, and pulmonary edema. Atypical symptoms include confusion, somnolence, and seizures, which are often confused with the symptoms of a primary neurologic disorder.

## Assessment and Diagnostic Findings

In acute nephritic syndrome, the kidneys become large, edematous, and congested. All renal tissues including the glomeruli, tubules, and blood vessels are affected to varying degrees. Patients with an IgA nephropathy have an elevated serum IgA and low to normal complement levels. Electron microscopy and immunofluorescent analysis help identify the nature of the lesion; however, a kidney biopsy may be needed for definitive diagnosis. (See Chapter 43 for discussion of kidney biopsy.)

If the patient improves, the amount of urine increases and the urinary protein and sediment diminish. The percentage of adults who recover is unknown. Some patients develop severe uremia (an excess of urea and other nitrogenous wastes in the blood) within weeks and require dialysis for survival. Others, after a period of apparent recovery, insidiously develop chronic glomerulonephritis.

## Complications

Complications of acute glomerulonephritis include hypertensive encephalopathy, heart failure, and pulmonary edema. Hypertensive encephalopathy is a medical emergency, and therapy is directed toward reducing the blood pressure without impairing renal function. This can occur in acute nephritic syndrome or preeclampsia with chronic hypertension of greater than 140/90 mm Hg. Rapidly progressive glomerulonephritis is characterized by a rapid decline in renal function. Without treatment, ESRD develops in a matter of weeks or months. Signs and symptoms are similar to those of acute glomerulonephritis (hematuria and proteinuria), but the course of the disease is more severe and rapid. Crescent-shaped cells accumulate in Bowman's space, disrupting the filtering surface. Plasma exchange (plasmapheresis) and treatment with high-dose corticosteroids and cytotoxic agents have been used to reduce the inflammatory response. Dialysis is initiated in acute glomerulonephritis if signs and symptoms of uremia are severe. The prognosis for patients with acute nephritic syndrome is excellent and rarely causes CKD (Porth & Matfin, 2009).

## Medical Management

Management consists primarily of treating symptoms, attempting to preserve kidney function, and treating complications promptly. Treatment may include corticosteroids, managing hypertension, and controlling proteinuria (Glick, 2007). Pharmacologic therapy depends on the cause of acute glomerulonephritis. If residual streptococcal infection is suspected, penicillin is the agent of choice; however, other antibiotic agents may be prescribed. Dietary protein is restricted when renal insufficiency and nitrogen retention (elevated BUN) develop. Sodium is restricted when the patient has hypertension, edema, and heart failure.

## Nursing Management

Although most patients with acute uncomplicated glomerulonephritis are cared for as outpatients, nursing care is important in every setting.

#### *Providing Care in the Hospital*

In a hospital setting, carbohydrates are given liberally to provide energy and reduce the catabolism of protein. I&O are carefully measured and recorded. Fluids are given based on the patient's fluid losses and daily body weight. Insensible fluid loss through the lungs (300 mL) and skin (600 mL) is considered when estimating fluid loss (see Chapter 14). If treatment is effective, diuresis will begin, resulting in decreased edema and blood pressure. Proteinuria and microscopic hematuria may persist for many months; in fact, 20% of patients have some degree of persistent proteinuria or decreased GFR 1 year after presentation (Porth & Matfin, 2009). Other nursing interventions focus on patient education about the disease process, explanations of laboratory and other diagnostic tests, and preparation for safe and effective self-care at home (Hughes, 2008).

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

Patient education is directed toward symptom management and monitoring for complications. Fluid and diet restrictions must be reviewed with the patient to avoid worsening of edema and hypertension. The patient is instructed verbally and in writing to notify the physician if symptoms of renal failure occur (eg, fatigue, nausea, vomiting, diminishing urine output) or at the first sign of any infection.

**Continuing Care**

The importance of follow-up evaluations of blood pressure, urinalysis for protein, and BUN and serum creatinine levels to determine if the disease has progressed is stressed to the patient. A referral for home care may be indicated; a visit from a home care nurse provides an opportunity for careful assessment of the patient's progress and detection of early signs and symptoms of renal insufficiency. If corticosteroids, immunosuppressant agents, or antibiotic medications are prescribed, the home care nurse or nurse in the outpatient setting uses the opportunity to review the dosage, desired actions, and adverse effects of medications and the precautions to be taken.

## CHRONIC GLOMERULONEPHRITIS

Chronic glomerulonephritis may be due to repeated episodes of acute nephritic syndrome, hypertensive nephrosclerosis, hyperlipidemia, chronic tubulointerstitial injury, or hemodynamically mediated glomerular sclerosis. Secondary glomerular diseases that can have systemic effects include lupus erythematosus, Goodpasture's syndrome (caused by antibodies to the glomerular basement membrane), diabetic glomerulosclerosis, and amyloidosis.

### Pathophysiology

The kidneys are reduced to as little as one-fifth their normal size (consisting largely of fibrous tissue). The cortex layer shrinks to 1 to 2 mm in thickness or less. Bands of scar tissue distort the remaining cortex, making the surface of the kidney rough and irregular. Numerous glomeruli and their tubules become scarred, and the branches of the renal artery are thickened. The resulting severe glomerular damage can progress to stage 5 CKD and require renal replacement therapies.

### Clinical Manifestations

The symptoms of chronic glomerulonephritis vary. Some patients with severe disease have no symptoms at all for many years (Porth & Matfin, 2009). The condition may be discovered when hypertension or elevated BUN and serum creatinine levels are detected. Most patients report general symptoms, such as loss of weight and strength, increasing irritability, and an increased need to urinate at night (nocturia). Headaches, dizziness, and digestive disturbances are also common.

As chronic glomerulonephritis progresses, signs and symptoms of CKD and chronic renal failure may develop. The patient appears poorly nourished, with a yellow-gray pigmentation of the skin and periorbital and peripheral (dependent) edema. Blood pressure may be normal or severely elevated. Retinal findings include hemorrhage, exudate, narrowed tortuous arterioles, and papilledema. Anemia causes pale mucous membranes. Cardiomegaly, a gallop rhythm, distended neck veins, and other signs and symptoms of heart failure may be present. Crackles can be heard in the bases of the lungs.

Peripheral neuropathy with diminished deep tendon reflexes and neurosensory changes occur late in the disease. The patient becomes confused and demonstrates a limited attention span. An additional late finding includes evidence of pericarditis with a pericardial friction rub and pulsus paradoxus (difference in blood pressure during inspiration and expiration of greater than 10 mm Hg).

### Assessment and Diagnostic Findings

A number of laboratory abnormalities occur. Urinalysis reveals a fixed specific gravity of about 1.010, variable proteinuria, and **urinary casts** (proteins secreted by damaged kidney tubules). As renal failure progresses and the GFR falls below 50 mL/min, the following changes occur:

- Hyperkalemia due to decreased potassium excretion, acidosis, catabolism, and excessive potassium intake from food and medications
- Metabolic acidosis from decreased acid secretion by the kidney and inability to regenerate bicarbonate
- Anemia secondary to decreased erythropoiesis (production of RBCs)
- Hypoalbuminemia with edema secondary to protein loss through the damaged glomerular membrane
- Increased serum phosphorus level due to decreased renal excretion of phosphorus
- Decreased serum calcium level (calcium binds to phosphorus to compensate for elevated serum phosphorus levels)
- Mental status changes
- Impaired nerve conduction due to electrolyte abnormalities and uremia

Chest x-rays may show cardiac enlargement and pulmonary edema. The electrocardiogram (ECG) may be normal or may indicate left ventricular hypertrophy associated with hypertension and signs of electrolyte disturbances, such as tall, tented (or peaked) T waves associated with hyperkalemia. Computed tomography (CT) and magnetic

resonance imaging (MRI) scans show a decrease in the size of the renal cortex.

## Medical Management

Management of symptoms guides the treatment. If the patient has hypertension, efforts are made to reduce the blood pressure with sodium and water restriction, antihypertensive agents, or both. Weight is monitored daily, and diuretic medications are prescribed to treat fluid overload. Proteins of high biologic value (dairy products, eggs, meats) are provided to promote good nutritional status. Adequate calories are provided to spare protein for tissue growth and repair. Urinary tract infections (UTIs) must be treated promptly to prevent further renal damage.

Dialysis is initiated early in the course of the disease to keep the patient in optimal physical condition, prevent fluid and electrolyte imbalances, and minimize the risk of complications of renal failure. The course of dialysis is smoother if treatment begins before the patient develops complications.

## Nursing Management

Whether the patient is hospitalized or cared for in the home, the nurse observes the patient for common fluid and electrolyte disturbances in renal disease (see Table 44-1). Changes in fluid and electrolyte status and in cardiac and neurologic status are reported promptly to the physician. Anxiety levels are often extremely high for both the patient and family. Throughout the course of the disease and treatment, the nurse gives emotional support by providing opportunities for the patient and family to verbalize their concerns, have their questions answered, and explore their options.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The nurse has a major role in teaching the patient and family about the prescribed treatment plan and the risks associated with noncompliance. Instructions to the patient include explanations and scheduling for follow-up evaluations: blood pressure, urinalysis for protein and casts, and laboratory studies of BUN and serum creatinine levels. If long-term dialysis is needed, the nurse teaches the patient and family about the procedure, how to care for the access site, dietary restrictions, and other necessary lifestyle modifications. These topics are discussed later in this chapter.

Periodic hospitalization, visits to the outpatient clinic or office, and home care referrals provide the nurse in each setting with the opportunity for careful assessment of the patient's progress and continued education about changes to report to the primary health care provider (worsening signs and symptoms of renal failure, such as nausea, vomiting, and diminished urine output). Specific teaching may include explanations about recommended diet and fluid modifications and medications (purpose, desired effects, adverse effects, dosage, and administration schedule).

#### Continuing Care

Periodic laboratory evaluations of creatinine clearance and BUN and serum creatinine levels are carried out to assess residual renal function and the need for dialysis or transplantation. If dialysis is initiated, the patient and family require considerable assistance and support in dealing with therapy and its long-term implications. The patient and family are reminded of the importance of participation in health promotion activities, including health screening. The patient is instructed to inform all health care providers about the diagnosis of glomerulonephritis so that all medical management, including pharmacologic therapy, is based on altered renal function.

# NEPHROTIC SYNDROME

**Nephrotic syndrome** is a type of renal failure characterized by increased glomerular permeability and is manifested by massive proteinuria (Porth & Matfin, 2009). Clinical findings include a marked increase in protein (particularly albumin) in the urine (proteinuria), a decrease in albumin in the blood (hypoalbuminemia), diffuse edema, high serum cholesterol, and low-density lipoproteins (hyperlipidemia).

The syndrome is apparent in any condition that seriously damages the glomerular capillary membrane and results in increased glomerular permeability to plasma proteins. Although the liver is capable of increasing the production of albumin, it cannot keep up with the daily loss of albumin through the kidneys. Thus, hypoalbuminemia results (Fig. 44-2).

## Pathophysiology

Nephrotic syndrome occurs with many intrinsic renal diseases and systemic diseases that cause glomerular damage. It is not a specific glomerular disease but a constellation of clinical findings that result from the glomerular damage (Porth & Matfin, 2009).

**Physiology ■■■ Pathophysiology**

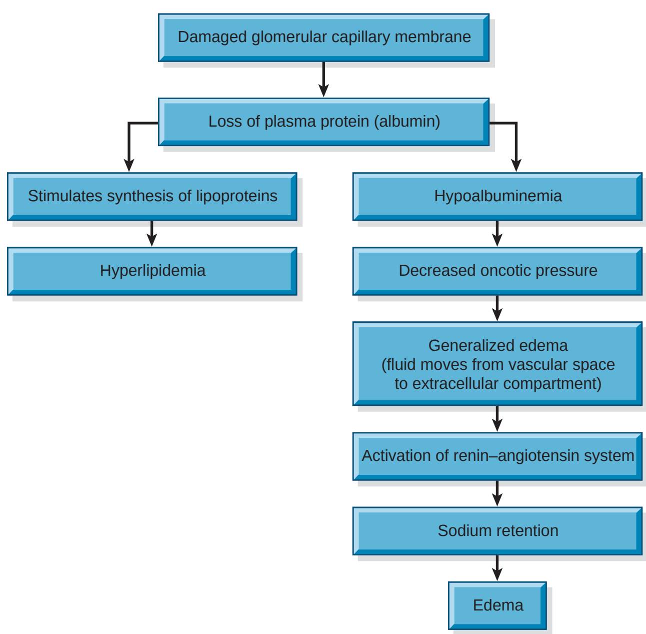



**Figure 44-2** Sequence of events in nephrotic syndrome.

### Clinical Manifestations

The major manifestation of nephrotic syndrome is edema. It is usually soft and pitting and commonly occurs around the eyes (periorbital), in dependent areas (sacrum, ankles, and hands), and in the abdomen (ascites). Patients may also exhibit irritability, headache, and malaise.

### Assessment and Diagnostic Findings

Proteinuria (predominately albumin) exceeding 3.5 g/day is the hallmark of the diagnosis of nephrotic syndrome (Porth & Matfin, 2009). Protein electrophoresis and immunoelectrophoresis may be performed on the urine to categorize the type of proteinuria. The urine may also contain increased white blood cells (WBCs) as well as granular and epithelial casts. A needle biopsy of the kidney may be performed for histologic examination of renal tissue to confirm the diagnosis.

### Complications

Complications of nephrotic syndrome include infection (due to a deficient immune response), thromboembolism (especially of the renal vein), pulmonary emboli, ARF (due to hypovolemia), and accelerated atherosclerosis (due to hyperlipidemia).

### Medical Management

Treatment is focused on treating the underlying disease state causing proteinuria, slowing progression of CKD, and relieving symptoms. Typical treatment includes diuretics for edema, ACE inhibitors to reduce proteinuria, and lipid-lowering agents for hyperlipidemia.

### Nursing Management

In the early stages of nephrotic syndrome, nursing management is similar to that of the patient with acute glomerulonephritis, but as the condition worsens, management is similar to that of the patient with ESRD (see the following section).

Patients with nephrotic syndrome need adequate instruction about the importance of following all medication and dietary regimens so that their condition can remain stable as long as possible. Patients must be made aware of the importance of communicating any health-related change to their health care providers as soon as possible so that appropriate medication and dietary changes can be made before further changes occur within the glomeruli.

## *Polycystic Kidney Disease*

### Pathophysiology

Polycystic kidney disease (PKD) is a genetic disorder characterized by the growth of numerous cysts in the kidneys. When cysts form in the kidneys, they are filled with fluid, destroying the nephrons. PKD cysts can profoundly enlarge the kidneys while replacing much of the normal structure, resulting in reduced kidney function and leading to kidney failure.

PKD can also cause cysts in the liver and problems in other organs, such as blood vessels in the brain and heart. The number of cysts as well as the complications they cause help distinguish PKD from the usually harmless "simple" cysts that can form in the kidneys in later years of life. In the United States, PKD and cystic diseases are the fifth leading cause of kidney failure. Two major inherited forms of PKD exist:

- *Autosomal dominant PKD* is the most common inherited form. Symptoms usually develop between the ages of 30 and 40, but they can begin earlier, even in childhood. About 90% of all PKD cases are autosomal dominant PKD.
- *Autosomal recessive PKD* is a rare inherited form. Symptoms of autosomal recessive PKD begin in the earliest months of life or in utero.

When autosomal dominant PKD causes kidneys to fail, which usually happens after many years, the patient requires dialysis or kidney transplantation. About one half of people with the most common type of PKD progress to CKD stage 5, requiring renal replacement.

### Clinical Manifestations

Signs and symptoms of PKD result from loss of renal function and the increasing size of the kidneys as the cysts grow. Renal damage can result in hematuria, polyuria (large amounts of urine), hypertension, development of renal calculi and associated urinary tract infections, and proteinuria. The growing cysts are noted with reports of abdominal fullness and flank pain (back and lower sides).

### Assessment and Diagnostic Findings

Since PKD is a genetic disease, careful evaluation of family history is necessary. Palpation of the abdomen will often reveal enlarged cystic kidneys. Diagnosis is usually made with ultrasound imaging of the kidney (Porth & Matfin, 2009).

### Medical Management

PKD has no cure and treatment is largely supportive including blood pressure control, pain control, and antibiotics to resolve infections. Once the kidneys fail, renal replacement therapy is indicated. Genetic testing and counseling may be indicated.

## RENAL CANCER

Renal cancer accounts for about 3% of all cancers in adult men and 2% in adult woman in the United States (American Cancer Society, 2009). In the United States, the incidence of renal cancer at all stages has increased in the past two decades. The incidence of renal cell carcinoma is higher in both men and women with an increased body mass index. Tobacco use continues to be a significant risk factor for renal carcinoma (Chart 44-3).

**CHART 44-3** ***Risk Factors for Renal Cancer***

- Gender: Affects men more than women
- Tobacco use
- Occupational exposure to industrial chemicals, such as petroleum products, heavy metals, and asbestos
- Obesity
- Unopposed estrogen therapy
- Polycystic kidney disease

The most common type of renal carcinoma arises from the renal epithelium and accounts for more than 85% of all kidney tumors. These tumors may metastasize early to the lungs, bone, liver, brain, and contralateral kidney. One quarter of patients have metastatic disease at the time of diagnosis. Although enhanced imaging techniques account for improved detection of early-stage kidney cancer, it is unknown why the rate of late-stage kidney cancers is high (Cohen & McGovern, 2005).

## Clinical Manifestations

Many renal tumors produce no symptoms and are discovered on a routine physical examination as a palpable abdominal mass. The classic signs and symptoms, which occur in only 10% of patients, include hematuria, pain, and a mass in the flank (Cohen & McGovern, 2005). The usual sign that first calls attention to the tumor is painless hematuria, which may be either intermittent and microscopic or continuous and gross. There may be a dull pain in the back from the pressure produced by compression of the ureter, extension of the tumor into the perirenal area, or hemorrhage into the kidney tissue. Colicky pains occur if a clot or mass of tumor cells passes down the ureter. Symptoms from metastasis may be the first manifestations of renal tumor and may include unexplained weight loss, increasing weakness, and anemia.

## Assessment and Diagnostic Findings

The diagnosis of a renal tumor may require intravenous (IV) urography, cystoscopic examination, nephrotomograms, renal angiograms, ultrasonography, or a CT scan. These tests may be exhausting for patients already debilitated by the systemic effects of a tumor as well as for elderly patients and those who are anxious about the diagnosis and outcome. The nurse assists the patient to prepare physically and psychologically for these procedures and monitors carefully for signs and symptoms of dehydration and exhaustion.

## Medical Management

The goal of management is to eradicate the tumor before metastasis occurs.

### *Surgical Management*

#### Nephrectomy

A radical nephrectomy is the preferred treatment if the tumor can be removed. This includes removal of the kidney (and tumor), adrenal gland, surrounding perinephric fat and Gerota's fascia, and lymph nodes. Laparoscopic nephrectomy can be performed for removal of the kidney with a small tumor. This procedure incurs less morbidity and a shorter recovery time. Radiation therapy, hormonal therapy, or chemotherapy may be used along with surgery. Immunotherapy may also be helpful. For patients with bilateral tumors or cancer of a functional single kidney, nephron-sparing surgery (partial nephrectomy) may be considered. Favorable results have been achieved in patients with small local tumors and a normal contralateral kidney (Cohen & McGovern, 2005).

Nephron-sparing surgery is increasingly being used to treat patients with solid renal lesions. The technical success rate of nephron-sparing surgery is excellent, and operative morbidity and mortality are low.

Patients with upper tract transitional cell carcinoma may benefit from laparoscopic nephroureterectomy. Although it is a lengthier surgical procedure, it has the same efficacy and is better tolerated by patients than open nephroureterectomy.

#### Renal Artery Embolization

In patients with metastatic renal carcinoma, the renal artery may be occluded to impede the blood supply to the tumor and thus kill the tumor cells. After angiographic studies are completed, a catheter is advanced into the renal artery, and embolizing materials (eg, Gelfoam, autologous blood clot, steel coils) are injected into the artery and carried with the arterial blood flow to occlude the tumor vessels mechanically. This decreases the local blood supply, making removal of the kidney (nephrectomy) easier. It also stimulates an immune response because infarction of the renal cell carcinoma releases tumor-associated antigens that enhance the patient's response to metastatic lesions. The procedure may also reduce the number of tumor cells entering the venous circulation during surgical manipulation.

After renal artery embolization and tumor infarction, a characteristic symptom complex called postinfarction syndrome occurs, lasting 2 to 3 days. The patient has pain localized to the flank and abdomen, elevated temperature, and gastrointestinal (GI) symptoms. Pain is treated with parenteral analgesic agents, and acetaminophen (Tylenol) is administered to control fever. Antiemetic medications, restriction of oral intake, and IV fluids are used to treat the GI symptoms.

### *Pharmacologic Therapy*

Currently, no pharmacologic agents are in widespread use for treatment of renal cell carcinoma, which is refractory to most chemotherapeutic agents. However, depending on the stage of the tumor, percutaneous partial or radical nephrectomy may be followed by treatment with chemotherapeutic agents. Radiation therapy may be used for palliation in patients who are not candidates for surgery.

Treatment with biologic response modifiers such as interleukin-2 (IL-2) is effective. IL-2, a protein that regulates cell growth, is used alone or in combination with lymphokine-activated killer cells (WBCs that have been stimulated by IL-2 to increase their ability to kill cancer cells). Interferon, another biologic response modifier, appears to have a direct antiproliferative effect on renal tumors. Temsirolimus (Torisel) is administered by IV infusion on a weekly basis to treat advanced renal cell carcinoma (Aschenbrenner, 2007).

Another promising experimental approach to renal cell carcinoma is a vaccination to stimulate immune response, with autologous tumor cells with IL-2–, granulocyte-macrophage stimulating factor–, and dendritic cell–type vaccines. If patients with renal cancer do not respond to immunotherapy, allogeneic stem cell transplantation may be indicated (Cohen & McGovern, 2005).

## Nursing Management

The patient with a renal tumor usually undergoes extensive diagnostic and therapeutic procedures. Treatment includes surgery, radiation therapy, and medications. After surgery,

the patient usually has catheters and drains in place to maintain a patent urinary tract, to remove drainage, and to permit accurate measurement of urine output. Because of the location of the surgical incision, the patient's position during surgery, and the nature of the surgical procedure, pain and muscle soreness are common. Pharmacologic management often includes immunosuppressant agents; therefore, patients are monitored for infection (Aschenbrenner, 2007).

The patient requires frequent analgesia during the postoperative period and assistance with turning, coughing, use of incentive spirometry, and deep breathing to prevent atelectasis and other pulmonary complications. The patient and family require assistance and support to cope with the diagnosis and uncertain prognosis. (See this chapter for discussion of postoperative care of the patient undergoing kidney surgery and Chapter 16 for discussion of care of the patient with cancer.)

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

The nurse teaches the patient to inspect and care for the incision and perform other general postoperative care including activity and lifting restrictions, driving, and pain management. Instructions are provided about when to notify the physician about problems (eg, fever, breathing difficulty, wound drainage, blood in the urine, pain or swelling of the legs).

The nurse encourages the patient to eat a healthy diet and to drink adequate liquids to avoid constipation and to maintain an adequate urine volume. Education and emotional support are provided related to the diagnosis, treatment, and continuing care because many patients are concerned about the loss of the other kidney, the possible need for dialysis, or the recurrence of cancer.

**Continuing Care**

Follow-up care is essential to detect signs of metastases and to reassure the patient and family about the patient's status and well-being. The patient who has had surgery for renal carcinoma should have a yearly physical examination and chest x-ray, because late metastases are not uncommon. All subsequent symptoms should be evaluated with possible metastases in mind.

If follow-up chemotherapy is necessary, the patient and family are informed about the treatment plan or chemotherapy protocol, what to expect with each visit, and when to notify the physician. Evaluation of remaining renal function (creatinine clearance, BUN and serum creatinine levels) may also be carried out periodically. A home care nurse may monitor the patient's physical status and psychological well-being and coordinate other indicated services and resources.

# RENAL FAILURE

Renal failure results when the kidneys cannot remove the body's metabolic wastes or perform their regulatory functions. The substances normally eliminated in the urine accumulate in the body fluids as a result of impaired renal excretion, affecting endocrine and metabolic functions as well as fluid, electrolyte, and acid–base disturbances. Renal failure is a systemic disease and is a final common pathway of many different kidney and urinary tract diseases. Each year, the number of deaths from irreversible renal failure increases (USRDS, 2007).

## Acute Renal Failure

**Acute renal failure (ARF)** is a rapid loss of renal function due to damage to the kidneys. Depending on the duration and severity of ARF, a wide range of potentially life-threatening metabolic complications can occur, including metabolic acidosis as well as fluid and electrolyte imbalances. Treatment is aimed at replacing renal function temporarily to minimize potentially lethal complications and reduce potential causes of increased renal injury with the goal of minimizing long-term loss of renal function. ARF is a problem seen in hospitalized patients and those in outpatient settings. A widely accepted criterion for ARF is a 50% or greater increase in serum creatinine above baseline (normal creatinine is less than 1.0 mg/dL) (Best & Counselman, 2008). Urine volume may be normal, or changes may occur. Possible changes include oliguria (less than 500 mL/day), nonoliguria (greater than 800 mL/day), or **anuria** (less than 50 mL/day) (Counts, 2008).

### Pathophysiology

Although the pathogenesis of ARF and oliguria is not always known, many times there is a specific underlying problem. Some of the factors may be reversible if identified and treated promptly, before kidney function is impaired. This is true of the following conditions that reduce blood flow to the kidney and impair kidney function: (1) hypovolemia; (2) hypotension; (3) reduced cardiac output and heart failure; (4) obstruction of the kidney or lower urinary tract by tumor, blood clot, or kidney stone; and (5) bilateral obstruction of the renal arteries or veins. If these conditions are treated and corrected before the kidneys are permanently damaged, the increased BUN and creatinine levels, oliguria, and other signs may be reversed.

Although renal stones are not a common cause of ARF, some types may increase the risk for ARF. Some hereditary stone diseases (see Chapter 45), primary struvite stones, and infection-related urolithiasis associated with anatomic and functional urinary tract anomalies and spinal cord injury may cause recurrent bouts of obstruction as well as crystal-specific damage to tubular epithelial cells and interstitial renal cells.

### Categories of Acute Renal Failure

The major categories of ARF are prerenal (hypoperfusion of kidney), intrarenal (actual damage to kidney tissue), and postrenal (obstruction to urine flow). Prerenal ARF, which occurs in 60% to 70% of cases, is the result of impaired blood flow that leads to hypoperfusion of the kidney and a decrease in the GFR. Intrarenal ARF is the result of actual

parenchymal damage to the glomeruli or kidney tubules. **Acute tubular necrosis (ATN)** is the most common type of intrinsic ARF. Characteristics of ATN are intratubular obstruction, tubular back leak (abnormal reabsorption of filtrate and decreased urine flow through the tubule), vasoconstriction, and changes in glomerular permeability. These processes result in a decrease of GFR, progressive azotemia, and fluid and electrolyte imbalances. CKD, diabetes, heart failure, hypertension, and cirrhosis can lead to ATN (Bednarski, Castner & Douglas, 2008). Postrenal ARF usually results from obstruction distal to the kidney. Pressure rises in the kidney tubules and eventually, the GFR decreases. Common causes of each type of ARF are summarized in Chart 44-4.

### Chart 44-4 • *Causes of Acute Renal Failure*

**Prerenal Failure**

- Volume depletion resulting from:
  - Hemorrhage
  - Renal losses (diuretics, osmotic diuresis)
  - Gastrointestinal losses (vomiting, diarrhea, nasogastric suction)
- Impaired cardiac efficiency resulting from:
  - Myocardial infarction
  - Heart failure
  - Dysrhythmias
  - Cardiogenic shock
- Vasodilation resulting from:
  - Sepsis
  - Anaphylaxis
  - Antihypertensive medications or other medications that cause vasodilation

**Intrarenal Failure**

- Prolonged renal ischemia resulting from:
  - Pigment nephropathy (associated with the breakdown of blood cells containing pigments that in turn occlude kidney structures)
  - Myoglobinuria (trauma, crush injuries, burns)
  - Hemoglobinuria (transfusion reaction, hemolytic anemia)
- Nephrotoxic agents such as:
  - Aminoglycoside antibiotics (gentamicin, tobramycin)
  - Radiopaque contrast agents
  - Heavy metals (lead, mercury)
  - Solvents and chemicals (ethylene glycol, carbon tetrachloride, arsenic)
  - Nonsteroidal anti-inflammatory drugs (NSAIDs)
  - Angiotensin-converting enzyme inhibitors (ACE inhibitors)
- Infectious processes such as:
  - Acute pyelonephritis
  - Acute glomerulonephritis

**Postrenal Failure**

- Urinary tract obstruction, including:
  - Calculi (stones)
  - Tumors
  - Benign prostatic hyperplasia
  - Strictures
  - Blood clots

## Phases of Acute Renal Failure

There are four phases of ARF: initiation, oliguria, diuresis, and recovery.

- The initiation period begins with the initial insult and ends when oliguria develops.
- The oliguria period is accompanied by an increase in the serum concentration of substances usually excreted by the kidneys (urea, creatinine, uric acid, organic acids, and the intracellular cations [potassium and magnesium]). The minimum amount of urine needed to rid the body of normal metabolic waste products is 400 mL. In this phase uremic symptoms first appear and life-threatening conditions such as hyperkalemia develop.

Some patients have decreased renal function with increasing nitrogen retention, yet actually excrete normal amounts of urine (2 L/day or more). This is the nonoliguric form of renal failure and occurs predominantly after exposure of the patient to nephrotoxic agents, burns, traumatic injury, and the use of halogenated anesthetic agents.

- The diuresis period is marked by a gradual increase in urine output, which signals that glomerular filtration has started to recover. Laboratory values stabilize and eventually decrease. Although the volume of urinary output may reach normal or elevated levels, renal function may still be markedly abnormal. Because uremic symptoms may still be present, the need for expert medical and nursing management continues. The patient must be observed closely for dehydration during this phase; if dehydration occurs, the uremic symptoms are likely to increase.
- The recovery period signals the improvement of renal function and may take 3 to 12 months. Laboratory values return to the patient's normal level. Although a permanent 1% to 3% reduction in the GFR is common, it is not clinically significant.

## Clinical Manifestations

Almost every system of the body is affected with failure of the normal renal regulatory mechanisms. The patient may appear critically ill and lethargic. The skin and mucous membranes are dry from dehydration. Central nervous system signs and symptoms include drowsiness, headache, muscle twitching, and seizures. Table 44-2 summarizes common clinical characteristics in all three categories of ARF.

## Assessment and Diagnostic Findings

Assessment of the patient with ARF includes evaluation for changes in the urine, diagnostic tests that evaluate the kidney contour, and a variety of laboratory values. See Chapter 43 for information about the normal characteristics of urine, diagnostic findings, and laboratory values in the renal system.

In ARF, urine output varies from scanty to a normal volume, hematuria may be present, and the urine has a low specific gravity (compared with a normal value of 1.010 to 1.025). One of the earliest manifestations of tubular damage is the inability to concentrate the urine (Porth & Matfin, 2009). Patients with prerenal azotemia have a decreased amount of sodium in the urine (less than 20 mEq/L) and

**Table 44-2 COMPARING CLINICAL CHARACTERISTICS OF ACUTE RENAL FAILURE**

| Characteristics | Categories: Prerenal | Intrarenal | Postrenal |
|---|---|---|---|
| Etiology | Hypoperfusion | Parenchymal damage | Obstruction |
| Blood urea nitrogen value | Increased (out of normal 20:1 proportion to creatinine) | Increased | Increased |
| Creatinine | Increased | Increased | Increased |
| Urine output | Decreased | Varies, often decreased | Varies, may be decreased, or sudden anuria |
| Urine sodium | Decreased to <20 mEq/L | Increased to >40 mEq/L | Varies, often decreased to 20 mEq/L or less |
| Urinary sediment | Normal, few hyaline casts | Abnormal casts and debris | Usually normal |
| Urine osmolality | Increased to 500 mOsm | About 350 mOsm similar to serum | Varies, increased or equal to serum |
| Urine specific gravity | Increased | Low normal | Varies |

normal urinary sediment. Patients with intrarenal azotemia usually have urinary sodium levels greater than 40 mEq/L with urinary casts and other cellular debris.

Ultrasonography is a critical component of the evaluation of patients with renal failure. A renal sonogram or a CT or MRI scan may show evidence of anatomic changes.

The BUN level increases steadily at a rate dependent on the degree of catabolism (breakdown of protein), renal perfusion, and protein intake. Serum creatinine levels are useful in monitoring kidney function and disease progression and increase with glomerular damage.

With a decline in the GFR, oliguria, and anuria, patients are at high risk for hyperkalemia. Protein catabolism results in the release of cellular potassium into the body fluids, causing severe hyperkalemia (high serum potassium levels). Hyperkalemia may lead to dysrhythmias, such as ventricular tachycardia and cardiac arrest. Sources of potassium include normal tissue catabolism, dietary intake, blood in the GI tract, or blood transfusion and other sources (eg, IV infusions, potassium penicillin, and extracellular shift in response to metabolic acidosis).

Progressive metabolic acidosis occurs in renal failure because patients cannot eliminate the daily metabolic load of acid-type substances produced by the normal metabolic processes. In addition, normal renal buffering mechanisms fail. This is reflected by a decrease in the serum $CO_2$-combining power and blood pH.

There may be an increase in blood phosphate concentrations; calcium levels may be low due to decreased absorption of calcium from the intestine and as a compensatory mechanism for the elevated blood phosphate levels. Anemia is another common laboratory finding in ARF, as a result of reduced erythropoietin production, uremic GI lesions, reduced RBC lifespan, and blood loss from the GI tract.

## Prevention

ARF has a high mortality rate that ranges from 25% to 90%. Factors that influence mortality include increased age, comorbid conditions, and preexisting renal and vascular diseases (Dirkes & Hodge, 2007). Therefore, prevention of ARF is essential (Chart 44-5).

A careful history is obtained to identify exposure to nephrotoxic agents or environmental toxins. The kidneys are susceptible to the adverse effects of medications because the kidneys are repeatedly exposed to substances in the blood. Patients taking nephrotoxic medications (eg, aminoglycosides, gentamicin, tobramycin, colistimethate, polymyxin B, amphotericin B, vancomycin, amikacin, cyclosporine) should be monitored closely for changes in renal function. BUN and serum creatinine levels should be obtained at baseline within 24 hours after initiation of these medications and at least twice a week while the patient is receiving them.

### Chart 44-5 • *Preventing Acute Renal Failure*

1. Provide adequate hydration to patients at risk for dehydration including:
   - Before, during, and after surgery
   - Patients undergoing intensive diagnostic studies requiring fluid restriction and contrast agents (eg, barium enema, intravenous pyelograms), especially elderly patients who may have marginal renal reserve
   - Patients with neoplastic disorders or disorders of metabolism (eg, gout) and those receiving chemotherapy
2. Prevent and treat shock promptly with blood and fluid replacement.
3. Monitor central venous and arterial pressures and hourly urine output of critically ill patients to detect the onset of renal failure as early as possible.
4. Treat hypotension promptly.
5. Continually assess renal function (urine output, laboratory values) when appropriate.
6. Take precautions to ensure that the appropriate blood is administered to the correct patient in order to avoid severe transfusion reactions, which can precipitate renal failure.
7. Prevent and treat infections promptly. Infections can produce progressive renal damage.
8. Pay special attention to wounds, burns, and other precursors of sepsis.
9. To prevent infections from ascending in the urinary tract, give meticulous care to patients with indwelling catheters. Remove catheters as soon as possible.
10. To prevent toxic drug effects, closely monitor dosage, duration of use, and blood levels of all medications metabolized or excreted by the kidneys.

Any agent that reduces renal blood flow (eg, long-term analgesic use) may cause renal insufficiency. Chronic use of analgesic agents, particularly nonsteroidal anti-inflammatory drugs (NSAIDs), may cause **interstitial nephritis** (inflammation within the renal tissue) and papillary necrosis. Patients with heart failure or cirrhosis with ascites are at particular risk for NSAID-induced renal failure. Increased age, preexisting renal disease, and the simultaneous administration of several nephrotoxic agents increase the risk for kidney damage.

Radiocontrast-induced nephropathy (CIN) is a major cause of hospital-acquired ARF. Patients undergo more than 1 million radiocontrast studies in the United States annually; of these approximately 150,000 will experience CIN, and at least 1% of these will require dialysis and experience a prolonged hospital stay (Barreto, 2007). This is a potentially preventable condition. Baseline levels of creatinine greater than 2 mg/dL identify patients at high risk. Limiting the patient's exposure to contrast agents and nephrotoxic medications will reduce the risk of CIN (Steward, 2007). Administration of *N*-acetylcysteine and sodium bicarbonate before and during procedures reduces risk, but prehydration with saline is considered the most effective method to prevent CIN (Barreto, 2007).

### Gerontologic Considerations

About half of all patients who develop ARF during hospitalization are older than 60 years. The etiology of ARF in older adults includes prerenal causes such as dehydration, intrarenal causes such as **nephrotoxic** agents (eg, medications, contrast agents), and complications of major surgery (Steward, 2007). Suppression of thirst, enforced bed rest, lack of access to drinking water, and confusion all contribute to the older patient's failure to consume adequate fluids and may lead to dehydration, further compromising already decreased renal function.

ARF in the elderly is also often seen in the community setting. Nurses in the ambulatory setting need to be aware of the risk. All medications need to be monitored for potential side effects that could result in damage to the kidney either through reduced circulation or nephrotoxicity. Outpatient procedures that require fasting or a bowel preparation may cause dehydration and therefore require careful monitoring.

### Medical Management

The kidneys have a remarkable ability to recover from insult. The objectives of treatment of ARF are to restore normal chemical balance and prevent complications until repair of renal tissue and restoration of renal function can occur. Management includes eliminating the underlying cause; maintaining fluid balance; avoiding fluid excesses; and, when indicated, providing renal replacement therapy. Prerenal azotemia is treated by optimizing renal perfusion, whereas postrenal failure is treated by relieving the obstruction. Intrarenal azotemia is treated with supportive therapy, with removal of causative agents, aggressive management of prerenal and postrenal failure, and avoidance of associated risk factors. Shock and infection, if present, are treated promptly (see Chapter 15).

Maintenance of fluid balance is based on daily body weight, serial measurements of central venous pressure, serum and urine concentrations, fluid losses, blood pressure, and the clinical status of the patient. The parenteral and oral intake and the output of urine, gastric drainage, stools, wound drainage, and perspiration are calculated and are used as the basis for fluid replacement. The insensible fluid produced through the normal metabolic processes and lost through the skin and lungs is also considered in fluid management.

Fluid excesses can be detected by the clinical findings of dyspnea, tachycardia, and distended neck veins. The patient's lungs are auscultated for moist crackles. Because pulmonary edema may be caused by excessive administration of parenteral fluids, extreme caution must be used to prevent fluid overload. The development of generalized edema is assessed by examining the presacral and pretibial areas several times daily. Mannitol (Osmitrol), furosemide (Lasix), or ethacrynic acid (Edecrin) may be prescribed to initiate diuresis.

Adequate renal blood flow in patients with prerenal causes of ARF may be restored by IV fluids or transfusions of blood products. If ARF is caused by hypovolemia secondary to hypoproteinemia, an infusion of albumin may be prescribed. Dialysis may be initiated to prevent complications of ARF, such as hyperkalemia, metabolic acidosis, pericarditis, and pulmonary edema. Dialysis corrects many biochemical abnormalities; allows for liberalization of fluid, protein, and sodium intake; diminishes bleeding tendencies; and promotes wound healing. **Hemodialysis** (a procedure that circulates the patient's blood through a dialyzer to remove waste products and excess fluid), **peritoneal dialysis** (PD) (a procedure that uses the patient's peritoneal membrane [the lining of the peritoneal cavity] as the semipermeable membrane to exchange fluid and solutes), or a variety of **continuous renal replacement therapies** (CRRTs) (methods used to replace normal kidney function by circulating the patient's blood through a hemofilter) may be performed. These and other treatment modalities for patients with renal dysfunction are discussed later in this chapter.

#### *Pharmacologic Therapy*

Hyperkalemia is the most life-threatening of the fluid and electrolyte changes that occur in patients with renal disturbances. Therefore, the patient is monitored for hyperkalemia through serial serum electrolyte levels (potassium value greater than 5.0 mEq/L [5 mmol/L]), ECG changes (tall, tented, or peaked T waves), and changes in clinical status (see Chapter 14). Other symptoms of hyperkalemia include irritability, abdominal cramping, diarrhea, paresthesia, and generalized muscle weakness. Muscle weakness may present as slurred speech, difficulty breathing, paresthesia, and paralysis. As the potassium level increases, both cardiac and other muscular function declines, making this a true medical emergency (Counts, 2008).

The elevated potassium levels may be reduced by administering cation-exchange resins (sodium polystyrene sulfonate [Kayexalate]) orally or by retention enema. Kayexalate works by exchanging sodium ions for potassium ions in the intestinal tract. Sorbitol may be administered in combination with Kayexalate to induce a diarrhea-type effect

(it induces water loss in the GI tract). If a Kayexalate retention enema is administered (the colon is the major site of potassium exchange), a rectal catheter with a balloon may be used to facilitate retention if necessary. The patient should retain the Kayexalate for 30 to 45 minutes to promote potassium removal. Afterward, a cleansing enema may be prescribed to remove remaining medication as a precaution against fecal impaction.

If the patient is hemodynamically unstable (low blood pressure, changes in mental status, dysrhythmia), IV dextrose 50%, insulin, and calcium replacement may be administered to shift potassium back into the cells. Albuterol sulfate (Ventolin HFA) by nebulizer can lower plasma potassium concentration by 0.5 to 1.5 mEq/L (Best & Counselman, 2008). The shift of potassium into the intracellular space is temporary, so arrangements for dialysis need to be made on an emergent basis.

Since many medications are eliminated through the kidneys, dosages must be reduced when a patient has ARF. Examples of commonly used agents that require adjustment are antibiotic medications (especially aminoglycosides), digoxin, ACE inhibitors, and magnesium-containing agents.

In addition, many medications have been used in patients with ARF in an attempt to improve patient outcomes. Diuretic agents are often used to control fluid volume, but they have not been shown to improve recovery from ARF (Dirkes & Hodge, 2007).

In patients with severe acidosis, the arterial blood gases and serum bicarbonate levels ($CO_2$-combining power) must be monitored because the patient may require sodium bicarbonate therapy or dialysis. If respiratory problems develop, appropriate ventilatory measures must be instituted. The elevated serum phosphate level may be controlled with phosphate-binding agents (eg, calcium or lanthanum carbonate) that help prevent a continuing rise in serum phosphate levels by decreasing the absorption of phosphate from the intestinal tract.

### Nutritional Therapy

ARF causes severe nutritional imbalances (because nausea and vomiting contribute to inadequate dietary intake), impaired glucose use and protein synthesis, and increased tissue catabolism. The patient is weighed daily and loses 0.2 to 0.5 kg (0.5 to 1 lb) daily if the nitrogen balance is negative (ie, caloric intake falls below caloric requirements). If the patient gains or does not lose weight or develops hypertension, fluid retention should be suspected.

Nutritional support is based on the underlying cause of ARF, the catabolic response, the type and frequency of renal replacement therapy, comorbidities, and nutritional status. Replacement of dietary proteins is individualized to provide the maximum benefit and minimize uremic symptoms. Caloric requirements are met with high-carbohydrate meals, because carbohydrates have a protein-sparing effect (ie, in a high-carbohydrate diet, protein is not used for meeting energy requirements but is "spared" for growth and tissue healing). Foods and fluids containing potassium or phosphorus (eg, bananas, citrus fruits and juices, coffee) are restricted.

The oliguric phase of ARF may last 10 to 20 days and is followed by the diuretic phase, at which time urine output begins to increase, signaling that kidney function is returning. Results of blood chemistry tests are used to determine the amounts of sodium, potassium, and water needed for replacement, along with assessment for overhydration or underhydration. Following the diuretic phase, the patient is placed on a high-protein, high-calorie diet and is encouraged to resume activities gradually.

## Nursing Management

The nurse has an important role in caring for the patient with ARF. The nurse monitors for complications, participates in emergency treatment of fluid and electrolyte imbalances, assesses the patient's progress and response to treatment, and provides physical and emotional support. Additionally, the nurse keeps family members informed about the patient's condition, helps them understand the treatments, and provides psychological support. Although the development of ARF may be the most serious problem, the nurse continues to provide nursing care indicated for the primary disorder (eg, burns, shock, trauma, obstruction of the urinary tract).

### Monitoring Fluid and Electrolyte Balance

Because of the serious fluid and electrolyte imbalances that can occur with ARF, the nurse monitors the patient's serum electrolyte levels and physical indicators of these complications during all phases of the disorder. Hyperkalemia is the most immediate life-threatening imbalance seen in ARF. Parenteral fluids, all oral intake, and all medications are screened carefully to ensure that hidden sources of potassium are not inadvertently administered or consumed. IV solutions must be carefully selected based on the patient's fluid and electrolyte status. The patient's cardiac function and musculoskeletal status are monitored closely for signs of hyperkalemia.

The nurse monitors fluid status by paying careful attention to fluid intake (IV medications should be administered in the smallest volume possible), urine output, apparent edema, distention of the jugular veins, alterations in heart sounds and breath sounds, and increasing difficulty in breathing. Accurate daily weights, as well as I&O records, are essential. Indicators of deteriorating fluid and electrolyte status are reported immediately to the physician, and preparation is made for emergency treatment. Severe fluid and electrolyte disturbances may be treated with hemodialysis, PD, or CRRT.

### Reducing Metabolic Rate

The nurse takes steps to reduce the patient's metabolic rate. Bed rest may be indicated to reduce exertion and the metabolic rate during the most acute stage of the disorder. Fever and infection, both of which increase the metabolic rate and catabolism, are prevented or treated promptly.

### Promoting Pulmonary Function

Attention is given to pulmonary function, and the patient is assisted to turn, cough, and take deep breaths frequently to prevent atelectasis and respiratory tract infection. Drowsiness and lethargy may prevent the patient from moving and turning without encouragement and assistance.

#### Preventing Infection

Asepsis is essential with invasive lines and catheters to minimize the risk of infection and increased metabolism. An indwelling urinary catheter is avoided whenever possible due to the high risk of UTI associated with its use but may be required to provide ongoing data required to monitor fluid I&O.

#### Providing Skin Care

The skin may be dry or susceptible to breakdown as a result of edema; therefore, meticulous skin care is important. Additionally, excoriation and itching of the skin may result from the deposit of irritating toxins in the patient's tissues. Bathing the patient with cool water, frequent turning, and keeping the skin clean and well moisturized and the fingernails trimmed to avoid excoriation are often comforting and prevent skin breakdown.

#### Providing Psychosocial Support

The patient with ARF may require treatment with hemodialysis, PD, or CRRT. The length of time that these treatments are necessary varies with the cause and extent of damage to the kidneys. The patient and family need assistance, explanation, and support during this period. The purpose of the treatment is explained to the patient and family by the physician. However, high levels of anxiety and fear may necessitate repeated explanation and clarification by the nurse. The family members may initially be afraid to touch and talk to the patient during these procedures but should be encouraged and assisted to do so.

In an intensive care setting, many of the nurse's functions are devoted to the technical aspects of patient care; however, it is essential that the psychological needs and other concerns of the patient and family be addressed. Continued assessment of the patient for complications of ARF and precipitating causes is essential.

## Chronic Renal Failure (End-Stage Renal Disease)

When a patient has sustained enough kidney damage to require renal replacement therapy on a permanent basis, the patient has moved into the fifth or final stage of CKD, also referred to as chronic renal failure (CRF) or ESRD.

### Pathophysiology

As renal function declines, the end products of protein metabolism (normally excreted in urine) accumulate in the blood. Uremia develops and adversely affects every system in the body. The greater the buildup of waste products, the more pronounced the symptoms are.

The rate of decline in renal function and progression of ESRD is related to the underlying disorder, the urinary excretion of protein, and the presence of hypertension. The disease tends to progress more rapidly in patients who excrete significant amounts of protein or have elevated blood pressure than in those without these conditions.

### Clinical Manifestations

Because virtually every body system is affected in ESRD, patients exhibit a number of signs and symptoms (Broscious & Castagnola, 2006). The severity of these signs and symptoms depends in part on the degree of renal impairment, other underlying conditions, and the patient's age. Cardiovascular disease is the predominant cause of death in patients with ESRD (Burrows & Muller, 2007). Peripheral neuropathy, a disorder of the peripheral nervous system, is present in some patients. Patients complain of severe pain and discomfort. Restless leg syndrome and burning feet can occur in the early stage of uremic peripheral neuropathy (Phillips & Ryr, 2005; Slack & Landis, 2006). The precise mechanisms for many of these systemic signs and symptoms have not been identified. However, it is generally thought that the accumulation of uremic waste products is the probable cause. Chart 44-6 summarizes the systemic signs and symptoms.

### Assessment and Diagnostic Findings

#### Glomerular Filtration Rate

As the GFR decreases (due to nonfunctioning glomeruli), the creatinine clearance decreases, while the serum creatinine and BUN levels increase. Serum creatinine is a more sensitive indicator of renal function than BUN. The BUN is affected not only by renal disease but also by protein intake in the diet, catabolism (tissue and RBC breakdown), parenteral nutrition, and medications such as corticosteroids.

#### Sodium and Water Retention

The kidney cannot concentrate or dilute the urine normally in ESRD. Appropriate responses by the kidney to changes in the daily intake of water and electrolytes, therefore, do not occur. Some patients retain sodium and water, increasing the risk for edema, heart failure, and hypertension. Hypertension may also result from activation of the renin–angiotensin–aldosterone axis and the concomitant increased aldosterone secretion. Other patients have a tendency to lose sodium and run the risk of developing hypotension and hypovolemia. Vomiting and diarrhea may cause sodium and water depletion, which worsens the uremic state.

#### Acidosis

Metabolic acidosis occurs in ESRD because the kidneys are unable to excrete increased loads of acid. Decreased acid secretion results from the inability of the kidney tubules to excrete ammonia ($NH_3^-$) and to reabsorb sodium bicarbonate ($HCO_3^-$). There is also decreased excretion of phosphates and other organic acids.

#### Anemia

Anemia develops as a result of inadequate erythropoietin production, the shortened lifespan of RBCs, nutritional deficiencies, and the patient's tendency to bleed, particularly from the GI tract. Erythropoietin, a substance normally produced by the kidneys, stimulates bone marrow to produce RBCs (Brattich, 2007). In ESRD, erythropoietin production decreases and profound anemia results, producing fatigue, angina, and shortness of breath.

## Chart 44-6 • *Assessing for End-stage Renal Disease*

Be alert for the following signs and symptoms:

**Neurologic**

- Weakness and fatigue
- Confusion
- Inability to concentrate
- Disorientation
- Tremors
- Seizures
- Asterixis
- Restlessness of legs
- Burning of soles of feet
- Behavior changes

**Integumentary**

- Gray-bronze skin color
- Dry, flaky skin
- Pruritus
- Ecchymosis
- Purpura
- Thin, brittle nails
- Coarse, thinning hair

**Cardiovascular**

- Hypertension
- Pitting edema (feet, hands, sacrum)
- Periorbital edema
- Pericardial friction rub
- Engorged neck veins
- Pericarditis
- Pericardial effusion
- Pericardial tamponade
- Hyperkalemia
- Hyperlipidemia

**Pulmonary**

- Crackles
- Thick, tenacious sputum
- Depressed cough reflex
- Pleuritic pain
- Shortness of breath
- Tachypnea
- Kussmaul-type respirations
- Uremic pneumonitis

**Gastrointestinal**

- Ammonia odor to breath ("uremic fetor")
- Metallic taste
- Mouth ulcerations and bleeding
- Anorexia, nausea, and vomiting
- Hiccups
- Constipation or diarrhea
- Bleeding from gastrointestinal tract

**Hematologic**

- Anemia
- Thrombocytopenia

**Reproductive**

- Amenorrhea
- Testicular atrophy
- Infertility
- Decreased libido

**Musculoskeletal**

- Muscle cramps
- Loss of muscle strength
- Renal osteodystrophy
- Bone pain
- Bone fractures
- Foot drop

#### *Calcium and Phosphorus Imbalance*

Another abnormality seen in ESRD is a disorder in calcium and phosphorus metabolism (McCarley & Arjomand, 2008). Serum calcium and phosphate levels have a reciprocal relationship in the body: As one increases, the other decreases. With a decrease in filtration through the glomerulus of the kidney, there is an increase in the serum phosphate level and a reciprocal or corresponding decrease in the serum calcium level. The decreased serum calcium level causes increased secretion of parathormone from the parathyroid glands. However, in renal failure, the body does not respond normally to the increased secretion of parathormone; as a result, calcium leaves the bone, often producing bone changes and bone disease as well as calcification of major blood vessels in the body. In addition, the active metabolite of vitamin D (1,25-dihydroxycholecalciferol) normally manufactured by the kidney decreases as renal failure progresses (Gesek & Desmond, 2008). Uremic bone disease, often called renal osteodystrophy, develops from the complex changes in calcium, phosphate, and parathormone balance. There is also evidence of calcification of blood vessels.

## Complications

Potential complications of chronic renal failure that concern the nurse and necessitate a collaborative approach to care include the following:

- Hyperkalemia due to decreased excretion, metabolic acidosis, catabolism, and excessive intake (diet, medications, fluids)
- Pericarditis, pericardial effusion, and pericardial tamponade due to retention of uremic waste products and inadequate dialysis
- Hypertension due to sodium and water retention and malfunction of the renin–angiotensin–aldosterone system
- Anemia due to decreased erythropoietin production, decreased RBC lifespan, bleeding in the GI tract from irritating toxins and ulcer formation, and blood loss during hemodialysis
- Bone disease and metastatic and vascular calcifications due to retention of phosphorus, low serum calcium levels, abnormal vitamin D metabolism, and elevated aluminum levels

## Medical Management

The goal of management is to maintain kidney function and homeostasis for as long as possible. All factors that contribute to ESRD and all factors that are reversible (eg, obstruction) are identified and treated. Management is accomplished primarily with medications and diet therapy, although dialysis may also be needed to decrease the level of uremic waste products in the blood and to control electrolyte balance.

### Pharmacologic Therapy

Complications can be prevented or delayed by administering prescribed phosphate-binding agents, calcium supplements, antihypertensive and cardiac medications, antiseizure medications, and erythropoietin (Epogen).

**Calcium and Phosphorus Binders**

Hyperphosphatemia and hypocalcemia are treated with medications that bind dietary phosphorus in the GI tract. Binders such as calcium carbonate (Os-Cal) or calcium acetate (PhosLo) are prescribed, but there is a risk of hypercalcemia. If calcium is high or the calcium–phosphorus product exceeds 55 mg/dL, a polymeric phosphate binder such as sevelamer hydrochloride (Renagel) may be prescribed (Zonderman & Doyle, 2006). These medications bind dietary phosphorus in the intestinal tract. All binding agents must be administered with food to be effective. Magnesium-based antacids are avoided to prevent magnesium toxicity.

**Antihypertensive and Cardiovascular Agents**

Hypertension is managed by intravascular volume control and a variety of antihypertensive agents. Heart failure and pulmonary edema may also require treatment with fluid restriction, low-sodium diets, diuretic agents, inotropic agents such as digoxin (Lanoxin) or dobutamine (Dobutrex), and dialysis. The metabolic acidosis of ESRD usually produces no symptoms and requires no treatment; however, sodium bicarbonate supplements or dialysis may be needed to correct the acidosis if it causes symptoms (Molzahn & Butera, 2006).

**Antiseizure Agents**

Neurologic abnormalities may occur, so the patient must be observed for early evidence of slight twitching, headache, delirium, or seizure activity. If seizures occur, the onset of the seizure is recorded along with the type, duration, and general effect on the patient. The physician is notified immediately. IV diazepam (Valium) or phenytoin (Dilantin) is usually administered to control seizures. The side rails of the bed should be raised and padded to protect the patient. The nursing management of the patient with seizures is discussed in Chapter 61.

**Erythropoietin**

Anemia associated with ESRD is treated with recombinant human erythropoietin (Epogen). Patients with anemia (hematocrit less than 30%) present with nonspecific symptoms, such as malaise, general fatigability, and decreased activity tolerance. Erythropoietin therapy is initiated to achieve a hematocrit of 33% to 38% and a target hemoglobin of 12 g/dL, which generally alleviates the symptoms of anemia (Brattich, 2007).

Erythropoietin is administered intravenously or subcutaneously three times a week in ESRD. It may take 2 to 6 weeks for the hematocrit to increase; therefore, the medication is not indicated for patients who need immediate correction of severe anemia. Adverse effects seen with erythropoietin therapy include hypertension (especially during early stages of treatment), increased clotting of vascular access sites, seizures, and depletion of body iron stores (Zonderman & Doyle, 2006).

Management involves adjustment of heparin to prevent clotting of the lines during hemodialysis treatments, frequent monitoring of hemoglobin and hematocrit, and periodic assessment of serum iron and transferrin levels. Because adequate stores of iron are necessary for an adequate response to erythropoietin, supplementary iron may be prescribed. Common iron supplements include iron sucrose (Venofer) and ferric gluconate (Ferrlecit). In addition, the patient's blood pressure and serum potassium level are monitored to detect hypertension and increasing serum potassium levels, which may occur with therapy and the increasing RBC mass. The occurrence of hypertension requires initiation or adjustment of the patient's antihypertensive therapy. Hypertension that cannot be controlled is a contraindication to recombinant erythropoietin therapy.

Patients who have received erythropoietin therapy have reported decreased levels of fatigue, increased feelings of well-being, better tolerance of dialysis, higher energy levels, and improved exercise tolerance. Additionally, this therapy has decreased the need for transfusion and its associated risks, including bloodborne infectious disease, antibody formation, and iron overload.

### Nutritional Therapy

Dietary intervention is necessary with deterioration of renal function and includes careful regulation of protein intake, fluid intake to balance fluid losses, sodium intake to balance sodium losses, and some restriction of potassium. At the same time, adequate caloric intake and vitamin supplementation must be ensured. Protein is restricted because urea, uric acid, and organic acids—the breakdown products of dietary and tissue proteins—accumulate rapidly in the blood when there is impaired renal clearance. The allowed protein must be of high biologic value (dairy products, eggs, meats). High-biologic-value proteins are those that are complete proteins and supply the essential amino acids necessary for growth and cell repair.

Usually, the fluid allowance per day is 500 mL to 600 mL more than the previous day's 24-hour urine output. Calories are supplied by carbohydrates and fat to prevent wasting. Vitamin supplementation is necessary because a protein-restricted diet does not provide the necessary complement of vitamins. Additionally, the patient on dialysis may lose water-soluble vitamins during the dialysis treatment.

Hyperkalemia is usually prevented by ensuring adequate dialysis treatments with potassium removal and careful monitoring of diet, medications, and fluids for their potassium content. Sodium polystyrene sulfonate (Kayexalate), a cation-exchange resin, may be needed for acute hyperkalemia.

### *Dialysis*

The patient with increasing symptoms of renal failure is referred to a dialysis and transplantation center early in the course of progressive renal disease. Dialysis is usually initiated when the patient cannot maintain a reasonable lifestyle with conservative treatment.

## Nursing Management

The patient with ESRD requires astute nursing care to avoid the complications of reduced renal function and the stresses and anxieties of dealing with a life-threatening illness.

Nursing care is directed toward assessing fluid status and identifying potential sources of imbalance, implementing a dietary program to ensure proper nutritional intake within the limits of the treatment regimen, and promoting positive feelings by encouraging increased self-care and greater independence. It is extremely important to provide explanations and information to the patient and family concerning ESRD, treatment options, and potential complications. A great deal of emotional support is needed by the patient and family because of the numerous changes experienced. Specific interventions, along with rationale and evaluation criteria, are presented in more detail in the plan of nursing care for the patient with chronic renal failure (Chart 44-7).

### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

The nurse plays an important role in teaching the patient with ESRD. Because of the extensive teaching needed, the home care nurse, dialysis nurse, and nurses in the hospital and outpatient settings all provide ongoing education and reinforcement while monitoring the patient's progress and compliance with the treatment regimen.

A referral to a nutritionist is made because of the dietary changes required. The patient is taught how to check the vascular access device for patency and appropriate precautions, such as avoiding venipuncture and blood pressure measurements on the arm with the access device.

Additionally, the patient and family need to know what problems to report to the health care provider. These include the following:

- Worsening signs and symptoms of renal failure (nausea, vomiting, change in usual urine output [if any], ammonia odor on breath)
- Signs and symptoms of hyperkalemia (muscle weakness, diarrhea, abdominal cramps)
- Signs and symptoms of access problems (clotted fistula or graft, infection)

These signs and symptoms of decreasing renal function, in addition to increasing BUN and serum creatinine levels, may indicate a need to alter the dialysis prescription. The dialysis nurses also provide ongoing education and support at each treatment visit.

**Continuing Care**

The importance of follow-up examinations and treatment is stressed to the patient and family because of changing physical status, renal function, and dialysis requirements. Referral for home care provides the home care nurse with the opportunity to assess the patient's environment and emotional status and the coping strategies used by the patient and family to deal with the changes in family roles often associated with chronic illness.

The home care nurse also assesses the patient for further deterioration of renal function and signs and symptoms of complications resulting from the primary renal disorder, the resulting renal failure, and effects of treatment strategies (eg, dialysis, medications, dietary restrictions). Patients need education and reinforcement of the dietary restrictions required, including fluid, sodium, potassium, and protein restriction. Reminders about the need for health promotion activities and health screening are an important part of nursing care for the patient with renal failure.

## Gerontologic Considerations

Diabetes, hypertension, chronic glomerulonephritis, interstitial nephritis, and urinary tract obstruction are the causes of ESRD in the elderly. The signs and symptoms of renal disease in the elderly are often nonspecific. The occurrence of symptoms of other disorders (heart failure, dementia) can mask the symptoms of renal disease and delay or prevent diagnosis and treatment. Patients often develop signs and symptoms of nephrotic syndrome, such as edema and proteinuria.

Hemodialysis and PD are used effectively in treating elderly patients. The number of elderly patients initiating dialysis has dramatically increased in the past decade (Kurella, Covinsky, Collins, et al., 2007). Although there is no specific age limitation for renal transplantation, concomitant disorders (eg, coronary artery disease, peripheral vascular disease) have made it a less common treatment for the elderly. However, the outcome is comparable to that of younger patients. Some elderly patients elect not to undergo dialysis or transplantation. Conservative management, including nutritional therapy, fluid control, and medications such as phosphate binders, may be considered in patients who are not suitable for or elect not to have dialysis or transplantation.

# RENAL REPLACEMENT THERAPIES

The use of renal replacement therapies becomes necessary when the kidneys can no longer remove wastes, maintain electrolytes, and regulate fluid balance. This can occur rapidly or over a long period of time and the need for replacement therapy can be acute (short term) or chronic (long term). The main renal replacement therapies include the various types of dialysis and kidney transplantation.

## *Dialysis*

Types of dialysis include hemodialysis, CRRT, and PD. Acute dialysis is indicated when there is a high and increasing level of serum potassium, fluid overload, or impending pulmonary edema, increasing acidosis, pericarditis, and severe confusion. It may also be used to remove medications or toxins (poisoning or medication overdose) from

## CHART 44-7 PLAN OF NURSING CARE
## *The Patient With Chronic Renal Failure*

**NURSING DIAGNOSIS:** Excess fluid volume related to decreased urine output, dietary excesses, and retention of sodium and water
**GOAL:** Maintenance of ideal body weight without excess fluid

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess fluid status:<br>a. Daily weight<br>b. Intake and output balance<br>c. Skin turgor and presence of edema<br>d. Distention of neck veins<br>e. Blood pressure, pulse rate, and rhythm<br>f. Respiratory rate and effort | 1. Assessment provides baseline and ongoing database for monitoring changes and evaluating interventions. | • Demonstrates no rapid weight changes<br>• Maintains dietary and fluid restrictions<br>• Exhibits normal skin turgor without edema<br>• Exhibits normal vital signs<br>• Exhibits no neck vein distention<br>• Reports no difficulty breathing or shortness of breath<br>• Performs oral hygiene frequently<br>• Reports decreased thirst<br>• Reports decreased dryness of oral mucous membranes |
| 2. Limit fluid intake to prescribed volume. | 2. Fluid restriction will be determined on basis of weight, urine output, and response to therapy. | |
| 3. Identify potential sources of fluid:<br>a. Medications and fluids used to take or administer medications: oral and intravenous<br>b. Foods | 3. Unrecognized sources of excess fluids may be identified. | |
| 4. Explain to patient and family rationale for fluid restriction. | 4. Understanding promotes patient and family cooperation with fluid restriction. | |
| 5. Assist patient to cope with the discomforts resulting from fluid restriction. | 5. Increasing patient comfort promotes compliance with dietary restrictions. | |
| 6. Provide or encourage frequent oral hygiene. | 6. Oral hygiene minimizes dryness of oral mucous membranes. | |

**NURSING DIAGNOSIS:** Imbalanced nutrition: less than body requirements related to anorexia, nausea, vomiting, dietary restrictions, and altered oral mucous membranes
**GOAL:** Maintenance of adequate nutritional intake

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess nutritional status:<br>a. Weight changes<br>b. Laboratory values (serum electrolyte, BUN, creatinine, protein, transferrin, and iron levels) | 1. Baseline data allow for monitoring of changes and evaluating effectiveness of interventions. | • Consumes protein of high biologic value<br>• Chooses foods within dietary restrictions that are appealing<br>• Consumes high-calorie foods within dietary restrictions<br>• Explains in own words rationale for dietary restrictions and relationship to urea and creatinine levels<br>• Takes medications on schedule that does not produce anorexia or feeling of fullness<br>• Consults written lists of acceptable foods<br>• Reports increased appetite at meals<br>• Exhibits no rapid increases or decreases in weight<br>• Demonstrates normal skin turgor without edema; wound healing and acceptable plasma albumin levels |
| 2. Assess patient's nutritional dietary patterns:<br>a. Diet history<br>b. Food preferences<br>c. Calorie counts | 2. Past and present dietary patterns are considered in planning meals. | |
| 3. Assess for factors contributing to altered nutritional intake:<br>a. Anorexia, nausea, or vomiting<br>b. Diet unpalatable to patient<br>c. Depression<br>d. Lack of understanding of dietary restrictions<br>e. Stomatitis | 3. Information about other factors that may be altered or eliminated to promote adequate dietary intake is provided. | |
| 4. Provide patient's food preferences within dietary restrictions. | 4. Increased dietary intake is encouraged. | |
| 5. Promote intake of high-biologic-value protein foods: eggs, dairy products, meats. | 5. Complete proteins are provided for positive nitrogen balance needed for growth and healing. | |

*Continued on following page*

CHART 44-7 PLAN OF NURSING CARE

## The Patient With Chronic Renal Failure (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 6. Encourage high-calorie, low-protein, low-sodium, and low-potassium snacks between meals. | 6. Reduces source of restricted foods and proteins and provides calories for energy, sparing protein for tissue growth and healing. | |
| 7. Alter schedule of medications so that they are not given immediately before meals. | 7. Ingestion of medications just before meals may produce anorexia and feeling of fullness. | |
| 8. Explain rationale for dietary restrictions and relationship to kidney disease and increased urea and creatinine levels. | 8. Promotes patient understanding of relationships between diet and urea and creatinine levels to renal disease | |
| 9. Provide written lists of foods allowed and suggestions for improving their taste without use of sodium or potassium. | 9. Lists provide a positive approach to dietary restrictions and a reference for patient and family to use when at home. | |
| 10. Provide pleasant surroundings at meal-times. | 10. Unpleasant factors that contribute to patient's anorexia are eliminated. | |
| 11. Weigh patient daily. | 11. Allows monitoring of fluid and nutritional status | |
| 12. Assess for evidence of inadequate protein intake:<br>a. Edema formation<br>b. Delayed wound healing<br>c. Decreased serum albumin levels | 12. Inadequate protein intake can lead to decreased albumin and other proteins, edema formation, and delay in wound healing. | |

**NURSING DIAGNOSIS:** Deficient knowledge regarding condition and treatment
**GOAL:** Increased knowledge about condition and related treatment

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Assess understanding of cause of renal failure, consequences of renal failure, and its treatment:<br>a. Cause of patient's renal failure<br>b. Meaning of renal failure<br>c. Understanding of renal function<br>d. Relationship of fluid and dietary restrictions to renal failure<br>e. Rationale for treatment (hemodialysis, peritoneal dialysis, transplantation) | 1. Provides baseline for further explanations and teaching | • Verbalizes relationship of cause of renal failure to consequences<br>• Explains fluid and dietary restrictions as they relate to failure of kidney's regulatory functions<br>• States in own words relationship of renal failure and need for treatment<br>• Asks questions about treatment options, indicating readiness to learn<br>• Verbalizes plans to continue as normal a life as possible<br>• Uses written information and instructions to clarify questions and seek additional information |
| 2. Provide explanation of renal function and consequences of renal failure at patient's level of understanding and guided by patient's readiness to learn. | 2. Patient can learn about renal failure and treatment as he or she becomes ready to understand and accept the diagnosis and consequences. | |
| 3. Assist patient to identify ways to incorporate changes related to illness and its treatment into lifestyle. | 3. Patient can see that his or her life does not have to revolve around the disease. | |
| 4. Provide oral and written information as appropriate about:<br>a. Renal function and failure<br>b. Fluid and dietary restrictions<br>c. Medications<br>d. Reportable problems, signs, and symptoms<br>e. Follow-up schedule<br>f. Community resources<br>g. Treatment options | 4. Provides patient with information that can be used for further clarification at home | |

*Continued*

CHART 44-7

## PLAN OF NURSING CARE
## *The Patient With Chronic Renal Failure* (Continued)

**NURSING DIAGNOSIS:** Activity intolerance related to fatigue, anemia, retention of waste products, and dialysis procedure
**GOAL:** Participation in activity within tolerance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess factors contributing to activity intolerance:<br>a. Fatigue<br>b. Anemia<br>c. Fluid and electrolyte imbalances<br>d. Retention of waste products<br>e. Depression | 1. Indicates factors contributing to severity of fatigue | • Participates in increasing levels of activity and exercise<br>• Reports increased sense of well-being<br>• Alternates rest and activity<br>• Participates in selected self-care activities |
| 2. Promote independence in self-care activities as tolerated; assist if fatigued. | 2. Promotes improved self-esteem | |
| 3. Encourage alternating activity with rest. | 3. Promotes activity and exercise within limits and adequate rest | |
| 4. Encourage patient to rest after dialysis treatments. | 4. Adequate rest is encouraged after dialysis treatments, which are exhausting to many patients. | |

**NURSING DIAGNOSIS:** Risk for situational low self-esteem related to dependency, role changes, change in body image, and change in sexual function
**GOAL:** Improved self-esteem

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's and family's responses and reactions to illness and treatment. | 1. Provides data about problems encountered by patient and family in coping with changes in life | • Identifies previously used coping styles that have been effective and those no longer possible due to disease and treatment (alcohol or drug use; extreme physical exertion)<br>• Patient and family identify and verbalize feelings and reactions to disease and necessary changes in their lives<br>• Seeks professional counseling, if necessary, to cope with changes resulting from renal failure<br>• Reports satisfaction with method of sexual expression |
| 2. Assess relationship of patient and significant family members. | 2. Identifies strengths and supports of patient and family | |
| 3. Assess usual coping patterns of patient and family members. | 3. Coping patterns that may have been effective in past may be harmful in view of restrictions imposed by disease and treatment. | |
| 4. Encourage open discussion of concerns about changes produced by disease and treatment:<br>a. Role changes<br>b. Changes in lifestyle<br>c. Changes in occupation<br>d. Sexual changes<br>e. Dependence on health care team | 4. Encourages patient to identify concerns and steps necessary to deal with them | |
| 5. Explore alternate ways of sexual expression other than sexual intercourse. | 5. Alternative forms of sexual expression may be acceptable. | |
| 6. Discuss role of giving and receiving love, warmth, and affection. | 6. Sexuality means different things to different people, depending on stage of maturity. | |

**COLLABORATIVE PROBLEMS:** Hyperkalemia; pericarditis, pericardial effusion, and pericardial tamponade; hypertension; anemia; bone disease and metastatic calcifications
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Hyperkalemia** | | |
| 1. Monitor serum potassium levels. Notify physician if level greater than 5.5 mEq/L, and prepare to treat hyperkalemia. | 1. Hyperkalemia causes potentially life-threatening changes in the body. | • Patient has normal potassium level<br>• Experiences no muscle weakness or diarrhea<br>• Exhibits normal ECG pattern<br>• Vital signs are within normal limits |
| 2. Assess patient for muscle weakness, diarrhea, ECG changes (tall-tented T waves and widened QRS). | 2. Cardiovascular signs and symptoms are characteristic of hyperkalemia. | |

*Continued on following page*

CHART 44-7

## PLAN OF NURSING CARE
## *The Patient With Chronic Renal Failure* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Pericarditis, Pericardial Effusion, and Pericardial Tamponade** | | |
| 1. Assess patient for fever, chest pain, and a pericardial friction rub (signs of pericarditis) and, if present, notify physician. | 1. About 30%–50% of patients with chronic renal failure develop pericarditis due to uremia; fever, chest pain, and a pericardial friction rub are classic signs. | • Has strong and equal peripheral pulses<br>• Absence of a paradoxical pulse<br>• Absence of pericardial effusion or tamponade on cardiac ultrasound<br>• Patient has normal heart sounds |
| 2. If patient has pericarditis, assess for the following every 4 hours:<br>a. Paradoxical pulse >10 mm Hg<br>b. Extreme hypotension<br>c. Weak or absent peripheral pulses<br>d. Altered level of consciousness<br>e. Bulging neck veins | 2. Pericardial effusion is a common fatal sequela of pericarditis. Signs of an effusion include a paradoxical pulse (>10 mm Hg drop in blood pressure during inspiration) and signs of shock due to compression of the heart by a large effusion. Cardiac tamponade exists when the patient is severely compromised hemodynamically. | |
| 3. Prepare patient for cardiac ultrasound to aid in diagnosis of pericardial effusion and cardiac tamponade. | 3. Cardiac ultrasound is useful in visualizing pericardial effusions and cardiac tamponade. | |
| 4. If cardiac tamponade develops, prepare patient for emergency pericardiocentesis. | 4. Cardiac tamponade is a life-threatening condition, with a high mortality rate. Immediate aspiration of fluid from the pericardial space is essential. | |
| **Hypertension** | | |
| 1. Monitor and record blood pressure as indicated. | 1. Provides objective data for monitoring. Elevated levels may indicate nonadherence to the treatment regimen. | • Blood pressure within normal limits<br>• Reports no headaches, visual problems, or seizures<br>• Edema is absent<br>• Demonstrates compliance with dietary and fluid restrictions |
| 2. Administer antihypertensive medications as prescribed. | 2. Antihypertensive medications play a key role in treatment of hypertension associated with chronic renal failure. | |
| 3. Encourage compliance with dietary and fluid restriction therapy. | 3. Adherence to diet and fluid restrictions and dialysis schedule prevents excess fluid and sodium accumulation. | |
| 4. Teach patient to report signs of fluid overload, vision changes, headaches, edema, or seizures. | 4. These are indications of inadequate control of hypertension and the need to alter therapy. | |
| **Anemia** | | |
| 1. Monitor RBC count, hemoglobin, and hematocrit levels as indicated. | 1. Provides assessment of degree of anemia | • Patient has a normal skin color without pallor<br>• Exhibits hematology values within acceptable limits<br>• Experiences no bleeding from any site |
| 2. Administer medications as prescribed, including iron and folic acid supplements, Epogen, and multivitamins. | 2. RBCs need iron, folic acid, and vitamins to be produced. Epogen stimulates the bone marrow to produce RBC. | |
| 3. Avoid drawing unnecessary blood specimens. | 3. Anemia is worsened by drawing numerous specimens. | |
| 4. Teach patient to prevent bleeding: avoid vigorous nose blowing and contact sports, and use a soft toothbrush. | 4. Bleeding from anywhere in the body worsens anemia. | |
| 5. Administer blood component therapy as indicated. | 5. Blood component therapy may be needed if the patient has symptoms. | |

*Continued*

**CHART 44-7** PLAN OF NURSING CARE
***The Patient With Chronic Renal Failure*** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Bone Disease and Metastatic Calcifications** | | |
| 1. Administer the following medications as prescribed: phosphate binders, calcium supplements, vitamin D supplements. | 1. Chronic renal failure causes numerous physiologic changes affecting calcium, phosphorus, and vitamin D metabolism. | • Exhibits serum calcium, phosphorus, and aluminum levels within acceptable ranges<br>• Exhibits no symptoms of hypocalcemia<br>• Has no bone demineralization on bone scan<br>• Discusses importance of maintaining activity level and exercise program |
| 2. Monitor serum lab values as indicated (calcium, phosphorus, aluminum levels) and report abnormal findings to physician. | 2. Hyperphosphatemia, hypocalcemia, and excess aluminum accumulation are common in chronic renal failure. | |
| 3. Assist patient with an exercise program. | 3. Bone demineralization increases with immobility. | |

the blood or for edema that does not respond to other treatment, hepatic coma, hyperkalemia, hypercalcemia, hypertension, and uremia (Mosenkis, Kirk & Berns, 2006).

Chronic or maintenance dialysis is indicated in advanced CKD and ESRD in the following instances: the presence of uremic signs and symptoms affecting all body systems (nausea and vomiting, severe anorexia, increasing lethargy, mental confusion), hyperkalemia, fluid overload not responsive to diuretics and fluid restriction, and a general lack of well-being. An urgent indication for dialysis in patients with renal failure is pericardial friction rub.

The decision to initiate dialysis should be reached only after thoughtful discussion among the patient, family, physician, and others as appropriate. Many potentially life-threatening issues are associated with the need for dialysis. The nurse can assist the patient and family by answering their questions, clarifying the information provided, and supporting their decision.

Successful kidney transplantation eliminates the need for dialysis. Not only is the quality of life much improved in patients with ESRD who undergo transplantation, but physiologic function is improved as well. Patients who undergo renal transplantation from living donors before dialysis is initiated generally have longer survival of the transplanted kidney than patients who receive transplantation after dialysis treatment is initiated.

## HEMODIALYSIS

Hemodialysis is used for patients who are acutely ill and require short-term dialysis (days to weeks) and for patients with advanced CKD and ESRD who require long-term or permanent renal replacement therapy. Hemodialysis prevents death but does not cure renal disease and does not compensate for the loss of endocrine or metabolic activities of the kidneys. More than 90% of patients requiring long-term renal replacement therapy are on chronic hemodialysis (USRDS, 2007). Most patients receive intermittent hemodialysis that involves treatments three times a week with the average treatment duration of 3 to 4 hours in an outpatient setting. Hemodialysis can also be performed at home by the patient and a caregiver. With home dialysis, treatment time and frequency can be adjusted to meet optimal patient needs.

The objectives of hemodialysis are to extract toxic nitrogenous substances from the blood and to remove excess water. A **dialyzer** (also referred to as an artificial kidney) serves as a synthetic semipermeable membrane, replacing the renal glomeruli and tubules as the filter for the impaired kidneys. In hemodialysis, the blood, laden with toxins and nitrogenous wastes, is diverted from the patient to a machine, a dialyzer, where toxins are filtered out and removed and the blood is returned to the patient.

Diffusion, osmosis, and ultrafiltration are the principles on which hemodialysis is based (see Chapter 14). The toxins and wastes in the blood are removed by **diffusion**—that is, they move from an area of higher concentration in the blood to an area of lower concentration in the **dialysate.** The dialysate is a solution made up of all the important electrolytes in their ideal extracellular concentrations. The electrolyte level in the patient's blood can be brought under control by properly adjusting the dialysate bath. The semipermeable membrane impedes the diffusion of large molecules, such as RBCs and proteins.

Excess water is removed from the blood by **osmosis,** in which water moves from an area of low concentration potential (the blood) to an area of high concentration potential (the dialysate bath). In **ultrafiltration,** water moves under high pressure to an area of lower pressure. This process is much more efficient than osmosis at water removal and is accomplished by applying negative pressure or a suctioning force to the dialysis membrane. Because patients with renal disease usually cannot excrete water, this force is necessary to remove fluid to achieve fluid balance.

The body's buffer system is maintained using a dialysate bath made up of bicarbonate (most common) or acetate, which is metabolized to form bicarbonate. The anticoagulant heparin is administered to keep blood from clotting in the dialysis circuit. Cleansed blood is returned to the body. By the end of the dialysis treatment, many waste products have been removed, the electrolyte balance has been restored to normal, and the buffer system has been replenished.

### Dialyzers

Dialyzers are hollow-fiber devices containing thousands of tiny strawlike tubes that carry the blood through the dialyzer. The tubes are porous and act as a semipermeable membrane

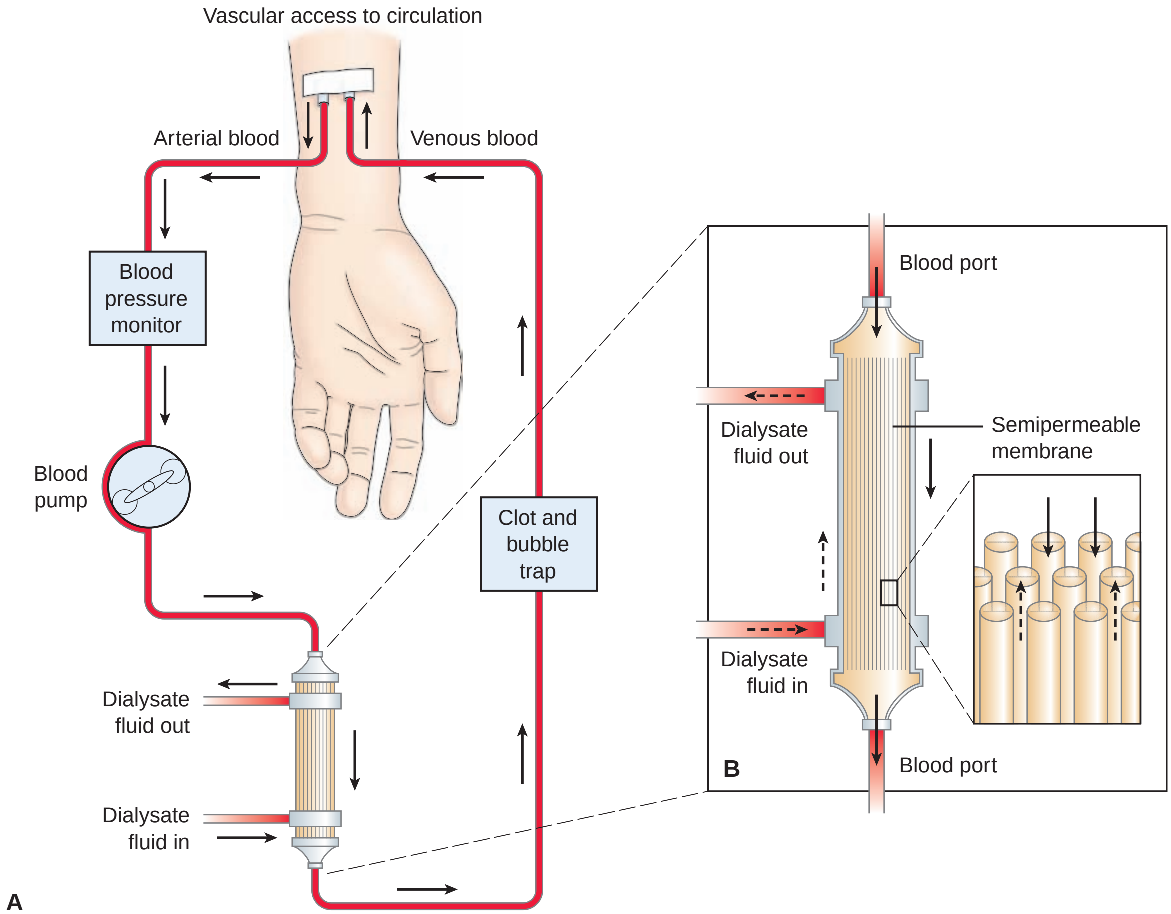



**Figure 44-3** Hemodialysis system. **A,** Blood from an artery is pumped into **(B)** a dialyzer where it flows through the cellophane tubes, which act as the semipermeable membrane (*inset*). The dialysate, which has the same chemical composition as the blood except for urea and waste products, flows in around the tubules. The waste products in the blood diffuse through the semipermeable membrane into the dialysate.

allowing toxins, fluid, and electrolytes to pass through. The constant flow of the solution maintains the concentration gradient to facilitate the exchange of wastes from the blood through the semipermeable membrane into the dialysate solution, where they are removed and discarded (Fig. 44-3).

Dialyzers have undergone many technologic changes in performance and biocompatibility. High-flux dialysis uses highly permeable membranes to increase the clearance of low- and mid-molecular-weight molecules. These special membranes are used with higher than traditional rates of flow for the blood entering and exiting the dialyzer (500 to 550 mL/min). High-flux dialysis increases the efficiency of treatments while shortening their duration and reducing the need for heparin.

## Vascular Access

Access to the patient's vascular system must be established to allow blood to be removed, cleansed, and returned to the patient's vascular system at rates between 300 and 800 mL/min. Several types of access are available.

### *Vascular Access Devices*

Immediate access to the patient's circulation for acute hemodialysis is achieved by inserting a double-lumen, noncuffed, large-bore catheter into the subclavian, internal jugular, or femoral vein by the physician (Fig. 44-4). This method of vascular access involves some risk (eg, hematoma, pneumothorax, infection, thrombosis of the subclavian vein, inadequate flow). The catheter is removed when no longer needed (eg, because the patient's condition has improved or another type of access has been established). Double-lumen, cuffed catheters may also be inserted, usually by either a surgeon or interventional radiologist, into the internal jugular vein of the patient. Since these catheters have cuffs under the skin, the insertion site heals, sealing the wound and reducing the risk for ascending infection. This feature makes these catheters safe for longer-term use. Infection rates, however, remain high and septicemia continues to be a common cause for hospital admission.

### *Arteriovenous Fistula*

The preferred method of permanent access is an **arteriovenous fistula (AVF)** that is created surgically (usually in the forearm) by joining (anastomosing) an artery to a vein, either side to side or end to side (Fig. 44-5A). Needles are inserted into the vessel to obtain blood flow adequate to pass through the dialyzer. The arterial segment of the fistula is used for arterial flow to the dialyzer and the venous segment for reinfusion of the dialyzed blood. This

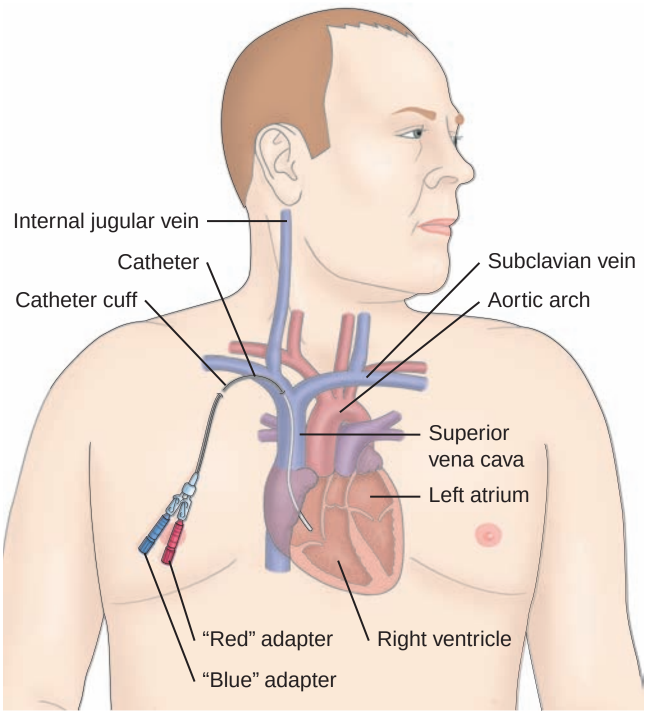



**Figure 44-4** Double-lumen, cuffed hemodialysis catheter used in acute hemodialysis. The red adapter is attached to a blood line through which blood is pumped from the patient to the dialyzer. After the blood passes through the dialyzer (artificial kidney), it returns to the patient through the blue adapter.

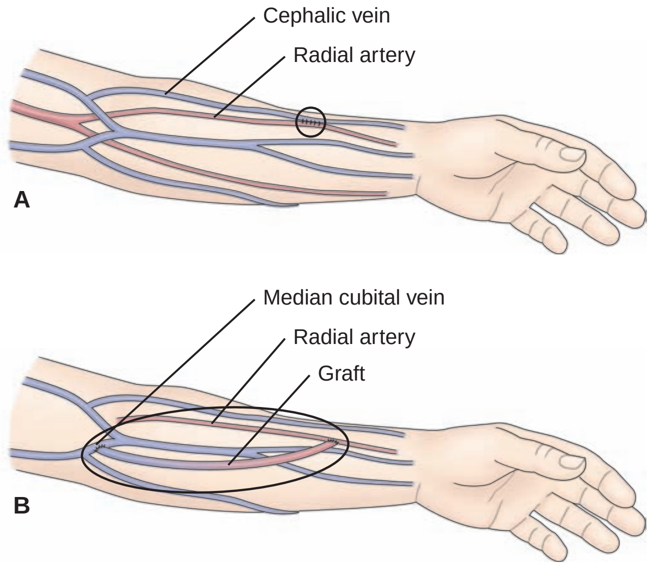



**Figure 44-5** **A,** Arteriovenous fistulas are created by anastomosing a patient's vein to an artery. This illustrates a side-to-side anastomosis. **B,** Arteriovenous grafts are established by placing synthetic tubing between the artery and vein.

access will need time, (2 to 3 months) to "mature" before it can be used. As the AVF matures, the venous segment dilates due to the increased blood flow coming directly from the artery. Once sufficiently dilated it will then accommodate two large-bore (14-, 15-, or 16-gauge) needles that are inserted for each dialysis treatment. The patient is encouraged to perform hand exercises to increase the size of these vessels (ie, squeezing a rubber ball for forearm fistulas) to accommodate the large-bore needles. Once established, this access has the longest useful life and thus is the best option for vascular access for the chronic hemodialysis patient.

### *Arteriovenous Graft*

An **arteriovenous graft** can be created by subcutaneously interposing a biologic, semibiologic, or synthetic graft material between an artery and vein (Fig. 44-5B). Usually a graft is created when the patient's vessels are not suitable for creation of an AV fistula. Patients with compromised vascular systems (eg, from diabetes) will require a graft because their native vessels are not suitable for creation of an AV Fistula. Grafts are usually placed in the arm but may be placed in the thigh or chest area. Stenosis, infection, and thrombosis are the most common complications that result in loss of this access. It is not at all uncommon to see a dialysis patient with numerous "old" or "nonfunctioning" accesses present on their arms. The patient is asked to identify which is the current access in use and it is checked carefully for the presence of a bruit and thrill.

*NURSING ALERT*

**Failure of the permanent dialysis access (fistula or graft) accounts for most hospital admissions of patients undergoing chronic hemodialysis. Thus, protection of the access is of high priority.**

## Complications

While hemodialysis can prolong life indefinitely, it does not alter the natural course of the underlying CKD, nor does it completely replace kidney function. The CKD complications previously discussed will continue to worsen and require more aggressive treatment. With the initiation of dialysis, disturbances of lipid metabolism (hypertriglyceridemia) are accentuated and contribute to cardiovascular complications. Heart failure, coronary heart disease, angina, stroke, and peripheral vascular insufficiency may occur and can incapacitate the patient. Cardiovascular disease remains the leading cause of death in patients receiving dialysis (Burrows & Muller, 2007).

Anemia is compounded by blood lost during hemodialysis. Gastric ulcers may result from the physiologic stress of chronic illness, medication, and preexisting medical conditions (eg, diabetes). Patients with uremia report a metallic taste and nausea when they require dialysis. Vomiting may occur during the hemodialysis treatment when rapid fluid shifts and hypotension occur. These contribute to the malnutrition seen in patients on dialysis. Worsening calcium metabolism and renal osteodystrophy can result in bone pain and fractures, interfering with mobility. As time on dialysis continues, calcification of major blood vessels has been reported and linked to hypertension and other vascular complications. Phosphorus deposits in the skin can occur and cause itching.

Up to 85% of people undergoing hemodialysis experience major sleep problems that further complicate their overall health status (Phillips & Ryr, 2005). Early-morning or late-afternoon dialysis may be a risk factor for developing sleep disturbances.

Other complications of dialysis treatment may include the following:

- Episodes of shortness of breath often occur as fluid accumulates between dialysis treatments.
- Hypotension may occur during the treatment as fluid is removed. Nausea and vomiting, diaphoresis, tachycardia, and dizziness are common signs of hypotension.
- Painful muscle cramping may occur, usually late in dialysis as fluid and electrolytes rapidly leave the extracellular space.
- Exsanguination may occur if blood lines separate or dialysis needles become dislodged.
- Dysrhythmias may result from electrolyte and pH changes or from removal of antiarrhythmic medications during dialysis.
- Air embolism is rare but can occur if air enters the vascular system.
- Chest pain may occur in patients with anemia or arteriosclerotic heart disease.
- Dialysis disequilibrium results from cerebral fluid shifts. Signs and symptoms include headache, nausea and vomiting, restlessness, decreased level of consciousness, and seizures. It is more likely to occur in acute renal failure or when blood urea nitrogen levels are very high (exceeding 150 mg/dL).

## Nursing Management

The nurse in the dialysis unit has an important role in monitoring, supporting, assessing, and educating the patient. During dialysis, the patient, the dialyzer, and the dialysate bath require constant monitoring because numerous complications are possible, including clotting of the circuit, air embolism, inadequate or excessive ultrafiltration hypotension, cramping, vomiting, blood leaks, contamination, and access complications. Nursing care of the patient and maintenance of the vascular access device are especially important and are discussed later in this chapter in the section titled Special Considerations: Nursing Management of the Hospitalized Patient on Dialysis.

### *Promoting Pharmacologic Therapy*

Many medications are removed from the blood during hemodialysis; therefore, dosage or timing of the medication administration may require adjustment. Medications that are water soluble are readily removed during hemodialysis treatment and those that are fat soluble or adhere to other substances (like albumin) are not dialyzed out very well. This is the reason some drug overdoses are treated with emergency hemodialysis and others are not.

Patients undergoing hemodialysis who require medications (eg, cardiac glycosides, antibiotic agents, antiarrhythmic medications, antihypertensive agents) are monitored closely to ensure that blood and tissue levels of these medications are maintained without toxic accumulation. Antihypertensive therapy, often part of the regimen of patients on dialysis, is one example when communication, teaching, and evaluation can make a difference in patient outcomes. The patient must know when and when not to take the medication. For example, if an antihypertensive agent is taken on a dialysis day, hypotension may occur during dialysis, causing dangerously low blood pressure. Many medications that are taken once daily can be held until after the dialysis treatment.

### *Promoting Nutritional and Fluid Therapy*

Diet is important for patients on hemodialysis because of the effects of uremia. Goals of nutritional therapy are to minimize uremic symptoms and fluid and electrolyte imbalances; to maintain good nutritional status through adequate protein, calorie, vitamin, and mineral intake; and to enable the patient to eat a palatable and enjoyable diet. Restricting dietary protein decreases the accumulation of nitrogenous wastes, reduces uremic symptoms, and may even postpone the initiation of dialysis for a few months. Restriction of fluid is also part of the dietary prescription because fluid accumulation may occur, leading to weight gain, heart failure, and pulmonary edema.

With the initiation of hemodialysis, the patient usually requires some restriction of dietary protein, sodium, potassium, and fluid intake. Protein intake is restricted to about 1.2 to 1.3 g/kg ideal body weight per day; therefore, protein must be of high biologic quality. Sodium is usually restricted to 2 to 3 g/day; fluids are restricted to an amount equal to the daily urine output plus 500 mL/day. The goal for patients on hemodialysis is to keep their interdialytic (between dialysis treatments) weight gain under 1.5 kg (Welch & Perkins, 2006). Potassium restriction depends on the amount of residual renal function and the frequency of dialysis. Dietary restriction is an unwelcome change in lifestyle for many patients with chronic renal failure. Patients can feel stigmatized in social situations because there may be few food choices available for their diet. If the restrictions are ignored, life-threatening complications, such as hyperkalemia and pulmonary edema, may result. Thus, the patient may feel punished for responding to basic human drives to eat and drink. The nurse who cares for a patient with symptoms or complications resulting from dietary indiscretion must avoid harsh, judgmental, or punitive tones when communicating with him or her. Regular education with reinforcement is needed to achieve this difficult change in life style (Welch & Perkins, 2006) (Chart 44-8).

### *Meeting Psychosocial Needs*

Patients requiring long-term hemodialysis are often concerned about the unpredictability of the illness and the disruption of their lives. They often have financial problems, difficulty holding a job, waning sexual desire and impotence, depression from being chronically ill, and fear of dying. Younger patients worry about marriage, having children, and the burden that they bring to their families. The regimented lifestyle that frequent dialysis treatments and restrictions in food and fluid intake impose is often demoralizing to the patient and family.

Dialysis alters the lifestyle of the patient and family. The amount of time required for dialysis and physician visits and being chronically ill can create conflict, frustration, guilt,

CHART 44-8

## NURSING RESEARCH PROFILE

## *Hemodialysis and Nonadherence*

Belguzar, K., Kayser, C. & Kilic, S. (2007). Nonadherence with diet and fluid restrictions and perceived social support in patients receiving hemodialysis. *Journal of Nursing Scholarship, 39*(3), 243–248.

**Purpose**

Nonadherence to diet and fluid restrictions has adverse consequences for patients receiving hemodialysis. The purpose of this study was to describe nonadherence with diet and fluid restrictions and the level of perceived social support in hemodialysis patients. Nonadherence often occurs when a person's behavior conflicts with medical advice regarding taking medications, following diets, or other lifestyle changes.

**Design**

This descriptive study surveyed 160 patients on hemodialysis in three centers in Turkey. Participants were asked about personal characteristics, and data were collected using the Dialysis Diet and Fluid Nonadherence Questionnaire (DDFQ) and Multidimensional Scale of Perceived Social Support (MSP). Data were collected during the patient's regularly scheduled dialysis session. The DDFQ is a four-item self-report questionnaire that assesses the frequency of nonadherence to diet and fluid restrictions for the previous 14 days. The MSP is a 12-item scale used to assess emotional support and the degree of satisfaction with perceived social support from family, friends, and significant others.

**Findings**

Adherence to fluid restriction is a difficult and stressful aspect of hemodialysis treatment, and most patients in this study showed some degree of nonadherence to fluid restrictions (68%) and diet (58%). Participants perceived total social support as low. Nonadherence was most common with younger patients, those who were married, and those with lower levels of perceived social support.

**Nursing Implications**

Nurses working in hemodialysis centers need to consider social support and how it affects adherence in patients receiving hemodialysis. The results of this study suggest that younger, married patients may require assistance to develop the levels of social support needed to adhere to fluid and diet restrictions between hemodialysis sessions.

and depression. It may be difficult for the patient, spouse, and family to express anger and negative feelings.

The nurse needs to give the patient and family the opportunity to express feelings of anger and concern about the limitations that the disease and treatment impose, possible financial problems, and job insecurity. If anger is not expressed, it may be directed inward and lead to depression, despair, and attempts at suicide (suicide is more prevalent in patients on dialysis); however, if anger is projected outward to other people, it may destroy already threatened family relationships.

Although these feelings are normal in this situation, they are often profound and overwhelming. Counseling and psychotherapy may be necessary. Depression may require treatment with antidepressant agents. Referring the patient and family to a mental health provider with expertise in the care of patients receiving dialysis may also be helpful. Clinical nurse specialists, psychologists, and social workers may be helpful in assisting the patient and family to cope with the changes brought about by renal failure and its treatment.

The "sense of loss" that the patient experiences cannot be underestimated because every aspect of a "normal life" is disrupted. Some patients use denial to deal with the overwhelming array of medical problems (eg, infections, hypertension, anemia, neuropathy). Staff who are tempted to label the patient as noncompliant must consider the impact of renal failure and its treatment on the patient and family and the coping strategies that they may use.

Palliative care principles that focus on symptom control are becoming increasingly important as greater attention is focused on quality-of-life issues (Cohen, Moss, Weisord, et al., 2006). Patients and their families should be encouraged to discuss end-of-life options and have developed advanced directives or living wills.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Preparing a patient for hemodialysis is challenging. Often the patient does not fully comprehend the impact of dialysis, and learning needs may go unrecognized. Good communication between dialysis staff and home care nurses is essential.

Assessment helps identify the learning needs of the patient and family members. In many cases, the patient is discharged home before learning needs and readiness to learn can be thoroughly evaluated; therefore, hospital-based nurses, dialysis staff, and home care nurses must work together to provide appropriate teaching that meets the patient's and family's changing needs and readiness to learn.

The diagnosis of chronic renal failure and the need for dialysis often overwhelm the patient and family. In addition, many patients with ESRD have depressed mentation, a shortened attention span, a decreased level of concentration, and altered perception. Therefore, teaching must occur in brief, 10- to 15-minute sessions, with time added for clarification, repetition, reinforcement, and questions from the patient and family. The nurse needs to convey a nonjudgmental attitude to enable the patient and family to discuss options and their feelings about those options. Team conferences are helpful for sharing information and providing every team member the opportunity to discuss the needs of the patient and family.

#### Home Hemodialysis

Most patients who undergo hemodialysis do so in an outpatient setting, but home hemodialysis is an option for some. Home hemodialysis requires a highly motivated patient who is willing to take responsibility for the procedure and is able to adjust each treatment to meet the body's changing

needs. It also requires the commitment and cooperation of a caregiver to assist the patient. However, many patients are not comfortable imposing on others this way and do not wish to subject family members to the feeling that their home is being turned into a clinic. The health care team never forces a patient to use home hemodialysis because this treatment requires significant changes in the home and family. Home hemodialysis must be the patient's and family's decision (American Nephrology Nurses Association, 2007a).

The patient undergoing home hemodialysis and the caregiver assisting that patient must be trained to prepare, operate, and disassemble the dialysis machine; maintain and clean the equipment; administer medications (eg, heparin) into the machine lines; and handle emergency problems (hemodialysis dialyzer rupture, electrical or mechanical problems, hypotension, shock, and seizures). Because home hemodialysis places primary responsibility for the treatment on the patient and the family member, they must understand and be capable of performing all aspects of the hemodialysis procedure (Chart 44-9).

Before home hemodialysis is initiated, the home environment, household and community resources, and ability and willingness of the patient and family to carry out this treatment are assessed. The home is surveyed to see if electrical outlets, plumbing facilities, and storage space are adequate. Modifications may be needed to enable the patient and assistant to perform dialysis safely and to deal with emergencies.

Once home hemodialysis is initiated, the home care nurse must visit periodically to evaluate compliance with the recommended techniques, to assess the patient for complications, to reinforce previous teaching, and to provide reassurance.

### Continuing Care

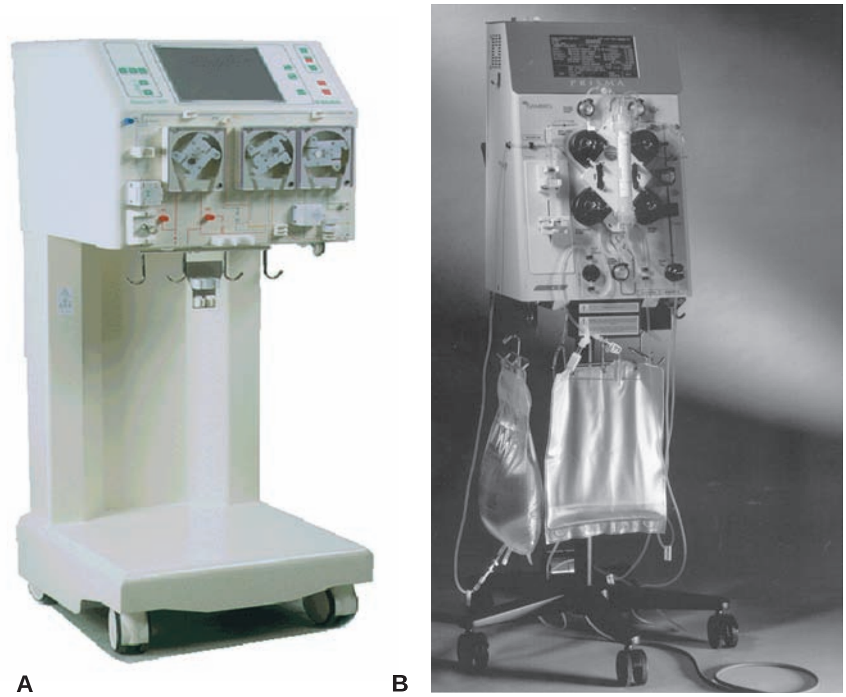
The health care team's goal in treating patients with chronic renal failure is to maximize their vocational potential, functional status, and quality of life. To facilitate renal rehabilitation, appropriate follow-up and monitoring by members of the health care team (physicians, dialysis nurses, social worker, psychologist, home care nurses, and others as appropriate) are essential to identify and resolve problems early on. Many patients with chronic renal failure can resume relatively normal lives, doing the things that are important to them: traveling, exercising, working, or actively participating in family activities. If appropriate interventions are available early in the course of dialysis, the potential for better health improves, and the patient can remain active in family and community life. Outcome goals for renal rehabilitation include employment for those able to work, improved physical functioning of all patients, improved understanding about adaptation and options for living well, increased control over the effects of kidney disease and dialysis, and resumption of activities enjoyed before dialysis.

## CONTINUOUS RENAL REPLACEMENT THERAPIES

Continuous renal replacement therapies (CRRTs) may be indicated for patients with acute or chronic renal failure who are too clinically unstable for traditional hemodialysis,

CHART 44-9 HOME CARE CHECKLIST *Hemodialysis*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Discuss renal failure and its effects on the body. | ✔ | ✔ |
| • Describe the cause of renal failure and why hemodialysis is necessary. | ✔ | ✔ |
| • Describe the basic principles of hemodialysis. | ✔ | ✔ |
| • Discuss common problems that may occur during hemodialysis and their prevention and management. | ✔ | ✔ |
| • Demonstrate knowledge about prescribed medications and the reason for their use, potential side effects, guidelines on when to notify physician, and the schedule of medications on dialysis and nondialysis days. | ✔ | ✔ |
| • Acknowledge dietary and fluid restrictions, rationale, and consequences of noncompliance. | ✔ | ✔ |
| • Describe commonly measured laboratory values, results, and implications. | ✔ | ✔ |
| • List guidelines for prevention and detection of fluid overload, meaning of "dry" weight, and how to weigh self. | ✔ | ✔ |
| • Demonstrate vascular access care, how to check patency, signs and symptoms of infection, and prevention of complications. | ✔ | ✔ |
| • Discuss strategies for detection, management, and relief of pruritus, neuropathy, and other complications of renal failure. | ✔ | ✔ |
| • Develop strategies to manage or reduce anxiety and maintain independence. | ✔ | ✔ |
| • Coordinate financial arrangements for dialysis and strategies to identify and obtain resources. | ✔ | ✔ |



A B

**Figure 44-6** Devices for administering continuous renal replacement therapy (CRRT) offer an integrated fluid warmer for the heating of infusion and dialysate fluids, a weighing system to reduce the possibility of error in assessing fluid balance, and a battery backup that allows treatments to continue when the patient is moved. **A,** Diapact CRRT System, B-Braun Medical, Inc., Bethlehem, PA. **B,** PRISMA, Gambro Corporation, Lakewood, CO.

for patients with fluid overload secondary to oliguric (low urine output) renal failure, and for patients whose kidneys cannot handle their acutely high metabolic or nutritional needs. CRRT does not produce rapid fluid shifts, does not require dialysis machines or dialysis personnel to carry out the procedures, and can be initiated quickly. Several types of CRRT are available and widely used in critical care units (Fig. 44-6). The methods are similar as they require access to the circulation and blood to pass through an artificial filter. A hemofilter (an extremely porous blood filter containing a semipermeable membrane) is used in all types.

### Continuous Venovenous Hemofiltration

Continuous venovenous hemofiltration (CVVH) is used to manage acute renal failure. Blood from a double-lumen venous catheter is pumped (using a small blood pump) through a hemofilter and then returned to the patient through the same catheter. CVVH provides continuous slow fluid removal (ultrafiltration); therefore, hemodynamic effects are mild and better tolerated by patients with unstable conditions. CVVH does not require arterial access, and critical care nurses can set up, initiate, maintain, and terminate the system.

### Continuous Venovenous Hemodialysis

Continuous venovenous hemodialysis (CVVHD) is similar to CVVH. Blood is pumped from a double-lumen venous catheter through a hemofilter and returned to the patient through the same catheter. In addition to the benefits of ultrafiltration, CVVHD uses a concentration gradient to facilitate the removal of uremic toxins and fluid. No arterial access is required, hemodynamic effects are usually mild, and critical care nurses can set up, initiate, maintain, and terminate the system (Martin & Jurschak, 2007).

Examples of less frequently used CRRT include slow continuous ultrafiltration (SCUF), continuous arteriovenous hemofiltration (CAVH), and continuous arteriovenous hemodialysis (CAVHD) (Martin & Jurschak, 2007).

## PERITONEAL DIALYSIS

The goals of PD are to remove toxic substances and metabolic wastes and to reestablish normal fluid and electrolyte balance. PD may be the treatment of choice for patients with renal failure who are unable or unwilling to undergo hemodialysis or renal transplantation. Patients who are susceptible to the rapid fluid, electrolyte, and metabolic changes that occur during hemodialysis experience fewer of these problems with the slower rate of PD. Therefore, patients with diabetes or cardiovascular disease, many older patients, and those who may be at risk for adverse effects of systemic heparin are likely candidates for PD. Additionally, severe hypertension, heart failure, and pulmonary edema not responsive to usual treatment regimens have been successfully treated with PD. Less than 8% of patients with ESRD receive PD as their treatment modality (USRDS, 2007).

In PD, the peritoneal membrane that covers the abdominal organs and lines the abdominal wall serves as the semipermeable membrane. Sterile dialysate fluid is introduced into the peritoneal cavity through an abdominal catheter at intervals (Fig. 44-7). Once the sterile solution is in the peritoneal cavity, uremic toxins such as urea and creatinine begin to be cleared from the blood. Diffusion and osmosis occur as waste products move from an area of higher concentration (the blood stream) to an area of lesser

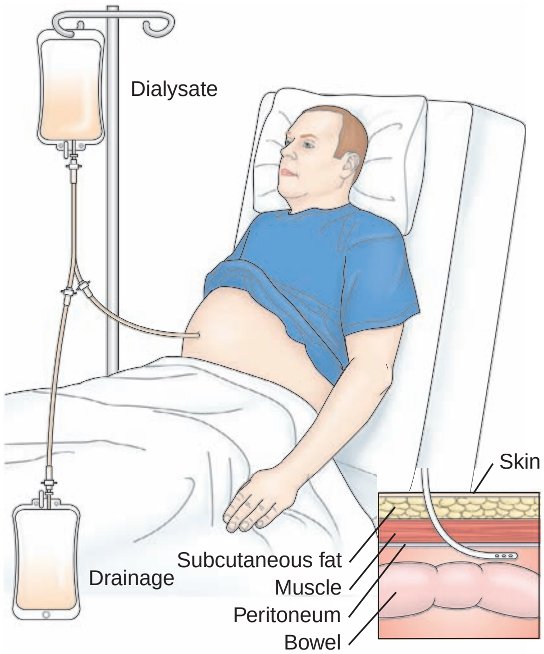



**Figure 44-7** In peritoneal dialysis and in acute intermittent peritoneal dialysis, dialysate is infused into the peritoneal cavity by gravity, after which the clamp on the infusion line is closed. After a dwell time (when the dialysate is in the peritoneal cavity), the drainage tube is unclamped and the fluid drains from the peritoneal cavity, again by gravity. A new container of dialysate is infused as soon as drainage is complete. The duration of the dwell time depends on the type of peritoneal dialysis.

concentration (the dialysate fluid) through a semipermeable membrane (the peritoneum). This movement of solute from the blood into the dialysate fluid is called clearance. Since substances cross the peritoneal membrane at different rates, adjustments in dwell time and amount of fluid used are made to facilitate the process. Ultrafiltration (water removal) occurs in PD through an osmotic gradient created by using a dialysate fluid with a higher glucose concentration. PD usually takes 36 to 48 hours to achieve what hemodialysis accomplishes in 6 to 8 hours.

## Procedure

As with other forms of treatment, the decision to begin PD is made by the patient and family in consultation with the physician. The patient may be acutely ill, thus requiring short-term treatment to correct severe disturbances in fluid and electrolyte status, or may have ESRD and need to receive ongoing treatments.

### *Preparing the Patient*

The nurse's preparation of the patient and family for PD depends on the patient's physical and psychological status, level of alertness, previous experience with dialysis, and understanding of and familiarity with the procedure.

The nurse explains the procedure to the patient and assists in obtaining signed consent. Baseline vital signs, weight, and serum electrolyte levels are recorded. Evaluation of the abdomen for placement of the catheter is done to facilitate self-care. Typically the catheter is placed on the nondominant side to allow the patient easier access to the catheter connection site when exchanges are done. The patient is encouraged to empty the bladder and bowel to reduce the risk of puncture of internal organs during the insertion procedure. Broad-spectrum antibiotic agents may be administered to prevent infection. The peritoneal catheter can be inserted in interventional radiology, in the operating room, or at the bedside. Depending on the situation, this will need to be explained to the patient and family.

### *Preparing the Equipment*

In addition to assembling the equipment for PD, the nurse consults with the physician to determine the concentration of dialysate to be used and the medications to be added to it. Heparin may be added to prevent fibrin formation and resultant occlusion of the peritoneal catheter. Potassium chloride may be prescribed to prevent hypokalemia. Antibiotics may be added to treat **peritonitis** (inflammation of the peritoneal membrane) caused by infection. Regular insulin may be added for patients with diabetes. Aseptic technique is imperative whenever medications are added.

Before medications are added, the dialysate is warmed to body temperature to prevent patient discomfort and abdominal pain and to dilate the vessels of the peritoneum to increase urea clearance. Solutions that are too cold cause pain, cramping, and vasoconstriction and reduce clearance. Dry heating (heating cabinet, incubator, or heating pad) is recommended. Methods not recommended include soaking the bags of solution in warm water (can introduce bacteria to the exterior of the bags of solution and increase the chance of peritonitis) and use of a microwave to heat the fluid (increases the danger of burning the peritoneum).

Immediately before initiating dialysis, using aseptic technique, the nurse assembles the administration set and tubing. The tubing is filled with the prepared dialysate to reduce the amount of air entering the catheter and peritoneal cavity, which could increase abdominal discomfort and interfere with instillation and drainage of the fluid.

### *Inserting the Catheter*

Ideally, the peritoneal catheter is inserted in the operating room or radiology suite to maintain surgical asepsis and minimize the risk of contamination. However, in some circumstances, the physician may insert the rigid stylet catheter at the bedside using strict asepsis. Whenever a rigid catheter is used, careful securing and close observation for bowel perforation is essential to minimize complications.

Catheters for long-term use (eg, Tenckhoff, Swan, or Cruz) are usually soft and flexible and made of silicone with a radiopaque strip to permit visualization on x-ray. These catheters have three sections: (1) an intraperitoneal section, with numerous openings and an open tip to let dialysate flow freely; (2) a subcutaneous section that passes from the peritoneal membrane and tunnels through muscle and subcutaneous fat to the skin; and (3) an external section for connection to the dialysate system. Most of these catheters have two cuffs, which are made of Dacron polyester. The cuffs stabilize the catheter, limit movement, prevent leaks, and provide a barrier against microorganisms. One cuff is placed just distal to the peritoneum, and the other cuff is placed subcutaneously. The subcutaneous tunnel (5 to 10 cm long) further protects against bacterial infection (Fig. 44-8).

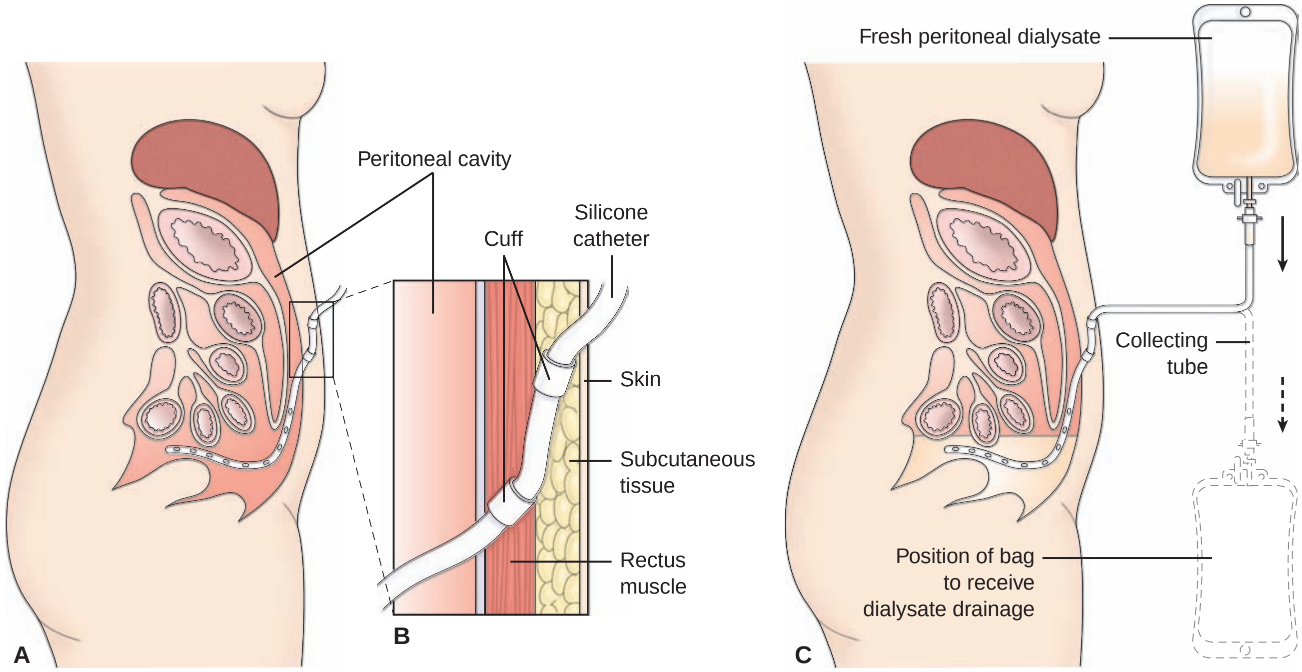



**Figure 44-8** Continuous ambulatory peritoneal dialysis. **A,** The peritoneal catheter is implanted through the abdominal wall. **B,** Dacron cuffs and a subcutaneous tunnel provide protection against bacterial infection. **C,** Dialysate flows by gravity through the peritoneal catheter into the peritoneal cavity. After a prescribed period of time, the fluid is drained by gravity and discarded. New solution is then infused into the peritoneal cavity until the next drainage period. Dialysis thus continues on a 24-hour-a-day basis, during which the patient is free to move around and engage in his or her usual activities.

### *Performing the Exchange*

PD involves a series of exchanges or cycles. An **exchange** is defined as the infusion (fill), dwell, and drainage of the dialysate. This cycle is repeated throughout the course of the dialysis. The dialysate is infused by gravity into the peritoneal cavity. A period of about 5 to 10 minutes is usually required to infuse 2 to 3 L of fluid. The prescribed dwell, or equilibration, time allows diffusion and osmosis to occur. At the end of the dwell time, the drainage portion of the exchange begins. The tube is unclamped and the solution drains from the peritoneal cavity by gravity through a closed system. Drainage is usually completed in 10 to 20 minutes. The drainage fluid is normally colorless or straw-colored and should not be cloudy. Bloody drainage may be seen in the first few exchanges after insertion of a new catheter but should not occur after that time. The number of cycles or exchanges and their frequency are prescribed based on monthly laboratory values and presence of uremic symptoms.

The removal of excess water during PD occurs because dialysate has a high dextrose concentration, making it hypertonic. An osmotic gradient is created between the blood and the dialysate solution. Dextrose solutions of 1.5%, 2.5%, and 4.25% are available in several volumes, from 1000 mL to 3000 mL. The higher the dextrose concentration, the greater the osmotic gradient and the more water will be removed. Selection of the appropriate solution is based on the patient's fluid status.

## Complications

Most complications of PD are minor, but several, if unattended, can have serious consequences.

### *Acute Complications*

#### Peritonitis

Peritonitis is the most common and serious complication of PD. The first sign of peritonitis is cloudy dialysate drainage fluid. Diffuse abdominal pain and rebound tenderness occur much later. Hypotension and other signs of shock may also occur with advancing infection. The patient with peritonitis may be treated as an inpatient or outpatient (most common), depending on the severity of the infection and the patient's clinical status. Drainage fluid is examined for cell count; Gram stain and culture are used to identify the organism and guide treatment. Antibiotic agents (aminoglycosides or cephalosporins) are usually added to subsequent exchanges until Gram stain or culture results are available for appropriate antibiotic determination. Intraperitoneal administration of antibiotics is as effective as IV administration and therefore most often used. Antibiotic therapy continues for 10 to 14 days. Careful selection and calculation of the antibiotic dosage are needed to prevent nephrotoxicity and further compromise of residual renal function.

Regardless of which organism causes peritonitis, the patient with peritonitis loses large amounts of protein through the peritoneum. Acute malnutrition and delayed healing may result. Therefore, attention must be given to detecting and promptly treating peritonitis.

#### Leakage

Leakage of dialysate through the catheter site may occur immediately after the catheter is inserted. Usually, the leak stops spontaneously if dialysis is withheld for several days,

giving the tissue surrounding the cuffs located on the abdominal catheter a chance to infiltrate the Dacron and seal the insertion tunnel. It also allows the exit site time to heal. During this time, it is important to reduce factors that might delay healing, such as undue abdominal muscle activity and straining during bowel movement. In many cases, leakage can be avoided by using small volumes (500 mL) of dialysate, gradually increasing the volume up to 2000 to 3000 mL.

#### Bleeding

A bloody **effluent** (drainage) may be observed occasionally, especially in young, menstruating women. (The hypertonic fluid pulls blood from the uterus, through the opening in the fallopian tubes, and into the peritoneal cavity.) Bleeding is also common during the first few exchanges after a new catheter insertion because some blood enters the abdominal cavity following insertion. In many cases, no cause can be found for the bleeding, although catheter displacement from the pelvis has occasionally been associated with bleeding. Some patients have had bloody effluent after an enema or from minor trauma. Invariably, bleeding stops in 1 to 2 days and requires no specific intervention. More frequent exchanges and the addition of heparin to the dialysate during this time may be necessary to prevent blood clots from obstructing the catheter.

### Long-Term Complications

Hypertriglyceridemia is common in patients undergoing long-term PD, suggesting that the therapy may accelerate atherogenesis. Despite this, the use of cardioprotective medications is relatively uncommon, and many patients have suboptimal blood pressure control. Given the high burden of disease in these patients, beta-blockers and ACE inhibitors should be used to control hypertension or protect the heart, and the use of aspirin and statins should be considered.

Other complications that may occur with long-term PD include abdominal hernias (incisional, inguinal, diaphragmatic, and umbilical), probably resulting from continuously increased intra-abdominal pressure. The persistently elevated intra-abdominal pressure also aggravates symptoms of hiatal hernia and hemorrhoids. Low back pain and anorexia from fluid in the abdomen and a constant sweet taste related to glucose absorption may also occur.

Mechanical problems occasionally occur and may interfere with instillation or drainage of the dialysate. Formation of clots in the peritoneal catheter and constipation are factors that may contribute to these problems.

## Approaches

PD can be performed using several different approaches: acute intermittent peritoneal dialysis, **continuous ambulatory peritoneal dialysis (CAPD),** and **continuous cyclic peritoneal dialysis (CCPD).**

### Acute Intermittent Peritoneal Dialysis

Indications for acute intermittent PD, a variation of PD, include uremic signs and symptoms (nausea, vomiting, fatigue, altered mental status), fluid overload, acidosis, and hyperkalemia. Although PD is not as efficient as hemodialysis in removing solute and fluid, it permits a more gradual change in the patient's fluid volume status and in waste product removal. Therefore, it may be the treatment of choice for the hemodynamically unstable patient. It can be carried out manually (the nurse warms, spikes, and hangs each container of dialysate) or by a cycler machine. Exchange times range from 30 minutes to 2 hours. A common routine is hourly exchanges consisting of a 10-minute infusion, a 30-minute dwell time, and a 20-minute drain time.

Maintaining the PD cycle is a nursing responsibility. Strict aseptic technique is maintained when changing solution containers and emptying drainage containers. Vital signs, weight, I&O, laboratory values, and patient status are frequently monitored. The nurse uses a flow sheet to document each exchange and records vital signs, dialysate concentration, medications added, exchange volume, dwell time, dialysate fluid balance for each exchange (fluid lost or gained), and cumulative fluid balance. The nurse also carefully assesses skin turgor and mucous membranes to evaluate fluid status and monitor the patient for edema.

If the peritoneal fluid does not drain properly, the nurse can facilitate drainage by turning the patient from side to side or raising the head of the bed. The catheter should never be pushed further into the peritoneal cavity. Other measures to promote drainage include checking the patency of the catheter by inspecting for kinks, closed clamps, or an air lock. The nurse monitors for complications, including peritonitis, bleeding, respiratory difficulty, and leakage of peritoneal fluid. Abdominal girth may be measured periodically to determine if the patient is retaining large amounts of dialysis solution. Additionally, the nurse must ensure that the PD catheter remains secure and that the dressing remains dry. Physical comfort measures, frequent turning, and skin care are provided. The patient and family are educated about the procedure and are kept informed about progress (fluid loss, weight loss, laboratory values). Emotional support and encouragement are given to the patient and family during this stressful and uncertain time.

### Continuous Ambulatory Peritoneal Dialysis

CAPD is the second most common form of dialysis for patients with ESRD to be started on (USRDS, 2007). CAPD is performed at home by the patient or a trained caregiver who is usually a family member. The procedure allows the patient reasonable freedom and control of daily activities but requires a serious commitment to be successful. Chart 44-10 discusses suitability for CAPD.

CAPD works on the same principles as other forms of PD: diffusion and osmosis. Less extreme fluctuations in the patient's laboratory values occur with CAPD than with intermittent PD or hemodialysis because the dialysis is constantly in progress. The serum electrolyte levels usually remain in the normal range.

#### Procedure

The patient performs exchanges four or five times a day, 24 hours a day, 7 days a week, at intervals scheduled throughout the day. Different manufacturers supply different equipment. Most commonly used is a Y-shaped system, in which a bag containing dialysate solution comes connected to one branch of the "Y" and a sterile empty

## Chart 44-10 • *Considerations in CAPD*

Although CAPD is not suitable for all patients with end-stage renal disease (ESRD), it is a viable therapy for those who can perform self-care and exchanges and who can fit therapy into their own routines. Often, patients report having more energy and feeling healthier once they begin CAPD. Nurses can be instrumental in helping patients with ESRD find the dialysis therapy that best suits their lifestyle. Those considering CAPD need to understand the advantages and disadvantages along with the indications and contraindications for this form of therapy.

**Advantages**

- Freedom from a dialysis machine
- Control over daily activities
- Opportunities to avoid dietary restrictions, increase fluid intake, raise serum hematocrit values, improve blood pressure control, avoid venipuncture, and gain a sense of well-being

**Disadvantages**

- Continuous dialysis 24 hours a day, 7 days a week

**Indications**

- Patient's willingness, motivation, and ability to perform dialysis at home
- Strong family or community support system (essential for success), particularly if the patient is an older adult
- Special problems with long-term hemodialysis, such as dysfunctional or failing vascular access devices, excessive thirst, severe hypertension, postdialysis headaches, and severe anemia requiring frequent transfusion
- Interim therapy while awaiting kidney transplantation
- ESRD secondary to diabetes because hypertension, uremia, and hyperglycemia are easier to manage with CAPD than with hemodialysis

**Contraindications**

- Adhesions from previous surgery (adhesions reduce clearance of solutes) or systemic inflammatory disease
- Chronic backache and preexisting disk disease, which could be aggravated by the continuous pressure of dialysis fluid in the abdomen
- Risk of complications, for example, in patients receiving immunosuppressive medications, which impede healing of the catheter site, and in patients with a colostomy, ileostomy, nephrostomy, or ileal conduit because of the risk of peritonitis. The risk for complications is not an absolute contraindication for CAPD therapy.
- Diverticulitis because CAPD has been associated with rupture of the diverticulum
- Severe arthritis or poor hand strength necessitating assistance in performing the exchange. However, blind or partially blind patients and those with other physical limitations can learn to perform CAPD.

bag is connected to the second branch. This leaves the third part of the "Y" open and available for connection to the transfer set on the PD catheter. To perform an exchange, the patient (or person doing the exchange) washes his or her hands, dons a mask, and then removes the cap from the transfer set while maintaining sterility. The open end of the "Y" set is connected to the end of the transfer set and the dialysate infused where it will dwell. After the dialysate is infused, the patient clamps off the transfer set and the tubing set, disconnects the tubing set, and applies a new cap to the transfer set, making it a closed system. The patient drains the fluid (effluent) from the peritoneal cavity through the catheter (over about 20 to 30 minutes) into an empty bag. Once the effluent has been fully drained, fresh fluid is instilled into the peritoneal cavity.

The longer the dwell time, the better the clearance of uremic toxins is. If dwell time is excessive, the patient will absorb some of the effluent back into the body simply because the osmotic gradient is lost. Once equilibrium is reached, the movement of fluid and toxins stops.

#### Complications

To reduce the risk of peritonitis, the patient (and all caregivers) must use meticulous care to avoid contaminating the catheter, fluid, or tubing and to avoid accidentally disconnecting the catheter from the tubing. Whenever a connection/disconnection is made, hands must be washed and a mask worn by anyone within 6 feet of the area to avoid contamination with airborne bacteria. Excess manipulation should be avoided and meticulous care of the catheter entry site is provided using a standardized protocol.

### *Continuous Cyclic Peritoneal Dialysis*

CCPD uses a machine called a cycler to provide the exchanges. It is programmed as to how much fluid to use and how long and how many exchanges need to be done. Since it is programmed, it also keeps track of the total amounts removed and will sound an alarm if limits are not met. It requires that a person set up and break down the system for use, which typically takes about 15 minutes.

CCPD combines overnight intermittent PD with a prolonged dwell time during the day. The peritoneal catheter is connected to a cycler machine every evening, usually just before the patient goes to sleep for the night. Because the machine is very quiet, the patient can sleep, and the extra-long tubing allows the patient to move and turn normally during sleep.

In the morning, the patient disconnects from the cycler. Sometimes dialysate is left in the abdominal cavity for a longer day dwell cycle. This day exchange is drained during the day either by using a "Y" set or reattaching to the cycler. This process is done every day to achieve the effects of dialysis required.

CCPD has a lower infection rate than other forms of PD because there are fewer opportunities for contamination with bag changes and tubing disconnections. It also allows the patient to be free from exchanges throughout the day, making it possible to engage in work and activities of daily living more freely.

## Nursing Management

### *Meeting Psychosocial Needs*

In addition to the complications of PD previously described, patients who elect to do PD may experience altered body image because of the presence of the abdominal catheter, bag, tubing, and cycler. Waist size increases from 1 to 2 inches (or more) with fluid in the abdomen. This affects clothing selection and may make the patient feel "fat." Body image may be so altered that patients do not want to look at or care for the catheter for days or weeks. The nurse may arrange for the patient to talk with other patients who have adapted well to PD. Although some patients have no psychological problems with the catheter—they think of it as their lifeline and as a life-sustaining device—other patients feel they are doing exchanges all day long and have no free time, particularly in the beginning. They may experience depression because they feel overwhelmed with the responsibility of self-care.

Patients undergoing PD may also experience altered sexuality patterns and sexual dysfunction. The patient and partner may be reluctant to engage in sexual activities, partly because of the catheter being psychologically "in the way" of sexual performance. The peritoneal catheter, drainage bag, and about 2 L of dialysate may interfere with the patient's sexual function and body image as well. In patients on CCPD, the presence of the dialysis cycler in the bedroom and the continual connection during the sleeping hours can also cause interference with intimacy. Although these problems may resolve with time, some problems may warrant special counseling. Questions by the nurse about concerns related to sexuality and sexual function often provide the patient with a welcome opportunity to discuss these issues and a first step toward their resolution.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Patients are taught as inpatients or outpatients to perform PD once their condition is medically stable. Training usually takes 5 days to 2 weeks. Patients are taught according to their own learning ability and knowledge level and only as much at one time as they can handle without feeling uncomfortable or becoming overwhelmed. Education topics for the patient and family who will be performing PD at home are described in Chart 44-11. The use of an adult learning theory–based curriculum may decrease peritonitis and exit site infection rates.

CHART 44-11 HOME CARE CHECKLIST
*Peritoneal Dialysis (CAPD or CCPD)*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Discuss basic information about normal kidney function. | ✔ | ✔ |
| • Discuss basic information about the disease process. | ✔ | ✔ |
| • Discuss the basic principles of peritoneal dialysis. | ✔ | ✔ |
| • Demonstrate catheter and exit site care. | ✔ | ✔ |
| • Demonstrate measurement of vital signs and weight measurement. | ✔ | ✔ |
| • Discuss monitoring and management of fluid balance. | ✔ | ✔ |
| • Discuss basic principles of aseptic technique. | ✔ | ✔ |
| • Demonstrate the CAPD exchange procedure using aseptic technique (CCPD patients should also demonstrate exchange procedure in case of failure or unavailability of cycling machine). | ✔ | ✔ |
| • Demonstrate cycler set-up procedure and maintenance if on CCPD. | ✔ | ✔ |
| • Discuss complications of peritoneal dialysis; prevention, recognition, and management of complications. | ✔ | ✔ |
| • Demonstrate procedure for adding medications to the dialysis solution. | ✔ | ✔ |
| • Demonstrate procedure for obtaining sterile dialysis fluid samples. | ✔ | ✔ |
| • Discuss routine laboratory tests needed and implications of results. | ✔ | ✔ |
| • Discuss dietary restrictions. | | |
| • Discuss medications: name of medications, their actions, potential side effects, and when to contact physician. | ✔ | ✔ |
| • Discuss ordering, storage, and inventory of dialysis supplies. | ✔ | ✔ |
| • Describe plan for follow-up care. | ✔ | ✔ |
| • Demonstrate maintenance of home dialysis records. | ✔ | ✔ |
| • Describe actions in case of emergency. | ✔ | ✔ |

Because of protein loss with continuous PD, the patient is instructed to eat a high-protein, well-balanced diet. The patient is also encouraged to increase his or her daily fiber intake to help prevent constipation, which can impede the flow of dialysate into or out of the peritoneal cavity. Many patients gain 3 to 5 lb within a month of initiating PD, so they may be asked to limit their carbohydrate intake to avoid excessive weight gain. Potassium, sodium, and fluid restrictions are not usually needed. Patients commonly lose about 2 to 3 L of fluid over and above the volume of dialysate infused into the abdomen during a 24-hour period, permitting a normal fluid intake even in an anephric patient (a patient without kidneys).

**Continuing Care**

Follow-up care through phone calls, visits to the outpatient department, and continuing home care assists patients in the transition to home and promotes their active participation in their own health care. Patients often depend on checking with the nurse to see if they are making the correct choices about dialysate or control of blood pressure, or simply to discuss a problem.

Patients may be seen by the PD team as outpatients once a month or more often if needed. The exchange procedure is evaluated at that time to see that strict aseptic technique is being used. Blood chemistry values are followed closely to make certain the therapy is adequate for the patient.

If a referral is made for home care, the home care nurse assesses the home environment and suggests modifications to accommodate the equipment and facilities needed to carry out PD. In addition, the nurse assesses the patient's and family's understanding of PD and evaluates their technique in performing PD. Assessments include checking for changes related to renal disease, complications such as peritonitis, and treatment-related problems such as heart failure, inadequate drainage, and weight gain or loss. The nurse continues to reinforce and clarify teaching about PD and renal disease and assesses the patient's and family's progress in coping with the procedure. This is also an opportunity to remind patients about the need to participate in appropriate health promotion activities and health screening (eg, gynecologic examinations, colonoscopy).

Because of the projected high numbers of elderly patients who will develop ESRD, the nursing home or extended care facility is likely to become an increasingly important site for both rehabilitation and long-term management of patients with renal failure.

## SPECIAL CONSIDERATIONS: NURSING MANAGEMENT OF THE HOSPITALIZED PATIENT ON DIALYSIS

Whether undergoing hemodialysis or PD, the patient may be hospitalized for treatment of complications related to the dialysis treatment, the underlying renal disorder, or health problems not related to renal dysfunction or its treatment.

### Protecting Vascular Access

When the patient undergoing hemodialysis is hospitalized for any reason, care must be taken to protect the vascular access. The nurse assesses the vascular access for patency and takes precautions to ensure that the extremity with the vascular access is not used for measuring blood pressure or for obtaining blood specimens; tight dressings, restraints, or jewelry over the vascular access must be avoided as well.

The bruit, or "thrill," over the venous access site must be evaluated at least every 8 hours. Absence of a palpable thrill or audible bruit may indicate blockage or clotting in the vascular access. Clotting can occur if the patient has an infection anywhere in the body (serum viscosity increases) or if the blood pressure has dropped. When blood flow is reduced through the access for any reason (hypotension, application of blood pressure cuff or tourniquet), the access can clot. If a patient has a hemodialysis catheter or implanted hemodialysis access device, the nurse must observe for signs and symptoms of infection such as redness, swelling, drainage from the exit site, fever, and chills. The nurse must assess the integrity of the dressing and change it as needed. Patients with renal disease are more prone to infection; therefore, infection control measures must be used for all procedures.

### Taking Precautions During Intravenous Therapy

When the patient needs IV therapy, the rate of administration must be as slow as possible and should be strictly controlled by a volumetric infusion pump. Because patients on dialysis cannot excrete water, rapid or excessive administration of IV fluid can result in pulmonary edema. Accurate intake and output records are essential.

### Monitoring Symptoms of Uremia

As metabolic end products accumulate, symptoms of uremia worsen. Patients whose metabolic rate accelerates (those receiving corticosteroid medications or parenteral nutrition, those with infections or bleeding disorders, those undergoing surgery) accumulate waste products more quickly and may require daily dialysis. These same patients are more likely than other patients receiving dialysis to experience complications.

### Detecting Cardiac and Respiratory Complications

Cardiac and respiratory assessment must be conducted frequently. As fluid builds up, fluid overload, heart failure, and pulmonary edema develop. Crackles in the bases of the lungs may indicate pulmonary edema.

Pericarditis may result from the accumulation of uremic toxins. If not detected and treated promptly, this serious complication may progress to pericardial effusion and cardiac tamponade. Pericarditis is detected by the patient's report of substernal chest pain (if the patient can communicate), low-grade fever (often overlooked), and pericardial friction rub. A pulsus paradoxus (a decrease in blood pressure of more than 10 mm Hg during inspiration) is often present. When pericarditis progresses to effusion, the friction rub disappears, heart sounds become distant and muffled, ECG waves show very low voltage, and the pulsus paradoxus worsens.

The effusion may progress to life-threatening cardiac tamponade, noted by narrowing of the pulse pressure in

addition to muffled or inaudible heart sounds, crushing chest pain, dyspnea, and hypotension. Although pericarditis, pericardial effusion, and cardiac tamponade can be detected by chest x-ray, they should also be detected through astute nursing assessment. Because of their clinical significance, assessment of the patient for these complications is a priority.

### Controlling Electrolyte Levels and Diet

Electrolyte alterations are common, and potassium changes can be life-threatening. All IV solutions and medications to be administered are evaluated for their electrolyte content. Serum laboratory values are assessed daily. If blood transfusions are required, they may be administered during hemodialysis, if possible, so that excess potassium can be removed. Dietary intake must also be monitored. The patient's frustrations related to dietary restrictions typically increase if the hospital food is unappetizing. The nurse needs to recognize that this may lead to dietary indiscretion and hyperkalemia.

Hypoalbuminemia is an indicator of malnutrition in patients undergoing long-term or maintenance dialysis. Although some patients can be treated with adequate nutrition alone, some patients remain hypoalbuminemic for reasons that are poorly understood.

### Managing Discomfort and Pain

Complications such as pruritus and pain secondary to neuropathy must be managed. Antihistamine agents, such as diphenhydramine hydrochloride (Benadryl), are commonly used, and analgesic medications may be prescribed. However, because elimination of the metabolites of medications occurs through dialysis rather than through renal excretion, medication dosages may need to be adjusted. Keeping the skin clean and well moisturized using bath oils, superfatted soap, and creams or lotions helps promote comfort and reduce itching. Teaching the patient to keep the nails trimmed to avoid scratching and excoriation also promotes comfort.

### Monitoring Blood Pressure

Hypertension in renal failure is common. It is usually the result of fluid overload and, in part, oversecretion of renin. Many patients undergoing dialysis receive some form of antihypertensive therapy and require ongoing teaching about its purpose and adverse effects. The trial-and-error approach that may be necessary to identify the most effective antihypertensive agent and dosage may confuse the patient if no explanation is provided. Antihypertensive agents must be withheld before dialysis to avoid hypotension due to the combined effect of the dialysis and the medication.

Typically these patients require single or multiple antihypertensive agents to achieve normal blood pressure, thus adding to the total number of medications needed on an ongoing basis.

### Preventing Infection

Patients with ESRD commonly have low WBC counts (and decreased phagocytic ability), low RBC counts (anemia), and impaired platelet function. Together, these pose a high risk for infection and potential for bleeding after even minor trauma. Preventing and controlling infection are essential because the incidence of infection is high. Infection of the vascular access site and pneumonia are common.

### Caring for the Catheter Site

Patients receiving CAPD usually know how to care for the catheter site; however, the hospital stay is an opportunity to assess catheter care technique and correct misperceptions or deviations from recommended technique. Recommended daily or three-or-four-times-weekly routine catheter site care is typically performed during showering or bathing. The exit site should not be submerged in bath water. The most common cleaning method is soap and water; liquid soap is recommended. During care, the nurse and patient need to make sure that the catheter remains secure to avoid tension and trauma. The patient may wear a gauze or semitransparent dressing over the exit site.

### Administering Medications

All medications and the dosage prescribed for any patient on dialysis must be closely monitored to avoid those that are toxic to the kidneys and may threaten remaining renal function. Medications are also scrutinized for potassium and magnesium content, because medications containing potassium or magnesium must be avoided. Care must be taken to evaluate all problems and symptoms that the patient reports without automatically attributing them to renal failure or to dialysis therapy.

### Providing Psychological Support

Patients undergoing dialysis for a while may begin to reevaluate their status, the treatment modality, their satisfaction with life, and the impact of these factors on their families and support systems. Nurses must provide opportunities for these patients to express their feelings and reactions and to explore options. The decision to begin dialysis does not require that dialysis be continued indefinitely, and it is not uncommon for patients to consider discontinuing treatment. These feelings and reactions must be taken seriously, and the patient should have the opportunity to discuss them with the dialysis team as well as with a psychologist, psychiatrist, psychiatric nurse, trusted friend, or spiritual advisor. The patient's informed decision about discontinuing treatment, after thoughtful deliberation, should be respected.

# KIDNEY SURGERY

A patient may undergo surgery to remove obstructions that affect the kidney (tumors or calculi), to insert a tube for draining the kidney (nephrostomy, ureterostomy), or to remove the kidney involved in unilateral kidney disease, renal carcinoma, or kidney transplantation.

## *Management of Patients Undergoing Kidney Surgery*

### Preoperative Considerations

Surgery is performed only after a thorough evaluation of renal function. Patient preparation to ensure that optimal renal function is maintained is essential. Fluids are encouraged to promote increased excretion of waste products

before surgery unless contraindicated because of preexisting renal or cardiac dysfunction. If kidney infection is present preoperatively, broad-spectrum antimicrobial agents may be prescribed to prevent bacteremia. Antibiotic agents must be given with extreme care because many are toxic to the kidneys. Coagulation studies (prothrombin time, partial thromboplastin time, platelet count) may be indicated if the patient has a history of bruising and bleeding. The preoperative preparation is similar to that described in Chapter 18.

Because many patients facing kidney surgery are apprehensive, the nurse encourages the patient to recognize and verbalize concerns. Confidence is reinforced by establishing a relationship of trust and by providing expert care. Patients faced with the prospect of losing a kidney may think that they will be dependent on dialysis for the rest of their lives. It is important to teach the patient and family that normal function may be maintained by a single healthy kidney.

## Perioperative Concerns

Renal surgery requires various patient positions to expose the surgical site adequately. Three surgical approaches are common: flank, lumbar, and thoracoabdominal (Fig. 44-9). During surgery, plans are carried out for managing altered urinary drainage. These may include inserting a nephrostomy or other drainage tube.

## Postoperative Management

Because the kidney is a highly vascular organ, hemorrhage and shock are the chief complications of renal surgery. Fluid and blood component replacement is frequently necessary in the immediate postoperative period to treat intraoperative blood loss.

Abdominal distention and paralytic ileus are fairly common after renal and ureteral surgery and are thought to be due to a reflex paralysis of intestinal peristalsis and manipulation of the colon or duodenum during surgery. Abdominal distention is relieved by decompression through a nasogastric tube (see Chapter 38 for treatment of paralytic ileus). Oral fluids are permitted when the passage of flatus is noted.

If infection occurs, antibiotics are prescribed after a culture reveals the causative organism. The toxic effects that antibiotic agents have on the kidneys (nephrotoxicity) must be kept in mind when assessing the patient. Low-dose heparin therapy may be initiated postoperatively to prevent thromboembolism in patients who had any type of urologic surgery.

## Nursing Management

In addition to those interventions listed in this section, Chart 44-12 provides a plan of nursing care for the patient undergoing kidney surgery.

### *Providing Immediate Postoperative Care*

Immediate postoperative care of the patient who has undergone surgery of the kidney includes assessment of all body systems. Respiratory and circulatory status, pain level, fluid and electrolyte status, and patency and adequacy of urinary drainage systems are assessed.

#### Respiratory Status

As with any surgery, the use of anesthesia increases the risk for respiratory complications. Noting the location of the surgical incision assists the nurse in anticipating respiratory problems and pain. Respiratory status is assessed by monitoring the rate, depth, and pattern of respirations. The location of the incision frequently causes pain on inspiration and coughing; therefore, the patient tends to splint the chest wall and take shallow respirations. Auscultation is performed to assess normal and adventitious breath sounds.

#### Circulatory Status and Blood Loss

The patient's vital signs and arterial or central venous pressure are monitored. Skin color and temperature and urine output provide information about circulatory status. The surgical incision and drainage tubes are observed frequently to help detect unexpected blood loss and hemorrhage.

#### Pain

Postoperative pain is a major problem for the patient because of the location of the surgical incision and patient's

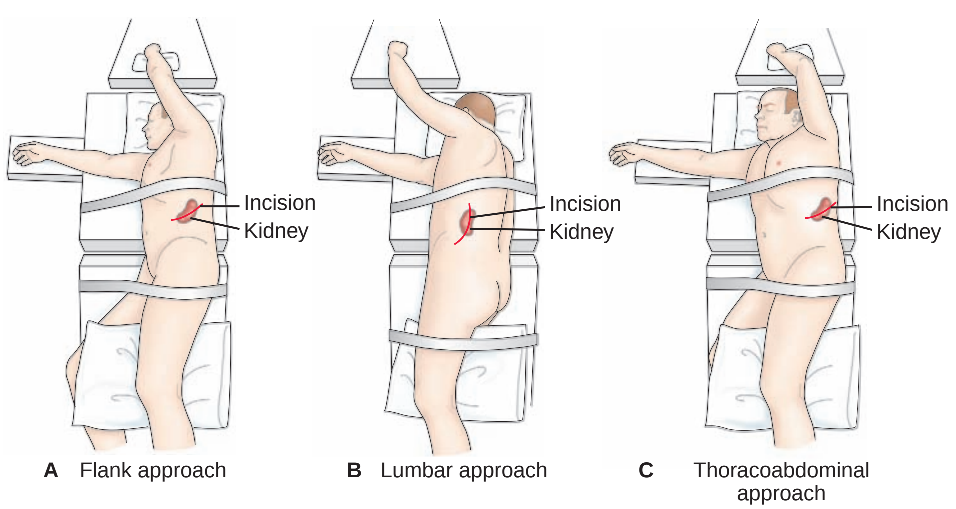



**Figure 44-9** Patient positioning and incisional approaches (**A,** flank; **B,** lumbar; **C,** thoracoabdominal) for kidney surgery are associated with significant postoperative discomfort.

CHART 44-12

## PLAN OF NURSING CARE
### *Care of Patient Undergoing Kidney Surgery*

**NURSING DIAGNOSIS:** Ineffective airway clearance related to pain of high abdominal or flank incision, abdominal discomfort, and immobility; risk for ineffective breathing pattern related to high abdominal incision
**GOAL:** Improved airway clearance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Administer analgesic agent as prescribed.<br>2. Splint incision with hands or pillow to assist patient in coughing.<br>3. Assist patient to change positions frequently.<br>4. Encourage use of incentive spirometer if indicated or prescribed.<br>5. Assist with and encourage early ambulation. | 1. Enables patient to take deep breaths and cough<br>2. Splints incision and promotes adequate cough and prevention of atelectasis<br>3. Promotes drainage and inflation of all lobes of the lungs<br>4. Encourages adequate deep breaths<br>5. Mobilizes pulmonary secretions | • Takes deep breaths and coughs adequately when encouraged and assisted<br>• Exhibits respiratory rate of 12–18 breaths/min<br>• Exhibits normal breath sounds without adventitious sounds<br>• Exhibits full thoracic excursion without shallow respirations<br>• Uses incentive spirometer with encouragement<br>• Splints incision while taking deep breaths and coughing<br>• Reports progressively less pain and discomfort with coughing and deep breaths<br>• Exhibits normal blood gas levels and chest x-ray<br>• Exhibits normal body temperature with no signs of atelectasis or pneumonia on assessment |

**NURSING DIAGNOSIS:** Acute pain and discomfort related to surgical incision, positioning, and stretching of muscles during kidney surgery
**GOAL:** Relief of pain and discomfort

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess level of pain.<br>2. Administer analgesic agents as prescribed.<br>3. Splint incision with hands or pillow during movement or deep breathing and coughing exercises.<br>4. Assist and encourage early ambulation. | 1. Provides baseline for later evaluation of pain relief strategies<br>2. Promotes pain relief<br>3. Minimizes sensation of pulling or tension on incision and provides sense of support to the patient<br>4. Promotes resumption of muscle activity exercise | • Reports relief of severe pain and discomfort<br>• Takes analgesia as prescribed<br>• Exercises aching muscles within recommendations<br>• Uses distraction, relaxation exercises, and imagery to relieve pain<br>• Exhibits no behavioral manifestations of pain and discomfort (eg, restlessness, perspiration, verbal expressions of pain)<br>• Participates in deep-breathing and coughing exercises<br>• Gradually increases physical activity and exercise |

**NURSING DIAGNOSIS:** Fear and anxiety related to diagnosis, outcome of surgery, and alteration in urinary function
**GOAL:** Reduction of fear and anxiety

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's anxiety and fear before surgery if possible.<br>2. Assess patient's knowledge about procedure and expected surgical outcome preoperatively.<br>3. Evaluate the meaning of alterations resulting from surgical procedure for the patient and family or partner.<br>4. Encourage patient to verbalize reactions, feelings, and fears. | 1. Provides a baseline for postoperative assessment<br>2. Provides a basis for further teaching<br>3. Enables understanding of patient's reactions and responses to expected and unexpected results of surgery<br>4. Affirms patient's understanding of and ultimate resolution of feelings and fears | • Verbalizes reactions and feelings to staff<br>• Shares reactions and feelings with family or partner<br>• Grieves appropriately for self and for changes in role and function<br>• Identifies information needed to promote own adaptation and coping<br>• Participates in activities and events in immediate environment |

*Continued*

CHART 44-12

## PLAN OF NURSING CARE
## *Care of Patient Undergoing Kidney Surgery* (Continued)

| Nursing Interventions | Rationale |
|---|---|
| 5. Encourage patient to share feelings with spouse or partner. | 5. Enables patient and partner to receive mutual support and reduces sense of isolation from each other |
| 6. Offer and arrange for visit from member of support group (eg, ostomy group, if indicated). | 6. Provides support from another person who has encountered the same or a similar surgical procedure and an example of how others have coped with the alteration |

**Expected Outcomes**

- Accepts visit from ostomy group if indicated
- Identifies support person or support group

**NURSING DIAGNOSIS:** Impaired urinary elimination related to urinary drainage; risk for infection related to altered urinary drainage
**GOAL:** Maintenance of urinary elimination; infection-free urinary tract

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess urinary drainage system immediately. | 1. Provides basis for further assessment and action |
| 2. Assess adequacy of urinary output and patency of drainage system. | 2. Provides baseline |
| 3. Use asepsis and hand hygiene when providing care and manipulating drainage system. | 3. Prevents or reduces risk of contamination of urinary drainage system |
| 4. Maintain closed urinary drainage system. | 4. Reduces risk of bacterial contamination and infection |
| 5. If irrigation of the drainage system is necessary, use sterile gloves and sterile irrigating solution and a closed drainage and irrigation system. | 5. Permits irrigation when necessary while maintaining closed drainage system, minimizing risk of infection |
| 6. If irrigation is necessary and prescribed, perform it gently with sterile saline and the prescribed amount of irrigating fluid. | 6. Maintains patency of the catheter or drainage system and prevents sudden increases in pressure in the urinary tract that may cause trauma, pressure on sutures or urinary tract structures, and pain |
| 7. Assist patient in turning and moving in bed and when ambulating to prevent displacement or inadvertent removal of urinary stent or ureteral catheters if in place. | 7. Prevents trauma from accidental displacement of urinary stent or ureteral catheter necessitating repeated instrumentation of the urinary tract (eg, cystoscopy) to replace them |
| 8. Observe urine color, volume, odor, and components. | 8. Provides information about adequacy of urine output, condition and patency of drainage system, and debris in urine |
| 9. Minimize trauma and manipulation of catheter, drainage system, and urethra. | 9. Reduces risk of contamination of drainage system and eliminates site of bacterial invasion |
| 10. Clean catheter gently with soap during bath, avoiding any to-and-fro movement of catheter. | 10. Removes debris and encrustations without causing trauma to or contamination of urethra |
| 11. Anchor drainage tube. | 11. Prevents movement or slipping of drainage tube, minimizing trauma to and contamination of urethra or catheter |
| 12. Maintain adequate fluid intake. | 12. Promotes adequate urine output and prevents urinary stasis |
| 13. Assist with and encourage early ambulation while ensuring placement of urinary drainage system. | 13. Minimizes cardiovascular and pulmonary complications while preventing loss, dislodging, or disruption of drainage system |
| 14. If patient is to be discharged with urinary drainage system (catheter) in place or a urinary diversion, instruct patient and family member in care. | 14. Knowledge and understanding of the drainage system or urinary diversion are essential to prevent infection and other complications. |

**Expected Outcomes**

- Exhibits adequate urinary output and patent drainage system
- Exhibits urinary output consistent with fluid intake
- Demonstrates normal laboratory values: BUN, serum creatinine levels, urine specific gravity, and osmolality
- Exhibits sterile urine on urine culture
- Exhibits clear, dilute urine without debris or encrustation in the drainage system
- States rationale for avoiding manipulation of catheter, drainage, or irrigation system
- Exhibits normal placement of urinary stent or ureteral catheters until removed by physician
- Maintains closed urinary drainage system
- Exhibits normal body temperature without signs or symptoms of urinary tract infection
- Cleans catheter with soap and water
- Consumes adequate fluid intake (6 to 8 glasses of water or more per day, unless contraindicated)
- Urinary drainage system remains in place until physician removes or discontinues it
- Maintains urinary drainage system without infection or obstruction
- Maintains urinary diversion as instructed
- Maintains self-care so that environment is odor-free
- States rationale for close follow-up and maintains recommended schedule of appointments with health care providers

*Continued on following page*

CHART 44-12

PLAN OF NURSING CARE

**Care of Patient Undergoing Kidney Surgery** *(Continued)*

**NURSING DIAGNOSIS:** Risk for imbalanced fluid volume related to surgical fluid loss, altered urinary output, parenteral fluid administration
**GOAL:** Normal fluid balance will be maintained

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Weigh patient daily. | 1. Daily weight is the most sensitive indicator of fluid loss or gain. | • Patient's weight will be within 2–3 lb of patient's baseline. |
| 2. Take accurate intake and output measurements. | 2. Detects fluid retention due to poor cardiac or renal output | • Intake that exceeds output will be detected early. |
| 3. Place all parenteral therapy on an infusion pump. | 3. Ensures that the patient does not receive excess or insufficient intravenous fluids | • The exact amount of solution is infused with no adverse effects resulting from overinfusion or underinfusion. |
| 4. Monitor amount and characteristics of urine. | 4. Assists in early detection of possible complications of surgery or tube insertion | • Urine is clear and absent of blood, pus, or any foreign substances. |
| 5. Monitor vital signs: temperature, pulse, respirations, and blood pressure. | 5. When fluid volume or cardiac output is altered, vital signs are affected. | • Temperature, pulse, respiration, and blood pressure are normal. |
| 6. Auscultate heart and lungs every shift. | 6. When fluid volume is increased because of poor cardiac or renal output, fluid accumulates in the lungs. Also, heart sounds change as heart failure develops; frequent auscultation ensures early detection. | • Normal heart and lung sounds are present. |

position on the operating table to permit access to the kidney. The location and severity of pain are assessed before and after analgesic medications are administered. Abdominal distention, which increases discomfort, is also noted.

### Urinary Drainage

Urine output and drainage from tubes inserted during surgery are monitored for amount, color, and type or characteristics. Decreased or absent drainage is promptly reported to the physician because it may indicate obstruction that could cause pain, infection, and disruption of the suture lines.

## *Monitoring and Managing Potential Complications*

Bleeding is a major complication of kidney surgery. If undetected and untreated it can result in hypovolemia and hemorrhagic shock. The nurse's role is to observe for these complications, to report their signs and symptoms, and to administer prescribed parenteral fluids and blood and blood components. Monitoring of vital signs, skin condition, the urinary drainage system, the surgical incision, and the level of consciousness is necessary to detect evidence of bleeding, decreased circulating blood, and fluid volume and cardiac output. Frequent monitoring of vital signs (initially monitored at least at hourly intervals) and urinary output is necessary for early detection of these complications.

If bleeding goes undetected or is not detected promptly, the patient may lose significant amounts of blood and may experience hypoxemia. In addition to hypovolemic shock due to hemorrhage, this type of blood loss may precipitate a myocardial infarction or transient ischemic attack. Bleeding may be suspected when the patient experiences fatigue and when urine output is less than 30 mL/h. As bleeding persists, late signs of hypovolemia occur, such as cool skin, flat neck veins, and change in level of consciousness or responsiveness. Transfusions of blood components are indicated, along with surgical repair of the bleeding vessel.

Pneumonia may be prevented through use of an incentive spirometer, adequate pain control, and early ambulation. Early signs of pneumonia include fever, increased heart and respiratory rates, and adventitious breath sounds.

Preventing infection is the rationale for using asepsis when changing dressings and handling and preparing catheters, other drainage tubes, central venous catheters, and IV catheters for administration of fluids. Insertion sites are monitored closely for signs and symptoms of inflammation: redness, drainage, heat, and pain. Special care must be taken to prevent urinary tract infection, which is associated with the use of indwelling urinary catheters. Catheters and other invasive tubes are removed as soon as they are no longer needed.

Antibiotics are commonly administered postoperatively to prevent infection. If antibiotic agents are prescribed, serum creatinine and BUN values must be monitored closely because many antibiotic agents are toxic to the kidney or can accumulate to toxic levels if renal function is decreased.

Preventing fluid imbalance is critical when caring for a patient undergoing kidney surgery, because both fluid loss and fluid excess are possible adverse effects of the surgery. Fluid loss may occur during surgery as a result of excessive urinary drainage when the obstruction is removed, or it may occur if diuretic agents are used. Such loss may also occur with GI losses, with diarrhea resulting from antibiotic use, or with nasogastric drainage. When postoperative IV therapy is inadequate to match the output or fluids lost, a fluid

deficit results. Fluid excess, or overload, may result from cardiac effects of anesthesia, administration of excessive amounts of fluids, or the patient's inability to excrete fluid because of changes in renal function. Decreased urine output may be an indication of fluid excess.

Astute assessment skills are needed to detect early signs of fluid excess (such as weight gain, pedal edema, urine output below 30 mL/h, and slightly elevated pulmonary wedge pressure, if available) before they become severe (appearance of adventitious breath sounds, shortness of breath).

Fluid excess may be treated with fluid restriction and administration of furosemide (Lasix) or other diuretic agents. If renal insufficiency is present, these medications may prove ineffective; therefore, dialysis may be necessary to prevent heart failure and pulmonary edema.

Deep venous thrombosis (DVT) may occur postoperatively because of surgical manipulation of the iliac vessels during surgery or prolonged immobility. Anti-embolism stockings are applied, and the patient is monitored closely for signs and symptoms of thrombosis and encouraged to exercise the legs. Heparin may be administered postoperatively to reduce the risk of thrombosis.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

If the patient has a drainage system in place, measures are taken to ensure that both the patient and family understand the importance of maintaining the system correctly at home and preventing infection. Verbal and written instructions and guidelines are provided to the patient and family at the time of hospital discharge. The patient may be asked to demonstrate management of the drainage system to ensure understanding. The importance of strategies to prevent postoperative complications (urinary tract infection and obstruction, DVT, atelectasis, and pneumonia) is stressed to the patient and family. Those signs, symptoms, problems, and questions that should be referred to the physician or other primary health care provider are reviewed by the nurse with the patient and family.

#### Continuing Care

The need for postoperative assessment and care after renal surgery continues regardless of the setting: the home, subacute care unit, outpatient clinic or office, or rehabilitation facility. Referral for home care is indicated for the patient going home with a urinary drainage system in place. During the home visit, the home care nurse reviews the instructions and guidelines given to the patient at hospital discharge. The nurse assesses the patient's ability to carry out the instructions in the home and answers questions that the patient or family has about management of the drainage system and the surgical incision.

Additionally, the home care nurse obtains vital signs and assesses the patient for signs and symptoms of urinary tract infection and obstruction. The nurse also ensures that pain is adequately controlled and that the patient is complying with recommendations. The home care nurse encourages adequate fluid intake and increased levels of activity. Together the nurse, patient, and family review the signs, symptoms, problems, and questions that should be referred to the physician or other primary health care provider. If the patient has a drainage tube in place, the nurse assesses the site and the patency of the system and monitors the patient for complications, such as DVT, bleeding, or pneumonia.

Because it is easy for the patient, family, and health care team to focus on the patient's immediate disorder to the exclusion of other health issues, the nurse reminds the patient and family about the importance of participating in health promotion activities, including health screening.

## Kidney Transplantation

Kidney transplantation has become the treatment of choice for most patients with ESRD. During the past 40 years, more than 400,000 kidney transplantations have been performed worldwide, and approximately 9000 are performed in the United States each year. In the United States, there are many more patients on the waiting list for kidney transplantation than there are organ donors (Danovitch, 2005). Patients choose kidney transplantation for various reasons, such as the desire to avoid dialysis or to improve their sense of well-being and the wish to lead a more normal life. Additionally, the cost of maintaining a successful transplantation is one-third the cost of dialysis treatment. Kidney transplantation is an elective procedure, not an emergency life-saving procedure. Therefore, patients should be in the best possible condition prior to transplantation.

Kidney transplantation involves transplanting a kidney from a living donor or deceased donor to a recipient who no longer has renal function (Chart 44-13). A living donor is a person who is alive at the time of donation and may or may not be related to the recipient. A deceased or cadaveric transplant comes from someone who has died and donated his or her organs. Transplantation from well-matched living donors who are related to the patient (those with compatible ABO and human leukocyte antigens) is slightly more successful than from cadaver donors. The success rate further increases if kidney transplantation from a living donor is performed before dialysis is initiated (Danovitch, 2005).

Prior to either receiving or donating an organ, an extensive medical evaluation is performed. Not everyone is suitable

### Chart 44-13 • *Kidney Donation*

An inadequate number of available kidneys remains the greatest limitation to treating patients with end-stage renal disease successfully. For those interested in donating a kidney, the National Kidney Foundation provides written information describing the organ donation program and a card specifying the organs to be donated in the event of death.

The organ donation card is signed by the donor and two witnesses and should be carried by the donor at all times. Procurement of an adequate number of kidneys for potential recipients is still a major problem, despite national legislation that requires relatives of deceased patients or patients declared brain-dead to be asked if they would consider organ donation.

In some states in the United States, drivers can indicate their desire to be organ donors on their driver's license application or renewal.

for a kidney transplant. Contraindications include recent malignancy, active or chronic infection, severe irreversible extrarenal disease (eg, inoperable cardiac disease, chronic lung disease, severe peripheral vascular disease), active autoimmune disease (eg, HIV, hepatitis B and C), morbid obesity (body mass index greater than 35), current substance abuse, inability to give informed consent, and history of nonadherence to treatment regimens (Counts, 2008). Donors may be rejected for the same reasons or any condition that is determined to have an impact on the remaining kidney. Examples include hypertension and diabetes mellitus since both are known causes of renal disease. It is imperative when donors are evaluated that serious consideration be given to the overall long-term health of the donor. Every precaution must be taken to ensure that the remaining kidney in the donor will remain healthy. If these conditions are met, the donor should remain healthy after donation and have a normal lifespan. Since one kidney can easily handle the body's needs, no long-term adjustments will need to be made.

The patient's native kidneys are not usually removed. The transplanted kidney is placed in the patient's iliac fossa anterior to the iliac crest because it allows for easier access to the blood supply needed to perfuse the kidney. The ureter of the newly transplanted kidney is transplanted into the bladder or anastomosed to the ureter of the recipient (Fig. 44-10). Once the blood supply has been reestablished to the transplanted kidney in the operating room, urine should begin to flow. The production of urine at this stage is an important indicator of the overall success of the procedure and ultimate long-term outcome.

## Preoperative Management

Preoperative management goals include bringing the patient's metabolic state to a level as close to normal as possible, making sure that the patient is free of infection, and preparing the patient for surgery and the postoperative course.

### Medical Management

A complete physical examination is performed to detect and treat any conditions that could cause complications after transplantation. Tissue typing, blood typing, and antibody screening are performed to determine compatibility of the tissues and cells of the donor and recipient. Other diagnostic tests must be completed to identify conditions requiring treatment before transplantation. The lower urinary tract is studied to assess bladder neck function and to detect ureteral reflux.

The patient must be free of infection at the time of renal transplantation, because after surgery medications to prevent transplant rejection will be prescribed. These medications suppress the immune response, leaving the patient immunosuppressed and at risk for infection. Therefore, the patient is evaluated and treated for any infections, including gingival (gum) disease and dental caries.

A psychosocial evaluation is conducted to assess the patient's ability to adjust to the transplant, coping styles, social history, social support available, and financial resources. A history of psychiatric illness is important to obtain because psychiatric conditions are often aggravated by the corticosteroids needed for immunosuppression after transplantation. If a dialysis routine has been established, hemodialysis is often performed the day before the scheduled transplantation procedure to optimize the patient's physical status.

### Nursing Management

The nursing aspects of preoperative care for the patient undergoing renal transplant are similar to those for patients undergoing other types of kidney or elective abdominal surgery. Preoperative teaching can be conducted in a variety of settings, including the outpatient preadmission area, the hospital, or the transplantation clinic during the preliminary workup phase. Patient teaching addresses postoperative pulmonary hygiene, pain management options, dietary

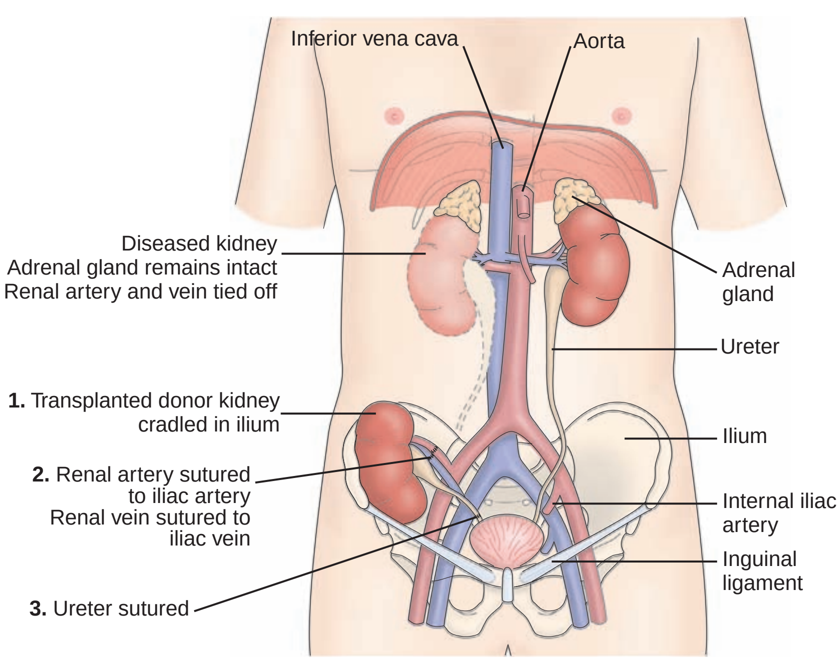



**Figure 44-10** Renal transplantation: **1,** The transplanted kidney is placed in the iliac fossa. **2,** The renal artery of the donated kidney is sutured to the ileac artery, and the renal vein is sutured to the iliac vein. **3,** The ureter of the donated kidney is sutured to the bladder or to the patient's ureter.

restrictions, IV and arterial lines, tubes (indwelling catheter and possibly a nasogastric tube), and early ambulation. The patient who receives a kidney from a living related donor may be concerned about the donor and how the donor will tolerate the surgical procedure.

Most patients have been on dialysis for months or years before transplantation. Many have waited months to years for a kidney transplant and are anxious about the surgery, possible rejection, and the need to return to dialysis. Helping the patient to deal with these concerns is part of the nurse's role in preoperative management, as is teaching the patient about what to expect after surgery.

## Postoperative Management

The goal of care is to maintain homeostasis until the transplanted kidney is functioning well. The patient whose kidney functions immediately has a more favorable prognosis than the patient whose kidney does not.

### *Medical Management*

After a kidney transplant, rejection and failure can occur within 24 hours (hyperacute), within 3 to 14 days (acute), or after many years. The long-term survival of a transplanted kidney depends on how well it matches the recipient and how well the body's immune response is controlled. Since the body's immune system views the transplanted kidney as "foreign," it continually works to reject it. To overcome or minimize the body's defense mechanisms, immunosuppressive agents are administered. Optimally, medications modify the immune system enough to prevent rejection, but not enough to allow infections or malignancies to occur.

Combinations of glucocorticoids and medications specifically developed to affect the action of lymphocytes are used to minimize the body's reaction to the transplanted organ. Treatment with combinations of new agents has dramatically improved survival rates, and now 90% to 95% of transplanted kidneys still function after 1 year (American Nephrology Nurses Association, 2007b). Doses of immunosuppressive agents are often adjusted depending on the patient's immunologic response to the transplant. However, the patient will be required to take some form of immunosuppressive therapy for the entire time that he or she has the transplanted kidney.

The risks associated with taking these medications include nephrotoxicity, hypertension, hyperlipidemia, hirsutism, tremors, blood dyscrasias, cataracts, gingival hyperplasia, and several types of cancer (American Nephrology Nurses Association, 2006).

### *Nursing Management*

#### Assessing the Patient for Transplant Rejection

After kidney transplantation, the nurse assesses the patient for signs and symptoms of transplant rejection: oliguria, edema, fever, increasing blood pressure, weight gain, and swelling or tenderness over the transplanted kidney or graft. Patients receiving cyclosporine may not exhibit the usual signs and symptoms of acute rejection. In these patients, the only sign may be an asymptomatic rise in the serum creatinine level (more than a 20% rise is considered acute rejection).

#### Preventing Infection

The results of blood chemistry tests and leukocyte and platelet counts are monitored closely because immunosuppression depresses the formation of leukocytes and platelets. The patient is closely monitored for infection because of susceptibility to impaired healing and infection related to immunosuppressive therapy and complications of renal failure. Clinical manifestations of infection include shaking chills, fever, rapid heartbeat (tachycardia), and respirations (tachypnea), as well as either an increase or a decrease in WBCs (leukocytosis or leukopenia).

Infection may be introduced through the urinary tract, the respiratory tract, the surgical site, or other sources. Urine cultures are performed frequently because of the high incidence of bacteriuria during early and late stages of transplantation. Any type of wound drainage should be viewed as a potential source of infection because drainage is an excellent culture medium for bacteria. Catheter and drain tips may be cultured when removed by cutting off the tip of the catheter or drain (using aseptic technique) and placing the tip in a sterile container to be taken to the laboratory for culture (Chart 44-14).

The nurse ensures that the patient is protected from exposure to infection by hospital staff, visitors, and other

### Chart 44-14 • *Renal Transplant Rejection and Infection*

Renal graft rejection and failure may occur within 24 hours (hyperacute), within 3 to 14 days (acute), or after many years (chronic). It is not uncommon for rejection to occur during the first year after transplantation.

**Detecting Rejection**

Ultrasonography may be used to detect enlargement of the kidney; percutaneous renal biopsy (most reliable) and x-ray techniques are used to evaluate transplant rejection. If the body rejects the transplanted kidney, the patient needs to return to dialysis. The rejected kidney may or may not be removed, depending on when the rejection occurs (acute versus chronic) and the risk for infection if the kidney is left in place.

**Potential Infection**

About 75% of kidney transplant recipients have at least one episode of infection in the first year after transplantation because of immunosuppressant therapy. Immunosuppressants of the past made the transplant recipient more vulnerable to opportunistic infections (candidiasis, cytomegalovirus, *Pneumocystis* pneumonia) and infection with other relatively nonpathogenic viruses, fungi, and protozoa, which can be a major hazard. Cyclosporine therapy has reduced the incidence of opportunistic infections because it selectively exerts its effect, sparing T cells that protect the patient from life-threatening infections. In addition, combination immunosuppressant therapy and improved clinical care have produced 1-year patient survival rates approaching 100% and graft survival exceeding 90%. Infections, however, remain a major cause of death at all points in time for kidney transplant recipients (Danovitch, 2005).

patients with active infections. Attention to hand hygiene by all who come in contact with the patient is imperative.

### Monitoring Urinary Function

A kidney from a living donor related to the patient usually begins to function immediately after surgery and may produce large quantities of dilute urine. A kidney from a cadaver donor may undergo acute tubular necrosis and therefore may not function for 2 or 3 weeks, during which time anuria, oliguria, or polyuria may be present. During this stage, the patient may experience significant changes in fluid and electrolyte status. Therefore, careful monitoring is indicated. The output from the urinary catheter (connected to a closed drainage system) is measured every hour. IV fluids are administered on the basis of urine volume and serum electrolyte levels and as prescribed by the physician. Hemodialysis may be necessary postoperatively to maintain homeostasis until the transplanted kidney is functioning well. It also may be required if fluid overload and hyperkalemia occur. After successful renal transplantation, the vascular access device may clot, possibly from improved coagulation with the return of renal function. The vascular access for hemodialysis is monitored to ensure patency and to evaluate for evidence of infection.

### Addressing Psychological Concerns

The rejection of a transplanted kidney is of great concern to the patient, the family, and the health care team for many months. The fear of kidney rejection and the complications of immunosuppressive therapy (Cushing's syndrome, diabetes, capillary fragility, osteoporosis, glaucoma, cataracts, acne, nephrotoxicity) place tremendous psychological stress on the patient. Anxiety and uncertainty about the future and difficult posttransplantation adjustment are often sources of stress for the patient and family.

An important nursing function is the assessment of the patient's stress and coping. The nurse uses each visit with the patient to determine if the patient and family are coping effectively and the patient is adhering to the prescribed medication regimen. If indicated or requested, the nurse refers the patient for counseling.

### Monitoring and Managing Potential Complications

The patient undergoing kidney transplantation is at risk for the postoperative complications that are associated with any surgical procedure. In addition, the patient's physical condition may be compromised because of the effects of long-standing renal failure and its treatment. Therefore, careful assessment for the complications related to renal failure and those associated with a major surgery are important aspects of nursing care. Breathing exercises, early ambulation, and care of the surgical incision are important aspects of postoperative care.

GI ulceration and corticosteroid-induced bleeding may occur. Fungal colonization of the GI tract (especially the mouth) and urinary bladder may occur secondary to corticosteroid and antibiotic therapy. Closely monitoring the patient and notifying the physician about the occurrence of these complications are important nursing interventions. In addition, the patient is monitored closely for signs and symptoms of adrenal insufficiency if the treatment has included use of corticosteroids.

### Promoting Home and Community-Based Care

***Teaching Patients Self-Care.*** The nurse works closely with the patient and family to be sure that they understand the need for continuing immunosuppressive therapy as prescribed. Additionally, the patient and family are instructed to assess for and report signs and symptoms of transplant rejection, infection, or significant adverse effects of the immunosuppressive regimen. These include decreased urine output; weight gain; malaise; fever; respiratory distress; tenderness over the transplanted kidney; anxiety; depression; changes in eating, drinking, or other habits; and changes in blood pressure. The patient is instructed to inform other health care providers (eg, dentist) about the kidney transplant and the use of immunosuppressive agents.

***Continuing Care.*** The patient needs to know that follow-up care after transplantation is a lifelong necessity. Individual verbal and written instructions are provided concerning diet, medication, fluids, daily weight, daily measurement of urine, management of I&O, prevention of infection, resumption of activity, and avoidance of contact sports in which the transplanted kidney may be injured. Because of the risk for other potential complications, the patient is followed closely.

Cardiovascular disease is the major cause of morbidity and mortality after transplantation, due in part to the increasing age of patients with transplants. An additional problem is possible malignancy; patients receiving long-term immunosuppressive therapy are at higher risk for cancers than the general population. So the patient is reminded of the importance of health promotion and health screening.

The American Association of Kidney Patients (listed at the end of this chapter) is a nonprofit organization that serves the needs of those with kidney disease. It can provide many helpful suggestions for patients and family members learning to cope with dialysis and transplantation.

## RENAL TRAUMA

The kidneys are protected by the rib cage and musculature of the back posteriorly and by a cushion of abdominal wall and viscera anteriorly. They are highly mobile and are fixed only at the renal pedicle (stem of renal blood vessels and the ureter). With traumatic injury, the kidneys can be thrust against the lower ribs, resulting in contusion and rupture. Rib fractures or fractures of the transverse process of the upper lumbar vertebrae may be associated with renal contusion or laceration. Failure to wear seat belts contributes to the incidence of renal trauma in motor vehicle crashes. Up to 80% of patients with renal trauma have associated injuries of other internal organs.

Injuries may be blunt (automobile and motorcycle crashes, falls, athletic injuries, assaults) or penetrating (gunshot wounds, stabbings). Blunt renal trauma accounts for 80% to 90% of all renal injuries; penetrating renal trauma accounts for the remaining 10% to 20%.

Blunt renal trauma is classified into one of four groups, as follows:

- Contusion: bruises or hemorrhages under the renal capsule; capsule and collecting system intact

- Minor laceration: superficial disruption of the cortex; renal medulla and collecting system are not involved
- Major laceration: parenchymal disruption extending into cortex and medulla, possibly involving the collecting system
- Vascular injury: tears of renal artery or vein

The most common renal injuries are contusions, lacerations, ruptures, and renal pedicle injuries or small internal lacerations of the kidney (Fig. 44-11). The kidneys receive half of the blood flow from the abdominal aorta; therefore, even a fairly small renal laceration can produce massive bleeding. About 70% of patients are in shock when admitted to the hospital. In some cases, there is an isolated renal artery thrombosis.

Clinical manifestations include pain, renal colic (due to blood clots or fragments obstructing the collecting system), hematuria, mass or swelling in the flank, ecchymoses, and lacerations or wounds of the lateral abdomen and flank. Hematuria is the most common manifestation of renal trauma; its presence after trauma suggests renal injury. There is no relationship between the degree of hematuria and the degree of injury. Hematuria may not occur, or it may be detectable only on microscopic examination. Signs and symptoms of hypovolemia and shock are likely with significant hemorrhage.

## Medical Management

The goals of management in patients with renal trauma are to control hemorrhage, pain, and infection as well as to preserve and restore renal function. All urine is saved and sent to the laboratory for analysis to detect RBCs and to evaluate the course of bleeding. Hematocrit and hemoglobin levels are monitored closely; decreasing values indicate hemorrhage.

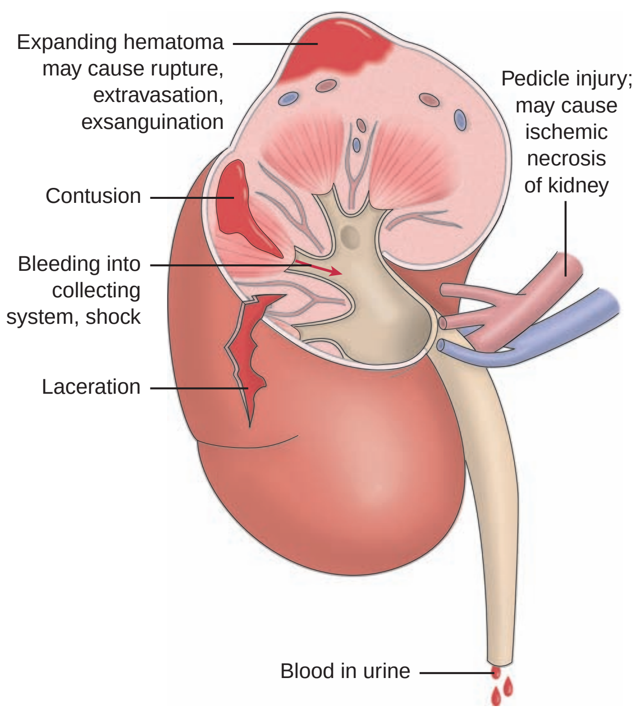



**Figure 44-11** Types and pathophysiologic effects of renal injuries: contusions, lacerations, rupture, and pedicle injury.

The patient is monitored for oliguria and signs of hemorrhagic shock, because a pedicle injury or shattered kidney can lead to rapid exsanguination (lethal blood loss). An expanding hematoma may cause rupture of the kidney capsule. To detect hematoma, the area around the lower ribs, upper lumbar vertebrae, flank, and abdomen is palpated for tenderness. A palpable flank or abdominal mass with local tenderness, swelling, and ecchymosis suggests renal hemorrhage. The area of the original mass can be outlined with a marking pen so that the examiner can evaluate the area for change.

Renal trauma is often associated with other injuries to the abdominal organs (liver, colon, small intestines); therefore, the patient is assessed for skin abrasions, lacerations, and entry and exit wounds of the upper abdomen and lower thorax because these may be associated with renal injury.

With a contusion of the kidney, healing may take place with conservative measures. If the patient has microscopic hematuria and a normal IV urogram, outpatient management is possible. If gross hematuria or a minor laceration is present, the patient is hospitalized and kept on bed rest until the hematuria clears. Antimicrobial medications may be prescribed to prevent infection from perirenal hematoma or urinoma (a cyst containing urine). Patients with retroperitoneal hematomas may develop low-grade fever as absorption of the clot takes place.

### *Surgical Management*

In renal trauma, any sudden change in the patient's condition suggests hemorrhage and requires rapid surgical intervention. Depending on the patient's condition and the nature of the injury, major lacerations may be treated through surgical intervention or conservatively (bed rest, no surgery). Vascular injuries require immediate exploratory surgery because of the high incidence of involvement of other organ systems and the serious complications that may result if these injuries are untreated. The patient is often in shock and requires aggressive fluid resuscitation. The damaged kidney may have to be removed (nephrectomy).

Early postoperative complications (within 6 months) include rebleeding, perinephritic abscess formation, sepsis, urine extravasation, and fistula formation. Other complications include stone formation, infection, cysts, vascular aneurysms, and loss of renal function. Hypertension can be a complication of any renal surgery but usually is a late complication of renal injury.

## Nursing Management

The patient with renal trauma must be assessed frequently during the first few days after injury to detect flank and abdominal pain, muscle spasm, and swelling over the flank. During this time, the patient who has undergone surgery is instructed about care of the incision and the importance of an adequate fluid intake. In addition, instructions about changes that should be reported to the physician, such as fever, hematuria, flank pain, or any signs and symptoms of decreasing kidney function, are provided. Guidelines for gradually increasing activity, lifting, and driving are also provided in accordance with the physician's prescription.

Follow-up nursing care includes monitoring the blood pressure to detect hypertension and advising the patient to

restrict activities for about 1 month after trauma to minimize the incidence of delayed or secondary bleeding. The patient should be advised to schedule periodic follow-up assessments of renal function (creatinine clearance, BUN and serum creatinine analyses). If a nephrectomy was necessary, the patient is advised to wear medical identification.

## CRITICAL THINKING EXERCISES

**1** You are a staff nurse in an outpatient dialysis facility. A 50-year-old woman with ESRD is scheduled to be seen in the clinic; it is anticipated that she will need dialysis in the near future. The patient lives alone and will require teaching about the dialysis options. Develop a teaching plan to explain the different types of dialysis, goals, and level of involvement on the part of the patient.

EBP **2** A 45-year-old married man visits the nephrology department to discuss options for dealing with his ESRD. His brother has begun the workup to donate one of his kidneys and the preliminary reports show that a match is possible. The patient states that he does not want his brother to go through the process of kidney donation if dialysis is possible. Identify the evidence for and the criteria used to evaluate the strength of the evidence for dialysis compared to kidney transplantation.

**3** You are caring for a 35-year-old woman who has been recently diagnosed with renal cancer. Identify possible treatment options. What nursing assessment and interventions should you make at this time? What explanations would you give the patient about renal cancer?

**4** A 55-year-old man who is blind has just had a catheter placed for PD. His wife, his primary caretaker, is deaf. Develop a teaching plan to explain peritoneal dialysis, goals, and level of involvement to the patient and family.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*


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## RESOURCES

American Association of Kidney Patients, www.aakp.org
American Nephrology Nurses' Association, www.annanurse.org
American Foundation for Urologic Disease, www.afud.org
American Kidney Fund, www.arbon.com/kidney
AV Fistula First, www.fistulafirst.org
National Institute of Diabetes and Digestive and Kidney Diseases, www.niddk.nih.gov
National Kidney and Urologic Diseases Information Clearinghouse, www.niddk.nih.gov
National Kidney Foundation, www.kidney.org
United Network for Organ Sharing, www.unos.org



# chapter 45

# Management of Patients With Urinary Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify factors contributing to upper and lower urinary tract infections (UTIs).
2. Use the nursing process as a framework for care of the patient with a UTI.
3. Differentiate between the various adult dysfunctional voiding patterns.
4. Develop a patient education plan for a patient who has mixed (stress and urge) urinary incontinence.
5. Identify potential causes of an obstruction of the urinary tract and management of the patient with this condition.
6. Develop a teaching plan for the patient undergoing treatment for renal calculi (kidney stones).
7. Formulate preoperative and postoperative nursing diagnoses for the patient undergoing surgery for urinary diversion.

## GLOSSARY

**bacteriuria:** more than $10^5$ colonies of bacteria per milliliter of urine

**cystectomy:** removal of the urinary bladder

**cystitis:** inflammation of the urinary bladder

**frequency:** voiding more often than every 3 hours

**ileal conduit:** transplantation of the ureters to an isolated section of the terminal ileum, with one end of the ureters brought to the abdominal wall

**interstitial cystitis:** inflammation of the bladder wall that eventually causes disintegration of the lining and loss of bladder elasticity

**micturition:** voiding or urination

**neurogenic bladder:** bladder dysfunction that results from a disorder or dysfunction of the nervous system; may result in either urinary retention or bladder overactivity, resulting in urinary urgency and urge incontinence

**nocturia:** awakening at night to urinate

**overflow incontinence:** involuntary urine loss associated with overdistention of the bladder due to mechanical or anatomic bladder outlet obstruction

**prostatitis:** inflammation of the prostate gland

**pyelonephritis:** inflammation of the renal pelvis

**pyuria:** white blood cells in the urine

**residual urine:** urine that remains in the bladder after voiding

**suprapubic catheter:** a urinary catheter that is inserted through a suprapubic incision into the bladder

**ureterosigmoidostomy:** transplantation of the ureters into the sigmoid colon, allowing urine to flow through the colon and out the rectum

**ureterovesical** or **vesicoureteral reflux:** backward flow of urine from the bladder into one or both ureters

**urethritis:** inflammation of the urethra

**urethrovesical reflux:** backward flow of urine from the urethra into the bladder

**urinary incontinence:** involuntary or uncontrolled loss of urine from the bladder sufficient to cause a social or hygienic problem

**urosepsis:** sepsis resulting from infected urine, most often a UTI

The urinary system is responsible for providing the route for drainage of urine formed by the kidneys. Care of the patient with disorders of the urinary tract requires an understanding of the anatomy, physiology, diagnostic testing, nursing care, and rehabilitation of patients with the multiple processes that affect the urinary system. Nurses care for patients with urologic disorders in all settings. This chapter focuses on the nursing management of patients with common urinary dysfunctions, including infections, dysfunctional voiding patterns, urolithiasis, genitourinary trauma, cancer of the urinary tract, and urinary diversions.

# INFECTIONS OF THE URINARY TRACT

Urinary tract infections (UTIs) are caused by pathogenic microorganisms in the urinary tract (the normal urinary tract is sterile above the urethra). UTIs are generally classified as infections involving the upper or lower urinary tract and further classified as uncomplicated or complicated, depending on other patient-related conditions (Chart 45-1).

Lower UTIs include bacterial **cystitis** (inflammation of the urinary bladder), bacterial **prostatitis** (inflammation of the prostate gland), and bacterial **urethritis** (inflammation of the urethra). There can be acute or chronic nonbacterial causes of inflammation in any of these areas that can be misdiagnosed as bacterial infections. Upper UTIs are much less common and include acute or chronic **pyelonephritis** (inflammation of the renal pelvis), interstitial nephritis (inflammation of the kidney), and renal abscesses. Upper and lower UTIs are further classified as uncomplicated or complicated, depending on whether the UTI is recurrent and the duration of the infection. Most uncomplicated UTIs are community acquired. Complicated UTIs usually occur in people with urologic abnormalities or recent catheterization and are often acquired during hospitalization.

A UTI is the second most common infection in the body. Most cases occur in women; one out of every five women in the United States will develop a UTI during her lifetime. The urinary tract is the most common site of nosocomial infection, accounting for greater than 40% of the total number reported by hospitals and affecting about 600,000 patients each year. In most of these hospital-acquired UTIs, instrumentation of the urinary tract or catheterization is the precipitating cause. More than 250,000 cases of acute pyelonephritis occur in the United States each year, with 100,000 patients requiring hospitalization. Approximately 11.3 million women are diagnosed with UTIs in the United States annually, representing an expenditure of about $1.6 billion in direct heath care costs. This amount does not include the indirect costs associated with time lost from work and the negative impact on the person's lifestyle (National Kidney and Urologic Diseases Information Clearinghouse, 2005).

## Lower Urinary Tract Infections

Several mechanisms maintain the sterility of the bladder: the physical barrier of the urethra, urine flow, ureterovesical junction competence, various antibacterial enzymes and antibodies, and antiadherent effects mediated by the mucosal cells of the bladder. Abnormalities or dysfunctions of these mechanisms are contributing risk factors for lower UTIs (Chart 45-2).

### Pathophysiology

For infection to occur, bacteria must gain access to the bladder, attach to and colonize the epithelium of the urinary tract to avoid being washed out with voiding, evade host

**Chart 45-1 • *Classifying Urinary Tract Infections***

Urinary tract infections (UTIs) are classified by location: the lower urinary tract (which includes the bladder and structures below the bladder) or the upper urinary tract (which includes the kidneys and ureters). They can also be classified as uncomplicated or complicated UTIs.

**Lower UTIs**

Cystitis, prostatitis, urethritis

**Upper UTIs**

Acute pyelonephritis, chronic pyelonephritis, renal abscess, interstitial nephritis, perirenal abscess

**Uncomplicated Lower or Upper UTIs**

Community-acquired infection; common in young women and not usually recurrent

**Complicated Lower or Upper UTIs**

Often nosocomial (acquired in the hospital) and related to catheterization; occur in patients with urologic abnormalities, pregnancy, immunosuppression, diabetes mellitus, and obstructions and are often recurrent

**CHART 45-2 *Risk Factors for Urinary Tract Infection***

- Inability or failure to empty the bladder completely
- Obstructed urinary flow caused by:
  - Congenital abnormalities
  - Urethral strictures
  - Contracture of the bladder neck
  - Bladder tumors
  - Calculi (stones) in the ureters or kidneys
  - Compression of the ureters
- Decreased natural host defenses or immunosuppression
- Instrumentation of the urinary tract (eg, catheterization, cystoscopic procedures)
- Inflammation or abrasion of the urethral mucosa
- Contributing conditions such as:
  - Diabetes mellitus (increased urinary glucose levels create an infection-prone environment in the urinary tract)
  - Pregnancy
  - Neurologic disorders
  - Gout
  - Altered states caused by incomplete emptying of the bladder and urinary stasis

defense mechanisms, and initiate inflammation. Many UTIs result from fecal organisms ascending from the perineum to the urethra and the bladder and then adhering to the mucosal surfaces.

### Bacterial Invasion of the Urinary Tract

By increasing the normal slow shedding of bladder epithelial cells (resulting in bacteria removal), the bladder can clear large numbers of bacteria. Glycosaminoglycan (GAG), a hydrophilic protein, normally exerts a nonadherent protective effect against various bacteria. The GAG molecule attracts water molecules, forming a water barrier that serves as a defensive layer between the bladder and the urine. GAG may be impaired by certain agents (cyclamate, saccharin, aspartame, and tryptophan metabolites). The normal bacterial flora of the vagina and urethral area also interfere with adherence of *Escherichia coli*. Urinary immunoglobulin A (IgA) in the urethra may also provide a barrier to bacteria.

### Reflux

An obstruction to free-flowing urine is a condition known as **urethrovesical reflux,** which is the reflux (backward flow) of urine from the urethra into the bladder (Fig. 45-1). With coughing, sneezing, or straining, the bladder pressure increases, which may force urine from the bladder into the urethra. When the pressure returns to normal, the urine flows back into the bladder, bringing into the bladder bacteria from the anterior portions of the urethra. Urethrovesical reflux is also caused by dysfunction of the bladder neck or urethra. The urethrovesical angle and urethral closure pressure may be altered with menopause, increasing the incidence of infection in postmenopausal women. Reflux is most often noted in young children, and treatment is based on its severity.

**Ureterovesical** or **vesicoureteral reflux** refers to the backward flow of urine from the bladder into one or both ureters (see Fig. 45-1). Normally, the ureterovesical junction prevents urine from traveling back into the ureter. The ureters tunnel into the bladder wall so that the bladder musculature compresses a small portion of the ureter during normal voiding. When the ureterovesical valve is impaired by congenital causes or ureteral abnormalities, the bacteria may reach the kidneys and eventually destroy them.

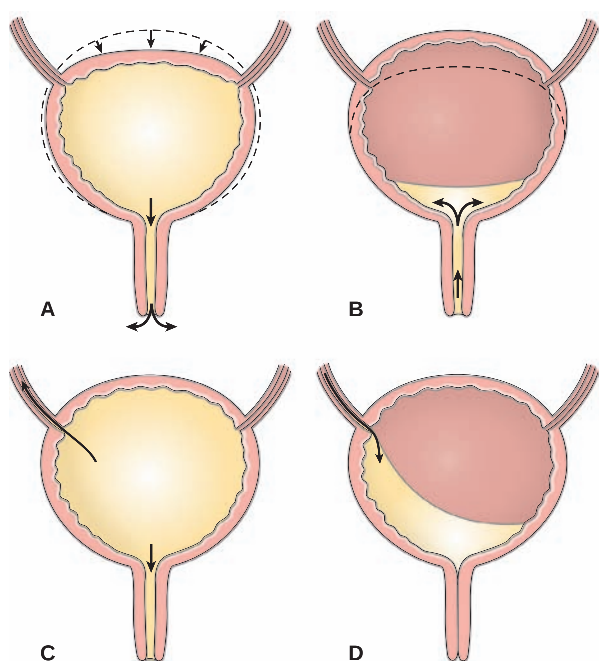



**Figure 45-1** Mechanisms of urethrovesical and ureterovesical reflux may cause urinary tract infection. **Urethrovesical reflux:** With coughing and straining, bladder pressure rises, which may force urine from the bladder into the urethra. **A,** When bladder pressure returns to normal, the urine flows back to the bladder **(B),** which introduces bacteria from the urethra to the bladder. **Ureterovesical reflux:** With failure of the ureterovesical valve, urine moves up the ureters during voiding **(C)** and flows into the bladder when voiding stops **(D).** This prevents complete emptying of the bladder. It also leads to urinary stasis and contamination of the ureters with bacteria-laden urine.

### Uropathogenic Bacteria

**Bacteriuria** is generally defined as more than $10^5$ colonies of bacteria per milliliter of urine. Because urine samples (especially in women) are commonly contaminated by the bacteria normally present in the urethral area, a bacterial count exceeding $10^5$ colonies/mL of clean-catch midstream urine is the measure that distinguishes true bacteriuria from contamination. In men, contamination of the collected urine sample occurs less frequently; hence, bacteriuria is defined as $10^4$ colonies/mL urine. Community-acquired UTIs are among the most common bacterial infections in women (Porth & Matfin, 2009).

The organisms most frequently responsible for UTIs are those normally found in the lower gastrointestinal (GI) tract, usually *E. coli*. However, isolation of *E. coli* is decreasing compared with previous observations, especially in males and in patients with indwelling bladder catheters, who instead have higher rates of *Pseudomonas* and *Enterococcus* organisms than females and noncatheterized patients (Porth & Matfin, 2009).

### Routes of Infection

Bacteria enter the urinary tract in three ways: by the transurethral route (ascending infection), through the bloodstream (hematogenous spread), or by means of a fistula from the intestine (direct extension).

The most common route of infection is transurethral, in which bacteria (often from fecal contamination) colonize the periurethral area and subsequently enter the bladder by means of the urethra. In women, the short urethra offers little resistance to the movement of uropathogenic bacteria. Sexual intercourse forces the bacteria from the urethra into the bladder. This accounts for the increased incidence of UTIs in sexually active women. Bacteria may also enter the urinary tract by means of the blood from a distant site of infection or through direct extension by way of a fistula from the intestinal tract.

## Clinical Manifestations

A variety of signs and symptoms are associated with UTI. About half of all patients with bacteriuria have no symptoms. Signs and symptoms of an uncomplicated lower UTI

(cystitis) include burning on urination, **frequency** (voiding more than every 3 hours), urgency, **nocturia** (awakening at night to urinate), incontinence, and suprapubic or pelvic pain. Hematuria and back pain may also be present. In older people, these symptoms are less common (see Gerontologic Considerations).

In patients with complicated UTIs, manifestations can range from asymptomatic bacteriuria to gram-negative sepsis with shock. Complicated UTIs often are caused by a broader spectrum of organisms, have a lower response rate to treatment, and tend to recur. Many patients with catheter-associated UTIs are asymptomatic; however, any patient with a catheter who suddenly develops signs and symptoms of septic shock should be evaluated for **urosepsis** (sepsis resulting from infected urine).

## Gerontologic Considerations

The incidence of bacteriuria in the elderly differs from that in younger adults. Bacteriuria increases with age and disability, and women are affected more frequently than men. UTI is the most common cause of acute bacterial sepsis in patients older than 65 years of age, in whom gram-negative sepsis carries a mortality rate exceeding 50%. Urologists see many asymptomatic patients with bacteriuria and 20% are women older than 65 years. In older patients who reside in nursing homes, 25% to 50% of females and 15% to 40% of males have chronic bacteriuria (Juthani-Mehta, 2007; Miller, 2009).

In the elderly population at large, structural abnormalities secondary to decreased bladder tone and neurogenic bladder (dysfunctional bladder) secondary to stroke or autonomic neuropathy of diabetes may prevent complete emptying of the bladder and increase the risk for UTI (Morton, Fontaine, Hudak, et al., 2005). When indwelling catheters are used, the risk of UTI increases dramatically. Elderly women often have incomplete emptying of the bladder and urinary stasis. In the absence of estrogen, postmenopausal women are susceptible to colonization and increased adherence of bacteria to the vagina and urethra. Oral or topical estrogen has been used to restore the glycogen content of vaginal epithelial cells and an acidic pH for some postmenopausal women with recurrent cystitis.

The antibacterial activity of prostatic secretions that protect men from bacterial colonization of the urethra and bladder decreases with aging. Although UTIs are rare in men, the prevalence of infection in men older than 50 years of age approaches that of women in the same age group. The increase of UTIs in men as they age is largely a result of prostatic hyperplasia or carcinoma, strictures of the urethra, and neuropathic bladder. The use of catheterization or cystoscopy in evaluation or treatment may also contribute to the higher incidence of UTIs in this group. The incidence of bacteriuria increases in men with confusion, dementia, or bowel or bladder incontinence. The most common cause of recurrent UTIs in elderly males is chronic bacterial prostatitis. Resection of the prostate gland may help reduce its incidence (see Chapter 49).

In institutionalized elderly patients, such as those in long-term care facilities, infecting pathogens are often resistant to many antibiotics. Chart 45-3 lists other factors that may contribute to UTI in elderly patients in these environments. Diligent hand hygiene, careful perineal care, and frequent toileting may decrease the incidence of UTIs.

> **CHART 45-3** GERONTOLOGIC CONSIDERATIONS
> ***Factors That Contribute to Urinary Tract Infection in Older Adults***
>
> - High incidence of multiple chronic medical conditions
> - Frequent use of antimicrobial agents
> - Presence of infected pressure ulcers
> - Immunocompromise
> - Cognitive impairment
> - Immobility and incomplete emptying of bladder
> - Use of a bedpan rather than a commode or toilet

The organisms responsible for UTIs in the institutionalized elderly may differ from those found in patients residing in the community; this is thought to result in part from the frequent use of antibiotic agents by patients in long-term care facilities. *E. coli* is the most common organism seen in elderly patients in the community or hospital. However, patients with indwelling catheters are more likely to be infected with *Proteus*, *Klebsiella*, *Pseudomonas*, or *Staphylococcus* species. Patients who have been previously treated with antibiotics may be infected with *Enterococcus* species. Frequent reinfections are common in older adults.

The most common subjective presenting symptom of UTI in older adults is generalized fatigue. The most common objective finding is a change in cognitive functioning, especially in those with dementia, because these patients usually exhibit even more profound cognitive changes with the onset of a UTI.

Controversy continues about the need for treatment of asymptomatic bacteriuria in institutionalized elderly patients, because resulting antibiotic-resistant organisms and sepsis may be greater threats to patients. Most experts now recommend withholding antibiotics unless symptoms develop. However, treatment regimens are generally the same as those for younger adults, although age-related changes in the intestinal absorption of medications and decreased renal function and hepatic flow may necessitate alterations in the antimicrobial regimen. Renal function must be monitored, and medication dosages should be altered accordingly.

> ***NURSING ALERT***
>
> **Elderly patients often lack the typical symptoms of UTI and sepsis. Although frequency and urgency may occur, nonspecific symptoms, such as altered sensorium, lethargy, anorexia, new incontinence, hyperventilation, and low-grade fever, may be the only clues.**

## Assessment and Diagnostic Findings

Results of various tests, such as bacterial colony counts, cellular studies, and urine cultures, help confirm the diagnosis of UTI. In an uncomplicated UTI, the strain of bacteria determines the antibiotic of choice.

### *Urine Cultures*

Urine cultures are useful for documenting a UTI and identifying the specific organism present. UTI is diagnosed by bacteria in the urine culture. A colony count of at least $10^5$

colony-forming units (CFU) per milliliter of urine on a clean-catch midstream or catheterized specimen is a major criterion for infection (Smythe, Moore & Goldsmith, 2006). However, UTI and subsequent sepsis have occurred with lower bacterial colony counts. About one third of women with symptoms of acute infections have negative midstream urine culture results and may go untreated if $10^5$ CFU/mL is used as the criterion for infection. The presence of any bacteria in specimens obtained by suprapubic needle aspiration of the urinary bladder or catheterization (insertion of a tube into the urinary bladder) is considered indicative of infection.

The following groups of patients should have urine cultures obtained when bacteriuria is present:

- All men (because of the likelihood of structural or functional abnormalities)
- All children
- Women with a history of compromised immune function or renal problems
- Patients with diabetes mellitus
- Patients who have undergone recent instrumentation (including catheterization) of the urinary tract
- Patients who have been recently hospitalized or who live in long-term care facilities
- Patients with prolonged or persistent symptoms
- Patients with three or more UTIs in the previous year
- Pregnant women
- Postmenopausal women
- Women who are sexually active
- Women who have new sexual partners

#### Cellular Studies

Microscopic hematuria is present in about half of patients with an acute UTI (see Chapter 43). **Pyuria** (greater than 4 white blood cells [WBCs] per high-power field) occurs in all patients with UTI; however, it is not specific for bacterial infection. Pyuria can also be seen with kidney stones, interstitial nephritis, and renal tuberculosis.

#### Other Studies

A multiple-test dipstick often includes testing for WBCs, known as the leukocyte esterase test, and nitrite testing. Urine hydroxyproline, an amino acid found mainly in collagen, may be tested for in disorders characterized by bone resorption (Karpoff & Labus, 2008).

Tests for sexually transmitted diseases (STDs), also referred to as sexually transmitted infections (STIs), may be performed because acute urethritis caused by sexually transmitted organisms (ie, *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, herpes simplex) or acute vaginitis infections (caused by *Trichomonas* or *Candida* species) may be responsible for symptoms similar to those of UTIs.

Diagnostic studies such as computed tomography (CT) and ultrasonography are useful diagnostic tools. A CT scan may detect pyelonephritis or abscesses, and ultrasonography is extremely sensitive for detecting obstruction, abscesses, tumors, and cysts. Transrectal ultrasonography (to assess the prostate and bladder) is the procedure of choice for men with recurrent or complicated UTIs. A cystourethroscopy may be indicated to visualize the ureters or to detect strictures, calculi, or tumors (Karpoff & Labus, 2008).

## Medical Management

Management of UTIs typically involves pharmacologic therapy and patient education. The nurse teaches the patient about prescribed medication regimens and infection prevention measures.

#### Acute Pharmacologic Therapy

The ideal medication for treatment of UTI is an antibacterial agent that eradicates bacteria from the urinary tract with minimal effects on fecal and vaginal flora, thereby minimizing the incidence of vaginal yeast infections. (Yeast vaginitis occurs in as many as 25% of patients treated with antimicrobial agents that affect vaginal flora. Yeast vaginitis can cause more symptoms and be more difficult and costly to treat than the original UTI.) Additionally, the antibacterial agent should be affordable and should have few adverse effects and low resistance. Because the organism in initial, uncomplicated UTIs in women is most likely *E. coli* or other fecal flora, the agent should be effective against these organisms (Mehnert-Kay, 2005). Various treatment regimens have been successful in treating uncomplicated lower UTIs in women: single-dose administration, short-course (3 to 4 days) regimens, or 7- to 10-day regimens. The trend is toward a shortened course of antibiotic therapy for uncomplicated UTIs, because most cases are cured after 3 days of treatment. Patients in institutional settings may require 7 to 10 days of medication for the treatment to be effective. Some of the medications commonly used to treat UTIs are listed in Table 45-1. Regardless of the regimen prescribed, the patient is instructed to take all the doses prescribed, even if relief of symptoms occurs promptly. Longer medication courses are indicated for men, pregnant women, and women with pyelonephritis and other types of complicated UTIs. Hospitalization and intravenous (IV) antibiotics are occasionally necessary (Karch, 2008).

#### Long-Term Pharmacologic Therapy

Although brief pharmacologic treatment of UTIs for 3 days is usually adequate in women, infection recurs in about 20% of women treated for uncomplicated UTIs. Infections that recur within 2 weeks of therapy do so because organisms of the original offending strain remain. Relapses suggest that the source of bacteriuria may be the upper urinary tract or that initial treatment was inadequate or administered for too short a time. Recurrent infections in men are usually caused by persistence of the same organism; further evaluation and treatment are indicated.

Reinfection with new bacteria is the reason for more than 90% of recurrent UTIs in women. If the diagnostic evaluation reveals no structural abnormalities in the urinary tract, the woman with recurrent UTIs may be instructed to begin treatment on her own whenever symptoms occur and to contact her health care provider only when symptoms persist, fever occurs, or the number of treatment episodes exceeds four in a 6-month period. The patient may be taught to use dip-slide culture devices to detect bacteria.

If infection recurs after completing antimicrobial therapy, another short course (3 to 4 days) of full-dose antimicrobial therapy followed by a regular bedtime dose of an antimicrobial agent may be prescribed. If there is no recurrence, medication is taken every other night for 6 to

**Table 45-1 EXAMPLES OF MEDICATIONS USED TO TREAT UTIs AND PYELONEPHRITIS**

| Drug Classes | Generic (Brand) Name | Major Indications |
|---|---|---|
| Antibiotic<br>Cephalosporin (first generation) | Cephalexin (Keflex) | Genitourinary infections |
| Antibiotic | Ampicillin (Principen) | UTI—not commonly used alone due to *Escherichia coli* resistance<br>Pyelonephritis |
| Antibiotic | Amoxicillin (Amoxil) | UTI—not commonly used alone due to *E. coli* resistance |
| Trimethoprim-sulfamethoxazole combination | Cotrimoxazole (TMP-SMZ, Bactrim Septra) | UTI<br>Pyelonephritis |
| Antibiotic<br>Urinary tract anti-infective | Nitrofurantoin (Macrodantin, Furadantin) | UTI |
| Fluoroquinolone<br>Antibiotic | Ciprofloxacin (Cipro) | UTI<br>Pyelonephritis |
| Fluoroquinolone | Levofloxacin (Levaquin) | Uncomplicated UTI |
| Urinary analgesic agent | Phenazopyridine (Pyridium) | For relief of burning, burning, pain and other symptoms associated with UTI |

UTI, urinary tract infection.

Compiled using information from Karch, A. (2008). 2008 *Lippincott's nursing drug guide*. Philadelphia: Lippincott Williams & Wilkins; and Mehnert-Kay, S. A. (2005). Diagnosis and management of uncomplicated urinary tract infections. *American Family Physician*, *72*(3), 451–456.

7 months. Long-term use of antimicrobial agents decreases the risk of reinfection and may be indicated in patients with recurrent infections.

If recurrence is caused by persistent bacteria from preceding infections, the cause (ie, kidney stone, abscess), if known, must be treated. After treatment and sterilization of the urine, low-dose preventive therapy (trimethoprim with or without sulfamethoxazole) each night at bedtime is often prescribed.

Current evidence about the effectiveness of daily intake of cranberry juice to prevent UTIs is inconclusive (McMurdo, Bissett, Price, et al., 2005). Patients who like cranberry juice can be encouraged to include it in their increased fluid intake to help flush bacteria (Dudek, 2006).

## NURSING PROCESS

### The Patient With a Lower Urinary Tract Infection

Nursing care of the patient with a lower UTI focuses on treating the underlying infection and preventing its recurrence.

#### Assessment

A history of signs and symptoms related to UTI is obtained from the patient with a suspected UTI. The presence of pain, frequency, urgency, hesitancy, and changes in urine are assessed, documented, and reported. The patient's usual pattern of voiding is assessed to detect factors that may predispose him or her to UTI. Infrequent emptying of the bladder, the association of symptoms of UTI with sexual intercourse, contraceptive practices, and personal hygiene are assessed. The patient's knowledge about prescribed antimicrobial medications and preventive health care measures is also assessed. Additionally, the urine is assessed for volume, color, concentration, cloudiness, and odor, all of which are altered by bacteria in the urinary tract.

#### Diagnosis

##### Nursing Diagnoses

Based on the assessment data, the nursing diagnoses may include the following:

- Acute pain related to infection within the urinary tract
- Deficient knowledge about factors predisposing the patient to infection and recurrence, detection and prevention of recurrence, and pharmacologic therapy

##### Collaborative Problems/Potential Complications

Based on assessment data, the following complications may develop:

- Sepsis (urosepsis)
- Renal failure, which may occur as the long-term result of either an extensive infective or inflammatory process

#### Planning and Goals

Major goals for the patient may include relief of pain and discomfort, increased knowledge of preventive measures and treatment modalities, and absence of complications.

#### Nursing Interventions

##### Relieving Pain

The pain associated with UTI is quickly relieved once effective antimicrobial therapy is initiated. Antispasmodic agents may also be useful in relieving bladder irritability and pain. Analgesic agents and the application of heat to the perineum help relieve pain and spasm. The patient is encouraged to drink liberal amounts of fluids (water is the best choice) to promote renal blood flow and to flush the bacteria from the urinary tract. Urinary tract irritants (eg, coffee, tea, citrus, spices, colas, alcohol) are avoided. Frequent voiding (every 2 to 3 hours) is encouraged to empty the bladder completely because this can significantly lower urine bacterial counts, reduce urinary stasis, and prevent reinfection.

***Monitoring and Managing Potential Complications***

Early recognition of UTI and prompt treatment are essential to prevent recurrent infection and the possibility of complications, such as renal failure, sepsis (urosepsis), strictures, and obstructions. The goal of treatment is to prevent infection from progressing and causing permanent renal damage and renal failure. Thus, the patient must be taught to recognize early signs and symptoms, to test for bacteriuria, and to initiate treatment as prescribed. Appropriate antimicrobial therapy, liberal fluid intake, frequent voiding, and hygienic measures are commonly prescribed for managing UTIs. The patient is instructed to notify the primary health care provider if fatigue, nausea, vomiting, or pruritus occurs. Periodic monitoring of renal function and evaluation for strictures, obstructions, or stones may be indicated for patients with recurrent UTIs.

Patients with UTIs are at increased risk for gram-negative sepsis. Indwelling catheters should be avoided if possible and removed at the earliest opportunity. However, if an indwelling catheter is necessary, the following specific nursing interventions are initiated to prevent infection and urosepsis:

- Using strict aseptic technique during insertion of the smallest catheter possible
- Securing the catheter with tape to prevent movement
- Frequently inspecting urine color, odor, and consistency
- Performing meticulous daily perineal care with soap and water
- Maintaining a closed system
- Following the manufacturer's instructions when using the catheter port to obtain urine specimens

Careful assessment of vital signs and level of consciousness may alert the nurse to kidney involvement or impending sepsis. Positive blood cultures and elevated WBC counts must be reported immediately. At the same time, appropriate antibiotic therapy and increased fluid intake are prescribed (IV antibiotic therapy and fluids may be required). Aggressive early treatment is the key to reducing the mortality rate associated with gram-negative sepsis, especially in elderly patients.

***Promoting Home and Community-Based Care***

**TEACHING PATIENTS SELF-CARE.** In helping patients learn about and prevent or manage a recurrent UTI, the nurse implements teaching that meets the patient's needs. Health-related behaviors that help prevent recurrent UTIs include practicing careful personal hygiene, increasing fluid intake to promote voiding and dilution of urine, urinating regularly and more frequently, and adhering to the therapeutic regimen. For a detailed discussion of patient teaching, see Chart 45-4.

## Evaluation

***Expected Patient Outcomes***

Expected patient outcomes may include:

1. Experiences relief of pain
   a. Reports absence of pain, urgency, frequency, nocturia, or hesitancy on voiding
   b. Takes analgesic, antispasmodic, and antibiotic agents as prescribed
2. Explains UTIs and their treatment
   a. Demonstrates knowledge of preventive measures and prescribed treatments
   b. Drinks 8 to 10 glasses of fluids daily
   c. Voids every 2 to 3 hours
   d. Produces urine that is clear and odorless
3. Experiences no complications
   a. Reports no symptoms of infection (fever, frequency)
   b. Has normal renal function, negative urine and blood cultures
   c. Exhibits normal vital signs and temperature; no signs or symptoms of sepsis (urosepsis)
   d. Maintains adequate urine output more than 30 mL/h

CHART 45-4 PATIENT EDUCATION

### *Preventing Recurrent Urinary Tract Infections*

**Hygiene**

- Shower rather than bathe in tub because bacteria in the bath water may enter the urethra.
- After each bowel movement, clean the perineum and urethral meatus from front to back. This will help reduce concentrations of pathogens at the urethral opening and, in women, the vaginal opening.

**Fluid Intake**

- Drink liberal amounts of fluids daily to flush out bacteria.
- Avoid coffee, tea, colas, alcohol, and other fluids that are urinary tract irritants.

**Voiding Habits**

- Void every 2 to 3 hours during the day and completely empty the bladder. This prevents overdistention of the bladder and compromised blood supply to the bladder wall. Both predispose the patient to UTI. Precautions expressly for women include voiding immediately after sexual intercourse.

**Therapy**

- Take medication *exactly* as prescribed. Special timing of administration may be required.
- If bacteria continue to appear in the urine, long-term antimicrobial therapy may be required to prevent colonization of the periurethral area and recurrence of infection.
- For recurrent infection, consider acidification of the urine through ascorbic acid (vitamin C), 1000 mg daily, or cranberry juice.
- If prescribed, test urine for presence of bacteria following manufacturer's and health care provider's instructions.
- Notify the primary health care provider if fever occurs or if signs and symptoms persist.
- Consult the primary health care provider regularly for follow-up.

## Upper Urinary Tract Infections

Pyelonephritis is a bacterial infection of the renal pelvis, tubules, and interstitial tissue of one or both kidneys. Causes involve either the upward spread of bacteria from the bladder or spread from systemic sources reaching the kidney via the bloodstream. Pathogenic bacteria from a bladder infection can ascend into the kidney, resulting in pyelonephritis. An incompetent ureterovesical valve or obstruction occurring in the urinary tract increases the susceptibility of the kidneys to infection (see Fig. 45-1), because static urine provides a good medium for bacterial growth. Bladder tumors, strictures, benign prostatic hyperplasia, and urinary stones are some potential causes of obstruction that can lead to infections. Systemic infections (such as tuberculosis) can spread to the kidneys and result in abscesses.

Pyelonephritis may be acute or chronic. Acute pyelonephritis is usually manifested by enlarged kidneys with interstitial infiltrations of inflammatory cells. Abscesses may be noted on or within the renal capsule and at the corticomedullary junction. Eventually, atrophy and destruction of tubules and the glomeruli may result. When pyelonephritis becomes chronic, the kidneys become scarred, contracted, and nonfunctioning. Chronic pyelonephritis is a cause of chronic kidney disease that can result in the need for renal replacement therapies such as transplantation or dialysis (Burrows-Hudson, 2005).

### ACUTE PYELONEPHRITIS

#### Clinical Manifestations

The patient with acute pyelonephritis is acutely ill with chills, fever, leukocytosis, bacteriuria, and pyuria. Low back pain, flank pain, nausea and vomiting, headache, malaise, and painful urination are common findings. Physical examination reveals pain and tenderness in the area of the costovertebral angle (see Chapter 43, Fig. 43-6). In addition, symptoms of lower urinary tract involvement, such as urgency and frequency, are common.

#### Assessment and Diagnostic Findings

An ultrasound study or a CT scan may be performed to locate any obstruction in the urinary tract. Relief of obstruction is essential to prevent the complications and eventual kidney damage. An IV pyelogram may be indicated with pyelonephritis if functional and structural renal abnormalities are suspected (Karpoff & Labus, 2008). Radionuclide imaging with gallium citrate and indium-111 ($^{111}$In)–labeled WBCs may be useful to identify sites of infection that may not be visualized on CT scan or ultrasound. Urine culture and sensitivity tests are performed to determine the causative organism so that appropriate antimicrobial agents can be prescribed.

#### Medical Management

Patients with acute uncomplicated pyelonephritis are most often treated on an outpatient basis if they are not exhibiting dehydration, nausea or vomiting, or symptoms of sepsis. In addition, they must be responsible and reliable to ensure that all medications will be taken as prescribed. For outpatients, a 2-week course of antibiotics is recommended because renal parenchymal disease is more difficult to eradicate than mucosal bladder infections. Commonly prescribed agents include some of the same medications prescribed for the treatment of UTIs (see Table 45-1).

Pregnant women may be hospitalized for 2 or 3 days of parenteral antibiotic therapy. Oral antibiotic agents may be prescribed once the patient is afebrile and showing clinical improvement.

A possible issue in acute pyelonephritis treatment is a chronic or recurring symptomless infection persisting for months or years. After the initial antibiotic regimen, the patient may need antibiotic therapy for up to 6 weeks if a relapse occurs. A follow-up urine culture is obtained 2 weeks after completion of antibiotic therapy to document clearing of the infection.

Hydration with oral or parenteral fluids is essential in all patients with UTIs when there is adequate kidney function. Hydration helps facilitate "flushing" of the urinary tract and reduces pain and discomfort.

### CHRONIC PYELONEPHRITIS

Repeated bouts of acute pyelonephritis may lead to chronic pyelonephritis.

#### Clinical Manifestations

The patient with chronic pyelonephritis usually has no symptoms of infection unless an acute exacerbation occurs. Noticeable signs and symptoms may include fatigue, headache, poor appetite, polyuria, excessive thirst, and weight loss. Persistent and recurring infection may produce progressive scarring of the kidney, resulting in renal failure (see Chapter 44).

#### Assessment and Diagnostic Findings

The extent of the disease is assessed by an IV urogram and measurements of creatinine clearance, blood urea nitrogen, and creatinine levels. Bacteria, if detected in the urine, are eradicated if possible.

#### Complications

Complications of chronic pyelonephritis include end-stage renal disease (from progressive loss of nephrons secondary to chronic inflammation and scarring), hypertension, and formation of kidney stones (from chronic infection with urea-splitting organisms).

#### Medical Management

Long-term use of prophylactic antimicrobial therapy may help limit recurrence of infections and renal scarring. Impaired renal function alters the excretion of antimicrobial agents and necessitates careful monitoring of renal function, especially if the medications are potentially toxic to the kidneys.

#### Nursing Management

The patient may require hospitalization or may be treated as an outpatient. When the patient requires hospitalization, fluid intake and output are carefully measured and recorded. Unless contraindicated, 3 to 4 L of fluids per day is encouraged to

dilute the urine, decrease burning on urination, and prevent dehydration. The nurse assesses the patient's temperature every 4 hours and administers antipyretic and antibiotic agents as prescribed. Symptomatic patients are often more comfortable on bed rest.

Patient teaching focuses on prevention of further infection by consuming adequate fluids, emptying the bladder regularly, and performing recommended perineal hygiene. The importance of taking antimicrobial medications exactly as prescribed is stressed, as is the need for keeping follow-up appointments.

## ADULT VOIDING DYSFUNCTION

Both neurogenic and non-neurogenic disorders can cause adult voiding dysfunction (Table 45-2). The **micturition** (voiding or urination) process involves several highly coordinated neurologic responses that mediate bladder function. A functional urinary system allows for appropriate bladder filling and complete bladder emptying (see Chapter 43). If voiding dysfunction goes undetected and untreated, the upper urinary system may be compromised. Chronic incomplete bladder emptying from poor detrusor pressure results in recurrent bladder infection. Incomplete bladder emptying due to bladder outlet obstruction (such as benign prostatic hyperplasia), causing high-pressure detrusor contractions, can result in hydronephrosis from the high detrusor pressure that radiates up the ureters to the renal pelvis.

### *Urinary Incontinence*

More than 17 million adults in the United States are estimated to have **urinary incontinence** (involuntary loss of urine from the bladder), with most of them experiencing overactive bladder syndrome, making this disorder more prevalent than diabetes or ulcer disease (Vinsnes, Harkless & Nyronning, 2007). Despite widespread media coverage, urinary incontinence remains underdiagnosed and underreported. Patients may be too embarrassed to seek help, causing them to ignore or conceal symptoms. Many patients resort to using absorbent pads or other devices without having their condition properly diagnosed and treated. Health care providers must be alert to subtle cues of urinary incontinence and stay informed about current management strategies.

The cost of urologic care in the United States is more than 11 billion dollars (Carson, 2007). The costs of care for patients with urinary incontinence include the expenses of absorbent products, medications, and surgical or nonsurgical treatment modalities, as well as psychosocial costs (ie, embarrassment, loss of self-esteem, and social isolation).

Although urinary incontinence is commonly regarded as a condition that occurs in older multiparous women, it can occur in young nulliparous women, especially during vigorous high-impact activity. Age, gender, and number of vaginal deliveries are established risk factors that explain, in part, the increased incidence in women (Chart 45-5). Urinary incontinence is a symptom of many possible disorders.

#### Types of Urinary Incontinence

This section provides some of the more common terms used to describe the many types of urinary incontinence (Miller, 2009; Muller, 2005).

*Stress incontinence* is the involuntary loss of urine through an intact urethra as a result of sneezing, coughing, or changing position (Miller, 2009). It predominantly affects women who have had vaginal deliveries and is thought to be the result of decreasing ligament and pelvic floor support of the urethra and decreasing or absent estrogen levels

**Table 45-2 CONDITIONS CAUSING ADULT VOIDING DYSFUNCTION**

| Condition | Voiding Dysfunction | Treatment |
|---|---|---|
| **Neurogenic Disorders** | | |
| Cerebellar ataxia | Incontinence or dyssynergia | Timed voiding; anticholinergic agents |
| Cerebrovascular accident | Retention or incontinence | Anticholinergic agents; bladder retraining |
| Dementia | Incontinence | Prompted voiding; anticholinergic agents |
| Diabetes mellitus | Incontinence and/or incomplete bladder emptying | Timed voiding; EMG/biofeedback; pelvic floor nerve stimulation; anticholinergic/antispasmodic agents; well-controlled blood glucose levels |
| Multiple sclerosis | Incontinence or incomplete bladder emptying | Timed voiding; EMG/biofeedback to learn pelvic muscle exercises and urge inhibition; pelvic floor nerve stimulation; antispasmodic agents |
| Parkinson's disease | Incontinence | Anticholinergic/antispasmodic agents |
| **Spinal Cord Dysfunction** | | |
| Acute injury | Urinary retention | Indwelling catheter |
| Degenerative disease | Incontinence and/or incomplete bladder emptying | EMG/biofeedback; pelvic floor nerve stimulation; anticholinergic agents |
| **Non-Neurogenic Disorders** | | |
| "Bashful bladder" | Inability to initiate voiding in public bathrooms | Relaxation therapy; EMG/biofeedback |
| Overactive bladder | Urgency, frequency, and/or urge incontinence | EMG/biofeedback; pelvic floor nerve stimulation; bladder drill (see Chart 45-8); anticholinergic agents |
| Post-general surgery | Acute urine retention | Catheterization |
| Postprostatectomy | Incontinence | *Mild:* biofeedback; bladder drill (see Chart 45-8); pelvic floor nerve stimulation<br>*Moderate/severe:* surgery—artificial sphincter |
| Stress incontinence | Incontinence with cough, laugh, sneeze, position change | *Mild:* biofeedback: bladder drill (see Chart 45-8); periurethral bulking with collagen<br>*Moderate/severe:* surgery |

CHART 45-5

### Risk Factors for Urinary Incontinence

- Pregnancy: vaginal delivery, episiotomy
- Menopause
- Genitourinary surgery
- Pelvic muscle weakness
- Incompetent urethra due to trauma or sphincter relaxation
- Immobility
- High-impact exercise
- Diabetes mellitus
- Stroke
- Age-related changes in the urinary tract
- Morbid obesity
- Cognitive disturbances: dementia, Parkinson's disease
- Medications: diuretics, sedatives, hypnotics, opioids
- Caregiver or toilet unavailable

within the urethral walls and bladder base. In men, stress incontinence is often experienced after a radical prostatectomy for prostate cancer because of the loss of urethral compression that the prostate had supplied before the surgery, and possibly bladder wall irritability.

*Urge incontinence* is the involuntary loss of urine associated with a strong urge to void that cannot be suppressed. The patient is aware of the need to void but is unable to reach a toilet in time (Miller, 2009). An uninhibited detrusor contraction is the precipitating factor. This can occur in a patient with neurologic dysfunction that impairs inhibition of bladder contraction or in a patient without overt neurologic dysfunction.

*Functional incontinence* refers to those instances in which lower urinary tract function is intact but other factors, such as severe cognitive impairment (eg, Alzheimer's dementia), make it difficult for the patient to identify the need to void or physical impairments make it difficult or impossible for the patient to reach the toilet in time for voiding.

*Iatrogenic incontinence* refers to the involuntary loss of urine due to extrinsic medical factors, predominantly medications. One such example is the use of alpha-adrenergic agents to decrease blood pressure. In some people with an intact urinary system, these agents adversely affect the alpha receptors responsible for bladder neck closing pressure; the bladder neck relaxes to the point of incontinence with a minimal increase in intra-abdominal pressure, thus mimicking stress incontinence. As soon as the medication is discontinued, the apparent incontinence resolves.

*Mixed urinary incontinence*, which encompasses several types of urinary incontinence, is involuntary leakage associated with urgency and also with exertion, effort, sneezing, or coughing (Miller, 2009).

Only with appropriate recognition of the problem, assessment, and referral for diagnostic evaluation and treatment can the outcome of incontinence be determined. All people with incontinence should be considered for evaluation and treatment.

## Gerontologic Considerations

Although urinary incontinence is not a normal consequence of aging, age-related changes in the urinary tract do predispose the older person to incontinence. However, if nurses and other health care providers accept incontinence as an inevitable part of illness or aging or consider it irreversible and untreatable, it cannot be treated successfully. Collaborative, interdisciplinary efforts are essential in assessing and effectively treating urinary incontinence (Specht, 2005). Chart 45-6 presents research about improving urinary incontinence in frail elderly patients. Urinary incontinence can decrease an elderly person's ability to maintain an independent lifestyle, which increases dependence on caregivers and may lead to institutionalization. Between 25% and 50% of all nursing home residents have urinary incontinence.

CHART 45-6

### NURSING RESEARCH PROFILE
### Improving Urinary Incontinence in Frail Elderly Patients

Vinsnes, A. G., Harkless, G. E. & Nyronning, S. (2007). Unit-based intervention to improve urinary incontinence in frail elderly. *Journal of Nursing Research & Clinical Studies, 27*(3), 53–56.

#### Purpose

Of the many health challenges that frail elderly people face, urinary incontinence is one of the most common. The purpose of this study was to determine the effect of a unit-based educational program in a nursing home on urinary incontinence in frail elderly people.

#### Design

This quantitative study used a quasi-experimental design and involved 18 patients (16 women, 2 men) with a mean age of 83 years who were all experiencing urinary incontinence before the study began. The intervention was a systemic educational program for staff delivered over 14 weeks, which included regular coaching about caring for elders with urinary incontinence. Outcome measures were postvoid residual urine volumes, urinary pad weights, oral fluid intake patterns, and urinary tract infections.

#### Findings

The education sessions were successful. Both the average and maximum incontinence pads weighed less following the intervention. Average postvoiding residual urine did not change, but the average minimum amount per resident decreased in volume. Daily fluid volume intake remained the same; however, more patients received drinks at night after the intervention with no subsequent increase in overall amount of incontinence.

#### Nursing Implications

This small study demonstrates the potential of using a unit-based educational program to improve care and change outcomes for patients. Future work is needed to expand the research to a larger, more diverse patient population; develop better tools and strategies for investigation; and enhance treatment and evaluation methods in the frail elderly population.

Many older people experience transient episodes of incontinence that tend to be abrupt in onset. When this occurs, the nurse should question the patient, as well as the family if possible, about the onset of symptoms and any signs or symptoms of a change in other organ systems. Acute UTI, infection elsewhere in the body, constipation, decreased fluid intake, and a change in a chronic disease pattern, such as elevated blood glucose levels in patients with diabetes or decreased estrogen levels in menopausal women, can provoke the onset of urinary incontinence. If the cause is identified and modified or eliminated early at the onset of incontinence, the incontinence itself may be eliminated. Although the bladder of the older person is more vulnerable to altered detrusor activity, age alone is not a risk factor for urinary incontinence (Vinsnes, et al., 2007).

Decreased bladder muscle tone is a normal age-related change found in the elderly. This leads to decreased bladder capacity, increased residual urine, and an increase in urgency (Miller, 2009).

Many medications affect urinary continence in addition to causing other unwanted or unexpected effects. All medications need to be assessed for potential interactions.

## Assessment and Diagnostic Findings

Once incontinence is recognized, a thorough history is necessary. This includes a detailed description of the problem and a history of medication use. The patient's voiding history, a diary of fluid intake and output, and bedside tests (eg, residual urine, stress maneuvers) may be used to help determine the type of urinary incontinence involved. Extensive urodynamic tests may be performed (see Chapter 43). Urinalysis and urine culture are performed to identify infection.

Urinary incontinence may be transient or reversible if the underlying cause is successfully treated and the voiding pattern reverts to normal. Chart 45-7 provides causes of transient incontinence.

## Medical Management

Management depends on the type of urinary incontinence and its causes. Management of urinary incontinence may be behavioral, pharmacologic, or surgical.

### Behavioral Therapy

Behavioral therapies are the first choice to decrease or eliminate urinary incontinence (Chart 45-8). In using these techniques, health care professionals help patients avoid potential adverse effects of pharmacologic or surgical interventions. Pelvic floor muscle exercises (sometimes called Kegel exercises) represent the cornerstone of behavioral intervention for addressing symptoms of stress, urge, and mixed incontinence. Other behavioral treatments include use of a voiding diary, biofeedback, verbal instruction (prompted voiding), and physical therapy (Miller, 2009).

### Pharmacologic Therapy

Pharmacologic therapy works best when used as an adjunct to behavioral interventions. Anticholinergic agents inhibit bladder contraction and are considered first-line medications for urge incontinence. Several tricyclic antidepressant medications (eg, amitriptyline [Endep], amoxapine [Asendin]) can also decrease bladder contractions as well as increase bladder neck resistance (Karch, 2008). Pseudoephedrine sulfate (Sudafed), which acts on alpha-adrenergic receptors, causing urinary retention, may be used to treat stress incontinence; it needs to be used with caution in men with prostatic hyperplasia. Hormone therapy (eg, estrogen) taken orally, transdermally, or topically was once the treatment of choice for urinary incontinence in postmenopausal women because it restores the mucosal, vascular, and muscular integrity of the urethra. However, the results of the Women's Health Initiative showed that after 1 year of therapy, incontinence had increased, especially in women taking estrogen alone compared to placebo (Mennick, 2005). More research is needed in this area.

### Surgical Management

Surgical correction may be indicated in patients who have not achieved continence using behavioral and pharmacologic therapy. Surgical options vary according to the underlying anatomy and the physiologic problem. Most procedures involve lifting and stabilizing the bladder or urethra to restore the normal urethrovesical angle or to lengthen the urethra.

Women with stress incontinence may undergo an anterior vaginal repair, retropubic suspension, or needle suspension to reposition the urethra. Procedures to compress the urethra and increase resistance to urine flow include sling procedures and placement of periurethral bulking agents such as artificial collagen.

Periurethral bulking is a semipermanent procedure in which small amounts of artificial collagen are placed within the walls of the urethra to enhance the closing pressure of the urethra. This procedure takes only 10 to 20 minutes and may be performed under local anesthesia or moderate sedation. A cystoscope is inserted into the urethra. An instrument is inserted through the cystoscope to deliver a small amount of collagen into the urethral wall at locations selected by the urologist. The patient is usually discharged home after voiding. There are no restrictions following the procedure, although occasionally more than one collagen bulking session may be necessary if the initial procedure did not halt stress incontinence. Collagen placement anywhere in the body is considered semipermanent because its durability averages between 12 and 24 months, until the body absorbs the material. Periurethral bulking with collagen offers an alternative to surgery, as in a frail, elderly person.

**Chart 45-7 • *Causes of Transient Incontinence: DIAPPERS***

**D**elirium
**I**nfection of urinary tract
**A**trophic vaginitis, urethritis
**P**harmacologic agents (anticholinergic agents, sedatives, alcohol, analgesic agents, diuretics, muscle relaxants, adrenergic agents)
**P**sychological factors (depression, regression)
**E**xcessive urine production (increased intake, diabetes insipidus, diabetic ketoacidosis)
**R**estricted activity
**S**tool impaction

## Chart 45-8 • *Behavioral Interventions for Urinary Incontinence*

Behavioral strategies are largely carried out, coordinated, and monitored by the nurse. These interventions may or may not be augmented by the use of medications.

### Fluid Management

An adequate daily fluid intake of approximately 50 to 60 ounces (1500 to 1600 mL), taken as small increments between breakfast and the evening meal, helps to reduce urinary urgency related to concentrated urine production, decreases the risk of urinary tract infection, and maintains bowel functioning. (Constipation, resulting from inadequate daily fluid intake, can increase urinary urgency and urine retention.) The best fluid is water. Fluids containing caffeine, carbonation, alcohol, or artificial sweetener should be avoided because they irritate the bladder wall, thus resulting in urinary urgency. Some patients who have heart failure or end-stage renal disease need to discuss their daily fluid limit with their primary health care provider.

### Standardized Voiding Frequency

After establishing a patient's natural voiding and urinary incontinence tendencies, voiding on a schedule can be very effective in those with and without cognitive impairment, although patients with cognitive impairment may require assistance with this technique from nursing personnel or family members. The object is to purposely empty the bladder before the bladder reaches the critical volume that would cause an urge or stress incontinence episode. This approach involves the following:

- **Timed voiding** involves establishing a set voiding frequency (such as every 2 hours if incontinent episodes tend to occur 2 or more hours after voiding). The individual chooses to "void by the clock" at the given interval while awake, rather than wait until a voiding urge occurs.
- **Prompted voiding** is timed voiding that is carried out by staff or family members when the individual has cognitive difficulties that make it difficult to remember to void at set intervals. The caregiver checks the patient to assess if he or she has remained dry and, if so, assists the patient to use the bathroom while providing positive reinforcement for remaining dry.
- **Habit retraining** is timed voiding at an interval that is more frequent than the individual would usually choose. This technique helps to restore the sensation of the need to void in individuals who are experiencing diminished sensation of bladder filling due to various medical conditions such as a mild cerebrovascular accident (CVA).
- **Bladder retraining,** also known as "bladder drill," incorporates a timed voiding schedule and urinary urge inhibition exercises to inhibit voiding, or leaking urine, in an attempt to remain dry for a set time. When the first timing interval is easily reached on a consistent basis without urinary urgency or incontinence, a new voiding interval, usually 10 to 15 minutes beyond the last, is established. Again, the individual practices urge inhibition exercises to delay voiding or avoid incontinence until the next preset interval arrives. When an acceptable voiding interval is reached, the patient continues that timed voiding sequence throughout the day.

### Pelvic Muscle Exercise (PME)

Also known as Kegel exercises, PME aims to strengthen the voluntary muscles that assist in bladder and bowel continence in both men and women. Research shows that written or verbal instruction alone is usually inadequate to teach an individual how to identify and strengthen the pelvic floor for sufficient bladder and bowel control. Biofeedback-assisted PME uses either electromyography or manometry to help the individual identify the pelvic muscles as he or she attempts to learn which muscle group is involved when performing PME. The biofeedback method also allows assessment of the strength of this muscle area.

PME involves gently tightening the same muscles used to stop flatus or the stream of urine for 5- to 10-second increments, followed by 10-second resting phases. To be effective, these exercises need to be performed two or three times a day for at least 6 weeks. Depending on the strength of the pelvic musculature when initially evaluated, anywhere from 10 to 30 repetitions of PME are prescribed at each session. Elderly patients may need to exercise for an even longer time to strengthen the pelvic floor muscles. Pelvic muscle exercises are helpful for women with stress, urge, or mixed incontinence and for men who have undergone prostate surgery.

### Vaginal Cone Retention Exercises

Vaginal cone retention exercises are an adjunct to the Kegel exercises. Vaginal cones of varying weight are inserted intravaginally twice a day. The patient tries to retain the cone for 15 minutes by contracting the pelvic muscles.

### Transvaginal or Transrectal Electrical Stimulation

Commonly used to treat urinary incontinence, electrical stimulation is known to elicit a passive contraction of the pelvic floor musculature, thus re-educating these muscles to provide enhanced levels of continence. This modality is often used with biofeedback-assisted pelvic muscle exercise training and voiding schedules. At high frequencies, it is effective for stress incontinence. At low frequencies, electrical stimulation can also relieve symptoms of urinary urgency, frequency, and urge incontinence. Intermediate ranges are used for mixed incontinence.

### Neuromodulation

Neuromodulation via transvaginal or transrectal nerve stimulation of the pelvic floor inhibits detrusor overactivity and hypersensory bladder signals and strengthens weak sphincter muscles.

It is also an option for people who are seeking help with stress incontinence who prefer to avoid surgery and who do not have access to behavioral therapies.

An artificial urinary sphincter can be used to close the urethra and promote continence. Two types of artificial sphincters are a periurethral cuff and a cuff inflation pump.

Men with overflow and stress incontinence may undergo a transurethral resection to relieve symptoms of prostatic enlargement. An artificial sphincter can be used after prostatic surgery for sphincter incompetence (Fig. 45-2). After surgery, periurethral bulking agents can be injected into the periurethral area to increase compression of the urethra.

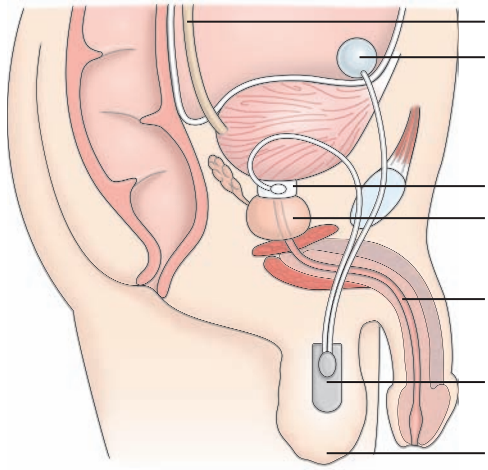



**Figure 45-2** Male artificial urinary sphincter. An inflatable cuff is inserted surgically around the urethra or neck of the bladder. To empty the bladder, the cuff is deflated by squeezing the control pump located in the scrotum.

### Nursing Management

Nursing management is based on the premise that incontinence is not inevitable with illness or aging and that it is often reversible and treatable. The nursing interventions are determined in part by the type of treatment that is undertaken. For behavioral therapy to be effective, the nurse must provide support and encouragement, because it is easy for the patient to become discouraged if therapy does not quickly improve the level of continence. Patient teaching is important and should be provided verbally and in writing (Chart 45-9). The patient should be taught to develop and use a log or diary to record timing of pelvic floor muscle exercises, frequency of voiding, any changes in bladder function, and any episodes of incontinence (Miller, 2009).

If pharmacologic treatment is used, its purpose is explained to the patient and family. It is important to tell patients with mixed incontinence that anticholinergic and antispasmodic agents can help decrease urinary urgency and frequency and urge incontinence but do not decrease the urinary incontinence related to stress incontinence. If surgical correction is undertaken, the procedure and its desired outcomes are described to the patient and family. Follow-up contact with the patient enables the nurse to answer the patient's questions and to provide reinforcement and encouragement.

## Urinary Retention

Urinary retention is the inability to empty the bladder completely during attempts to void. Chronic urine retention often leads to **overflow incontinence** (from the pressure of the retained urine in the bladder). **Residual urine** is urine that remains in the bladder after voiding. In a healthy adult younger than 60 years of age, complete bladder emptying should occur with each voiding. In adults older than 60 years of age, 50 to 100 mL of residual urine may remain after each voiding because of the decreased contractility of the detrusor muscle.

Urinary retention can occur postoperatively in any patient, particularly if the surgery affected the perineal or anal regions and resulted in reflex spasm of the sphincters. General anesthesia reduces bladder muscle innervation and suppresses the urge to void, impeding bladder emptying.

### Pathophysiology

Urinary retention may result from diabetes, prostatic enlargement, urethral pathology (infection, tumor, calculus), trauma (pelvic injuries), pregnancy, or neurologic disorders such as stroke, spinal cord injury, multiple sclerosis, or Parkinson's disease. Some medications cause urinary retention, either by inhibiting bladder contractility or by increasing bladder outlet resistance (Karch, 2008).

### Assessment and Diagnostic Findings

The assessment of a patient for urinary retention is multifaceted because the signs and symptoms are challenging to detect. The following questions serve as a guide in assessment:

- What was the time of the last voiding, and how much urine was voided?
- Is the patient voiding small amounts of urine frequently?
- Is the patient dribbling urine?
- Does the patient complain of pain or discomfort in the lower abdomen? (Discomfort may be relatively mild if the bladder distends slowly.)
- Is the pelvic area rounded and swollen (could indicate urine retention and a distended bladder)?

**CHART 45-9** PATIENT EDUCATION
***Strategies for Promoting Urinary Continence***

- Increase your awareness of the amount and timing of all fluid intake.
- Avoid taking diuretics after 4 PM.
- Avoid bladder irritants, such as caffeine, alcohol, and aspartame (NutraSweet).
- Take steps to avoid constipation: Drink adequate fluids, eat a well-balanced diet high in fiber, exercise regularly, and take stool softeners if recommended.
- Void regularly, five to eight times a day (about every 2 to 3 hours):
  - First thing in the morning
  - Before each meal
  - Before retiring to bed
  - Once during the night if necessary
- Perform all pelvic floor muscle exercises as prescribed, every day.
- Stop smoking (smokers usually cough frequently, which increases incontinence).

- Does percussion of the suprapubic region elicit dullness (possibly indicating urine retention and a distended bladder)?
- Are other indicators of urinary retention present, such as restlessness and agitation?
- Does a postvoid bladder ultrasound test reveal residual urine?

The patient may verbalize an awareness of bladder fullness and a sensation of incomplete bladder emptying. Signs and symptoms of UTI (hematuria, urgency, frequency, and nocturia) may be present. A series of urodynamic studies, described in Chapter 43, may be performed to identify the type of bladder dysfunction and to aid in determining appropriate treatment. A voiding diary can be used to provide a written record of the amount of urine voided and the frequency of voiding. Postvoid residual urine may be assessed either using straight catheterization or an ultrasound bladder scanner and is considered diagnostic of urinary retention if there is more than 100 mL of residual urine.

## Complications

Urine retention can lead to chronic infections that if unresolved predispose the patient to renal calculi (urolithiasis or nephrolithiasis), pyelonephritis, sepsis, or hydronephrosis. In addition, urine leakage can lead to perineal skin breakdown, especially if regular hygiene measures are neglected.

## Nursing Management

Strategies are instituted to prevent overdistention of the bladder and to treat infection or correct obstruction. However, many complications can be prevented with careful assessment and appropriate nursing interventions. The nurse explains to the patient why normal voiding is not occurring and monitors urine output closely. The nurse also provides reassurance about the temporary nature of retention and successful management strategies.

### *Promoting Urinary Elimination*

Nursing measures to encourage normal voiding patterns include providing privacy, ensuring an environment and body position conducive to voiding, and assisting the patient with the use of the bathroom or bedside commode, rather than a bedpan, to provide a more natural setting for voiding. If his condition allows, the male patient may stand beside the bed to use the urinal; most men find this position more comfortable and natural.

Additional measures include applying warmth to relax the sphincters (ie, sitz baths, warm compresses to the perineum, showers), giving the patient hot tea, and offering encouragement and reassurance. Simple trigger techniques, such as turning on the water faucet while the patient is trying to void, may also be used. Other examples of trigger techniques are stroking the abdomen or inner thighs, tapping above the pubic area, and dipping the patient's hands in warm water. After surgery or childbirth, prescribed analgesic agents should be administered because pain in the perineal area can make voiding difficult. A combination of techniques may be necessary to initiate voiding.

When the patient cannot void, catheterization is used to prevent overdistention of the bladder (see later discussion of neurogenic bladder and catheterization). In the case of prostatic obstruction, attempts at catheterization (by the urologist) may not be successful, requiring insertion of a **suprapubic catheter** (catheter inserted through a small abdominal incision into the bladder). After urinary drainage is restored, bladder retraining is initiated for the patient who cannot void spontaneously.

### *Promoting Home and Community-Based Care*

In addition to the strategies listed for promoting urinary continence found in Chart 45-9, modifications to the home environment can provide simple and effective ways to assist in treating urinary incontinence and retention. For example, the patient may need to remove obstacles, such as throw rugs or other objects, to provide easy, safe access to the bathroom. Other modifications that the nurse may recommend include installing support bars in the bathroom; placing a bedside commode, bedpan, or urinal within easy reach; leaving lights on in the bedroom and bathroom; and wearing clothing that is easy to remove quickly.

# *Neurogenic Bladder*

**Neurogenic bladder** is a dysfunction that results from a lesion of the nervous system and leads to urinary incontinence. It may be caused by spinal cord injury, spinal tumor, herniated vertebral disk, multiple sclerosis, congenital disorders (spina bifida or myelomeningocele), infection, or complications of diabetes mellitus (see Chapters 41, 63, and 64).

## Pathophysiology

The two types of neurogenic bladder are spastic (or reflex) bladder and flaccid bladder. Spastic bladder is the more common type and is caused by any spinal cord lesion above the voiding reflex arc (upper motor neuron lesion). The result is a loss of conscious sensation and cerebral motor control. A spastic bladder empties on reflex, with minimal or no controlling influence to regulate its activity.

Flaccid bladder is caused by a lower motor neuron lesion, commonly resulting from trauma. This form of neurogenic bladder is also increasingly being recognized in patients with diabetes mellitus. The bladder continues to fill and becomes greatly distended, and overflow incontinence occurs. The bladder muscle does not contract forcefully at any time. Because sensory loss may accompany a flaccid bladder, the patient feels no discomfort.

## Assessment and Diagnostic Findings

Evaluation for neurogenic bladder involves measurement of fluid intake, urine output, and residual urine volume; urinalysis; and assessment of sensory awareness of bladder fullness and degree of motor control. Comprehensive urodynamic studies are also performed.

## Complications

The most common complication of neurogenic bladder is infection resulting from urinary stasis and catheterization. Long-term complications include urolithiasis (stones in the urinary tract), vesicoureteral reflux, and hydronephrosis, all of which can lead to destruction of the kidney.

## Medical Management

The problems resulting from neurogenic bladder disorders vary considerably from patient to patient and are a major challenge to the health care team. Several long-term objectives appropriate for all types of neurogenic bladders include preventing overdistention of the bladder, emptying the bladder regularly and completely, maintaining urine sterility with no stone formation, and maintaining adequate bladder capacity with no reflux.

Specific interventions include continuous, intermittent, or self-catheterization (discussed later in this chapter); use of an external condom-type catheter; a diet low in calcium (to prevent calculi); and encouragement of mobility and ambulation. A liberal fluid intake is encouraged to reduce the urinary bacterial count, reduce stasis, decrease the concentration of calcium in the urine, and minimize the precipitation of urinary crystals and subsequent stone formation.

A bladder retraining program may be effective in treating a spastic bladder or urine retention. Use of a timed, or habit, voiding schedule may be established. To further enhance emptying of a flaccid bladder, the patient may be taught to "double void." After each voiding, the patient is instructed to remain on the toilet, relax for 1 to 2 minutes, and then attempt to void again in an effort to further empty the bladder.

### *Pharmacologic Therapy*

Parasympathomimetic medications, such as bethanechol (Urecholine), may help to increase the contraction of the detrusor muscle.

### *Surgical Management*

In some cases, surgery may be carried out to correct bladder neck contractures or vesicoureteral reflux or to perform some type of urinary diversion procedure.

## Catheterization

WATCH & LEARN PRACTICE & LEARN

In patients with a urologic disorder or with marginal kidney function, care must be taken to ensure that urinary drainage is adequate and that kidney function is preserved. When urine cannot be eliminated naturally and must be drained artificially, catheters may be inserted directly into the bladder, the ureter, or the renal pelvis (Senese, Hendricks, Morrison, et al., 2006). Catheters vary in size, shape, length, material, and configuration. The type of catheter used depends on its purpose.

Catheterization is performed to achieve the following:

- Relieve urinary tract obstruction
- Assist with postoperative drainage in urologic and other surgeries
- Provide a means to monitor accurate urine output in critically ill patients
- Promote urinary drainage in patients with neurogenic bladder dysfunction or urine retention
- Prevent urinary leakage in patients with stage III to IV pressure ulcers (see Chapter 11)

A patient should be catheterized only if necessary, because catheterization commonly leads to UTI. Catheters impede most of the natural defenses of the lower urinary tract by obstructing the periurethral ducts, irritating the bladder mucosa, and providing an artificial route for organisms to enter the bladder. Organisms may be introduced from the urethra into the bladder during catheterization, or they may migrate along the epithelial surface of the urethra or external surface of the catheter. In addition, urinary catheters have been associated with other complications, such as bladder spasms, urethral strictures, and pressure necrosis.

### Indwelling Catheters

When an indwelling catheter cannot be avoided, a closed drainage system is essential. This drainage system is designed to prevent any disconnections, thereby reducing the risk of contamination. Triple-lumen catheters are commonly used after transurethral prostate surgery (see Chapter 49). This system has a triple-lumen indwelling urethral catheter attached to a closed sterile drainage system. With the triple-lumen catheter, urinary drainage occurs through one channel. The retention balloon of the catheter is inflated with water or air through the second channel, and the bladder is continuously irrigated with sterile irrigating solution through the third channel.

The spout (or drainage port) of any urinary drainage bag can become contaminated when opened to drain the bag. Bacteria enter the urinary drainage bag, multiply rapidly, and then migrate to the drainage tubing, catheter, and bladder. By keeping the drainage bag lower than the patient's bladder and not allowing urine to flow back into the bladder, this risk is reduced.

### Suprapubic Catheters

Suprapubic catheterization allows bladder drainage by inserting a catheter or tube into the bladder through a suprapubic (above the pubis) incision or puncture (Fig. 45-3). The catheter or suprapubic drainage tube is then threaded into the bladder and secured with sutures or tape, and the area around the catheter is covered with a sterile dressing. The catheter is connected to a sterile closed drainage system, and the tubing is secured to prevent tension on the catheter. This may be a temporary measure to divert the flow of urine from the urethra when the urethral route is impassable (because of injuries, strictures, prostatic obstruction), after gynecologic or other abdominal surgery when bladder dysfunction is likely to occur, and occasionally after pelvic fractures.

Suprapubic bladder drainage may be maintained continuously for several weeks. When the patient's ability to void is to be tested, the catheter is clamped for 4 hours, during which time the patient attempts to void. After the patient voids, the catheter is unclamped, and the residual urine is measured. If the amount of residual urine is less than 100 mL on two separate occasions (morning and evening), the catheter is usually removed. However, if the patient complains of pain or discomfort, the suprapubic catheter is usually left in place until the patient can void successfully.

Suprapubic drainage offers certain advantages. Patients can usually void sooner after surgery than those with urethral catheters, and they may be more comfortable. The catheter allows greater mobility, permits measurement of

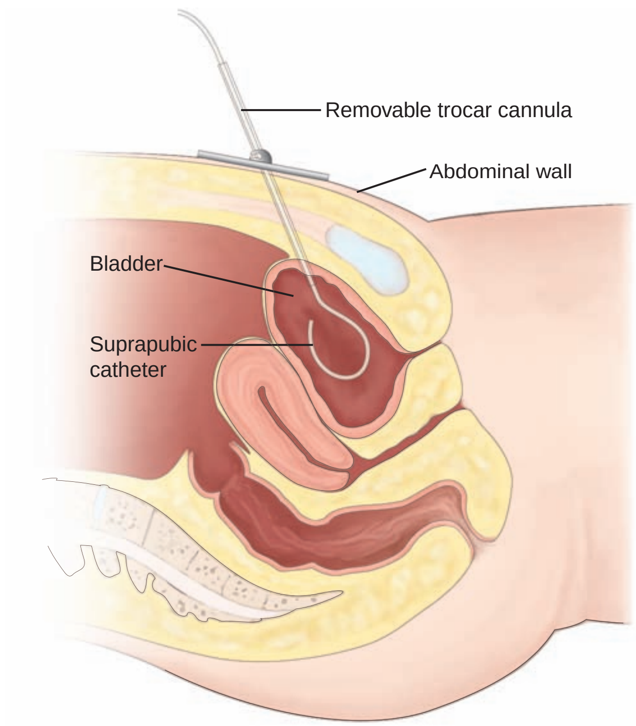



**Figure 45-3** Suprapubic bladder drainage. A trocar cannula is used to puncture the abdominal and bladder walls. The catheter is threaded through the trocar cannula, which is then removed, leaving the catheter in place. The catheter is secured by tape or sutures to prevent unintentional removal.

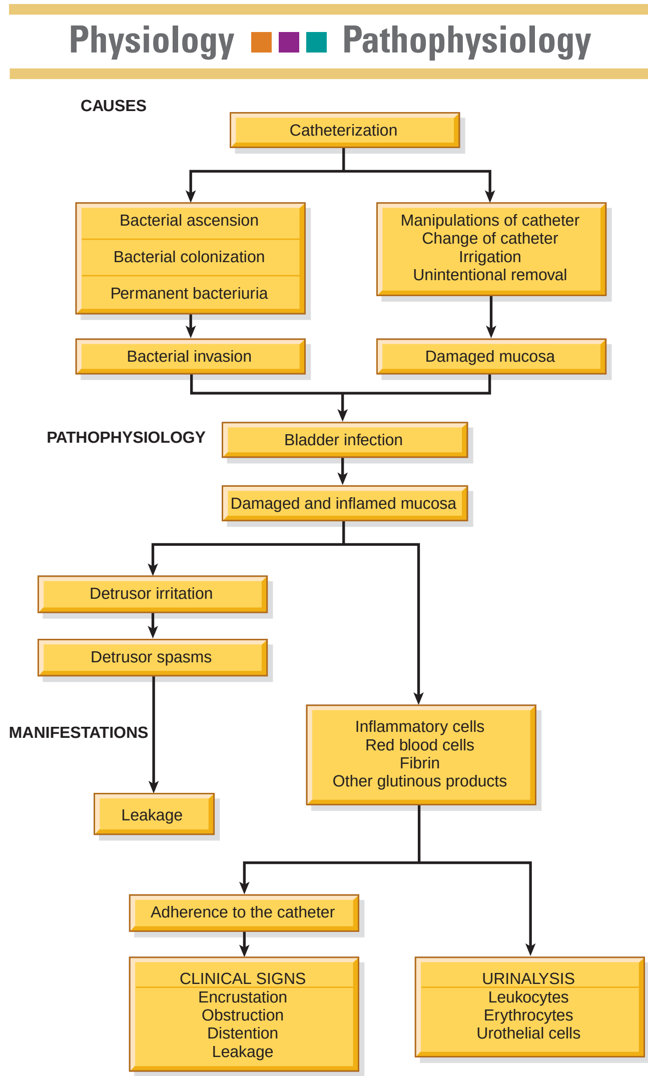



**Figure 45-4** Pathophysiology and manifestations of bladder infection with long-term catheterization in elderly patients.

residual urine without urethral instrumentation, and presents less risk of bladder infection. The suprapubic catheter is removed when it is no longer required, and a sterile dressing is placed over the site.

The patient requires liberal amounts of fluid to prevent encrustation around the catheter. Other potential problems include the formation of bladder stones, acute and chronic infections, and problems collecting urine. A wound care specialist/enterostomal therapist, also referred to as a wound-ostomy-continence nurse (WOCN), may be consulted to assist the patient and family in selecting the most suitable urine collection system and to teach them about its use and care.

## Nursing Management

### *Assessing the Patient and the System*

For patients with indwelling catheters, the nurse assesses the drainage system to ensure that it provides adequate urinary drainage. The color, odor, and volume of urine are also monitored. An accurate record of fluid intake and urine output provides essential information about the adequacy of renal function and urinary drainage.

Patients at high risk for UTI from catheterization need to be identified and monitored carefully. These include women; older adults; and patients who are debilitated, malnourished, chronically ill, immunosuppressed, or have diabetes. They are observed for signs and symptoms of UTI: cloudy malodorous urine, hematuria, fever, chills, anorexia, and malaise. Any drainage and excoriation in the area around the urethral orifice is noted. Urine cultures provide the most accurate means of assessing a patient for infection.

#### Gerontologic Considerations

The elderly patient with an indwelling catheter may not exhibit the typical signs and symptoms of infection. Therefore, any subtle change in physical condition or mental status must be considered a possible indication of infection and promptly investigated because sepsis may occur before the infection is diagnosed. Figure 45-4 summarizes the sequence of events leading to infection and leakage of urine that often follow long-term use of an indwelling catheter in an elderly patient.

### *Preventing Infection*

Certain principles of care are essential to prevent infection in patients with a closed urinary drainage system (Chart 45-10). The catheter is a foreign body in the urethra and produces a reaction in the urethral mucosa with some urethral discharge.

## Chart 45-10 • *Preventing Infection in the Patient With an Indwelling Urinary Catheter*

- Use scrupulous aseptic technique during insertion of the catheter. Use a preassembled, sterile, closed urinary drainage system.
- To prevent contamination of the closed system, *never* disconnect the tubing. The drainage bag must *never* touch the floor. The bag and collecting tubing are changed if contamination occurs, if urine flow becomes obstructed, or if tubing junctions start to leak at the connections.
- If the collection bag *must* be raised above the level of the patient's bladder, clamp the drainage tube. This prevents backflow of contaminated urine into the patient's bladder from the bag.
- Ensure a free flow of urine to prevent infection. Improper drainage occurs when the tubing is kinked or twisted, allowing pools of urine to collect in the tubing loops.
- To reduce the risk of bacterial proliferation, empty the collection bag at least every 8 hours through the drainage spout—more frequently if there is a large volume of urine.
- Avoid contamination of the drainage spout. A receptacle in which to empty the bag is provided for each patient.
- Never irrigate the catheter routinely. If the patient is prone to obstruction from clots or large amounts of sediment, use a three-way system with continuous irrigation.
- Never disconnect the tubing to obtain urine samples, to irrigate the catheter, or to ambulate or transport the patient.
- Never leave the catheter in place longer than is necessary.
- Avoid routine catheter changes. The catheter is changed only to correct problems such as leakage, blockage, or encrustations.
- Avoid unnecessary handling or manipulation of the catheter by the patient or staff.
- Carry out hand hygiene before and after handling the catheter, tubing, or drainage bag.
- Wash the perineal area with soap and water at least twice a day; avoid a to-and-fro motion of the catheter. Dry the area well, but avoid applying powder because it may irritate the perineum.
- Monitor the patient's voiding when the catheter is removed. The patient must void within 8 hours; if unable to void, the patient may require catheterization with a straight catheter.
- Obtain a urine specimen for culture at the first sign of infection.

Vigorous cleansing of the meatus while the catheter is in place is discouraged because the cleansing action can move the catheter back and forth, increasing the risk of infection. To remove obvious encrustations from the external catheter surface, the area is washed gently with soap during the daily bath. The catheter is anchored as securely as possible to prevent it from moving in the urethra. Encrustations arising from urinary salts may serve as a nucleus for stone formation; however, using silicone catheters results in significantly less crust formation.

A liberal fluid intake, within the limits of the patient's cardiac and renal reserve, and an increased urine output must be ensured to flush the catheter and to dilute urinary substances that might form encrustations (Senese, et al., 2006).

Urine cultures are obtained as prescribed or indicated when monitoring the patient for infection; many catheters have an aspiration (puncture) port from which a specimen can be obtained.

Bacteriuria is considered inevitable in patients with indwelling catheters; therefore, controversy remains about the usefulness of taking cultures and treating asymptomatic bacteriuria, because overtreatment may lead to resistant strains of bacteria. Continual observation for fever, chills, and other signs and symptoms of systemic infection is necessary. Infections are treated aggressively.

### Minimizing Trauma

Trauma to the urethra can be minimized by:

- Using an appropriate-sized catheter
- Lubricating the catheter adequately with a water-soluble lubricant during insertion
- Inserting the catheter far enough into the bladder to prevent trauma to the urethral tissues when the retention balloon of the catheter is inflated

Manipulation of the catheter is the most common cause of trauma to the bladder mucosa in the catheterized patient. Infection can occur when urine invades the damaged mucosa.

The catheter is secured properly to prevent it from moving, causing traction on the urethra, or being unintentionally removed, and care is taken to ensure that the catheter position permits leg movement. In male patients, the drainage tube (not the catheter) is taped laterally to the thigh to prevent pressure on the urethra at the penoscrotal junction, which can eventually lead to formation of an urethrocutaneous fistula. In female patients, the drainage tubing attached to the catheter is taped to the thigh to prevent tension and traction on the bladder.

Special care should be taken to ensure that any patient who is confused does not remove the catheter with the retention balloon still inflated, because this could cause bleeding and considerable injury to the urethra.

### Retraining the Bladder

When an indwelling urinary catheter is in place, the detrusor muscle does not actively contract the bladder wall to stimulate emptying because urine is continuously draining from the bladder. As a result, the detrusor may not immediately respond to bladder filling when the catheter is removed, resulting in either urine retention or urinary incontinence. This condition, known as postcatheterization detrusor instability, can be managed with bladder retraining (Chart 45-11).

Immediately after the indwelling catheter is removed, the patient is placed on a timed voiding schedule, usually every 2 to 3 hours. At the given time interval, the patient is instructed to void. The bladder is then scanned using a portable ultrasonic bladder scanner, and if the bladder has not emptied completely, straight catheterization may be performed (Altschuler & Diaz, 2006). After a few days, as the nerve endings in the bladder wall become resensitized to the bladder filling and emptying, bladder function usually

**Chart 45-11 • *Bladder Retraining After Indwelling Catheterization***

- Instruct the patient to drink a measured amount of fluid from 8 AM to 10 PM to avoid bladder overdistention. Offer no fluids (except sips) after 10 PM.
- At specific times, ask the patient to void by applying pressure over the bladder, tapping the abdomen, or running water to trigger the bladder.
- Immediately after the voiding attempt, catheterize the patient to determine the amount of residual urine.
- Measure the volumes of urine voided and obtained by catheterization.
- Palpate the bladder at repeated intervals to assess for distention.
- Instruct the patient who has no voiding sensation to be alert for any signs that indicate a full bladder, such as perspiration, cold hands or feet, or feelings of anxiety.
- Lengthen the intervals between catheterizations as the volume of residual urine decreases. Catheterization is usually discontinued when the volume of residual urine is less than 100 mL.

returns to normal. If the person has had an indwelling catheter in place for an extended period, bladder retraining will take longer; in some cases, function may never return to normal and long-term intermittent catheterization may become necessary.

### Assisting With Intermittent Self-Catheterization

Intermittent self-catheterization provides periodic drainage of urine from the bladder. By promoting drainage and eliminating excessive residual urine, intermittent catheterization protects the kidneys, reduces the incidence of UTIs, and improves continence. It is the treatment of choice in some patients with spinal cord injury and other neurologic disorders, such as multiple sclerosis, when the ability to empty the bladder is impaired. Self-catheterization promotes independence, results in few complications, and enhances self-esteem and quality of life.

When teaching the patient how to perform self-catheterization, the nurse must use aseptic technique to minimize the risk of cross-contamination. However, the patient may use a "clean" (nonsterile) technique at home, where the risk of cross-contamination is reduced. Either antibacterial liquid soap or povidone-iodine (Betadine) solution is recommended for cleaning urinary catheters at home. The catheter is thoroughly rinsed with tap water after soaking in the cleaning solution. It must dry before reuse. It should be kept in its own container, such as a plastic food-storage bag.

In teaching the patient, the nurse emphasizes the importance of frequent catheterization and emptying the bladder at the prescribed time. The average daytime clean intermittent catheterization schedule is every 4 to 6 hours and just before bedtime. If the patient is awakened at night with an urge to void, catheterization may be performed after an attempt is made to void normally.

The female patient assumes a Fowler's position and uses a mirror to help locate the urinary meatus. She lubricates the catheter and inserts it 7.5 cm (3 inches) into the urethra, in a downward and backward direction. The male patient assumes a Fowler's or sitting position, lubricates the catheter, and retracts the foreskin of the penis with one hand while grasping the penis and holding it at a right angle to the body. (This maneuver straightens the urethra and makes it easier to insert the catheter.) He inserts the catheter 15 to 25 cm (6 to 10 inches) until urine begins to flow. After removal, the catheter is cleaned, rinsed, dried, and placed in a plastic bag or case. Patients who follow an intermittent catheterization routine should consult a primary health care provider at regular intervals to assess urinary function and to detect complications. If the patient cannot perform intermittent self-catheterization, a family member or caregiver may be taught to carry out the procedure at regular intervals during the day.

An alternative to self-catheterization is creation of the Mitrofanoff umbilical appendicovesicostomy, which provides easy access to the bladder, but requires an extensive surgical procedure. In this procedure, the bladder neck is closed and the appendix is used to create access to the bladder from the skin surface through a submucosal tunnel created with the appendix. One end of the appendix is brought to the skin surface and used as a stoma and the other end is tunneled into the bladder. The appendix serves as an artificial urinary sphincter when an alternative is necessary to empty the bladder. A surgically prepared continent urine reservoir with a sphincter mechanism is required in cases of bladder cancer and severe **interstitial cystitis** (inflammation of the bladder wall). Various types of urologic stomas may be used when a radical **cystectomy** (surgical removal of the bladder) is necessary.

## UROLITHIASIS AND NEPHROLITHIASIS

Urolithiasis and nephrolithiasis refer to stones (calculi) in the urinary tract and kidney, respectively. Urinary stones account for more than 320,000 hospital admissions each year. The occurrence of urinary stones occurs predominantly in the third to fifth decades of life and affects men more than women. About half of patients with a single renal stone have another episode within 5 years (Colella, Kochis, Galli, et al., 2005).

### Pathophysiology

Stones are formed in the urinary tract when urinary concentrations of substances such as calcium oxalate, calcium phosphate, and uric acid increase. Referred to as supersaturation, this is dependent on the amount of the substance, ionic strength, and pH of the urine. Stones may be found anywhere from the kidney to the bladder and may vary in size from minute granular deposits, called sand or gravel, to bladder stones as large as an orange. The different sites of calculi formation in the urinary tract are shown in Figure 45-5.

Stone formation is not clearly understood, and there are a number of theories about their causes. One theory is that there is a deficiency of substances that normally prevent crystallization in the urine, such as citrate, magnesium, nephrocalcin, and uropontin (Porth & Matfin, 2009). Another theory relates to fluid volume status of the patient

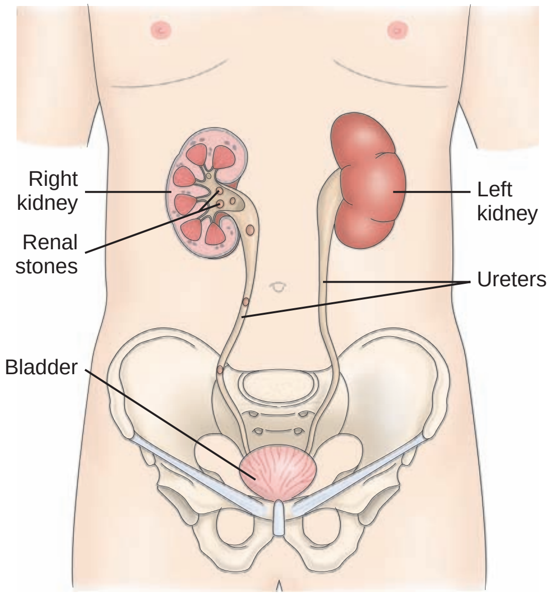



**Figure 45-5** Examples of potential sites of calculi formation (urolithiasis) in the urinary tract.

(stones tend to occur more often in dehydrated patients). Certain factors favor the formation of stones, including infection, urinary stasis, and periods of immobility, all of which slow renal drainage and alter calcium metabolism. In addition, increased calcium concentrations in the blood and urine promote precipitation of calcium and formation of stones (about 75% of all renal stones are calcium based). Causes of hypercalcemia (high serum calcium) and hypercalciuria (high urine calcium) may include the following:

- Hyperparathyroidism
- Renal tubular acidosis
- Cancers
- Granulomatous diseases (eg, sarcoidosis, tuberculosis), which may cause increased vitamin D production by the granulomatous tissue
- Excessive intake of vitamin D
- Excessive intake of milk and alkali
- Myeloproliferative diseases (leukemia, polycythemia vera, multiple myeloma), which produce an unusual proliferation of blood cells from the bone marrow

For patients with stones containing uric acid, struvite, or cystine, a thorough physical examination and metabolic workup are indicated because of associated disturbances contributing to the stone formation. Uric acid stones (5% to 10% of all stones) may be seen in patients with gout or myeloproliferative disorders. Struvite stones account for 15% of urinary calculi and form in persistently alkaline, ammonia-rich urine caused by the presence of urease-splitting bacteria such as *Proteus*, *Pseudomonas*, *Klebsiella*, *Staphylococcus*, or *Mycoplasma* species. Predisposing factors for struvite stones include neurogenic bladder, foreign bodies, and recurrent UTIs. Cystine stones (1% to 2% of all stones) occur exclusively in patients with a rare inherited defect in renal absorption of cystine (an amino acid) (Porth & Matfin, 2009).

Several conditions as well as certain metabolic risk factors predispose patients to stone formation. These include anatomic derangements such as polycystic kidney disease, horseshoe kidneys, chronic strictures, and medullary sponge disease. Urinary stone formation can occur in patients with inflammatory bowel disease and in those with an ileostomy or bowel resection because these patients absorb more oxalate. Medications known to cause stones in some patients include antacids, acetazolamide (Diamox), vitamin D, laxatives, and high doses of aspirin (Karch, 2008). However, in many patients, no cause may be found.

## Clinical Manifestations

Signs and symptoms of stones in the urinary system depend on the presence of obstruction, infection, and edema. When stones block the flow of urine, obstruction develops, producing an increase in hydrostatic pressure and distending the renal pelvis and proximal ureter. Infection (pyelonephritis and UTI with chills, fever, and frequency) can be a contributing factor with struvite stones (Porth & Matfin, 2009). Some stones cause few, if any, symptoms while slowly destroying the functional units (nephrons) of the kidney; others cause excruciating pain and discomfort.

Stones in the renal pelvis may be associated with an intense, deep ache in the costovertebral region. Hematuria is often present; pyuria may also be noted. Pain originating in the renal area radiates anteriorly and downward toward the bladder in the female and toward the testis in the male. If the pain suddenly becomes acute, with tenderness over the costovertebral area, and nausea and vomiting appear, the patient is having an episode of renal colic. Diarrhea and abdominal discomfort may occur. These GI symptoms are due to renointestinal reflexes and the anatomic proximity of the kidneys to the stomach, pancreas, and large intestine.

Stones lodged in the ureter (ureteral obstruction) cause acute, excruciating, colicky, wavelike pain, radiating down the thigh and to the genitalia. Often, the patient has a desire to void, but little urine is passed, and it usually contains blood because of the abrasive action of the stone. This group of symptoms is called ureteral colic. Colic is mediated by prostaglandin E, a substance that increases ureteral contractility and renal blood flow and that leads to increased intraureteral pressure and pain. In general, the patient spontaneously passes stones 0.5 to 1 cm in diameter. Stones larger than 1 cm in diameter usually must be removed or fragmented (broken up by lithotripsy) so that they can be removed or passed spontaneously.

Stones lodged in the bladder usually produce symptoms of irritation and may be associated with UTI and hematuria. If the stone obstructs the bladder neck, urinary retention occurs. If infection is associated with a stone, the condition is far more serious, with urosepsis threatening the patient's life.

## Assessment and Diagnostic Findings

The diagnosis is confirmed by x-rays of the kidneys, ureters, and bladder (KUB) or by ultrasonography, IV urography, or retrograde pyelography. Blood chemistries and a 24-hour urine test for measurement of calcium, uric acid, creatinine, sodium, pH, and total volume are part of the diagnostic workup. Dietary and medication histories and family history of renal stones are obtained to identify factors predisposing the patient to the formation of stones.

When stones are recovered (stones may be freely passed by the patient or removed through special procedures), chemical analysis is carried out to determine their composition. Stone analysis can provide a clear indication of the underlying disorder. For example, calcium oxalate or calcium phosphate stones usually indicate disorders of oxalate or calcium metabolism, whereas urate stones suggest a disturbance in uric acid metabolism (Porth & Matfin, 2009).

## Medical Management

The goals of management are to eradicate the stone, determine the stone type, prevent nephron destruction, control infection, and relieve any obstruction that may be present. The immediate objective of treatment of renal or ureteral colic is to relieve the pain until its cause can be eliminated. Opioid analgesic agents are administered to prevent shock and syncope that may result from the excruciating pain. Nonsteroidal anti-inflammatory drugs (NSAIDs) are effective in treating renal stone pain because they provide specific pain relief. They also inhibit the synthesis of prostaglandin E, reducing swelling and facilitating passage of the stone. Generally once the stone has passed, the pain is relieved. Hot baths or moist heat to the flank areas may also be helpful. Unless the patient is vomiting or has heart failure or any other condition requiring fluid restriction, fluids are encouraged. This increases the hydrostatic pressure behind the stone, assisting it in its downward passage. A high, around-the-clock fluid intake reduces the concentration of urinary crystalloids, dilutes the urine, and ensures a high urine output.

### Nutritional Therapy

Nutritional therapy plays an important role in preventing renal stones (Dudek, 2006) (Chart 45-12). Fluid intake is the mainstay of most medical therapy for renal stones. Unless fluids are contraindicated, patients with renal stones should drink eight to ten 8-ounce glasses of water daily or have IV fluids prescribed to keep the urine dilute. A urine output exceeding 2 L/day is advisable.

**CHART 45-12** PATIENT EDUCATION
***Preventing Kidney Stones***

- Avoid protein intake; usually protein is restricted to 60 g/day to decrease urinary excretion of calcium and uric acid.
- A sodium intake of 3 to 4 g/day is recommended. Table salt and high-sodium foods should be reduced, because sodium competes with calcium for reabsorption in the kidneys.
- Low-calcium diets are not generally recommended, except for true absorptive hypercalciuria. Evidence shows that limiting calcium, especially in women, can lead to osteoporosis and does not prevent renal stones.
- Avoid intake of oxalate-containing foods (eg, spinach, strawberries, rhubarb, tea, peanuts, wheat bran).
- During the day, drink fluids (ideally water) every 1 to 2 hours.
- Drink two glasses of water at bedtime and an additional glass at each nighttime awakening to prevent urine from becoming too concentrated during the night.
- Avoid activities leading to sudden increases in environmental temperatures that may cause excessive sweating and dehydration.
- Contact your primary health care provider at the first sign of a urinary tract infection.

#### Calcium Stones

Historically, patients with calcium-based renal stones were advised to restrict calcium in their diet. However, recent evidence has questioned the advisability of this practice, except for patients with type II absorptive hypercalciuria (half of all patients with calcium stones), in whom stones are clearly the result of excess dietary calcium. Liberal fluid intake is encouraged along with dietary restriction of protein and sodium; however, dietary changes cannot be recommended with confidence because of insufficient evidence. It was once thought that a high-protein diet was associated with increased urinary excretion of calcium and uric acid, thereby causing a supersaturation of these substances in the urine. Similarly, a high sodium intake was thought to increase the amount of calcium in the urine. These beliefs have not been supported by research (Flagg, 2007). Medications such as ammonium chloride may be used, and if increased parathormone production (resulting in increased serum calcium levels in blood and urine) is a factor in the formation of stones, therapy with thiazide diuretics may be beneficial in reducing the calcium loss in the urine and lowering the elevated parathormone levels (Porth & Matfin, 2009).

#### Uric Acid Stones

For uric acid stones, the patient is placed on a low-purine diet to reduce the excretion of uric acid in the urine. Foods high in purine (shellfish, anchovies, asparagus, mushrooms, and organ meats) are avoided, and other proteins may be limited. Allopurinol (Zyloprim) may be prescribed to reduce serum uric acid levels and urinary uric acid excretion.

#### Cystine Stones

A low-protein diet is prescribed, the urine is alkalinized, and fluid intake is increased.

#### Oxalate Stones

A dilute urine is maintained and the intake of oxalate is limited. Many foods contain oxalate; however, only certain foods increase the urinary excretion of oxalate. These include spinach, strawberries, rhubarb, chocolate, tea, peanuts, and wheat bran.

### Interventional Procedures

If the stone does not pass spontaneously or if complications occur, common interventions include endoscopic or other procedures. For example, ureteroscopy, extracorporeal shock wave lithotripsy (ESWL), or endourologic (percutaneous) stone removal may be necessary.

Ureteroscopy (Fig. 45-6A) involves first visualizing the stone and then destroying it. Access to the stone is accomplished by inserting a ureteroscope into the ureter and then inserting a laser, electrohydraulic lithotriptor, or ultrasound device through the ureteroscope to fragment and remove the stones. A stent may be inserted and left in place for 48 hours or more after the procedure to keep the ureter

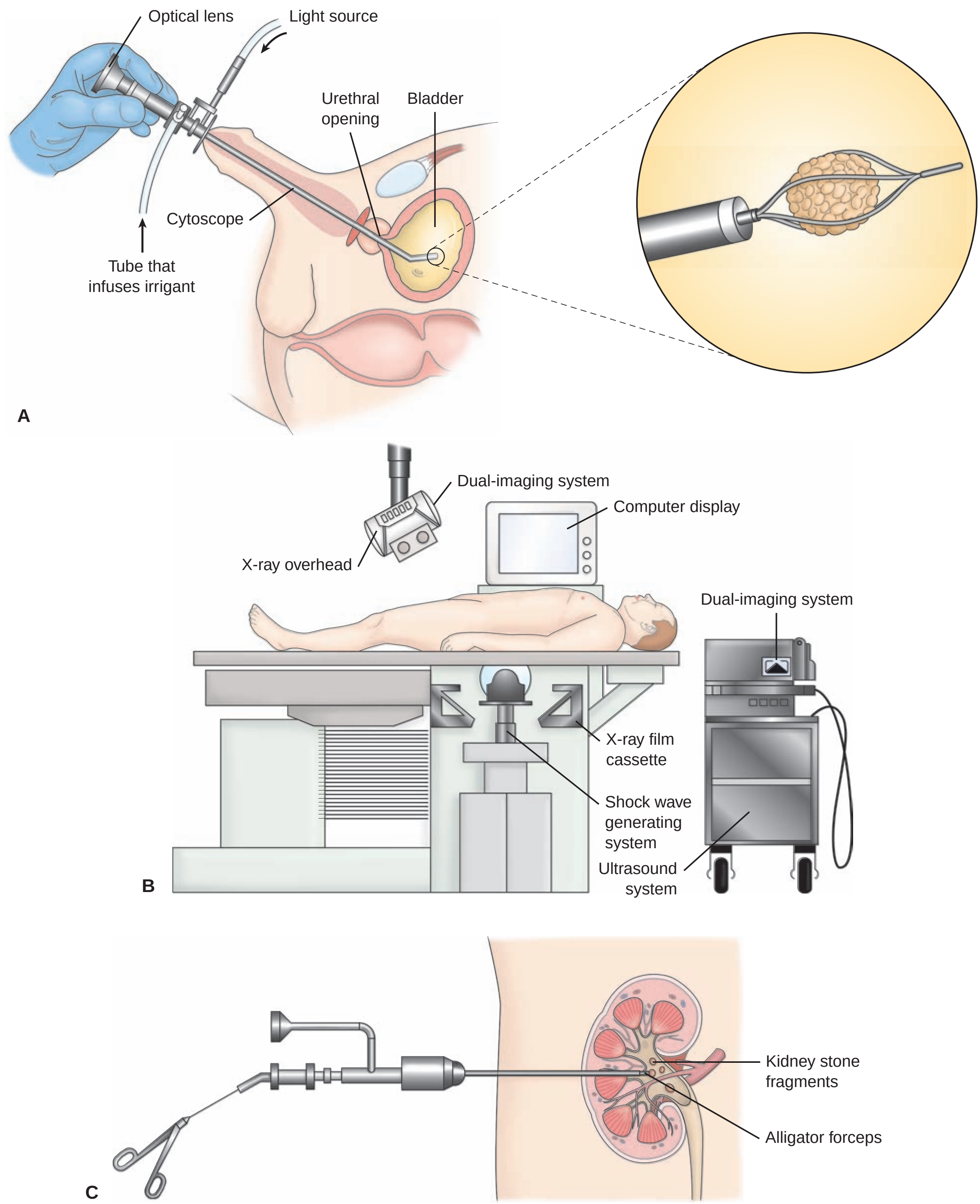



**Figure 45-6** Methods of treating renal stones. **A,** During a cystoscopy, which is used for removing small stones located in the ureter close to the bladder, a ureteroscope is inserted into the ureter to visualize the stone. The stone is then fragmented or captured and removed. **B,** Extracorporeal shock water lithotripsy (ESWL) is used for most symptomatic, nonpassable upper urinary stones. Electromagnetically generated shock waves are focused over the area of the renal stone. The high-energy dry shock waves pass through the skin and fragment the stone. **C,** Percutaneous nephrolithotomy is used to treat larger stones. A percutaneous tract is formed and a nephroscope is inserted through it. Then the stone is extracted or pulverized.

patent. Hospital stays are generally brief, and some patients can be treated as outpatients.

ESWL is a noninvasive procedure used to break up stones in the calyx of the kidney (Fig. 45-6B). After the stones are fragmented to the size of grains of sand, the remnants of the stones are spontaneously voided. In ESWL, a high-energy amplitude of pressure, or shock wave, is generated by the abrupt release of energy and transmitted through water and soft tissues. When the shock wave encounters a substance of different intensity (a renal stone), a compression wave causes the surface of the stone to fragment. Repeated shock waves focused on the stone eventually reduce it to many small pieces that are excreted in the urine.

Discomfort from the multiple shocks may occur, although the shock waves usually do not cause damage to other tissue. The patient is observed for obstruction and infection resulting from blockage of the urinary tract by stone fragments. All urine is strained after the procedure; voided gravel or sand is sent to the laboratory for chemical analysis. Several treatments may be necessary to ensure disintegration of stones. Although lithotripsy is a costly treatment, its cost is offset by a decrease in the length of hospital stay and avoidance of a surgical procedure.

Endourologic methods of stone removal (Fig. 45-6C) may be used to extract renal calculi that cannot be removed by other procedures. A percutaneous nephrostomy or a percutaneous nephrolithotomy (which are similar procedures) may be performed. A nephroscope is introduced through a percutaneous route into the renal parenchyma. Depending on its size, the stone may be extracted with forceps or by a stone retrieval basket. If the stone is too large to initially be removed, an ultrasound probe inserted through a nephrostomy tube is used to pulverize the stone. Small stone fragments and stone dust are then removed.

Electrohydraulic lithotripsy is a similar method in which an electrical discharge is used to create a hydraulic shock wave to break up the stone. A probe is passed through the cystoscope, and the tip of the lithotriptor is placed near the stone. The strength of the discharge and pulse frequency can be varied. This procedure is performed under topical anesthesia. After the stone is extracted, the percutaneous nephrostomy tube is left in place for a time to ensure that the ureter is not obstructed by edema or blood clots. The most common complications are hemorrhage, infection, and urinary extravasation. After the tube is removed, the nephrostomy tract usually closes spontaneously.

Chemolysis, stone dissolution using infusions of chemical solutions (eg, alkylating agents, acidifying agents) for the purpose of dissolving the stone, is an alternative treatment sometimes used in patients who are at risk for complications with other types of therapy, who refuse to undergo other methods, or who have stones (struvite) that dissolve easily. A percutaneous nephrostomy is performed, and the warm chemical solution is allowed to flow continuously onto the stone. The solution exits the renal collecting system by means of the ureter or the nephrostomy tube. The pressure inside the renal pelvis is monitored during the procedure.

Several of these treatment modalities may be used in combination to ensure removal of the stones.

#### Surgical Management

Surgical removal was the major mode of therapy before the advent of lithotripsy. However, today, surgery is performed in only 1% to 2% of patients. Surgical intervention is indicated if the stone does not respond to other forms of treatment. It may also be performed to correct anatomic abnormalities within the kidney to improve urinary drainage. If the stone is in the kidney, the surgery performed may be a nephrolithotomy (incision into the kidney with removal of the stone) or a nephrectomy, if the kidney is nonfunctional secondary to infection or hydronephrosis. Stones in the kidney pelvis are removed by a pyelolithotomy, those in the ureter by ureterolithotomy, and those in the bladder by cystotomy. If the stone is in the bladder, an instrument may be inserted through the urethra into the bladder, and the stone crushed. Such a procedure is called a cystolitholapaxy. Nursing management following kidney surgery is discussed in Chapter 44.

## NURSING PROCESS

### The Patient With Kidney Stones

#### Assessment

The patient with suspected renal stones is assessed for pain and discomfort as well as associated symptoms, such as nausea, vomiting, diarrhea, and abdominal distention. The severity and location of pain are determined, along with any radiation of the pain. Nursing assessment also includes observing for signs and symptoms of UTI (chills, fever, frequency, and hesitancy) and obstruction (frequent urination of small amounts, oliguria, or anuria). The urine is inspected for blood and is strained for stones or gravel.

The history focuses on factors that predispose the patient to urinary tract stones or that may have precipitated the current episode of renal or ureteral colic. The patient's knowledge about renal stones and measures to prevent their occurrence or recurrence is also assessed.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, the nursing diagnoses in the patient with renal stones may include the following:

- Acute pain related to inflammation, obstruction, and abrasion of the urinary tract
- Deficient knowledge regarding prevention of recurrence of renal stones

##### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications that may develop include the following:

- Infection and urosepsis (from UTI and pyelonephritis)
- Obstruction of the urinary tract by a stone or edema with subsequent acute renal failure

#### Planning and Goals

The major goals for the patient may include relief of pain and discomfort, prevention of recurrence of renal stones, and absence of complications.

## Nursing Interventions

### *Relieving Pain*

Severe acute pain is often the presenting symptom of a patient with renal and urinary calculi and requires immediate attention. Opioid analgesic agents (IV or intramuscular) may be prescribed and administered to provide rapid relief along with an IV NSAID. The patient is encouraged and assisted to assume a position of comfort. If activity brings pain relief, the patient is assisted to ambulate. The pain level is monitored closely, and an increase in severity is reported promptly to the physician so that relief can be provided and additional treatment initiated.

### *Monitoring and Managing Potential Complications*

Increased fluid intake is encouraged to prevent dehydration and increase hydrostatic pressure within the urinary tract to promote passage of the stone. If the patient cannot take adequate fluids orally, IV fluids are prescribed. The total urine output and patterns of voiding are monitored. Ambulation is encouraged as a means of moving the stone through the urinary tract.

All urine is strained through gauze because uric acid stones may crumble. Any blood clots passed in the urine should be crushed and the sides of the urinal and bedpan inspected for clinging stones. Because renal stones increase the risk of infection, sepsis, and obstruction of the urinary tract, the patient is instructed to report decreased urine volume, bloody or cloudy urine, fever, and pain.

Patients with calculi require frequent nursing observation to detect the spontaneous passage of a stone. The patient is instructed to immediately report any sudden increases in pain intensity because of the possibility of a stone fragment obstructing a ureter. Vital signs, including temperature, are monitored closely to detect early signs of infection. UTIs may be associated with renal stones due to an obstruction from the stone or from the stone itself. All infections should be treated with the appropriate antibiotic agent before efforts are made to dissolve the stone.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Because the risk of recurring renal stones is high, the nurse provides education about the causes of kidney stones and recommendations to prevent their recurrence (see Chart 45-12). The patient is encouraged to follow a regimen to avoid further stone formation, including maintaining a high fluid intake because stones form more readily in concentrated urine. A patient who has shown a tendency to form stones should drink enough fluid to excrete greater than 2000 mL (preferably 3000 to 4000 mL) of urine every 24 hours.

Urine cultures may be performed every 1 to 2 months the first year and periodically thereafter. Recurrent UTI is treated vigorously. Because prolonged immobilization slows renal drainage and alters calcium metabolism, increased mobility is encouraged whenever possible. In addition, excessive ingestion of vitamins (especially vitamin D) and minerals is discouraged.

If lithotripsy, percutaneous stone removal, ureteroscopy, or other surgical procedures for stone removal have been performed, the nurse instructs the patient about the signs and symptoms of complications that need to be reported to the physician. The importance of follow-up to assess kidney function and to ensure the eradication or removal of all kidney stones is emphasized to the patient and family.

If ESWL has been performed, the nurse must provide instructions for home care and necessary follow-up. The patient is encouraged to increase fluid intake to assist in the passage of stone fragments, which may occur for 6 weeks to several months after the procedure. The patient and family are instructed about signs and symptoms of complications. It is also important to inform the patient to expect hematuria (it is anticipated in all patients), but it should disappear within 4 to 5 days. If the patient has a stent in the ureter, hematuria may be expected until the stent is removed. The patient is instructed to check his or her temperature daily and notify the physician if the temperature is greater than 38°C (about 101°F) or the pain is unrelieved by the prescribed medication. The patient is also informed that a bruise may be observed on the treated side of the back.

**CONTINUING CARE.** Close monitoring of the patient in follow-up care ensures that treatment has been effective and that no complications have developed. The nurse has the opportunity to assess the patient's understanding of ESWL and possible complications. Additionally, the nurse has the opportunity to assess the patient's understanding of factors that increase the risk of recurrence of renal calculi and strategies to reduce those risks.

It is necessary to assess the patient's ability to monitor urinary pH and interpret the results during follow-up visits. Because of the high risk of recurrence, the patient with renal stones needs to understand the signs and symptoms of stone formation, obstruction, and infection and the importance of reporting these signs promptly. If medications are prescribed for the prevention of stone formation, the nurse explains their actions, importance, and side effects to the patient.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Reports relief of pain
2. States increased knowledge of health-seeking behaviors to prevent recurrence
   a. Consumes increased fluid intake (at least eight 8-ounce glasses of fluid per day)
   b. Participates in appropriate activity
   c. Consumes diet prescribed to reduce dietary factors predisposing to stone formation
   d. Recognizes symptoms (fever, chills, flank pain, hematuria) to be reported to health care provider
   e. Monitors urinary pH as directed
   f. Takes prescribed medication as directed to reduce stone formation
3. Experiences no complications
   a. Reports no signs or symptoms of infection or urosepsis
   b. Voids 200 to 400 mL per voiding of clear urine without evidence of bleeding
   c. Experiences absence of urgency, frequency, and hesitancy
   d. Maintains normal body temperature

## GENITOURINARY TRAUMA

Various types of injuries of the flank, back, or upper abdomen may result in trauma to the ureters, bladder, or urethra. Approximately 10% of all injuries seen in the emergency department involve the genitourinary system (Tanagho & McAninch, 2007). (Renal trauma is discussed in Chapter 44.)

### Specific Injuries

#### Ureteral Trauma

Penetrating trauma and unintentional injury during surgery are the major causes of trauma to the ureters. Gunshot wounds account for 95% of ureteral injuries, which may range from contusions to complete transection. Unintentional injury to the ureter may occur during gynecologic or urologic surgery. There are no specific signs or symptoms of ureteral injury; many traumatic injuries are discovered during exploratory surgery. If the ureteral trauma is not detected and urine leakage continues, fistulas can develop.

IV urography detects 90% of ureteral injuries and can be performed on the operating table in patients undergoing emergency surgery. Surgical repair with placement of stents (to divert urine away from an anastomosis) is usually necessary.

#### Bladder Trauma

Injury to the bladder may occur with pelvic fractures and multiple trauma or from a blow to the lower abdomen when the bladder is full. Blunt trauma may result in contusion evident as an ecchymosis—a large bruise resulting from escape of blood into the tissues and involving a segment of the bladder wall—or in rupture of the bladder extraperitoneally, intraperitoneally, or both. Complications from these injuries include hemorrhage, shock, sepsis, and extravasation of blood into the tissues, which must be treated promptly.

#### Urethral Trauma

Urethral injuries usually occur with blunt trauma to the lower abdomen or pelvic region. Many patients also have associated pelvic fractures. The classic triad of symptoms comprises blood at the urinary meatus, inability to void, and a distended bladder.

### Medical Management

The goals of management in patients with genitourinary trauma are to control hemorrhage, pain, and infection and to maintain urinary drainage. Genitourinary trauma is frequently associated with renal trauma (see Chapter 44). Hematocrit and hemoglobin levels are monitored closely; decreasing values can indicate hemorrhage within the genitourinary system. The patient is also monitored for oliguria, signs of hemorrhagic shock, and signs and symptoms of acute peritonitis.

#### Surgical Management

In urethral trauma, unstable patients who need monitoring of urine output may need a suprapubic catheter inserted. The patient is catheterized after urethrography has been performed to minimize the risk of urethral disruption and extensive, long-term complications, such as stricture, incontinence, and impotence. Surgical repair may be performed immediately or at a later time. Delayed surgical repair tends to be the favored procedure because it is associated with fewer long-term complications, such as impotence, strictures, and incontinence. After surgery, an indwelling urinary catheter may remain in place for up to 1 month.

### Nursing Management

The patient with genitourinary trauma should be assessed frequently during the first few days after injury to detect flank and abdominal pain, muscle spasm, and swelling over the flank.

During this time, patients can be instructed about care of the incision and the importance of an adequate fluid intake. In addition, instructions about changes that should be reported to the physician, such as fever, hematuria, flank pain, or any signs and symptoms of decreasing kidney function, are provided. The patient with a ruptured bladder may have gross bleeding for several days after repair. Guidelines for increasing activity gradually, lifting, and driving are also provided in accordance with the physician's prescription.

Follow-up nursing care includes monitoring the blood pressure to detect hypertension and advising the patient to restrict activities for about 1 month after trauma to minimize the incidence of delayed or secondary bleeding.

## URINARY TRACT CANCERS

In 2009, the American Cancer Society (ACS) estimated that there were more than 131,000 new cases in the urinary system. Urinary tract cancers include those of the urinary bladder; kidney and renal pelvis; ureters; and other urinary structures, such as the prostate. (Renal cancer is discussed in Chapter 44, and prostate cancer is discussed in Chapter 49.) Malignant tumors include transitional cell carcinomas (90%), squamous cell carcinomas (5% to 8%), adenocarcinomas (1% to 2%), sarcomas (less than 1%), and other types of cancers.

### *Cancer of the Bladder*

Cancer of the urinary bladder is more common in people older than 55 years of age. It affects more men than women (4:1) and is more common in Caucasians than in African Americans. Bladder cancer is the fourth leading cause of cancer in American men, accounting for more than 14,000 deaths in the United States annually, and has a high incidence worldwide (ACS, 2009).

Bladder cancer, combined with prostatic cancer, is the most common urologic malignancy, accounting for 90% of all tumors seen. Cancers arising from the prostate, colon, and rectum in males and from the lower gynecologic tract in females may metastasize to the bladder.

Tobacco use continues to be a leading risk factor for all urinary tract cancers. People who smoke develop bladder cancer twice as often as those who do not smoke (Chart 45-13) (ACS, 2009).

**CHART 45-13** Risk Factors for Bladder Cancer

- Cigarette smoking: risk proportional to pack-years of smoking
- Exposure to environmental carcinogens: dyes, rubber, leather, ink, or paint
- Recurrent or chronic bacterial infection of the urinary tract
- Bladder stones
- High urinary pH
- High cholesterol intake
- Pelvic radiation therapy
- Cancers arising from the prostate, colon, and rectum in males

## Clinical Manifestations

Bladder tumors usually arise at the base of the bladder and involve the ureteral orifices and bladder neck. Visible, painless hematuria is the most common symptom of bladder cancer. Infection of the urinary tract is a common complication, producing frequency and urgency. However, any alteration in voiding or change in the urine may indicate cancer of the bladder. Pelvic or back pain may occur with metastasis.

## Assessment and Diagnostic Findings

The diagnostic evaluation includes cystoscopy (the mainstay of diagnosis), excretory urography, CT, ultrasonography, and bimanual examination with the patient anesthetized. Biopsies of the tumor and adjacent mucosa are the definitive diagnostic procedures. Transitional cell carcinomas and carcinomas in situ shed recognizable cancer cells. Cytologic examination of fresh urine and saline bladder washings provide information about the prognosis and staging, especially for patients at high risk for recurrence of primary bladder tumors.

Although the mainstay diagnostic tools such as cytology and CT have a high detection rate, they are costly. Newer diagnostic tools such as bladder tumor antigens, nuclear matrix proteins, adhesion molecules, cytoskeletal proteins, and growth factors are being studied to support the early detection and diagnosis of bladder cancer (ACS, 2009).

## Medical Management

Treatment of bladder cancer depends on the grade of the tumor (the degree of cellular differentiation), the stage of tumor growth (the degree of local invasion and the presence or absence of metastasis), and the multicentricity (having many centers) of the tumor. The patient's age and physical, mental, and emotional status are considered when determining treatment modalities.

### *Surgical Management*

Transurethral resection or fulguration (cauterization) may be performed for simple papillomas (benign epithelial tumors). These procedures, described in more detail in Chapter 49, eradicate the tumors through surgical incision or electrical current with the use of instruments inserted through the urethra. After this bladder-sparing surgery, intravesical administration of bacille Calmette-Guérin (BCG) is the treatment of choice. BCG is an attenuated live strain of *Mycobacterium bovis*, the causative agent in tuberculosis. The exact action of BCG is unknown, but it is thought to produce a local inflammatory as well as a systemic immunologic response (Sharma, Old & Allison, 2007).

Management of superficial bladder cancers presents a challenge because there are usually widespread abnormalities in the bladder mucosa. The entire lining of the urinary tract, or urothelium, is at risk because carcinomatous changes can occur in the mucosa of the bladder, renal pelvis, ureter, and urethra. About 25% to 40% of superficial tumors recur after transurethral resection or fulguration. Patients with benign papillomas should undergo cytology and cystoscopy periodically for the rest of their lives because aggressive malignancies may develop from these tumors.

A simple cystectomy or a radical cystectomy is performed for invasive or multifocal bladder cancer. Radical cystectomy in men involves removal of the bladder, prostate, and seminal vesicles and immediate adjacent perivesical tissues. In women, radical cystectomy involves removal of the bladder, lower ureter, uterus, fallopian tubes, ovaries, anterior vagina, and urethra. It may include removal of pelvic lymph nodes. Removal of the bladder requires a urinary diversion procedure, which is described later in this chapter.

Although radical cystectomy remains the standard of care for invasive bladder cancer in the United States, researchers are exploring trimodality therapy—transurethral resection of the bladder tumor, radiation, and chemotherapy—in an effort to spare patients the need for cystectomy. This approach to transitional cell bladder cancer mandates lifelong surveillance with periodic cystoscopy. Although most patients respond completely and their bladders remain free from invasive relapse, one fourth develop a relapse of noninvasive disease. This may be managed with transurethral resection of the bladder tumor and intravesical therapies but carries an additional risk that a late cystectomy may be required.

### *Pharmacologic Therapy*

Chemotherapy with a combination of methotrexate (Rheumatrex), 5-fluorouracil (5-FU), vinblastine (Velban), doxorubicin (Adriamycin), and cisplatin (Platinol) has been effective in producing partial remission of transitional cell carcinoma of the bladder in some patients. IV chemotherapy may be accompanied by radiation therapy. Topical chemotherapy (intravesical chemotherapy or instillation of antineoplastic agents into the bladder, resulting in contact of the agent with the bladder wall) is considered when there is a high risk of recurrence, when cancer in situ is present, or when tumor resection has been incomplete. Topical chemotherapy delivers a high concentration of medication (thiotepa [Thioplex], doxorubicin, mitomycin [Mutamycin], and BCG [TheraCys]) to the tumor to promote tumor destruction. Bladder cancer may also be treated by direct infusion of the cytotoxic agent through the bladder's arterial blood supply to achieve a higher concentration of the chemotherapeutic agent with fewer systemic toxic effects.

BCG is now considered the most effective intravesical agent for recurrent bladder cancer, especially superficial transitional cell carcinoma, because it is an immunotherapeutic

agent that enhances the body's immune response to cancer. BCG has a 43% advantage in preventing tumor recurrence, a significantly better rate than the 16% to 21% advantage of intravesical chemotherapy. In addition, BCG is particularly effective in the treatment of carcinoma in situ, eradicating it in more than 80% of cases. In contrast to intravesical chemotherapy, BCG has also been shown to decrease the risk of tumor progression (Sharma, et al., 2007).

The optimal course of BCG appears to be a 6-week course of weekly instillations, followed by a 3-week course at 3 months for tumors that do not respond. In high-risk cancers, maintenance BCG administered in a 3-week course at 6, 12, 18, and 24 months may limit recurrence and prevent progression (Sharma, et al., 2007). However, the adverse effects associated with this prolonged therapy may limit its widespread applicability.

The patient is allowed to eat and drink before the instillation procedure. Once the bladder is full, the patient must retain the intravesical solution for 2 hours before voiding. At the end of the procedure, the patient is encouraged to void and to drink liberal amounts of fluid to flush the medication from the bladder.

#### *Radiation Therapy*

Radiation of the tumor may be performed preoperatively to reduce microextension of the neoplasm and viability of tumor cells, thus reducing the chances that the cancer may recur in the immediate area or spread through the circulatory or lymphatic systems. Radiation therapy is also used in combination with surgery or to control the disease in patients with inoperable tumors.

For more advanced bladder cancer or for patients with intractable hematuria (especially after radiation therapy), a large, water-filled balloon placed in the bladder produces tumor necrosis by reducing the blood supply of the bladder wall (hydrostatic therapy). The instillation of formalin, phenol, or silver nitrate relieves hematuria and strangury (slow and painful discharge of urine) in some patients.

#### *Investigational Therapy*

The use of photodynamic techniques in treating superficial bladder cancer is under investigation. This procedure involves systemic injection of a photosensitizing material (hematoporphyrin), which the cancer cell picks up. A laser-generated light then changes the hematoporphyrin in the cancer cell into a toxic agent. This process has received renewed interest with regulatory approval of several photosensitizing medications and light applicators as potential palliative and curative treatments (Huang, 2005).

## URINARY DIVERSIONS

Urinary diversion procedures are performed to divert urine from the bladder to a new exit site, usually through a surgically created opening (stoma) in the skin. These procedures are primarily performed when a bladder tumor necessitates cystectomy. Urinary diversion has also been used in managing pelvic malignancy, birth defects, strictures, trauma to the ureters and urethra, neurogenic bladder, chronic infection causing severe ureteral and renal damage, and intractable interstitial cystitis. It may also be used as a last resort in managing incontinence.

Controversy exists about the best method of establishing permanent diversion of the urinary tract. New techniques are frequently introduced in an effort to improve patient outcomes and quality of life. The age of the patient, condition of the bladder, body build, degree of obesity, degree of ureteral dilation, status of renal function, and the patient's learning ability and willingness to participate in postoperative care are all taken into consideration when determining the appropriate surgical procedure.

The extent to which the patient accepts urinary diversion depends to a large degree on the location or position of the stoma, whether the drainage device (pouch or bag) establishes a watertight seal to the skin, and the patient's ability to manage the pouch and drainage apparatus.

There are two types of urinary diversion. In a cutaneous urinary diversion, urine drains through an opening created in the abdominal wall and skin (Fig. 45-7). In a **continent urinary diversion,** a portion of the intestine is used to create a new reservoir for urine (Fig. 45-8).

## *Cutaneous Urinary Diversions*

### ILEAL CONDUIT

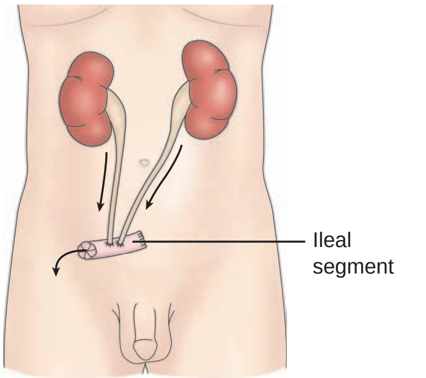
The **ileal conduit** (ileal loop) is the oldest and most common of the urinary diversion procedures in use because of the low number of complications and surgeons' familiarity with the procedure. In an ileal conduit, the urine is diverted by implanting the ureter into a 12-cm loop of ileum that is led out through the abdominal wall. This loop of ileum is a simple conduit (passageway) for urine from the ureters to the surface. A loop of the sigmoid colon may also be used. An ileostomy bag is used to collect the urine. The resected (cut) ends of the remaining intestine are anastomosed (connected) to provide an intact bowel (Diepenbrock, 2007).

Stents, usually made of thin, pliable tubing, are placed in the ureters to prevent occlusion secondary to postsurgical edema. The bilateral ureteral stents allow urine to drain from the kidney to the stoma and provide a method for accurate measurement of urine output. They may be left in place 10 to 21 days postoperatively. Jackson-Pratt tubes or other types of drains are inserted to prevent the accumulation of fluid in the space created by removal of the bladder.

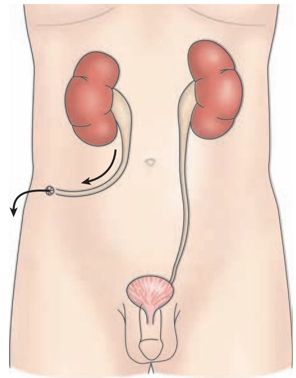
After surgery, a skin barrier and a transparent, disposable urinary drainage bag are applied around the conduit and connected to drainage. A custom-cut appliance is used until the edema subsides and the stoma shrinks to normal size. The clear bag allows the stoma to be inspected and the patency of the stent and the urine output to be monitored. The ileal bag drains urine (not feces) continuously. The appliance (bag) usually remains in place as long as it is watertight; it is changed when necessary to prevent leakage of urine.

#### Complications

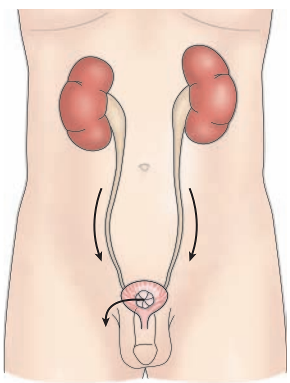
Complications that may follow placement of an ileal conduit include wound infection or wound dehiscence, urinary leakage, ureteral obstruction, hyperchloremic acidosis, small bowel obstruction, ileus, and gangrene of the stoma. Delayed



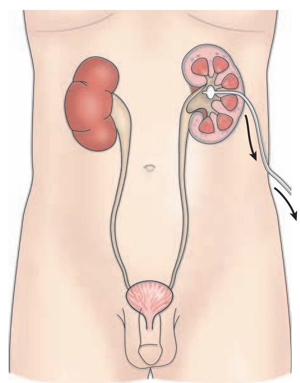

**A** Conventional ileal conduit.
The surgeon transplants the ureters to an isolated section of the terminal ileum (ileal conduit), bringing one end to the abdominal wall. The ureter may also be transplanted into the transverse sigmoid colon (colon conduit) or proximal jejunum (jejunal conduit).



**B** Cutaneous ureterostomy.
The surgeon brings the detached ureter through the abdominal wall and attaches it to an opening in the skin.



**C** Vesicostomy.
The surgeon sutures the bladder to the abdominal wall and creates an opening (stoma) through the abdominal and bladder walls for urinary drainage.



**D** Nephrostomy.
The surgeon inserts a catheter into the renal pelvis via an incision in the flank or by percutaneous catheter placement into the kidney.

**Figure 45-7** Types of cutaneous diversions include **(A)** the conventional ileal conduit, **(B)** cutaneous ureterostomy, **(C)** vesicostomy, and **(D)** nephrostomy.

complications include ureteral obstruction, contraction or narrowing of the stoma (stenosis), renal deterioration due to chronic reflux, pyelonephritis, and renal calculi.

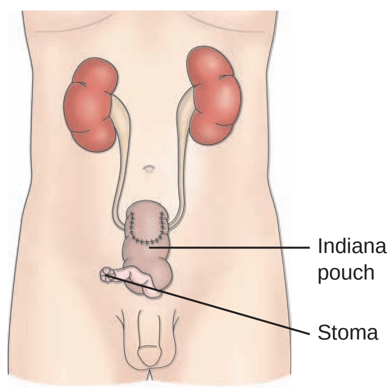
## Nursing Management

In the immediate postoperative period, urine volumes are monitored hourly. Throughout the patient's hospitalization, the nurse monitors closely for complications, reports signs and symptoms of them promptly, and intervenes quickly to prevent their progression.

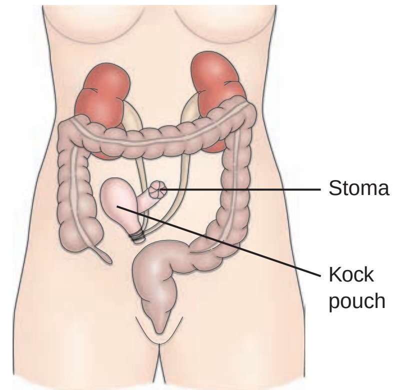
A urine output below 30 mL/h may indicate dehydration or an obstruction in the ileal conduit, with possible backflow or leakage from the ureteroileal anastomosis. After the physician's order is obtained, a catheter may be inserted through the urinary conduit to monitor the patient for possible stasis or residual urine from a constricted stoma. Urine may drain through the bilateral ureteral stents as well as around the stents. If the ureteral stents are not draining, the nurse may be instructed to carefully irrigate with 5 to 10 mL sterile normal saline solution, being careful not to exert tension that could dislodge the stent. Hematuria may be noted in the first 48 hours after surgery but usually resolves spontaneously.

### *Providing Stoma and Skin Care*

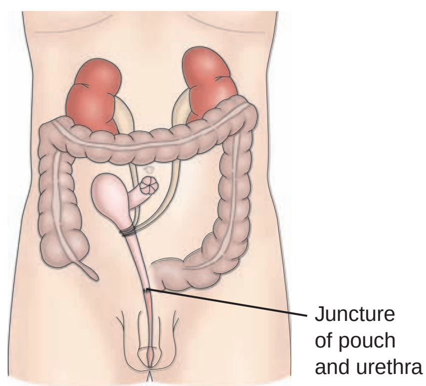
Because the patient requires specialized care, a consultation is initiated with a WOCN. The stoma is inspected frequently for color and viability. A healthy stoma is pink or red. A change from this normal color to purple, brown, or black suggests that the vascular supply may be compromised. If cyanosis and a compromised blood supply persist, surgical intervention may be necessary. The stoma is not sensitive to touch, but the skin around the stoma becomes sensitive if urine or the appliance irritates it. The skin is inspected for (1) signs of irritation and bleeding of the stoma mucosa, (2) encrustation and skin irritation around the stoma (from alkaline urine coming in contact with exposed skin), and (3) wound infections.



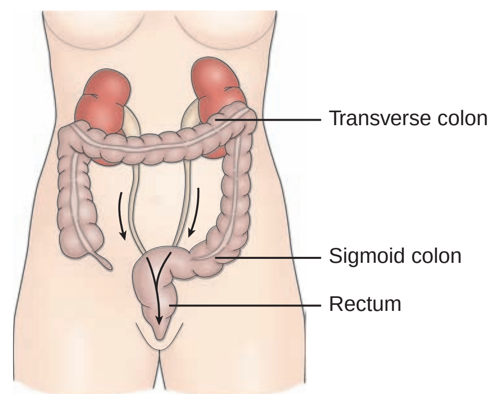

**A** Indiana pouch.
The surgeon introduces the ureters into a segment of ileum and cecum. Urine is drained periodically by inserting a catheter into the stoma.




**B** Continent ileal urinary diversions (Kock pouch).
The surgeon transplants the ureters to an isolated segment of small bowel, ascending colon, or ileocolonic segment and develops an effective continence mechanism or valve. Urine is drained by inserting a catheter into the stoma.




**C**
In male patients, the Kock pouch can be modified by attaching one end of the pouch to the urethra, allowing more normal voiding. The female urethra is too short for this modification.




**D** Ureterosigmoidostomy.
The surgeon introduces the ureters into the sigmoid colon, thereby allowing urine to flow through the colon and out of the rectum.

**Figure 45-8** Types of continent urinary diversions include **(A)** the Indiana pouch; **(B, C)** the Kock pouch, also called a continent ileal diversion; and **(D)** ureterosigmoidostomy.

### *Testing Urine and Caring for the Ostomy*

Moisture in bed linens or clothing or the odor of urine around the patient should alert the nurse to the possibility of leakage from the appliance, potential infection, or a problem in hygienic management. Because severe alkaline encrustation can accumulate rapidly around the stoma, the urine pH is kept below 6.5 by administration of ascorbic acid by mouth. Urine pH is determined by testing the urine draining from the stoma, not from the collecting appliance. A properly fitted appliance is essential to prevent exposure of the skin around the stoma to urine. If the urine is foul-smelling, the stoma is catheterized, if prescribed, to obtain a urine specimen for culture and sensitivity testing.

### *Encouraging Fluids and Relieving Anxiety*

Because mucous membrane is used in forming the conduit, the patient may excrete a large amount of mucus mixed with urine. This causes anxiety in many patients. To help relieve this anxiety, the nurse reassures the patient that this is a normal occurrence after an ileal conduit procedure. The nurse encourages adequate fluid intake to flush the ileal conduit and decrease the accumulation of mucus.

### *Selecting the Ostomy Appliance*

Various urine collection appliances are available, and the nurse is instrumental (often with consultation with a WOCN) in selecting an appropriate one. The urinary appliance may consist of one or two pieces and may be disposable (usually used once and discarded) or reusable. The choice of appliance is determined by the location of the stoma and by the patient's normal activity, manual dexterity, visual function, body build, economic resources, and preference.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Patient education begins in the hospital but continues into the home setting because patients are usually discharged

within days of surgery. The nurse teaches the patient how to assess and manage the urinary diversion as well as how to deal with body image changes. A WOCN is invaluable in consulting with the nurse on various aspects of care and patient education.

***Changing the Appliance.*** The patient and family are taught to apply and change the appliance so that they are comfortable carrying out the procedure and can do so proficiently. Ideally, the appliance system is changed before the system leaks and at a time that is convenient for the patient. Many patients find that early morning is most convenient because the urine output is reduced. A variety of appliances are available; an average collecting appliance lasts 3 to 7 days before leakage occurs.

Regardless of the type of appliance used, a skin barrier is essential to protect the skin from irritation and excoriation. To maintain skin integrity, a skin barrier or leaking pouch is never patched with tape to prevent accumulation of urine under the skin barrier or faceplate. The patient is instructed to avoid moisturizing soaps when cleaning the area because they interfere with the adhesion of the pouch. Because the degree to which the stoma protrudes is not the same in all patients, there are various accessories and custom-made appliances to solve individual problems. Patient guidelines for applying reusable and disposable systems are presented in Chart 45-14.

***Controlling Odor.*** The patient is instructed to avoid foods that give the urine a strong odor (eg, asparagus, cheese, eggs). Today, most appliances contain odor barriers, but a few drops of liquid deodorizer or diluted white vinegar may be introduced through the drain spout into the bottom of the pouch with a syringe or eyedropper to reduce odors. Ascorbic acid by mouth helps acidify the urine and suppress urine odor. Patients should be cautioned not to put aspirin tablets in the pouch to control odor because they may ulcerate the stoma. Also, the patient is reminded that odor will develop if the pouch is worn longer than recommended and not cared for properly.

***Managing the Ostomy Appliance.*** The patient is instructed to empty the pouch by means of a drain valve when it is one-third full because the weight of more urine will cause the pouch to separate from the skin. Some patients prefer wearing a leg bag attached with an adapter to the drainage apparatus. To promote uninterrupted sleep, a collecting bottle and tubing (one unit) are snapped onto an adapter that connects to the ileal appliance. A small amount of urine is left in the bag when the adapter is attached to prevent the bag from collapsing against itself. The tubing may be threaded down the pajama or pants leg to prevent kinking. The collecting bottle and tubing are rinsed daily with cool water and once a week with a 3:1 solution of water and white vinegar.

***Cleaning and Deodorizing the Appliance.*** Usually, the reusable appliance is rinsed in warm water and soaked in a 3:1 solution of water and white vinegar or a commercial deodorizing solution for 30 minutes. It is rinsed with tepid water and air-dried away from direct sunlight. (Hot water and exposure to direct sunlight dry the pouch and increase the incidence of cracking.) After drying, the appliance may be powdered with cornstarch and stored. Two appliances are necessary—one to be worn while the other is air-drying.

CHART 45-14

PATIENT EDUCATION

## *Using Urinary Diversion Collection Appliances*

### Applying a Reusable Pouch System

1. Gather all necessary supplies.
2. Prepare new appliance according to the manufacturer's directions.
   - Apply double-faced adhesive disk that has been properly sized to fit the reusable pouch face-plate. Remove paper backing and set pouch aside, or apply thin layer of contact cement to one side of the reusable pouch faceplate. Set pouch aside.
3. Remove soiled pouch gently. Lay aside to clean later.
4. Clean peristomal skin (skin around stoma) with small amount of soap and water. Rinse thoroughly and dry. If a film of soap remains on the skin and the site does not dry, the appliance will not adhere adequately.
5. Use a wick (rolled gauze pad or tampon) over the stoma to absorb urine and keep the skin dry throughout the appliance change.
6. Inspect peristomal skin for irritation.
7. A skin protector wipe or barrier ring may be applied before centering the faceplate opening directly over the stoma.
8. Position appliance over stoma and press gently into place.
9. If desired, use a pouch cover or apply cornstarch under the pouch to prevent perspiration and skin irritation.
10. Clean soiled pouch and prepare for reuse.

### Applying a Disposable Pouch System

1. Gather all necessary supplies.
2. Measure stoma and prepare an opening in the skin barrier about an $\frac{1}{8}$-inch larger than the stoma and the same shape as the stoma.
3. Remove paper backing from skin barrier and set aside.
4. Gently remove old appliance and set aside.
5. Clean peristomal skin with warm water and dry thoroughly.
6. Inspect peristomal skin (skin around stoma) for irritation.
7. Use a wick (rolled gauze pad or tampon) over the stoma to absorb urine and keep the skin dry during the appliance change.
8. Center opening of skin barrier over stoma and apply with firm, gentle pressure to attain a water-tight seal.
9. If using a two-piece system, snap pouch onto the flanged wafer that adheres to skin.
10. Close drainage tap or spout at bottom of pouch.
11. A pouch cover can be used or cornstarch applied under pouch to prevent perspiration and skin irritation.
12. Apply hypoallergenic tape around the skin barrier in a picture-frame manner.
13. Dispose of soiled appliance.

### Continuing Care

Follow-up care is essential to determine how the patient has adapted to the altered body image changes and lifestyle changes. Referral for home care is indicated to determine how well the patient and family are coping with the changes necessitated by altered urinary drainage. The home care nurse assesses the patient's physical status and emotional response to urinary diversion. Additionally, the nurse assesses the ability of the patient and family to manage the urinary diversion and appliance, reinforces previous teaching, and provides additional information (eg, community resources, sources of ostomy supplies, insurance coverage for supplies).

As the postoperative edema subsides, the home care nurse assists in determining the appropriate changes needed in the ostomy appliance. The size of the stoma is measured every 3 to 6 weeks for the first few months postoperatively. The correct appliance size is determined by measuring the widest part of the stoma with a ruler. The permanent appliance should be no more than 1.6 mm (1/8 inch) larger than the diameter of the stoma and the same shape as the stoma to prevent contact of the skin with drainage.

The nurse teaches the patient and family about resources (see the list of resources at end of this chapter). Local chapters of the ACS can provide medical equipment and supplies and other resources for the patient who has undergone ostomy surgery for cancer.

The home care nurse assesses the patient for potential long-term complications such as ureteral obstruction, stenosis, hernias, or deterioration of renal function. The nurse also reinforces previous teaching about these complications.

## CUTANEOUS URETEROSTOMY

A cutaneous ureterostomy (see Fig. 45-7), in which the ureters are directed through the abdominal wall and attached to an opening in the skin, is used for selected patients with ureteral obstruction (ie, advanced pelvic cancer) because it requires less extensive surgery than other urinary diversion procedures. It is also an appropriate procedure for patients who have had previous abdominal irradiation.

A urinary appliance is fitted immediately after surgery. The management of the patient with a cutaneous ureterostomy is similar to the care of the patient with an ileal conduit, although the stomas are usually flush with the skin or retracted.

# *Continent Urinary Diversions*

## CONTINENT ILEAL URINARY RESERVOIR (INDIANA POUCH)

The most common continent urinary diversion is the Indiana pouch, created for the patient whose bladder is removed or no longer functions. The Indiana pouch uses a segment of the ileum and cecum to form the reservoir for urine (see Fig. 45-8A). The ureters are tunneled through the muscular bands of the intestinal pouch and anastomosed. The reservoir is made continent by narrowing the efferent portion of the ileum and sewing the terminal ileum to the subcutaneous tissue, forming a continent stoma flush with the skin. The pouch is sewn to the anterior abdominal wall around a cecostomy tube. Urine collects in the pouch until a catheter is inserted and the urine is drained (Diepenbrock, 2007).

The pouch must be drained at regular intervals by a catheter to prevent absorption of metabolic waste products from the urine, reflux of urine to the ureters, and UTI. Postoperative nursing care of the patient with a continent ileal urinary pouch is similar to nursing care of the patient with an ileal conduit. However, these patients usually have additional drainage tubes (cecostomy catheter from the pouch, stoma catheter exiting from the stoma, ureteral stents, and Penrose drain, as well as a urethral catheter). All drainage tubes must be carefully monitored for patency and amount and type of drainage. In the immediate postoperative period, the cecostomy tube is irrigated two or three times daily to remove mucus and prevent blockage.

Other variations of continent urinary reservoirs include the **Kock pouch** (U-shaped pouch constructed of ileum, with a nipplelike one-way valve; see Fig. 45-8B, C) and the **Charleston pouch** (uses the ileum and ascending colon as the pouch, with the appendix and colon junction serving as the one-way valve mechanism). With both of these methods, the pouch must be drained at regular intervals by a catheter.

## URETEROSIGMOIDOSTOMY

**Ureterosigmoidostomy,** another form of continent urinary diversion, is an implantation of the ureters into the sigmoid colon (see Fig. 45-8D). It is usually performed in patients who have had extensive pelvic irradiation, previous small bowel resection, or coexisting small bowel disease.

After surgery, voiding occurs from the rectum (for life), and an adjustment in lifestyle will be necessary because of urinary frequency. Drainage has a consistency equivalent to watery diarrhea, and the patient has some degree of nocturia. Patients usually need to plan activities around the frequent need to urinate, which in turn may affect the patient's social life. However, patients have the advantage of urinary control without having to wear an external appliance.

### Nursing Management

In addition to the usual preoperative regimen, the patient may be placed on a liquid diet for several days preoperatively to reduce residue in the colon. Antibiotic agents (neomycin, kanamycin) are administered to disinfect the bowel. Ureterosigmoidostomy requires a competent anal sphincter, adequate renal function, and active renal peristalsis. The degree of anal sphincter control may be determined by assessing the patient's ability to retain enemas.

The postoperative regimen initially includes placing a catheter in the rectum to drain the urine and prevent reflux of urine into the ureters and kidneys. The tube is taped to the buttocks, and special skin care is given around the anus to prevent excoriation. Irrigations of the rectal tube may be prescribed, but force is never used because of the danger of introducing bacteria into the newly implanted ureters.

#### Monitoring Fluid and Electrolytes

In ureterosigmoidostomy, larger areas of the bowel mucosa are exposed to urine and electrolyte reabsorption. As a result, electrolyte imbalance and acidosis may occur. Potassium and magnesium in the urine may cause diarrhea. Fluid and electrolyte balance is maintained in the immediate postoperative period by closely monitoring the serum electrolyte levels and administering appropriate IV fluids. Acidosis may be prevented by placing the patient on a low-chloride diet supplemented with sodium potassium citrate.

The patient should be instructed never to wait longer than 2 to 3 hours before emptying urine from the intestine. This keeps rectal pressure low and minimizes the absorption of urinary constituents from the colon. It is essential to teach the patient about the symptoms of UTI: fever, flank pain, urgency, and frequency.

#### Retraining the Anal Sphincter

After the rectal catheter is removed, the patient learns to control the anal sphincter through special sphincter exercises. At first, urination is frequent. With reassurance and encouragement and the passage of time, the patient gains greater control and learns to differentiate between the need to void and the need to defecate.

#### Promoting Dietary Measures

Specific dietary instructions include avoidance of gas-forming foods (flatus can cause stress incontinence and offensive odors). Other ways to avoid gas are to avoid chewing gum, smoking, and any other activity that involves swallowing air. Salt intake may be restricted to prevent hyperchloremic acidosis. Potassium intake is increased through foods and medication because potassium may be lost in acidosis.

#### Monitoring and Managing Potential Complications

Pyelonephritis (upper UTI) due to reflux of bacteria from the colon is fairly common. Long-term antibiotic therapy may be prescribed to prevent infection. A late complication is adenocarcinoma of the sigmoid colon, possibly from cellular changes due to exposure of the colonic mucosa to urine. Urinary carcinogens promote late malignant transformation of the colon after a ureterosigmoidostomy, warranting lifelong medical follow-up.

## Other Urinary Diversion Procedures

Variations in urinary diversion surgical procedures are devised frequently in an effort to identify and perfect procedures that will improve patient outcomes and reduce the incidence of postoperative problems. These include cecal, patched cecal, and Mainz reservoirs. These techniques involve isolating a part of the large intestine to form a reservoir for urine and creating an abdominal stoma. Another surgical procedure, the Camey procedure, uses a portion of the ileum as a bladder substitute. In this procedure, the isolated ileum serves as the reservoir for urine; it is anastomosed directly to the portion of the remaining urethra after cystectomy. This procedure permits emptying of the bladder through the urethra. However, the Camey procedure applies only to men because the entire urethra is removed when a cystectomy is performed in women.

## NURSING PROCESS

### The Patient Undergoing Urinary Diversion Surgery

#### Preoperative Assessment

The following are key preoperative nursing assessment concerns:

- Cardiopulmonary function assessments are performed because patients undergoing cystectomy are often older people who may be at greater risk for cardiac and respiratory complications.
- A nutritional status assessment is important because of possible poor nutritional intake related to underlying health problems.
- Learning needs are assessed in consultation with a WOCN to evaluate the patient's and the family's understanding of the procedure as well as the changes in physical structure and function that result from the surgery. The patient's self-concept and self-esteem are assessed, in addition to methods for coping with stress and loss. The patient's mental status, manual dexterity and coordination, and preferred method of learning are noted because they affect postoperative self-care.

#### Preoperative Nursing Diagnoses

Based on the assessment data, the preoperative nursing diagnoses for the patient undergoing urinary diversion surgery may include the following:

- Anxiety related to anticipated losses associated with the surgical procedure
- Imbalanced nutrition, less than body requirements related to inadequate nutritional intake
- Deficient knowledge about the surgical procedure and postoperative care

#### Preoperative Planning and Goals

The major goals for the patient may include relief of anxiety, improved preoperative nutritional status, and increased knowledge about the surgical procedure, expected outcomes, and postoperative care.

#### Preoperative Nursing Interventions

***Relieving Anxiety***

The threat of cancer and removal of the bladder create anxiety related to changes in body image. Patients may face problems adapting to an external appliance, a stoma, a surgical incision, and altered toileting habits. Men must also adapt to sexual impotency; a penile implant is considered if the patient is a candidate for the procedure. Women also have anxiety related to altered appearance, body image, and self-esteem. A supportive approach, both physical and psychosocial, is needed and includes assessing the patient's self-concept and manner of coping with stress and loss; helping the patient to identify ways to maintain his or her lifestyle and independence with as few changes as possible; and

encouraging the patient to express fears and anxieties about the ramifications of the upcoming surgery. A visitor from the Ostomy Visitation Program of the ACS can provide emotional support and make adaptation easier both before and after surgery.

#### *Ensuring Adequate Nutrition*

In addition to cleansing the bowel to minimize fecal stasis, decompress the bowel, and minimize postoperative ileus, a low-residue diet is prescribed. In addition, antibiotic medications are administered to reduce pathogenic flora in the bowel and to reduce the risk of infection. Because the patient undergoing a urinary diversion procedure for cancer may be severely malnourished due to the tumor, radiation enteritis, and anorexia, enteral or parenteral nutrition may be prescribed to promote healing. Adequate preoperative hydration is imperative to ensure urine flow during surgery and to prevent hypovolemia during the prolonged surgical procedure.

#### *Explaining Surgery and Its Effects*

Participation of a WOCN is invaluable for informed preoperative teaching and postoperative care planning. Explanations of the surgical procedure, the appearance of the stoma, the rationale for preoperative bowel preparation, the reasons for wearing a collection device, and the anticipated effects of the surgery on sexual functioning are part of patient teaching. The placement of the stoma site is planned preoperatively with the patient standing, sitting, and lying down to locate the stoma away from bony prominences, skin creases, and folds. The stoma should also be placed away from old scars, the umbilicus, and the belt line.

For ease of self-care, the patient must be able to see and reach the site comfortably. The site is marked with indelible ink so that it can be located easily during surgery. The patient is assessed for allergies or sensitivity to tape or adhesives. Patch testing of certain appliances may be necessary before the ostomy equipment is selected. This is particularly important if the patient is or may be allergic to latex (see Chapter 18).

### Preoperative Evaluation

To measure the effectiveness of care, the nurse evaluates the patient's preoperative anxiety level and nutritional status as well as preexisting knowledge and expectations of surgery.

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Exhibits reduced anxiety about surgery and expected losses
   a. Verbalizes fears with health care team and family
   b. Expresses positive attitude about outcome of surgery
2. Exhibits adequate nutritional status
   a. Maintains adequate intake before surgery
   b. Maintains body weight
   c. States rationale for enteral or parenteral nutrition if needed
   d. Exhibits normal skin turgor, moist mucous membranes, adequate urine output, and absence of excessive thirst
3. Demonstrates knowledge about the surgical procedure and postoperative course
   a. Identifies limitations expected after surgery
   b. Discusses expected immediate postoperative environment (tubes, equipment, nursing surveillance)
   c. Practices deep-breathing, coughing, and foot exercises

### Postoperative Assessment

The role of the nurse in the immediate postoperative period is to prevent complications and to assess the patient carefully for any signs and symptoms of complications. The catheters and any drainage devices are monitored closely. Urine volume, patency of the drainage system, and color of the drainage are assessed. A sudden decrease in urine volume or increase in drainage is reported promptly to the physician because these may indicate obstruction of the urinary tract, inadequate blood volume, or bleeding. In addition, the patient's need for pain control is assessed regularly as with all postoperative patients.

### Postoperative Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major postoperative nursing diagnoses for the patient following urinary diversion surgery may include the following:

- Risk for impaired skin integrity related to problems in managing the urine collection appliance
- Acute pain related to surgical incision
- Disturbed body image related to urinary diversion
- Potential for sexual dysfunction related to structural and physiologic alterations
- Deficient knowledge about management of urinary function

#### *Collaborative Problems/Potential Complications*

Potential complications may include the following:

- Peritonitis due to disruption of anastomosis
- Stoma ischemia and necrosis due to compromised blood supply to stoma
- Stoma retraction and separation of mucocutaneous border due to tension or trauma

### Postoperative Planning and Goals

The major goals for the patient may include maintaining skin integrity, relieving pain, increasing self-esteem, developing appropriate coping mechanisms to accept and deal with altered urinary function and sexuality, increasing knowledge about management of urinary function, and preventing potential complications.

### Postoperative Nursing Interventions

Postoperative management focuses on monitoring urinary function, preventing postoperative complications (infection and sepsis, respiratory complications, fluid and electrolyte imbalances, fistula formation, and urine leakage), and promoting patient comfort. Catheters or drainage systems are monitored, and urine output is monitored carefully. A nasogastric tube is inserted during surgery to decompress the GI tract and to relieve pressure on the

intestinal anastomosis. It is usually kept in place for several days after surgery. As soon as bowel function resumes, as indicated by bowel sounds, the passage of flatus, and a soft abdomen, oral fluids are permitted. Until that time, IV fluids and electrolytes are administered. The patient is assisted to ambulate as soon as possible to prevent complications of immobility.

***Maintaining Skin Integrity***

Strategies to promote skin integrity begin with reducing and controlling those factors that increase the patient's risk of poor nutrition and poor healing. As indicated previously, meticulous skin care and management of the drainage system are provided by the nurse until the patient can manage them and is comfortable doing so. Care is taken to keep the drainage system intact to protect the skin from exposure to drainage. Supplies must be readily available to manage the drainage in the immediate postoperative period. Consistency in implementing the skin care program throughout the postoperative period results in maintenance of skin integrity and patient comfort. Additionally, maintenance of skin integrity around the stoma enables the patient and family to adjust more easily to the alterations in urinary function and helps them learn skin care techniques.

***Relieving Pain***

Analgesic medications are administered liberally postoperatively to relieve pain and promote comfort, thereby allowing the patient to turn, cough, and perform deep-breathing exercises. Patient-controlled analgesia and regular administration of analgesic agents around the clock are two options that may be used to ensure adequate pain relief. A pain intensity scale is used to evaluate the adequacy of the medication and the approach to pain management.

***Improving Body Image***

The patient's ability to cope with the changes associated with the surgery depends to some degree on his or her body image and self-esteem before the surgery and the support and reaction of others. Allowing the patient to express concerns and anxious feelings can help, especially in adjusting to the changes in toileting habits. The nurse can also help improve the patient's self-concept by teaching the skills needed to be independent in managing the urinary drainage devices. Education about ostomy care is conducted in a private setting to encourage the patient to ask questions without fear of embarrassment. Explaining why the nurse must wear gloves when performing ostomy care can prevent the patient from misinterpreting the use of gloves as a sign of aversion to the stoma.

***Exploring Sexuality Issues***

Patients who experience altered sexual function as a result of the surgical procedure may mourn this loss. Encouraging the patient and partner to share their feelings about this loss with each other and acknowledging the importance of sexual function and expression may encourage the patient and partner to seek sexual counseling and to explore alternative ways of expressing sexuality. A visit from another "ostomate" who is functioning fully in society and family life may also assist the patient and family in recognizing that full recovery is possible.

***Monitoring and Managing Potential Complications***

Complications are not unusual because of the complexity of the surgery, the underlying reason (cancer, trauma) for the urinary diversion procedure, and the patient's frequently less-than-optimal nutritional status. Complications may include respiratory disorders (eg, atelectasis, pneumonia), fluid and electrolyte imbalances, breakdown of any anastomosis, sepsis, fistula formation, fecal or urine leakage, and skin irritation. If these occur, the patient will remain hospitalized for an extended length of time and will probably require parenteral nutrition, GI decompression by means of nasogastric suction, and further surgery. The goals of management are to establish drainage, provide adequate nutrition for healing to occur, and prevent sepsis.

**PERITONITIS.** Peritonitis can occur postoperatively if urine leaks at the anastomosis. Signs and symptoms include abdominal pain and distention, muscle rigidity with guarding, nausea and vomiting, paralytic ileus (absence of bowel sounds), fever, and leukocytosis.

Urine output must be monitored closely, because a sudden decrease in output with a corresponding increase in drainage from the incision or drains may indicate urine leakage. In addition, the urine drainage device is observed for leakage. The pouch is changed if a leak is observed. Small leaks in the anastomosis may seal themselves, but surgery may be needed for larger leaks.

Vital signs (blood pressure, pulse and respiratory rates, temperature) are monitored. Changes in vital signs, as well as increasing pain, nausea and vomiting, and abdominal distention, are reported to the physician and may indicate peritonitis.

**STOMA ISCHEMIA AND NECROSIS.** The stoma is monitored because ischemia and necrosis of the stoma can result from tension on the mesentery blood vessels, twisting of the bowel segment (conduit) during surgery, or arterial insufficiency. The new stoma must be inspected at least every 4 hours to assess the adequacy of its blood supply. The stoma should be red or pink. If the blood supply to the stoma is compromised, the color changes to purple, brown, or black. These changes are reported immediately to the physician. The physician or WOCN may insert a small, lubricated tube into the stoma and shine a flashlight into the lumen of the tube to assess for superficial ischemia or necrosis. A necrotic stoma requires surgical intervention. If the ischemia is superficial, the dusky stoma is observed and may slough its outer layer in several days.

**STOMA RETRACTION AND SEPARATION.** Stoma retraction and separation of the mucocutaneous border can occur as a result of trauma or tension on the internal bowel segment used for creation of the stoma. In addition, mucocutaneous separation can occur if the stoma does not heal as a result of accumulation of urine on the stoma and mucocutaneous border. Using a collection drainage pouch with an antireflux valve is helpful because the valve prevents urine from pooling on the stoma and mucocutaneous border. Meticulous skin care to keep the area around the stoma clean and dry promotes healing. If a separation of the mucocutaneous border occurs, surgery is not usually needed. The separated area is protected by applying karaya powder, stoma adhesive paste,

and a properly fitted skin barrier and pouch. By protecting the separation, healing is promoted. If the stoma retracts into the peritoneum, surgical intervention is mandatory.

If surgery is needed to manage these complications, the nurse provides explanations to the patient and family. The need for additional surgery is usually perceived as a setback by the patient and family. Emotional support of the patient and family is provided along with physical preparation of the patient for surgery.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** A major postoperative objective is to assist the patient to achieve the highest level of independence and self-care possible. The nurse and WOCN work closely with the patient and family to instruct and assist them in all phases of managing the ostomy. Adequate supplies and complete instruction are necessary to enable the patient and a family member to develop competence and confidence in their skills. Written and verbal instructions are provided, and the patient is encouraged to contact the nurse or physician with follow-up questions. Follow-up telephone calls from the nurse to the patient and family after discharge may provide added support and provide another opportunity to answer their questions. Follow-up visits and reinforcement of correct skin care and appliance management techniques also promote skin integrity. Specific techniques for managing the appliance are described in Chart 45-14.

The patient is encouraged to participate in decisions regarding the type of collecting appliance and the time of day to change the appliance. The patient is assisted and encouraged to look at and touch the stoma early to overcome any fears. The patient and family need to know the characteristics of a normal stoma:

- Pink and moist, like the inside of the mouth
- Insensitive to pain because it has no nerve endings
- Vascular, which means it may bleed when cleaned

Additionally, if a segment of the GI tract was used to create the urinary diversion, mucus may be visible in the urine. By learning what is normal, the patient and family become familiar with what signs and symptoms they should report to the physician or nurse and what problems they can handle themselves.

Information provided to the patient and the extent of involvement in self-care are determined by the patient's physical recovery and ability to accept and acquire the knowledge and skill needed for independence. Verbal and written instructions are provided, and the patient is given the opportunity to practice and demonstrate the knowledge and skills needed to manage urinary drainage.

**CONTINUING CARE.** Follow-up care is essential to determine how the patient has adapted to the body image changes and lifestyle adjustments. Visits from a home care nurse are important to assess the patient's adaptation to the home setting and management of the ostomy. Teaching and reinforcement may assist the patient and family to cope with altered urinary function. It is also necessary to assess for long-term complications that may occur, such as pouch leakage or rupture, stone formation, stenosis of the stoma, deterioration in renal function, or incontinence.

Long-term monitoring for anemia is performed to identify vitamin B deficiency, which may occur when a significant portion of the terminal ileum is removed. This may take several years to develop and can be treated with vitamin B injections. The patient and family are informed about the United Ostomy Association and any local ostomy support groups to provide ongoing support, assistance, and education.

### Postoperative Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Maintains skin integrity
   a. Maintains intact skin and demonstrates skill in managing drainage system and appliance
   b. States actions to take if skin excoriation occurs
2. Reports relief of pain
3. Exhibits improved body image as evidenced by the following:
   a. Voices acceptance of urinary diversion, stoma, and appliance
   b. Demonstrates increasingly independent self-care, including hygiene and grooming
   c. States acceptance of support and assistance from family members, health care providers, and other ostomates
4. Copes with sexuality issues
   a. Verbalizes concern about possible alterations in sexuality and sexual function
   b. Reports discussion of sexual concerns with partner and appropriate counselor
5. Demonstrates knowledge needed for self-care
   a. Performs self-care and proficient management of urinary diversion and appliance
   b. Asks questions relevant to self-management and prevention of complications
   c. Identifies signs and symptoms needing care from physician, nurse, or other health care providers
6. Absence of complications as evidenced by the following:
   a. Reports absence of pain or tenderness in abdomen
   b. Has temperature within normal range
   c. Reports no urine leakage from incision or drains
   d. Has urine output within desired volume limits
   e. Maintains stoma that is red or pink, moist, and appropriate in size without edema
   f. Has intact and healed border of the stoma

## CRITICAL THINKING EXERCISES

EBP **1** As the head nurse in a long-term care facility, you are approached by the daughter of one of the residents. She requests that her mother, who can ambulate with assistance, have an indwelling urinary catheter inserted "for convenience sake." What is the evidence base that determines your response? Identify the criteria used to evaluate the strength of the evidence.

EBP **2** As one of the nurses in a busy urology practice, you often care for elderly women with incontinence. Describe the major types of incontinence and compare

and contrast them. What are the evidence-based management techniques used in treating the different types of incontinence?

**3** A 35-year-old man is admitted to a medical-surgical nursing unit with a suspected renal stone. Describe the pathophysiology of renal stone formation. What diagnostic tests should be performed to confirm the diagnosis? What is the most common priority nursing diagnosis in the patient admitted with a renal stone? What history and physical findings are common in the patient who is trying to pass the stone? If the patient does not pass the stone or develops complications, what are the interventional procedures available for stone removal?

**4** You are caring for a 78-year-old patient after the creation of an ileal conduit. What is the best description of the ileal conduit? Describe the complications that may follow the placement of an ileal conduit. What assessments do you commonly perform in the immediate postoperative period? What is the role of a WOCN in the care of this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

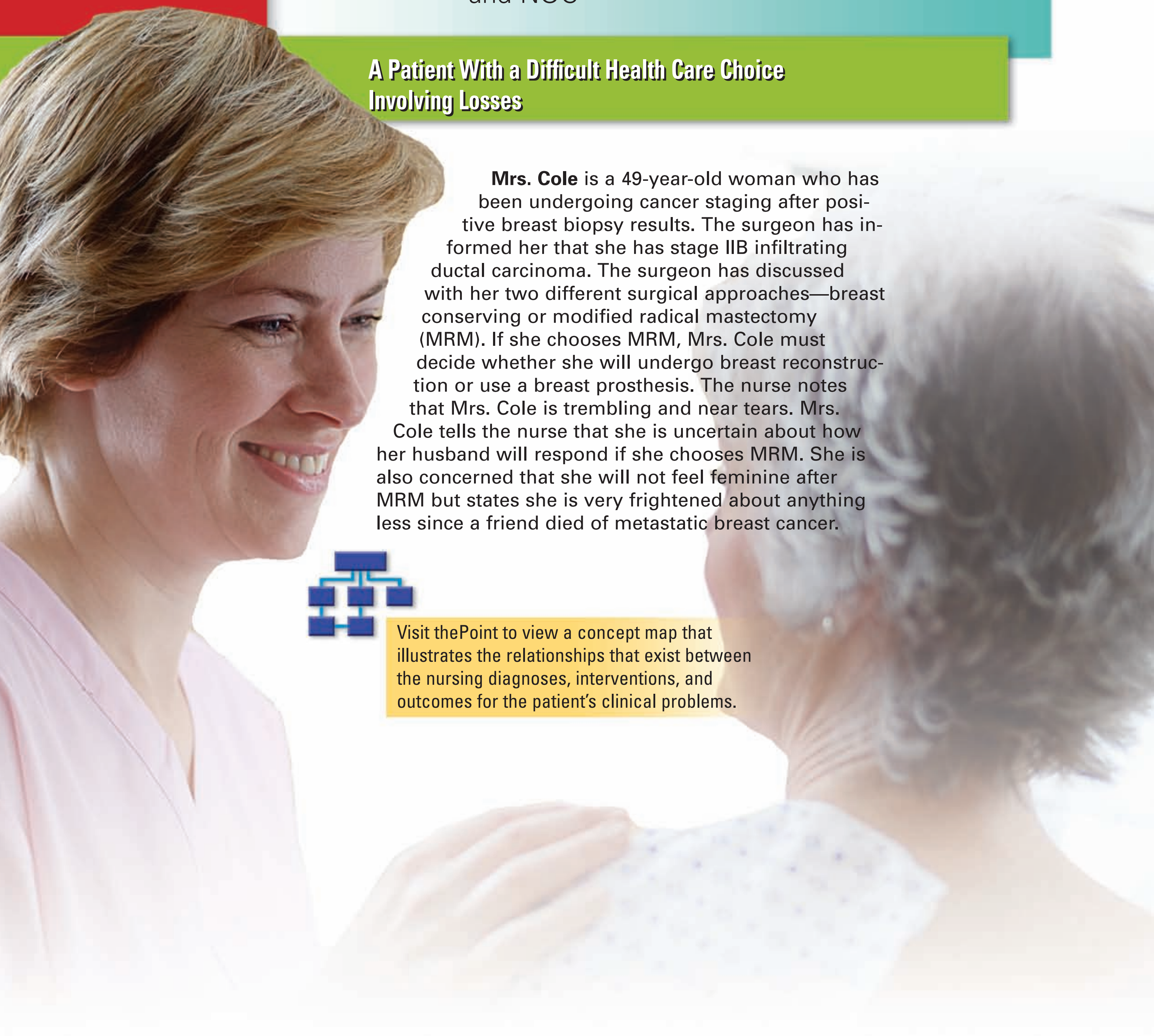
American Cancer Society, www.cancer.org
American Urological Association, www.auanet.org
National Association for Continence, www.nafc.org
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Institutes of Health, www.niddk.nih.gov
National Kidney Foundation, www.kidney.org

unit 10

# Reproductive Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With a Difficult Health Care Choice Involving Losses



**Mrs. Cole** is a 49-year-old woman who has been undergoing cancer staging after positive breast biopsy results. The surgeon has informed her that she has stage IIB infiltrating ductal carcinoma. The surgeon has discussed with her two different surgical approaches—breast conserving or modified radical mastectomy (MRM). If she chooses MRM, Mrs. Cole must decide whether she will undergo breast reconstruction or use a breast prosthesis. The nurse notes that Mrs. Cole is trembling and near tears. Mrs. Cole tells the nurse that she is uncertain about how her husband will respond if she chooses MRM. She is also concerned that she will not feel feminine after MRM but states she is very frightened about anything less since a friend died of metastatic breast cancer.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **DECISIONAL CONFLICT**—Uncertainty about course of action to be taken when choice among competing actions involves risk, loss, or challenge to personal life values | **ACTIVE LISTENING**—Attending closely to and attaching significance to a patient's verbal and nonverbal messages | **DECISION MAKING**—Ability to make judgments and choose between two or more alternatives |
| **ANTICIPATORY GRIEVING**—Intellectual and emotional responses and behaviors by which individuals, families, and communities work through the process of modifying self-concept based on the perception of potential loss | **DECISION-MAKING SUPPORT**—Providing information and support for a patient who is making a decision regarding health care | **GRIEF RESOLUTION**—Adjustment to actual or impending loss |
| | **ANTICIPATORY GUIDANCE**—Preparation of a patient for an anticipated developmental and/or situational crisis<br>**GRIEF WORK FACILITATION**—Assistance with the resolution of a significant loss<br>**EMOTIONAL SUPPORT**—Provision of reassurance, acceptance and encouragement during times of stress | **PSYCHOSOCIAL ADJUSTMENT: LIFE CHANGE**—Adaptive psychosocial response of an individual to a significant life change |


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chapter 46

# Assessment and Management of Female Physiologic Processes

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe female reproductive function.
2. Describe approaches to effective sexual assessment.
3. Describe indicators of domestic violence and abuse of women and methods of identifying and treating women who are survivors of abuse.
4. Identify the diagnostic examinations and tests used to determine alteration in female reproductive function and describe the nurse's role before, during, and after these examinations and procedures.
5. Identify types of menstrual disorders and related nursing implications.
6. Describe nursing care for patients with premenstrual syndrome.
7. Develop a teaching plan for women who are approaching or have completed menopause.
8. Describe methods of contraception and implications for health care and education.
9. Describe the nursing management of the patient having an abortion.
10. Describe the causes and management of infertility.
11. Use the nursing process to plan for the care of the patient with an ectopic pregnancy.
12. Discuss the healthy older woman and health teaching related to aging.

## GLOSSARY

**adnexa:** the fallopian tubes and ovaries
**amenorrhea:** absence of menstrual flow
**androgens:** hormones produced by the ovaries and adrenals that affect many aspects of female health, including follicle development, libido, oiliness of hair and skin, and hair growth
**cervix:** bottom (inferior) part of the uterus that is located in the vagina
**chandelier sign:** pain on gentle movement of the cervix; associated with pelvic infection
**corpus luteum:** site of a follicle that changes after ovulation to produce progesterone
**cystocele:** weakness of the anterior vaginal wall that allows the bladder to protrude into the vagina

## GLOSSARY *(Continued)*

**dysmenorrhea:** painful menstruation
**dyspareunia:** difficult or painful sexual intercourse
**endometrial ablation:** procedure performed through a hysteroscope in which the lining of the uterus is burned away or ablated to treat abnormal uterine bleeding
**endometriosis:** condition in which endometrial tissue implants in other areas of the pelvis; may produce dysmenorrhea or infertility
**endometrium:** lining of the uterus
**estrogen:** hormone that develops and maintains the female reproductive system
**follicle-stimulating hormone (FSH):** hormone released by the pituitary gland to stimulate estrogen production and ovulation
**fornix:** upper part of the vagina
**fundus:** body of the uterus
**graafian follicle:** cystic structure that develops on the ovary as ovulation begins
**hymen:** tissue that covers the vaginal opening partially or completely before vaginal penetration
**hysteroscopy:** a procedure performed using a long telescope-like instrument inserted through the cervix to diagnose uterine problems
**introitus:** perineal opening to the vagina
**luteal phase:** stage in the menstrual cycle in which the endometrium becomes thicker and more vascular
**luteinizing hormone (LH):** hormone released by the pituitary gland that stimulates progesterone production
**menarche:** beginning of menstrual function
**menopause:** permanent cessation of menstruation resulting from the loss of ovarian follicular activity
**menstruation:** sloughing and discharge of the lining of the uterus if conception does not take place
**ovaries:** almond-shaped reproductive organs that produce eggs at ovulation and play a major role in hormone production
**ovulation:** discharge of a mature ovum from the ovary
**perimenopause:** the period immediately prior to menopause and the first year after menopause
**polyp (cervical or endometrial):** growth of tissue on the cervix or endometrial lining; usually benign
**progesterone:** hormone produced by the corpus luteum
**proliferative phase:** stage in the menstrual cycle before ovulation when the endometrium proliferates
**rectocele:** weakness of the posterior vaginal wall that allows the rectal cavity to protrude into the submucosa of the vagina
**secretory phase:** stage of the menstrual cycle in which the endometrium becomes thickened, more vascular, and edematous
**uterine prolapse:** relaxation of pelvic tone that allows the cervix and uterus to descend into the lower vagina

Women are becoming more knowledgeable about their health. Nurses who work with them need to understand normal female anatomy and physiology and the physical, developmental, psychological, and sociocultural influences on women's health, health practices, and use of health care resources. Health assessment, maintenance, and promotion across the lifespan must consider women's growth and development, sexuality, contraception, preconception care, conception, prenatal care, effects of pregnancy on health, perimenopause, menopause, and aging. It is also necessary to consider how medications and diseases affect women. In addition, women's sexuality is complex and often affected by many factors, and related issues need careful evaluation and treatment. Because women use the health care system more often than men and make up the majority of health care workers, addressing women's health needs and concerns improves quality and access for women and their families.

## ROLE OF NURSES IN WOMEN'S HEALTH

As their presence in the labor market continues to increase, women face challenges in their roles, lifestyles, and family patterns. Furthermore, they encounter environmental hazards and stress, prompting greater attention on health and health-promoting practices. As a result, many women are taking a greater interest in and responsibility for their own health and health care, although not all women have the time, finances, or other resources to do so.

In recent years, many women have delayed pregnancy and childbearing until well after they have established careers, in part because of the wide variety of contraceptive methods that are available. Advances in the treatment of infertility have enabled many women previously unable to have children to become pregnant and have allowed couples well into their 40s to have children. Women who have many roles and multiple responsibilities (eg, workers, wives, mothers, parental caretakers) often "multitask"; they have little time for themselves and often put the needs of others before their own health needs. Nurses must be sensitive to these needs and knowledgeable about preventive health care for women. Nurses are in an ideal position to encourage women to determine their own health goals and behaviors, teach about health promotion and illness prevention, offer intervention strategies, and provide support, counseling, and ongoing monitoring. Areas of special interest in health promotion include the following:

- Normal physical changes and optimal personal hygiene
- Strategies for detecting and preventing disease, especially sexually transmitted diseases (STDs), also referred to as sexually transmitted infections (STIs), including human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS)
- Issues related to sexuality and sexual function, such as contraception; preconception, prenatal, and postnatal care; sexual satisfaction; and menopause
- Diet, exercise, and health-promoting practices that maintain and enhance health, including having a normal weight for height
- Appropriate stress management to reduce the detrimental effects of stress on health and well-being
- Treatment for substance abuse and smoking

Nurses need to model a healthy lifestyle for their patients. It is important that nurses promote positive practices and behaviors related to the reproductive and sexual health of all patients. Necessary strategies include the following:

- Recommending regular examinations to promote health, detect health problems at an early stage, assess problems related to gynecologic and reproductive function, and discuss questions or concerns related to sexual function and sexuality
- Providing an open, nonjudgmental environment (crucial in providing nursing and health care, especially when patients are discussing personal issues). Nurses must convey understanding and sensitivity and be alert to cues about unspoken patient concerns.
- Recognizing signs and symptoms of abuse and screening all patients in a private and safe environment
- Recognizing cultural differences and beliefs and respecting sexual orientation

## ASSESSMENT OF THE FEMALE REPRODUCTIVE SYSTEM

### *Anatomic and Physiologic Overview*

#### Anatomy of the Female Reproductive System

The female reproductive system consists of external and internal pelvic structures. Other anatomic structures that affect the female reproductive system include the hypothalamus and pituitary gland of the endocrine system.

##### *External Genitalia*

The external genitalia (the vulva) include two thick folds of tissue called the labia majora and two smaller lips of delicate tissue called the labia minora, which lie within the labia majora. The upper portions of the labia minora unite, forming a partial covering for the clitoris, a highly sensitive organ composed of erectile tissue. Between the labia minora, below and posterior to the clitoris, is the urinary meatus, the external opening of the female urethra, which is about 3 cm (less than 1.5 in) long. Below this orifice is a larger opening, the vaginal orifice or **introitus** (Fig. 46-1). On each side of the vaginal orifice is a vestibular (Bartholin's) gland, a bean-sized structure that empties its mucous secretion through a small duct. The opening of the duct lies within the labia minora, external to the hymen. The area between the vagina and rectum is called the perineum.

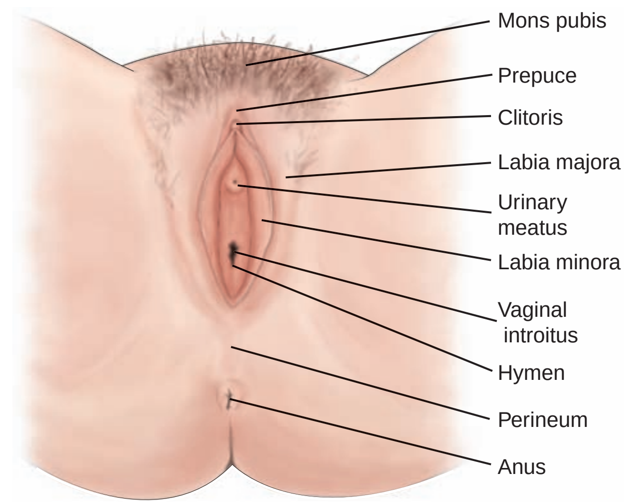



**Figure 46-1** External female genitalia.

### *Internal Reproductive Structures*

The internal structures consist of the vagina, uterus, ovaries, and fallopian or uterine tubes (Fig. 46-2).

#### Vagina

The vagina, a canal lined with mucous membrane, is 7.5 to 10 cm (3 to 4 in) long and extends upward and backward from the vulva to the cervix. Anterior to it are the bladder and the urethra, and posterior to it lies the rectum. The anterior and posterior walls of the vagina normally touch each other. The upper part of the vagina, the **fornix,** surrounds the **cervix** (the inferior part of the uterus).

#### Uterus

The uterus, a pear-shaped, muscular organ, is about 7.5 cm (3 in) long and 5 cm (2 in) wide at its upper part. Its walls are about 1.25 cm (0.5 in) thick. The size of the uterus varies, depending on parity (number of viable births) and uterine abnormalities (eg, fibroids, which are a type of tumor that may distort the uterus). A nulliparous woman (one who has not completed a pregnancy to the stage of fetal viability) usually has a smaller uterus than a multiparous woman (one who has completed two or more pregnancies to the stage of fetal viability). The uterus lies posterior to the bladder and is held in position by several ligaments. The round ligaments extend anteriorly and laterally to the internal inguinal ring and down the inguinal canal, where they blend with the tissues of the labia majora. The broad ligaments are folds of peritoneum extending from the lateral pelvic walls and enveloping the fallopian tubes. The uterosacral ligaments extend posteriorly to the sacrum. The uterus has two parts: the cervix, which projects into the vagina, and a larger upper part, the **fundus** or body, which is covered posteriorly and partly anteriorly by peritoneum. The triangular inner portion of the fundus narrows to a small canal in the cervix that has constrictions at each end, referred to as the external os and internal os. The upper lateral parts of the uterus are called the cornua. From here, the oviducts or fallopian (or uterine) tubes extend outward, and their lumina are internally continuous with the uterine cavity (Porth & Matfin, 2009).

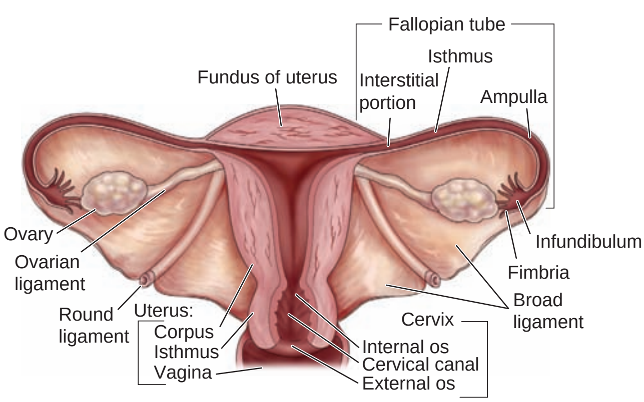



**Figure 46-2** Internal female reproductive structures.

#### Ovaries

The **ovaries** lie behind the broad ligaments and behind and below the fallopian tubes. They are oval bodies about 3 cm (1.2 in) long. At birth, they contain thousands of tiny egg cells, or ova. The ovaries and the fallopian tubes together are referred to as the **adnexa.**

## Function of the Female Reproductive System

### *Ovulation*

At puberty (usually between 12 and 14 years of age, but earlier for some; 10 or 11 years of age is not uncommon), the ova begin to mature and menstrual cycles begin. In the follicular phase, an ovum enlarges as a type of cyst called a **graafian follicle** until it reaches the surface of the ovary, where transport occurs. The ovum (or oocyte) is discharged into the peritoneal cavity. This periodic discharge of matured ovum is referred to as **ovulation.** The ovum usually finds its way into the fallopian tube, where it is carried to the uterus. If it is penetrated by a spermatozoon, the male reproductive cell, a union occurs and conception takes place. After the discharge of the ovum, the cells of the graafian follicle undergo a rapid change. Gradually, they become yellow **(corpus luteum)** and produce **progesterone,** a hormone that prepares the uterus for receiving the fertilized ovum. Ovulation usually occurs 2 weeks prior to the next menstrual period.

### *Menstrual Cycle*

The menstrual cycle is a complex process involving the reproductive and endocrine systems. The ovaries produce steroid hormones, predominantly estrogens and progesterone. Several different **estrogens** are produced by the ovarian follicle, which consists of the developing ovum and its surrounding cells. The most potent of the ovarian

estrogens is estradiol. Estrogens are responsible for developing and maintaining the female reproductive organs and the secondary sex characteristics associated with the adult female. Estrogens play an important role in breast development and in monthly cyclic changes in the uterus (Porth & Matfin, 2009).

Progesterone is also important in regulating the changes that occur in the uterus during the menstrual cycle. It is secreted by the corpus luteum, which is the ovarian follicle after the ovum has been released. Progesterone is the most important hormone for conditioning the **endometrium** (the mucous membrane lining the uterus) in preparation for implantation of a fertilized ovum. If pregnancy occurs, the progesterone secretion becomes largely a function of the placenta and is essential for maintaining a normal pregnancy. In addition, progesterone, working with estrogen, prepares the breast for producing and secreting milk. **Androgens** are also produced by the ovaries and adrenal glands, but only in small amounts. These hormones are involved in the early development of the follicle and also affect the female libido (Porth & Matfin, 2009).

Two gonadotropic hormones are released by the pituitary gland: **follicle-stimulating hormone (FSH)** and **luteinizing hormone (LH).** FSH is primarily responsible for stimulating the ovaries to secrete estrogen. LH is primarily responsible for stimulating progesterone production. Feedback mechanisms, in part, regulate FSH and LH secretion. For example, elevated estrogen levels in the blood inhibit FSH secretion but promote LH secretion, whereas elevated progesterone levels inhibit LH secretion. In addition, gonadotropin-releasing hormone (GnRH) from the hypothalamus affects the rate of FSH and LH release.

The secretion of ovarian hormones follows a cyclic pattern that results in changes in the uterine endometrium and in **menstruation** (Fig. 46-3, Table 46-1). This cycle is typically 28 days in length, but there are many normal variations (from 21 to 42 days). In the **proliferative phase** at the beginning of the cycle (just after menstruation), FSH output increases, stimulating estrogen secretion. This causes the endometrium to thicken and become more vascular. In the **secretory phase** near the middle portion of the cycle (day 14 in a 28-day cycle), LH output increases, stimulating ovulation. Under the combined stimulus of estrogen and progesterone, the endometrium reaches the peak of its thickening and vascularization. In the **luteal phase,** which begins after ovulation, progesterone is secreted by the corpus luteum.

If the ovum is fertilized, estrogen and progesterone levels remain high, and the complex hormonal changes of pregnancy follow. If the ovum has not been fertilized, FSH and LH output diminishes, estrogen and progesterone secretion falls, the ovum disintegrates, and the endometrium, which has become thick and congested, becomes hemorrhagic. The product, menstrual flow, consisting of old blood, mucus, and endometrial tissue, is discharged through the cervix and into the vagina. After the menstrual flow stops, the cycle begins again; the endometrium proliferates and thickens from estrogenic stimulation, and ovulation recurs (Porth & Matfin, 2009).

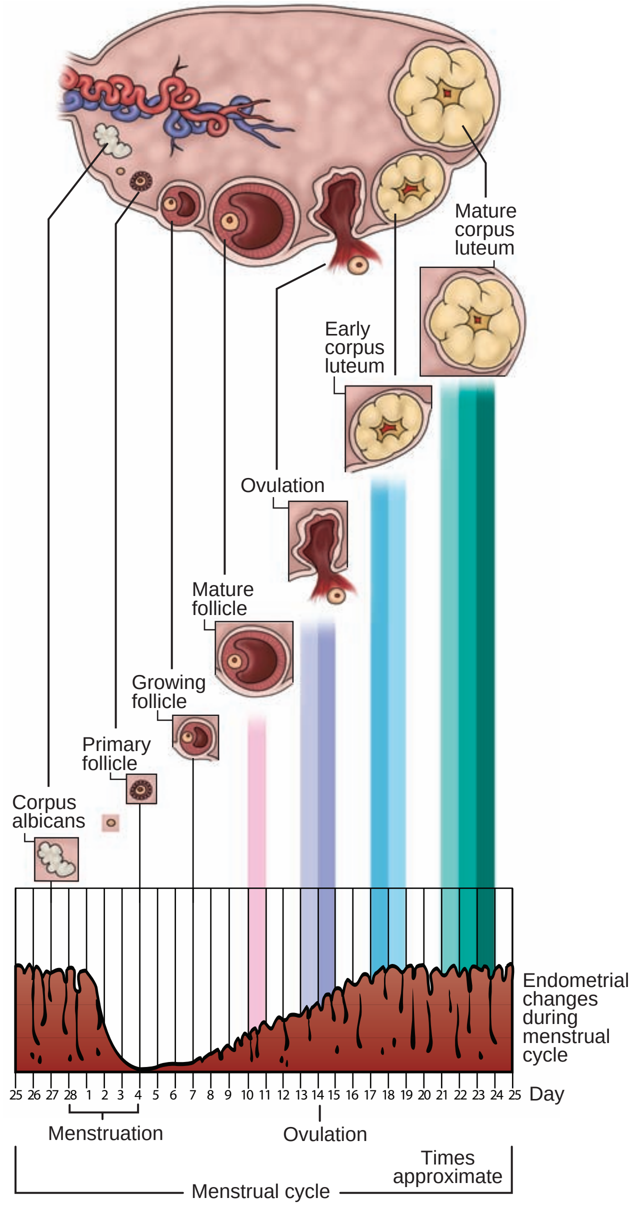



**Figure 46-3** One menstrual cycle and the corresponding changes in the endometrium.

### *Menopausal Period*

The menopausal period marks the end of a woman's reproductive capacity. It usually occurs between 45 and 52 years of age but may occur as early as 42 or as late as 55; the median age is 51 years. Perimenopause precedes this and can begin as early as 35 years of age. Physical, emotional, and menstrual changes may occur, and this transition offers another opportunity for health promotion and disease prevention teaching and counseling. **Menopause** is not a pathologic phenomenon but a normal part of aging and maturation. Menstruation ceases, and because the ovaries are no longer active, the

**Table 46-1 HORMONAL CHANGES DURING THE MENSTRUAL CYCLE**

(Times approximate)

Days 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 1 2

| Phase | Menstrual | Follicular | Ovulation | Luteal | Premenstrual |
|---|---|---|---|---|---|
| **Ovary** | Degenerating corpus luteum; beginning follicular development | Growth and maturation of follicle | Ovulation | Active corpus luteum | Degenerating corpus luteum |
| **Estrogen Production** | Low | Increasing | High | Declining, then a secondary rise | Decreasing |
| **Progesterone Production** | None | Low | Low | Increasing | Decreasing |
| **FSH Production** | Increasing | High, then declining | Low | Low | Increasing |
| **LH Production** | Low | Low, then increasing | High | High | Decreasing |
| **Endometrium** | Degeneration and shedding of superficial layer. Coiled arteries dilate, then constrict again. | Reorganization and proliferation of superficial layer | Continued growth | Active secretion and glandular dilation; highly vascular; edematous | Vasoconstriction of coiled arteries; beginning degeneration |

reproductive organs become smaller. No more ova mature; therefore, no ovarian hormones are produced. (An earlier menopause may occur if the ovaries are surgically removed or are destroyed by radiation or chemotherapy or because of an unknown etiology.) Multifaceted changes also occur throughout the woman's body. These changes are neuroendocrinologic, biochemical, and metabolic and are related to normal maturation or aging (Table 46-2).

## Assessment

A nurse who is obtaining information from a patient for the health history and performing physical assessment is in an ideal position to discuss the woman's general health issues, health promotion, and health-related concerns. Relevant topics include fitness, nutrition, cardiovascular risks, health screening, sexuality, menopause, abuse, health risk behaviors, emotional well-being, and immunizations. Recommendations for health screening are summarized in Chart 46-1.

### Health History

In addition to the general health history, the nurse asks about past illnesses and experiences specific to a woman's health. Data should be collected about the following:

- Menstrual history (including **menarche,** length of cycles, duration and amount of flow, presence of cramps or pain, bleeding between periods or after intercourse, bleeding after menopause)
- Pregnancies (number of pregnancies, outcomes of pregnancies)

**Table 46-2 AGE-RELATED CHANGES IN THE FEMALE REPRODUCTIVE SYSTEM**

| | Physiologic Changes | Signs and Symptoms |
|---|---|---|
| Cessation of ovarian function and decreased estrogen production | Decreased ovulation | Decreased/loss of ability to conceive; increased infertility |
| | Onset of menopause | Irregular menses with eventual cessation of menses |
| | Vasomotor instability and hormonal fluctuations | Hot flashes or flushing; night sweats, sleep disturbances; mood swings; fatigue |
| | Decreased bone formation | Bone loss and increased risk for osteoporosis and osteoporotic fractures; loss of height |
| | Decreased vaginal lubrication | Dyspareunia, resulting in lack of interest in sex |
| | Thinning of urinary and genital tracts | Increased risk for urinary tract infection |
| | Increased pH of vagina | Increased incidence of inflammation (atrophic vaginitis) with discharge, itching, and vulvar burning |
| | Thinning of pubic hair and shrinking of labia | |
| Relaxation of pelvic musculature | Prolapse of uterus, cystocele, rectocele | Dyspareunia, incontinence, feelings of perineal pressure |

## Chart 46-1 • *Summary of Health Screening and Counseling Issues for Women*

### Ages 19–39

**Sexuality and Reproductive Issues**

Annual pelvic examination
Annual clinical breast examination
Contraceptive options
High-risk sexual behaviors

**Health and Risk Behaviors**

Hygiene
Injury prevention
Nutrition
Exercise patterns
Risk for domestic abuse
Use of tobacco, drugs, and alcohol
Life stresses
Immunizations

**Diagnostic Testing***

Pap smear every 3 years after onset of sexual intercourse
STD/STI screening as indicated

### Ages 40–64

**Sexuality and Reproductive Issues**

Annual pelvic examination
Annual clinical breast examination
Contraceptive options
High-risk sexual behaviors
Menopausal concerns

**Health and Risk Behaviors**

Hygiene
Bone loss and injury prevention
Nutrition
Exercise patterns
Risk for domestic abuse
Use of tobacco, drugs, and alcohol
Life stresses
Immunizations

**Diagnostic Testing***

Pap smear every 2 to 3 years after three consecutive negative tests if no history of cervical abnormalities, HIV infection, or DES exposure
Mammography
Cholesterol and lipid profile
Colorectal cancer screening
Bone mineral density testing
Thyroid-stimulating hormone testing
Hearing and eye examinations

### Ages 65 and Over

**Sexuality and Reproductive Issues**

Annual pelvic examination
Annual clinical breast examination
High-risk sexual behaviors

**Health and Risk Behaviors**

Hygiene
Injury prevention
Nutrition
Exercise patterns
Risk for domestic abuse
Use of tobacco, drugs, and alcohol
Life stresses
Immunizations

**Diagnostic Testing***

Pap smear every 2 to 3 years after three consecutive negative tests if no history of cervical abnormalities, HIV infection, or DES exposure
Mammography
Cholesterol and lipid profile
Colorectal cancer screening
Bone mineral density testing
Thyroid-stimulating hormone testing
Hearing and eye examinations

*Each individual's risks (family history, personal history) influence the need for specific assessments and their frequency.

- Exposure to medications (diethylstilbestrol [DES], immunosuppressive agents, others)
- Pain with menses **(dysmenorrhea),** pain with intercourse **(dyspareunia),** pelvic pain
- Symptoms of vaginitis (ie, odor or itching)
- Problems with urinary function, including frequency, urgency, and incontinence
- Bowel problems
- Sexual history
- STDs and methods of treatment
- Current or previous sexual abuse or physical abuse
- Past surgery or other procedures on reproductive tract structures (including female genital mutilation or female circumcision)
- Chronic illness or disability that may affect health status, reproductive health, need for health screening, or access to health care
- Presence of or family history of a genetic disorder. Chart 46-2 presents information about genetic reproductive disorders.

In collecting data related to reproductive health, the nurse can teach the patient about normal physiologic processes, such as menstruation and menopause, and assess possible abnormalities. Many problems experienced by young or middle-age women can be corrected easily. However, if they are not treated, they may result in anxiety and health problems. Issues related to sexuality and sexual function are typically more often brought to the attention of the gynecologic or women's health care provider than other health care providers; however, nurses caring for all women should consider these issues part of routine health assessment.

### Sexual History

A sexual assessment includes both subjective and objective data. Health and sexual histories, physical examination findings, and laboratory results are all part of the database. The purpose of a sexual history is to obtain information that provides a picture of a woman's sexuality and sexual practices and to promote sexual health. The sexual history may enable a patient to discuss sexual matters openly and

CHART 46-2

GENETICS IN NURSING PRACTICE

## *Reproductive Disorders*

Various reproductive disorders are influenced by genetic factors. Some examples are:

- Hereditary breast or ovarian cancer syndromes
- Hereditary nonpolyposis colon cancer syndrome (risk for uterine cancer)
- Müllerian aplasia
- 21-Hydroxylase deficiency (female masculinization)
- Turner syndrome (45,XO)
- Klinefelter syndrome (47,XXY)

### Nursing Assessments

**Family History Assessment**

- Assess family history for other family members with similar reproductive problems/abnormalities.
- Inquire about ethnic background (eg, Ashkenazi Jewish populations and hereditary breast/ovarian cancer mutations).
- Inquire about relatives with other cancers, including early-onset ovarian, uterine, renal, prostate cancers.

**Patient Assessment**

- In females with delayed puberty or primary amenorrhea, assess for clinical features of Turner syndrome (short stature, webbing of the neck, widely spaced nipples).
- In males with delayed puberty or infertility, assess for clinical features of Klinefelter syndrome (tall stature, gynecomastia, learning disabilities).
- Assess for other congenital anomalies in females with Müllerian defect, including renal and vertebral anomalies.

### Management Issues Specific to Genetics

- Inquire whether genetics testing (DNA chromosomal, metabolic) has been carried out on affected family member(s).
- If indicated, refer for further genetics counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetics testing, and gene-based interventions.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed gene-related reproductive disorders.
- Participate in management and coordination of care of patients with genetic conditions, individuals predisposed to develop or pass on a genetic condition.

### Genetics Resources for Nurses and their Patients on the Web

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**American Cancer Society**—offers general information about cancer and support resources for families, www.cancer.org

**Gene Clinics**—a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling and testing information, www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**National Cancer Institute**—current information about cancer research, treatment, resources for health care providers, individuals and families, www.nci.nih.gov

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/omim/stats/html

to discuss sexual concerns with an informed health professional. This information can be obtained after the gynecologic–obstetric or genitourinary history is completed. By incorporating the sexual history into the general health history, the nurse can move from areas of lesser sensitivity to areas of greater sensitivity after establishing initial rapport.

Taking the sexual history becomes a dynamic process reflecting an exchange of information between the patient and the nurse and provides the opportunity to clarify myths and explore areas of concern that the patient may not have felt comfortable discussing in the past. In obtaining a sexual history, the nurse must not assume the patient's sexual preference until clarified. When asking about sexual health, the nurse also cannot assume that the patient is married or unmarried. Asking a patient to label herself as single, married, widowed, or divorced may be considered by some women as inappropriate. Asking about a partner or about current meaningful relationships may be a less offensive way to initiate a sexual history.

The PLISSIT (*p*ermission, *l*imited *i*nformation, *s*pecific *s*uggestions, *i*ntensive *t*herapy) model of sexual assessment and intervention may be used to provide a framework for nursing interventions (Annon, 1976). The assessment begins by introducing the topic and asking the woman for permission to discuss issues related to sexuality with her.

The nurse can begin by explaining the purpose of obtaining a sexual history (eg, "I ask all my patients about their sexual health. May I ask you some questions about this?"). History taking continues by inquiring about present sexual activity and sexual orientation (eg, "Are you currently having sex? With a man, a woman, or both?"). Inquiries about possible sexual dysfunction may include, "Are you having any problems related to your current sexual activity?" Such problems may be related to medication, life changes, disability, or the onset of physical or emotional illness. A patient can be asked about her thoughts on what is causing the current problem.

Information about sexual function can be introduced during the health history. As the discussion progresses, the nurse may offer specific suggestions for interventions. A professional who specializes in sex therapy may provide more intensive therapy if necessary. By initiating an

assessment about sexual concerns, the nurse communicates to the patient that issues about changes or problems in sexual functioning are valid health issues, which provides a safe environment for discussing these sensitive topics. Young women may be apprehensive about having irregular periods, may be concerned about STDs, or may need contraception. They may want information about using tampons, emergency contraception, or issues related to pregnancy. Perimenopausal women may have concerns about irregular menses. Menopausal women may be concerned about vaginal dryness and discomfort with intercourse. Women of any age may have concerns about relationships, sexual satisfaction, orgasm, or masturbation.

Risk of STDs can be assessed by asking about the number of sexual partners in the past year or in the patient's lifetime. An open-ended question related to the patient's need for further information should be included (eg, "Do you have any questions or concerns about your sexual health?"). Women can be advised that intercourse should never be painful; pain should be investigated by a care provider. They should also be encouraged to talk openly about their sexual feelings with their partner; in an intimate relationship, feelings are facts (Sarrel, 2005).

### Female Genital Mutilation or Cutting

Female genital mutilation (FGM), or cutting, refers to the partial or total removal of the external female genitalia or other injury to female organs. Over 140 million girls and women have been subjected to this practice. Some cultures accept FGM as a rite of passage to womanhood and believe that this practice promotes hygiene, protects virginity and family honor, prevents promiscuity, improves female attractiveness and male sexual pleasure, and enhances fertility. FGM is considered an acceptable practice in many cultures, mostly in Africa and the Middle East. However, FGM is illegal in the United States and many organizations (eg, World Health Organization, Amnesty International) consider it a health and human rights issue and are working to end it. An increasing number of women entering the United States health care system underwent FGM before coming to the United States (Turner, 2007), and others have undergone FGM since their arrival in this country. Some of these women think that the practice is acceptable and do not consider themselves mutilated, whereas others believe it to be harmful and feel that they have been traumatized.

FGM is usually performed when a girl is between 4 and 10 years of age, but it may be performed on a newborn, adolescent, at the time of marriage, or during the first pregnancy. Short-term complications of FGM include hemorrhage, cellulitis, lacerations, urinary dysfunction, and infection. Long-term complications include urinary dysfunction, chronic vaginitis and pelvic infections, inability to undergo pelvic examination, painful intercourse, impaired sexual response, anemia, increased risk of HIV infection due to tearing of scar tissue, and psychological and psychosexual sequelae. Because FGM can affect sexual function, menstrual hygiene, and bladder function, the possibility of FGM must be considered in the sexual history, particularly in women from cultures and countries where the practice is common.

Nurses who care for patients who have undergone FGM need to be sensitive, empathetic, knowledgeable, culturally competent, and nonjudgmental (Turner, 2007). Respect for others' health beliefs, practices, and behaviors, and recognition of the complexity of issues involved is crucial. The nurse should use the woman's terminology. "Cutting" is a more acceptable term than mutilation. Speculums are not used in some developing countries; the function of this instrument should be explained and an appropriate-sized speculum used to examine women who have experienced FGM.

### Domestic Violence

Domestic violence is a broad term that includes child abuse, elder abuse, and abuse of women and men. Abuse can be emotional, physical, sexual, or economic. Abuse involves fear of one partner by another and control by threats, intimidation, and physical abuse. Abuse is related to the need to maintain control of a partner and is rooted in sex role inequality.

More than 6 million women experience domestic violence each year, and battered women are encountered daily in nursing practice. Battering involves repeated physical or sexual assault in a context of coercive control and, more broadly, emotional degradation, threats, and intimidation. Violence is rarely a one-time occurrence in a relationship; it usually continues and escalates in severity. This is an important point to emphasize when a woman states that her partner has hurt her but has promised to change. Batterers can change their behavior but not without extensive counseling and motivation. If a woman states that she is being hurt, sensitive care is required (Chart 46-3).

By knowing about this major public health problem, being alert to abuse-related problems, and learning how to elicit information from women about abuse in their lives, nurses can offer intervention for a problem that might otherwise go undetected and can save lives by making women safer through education and support. Asking each woman about violence in her life in a safe environment (ie, a private room with the door closed) is part of a comprehensive assessment and universal screening. Asking about abuse directly is effective in identifying the presence of abuse and should be included in the health history of all women (Chart 46-4). The third and fourth questions of the screening questionnaire are specifically directed at abuse in women with disabilities.

No specific signs or symptoms are diagnostic of battering; however, nurses may see an injury that does not fit the account of how it happened (eg, a bruise on the side of the upper arm after "I walked into a door"). Manifestations of abuse may involve suicide attempts, drug and alcohol abuse, frequent emergency department visits, vague pelvic pain, somatic complaints, and depression. However, there may be no obvious signs or symptoms. Women in abusive situations often report that they do not feel well, possibly because of the stress of fear and anticipation of impending abuse.

The assessment for abuse by health professionals has lagged behind community awareness and response (Alpert, 2007). In addition to asking about domestic abuse, nurses need to provide resources and referral, as well as to follow written protocols of their institution or agency to ensure

## Chart 46-3 • *Managing Reported Domestic Abuse*

1. Reassure the woman that she is not alone. *Rationale: Women often believe that they are alone in experiencing abuse at the hands of their partners.*
2. Express your belief that no one should be hurt, that abuse is the fault of the batterer and is against the law. *Rationale: Doing so lets the woman know that no one deserves to be abused and that she has not caused the abuse.*
3. Assure the woman that her information is confidential, although it does become part of her medical record. *If children are suspected of being abused or are being abused, the law requires that this be reported to the authorities.* Some states require reporting of spousal or partner abuse. Domestic violence agencies and medical and nursing groups disagree with this policy and are trying to have it changed. Serious opposition is based on the fact that reporting does not and cannot currently guarantee a woman's safety and may place her in more danger. It may also interfere with a patient's willingness to discuss her personal life and concerns with care providers. This places a serious barrier in the way of comprehensive nursing care. If nurses are in doubt about laws on reporting abuse, they need to check with their local or state domestic violence agency. *Rationale: Women are often afraid that their information will be reported to the police or protective services and their children may be taken away.*
4. Document the woman's statement of abuse and take photographs of any visible injuries if written formal consent has been obtained. (Emergency departments usually have a camera available if one is not on the nursing unit.) *Rationale: Doing so provides documentation of injuries that may be needed for later legal or criminal proceedings.*
5. Provide teaching. *Rationale: The following options may be life-saving for the woman and her children:*
   - Inform the woman that shelters are available to ensure safety for her and her children. (Lengths of stay in shelters vary by state but are often up to 2 months. Staff often assist with housing, jobs, and the emotional distress that accompanies the break-up of the family.) Provide list of shelters.
   - Inform the woman that violence gets worse, not better.
   - If the woman chooses to go to a shelter, let her make the call.
   - If the woman chooses to return to the abuser, remain nonjudgmental and provide information that will make her safer than she was before disclosing her situation.
   - Make sure that the woman has a 24-hour hotline telephone number that provides information and support (Spanish translation and a device for the deaf are also available), police number, and 911.
   - Assist her to set up a safety plan in case she decides to return home. (A safety plan is an organized plan for departure with packed bags and important papers hidden in a safe spot.)

comprehensive care (Furniss, McCaffrey, Parnell, et al., 2007).

### *Incest and Childhood Sexual Abuse*

More than one in five women has experienced incest or childhood sexual abuse, and nurses frequently encounter women who have been sexually traumatized. It has been reported that female survivors of sexual abuse have more health problems and undergo more surgery than women who were not victims of abuse. Victims of childhood sexual abuse are reported to experience more chronic depression, posttraumatic stress disorder, morbid obesity, marital instability, gastrointestinal problems, and headaches, as well as use health care services more frequently than people who were not victims. In women, chronic pelvic pain is often associated with physical violence, emotional neglect, and sexual abuse in childhood (McFarlane, Malecha, Watson, et al., 2005). Women who have experienced rape or sexual abuse may be very anxious about pelvic examinations, labor, pelvic or breast irradiation, or any treatment or examination that involves hands-on treatment or requires removal of clothing. Nurses should be prepared to offer support and referral to psychologists, community resources, and self-help groups.

## CHART 46-4 *Screening for Abuse*

**Abuse Assessment Screen-Disability (AAS-D)**

- Within the last year, have you been hit, slapped, kicked, pushed, shoved, or otherwise physically hurt by someone?
- Within the last year, has anyone forced you to have sexual activities?
- Within the last year, has anyone prevented you from using a wheelchair, cane, respiratory, or other assistive devices?
- Within the last year, has anyone you depend on refused to help you with an important personal need, such as taking your medicine, getting to the bathroom, getting out of bed, bathing, getting dressed, or getting food or drink?

Center for Research on Women with Disabilities. Abuse Assessment Screen-Disability. www.bcm.edu/crowd/?PMID=1325m

### *Rape and Sexual Assault*

Sexual assault occurs about every 2 minutes in the United States (U.S. Department of Justice, 2007). Men, women, and children may be victims. Many rapes occur on dates. Sexual assault nurse examiners, emergency department staff, and gynecologists perform the painstaking collection of forensic evidence that is needed for criminal prosecution. Oral, anal, and genital tissue is examined for evidence of trauma, semen, or infection. Saliva, hair, and fingernail evidence is also collected. Cultures are obtained for STDs, and prophylactic antibiotics are prescribed. The postexposure prophylaxis recommended by the Centers for Disease Control and Prevention (CDC) consists of ceftriaxone (Rocephin), metronidazole (Flagyl), and azithromycin (Zithromax) (CDC, 2006, 2007). The first injection of hepatitis B

vaccine may also be given if the patient is not already immune, with subsequent doses given at 1 to 2 months and 4 to 6 months (CDC, 2006). HIV testing is offered and is repeated in 3 to 6 months. HIV prophylaxis is not universally recommended but is considered when mucosal exposure to contamination has occurred. Prophylaxis against chlamydia and gonorrhea is provided. Emergency contraception is explained and provided if requested and appropriate. Emotional counseling is provided, and follow-up treatment visits are arranged. Rape trauma syndrome is the emotional reaction to a sexual assault and may consist of shock, sleep disturbances, nightmares, flashbacks, anxiety, anger, mood swings, and depression. It is important and helpful for survivors to discuss the experience and to obtain professional counseling.

Screening for abuse, rape, and violence should be part of routine assessment because women often do not report or seek treatment for assault. Often, the assailant is a partner, husband, or date. Nurses may encounter women with infections or pregnancies related to sexual assault who require support, understanding, and comprehensive care.

### Health Issues in Women With Disabilities

Approximately 20% of women have disabilities and encounter physical, architectural, and attitudinal barriers that may limit their full participation in society. Women with disabilities may experience stereotyping and increased risk of abuse. They have reported that others, including health care providers, often equate them with their disability. Studies have shown that women with disabilities receive less primary health care and preventive health screening than other women, often because of access problems and health care providers who focus on the causes of disability rather than on health issues that are of concern to all women (Smeltzer, 2006, 2007). To address these issues, the health history must include questions about barriers to health care encountered by women with disabilities and the effect of their disability on their health status and health care. Other issues to be addressed are identified in Chart 46-5. If a patient has hearing loss, vision loss, or another disability that affects communication, it may be necessary to obtain the assistance of an interpreter or to establish another method of communication. Nurses assessing women with disabilities may require additional time and the assistance of others to be certain that accurate information is obtained in a sensitive and unhurried manner (Smeltzer, 2007; Smeltzer & Sharts-Hopko, 2005). Women with disabilities may have had previous negative experiences with health care providers (Smeltzer, Sharts-Hopko, Ott, et al., 2007), and it is important that nurses provide them with knowledgeable and sensitive care. See Chapter 10 for further discussion of health care of patients with disabilities.

### Gerontologic Considerations

Care of older women with gynecologic concerns requires knowledge and understanding. Many older women are functioning at various levels across the health spectrum; some function at a high level in their jobs or families, whereas others may be very ill. Nurses need to be prepared to care for older women who may be bright, energetic, and ambitious or who are coping with multiple family crises,

**CHART 46-5** *Assessing a Woman With a Disability*

**Health History**

Address questions directly to the woman herself rather than to people accompanying her. Ask about:

- Self-care limitations resulting from her disability (ability to feed and dress self, use of assistive devices, transportation requirements, other assistance needed)
- Sensory limitations (lack of sensation, low vision, deaf or hard of hearing)
- Accessibility issues (ability to get to health care provider, transfer to examination table, accessibility of office/clinic of health care provider, previous experiences with health care providers, health screening practices; her understanding of physical examination)
- Cognitive or developmental changes that affect understanding
- Limitations secondary to disability that affect general health issues and reproductive health and health care
- Sexual function and concerns (those of all women and those that may be affected by the presence of a disabling condition)
- Menstrual history and menstrual hygiene practices
- Physical, sexual, or psychological abuse (including abuse by care providers; abuse by neglect, withholding or withdrawing assistive devices or personal or health care)
- Presence of secondary disabilities (ie, those resulting from the patient's primary disability: pressure ulcers, spasticity, osteoporosis, etc.)
- Health concerns related to aging with a disability

**Physical Assessment**

Provide instructions directly to the woman herself rather than to people accompanying her; provide written or audiotaped instructions.

Ask the woman what assistance she needs for the physical examination and provide assistance if needed:
—Undressing and dressing
—Providing a urine specimen
—Standing on scale to be weighed (provide alternative means of obtaining weight if she is unable to stand on scale)
—Moving on and off the examination table
—Assuming, changing, and maintaining positions

Consider the fatigue experienced by the woman during a lengthy examination and allow rest.

Provide assistive devices and other aids/methods needed to allow adequate communication with the patient (interpreters, signers, large-print written materials).

Complete examination that would be indicated for any other woman; having a disability is *never* justification for omitting parts of the physical examination, including the pelvic examination.

including their own health issues as well as for those who are experiencing a life-altering or life-threatening health problem. Older women are at risk for several conditions, including diabetes, dyslipidemia, hypertension, and thyroid disease, all of which have symptoms that may be dismissed as typical aging. Nurses can help prevent morbidity and mortality from these conditions by encouraging women to obtain regular health screenings (Thakur & Supiano, 2007). In addition, knowledge related to heart disease prevention, pharmacology, diet, signs of dementia or cognitive decline, fall prevention, osteoporosis prevention, gynecologic and breast cancers, and sexuality are important for providing high-level nursing care. Health disparities, cultural competency, and end-of-life issues also need to be considered.

## Physical Assessment

Periodic examinations and routine cancer screening are important for all women. Annual breast and pelvic examinations are important for all women 18 years of age or older and for those who are sexually active, regardless of age. Patients deserve understanding and support because of the emotional and physical considerations associated with gynecologic examinations. Women may be embarrassed by the usual questions asked by a gynecologist or women's health care provider. Because gynecologic conditions are of a personal and private nature to most women, such information is shared only with those directly involved in patient care (as is true with all patient information).

Throughout the examination, the nurse explains the procedures to be performed. This not only encourages the woman to relax but also provides an opportunity for her to ask questions and minimizes the negative feelings that many women associate with gynecologic examinations.

The first pelvic examination is often anxiety producing; the nurse can alleviate many of these feelings with explanations and teaching (Chart 46-6). It may be helpful to emphasize that a pelvic examination should not usually be uncomfortable. Before the examination begins, the patient is asked to empty her bladder and to provide a urine specimen if urine tests are part of the total assessment. Voiding ensures patient comfort and eases the examination because a full bladder can make palpation of pelvic organs uncomfortable for the patient and difficult for the examiner.

### Positioning

Although several positions may be used for the pelvic examination, the supine lithotomy position is used most commonly, although the upright lithotomy position (in which the woman assumes a semisitting posture) may also be used. This position offers several advantages:

- It is more comfortable for some women.
- It allows better eye contact between patient and examiner.
- It may provide an easier means for the examiner to carry out the bimanual examination.
- It enables the woman to use a mirror to see her anatomy (if she chooses) to visualize any conditions that require treatment or to learn about using certain types of contraceptive methods.

In the supine lithotomy position, the patient lies on the table with her feet on foot rests or stirrups. She is encouraged to relax so that her buttocks are positioned at the edge of the examination table, and she is asked to relax and spread her thighs as widely apart as possible. If the patient is unable to lie safely on the examination table or unable to maintain the supine lithotomy position because of acute illness or disability, the Sims' position (or alternate positions) may be used. In Sims' position, the patient lies on her left side with her right leg bent at a 90-degree angle. The right labia may be retracted to gain adequate access to the vagina. The presence of a disability does not justify skipping any parts of the physical assessment, including the pelvic examination.

The following equipment is obtained and readily available: a good light source; a vaginal speculum; clean examination gloves; lubricant, spatula, cytobrush, glass slides, fixative solution or spray; and diagnostic testing supplies for screening for occult rectal blood if the woman is older than 40 years of age. Latex-free gloves should be available if the patient or clinician is allergic to latex. This allergy is becoming more prevalent in nurses and other health care providers and patients and is potentially life-threatening. Patients should be questioned about previous reactions to latex. (See Chapter 18 for a latex screening form and Chapter 53 for more information on latex allergy.)

### Inspection

After the patient is prepared, the examiner inspects the labia majora and minora, noting the epidermal tissue of the labia majora; the skin fades to the pink mucous membrane of the vaginal introitus. Lesions of any type (eg, venereal warts, pigmented lesions [melanoma]) are evaluated. In the nulliparous woman, the labia minora come together at the opening of the vagina. In a woman who has delivered children vaginally, the labia minora may gape and vaginal tissue may protrude.

Trauma to the anterior vaginal wall during childbirth may have resulted in incompetency of the musculature, and

**CHART 46-6** PATIENT EDUCATION
***The Pelvic Examination***

A pelvic examination includes assessment of the appearance of the vulva, vagina, and cervix and the size and shape of the uterus and ovaries to ensure reproductive health and absence of illness. The following should make the examination proceed more smoothly:

- You may have a feeling of fullness or pressure during the examination, but you should not feel pain. It is important to relax, because if you are very tense, you may feel discomfort.
- It is normal to feel uncomfortable and apprehensive.
- A narrow, warmed speculum will be inserted to visualize the cervix.
- A Papanicolaou (Pap) smear will be obtained and should not be uncomfortable.
- You may watch the examination with a mirror if you choose.
- The examination usually takes no longer than 5 minutes.
- Draping will be used to minimize exposure and reduce embarrassment.

a bulge caused by the bladder protruding into the submucosa of the anterior vaginal wall **(cystocele)** may be seen. Childbirth trauma may also have affected the posterior vaginal wall, producing a bulge caused by rectal cavity protrusion **(rectocele).** The cervix may descend under pressure through the vaginal canal and be seen at the introitus **(uterine prolapse).** See Chapter 47 for a discussion of these structural changes. To identify such protrusions, the examiner asks the patient to "bear down."

The introitus should be free of superficial mucosal lesions. The labia minora may be separated by the fingers of the gloved hand and the lower part of the vagina palpated. In women who have not had vaginal intercourse, a **hymen** of variable thickness may be felt circumferentially within the vaginal opening. The hymenal ring usually permits the insertion of one finger. Rarely, the hymen totally occludes the vaginal entrance (imperforate hymen).

In women who have had intercourse, a rim of scar tissue representing the remnants of the hymenal ring may be palpated circumferentially around the vagina near its opening. The greater vestibular glands (Bartholin's glands) lie between the labia minora and the remnants of the hymenal ring. An abscess of the Bartholin's gland can cause discomfort and requires incision and drainage.

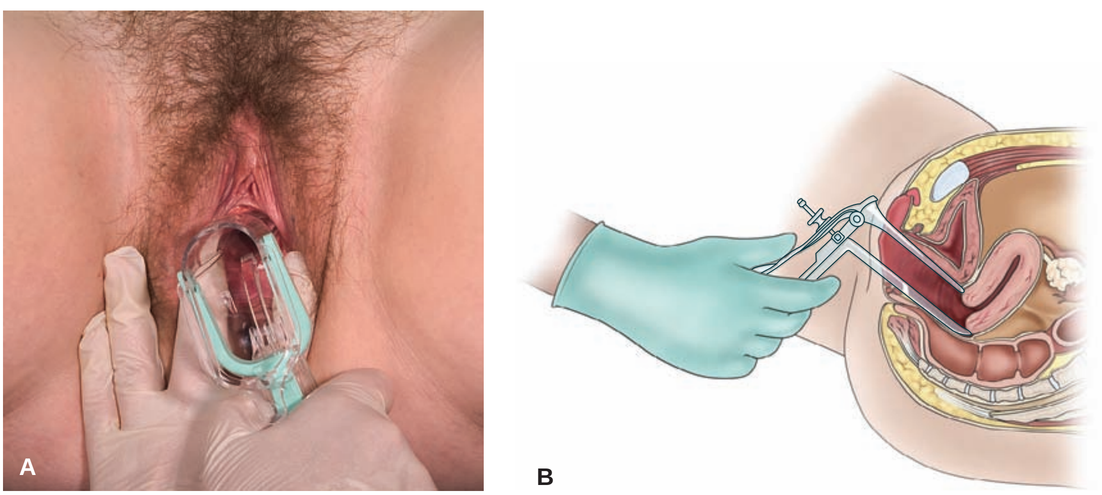
### *Speculum Examination*

The bivalved speculum, either metal or plastic, is available in many sizes. Metal specula are soaked, scrubbed, and sterilized between patients. Some clinicians and some patients prefer plastic specula, which permit one-time use. The speculum can be warmed with a heating pad or warm water to make insertion more comfortable for the patient. The speculum is not usually lubricated because commercial lubricants may interfere with cervical cytology (Papanicolaou [Pap] smear) findings.

The speculum is gently inserted into the posterior portion of the introitus and slowly advanced to the top of the vagina; this should not be painful or uncomfortable for the woman. The speculum is then slowly opened and the setscrew of the thumb rest is tightened to hold the speculum open (Fig. 46-4).

#### Inspecting the Cervix

The cervix is inspected. In nulliparous women, the cervix usually is 2 to 3 cm wide and smooth. In women who have borne children, the cervix may have a laceration, usually transverse, giving the cervical os a "fishmouth" appearance. Epithelium from the endocervical canal may have grown onto the surface of the cervix, appearing as beefy-red surface



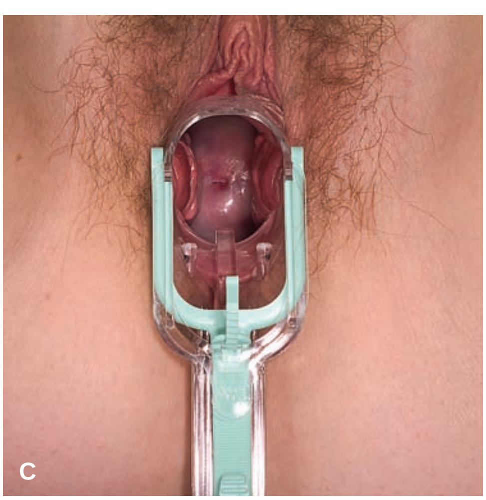


**Figure 46-4** Technique for speculum examination of the vagina and cervix. **A,** The labia are spread apart with a gloved left hand, while the speculum is grasped in the right hand and turned counterclockwise before being inserted into the vagina. Once the speculum is inserted, the blades are then spread apart (**B**) to reveal the cervical os (**C**).

epithelium circumferentially around the os. Occasionally, the cervix of a woman whose mother took DES during pregnancy has a hooded appearance (a peaked aspect superiorly or a ridge of tissue surrounding it); this is evaluated by colposcopy when identified.

Malignant changes may not be obviously differentiated from the rest of the cervical mucosa. Small, benign cysts may appear on the cervical surface. These are usually bluish or white and are called nabothian cysts. A **polyp** of endocervical mucosa may protrude through the os and usually is dark red. Polyps can cause irregular bleeding; they are rarely malignant and usually are removed easily in an office or clinic setting. A carcinoma may appear as a cauliflower-like growth that bleeds easily when touched. Bluish coloration of the cervix is a sign of early pregnancy (Chadwick's sign).

### Obtaining Pap Smears and Other Samples

A Pap smear is obtained by rotating a small spatula at the os, followed by a cervical brush rotated in the os. The material obtained is spread on a glass slide and sprayed/fixed immediately, or inserted into liquid (thin "prep"). A small broomlike device can also be used to obtain specimens for the Pap smear.

A specimen of any purulent material appearing at the cervical os is obtained for culture. A sterile applicator is used to obtain the specimen, which is immediately placed in an appropriate medium for transfer to a laboratory. In a patient who has a high risk of infection, routine cultures for gonococcal and chlamydial organisms are recommended because of the high incidence of both diseases and the complications of pelvic infection, fallopian tube damage, and subsequent infertility.

Vaginal discharge, which may be normal or may result from vaginitis, may be present. Table 46-3 summarizes the characteristics of vaginal discharge found in different conditions.

### Inspecting the Vagina

The vagina is inspected as the examiner withdraws the speculum. It is smooth in young girls and thickens after puberty, with many rugae (folds) and redundancy in the epithelium. In menopausal women, the vagina thins and has fewer rugae because of decreased estrogen.

### Bimanual Palpation

To complete the pelvic examination, the examiner performs a bimanual examination, usually from a standing position. The fingers are advanced vertically along the vaginal canal, and the vaginal wall is palpated. Any firm part of the vaginal wall may represent old scar tissue from childbirth trauma but may also require further evaluation.

### Cervical Palpation

The cervix is palpated and assessed for its consistency, mobility, size, and position. The normal cervix is uniformly firm but not hard. Softening of the cervix is a finding in early pregnancy. Hardness and immobility of the cervix may reflect invasion by a neoplasm. Pain on gentle movement of the cervix is called a positive **chandelier sign** or positive cervical motion tenderness (recorded as +CMT) and usually indicates a pelvic infection.

### Uterine Palpation

To palpate the uterus, the examiner places the opposite hand on the abdominal wall halfway between the umbilicus and the pubis and presses firmly toward the vagina. Movement of the abdominal wall causes the body of the uterus to descend, and the organ becomes freely movable between the hand used to examine the abdomen and the fingers of the hand used to examine the pelvis. Uterine size, mobility, and contour can be estimated through palpation. Fixation of the uterus in the pelvis may be a sign of **endometriosis** or malignancy.

The body of the uterus is normally twice the diameter and twice the length of the cervix, curving anteriorly toward the abdominal wall. Some women have a retroverted or retroflexed uterus, which tips posteriorly toward the sacrum, whereas others have a uterus that is neither anterior nor posterior and is described as midline.

### Adnexal Palpation

Next, the right and left adnexal areas are palpated to evaluate the fallopian tubes and ovaries. The fingers of the hand examining the pelvis are moved first to one side, then to the other, while the hand palpating the abdominal area is moved correspondingly to either side of the abdomen and downward. The adnexa (ovaries and fallopian tubes) are trapped between the two hands and palpated for an obvious mass, tenderness, and mobility. Commonly, the ovaries are slightly tender, and the patient is informed that slight discomfort on palpation is normal.

### Vaginal and Rectal Palpation

Bimanual palpation of the vagina and cul-de-sac is accomplished by placing the index finger in the vagina and the middle finger in the rectum. To prevent cross-contamination between the vaginal and rectal orifices, the examiner puts on new gloves. A gentle movement of these fingers toward each other compresses the posterior vaginal wall and the anterior rectal wall and assists the examiner in identifying the integrity of these structures. During this procedure, the patient may sense an urge to defecate. The nurse assures the

**Table 46-3 CHARACTERISTICS OF VAGINAL DISCHARGE**

| Cause of Discharge | Symptoms | Odor | Consistency/Color |
|---|---|---|---|
| Physiologic | None | None | Mucus/white |
| *Candida* species infection | Itching, irritation | Yeast odor or none | Thin to thick, curdlike/white |
| Bacterial vaginosis | Odor | Fishy, often noticed after intercourse | Thin/grayish or yellow |
| *Trichomonas* species infection | Irritation, odor | Malodorous | Copious, often frothy/yellow-green |
| Atrophic | Vulvar or vaginal dryness | Occasional mild malodor | Usually scant and mucoid/may be blood-tinged |

patient that this is unlikely to occur. Ongoing explanations are provided to reassure and educate the patient about the procedure.

### Gerontologic Considerations

Yearly examinations are important; they identify problems of the reproductive tract in aging women early. Some older women do not have regular gynecologic examinations. For example, a woman who delivered her children at home may never have had a pelvic examination. Some women regard it as an embarrassing and unpleasant procedure. Nurses play an important role; they can encourage all women to have an annual gynecologic examination. Nurses can make the examination a time for education and reassurance rather than a time of embarrassment.

Perineal pruritus is abnormal in elderly women and should be evaluated because it may indicate a disease process (diabetes or malignancy). Vulvar dystrophy, a thickened or whitish discoloration of tissue, may be visible, and biopsy is needed to rule out abnormal cells. Topical cortisone and hormone creams may be prescribed for symptomatic relief.

With relaxing pelvic musculature, uterine prolapse and relaxation of the vaginal walls can occur. Appropriate evaluation and surgical repair can provide relief if the patient is a candidate for surgery. After surgery, the patient should know that tissue repair and healing may require more time with aging. Pessaries (latex devices that provide support) are often used if surgery is contraindicated or before surgery to see if surgery can be avoided. They are fitted by a health care provider and may reduce discomfort and pressure. Use of a pessary requires the patient to have routine gynecologic examinations to monitor for irritation or infection. The patient must be assessed for allergy prior to insertion of a latex pessary (see Chapter 47 for details about pessaries).

## Diagnostic Evaluation

### Cytologic Test for Cancer (Pap Smear)

The Pap smear is used to detect cervical cancer. Cervical secretions are gently removed from the cervical os and may be transferred to a glass slide and fixed immediately by spraying with a fixative or immersed in solution (Fig. 46-5). If the Pap smear reveals atypical cells, the liquid method allows for human papillomavirus (HPV) testing (see Chapter 47 for further discussion of HPV, a commonly transmitted STD that can cause venereal warts or cervical cancer). HPV DNA testing is helpful in that it can detect high-risk types that may require careful monitoring. HPV infection is often temporary, especially in healthy young women.

The proper technique for obtaining a cervical specimen for cytologic study is described in Chart 46-7. A Pap smear should be performed when a patient is not menstruating, because blood usually interferes with interpretation. To avoid washing away cellular material, the patient should be instructed not to douche before having a Pap smear taken.

Terminology used to describe findings includes the following categories:

- Normal
- Atypical squamous cells of undetermined significance (ASCUS), either HPV + or –
- Low-grade squamous intraepithelial lesion (LSIL), which is equivalent to cervical intraepithelial neoplasia (CIN; grade 1) and to mild changes related to exposure to HPV
- High-grade squamous intraepithelial lesion (HGSIL), which equates to moderate and severe dysplasia, carcinoma in situ (CIS), as well as CIN grade 2 and CIN grade 3

The terms in the last category are precursors to invasive carcinoma of the cervix that indicate the need for evaluation and treatment.

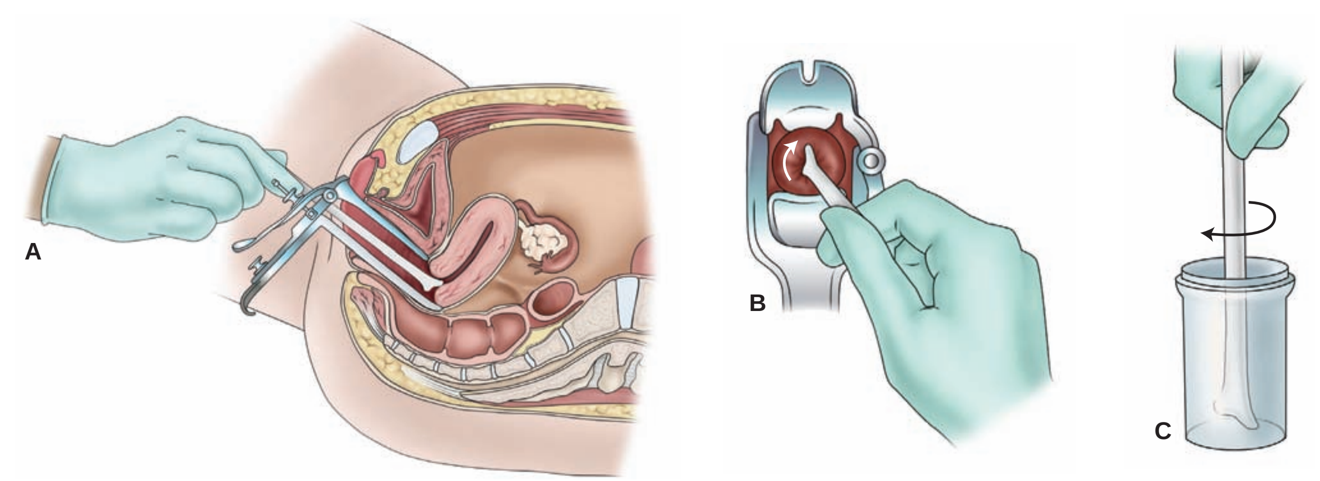



**Figure 46-5** Method of using an Ayre spatula to obtain cervical secretions for cytology. **A,** Speculum in place and the Ayre spatula in position at the cervical os. **B,** The tip of the spatula is placed in the cervical os and the spatula rotated 360 degrees, firmly but nontraumatically. **C,** Instead of the cells being smeared on a slide, the sampling device is rinsed or twirled in the small vial containing the transport medium and sent to the laboratory.

## CHART 46-7 Guidelines for Obtaining an Optimal Pap Smear

**Equipment Needed**

- Speculum
- Gloves
- Slide, spatula, and cytobrush or thin prep kit

**Implementation**

| Nursing Action | Rationale |
|---|---|
| 1. Do not obtain a Pap smear if the woman is menstruating or has other frank bleeding (exception: high suspicion of neoplasia). | 1. Blood obscures a proper reading of cells. |
| 2. If performing more than one test (eg, Pap and GC), obtain the Pap smear first. | 2. By performing the Pap smear first, the chance of a bloody smear is avoided. |
| 3. Label the frosted end of the slide with the patient's name in pencil or label Thin-prep Pap bottle. | 3. Ink may rub off or blur. Labeling with a pencil prevents improper identification. |
| 4. Put on gloves before gently inserting the unlubricated speculum. (Speculum may be moistened with warm water.) | 4. Gloves provide protection and warm water prevents discomfort. Lubricants may obscure cells on Pap smear. |
| 5. Place the longer end of the Ayre spatula in the cervical canal and rotate it in a full circle to obtain a sample from the exocervix. Spread the material obtained onto the Pap smear slide. | 5. This technique obtains a sampling of the exocervix and squamocolumnar junction. |
| 6. Insert a cytobrush 2 cm into the cervical canal and rotate 180 degrees. Roll the brush onto the Pap smear slide. (With Thin-prep Pap smears, the brushings are not spread onto a slide. The spatula and brush are placed in a bottle of fixative and swirled.) | 6. This technique obtains a sampling of the endocervical cells and may sample cells from the squamocolumnar junction if it is high in the canal. |
| 7. In women who have had a hysterectomy for a gynecological cancer, use a cotton applicator moistened with saline solution to obtain a sampling of cells from the vaginal cuff or posterior vagina. Women who have had a hysterectomy for benign conditions do not require frequent Pap smears. | 7. Saline solution prevents drying, which makes interpretation difficult for the cytologist and prevents absorption of cells into the cotton, increasing the yield on the slide. |
| 8. Immediately spray the slide or, if a Thin-prep, swirl the brush and spatula in the solution. | 8. Exposure to light or air causes distortion of cells. |

The patient may incorrectly assume that an abnormal Pap smear signifies cancer. If the Pap smear (liquid immersion method) shows atypical cells and no high-risk HPV types, the next Pap smear is performed in 1 year. If a specific infection is causing inflammation, it is treated appropriately, and the Pap smear is repeated. If the repeat Pap smear reveals atypical squamous cells with high-risk HPV types, colposcopy may be indicated. Pap smears that indicate LSIL should be repeated in 4 to 6 months and colposcopy performed if the LSIL has not resolved. Patients with Pap smears that indicate HGSIL and CIS require prompt colposcopy.

If the Pap smear results are abnormal, prompt notification, evaluation, and treatment are crucial. Notification of patients is often the responsibility of nurses in a women's health care practice or clinic. Pap smear follow-up is essential because it can prevent cervical cancer. Some women do not adhere to recommendations—particularly women who are young, who are of low socioeconomic status, who have difficulty coping with the diagnosis, or who have no social support. Fear, lack of understanding, and child care responsibilities have all been identified by women as reasons for poor follow-up. Women with a history of abuse, obese women, and women who have had a negative gynecologic experience may also find returning for follow-up difficult. Interventions are tailored to meet the needs of the particular patient. Intensive telephone counseling, tracking systems, brochures, videos, and financial incentives have all been used to encourage follow-up. The nurse provides clear explanations and emotional support along with a carefully designed setting-specific follow-up protocol designed to meet the needs of the patient.

The Committee on Adolescent Health Care of the American College of Obstetricians and Gynecologists (ACOG, 2006b) issued a set of guidelines for the evaluation and management of abnormal cervical cytology and histology in adolescent females. The committee stressed the need for a complete and accurate sexual history in making decisions about initiation of cervical cytology screening in adolescents.

## Colposcopy and Cervical Biopsy

If a Pap smear result requires evaluation, a colposcopy is performed. The colposcope is a portable microscope (magnification from 10X to 25X) that allows the examiner to visualize the cervix and obtain a sample of abnormal tissue for analysis. Nurse practitioners and gynecologists require special training in this diagnostic technique.

After inserting a speculum and visualizing the cervix and vaginal walls, the examiner applies acetic acid to the cervix. Subsequent abnormal findings that indicate the need for biopsy include leukoplakia (white plaque visible before applying acetic acid), acetowhite tissue (white epithelium after applying acetic acid), punctation (dilated capillaries occurring in a dotted or stippled pattern), mosaicism (a tilelike pattern), and atypical vascular patterns. If biopsy specimens show premalignant cells or CIN, the patient usually requires cryotherapy, laser therapy, or a cone biopsy (excision of an inverted tissue cone from the cervix).

## Cryotherapy and Laser Therapy

Cryotherapy (freezing cervical tissue with nitrous oxide) and laser treatment are used in the outpatient setting. Cryotherapy may result in cramping and occasional feelings of faintness (vasovagal response). A watery discharge is normal for a few weeks after the procedure as the cervix heals.

## Cone Biopsy and Loop Electrosurgical Excision Procedure

If endocervical curettage findings indicate abnormal changes or if the lesion extends into the canal, the patient may undergo a cone biopsy. This can be performed surgically or with a procedure called loop electrosurgical excision procedure (LEEP), which uses a laser beam.

Usually performed in the outpatient setting, LEEP is associated with a high success rate in removal of abnormal cervical tissue. The gynecologist excises a small amount of cervical tissue, and the pathologist examines the borders of the specimen to determine if disease is present. A patient who has received anesthesia for a surgical cone biopsy is advised to rest for 24 hours after the procedure and to leave any vaginal packing in place until it is removed (usually the next day). The patient is instructed to report any excessive bleeding.

The nurse or physician provides guidelines regarding postoperative sexual activity, bathing, and other activities. Because open tissue may be potentially exposed to HIV and other pathogens, the patient is cautioned to avoid intercourse until healing is complete and verified at follow-up. LEEP has a low incidence of complications, but there is a slight increase in the risk of later cervical stenosis or premature deliveries.

## Endometrial (Aspiration) Biopsy

Endometrial biopsy, a method of obtaining endometrial tissue, is performed as an outpatient procedure. This procedure is usually indicated in cases of midlife irregular bleeding, postmenopausal bleeding, and irregular bleeding while taking hormone therapy or tamoxifen. A tissue sample obtained through biopsy permits diagnosis of cellular changes in the endometrium.

Women who undergo endometrial biopsy may experience slight discomfort. The examiner may apply a tenaculum (a clamplike instrument that stabilizes the uterus) after the pelvic examination and then inserts a thin, hollow, flexible suction tube (Pipelle or sampler) through the cervix into the uterus.

Findings on aspiration may include normal endometrial tissue, hyperplasia, or endometrial cancer. Simple hyperplasia is an overgrowth of the uterine lining and is usually treated with progesterone. Complex hyperplasia, which refers to overgrowth of cells with abnormal features, is a risk factor for uterine cancer and is treated with progesterone and careful follow-up. Women who are overweight, who are older than 45 years of age, who have a history of nulliparity and infertility, or who have a family history of colon cancer seem to be at higher risk for hyperplasia. Endometrial cancer is discussed in Chapter 47.

## Dilation and Curettage

Dilation and curettage (D & C) may be diagnostic (identifies the cause of irregular bleeding) or therapeutic (often temporarily stops irregular bleeding). The cervical canal is widened with a dilator, and the uterine endometrium is scraped with a curette. The purpose of the procedure is to secure endometrial or endocervical tissue for cytologic examination, to control abnormal uterine bleeding, and as a therapeutic measure for incomplete abortion.

Because D & C is usually carried out under anesthesia and requires surgical asepsis, it is usually performed in the operating room. However, it may take place in the outpatient setting with the patient receiving a local anesthetic supplemented with diazepam (Valium) or midazolam (Versed).

The nurse explains the procedure, preparation, and expectations regarding postoperative discomfort and bleeding. The patient is instructed to void before the procedure. The patient is placed in the lithotomy position, the cervix is dilated with a dilating instrument, and endometrial scrapings are obtained by a curette. A perineal pad is placed over the perineum after the procedure, and excessive bleeding is reported. No restrictions are placed on dietary intake. If pelvic discomfort or low back pain occurs, mild analgesics usually provide relief. The physician indicates when sexual intercourse may be safely resumed. To reduce the risk of infection and bleeding, most physicians advise no vaginal penetration or use of tampons for 2 weeks.

## Endoscopic Examinations

### *Laparoscopy (Pelvic Peritoneoscopy)*

A laparoscopy involves inserting a laparoscope (a tube about 10 mm wide and similar to a small periscope) into the peritoneal cavity through a 2-cm (0.75-in) incision below the umbilicus to allow visualization of the pelvic structures (Fig. 46-6). Laparoscopy may be used for diagnostic purposes (eg, in cases of pelvic pain when no cause can be found) or treatment. Laparoscopy facilitates many surgical procedures, such as tubal ligation, ovarian biopsy, myomectomy, hysterectomy, and lysis of adhesions (scar tissue that can cause pelvic discomfort). A surgical instrument (intrauterine sound or cannula) may be positioned inside the uterus to permit manipulation or movement during laparoscopy, affording better visualization. The pelvic organs can be visualized after the injection of carbon dioxide intraperitoneally into the cavity. Called insufflation, this technique separates the intestines from the pelvic organs. If a patient is undergoing sterilization, the fallopian or uterine tubes may be electrocoagulated, sutured, or ligated and a segment removed for histologic verification (clips are an alternative device for occluding the tubes).

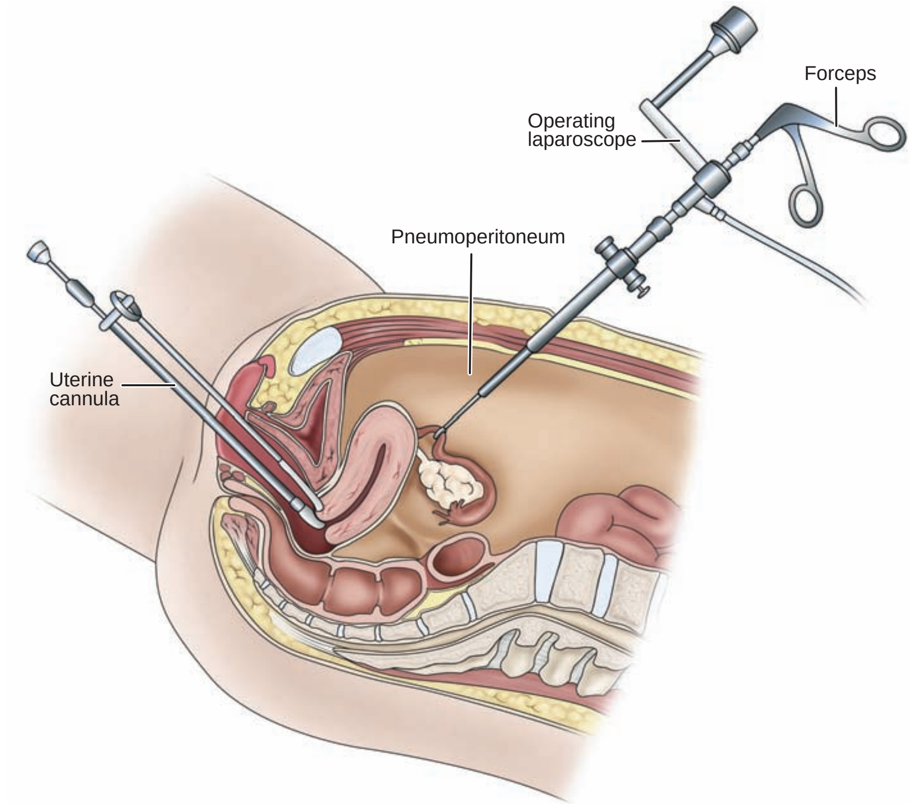



**Figure 46-6** Laparoscopy. The laparoscope (*right*) is inserted through a small incision in the abdomen. A forceps is inserted through the scope to grasp the fallopian tube. To improve the view, a uterine cannula (*left*) is inserted into the vagina to push the uterus upward. Insufflation of gas creates an air pocket (pneumoperitoneum), and the pelvis is elevated (note the angle), which forces the intestines higher in the abdomen.

After the laparoscopy is completed, the laparoscope is withdrawn, carbon dioxide is allowed to escape through the outer cannula, the small skin incision is closed with sutures or a clip, and the incision is covered with an adhesive bandage. The patient is carefully monitored for several hours to detect any untoward signs indicating bleeding (most commonly from vascular injury to the hypogastric vessels), bowel or bladder injury, or burns from the coagulator. These complications are rare, making laparoscopy a cost-effective and safe short-stay procedure. The patient may experience abdominal or shoulder pain related to the use of carbon dioxide gas.

### Hysteroscopy

**Hysteroscopy** (transcervical intrauterine endoscopy) allows direct visualization of all parts of the uterine cavity by means of a lighted optical instrument. The procedure is best performed about 5 days after menstruation ceases, in the estrogenic phase of the menstrual cycle. The vagina and vulva are cleansed, and a paracervical anesthetic block is performed or lidocaine spray is used. The instrument used for the procedure, a hysteroscope, is passed into the cervical canal and advanced 1 or 2 cm under direct vision. Uterine-distending fluid (normal saline solution or 5% dextrose in water) is infused through the instrument to dilate the uterine cavity and enhance visibility. Hysteroscopy, which has few complications, is useful for evaluating endometrial pathology.

Hysteroscopy may be indicated as an adjunct to a D & C and laparoscopy in cases of infertility, unexplained bleeding, retained intrauterine device (IUD), and recurrent early pregnancy loss. Treatment for some conditions (eg, fibroid tumors) can be accomplished during this procedure, and sterilization may also be performed. Hysteroscopy is contraindicated in patients with cervical or endometrial carcinoma or acute pelvic inflammation.

**Endometrial ablation** (destruction of the uterine lining) is performed with a hysteroscope and resector (cutting loop), roller ball (a barrel-shaped electrode), or laser beam in cases of severe bleeding not responsive to other therapies. Performed in an outpatient setting under general, regional, or local anesthesia, this rapid procedure is an alternative to hysterectomy for some patients. Following uterine distension with fluid infusion, the lining of the uterus is destroyed. Hemorrhage, perforation, and burns can occur.

## Other Diagnostic Procedures

Many diagnostic procedures are helpful in evaluating pelvic conditions. These may include x-rays, barium enemas, gastrointestinal x-ray series, intravenous urography, and cystography studies. In addition, because the uterus, ovaries, and fallopian tubes are near the structures of the urinary tract, urologic diagnostic studies, such as x-ray study of the kidney, ureters, and bladder (KUB) and pyelography are used, as are angiography and radioisotope scanning, if needed. Other diagnostic procedures include hysterosalpingography and computed tomography (CT) scanning.

### Hysterosalpingography or Uterotubography

Hysterosalpingography (HSG) is an x-ray study of the uterus and the fallopian tubes after injection of a contrast

agent. The diagnostic procedure is performed to evaluate infertility or tubal patency and to detect any abnormal condition in the uterine cavity. Sometimes the procedure is therapeutic because the flowing contrast agent flushes debris or loosens adhesions.

Prior to hysterosalpingography, laxatives and an enema may be administered to evacuate the intestinal tract so that gas shadows do not distort the x-ray findings. A mild sedative or an analgesic agent, such as ibuprofen (Advil, Motrin) may be prescribed. The patient is placed in the lithotomy position and the cervix is exposed with a bivalved speculum. A cannula is inserted into the cervix and the contrast agent is injected into the uterine cavity and the fallopian tubes. X-rays are taken to show the path and the distribution of the contrast agent.

Some patients experience nausea, vomiting, cramps, and faintness. After the test, the patient is advised to wear a perineal pad for several hours, because the radiopaque contrast agent may stain clothing.

#### Computed Tomography

CT has several advantages over ultrasonography (described below), even though it involves radiation exposure and is more costly. It is more effective than ultrasonography for obese patients or for patients with a distended bowel. CT can also demonstrate a tumor and any extension into the retroperitoneal lymph nodes and skeletal tissue, although it has limited value in diagnosing other gynecologic abnormalities.

#### Ultrasonography

Ultrasonography (or ultrasound) is a useful adjunct to the physical examination, particularly in obstetric patients or in patients with abnormal pelvic examination findings. It is a simple procedure based on sound wave transmission that uses pulsed ultrasonic waves at frequencies exceeding 20,000 Hz (formerly cycles per second) by way of a transducer placed in contact with the abdomen (abdominal scan) or a vaginal probe (vaginal ultrasound). Mechanical energy is converted into electrical impulses, which in turn are amplified and recorded on an oscilloscope screen while a photograph or video recording of the patterns is taken. The entire procedure takes usually less than 10 minutes and involves no ionizing radiation and no discomfort other than a full bladder, which is necessary for good visualization during an abdominal scan. (A vaginal ultrasound or sonogram does not require a full bladder; however, the vaginal probe can cause mild discomfort in some women.) Saline may be instilled into the uterus (saline infusion sonogram) to help delineate endometrial polyps or fibroids.

#### Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) produces patterns that are finer and more definitive than other imaging procedures, and it does not expose patients to radiation. However, MRI is more costly.

*NURSING ALERT*

**All metal devices, including medication skin patches with foil backing, must be removed before MRI is performed to avoid burns.**

# MANAGEMENT OF FEMALE PHYSIOLOGIC PROCESSES

Many health concerns of women are related to normal changes or abnormalities of the menstrual cycle and may result from women's lack of understanding of the menstrual cycle, developmental changes, and factors that may affect the pattern of the menstrual cycle. Educating women about the menstrual cycle and changes over time is an important aspect of the nurse's role in providing quality care to women. Teaching should begin early, so that menstruation and the lifelong changes in the menstrual cycle can be anticipated and accepted as a normal part of life.

## Menstruation

Menstruation, a cyclic vaginal flow of tissue that lines the uterus, occurs about every 28 days during the reproductive years, although normal cycles can vary from 21 to 42 days. The flow usually lasts 4 to 5 days, during which time 50 to 60 mL (4 to 12 tsp) of blood are lost.

A perineal pad or tampon is generally used to absorb menstrual discharge. Tampons are used extensively. There is no significant evidence of untoward effects from their use, provided that there is no difficulty in inserting them. However, tampons should not be used for more than 4 to 6 hours, and superabsorbent tampons should not be used because of their association with toxic shock syndrome. If a tampon is difficult to remove or shreds when removed, less absorbent tampons should be used. If the string breaks or retracts, the woman should squat in a comfortable position, insert one finger into the vagina, try to locate the tampon, and remove it. If she feels uncomfortable attempting this maneuver or cannot remove the tampon, she should consult a gynecologic health care provider promptly.

### Psychosocial Considerations

Girls who are approaching menarche (the onset of menstruation) should be instructed about the normal process of the menstrual cycle before it occurs. Psychologically, it is much healthier and appropriate to refer to this event as a "period" rather than as "being sick." With adequate nutrition, rest, and exercise, most women feel little discomfort, although some report breast tenderness and a feeling of fullness 1 or 2 days before menstruation begins. Others report fatigue and some discomfort in the lower back, legs, and pelvis on the first day and temperament or mood changes. Slight deviations from a usual pattern of daily living are considered normal, but excessive deviation may require evaluation. Regular exercise and a healthy diet have been found to decrease discomfort for some women. Heating pads or nonsteroidal anti-inflammatory drugs (NSAIDs) may be very effective for cramps. For women with excessive cramping or dysmenorrhea, referral to a women's health care provider is appropriate; following evaluation, practitioners may prescribe oral contraceptives.

### Cultural Considerations

Culture refers to knowledge, beliefs, customs, and values acquired as members of a racial, ethnic, religious, or social group. The United States is becoming more culturally

diverse. Various aspects of culture affect many health care encounters, and these encounters can be positive if nurses understand the various cultures of their patients.

Cultural views and beliefs about menstruation differ. Some women believe that it is detrimental to change a pad or tampon too frequently; they think that allowing the discharge to accumulate increases the flow, which is considered desirable. Some women believe they are vulnerable to illness during menstruation. Others believe it is harmful to swim, shower, have their hair permed, have their teeth filled, or eat certain foods during menstruation. They may also avoid using contraception during menstruation.

In such situations, nurses are in a position to provide women with facts in an accepting and culturally sensitive manner. The objective is to be mindful of these unexpressed, deep-rooted beliefs and to provide the facts with care. Aspects of gynecologic problems cannot always be expressed easily. The nurse needs to convey confidence and openness and to offer facts to facilitate communication. Suggestions to improve care include overcoming language barriers, providing appropriate materials in the patient's language, asking about traditional beliefs and dietary practices, and asking about fears regarding care. Patience, sensitivity, and a desire to learn about other cultures and groups will enhance the nursing care of all women (Chart 46-8).

## Perimenopause

**Perimenopause** is the period extending from the first signs of menopause—usually hot flashes, vaginal dryness, or irregular menses—to beyond the complete cessation of menses. It has also been defined as the period around menopause, lasting to 1 year after the last menstrual period. Women often have varied beliefs about aging, and these must be considered when caring for or educating perimenopausal patients.

### Nursing Management

Perimenopausal women often benefit from information about the subtle physiologic changes they are experiencing. Perimenopause has been described as an opportune time for teaching women about health promotion and disease prevention strategies. When discussing health-related concerns with midlife women, nurses should consider the following issues:

- Sexuality, fertility, contraception, and STDs
- Unintended pregnancy (if contraception is not used correctly and consistently)
- Oral contraceptive use. Oral contraceptives provide perimenopausal women with protection against uterine cancer, ovarian cancer, anemia, pregnancy, and fibrocystic breast changes as well as relief from perimenopausal symptoms. This option should be discussed with perimenopausal women. (Women who smoke and are 35 years of age or older should not take oral contraceptives because of an increased risk of cardiovascular disease.) Contraception is discussed in detail later in this chapter.
- Breast health. About 16% of cases of breast cancer occur in perimenopausal women, so breast self-examination, routine physical examinations, and mammograms are essential.

Women in their 40s are often less concerned with menopause and more interested in their health, well-being, and appearance. They view taking care of themselves as one way to look and feel younger (Beyene, Gilliss & Lee, 2007).

## Menopause

Menopause is the permanent physiologic cessation of menses associated with declining ovarian function; during this time, reproductive function diminishes and ends. Postmenopause is the period beginning from about 1 year after menses cease. Menopause may be associated with some atrophy of breast tissue and genital organs, loss in bone density, and vascular changes.

Menopause starts gradually and is usually signaled by changes in menstruation. The monthly flow may increase or

**Chart 46-8 • *Health Care for Women Who Are Lesbians***

Lesbians can generally be defined as women who have sex with or primary emotional partnerships with women, but there is no universally accepted definition; variability exists in relationships and sexual preferences. Lesbians are found in every ethnic group and socioeconomic class. They can be single, celibate, divorced, and are seen in all age groups, including teens and seniors. Most experts believe that sexual orientation is not a conscious choice.

Lesbians have often encountered insensitivity in health care encounters. When they are asked if they are sexually active and respond affirmatively, contraception is immediately urged as health care providers may assume incorrectly that they practice heterosexual intercourse. Similar to many other marginalized groups of women, they often feel invisible and underuse health care. Whether heterosexual or homosexual, nurses need to consider lesbianism within the continuum of human sexual behavior and need to use gender-neutral questions and terms that are nonjudgmental and accepting. Lesbian teens are at risk for suicide and STDs. Many lesbians do participate in heterosexual activity and often consider themselves at low risk for STDs. Because HPV, herpes infections, and other organisms implicated in STDs are transmitted by secretions and contact, they may need information on STDs and contraception. If sex toys are used and not cleaned, pelvic infections can occur.

Lesbians have lower health screening rates than other women. They are at high risk for cancer, heart disease, depression, and alcohol abuse. They may have a higher body mass index, may bear fewer or no children, and often have fewer health preventive screenings than heterosexual women. These factors may increase the risk of colon, endometrial, ovarian, and breast cancer, as well as cardiovascular disease and diabetes. Adolescent lesbians are at risk for smoking and suicide/depression. Nurses need to understand the unique needs of this population and provide appropriate and sensitive care (Roberts, 2006).

decrease, become irregular, and finally cease. Often, the interval between periods is longer; a lapse of several months between periods is not uncommon. Changes signaling menopause begin to occur as early as the late 30s, when ovulation occurs less frequently, estrogen levels fluctuate, and FSH levels increase in an attempt to stimulate estrogen production.

## Clinical Manifestations

Because of these hormonal changes, some women notice irregular menses, breast tenderness, and mood changes long before menopause occurs. The hot or warm flashes and night sweats reported by some women are thought to be caused by hormonal changes and denote vasomotor instability. They may vary in intensity from a barely perceptible warm feeling to a sensation of extreme warmth accompanied by profuse sweating, causing discomfort, sleep disturbances, and subsequent fatigue. Other physical changes may include increased bone loss (discussed later in this chapter).

The entire genitourinary system is affected by the reduced estrogen level. Changes in the vulvovaginal area may include a gradual thinning of pubic hair and a gradual shrinkage of the labia. Vaginal secretions decrease, and women may report dyspareunia (discomfort during intercourse). The vaginal pH increases during menopause, predisposing women to bacterial infections and atrophic vaginitis. Discharge, itching, and vulvar burning may result.

Some women report fatigue, forgetfulness, weight gain, irritability, trouble sleeping, feeling "blue," and feelings of panic. Menopausal complaints need to be evaluated carefully because they may indicate other disorders. Most women have few problems and are relieved to be free from menstrual periods.

## Psychological Considerations

Women's reactions and feelings related to loss of reproductive capacity may vary. Some women may experience role confusion, whereas others experience a sense of sexual and personal freedom. Women may be relieved that the childbearing phase of their lives is over. Each woman's personal views about menopause and circumstances affect her response and must be considered on an individual basis. Nurses need to be sensitive to all possibilities and take their cues from the patient. Chart 46-9 describes how women with disabilities may view menopause.

## Medical Management

Women approaching menopause often have many concerns about their health. Some have concerns based on a family history of heart disease, osteoporosis, or cancer. Each woman needs to be as knowledgeable as possible about her health options and should be encouraged to discuss her

### CHART 46-9 NURSING RESEARCH PROFILE
### *Perceptions of Women With Disabilities About Menopause*

Harrison, T. & Becker, H. (2007). A qualitative study of menopause among women with disabilities. *Advances in Nursing Science, 30*(2), 123–138.

#### Purpose

Because of preexisting impairments and treatments associated with disabling conditions, women with disabilities may experience menopause in ways that differ from women without disabilities. Little information about menopause in women with disabilities or their experiences related to menopause is available. The purpose of this study was to examine the perceptions of women with mobility impairments about menopause—how they understand and react to menopause.

#### Design

A total of 19 women between 42 and 64 years of age were included in this qualitative, decisional support menopause intervention study. The women were interviewed by telephone using a semistructured questionnaire that addressed their experience with menopause, the effect of menopause on their daily lives, their responses to menopause, their prior knowledge about menopause, and their sources of information about menopause. Interviews were audiotaped and then transcribed verbatim. Data were analyzed using qualitative methods to identify and categorize both themes and patterns of the women's experiences.

#### Results

The women reported concerns about medical issues related to menopause. They viewed menopause as having possible negative effects on their health and well-being because of disorders (eg, osteoporosis) that occur in women with mobility limitations well before the onset of menopause. In most cases, they indicated a desire to make decisions about medical management of menopause and its symptoms. Nevertheless, they considered menopause to be a minor issue compared to the other physical issues they face related to their disability. They indicated that information was their best defense; in addition, they found that knowledge of their own body could be helpful. They reported that they try to avoid health care providers.

#### Nursing Implications

The concerns related to menopause expressed by women with disabilities should be further explored by nurses. Because women desire a major role in medical decision making related to menopause, they need to be provided with accurate, up-to-date information about results of studies related to all methods of symptom management. Furthermore, the women's view that they know their own bodies better than anyone else needs to be recognized and taken into consideration when providing care. Lastly, some women with disabilities reported that avoidance of health care providers might be beneficial. This suggests that nurses should take every opportunity to discuss health-related issues and concerns of women with disabilities.

concerns with her primary health care provider so that she can make an informed decision about managing menopausal symptoms and maintaining her health.

### Hormone Therapy

Until recently, hormone therapy (HT) was prescribed to prevent hot flashes, reduce the risk of osteoporotic fractures, and decrease the risk of cardiovascular disease. Contrary to long-held beliefs, HT or menopausal hormonal therapy (North American Menopause Society, 2007) (previously referred to as hormone replacement therapy [HRT]) has been found to increase some health disorders and to be less effective in preventing others than previously believed. Although HT decreases hot flashes and reduces the risk of osteoporotic fractures as well as colorectal cancer, studies have shown that it increases the risk of breast cancer, heart attack, stroke, and blood clots (Heiss, Wallace, Anderson, et al., 2008; Writing Group for Women's Health Initiative Investigators, 2002). Thus, the benefits of HT are inadequate given the increased risk of these other disorders. Because of these findings, many women have discontinued HT or are reluctant to begin HT. Although some women have elected to use HT in low doses on the advice of their health care providers, the effect of these low doses has not been studied. The current recommendation for treatment of hot flashes with HT is to use the lowest dose possible for the shortest time possible.

Nurses need to be knowledgeable about HT-related issues to be able to respond to women's questions about HT use.

#### Methods of Administration

Both estrogen and progestin are prescribed for women who have not had a hysterectomy; progestin prevents proliferation of the uterine lining and hyperplasia. Women who no longer have a uterus because of hysterectomy can take estrogen without progestin (ie, unopposed estrogen) because there is no longer a risk of estrogen-induced hyperplasia of the uterine lining. Although there is a slight increase of risk of stroke in women taking estrogen alone following hysterectomy, the risk of breast cancer is unchanged (Heiss, et al., 2008).

Some women take both estrogen and progestin daily; others take estrogen for 25 consecutive days each month, with progestin taken in cycles (eg, 10 to 14 days of the month). Women who take HT for 25 days often experience bleeding after completing the progestin. Other women take estrogen and progestin every day and usually experience no bleeding. They occasionally have irregular spotting, which should be evaluated by their health care provider. Progestin administration may be oral, transdermal, vaginal, or intrauterine.

Estrogen patches, which are replaced once or twice weekly, are another option but require a progestin along with them if the woman still has a uterus. Another type of patch provides estrogen and progestin treatment. Skin should be dry at the area of application, and cleansing the site with alcohol may improve adhesiveness. Vaginal treatment with an estrogen cream, suppository, or an estradiol ring (Estring) may be used for vaginal dryness or atrophic vaginitis. The estradiol ring is a small, flexible vaginal ring that slowly releases estrogen in small doses over 3 months. Vaginal estrogen preparations may improve vulvovaginal sensation; however, women who use them should be monitored for endometrial hyperplasia (Speroff & Fritz, 2005).

#### Risks and Benefits

HT is contraindicated in women with a history of breast cancer, vascular thrombosis, impaired liver function, uterine cancer, and undiagnosed abnormal vaginal bleeding. Because the risk of thromboembolic phenomena is increased with HT, women who elect to take it should be taught the signs and symptoms of deep vein thrombosis and pulmonary embolism and instructed to report these signs and symptoms immediately. Women who take HT should be assessed for leg redness, tenderness, chest pain, and shortness of breath. Furthermore, they need to be informed about the importance of regular follow-up care, including a yearly physical examination and mammogram. An endometrial biopsy is indicated for any irregular bleeding. Because the risk of complications increases the longer HT is used, HT should be used for the shortest time possible (American Heart Association, 2007). Estrogen alone or in combination with a progestin does not reduce risk of dementia or cognitive impairment.

### Alternative Therapy for Hot Flashes

Because women often seek information about alternatives to HT use, nurses must be knowledgeable about other approaches women can use to promote their health in the perimenopausal and postmenopausal period. Problematic hot flashes have been treated with venlafaxine (Effexor), paroxetine (Paxil), gabapentin (Neurontin), and clonidine (Catapres). Similarly, vitamin $B_6$ and vitamin E may be effective. Some women have expressed interest in other alternative treatments (eg, natural estrogens and progestins, black cohosh, ginseng, dong quai, soy products, and several other herbal preparations); however, few data exist about their safety or effectiveness. Therefore, assessment of menopausal women should address their use of complementary and alternative therapies and supplements. The North American Menopause Society provides additional suggestions. Glucose levels also affect hot flashes; thus, nurses can encourage patients to maintain stable glucose levels (Dormire & Becker, 2007).

### Maintaining Bone Health

Acceleration of bone loss resulting in osteoporosis and microarchitectural deterioration of bone tissue occurs at menopause and leads to increased bone fragility and risk of fracture. Other factors that increase a woman's risk of osteoporosis include a thin body frame, race (Caucasian or Asian), family history of osteoporosis, nulliparity, early menopause, moderate to heavy alcohol ingestion, smoking, caffeine use, sedentary lifestyle, and a diet low in calcium. About 80% of people with osteoporosis are women, and about half of these women will experience a fracture related to osteoporosis during her lifetime (National Osteoporosis Foundation, 2008). Thus, women are advised to remain active and to begin or continue a regular exercise program of weight-bearing activity, such as walking, which helps maintain bone mass; to take a calcium supplement; to decrease

or stop smoking; and to discuss with their health care provider the use of pharmacologic agents to reduce bone loss if indicated. Osteoporosis and its treatment are described in detail in Chapter 68.

#### Maintaining Cardiovascular Health

The American Heart Association (2007) recommends a variety of strategies to lower the risk of heart disease in women. These include lifestyle changes and behavioral strategies. Diet, exercise, stress reduction, and a healthy lifestyle all contribute to older women's cardiac health and are an essential part of health promotion. Regular physical exercise increases the heart rate and high-density lipoprotein levels. Weight-bearing exercise (eg, walking, jogging) at least four times a week is recommended. Pharmacologic therapy (eg, aspirin, beta-blockers, "statins," angiostatin-converting enzyme inhibitors) may be indicated in women who have cardiovascular disease or are at high risk for it. Prevention and treatment of cardiovascular disease are discussed in detail in Chapter 26.

#### Behavioral Strategies

As previously stated, regular physical exercise is beneficial. It may also reduce stress, enhance well-being, and improve self-image. In addition, weight-bearing exercise may prevent loss of muscle tissue and bone tissue.

Women are also encouraged to participate in other health-promoting activities. These include regular health screening recommended for women at the time of menopause: gynecologic examinations, mammograms, colonoscopy, fecal occult blood testing, and bone mineral density testing if at risk for osteoporosis.

#### Nutritional Therapy

Women are encouraged to decrease their fat and caloric intake and increase their intake of whole grains, fiber, fruit, and vegetables. Women of all ages tend to ingest less than the recommended amount of calcium; therefore, they should be encouraged to increase their intake of foods high in calcium (eg, nonfat yogurt, green leafy vegetables, seafood, and calcium-fortified foods). Calcium and vitamin D supplementation may be helpful in reducing bone loss and preventing the morbidity associated with osteoporotic fractures (National Osteoporosis Foundation, 2008).

### Nursing Management

Nurses can encourage women to view menopause as a natural change resulting in freedom from symptoms related to menses. No relationship exists between menopause and mental health problems; however, social circumstances (eg, adolescent children, ill partners, and dependent or ill parents) that may coincide with menopause can be stressful.

Measures should be taken to promote general health. The nurse explains to the patient that cessation of menses is a normal occurrence that is rarely accompanied by nervous symptoms or illness. The current expected lifespan after menopause for the average woman is 30 to 35 years, which may encompass as many years as the childbearing phase of her life. Normal sexual urges continue, and women retain their usual response to sex long after menopause. Many women enjoy better health after menopause than before, especially those who have experienced dysmenorrhea. The individual woman's evaluation of herself and her worth, now and in the future, is likely to affect her emotional reaction to menopause. Patient teaching and counseling regarding healthy lifestyles, health promotion, and health screening are of paramount importance (Chart 46-10).

# Menstrual Disorders

Menstrual disorders may include premenstrual syndrome (PMS); dysmenorrhea; amenorrhea; and excessive bleeding, irregular bleeding, or bleeding between cycles or unrelated to cycles. These disorders need to be discussed with a health care provider and managed individually. Menstrual-related disorders have been reported in as many as 19% of women who report feeling more anxious, sad, nervous, restless, hopeless, and worthless than those without complaints. Affected women are more likely to smoke cigarettes, drink alcohol to excess, and be overweight (Strine, Chapman & Ahluwalia, 2005). Dysmenorrhea may result from endometriosis or anatomic abnormalities or it can be a normal variation. Amenorrhea may be related to pregnancy, thyroid disorders, anatomic abnormalities, and eating disorders. Excessive bleeding may be caused by fibroids, clotting disorders, thyroid disorders, and miscarriage. Irregular bleeding may be secondary to hormonal changes in adolescence or perimenopause or may result from pregnancy, threatened abortion, or a variety of other factors.

## PREMENSTRUAL SYNDROME

Premenstrual symptoms are common in ovulating women and can influence quality of life. Symptoms occur in the luteal phase and disappear with the onset of menses. PMS is a combination of bothersome symptoms, and premenstrual dysphoric disorder is a severe type of premenstrual disorder that significantly impairs normal activity (Chart 46-11). The cause of these conditions is unknown; they are diagnosed if symptoms occur during the 5 days prior to the onset of menses, disappear within 4 days of the onset of menses, and occur through several cycles. PMS tends to become less symptomatic with menopause.

### Clinical Manifestations

Major symptoms of PMS include physical symptoms such as headache, fatigue, low back pain, painful breasts, and a feeling of abdominal fullness. Behavioral and emotional symptoms may include general irritability, mood swings, fear of losing control, binge eating, and crying spells. Symptoms vary widely from one woman to another and from one cycle to the next in the same woman. Great variability is found in the degree of symptoms. Many women are affected to some degree, but some are severely affected.

A generally stressful life and problematic relationships may be related to the intensity of physical symptoms. Some women report moderate to severe life disruption secondary to PMS that negatively affects their interpersonal relationships. PMS may also be a factor in reduced productivity, work-related injuries, and absenteeism.

CHART 46-10 HOME CARE CHECKLIST
*The Woman Approaching Menopause*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe menopause as a normal period in a woman's life. | ✔ | ✔ |
| • State that fatigue and stress may worsen hot flashes. | ✔ | ✔ |
| • State that a nutritious diet and weight control will enhance physical and emotional well-being. | ✔ | ✔ |
| • State the importance of exercising for at least 30 minutes three or four times a week to maintain good health. | ✔ | ✔ |
| • Describe involvement in outside activities as beneficial in reducing anxiety and tension. | ✔ | ✔ |
| • Identify the following as changes that often occur in midlife: departure of children, aging, dependence of parents, possible loss of loved ones. | ✔ | ✔ |
| • Describe this phase of life as having the potential for intellectual growth, personal accomplishment, and initiation of new activities. | ✔ | ✔ |
| • State the following points about sexual activity: | | |
| Frequent sexual activity helps to maintain the elasticity of the vagina. | ✔ | |
| Contraception is advised until 1 year passes without menses. | ✔ | |
| Safer sex is important at any age. | ✔ | |
| Sexual functioning may be enhanced at midlife. | ✔ | |
| • Identify the importance of an annual physical examination to screen for problems and to promote general health. | ✔ | |
| • Identify strategies and methods to prevent or manage the following problems: | ✔ | |
| Itching or burning of vulvar areas: see primary health care provider to rule out dermatologic abnormalities and, if appropriate, to obtain a prescription for a lubricating or hormonal cream. | | |
| Dyspareunia (painful intercourse) due to vaginal dryness; use a water-soluble lubricant, such as K-Y Jelly, Astro-Glide, Replens, hormone cream, or contraceptive foam. | ✔ | |
| Decreased perineal muscle tone and bladder control: practice Kegel exercises daily (contract the perineal muscles as though stopping urination; hold for 5–10 seconds and release; repeat frequently during the day). | ✔ | |
| Dry skin: use mild emollient skin cream and lotions to prevent dry skin. | ✔ | |
| Weight control: join a weight-reduction support group such as Weight Watchers or a similar group if appropriate, or consult a registered dietitian for guidance about the tendency to gain weight, particularly around the hips, thighs, and abdomen. | ✔ | |
| Osteoporosis: observe recommended calcium and vitamin D intake, including calcium supplements, if indicated, to slow the process of osteoporosis; avoid smoking, alcohol, and excessive caffeine, all of which increase bone loss. Perform weight-bearing exercises. Undergo bone density testing when appropriate. | ✔ | |
| Risk for urinary tract infection (UTI): drink 6 to 8 glasses of water daily and take vitamin C (500 mg) as a possible way to reduce the incidence of UTI related to atrophic changes of the urethra. | ✔ | |
| Vaginal bleeding: report any bleeding after 1 year of no menses to a primary health care provider *immediately, no matter how minimal.* | ✔ | |

## Medical Management

Because there is no single treatment or known cure for PMS, women should chart their symptoms so they can anticipate and therefore cope with them. Regular exercise may be helpful. Although women have been advised to avoid caffeine, high-fat foods, and refined sugars, little research demonstrates the efficacy of dietary changes. Alternative therapies that have been used include vitamins B and E, magnesium, and oil of evening primrose capsules. No studies have evaluated the effectiveness of these therapies.

Pharmacologic remedies include selective serotonin reuptake inhibitors (eg, fluoxetine [Prozac, Sarafem]), GnRH agonists, prostaglandin inhibitors (eg, ibuprofen and naproxen [Anaprox, Aleve]), diuretics, antianxiety agents, and calcium supplements. Oral contraceptives containing drospirenone (a synthetic progestin) and extended regimens also may be effective (Coffee, Kuehl, Willis, et al., 2006; Lopez, Kaptein & Helmerhorst, 2008).

**Chart 46-11 • *Causes, Manifestations, and Treatment of Premenstrual Syndrome***

**Cause**

- Unknown; may be related to hormonal changes combined with other factors (diet, stress, and lack of exercise)
- Many women have some symptoms related to menses, but PMS affects 2% to 5% of women and is a complex of symptoms that result in dysfunction.

**Physical Symptoms**

- Fluid retention (eg, bloating, breast tenderness)
- Headache

**Affective Symptoms**

- Depression
- Anger
- Irritability
- Anxiety
- Confusion
- Withdrawal
- Symptoms begin in the 5 days preceding menses and relief occurs within 4 days of onset of menses. Dysfunction usually occurs in relationships, parenting, work, or school.

**Treatment**

- Use of social support and family resources
- Nutritious diet consisting of whole grains, fruits, and vegetables; increased water intake may help
- Serotonin reuptake inhibitors
- Alprazolam (Xanax) has been effective but risk of physical and psychological dependence is high.
- Spironolactone, a diuretic, may be effective in treating fluid retention.
- Initiation/maintenance of exercise program
- Stress reduction techniques

### Nursing Management

The nurse obtains a health history, noting the time when symptoms began and their nature and intensity. The nurse then determines whether symptoms occur before or shortly after the menstrual flow begins. In addition, the nurse can show the patient how to record the timing and intensity of symptoms. A nutritional history is also elicited to determine if the diet is high in salt, caffeine, or alcohol or low in essential nutrients.

The patient's goals may include reduction of anxiety, mood swings, crying, binge eating, fear of losing control, improved coping with day-to-day stressors, improved relationships with family and coworkers, and increased knowledge about PMS. Positive coping measures are promoted. This may involve encouraging the woman's partner to offer support and assistance with child care. The patient can try to plan her working time to accommodate the days she is less productive because of PMS. The nurse encourages the patient to use exercise, meditation, imagery, and creative activities to reduce stress. The nurse also encourages the patient to take medications as prescribed and provides instructions about the desired effects of the medications. Enrolling in a PMS group may help the patient learn to recognize and cope with this condition.

If the patient has severe symptoms of PMS or premenstrual dysphoric disorder, the nurse assesses her for suicidal, uncontrollable, and violent behavior. An immediate psychiatric evaluation is necessary for women with any suggestions of suicidal tendencies. In rare cases, uncontrollable behavior may lead to violence toward family members. If abuse of children or other members of a patient's family is suspected, it is important to implement and follow reporting protocols. Referral for immediate psychiatric or psychological care and counseling is required.

## DYSMENORRHEA

Primary dysmenorrhea is painful menstruation, with no identifiable pelvic pathology. It occurs at the time of menarche or shortly thereafter. It is characterized by crampy pain that begins before or shortly after the onset of menstrual flow and continues for 48 to 72 hours. Pelvic examination findings are normal. Dysmenorrhea is thought to result from excessive production of prostaglandins, which causes painful contraction of the uterus and arteriolar vasospasm. Psychological factors, such as anxiety and tension, may also contribute to dysmenorrhea. As women become older, dysmenorrhea often decreases and frequently completely resolves after childbirth.

In secondary dysmenorrhea, pelvic pathology such as endometriosis, tumor, or pelvic inflammatory disease (PID) contributes to symptoms. Patients frequently have pain that occurs several days before menses, with ovulation, and occasionally with intercourse.

### Assessment and Diagnostic Findings

A pelvic examination is performed to rule out possible disorders, such as endometriosis, PID, adenomyosis, and uterine fibroids. A laparoscopy may be required to identify organic causes.

### Management

In primary dysmenorrhea, the reason for the discomfort is explained, and the patient is assured that menstruation is a normal function of the reproductive system. If the patient is young and accompanied by her mother, the mother may also need reassurance. Many young women expect to have painful periods if their mothers did. The discomfort of cramps can be treated once anxiety and concern about its cause are dispelled by adequate explanation. Symptoms usually subside with appropriate medication. Aspirin, a mild prostaglandin inhibitor, may be taken at recommended doses every 4 hours. Other useful prostaglandin antagonists include NSAIDs such as ibuprofen, naproxen, and mefenamic acid (Ponstel). If one medication does not provide relief, another may be recommended. Usually these medications are well tolerated, but some women experience gastrointestinal side effects. Contraindications include allergy, peptic ulcer history, sensitivity to aspirinlike medications, asthma, and pregnancy. Low-dose oral contraceptives

provide relief in more than 90% of patients and may be prescribed for women with dysmenorrhea who are sexually active but do not desire pregnancy.

Continuous low-level local heat may also be effective in relieving primary dysmenorrhea. Heat therapy and medication have been found to work well in combination. The patient is encouraged to continue her usual activities and to increase physical exercise if possible because this relieves discomfort for some women. Taking analgesic agents before cramps start, in anticipation of discomfort, is advised.

Management of secondary dysmenorrhea is directed at diagnosis and treatment of the underlying cause (eg, endometriosis or PID).

## AMENORRHEA

**Amenorrhea** (absence of menstrual flow) is a symptom of a variety of disorders and dysfunctions. Primary amenorrhea (delayed menarche) refers to the situation in which young women older than 16 years of age have not begun to menstruate but otherwise show evidence of sexual maturation, or in which young women have not begun to menstruate and have not begun to show development of secondary sex characteristics by 14 years of age. Amenorrhea may be of considerable concern but often occurs as a result of minor variations in body build, heredity, environment, and physical, mental, and emotional development.

The nurse encourages the patient to express her concerns and anxiety about this problem because the patient may feel that she is different from her peers. A complete physical examination, careful health history, and simple laboratory tests help rule out possible causes, such as metabolic or endocrine disorders and systemic diseases. Treatment is directed toward correcting any abnormalities.

Secondary amenorrhea (an absence of menses for three cycles or 6 months after a normal menarche) may be caused by pregnancy, emotional upset, eating disorder, or excessive exercise. In adolescents, secondary amenorrhea can be caused by minor emotional upset related to being away from home, attending college, tension due to schoolwork, or interpersonal problems. However, the second most common cause is pregnancy, so a pregnancy test is almost always indicated.

Secondary nutritional disturbances may also be factors. Obesity can result in anovulation and subsequent amenorrhea. Eating disorders, such as anorexia and bulimia, often result in lack of menses because the decrease in body fat and caloric intake affects hormonal function. Intense exercise can induce menstrual disturbances. Competitive female athletes often experience amenorrhea. If they do, they may be placed on HT to prevent bone loss related to low estrogen levels. On occasion, a pituitary or thyroid dysfunction may cause amenorrhea. These dysfunctions can be treated successfully by treatment of the underlying endocrine disorder. Infrequent periods (oligomenorrhea) may be related to thyroid disorders, polycystic ovarian syndrome, or premature ovarian failure. Women who are HIV positive are apt to miss menstrual periods and need to be evaluated for pregnancy, thyroid disorders, hyperprolactinemia, and menopause (if appropriate) (Cejtin, Kalinowski, Bacchetti, et al., 2006).

## ABNORMAL UTERINE BLEEDING

Dysfunctional uterine bleeding is abnormal bleeding that has no known organic cause. The bleeding is defined as irregular, painless bleeding of endometrial origin that may be excessive, prolonged, or without pattern. Dysfunctional uterine bleeding can occur at any age but is most common at opposite ends of the reproductive lifespan. It is usually secondary to anovulation (lack of ovulation) and is common in adolescents and women approaching menopause.

Adolescents account for many cases of abnormal uterine bleeding; they often do not ovulate regularly as the pituitary–ovarian axis matures. Perimenopausal women also experience this condition because of irregular ovulation secondary to decreasing ovarian hormone production. Other causes may include fibroids, obesity, and hypothalamic dysfunction.

Abnormal or unusual vaginal bleeding that is atypical in time or amount must be evaluated because it could possibly be a manifestation of a major disorder. A physical examination is performed, and the patient is evaluated for conditions such as pregnancy, neoplasm, infection, anatomic abnormalities, endocrine disorders, trauma, blood dyscrasias, platelet dysfunction, and hypothalamic disorders.

### Menorrhagia

Menorrhagia is prolonged or excessive bleeding at the time of the regular menstrual flow. In young women the cause is usually related to endocrine disturbance, whereas in later life it usually results from inflammatory disturbances, tumors of the uterus, or hormonal imbalance.

Women with menorrhagia are urged to see a primary health care provider and to describe the amount of bleeding by pad count and saturation (ie, absorbency of perineal pad or tampon and number saturated hourly). Persistent heavy bleeding can result in anemia. It can also be a sign of a bleeding disorder or a result of anticoagulant therapy. Hysterectomy can be challenging in these women; endometrial ablation has been found to be less risky (El-Nashar, Hopkins, Feitoza, et al., 2007).

### Metrorrhagia

Metrorrhagia (vaginal bleeding between regular menstrual periods) is probably the most significant form of menstrual dysfunction because it may signal cancer, benign tumors of the uterus, or other gynecologic problems. This condition warrants prompt evaluation and treatment. Although bleeding between menstrual periods by women taking oral contraceptives is usually not serious, irregular bleeding by women taking HT should be evaluated.

Menometrorrhagia is heavy vaginal bleeding between and during periods. It, too, requires evaluation.

### Postmenopausal Bleeding

Bleeding 1 year after menses cease at menopause must be investigated, and a malignant condition must be considered until proven otherwise. A vaginal ultrasound can be used to measure the thickness of the endometrial lining. The uterine lining in postmenopausal women should be thin because of low estrogen levels. A lining thicker than 5 mm usually warrants evaluation by endometrial biopsy or a D & C.

## Dyspareunia

Dyspareunia (difficult or painful intercourse) can be superficial, deep, primary, or secondary and may occur at the beginning of, during, or after intercourse. Dyspareunia may be related to many factors, including injury during childbirth; lack of vaginal lubrication; a history of incest, sexual abuse, or assault; endometriosis; pelvic infection; vaginal atrophy with menopause; gastrointestinal disorders; fibroids; urinary tract infection; STDs; or vulvodynia (vulvar pain that affects women of all ages without any discernible physical cause). Depending on the cause of dyspareunia, counseling, extra lubrication, or antidepressants may be prescribed. Women's health issues related to sexuality may be affected by many factors. Thus, these issues need to be taken seriously, carefully assessed, and treated.

## Contraception

Each year, more than half of the pregnancies in the United States are unintended; this is the highest rate among industrialized nations. Although unintended pregnancies occur in women of all ages, incomes, and racial and ethnic groups, the highest rates occur among adolescents and perimenopausal women. Adolescents are more likely to experience pregnancy complications and are more prone to have low-birthweight babies. In addition, adolescent mothers are less likely to obtain a high school diploma and are more likely subsequently to live in poverty. One of two unplanned pregnancies end in abortion (Paru, Boatwright, Tozer, et al., 2006).

Women may fail to use effective methods of contraception consistently or at all. Of the women who undergo abortions, many were not using contraception when they became pregnant, and others have never used any method of contraception. Decreasing unwanted pregnancies may reduce the number of abortions, abused children, stressed families, and infant mortality and morbidity.

Nurses can assist with information and support. Women can be asked directly when they plan to have their next pregnancy and about their need for contraception. Many women who are sexually active or who are considering becoming sexually active can benefit from learning about contraception. Nurses who are involved in helping patients make contraceptive choices need to listen, take time to answer questions, and teach and assist patients in choosing the method they prefer. It is important for women to receive unbiased and nonjudgmental information, understand the benefits and risks of each method, learn about alternatives and how to use them, and receive positive reinforcement and acceptance of their choice. Some women have received misinformation (ie, contraception causes cancer or weight gain). Adolescents who worry that they may be unable to become pregnant may not be willing to use contraception. Factors related to this fear include a history of an STD, an older partner, a partner who desires a pregnancy, and the adolescent's desire for pregnancy (White, Rosengard, Weitzen, et al., 2006).

### ABSTINENCE

Abstinence, or celibacy, is the only completely effective means of preventing pregnancy. Abstinence may not be a desired or available option for many women because of cultural expectations and their own and their partner's values and sexual needs.

### STERILIZATION

After abstinence, sterilization by bilateral tubal occlusion or vasectomy is the most effective means of contraception. Both procedures must be considered permanent because neither is easily reversible. Women and men who choose these methods should be certain that they no longer wish to have children, no matter how the circumstances in their life may change. Often, decisions made hastily may be regretted later. Some gynecologists suggest a waiting period to ensure that patients are certain about a potentially irreversible decision.

#### Tubal Ligation

Sterilization by tubal ligation is one of the most common surgical procedures performed on women. Tubal ligation is usually performed as a same-day surgical procedure and is carried out by laparoscopy or hysteroscopy, with the patient receiving a general or local anesthetic. After the laparoscope is inserted, the fallopian tubes are visualized and may be coagulated, sutured (Pomeroy procedure), or ligated with silicone bands or a spring clip, thereby disrupting their patency. The use of spring clips is associated with the highest rate of pregnancy following sterilization. In another procedure, transcervical tubal occlusion procedure, a 0.6-inch metal coil or spring is inserted into the fallopian tubes through the cervix, thus avoiding the need for laparoscopy or a surgical incision. This method, referred to as the Essure procedure, is performed via hysteroscopy and obstructs the tubes by inducing scar tissue. Women who have had this procedure should abstain from unprotected intercourse for 3 months to avoid pregnancy until the scar tissue develops and the effectiveness of the procedure is verified by HSG.

Despite a very high rate of effectiveness, all women who have undergone tubal ligation but miss a period should be tested for pregnancy because ectopic and intrauterine pregnancies, although rare, may occur. Ovulation and menstruation are not affected by sterilization, although some women report heavier menstrual bleeding and more cramping after tubal ligation.

Before undergoing tubal ligation, the patient should be informed that an IUD, if present, will be removed. If the patient is taking oral contraceptives, she usually continues them up to the time of the procedure. If a laparoscopic procedure is performed, the patient may experience postoperative abdominal or shoulder discomfort for a few days, related to the carbon dioxide gas and the manipulation of organs. The patient is instructed to report heavy bleeding, fever, or pain that persists or increases. She should avoid intercourse, strenuous exercise, and lifting for 2 weeks. Risks associated with tubal ligation are minimal and are more often related to anesthesia than to the surgery itself. Risk is increased in women with diabetes, previous abdominal or pelvic surgery, or obesity.

#### Vasectomy

Vasectomy (male sterilization) and hysteroscopic/laparoscopic tubal ligation are compared in Table 46-4. See Chapter 49 for a discussion of vasectomy.

**Table 46-4 COMPARISON OF STERILIZATION METHODS**

| Sterilization Method | Advantages | Disadvantages |
|---|---|---|
| Vasectomy | • Highly effective<br>• Relieves female of contraceptive burden<br>• Inexpensive in long run<br>• Permanent<br>• Highly acceptable procedure to most patients<br>• Very safe<br>• Quickly performed | • Expensive in short term<br>• Serious long-term effects suggested (although currently unproved)<br>• Permanent (although reversal is possible, it is expensive and requires highly technical and major surgery, and results cannot be guaranteed)<br>• Regret in 5%–10% of patients<br>• No protection against STDs, including HIV<br>• Not effective until sperm remaining in reproductive system are ejaculated |
| Hysteroscopic and laparoscopic tubal sterilization | • Low incidence of complications<br>• Short recovery<br>• Leaves small or no scar<br>• Quickly performed | • Permanent<br>• Reversal difficult and expensive<br>• Sterilization procedures technically difficult<br>• Requires surgeon, operating room (aseptic conditions), trained assistants, medications, surgical equipment (Essure [insertion of coil or spring in fallopian tubes] requires hysteroscopy rather than surgery)<br>• Expensive at the time performed<br>• If failure, high probability of ectopic pregnancy<br>• No protection against STDs, including HIV |

## HORMONAL CONTRACEPTION

Oral contraceptives block ovarian stimulation by preventing the release of FSH from the anterior pituitary gland. In the absence of FSH, a follicle does not ripen, and ovulation does not occur. Progestins (synthetic forms of progesterone) suppress the LH surge, prevent ovulation, and also render the cervical mucus impenetrable to sperm. Hormonal contraceptive agents may be oral, transdermal, vaginal, or injectable. Combined oral contraceptives that contain both estrogens and progestins are currently used by many women to prevent pregnancy.

### Benefits and Risks

Benefits of combined hormonal contraceptive use include a reduction in the incidence of benign breast disease; improvement in acne; and reduced risk of uterine and ovarian cancers, anemia, and pelvic infection. In general, prolonged hormonal contraceptive use has resulted in no definite long-term undesirable effects, although there is an increased risk of gallbladder problems (eg, cholestasis). Resumption of normal menses is delayed 2 to 3 months or longer in about 20% of hormonal contraceptive users. Risks include venous thromboembolism, although its incidence has decreased because the estrogen concentrations used today are less than that used in early preparations. Venous thromboembolism is less than half as likely with hormonal contraceptives than with pregnancy. Fetal anomalies do not appear to be an issue, and normal reproductive tract function and fertility resume after hormonal contraceptive use is discontinued. However, most health care providers recommend that women who wish to become pregnant use a barrier contraceptive method for 1 to 2 months after stopping hormonal contraceptives before attempting to become pregnant to permit a normal period for accurate dating of the pregnancy.

A few patients experience adverse reactions when using hormonal contraceptives. These include nausea, depression, headache, leg cramps, and breast soreness. Usually, these symptoms subside after 3 or 4 months. Because such symptoms are sometimes related to sodium and water retention caused by estrogen, a smaller dose of the hormone or a different hormonal combination may alleviate the problem. Many patients experience spotting in the first month of use of hormonal contraceptive or if they use it irregularly, so they need to be reassured and advised to use it as prescribed. Chart 46-12 compares different oral contraceptive regimens, and Chart 46-13 describes the benefits and risks of oral contraceptive use.

### Contraindications

Absolute contraindications to hormonal contraceptives include current or past thromboembolic disorder, cerebrovascular disease, or artery disease; migraine headaches with visual auras; known or suspected breast cancer; known or suspected current or past estrogen-dependent neoplasia; pregnancy; current or past benign or malignant liver tumors; liver dysfunction; clotting disorders; congenital hyperlipidemia; and abnormal vaginal bleeding (ACOG, 2006c).

Relative contraindications include hypertension, bile-induced jaundice, acute phase of mononucleosis, and sickle cell disease. Controlled hypertension in otherwise healthy young nonsmokers is generally not a contraindication to use of combination agents but does require a low dose and careful blood pressure monitoring. Women older than 35 years of age who smoke are at risk for cardiac problems and should not use hormonal contraceptives. Occasionally, neuro-ocular complications arise, but a cause-and-effect relationship has not been established. If visual disturbances occur, hormonal contraceptives should be discontinued.

CHART 46-12

PHARMACOLOGY

### *Comparison of Hormonal Contraceptive Regimens*

There are two kinds of hormonal contraceptives: combined (consisting of an estrogen and a progestin) and progestin only.

**Combined Preparations** (pills, transdermal patches, vaginal rings)

- Monophasic preparations supply the same dose of estrogen and progestin for 21 days.
- Biphasic preparations and triphasic pills vary the amount of hormonal components during the cycle.
- Usually leads to a lighter-than-normal menstrual flow, which results from withdrawal.

**Progestin-Only "Mini" Preparations**

- Preparations provide less protection against conception than combined preparations.
- About 40% of women taking progestin-only preparations have ovulatory cycles.
- Progestin-only preparations are useful for women who have had estrogen-related side effects (eg, headaches, hypertension, leg pain, chloasma or skin discoloration, weight gain, or nausea) on combination pills.
- Progestin-only preparations are useful for lactating women who need a hormonal contraceptive method.
- Depo-Provera, a progestin-only injection, lasts for 3 months.
- Implanon, a subdermal implant lasts for 3 years.

Chart 46-14 summarizes patient education guidelines that are important for women using combination hormonal contraceptives.

Coexisting medical disorders may make contraception a complex issue. These disorders include chronic hypertension, lipid disorders, diabetes, migraines, fibroids, obesity, lupus, depression, seizures, and HIV infection or AIDS. Contraception needs to be addressed individually in women with these conditions, and clinicians may prescribe injectable hormonal contraceptives (eg, Depo-Provera) or IUDs (ACOG, 2006c).

## Methods of Hormonal Contraception

Various hormonal methods of birth control are approved by the U.S. Food and Drug Administration (FDA). Combination methods include the combination of oral contraceptive pills, vaginal ring (NuvaRing), and transdermal patch (Ortho Evra). Progestin-only methods include the progestin-only pills or minipills, progestin-only emergency contraception (Plan B), once-every-3-month injection (Depo-Provera), levonorgestrel-releasing intrauterine system (Mirena), and single-rod subdermal implant (Implanon).

*NURSING ALERT*

**Patients need to be aware that hormonal contraceptives protect them from pregnancy but not from STDs or HIV infection. In addition, sex with multiple partners or sex without a condom may also result in chlamydial and other infections, including HIV infection.**

### *Oral Contraceptives*

Many women currently use oral contraceptive preparations of synthetic estrogens and progestins. A variety of formulations are available. Extended regimens of oral hormonal contraceptive agents are an option for women who have heavy or uncomfortable menstrual bleeding or who wish to have fewer periods. With the use of these regimens, women may have an increased occurrence of breakthrough bleeding; the blood may be dark brown rather than red. It may be more difficult to tell if a pregnancy occurs with this method, although pregnancy is unlikely if pills are taken as prescribed. Studies are ongoing to assess the risks of exposure to increased estrogen resulting from this method.

CHART 46-13

PHARMACOLOGY

### *Benefits and Risks of Combination Hormonal Contraceptives*

**Benefits**

- Decreased cramps and bleeding
- Regular bleeding cycle
- Decreased incidence of anemia
- Decrease in acne with some formulations
- Protection from uterine and ovarian cancer
- Decreased incidence of ectopic pregnancy
- Protection from benign breast disease
- Decreased incidence of pelvic infection

**Risks**

- Rare in healthy women
- Bothersome side effects (eg, breakthrough bleeding, breast tenderness)
- Nausea, weight gain, mood changes
- Small increased risk of developing blood clots, stroke, or heart attack, related more to smoking than to oral contraceptive use alone
- Possible increased incidence of benign liver tumors and gallbladder disorders
- No protection from STDs/STIs (possible increased risk with unsafe sex)

CHART 46-14 PATIENT EDUCATION
**Using Combination Contraceptives**

- Use condoms to protect against sexually transmitted diseases.
- Take pill at exactly the same time every day *or* put the patch on once a week or remove the vaginal ring after 3 weeks.
- Stop smoking or cut down on smoking.
- Report the following symptoms immediately:
  A —abdominal pains
  C —chest pains
  H —headaches
  E —eye problems (blurred vision or spots)
  S —severe leg pains

### *Transdermal Contraceptives*

Ortho Evra is a thin, beige, matchbook-size skin patch that releases an estrogen and a progestin continuously. It is changed every week for 3 weeks, and no patch is used during the fourth week, resulting in withdrawal bleeding. The effectiveness of Ortho Evra is comparable to that of oral contraceptives. Its risks are similar to those of oral contraceptives and include an increased risk of blood clots. The patch may be applied to the torso, chest, arms, or thighs; it should not be applied to the breasts. The patch is convenient and more easily remembered than a daily pill but is not as effective for women who weigh more than 198 lb (90 kg). In addition, it may also irritate skin conditions (eg, psoriasis) in some women and results in higher blood estrogen levels than oral contraceptives.

### *Vaginal Contraceptives*

NuvaRing (etonogestrel/ethinyl estradiol vaginal ring) is a combination hormonal contraceptive that releases estrogen and progestin. It is inserted in the vagina for 3 weeks and then removed, resulting in withdrawal bleeding. It is as effective as oral contraceptives and results in lower hormone blood levels than oral contraceptives. NuvaRing is flexible, does not require sizing or fitting, and is effective when placed anywhere in the vagina. Patients are occasionally reluctant to consider vaginal methods of contraception unless discussed openly and as a convenient alternative to other routes of administration. Some women are uncomfortable with this method and may fear that the ring may migrate or be uncomfortable or be noticed by a partner. The nurse can be helpful in dispelling misconceptions. The patient can be informed that while some women notice a slight increase in vaginal discharge, this effective method of contraception has been found to increase the vaginal health-promoting lactobacillus (ACOG, 2006d; Roumen, 2008). NuvaRing is usually more expensive than oral contraceptives.

### *Injectable Contraceptives*

An intramuscular injection of Depo-Provera (a long-acting progestin) every 3 months inhibits ovulation and provides a reliable, private, and convenient contraceptive method. A subcutaneous formulation is also available. It can be used by lactating women and those with hypertension, liver disease, migraine headaches, heart disease, and hemoglobinopathies. With continued use, women must be prepared for irregular bleeding episodes and spotting decrease, or amenorrhea.

Advantages of Depo-Provera include reduction of menorrhagia, dysmenorrhea, and anemia due to heavy menstrual bleeding. It may reduce the risk of pelvic infection, has been associated with improvement in hematologic status in women with sickle cell disease, and does not interfere with the efficacy of antiseizure agents. It decreases the risk of endometrial cancer, PID, endometriosis, and uterine fibroids.

Possible side effects of Depo-Provera include irregular menstrual bleeding, bloating, headaches, hair loss, decreased sex drive, bone loss, and weight loss or weight gain. The contraceptive does not protect against STDs. Fertility may be delayed when women discontinue this method; therefore, other methods of contraception may be more appropriate for the woman who wishes to conceive within a year of discontinuing contraception. While Depo-Provera is used, bone density is decreased, and this may be a risk factor for future osteoporosis. Severe allergic response is rare but possible following injection (Haider & Darney, 2007).

Depo-Provera is contraindicated in women who are pregnant and those who have abnormal vaginal bleeding of unknown cause, breast or pelvic cancer, or sensitivity to synthetic progestin. The long-term effects on infants of nursing mothers who use Depo-Provera are unknown but are thought to be negligible.

### *Implants*

Implanon is a single-rod subdermal implant that is usually placed inside the upper arm via a small incision. It is effective for 3 years. Implanon may cause irregular bleeding but may improve dysmenorrhea, and it does not affect bone density. This contraceptive can be used by lactating women.

## INTRAUTERINE DEVICE

An IUD is a small plastic device, usually T-shaped, that is inserted into the uterine cavity to prevent pregnancy. A string attached to the IUD is visible and palpable at the cervical os. An IUD prevents conception by causing a local inflammatory reaction that is toxic to spermatozoa and blastocysts, thus preventing fertilization. The IUD does not work by causing abortion.

Advantages include effectiveness over a long period of time, few if any systemic effects, and reduction of patient error. This reversible method of birth control is as effective as sterilization and more effective than barrier methods.

Disadvantages include possible excessive bleeding, cramps, and backaches; a slight risk of tubal pregnancy; slight risk of pelvic infection on insertion; displacement of the device; and, rarely, perforation of the cervix and uterus. If a pregnancy occurs with an IUD in place, the device is removed immediately to avoid infection. Spontaneous abortion (miscarriage) may occur on removal. An IUD is not usually used in women who have not had children because a small nulliparous uterus may not tolerate it. Women with multiple partners, women with heavy or crampy periods, or those with a history of ectopic pregnancy or pelvic infection should be encouraged to use other methods of contraception.

Some clinicians test for chlamydia and gonorrhea prior to insertion to prevent PID.

The ParaGard T 380A, an IUD that has been available for 15 years, is effective for at least 10 years. It prevents fertilization by impairing sperm function as copper has an antispermatic effect. The Levonorgestrel Intrauterine System (LNG-IUS; Mirena), another IUD, releases levonorgestrel, a synthetic progestin used in oral contraceptives, and is effective for at least 5 years. It works by impairing sperm function, thickening cervical mucus, and suppressing the endometrium. It has also been used therapeutically to reduce heavy bleeding; it may prevent the need for hysterectomy in some women with heavy vaginal bleeding. LNG-IUS is also helpful in women with menorrhagia, dysmenorrhea, endometriosis, and fibroids (ACOG, 2006d).

## MECHANICAL BARRIERS

### Diaphragm

The diaphragm is an effective contraceptive device that consists of a round, flexible spring (50 to 90 mm wide) covered with a domelike latex rubber cup. A spermicidal (contraceptive) jelly or cream is used to coat the concave side of the diaphragm before it is inserted deep into the vagina, covering the cervix completely. The spermicide inhibits spermatozoa from entering the cervical canal. The diaphragm is not felt by the user or her partner when properly fitted and inserted. Because women vary in size, the diaphragm must be sized and fitted by an experienced clinician. The woman is instructed in using and caring for the device. A return demonstration ensures that the woman can insert the diaphragm correctly and that it covers the cervix.

Each time the woman uses the diaphragm, she should examine it carefully. By holding it up to a bright light, she should ensure that it has no pinpoint holes, cracks, or tears. She then applies spermicidal jelly or cream and inserts the diaphragm. The diaphragm should remain in place at least 6 hours after coitus (no more than 12 hours). Additional spermicide is necessary if more than 6 hours have passed before intercourse occurs and before each act of repeated intercourse. On removal, the diaphragm should be cleansed thoroughly with mild soap and water, rinsed, and dried before being stored in its original container.

Disadvantages include allergic reactions in those who are sensitive to latex and an increased incidence of urinary tract infections. Toxic shock syndrome has been reported in some diaphragm users but is rare.

*NURSING ALERT*

**The nurse must assess the woman for possible latex allergy because use of latex barrier methods (eg, diaphragm, cervical cap, male condoms) may cause severe allergic reactions, including anaphylaxis, in patients with latex allergy.**

### Cervical Cap

The cervical cap is much smaller (22 to 35 mm) than the diaphragm and covers only the cervix. If a woman can feel her cervix, she can usually learn to use a cervical cap. The chief advantage is that the cap may be left in place for 2 days after coitus. Although convenient to use, the cervical cap may cause cervical irritation; therefore, before fitting a cap, most clinicians obtain a Pap smear and repeat the smear after 3 months. The cap is used with a spermicide and does not require additional spermicide for repeated intercourse.

### Contraceptive Sponge

The sponge, another barrier method of contraception, is made of soft, disposable polyurethane foam that is moistened with water and inserted into the vagina before intercourse. It contains and releases a spermicide (eg, nonoxynol-9) that is continuously released into the vagina in small amounts through a 24-hour wear time. The sponge is left in place in the vagina for at least 6 hours after intercourse and can be kept in place for up to 24 additional hours without the need to replace it with repeated acts of intercourse during that period of time. The sponge is sold over the counter and does not require a prescription or special fitting by a health care provider. The sponge should not be used by women with allergy to polyurethane. It should not be used during menstruation. Women who have a history of toxic shock syndrome should not use the contraceptive sponge.

### Female Condom

The female condom was developed to give control of barrier protection to women—to provide them with protection from STDs and HIV as well as pregnancy. The female condom (Reality) consists of a cylinder of polyurethane enclosed at one end by a closed ring that covers the cervix and at the other end by an open ring that covers the perineum (Fig. 46-7). (New, improved models are currently pending approval by the FDA.) Advantages include some degree of protection from STDs (HPV, herpes simplex virus, and HIV). Disadvantages include the inability to use the female condom with some positions (ie, standing). Women have found that it can be noisy and slippery.

### Spermicides

Spermicides are made from nonoxynol-9 or octoxynol and are available over the counter as foams, gels, films, and suppositories and also on condoms. Spermicides do not protect women from HIV or other STDs (Alan Guttmacher Institute, 2008). In fact, nonoxynol-9 has been found to be associated with minute tears in vaginal tissue with frequent use (eg, daily), possibly increasing the possibility of contracting HIV from an infected partner.

### Male Condom

The male condom is an impermeable, snug-fitting cover applied to the erect penis before it enters the vaginal canal. The tip of the condom is pinched while being applied to leave space for ejaculate. If no space is left, ejaculation may cause a tear or hole in the condom and reduce its effectiveness. The penis, with the condom held in place, is removed from the vagina while still erect to prevent the ejaculate from leaking. Condoms are now available in large and small sizes.

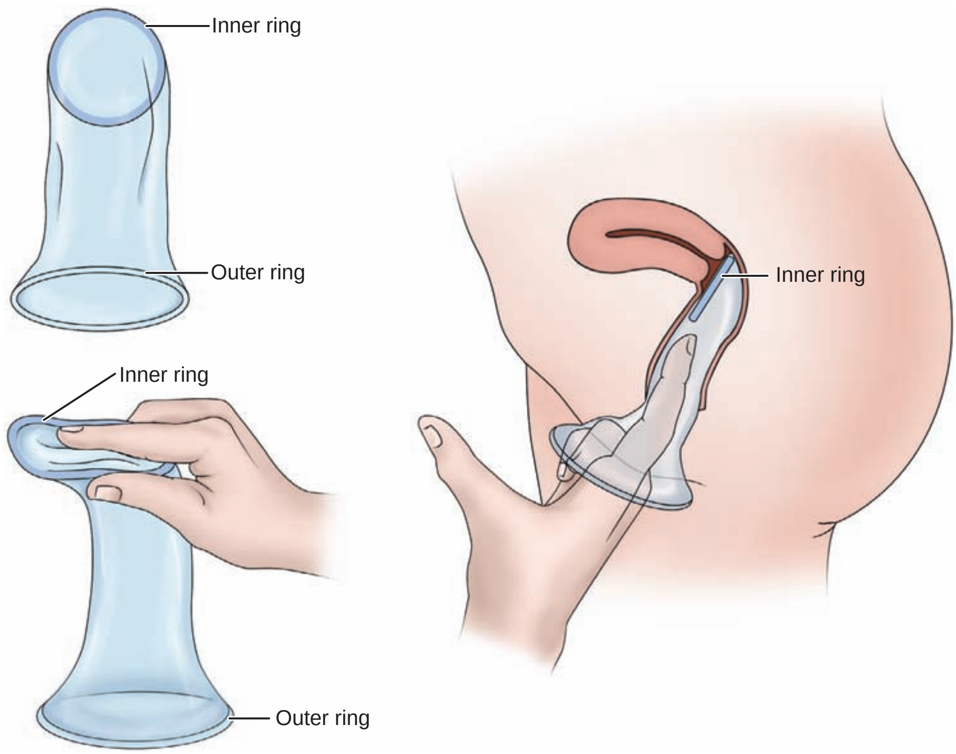



**Figure 46-7** Female condom. To insert the female condom, hold the inner ring between the thumb and middle finger. Put the index finger on the pouch between the thumb and other fingers and squeeze the ring. Slide the condom into the vagina as far as it will go. The inner ring keeps the condom in place.

The latex condom also creates a barrier against transmission of STDs (gonorrhea, chlamydial infection, and HIV) by body fluids and may reduce the risk of herpes virus transmission. However, natural condoms (those made from animal tissue) do not protect against HIV infection. Nurses need to reassure women that they have a right to insist that their male partners use condoms and a right to refuse sex without condoms, although women in abusive relationships may increase their risk of abuse by doing so. Some women carry condoms with them to be certain that one is available. Nurses should be familiar and comfortable with instructions about using condoms because many women need to know about this way of protecting themselves from HIV and other STDs. Condoms do not provide complete protection from STDs because HPV may be transmitted by skin-to-skin contact. Other STDs may be transmitted if any abraded skin is exposed to body fluids. This information should be included in patient teaching.

The nurse needs to consider the possibility of latex allergy. Swelling and itching can also occur. Possible warning signs of latex allergy include oral itching after blowing up a balloon or eating kiwis, bananas, pineapples, passion fruit, avocados, or chestnuts. Because many contraceptives are made of latex, patients who experience burning or itching while using latex contraceptives are instructed to see their primary health care provider. Alternatives to latex condoms may include the female condom (Reality) and the male condom (Avanti), made of polyurethane.

## COITUS INTERRUPTUS OR WITHDRAWAL

Coitus interruptus (removing the penis from the vagina before ejaculation) requires careful control by the male partner. Although it is a frequently used method of preventing pregnancy and better than no method, it is considered an unreliable method of contraception.

## RHYTHM AND NATURAL METHODS

Natural family planning is any method of conception regulation that is based on awareness of signs and symptoms of fertility during a menstrual cycle. The advantages of natural contraceptive methods include: (1) they are not hazardous to health, (2) they are inexpensive, and (3) they are approved by some religions that do not approve of other methods of contraception. The disadvantage is that they require discipline by the couple, who must monitor the menstrual cycle and abstain from sex during the fertile phase.

Current methods include the calendar method, the basal body temperature method, the ovulation method, and the symptothermal method. The calendar and basal body temperature methods are older than the ovulation method and the symptothermal method. Combinations of these methods are often used (Fehring, Schneider, Raviele, et al., 2007). The fertile phase (in which sexual abstinence is required) is estimated to occur about 14 days before menstruation, although it may occur between the 10th and 17th days. Spermatozoa can fertilize an ovum up to 72 hours after intercourse, and the ovum can be fertilized for 24 hours after leaving the ovary. The pregnancy rate with the rhythm (ie, calendar) method is about 40% yearly.

Women who carefully determine their "safe period," based on a precise recording of menstrual dates for at least 1 year, and who follow a carefully worked-out formula may achieve very effective protection. A long abstinence period during each cycle is required. These prerequisites require more time and control than many couples have. Changes in

cervical mucus and basal body temperature due to hormonal changes related to ovulation form the scientific basis for the symptothermal method of ovulatory timing. Courses in natural family planning are offered at many Catholic hospitals and some family planning clinics.

Ovulation detection methods (eg, Clearblue Easy Fertility Monitor) are available in most pharmacies. The presence of the enzyme guaiacol peroxidase in cervical mucus signals ovulation 6 days beforehand and also affects mucosal viscosity. Over-the-counter test kits are easy to use and reliable but can be expensive. Ovulation prediction kits are more effective for planning conception than for avoiding it. But if they are used in combination with cervical mucus changes and the calendar method, they may be effective; further research is needed (Fehring, et al., 2007).

Douching is not a contraceptive method and may enhance rather than decrease the chances of conception.

## EMERGENCY CONTRACEPTION

The need for emergency contraception may arise after an episode of unprotected sexual intercourse. Therefore, nurses need to be aware of emergency contraception as an option for women and the indications for its use. It is clearly not suitable for long-term avoidance of pregnancy because it is not as effective as oral contraceptives or other reliable methods used regularly. However, it is valuable following intercourse when a pregnancy is not intended and in emergency situations such as rape, a defective or torn condom or diaphragm, or other situations that may result in unwanted conception. Women need to be made aware of emergency contraception and how to obtain it.

### Methods of Emergency Contraception

#### *Hormonal Methods*

A properly timed, adequate dose of estrogen and a progestin or progestin-only medication after intercourse without effective contraception, or when a method has failed, can prevent pregnancy by inhibiting or delaying ovulation. This method does not interrupt an established pregnancy and does not cause an abortion.

Generally, emergency contraception is currently available only with prescription and is not available over the counter. Emergency contraceptives may be dispensed by pharmacists without a prescription in some states. The sooner emergency contraception is taken, the more effective it is. It is considered safe and effective by the FDA and can be prescribed or purchased as Plan B (progestin only) packages of emergency contraception with patient literature. It can also be prescribed as a specific number of contraceptive pills, depending on the medication and dose used.

This method must be used not more than 5 days following intercourse. Nausea, a common side effect, can be minimized by taking the medication with meals and with an antiemetic agent. Other side effects, such as breast soreness and irregular bleeding, may occur but are transient. Patients who use this method should be advised of the potential failure rate and also counseled about other contraceptive methods. There are no known contraindications to the use of this method, except an established pregnancy (Allen & Goldberg, 2007).

The nurse reviews with the patient instructions for emergency contraception based on the medication regimen prescribed. If the woman is breastfeeding, a progestin-only formulation is prescribed. To avoid exposing infants to synthetic hormones through breast milk, the patient can manually express milk and bottle feed for 24 hours after treatment. The patient should be informed that her next menstrual period may begin a few days earlier or a few days later than expected. She is instructed to return for a pregnancy test if she has not had a menstrual period in 3 weeks and should be offered another visit to provide a regular method of contraception if she does not have one currently.

#### *Postcoital Intrauterine Device Insertion*

Postcoital IUD insertion, another form of emergency contraception, involves insertion of a copper-bearing IUD within 5 days of coitus in women who want this method of contraception; however, it may be inappropriate for some women or if contraindications exist. The mechanism of action is unknown, but it is thought that the IUD interferes with fertilization (Allen & Goldberg, 2007). The patient may experience discomfort on insertion and may have heavier menstrual periods and increased cramping. Contraindications include a confirmed or suspected pregnancy or any contraindication to regular copper IUD use. The patient must be informed that there is a risk that insertion of an IUD may disrupt a pregnancy that is already present.

### Nursing Management

Patients who use emergency contraception may be anxious, embarrassed, and lacking information about birth control. The nurse must be supportive and nonjudgmental and provide facts and appropriate patient teaching. If the patient repeatedly uses this method of birth control, she should be informed that the failure rate with this method is higher than with a regularly used method. A toll-free telephone information service (1-888-NOT-2-LATE) operates 24 hours a day in English and Spanish and provides information and referrals to health care providers. Nurses can educate and inform women about emergency contraception options to reduce unwanted pregnancies and abortions. See the list of resources at the end of this chapter for more information.

# *Abortion*

Interruption of pregnancy or expulsion of the product of conception before the fetus is viable is called abortion. The fetus is generally considered to be viable any time after the 5th to 6th month of gestation.

## SPONTANEOUS ABORTION

It is estimated that 1 of every 5 to 10 conceptions ends in spontaneous abortion. Most of these occur because an abnormality in the fetus makes survival impossible. Other causes may include systemic diseases, hormonal imbalance, or anatomic abnormalities. If a pregnant woman experiences bleeding and cramping, a threatened abortion is diagnosed because an actual abortion is usually imminent.

Spontaneous abortion occurs most commonly in the 2nd or 3rd month of gestation.

There are various types of spontaneous abortion, depending on the nature of the process (threatened, inevitable, incomplete, or complete). In a threatened abortion, the cervix does not dilate. With bed rest and conservative treatment, the abortion may be prevented. If not, an abortion is imminent. If only some of the tissue is passed, the abortion is referred to as incomplete. An emptying or evacuation procedure (D & C, or dilation and evacuation [D & E]) or administration of oral misoprostol (Cytotec) is usually required to remove the remaining tissue. If the fetus and all related tissue are spontaneously evacuated, the abortion is termed complete, and no further treatment is required.

### Habitual Abortion

Habitual or recurrent abortion is defined as successive, repeated, spontaneous abortions of unknown cause. As many as 60% of abortions may result from chromosomal anomalies. After two consecutive abortions, the patient is referred for genetic counseling and testing and other possible causes are explored.

If bleeding occurs in a pregnant woman with a past history of habitual abortion, conservative measures, such as bed rest and administration of progesterone to support the endometrium, are attempted to save the pregnancy. Supportive counseling is crucial in this stressful condition. Bed rest, sexual abstinence, a light diet, and no straining on defecation may be recommended in an effort to prevent spontaneous abortion. If infection is suspected, antibiotics may be prescribed.

In the condition known as incompetent or dysfunctional cervix, the cervix dilates painlessly in the second trimester of pregnancy, often resulting in a spontaneous abortion. In such cases, a surgical procedure called cervical cerclage may be used to prevent the cervix from dilating prematurely, although its effectiveness is unclear. It involves placing a purse-string suture around the cervix at the level of the internal os. Bed rest is usually advised to keep the weight of the uterus off the cervix. About 2 to 3 weeks before term or at the onset of labor, the suture is cut. Delivery is usually by cesarean section.

### Medical Management

After a spontaneous abortion, all tissue passed vaginally is saved for examination if possible. The patient and all personnel who care for her are alerted to save any discharged material. In the rare case of heavy bleeding, the patient may require blood component transfusions and fluid replacement. An estimate of the bleeding volume can be determined by recording the number of perineal pads and the degree of saturation over 24 hours. When an incomplete abortion occurs, oxytocin may be prescribed to cause uterine contractions before D & E or uterine suctioning.

### Nursing Management

Because patients experience loss and anxiety, emotional support and understanding are important aspects of nursing care. Women may be grieving or relieved, depending on their feelings about the pregnancy. Providing opportunities for the patient to talk and express her emotions is helpful and also provides clues for the nurse in planning more specific care.

## ELECTIVE ABORTION

A voluntary induced termination of pregnancy is called an elective abortion and is usually performed by skilled health care providers. In 1973, the U.S. Supreme Court in *Roe v. Wade* ruled that decisions about abortion reside with a woman and her physician in the first trimester. During the second trimester, the state may regulate practice in the interest of a woman's health, and during the final weeks of pregnancy may choose to protect the life of the fetus, except when necessary to preserve the life or health of the woman.

The U.S. rate of abortion is among the highest in the industrialized Western world. These numbers indicate the need for effective contraceptive education, information about emergency contraception, and counseling.

### Medical Management

Before the abortion procedure is performed (Chart 46-15), a nurse or counselor trained in pregnancy counseling should talk with the patient and explore her fears, feelings, and options. The nurse then identifies the patient's choice (ie, continuing pregnancy and parenthood; continuing pregnancy followed by adoption; or terminating pregnancy by abortion). If abortion is chosen, the patient has a pelvic examination to determine uterine size. A pelvic ultrasound may also be performed. Laboratory studies before an abortion must include a pregnancy test to confirm the pregnancy, hematocrit to rule out anemia, and Rh determination. Patients with anemia may need an iron supplement, and patients who are Rh-negative may require RhoGAM to prevent isoimmunization. Before the procedure, all patients should be screened for STDs to prevent introducing pathogens upward through the cervix during the procedure.

*NURSING ALERT*

**Women who have resorted to unskilled attempts to end a pregnancy are often critically ill because of infection, hemorrhage, or uterine rupture. If a woman has undergone such efforts to end a pregnancy, prompt medical attention, broad-spectrum antibiotics, and replacement of fluids and blood components may be required before careful attempts are made to evacuate the uterus.**

Surgical terminations include D & C or vacuum aspiration of uterine contents. Medications can also be used. Mifepristone (RU-486, Mifeprex) is used only in early pregnancy (up to 49 days from the last menstrual period). It works by blocking progesterone. Cramping and bleeding similar to a heavy menstrual period occur. After counseling and consent and often a sonogram to confirm the pregnancy, mifepristone is administered. This is followed by a dose of misoprostol orally or vaginally. If the pregnancy persists, a suction aspiration is performed. Contraindications include ectopic pregnancy, adrenal failure, allergy to the medications, bleeding disorder, irritable bowel syndrome, or uncontrolled seizure disorders. Several deaths from sepsis have occurred following medical abortion; researchers and the FDA

## Chart 46-15 • *Types of Elective Abortions*

**Vacuum Aspiration**

- The cervix is dilated manually with instrumentation or by laminaria (small suppositories made of seaweed that swells as it absorbs water).
- A uterine aspirator is introduced.
- Suction is applied, and tissue is removed from the uterus.

This is the most common type of termination procedure and is used early in pregnancy, up to 14 weeks. Laminaria may be used to soften and dilate the cervix prior to the procedure.

**Dilation and Evacuation**

Cervical dilation with laminaria followed by vacuum aspiration

**Labor Induction**

These procedures account for less than 1% of all terminations and generally take place in an inpatient setting.

1. Installation of saline or urea results in uterine contractions.
   - Although rare, serious complications can occur, including cardiovascular collapse, cerebral edema, pulmonary edema, renal failure, and disseminated intravascular coagulopathy (DIC).
2. Prostaglandins
   - Prostaglandins are introduced into the amniotic fluid or by vaginal suppository or intramuscular injection in later pregnancy.
   - Strong uterine contractions begin within 4 hours and usually result in abortion.
   - Gastrointestinal side effects (eg, nausea, vomiting, diarrhea, and abdominal cramping) and fever can occur.
3. Intravenous oxytocin
   Used for later abortions for genetic indications. Requires patient to go through labor.

**Medical Abortion**

**Mifepristone**

- Mifepristone (formerly known as RU-486) is a progesterone antagonist that prevents implantation of the ovum.
- Administered orally within 10 days of an expected menstrual period, mifepristone produces a medical abortion in most patients.
- Combined with a prostaglandin suppository, mifepristone causes abortion in up to 95% of patients.
- Prolonged bleeding may occur. Other side effects may include abdominal pain, nausea, vomiting, and diarrhea. This method may not be used in women with adrenal failure, asthma, long-term corticosteroid therapy, an IUD in place, porphyria, or a history of allergy to mifepristone or other prostaglandins. It is less effective when used in pregnancies more than 49 days from the beginning of the last menstrual period.

**Methotrexate**

- Methotrexate has also been used to terminate pregnancy because it is a teratogen that is lethal to the fetus. It has been found to have minimal risk and few side effects in the woman. Its low cost may provide an alternative for some women.

**Misoprostol**

- Misoprostol is a synthetic prostaglandin analog that produces cervical effacement and uterine contractions.
- Inserted vaginally, misoprostol is effective in terminating a pregnancy in about 75% of cases.
- When combined with methotrexate or mifepristone, misoprostol's effectiveness rate is high.

are closely monitoring the morbidity and mortality associated with medical abortion. Currently, there is no evidence that a previous medical or surgical abortion increases the risk of adverse future pregnancy outcomes (Virk, Zhang & Olsen, 2007).

## Nursing Management

Patient teaching is an important aspect of care for women who elect to terminate a pregnancy. A patient undergoing elective abortion is informed about what the procedure entails and the expected course after the procedure. The patient is scheduled for a follow-up appointment 2 weeks after the procedure and is instructed about signs and symptoms (ie, fever, heavy bleeding, or pain) that should be reported.

Available contraceptive methods are reviewed with the patient at this time. Effectiveness depends on the method used and the extent to which the woman and her partner follow the instructions for use. A woman who has used any method of birth control should be assessed for her understanding of the method and its potential side effects as well as her satisfaction with the method. If the woman has not been using contraception, the nurse explains all methods and their benefits and risks and helps the patient make a contraceptive choice for use after abortion. Related teaching issues, such as the need to use barrier contraceptive devices (ie, condoms) for protection against transmission of STDs and HIV infection and the availability of emergency contraception, are becoming increasingly important.

Psychological support is another important aspect of nursing care. The nurse needs to be aware that women terminate pregnancies for many reasons. Some women terminate pregnancies because of severe genetic defects. Women who have been raped or impregnated in incestuous relationships or by an abusive partner may elect to terminate their pregnancies. The care of a woman undergoing termination of pregnancy is stressful, and assistance needs to be provided in a safe and nonjudgmental way. Nurses have the right to refuse to participate in a procedure that is against their religious beliefs but are professionally obligated not to impose their beliefs or judgments on their patients.

# *Infertility*

Infertility is defined as a couple's inability to achieve pregnancy after 1 year of unprotected intercourse. Primary infertility refers to a couple who has never had a child. Secondary infertility means that at least one conception has occurred, but currently the couple cannot achieve a pregnancy. In the United States, infertility affects 6 million couples. It is often

a complex physical problem, and its causes are usually related to azoospermia, anovulation, or tubal obstruction.

## Pathophysiology

### *Ovarian and Ovulation Factors*

Diagnostic studies performed to determine if ovulation is regular and whether the progestational endometrium is adequate for implantation may include a serum progesterone level and an ovulation index. The ovulation index involves a urine-stick test to determine whether the surge in LH that precedes follicular rupture has occurred. Ovulatory dysfunction is complex, but many women with ovulation disorders have polycystic ovary syndrome, described in Chapter 47, and may be treated with clomiphene (Clomid) to induce ovulation or insulin sensitizing agents. Once insulin levels are normalized, ovulation often occurs. Some women have high prolactin levels, which inhibit ovulation, and they are treated with dopaminergic drugs after a pituitary adenoma is ruled out by MRI. If a woman has premature ovarian failure, oocyte donation may be considered.

### *Tubal and Uterine Factors*

HSG is used to rule out uterine or tubal abnormalities. A contrast agent injected into the uterus through the cervix produces an outline of the shape of the uterine cavity and the patency of the tubes. This process sometimes removes mucus or tissue that is lodged in the tubes. Laparoscopy permits direct visualization of the tubes and other pelvic structures and can assist in identifying conditions that may interfere with fertility (eg, endometriosis).

Fibroids, polyps, and congenital malformations are possible causative factors affecting the uterus. Their presence may be determined by pelvic examination, hysteroscopy, saline sonogram (a variation of a sonogram), and HSG. Endometriosis, even if mild, is associated with reduced fertility.

### *Male Factors*

An analysis of semen provides information about the number of sperm (density), percentage of moving forms, quality of forward movement (forward progression), and morphology (shape and form). From 2 to 6 mL of watery alkaline semen is normal. A normal count has 60 to 100 million sperm/mL. However, the incidence of impregnation is lessened only when the count decreases to less than 20 million sperm/mL.

Men may also be affected by varicoceles, varicose veins around the testicle, which decrease semen quality by increasing testicular temperature. Retrograde ejaculation or ejaculation into the bladder is assessed by urinalysis after ejaculation. Blood tests for male partners may include measuring testosterone; FSH and LH (both of which are involved in maintaining testicular function); and prolactin levels.

## Medical Management

The treatment of infertility is complex and often requires advanced technology. The specific type of treatment depends on the cause of the problem, if it can be identified. Many infertile couples have normal test results for ovulation, sperm production, and fallopian tube patency.

### *Pharmacologic Therapy*

Pharmacologically induced ovulation is undertaken when women do not ovulate on their own or ovulate irregularly. Women older than 37 years are less likely to be fertile. These couples are often treated with clomiphene to stimulate ovulation. Gonadotropin treatment may also be used if conception does not occur. Various other medications are used, depending on the primary cause of infertility (Chart 46-16).

**CHART 46-16** PHARMACOLOGY
### *Medications That Induce Ovulation*

- Clomiphene citrate (Clomid, Serophene) is an estrogen antagonist that increases gonadotropin release, resulting in follicular rupture or ovulation. Clomiphene is used when the hypothalamus is not stimulating the pituitary gland to release follicle-stimulating hormone (FSH) and luteinizing hormone (LH). This medication stimulates follicles in the ovary. It is usually taken for 5 days beginning on the 5th day of the menstrual cycle. Ovulation should occur 4 to 8 days after the last dose. Patients receive instructions about timing intercourse to facilitate fertilization.
- Menotropins (Repronex, Pergonal), a combination of FSH and LH, may be used to stimulate the ovaries to produce eggs. These agents are used for women with deficiencies in FSH and LH. When followed by administration of human chorionic gonadotropin, menotropins stimulates the ovaries, so monitoring by ultrasound and hormone levels is essential because overstimulation may occur.
- Follitropin-alpha (Gonal-F), follitropin-beta (Follistim), and urofollitropin (Bravelle) may be used to treat ovulation disorders or to stimulate a follicle and egg production for intrauterine insemination or in vitro fertilization or other assisted reproductive technologies.
- Gonadotropin-releasing hormone agonists (leuprolide [Lupron, Synarel]) suppress FSH, prevent premature egg release, and shrink fibroids.
- Bromocriptine (Parlodel) may be used in treatment of infertility due to elevated prolactin levels.
- Progesterone (Prometrium Crinone, progesterone in oil) vaginal suppositories help improve the uterine lining after ovulation.
- Urofollitropin (Metrodin, Bravelle), which contains FSH with a small amount of LH, is used in some disorders (eg, polycystic ovarian syndrome) to stimulate follicle growth. Clomiphene is then used to stimulate ovulation.
- Chorionic gonadotropin (Ovidrel, Novarel, Pregnyl), which mimics LH, releases an egg after hyperstimulation and supports the corpus luteum.
- Metformin (Glucophage, Fortamet) may be used in polycystic ovarian syndrome to induce regular ovulation.
- Aspirin and heparin may be used to prevent recurrent pregnancy loss in patients with elevated antiphospholipid antibodies.

Blood tests and ultrasounds are used to monitor ovulation. Multiple pregnancies (ie, twins, triplets or more) may occur with use of these medications. Ovarian hyperstimulation syndrome (OHSS) may also occur. This condition is characterized by enlarged multicystic ovaries and is complicated by a shift of fluid from the intravascular space into the abdominal cavity. The fluid shift can result in ascites, pleural effusion, and edema; hypovolemia may also occur. Risk factors include younger age, history of polycystic ovarian syndrome, high serum estradiol levels, a larger number of follicles, and pregnancy.

### Artificial Insemination

Artificial insemination is the deposit of semen into the female genital tract by artificial means. If the sperm cannot penetrate the cervical canal normally, artificial insemination using a partner's or husband's semen or that of a donor may be considered. When the sperm of the woman's partner is defective or absent (azoospermia) or when there is a risk of transmitting a genetic disease, donor sperm may be used. Safeguards are put in place to address legal, ethical, emotional, and religious issues. Written consent is obtained to protect all parties involved, including the woman, the donor, and the resulting child. The donor's semen is frozen, and the donor is evaluated to ensure that he is free of genetic disorders and STDs, including HIV infection.

Certain conditions must be met before semen is transferred to the vagina or uterus. The woman must have no abnormalities of the genital system, the fallopian tubes must be patent, and ova must be available. In the male, sperm need to be normal in shape, amount, motility, and endurance. The time of ovulation should be determined as accurately as possible so that the 2 or 3 days during which fertilization is possible each month can be targeted for treatment.

Ultrasonography and blood studies of varying hormone levels are used to pinpoint the best time for insemination and to monitor for OHSS. Fertilization seldom occurs from a single insemination. Usually, insemination is attempted between days 10 and 17 of the cycle; three different attempts may be made during one cycle. The woman may have received clomiphene or other medications to stimulate ovulation before insemination. The recipient is placed in the lithotomy position on the examination table, a speculum is inserted, and the vagina and cervix are swabbed with a cotton-tipped applicator to remove any excess secretions. The sperm are washed before insertion to remove biochemicals and to select the most active sperm. Semen is drawn into a sterile syringe, and a cannula is attached. The semen is then directed to the external os. In IUI, semen is placed into the uterine cavity.

### In Vitro Fertilization

In vitro fertilization (IVF) involves ovarian stimulation, egg retrieval, fertilization, and embryo transfer. This procedure is accomplished by first stimulating the ovary to produce multiple eggs or ova, usually with medications, because success rates are greater with more than one embryo. Many different protocols exist for inducing ovulation with one or more agents. Patients are carefully selected and evaluated, and cycles are carefully monitored using ultrasound and monitoring hormone levels. At the appropriate time, the ova are recovered by transvaginal ultrasound retrieval. Sperm and eggs are coincubated for up to 36 hours, and the embryos are transferred about 48 hours after retrieval. Implantation should occur in 3 to 5 days.

Gamete intrafallopian transfer (GIFT), a variation of IVF, is the treatment of choice for patients with ovarian failure. GIFT is considered in unexplained infertility and when there is religion-based discomfort with IVF. The most common indications for IVF and GIFT are irreparable tubal damage, endometriosis, unexplained infertility, inadequate sperm, and exposure to DES. Success rates for GIFT vary from 20% to 30%.

### Other Assisted Reproductive Technologies

In intracytoplasmic sperm injection (ICSI), an ovum is retrieved as described previously, and a single sperm is injected through the zona pellucida, through the egg membrane, and into the cytoplasm of the oocyte. The fertilized egg is then transferred back to the donor. ICSI is the treatment of choice in severe male factor infertility.

Women who cannot produce their own eggs (ie, premature ovarian failure) have the option of using the eggs of a donor after stimulation of the donor's ovaries. The recipient also receives hormones in preparation for these procedures. Couples may also choose this modality if the female partner has a genetic disorder that may be passed on to children.

## Nursing Management

Nursing interventions that are appropriate when working with couples during infertility evaluations include assisting in reducing stress in the relationship, encouraging cooperation, protecting privacy, fostering understanding, and referring the couple to appropriate resources when necessary. Because infertility evaluations and treatments are expensive, time-consuming, invasive, stressful, and not always successful, couples need support in working together to deal with this process.

Resolve, Inc., a nonprofit self-help group that provides information and support for infertile patients, was founded by a nurse who experienced difficulty conceiving. The literature on infertility that is produced by this group is an important resource for patients and professionals. Most areas of the country have local support groups. More information can be obtained by visiting the Resolve Web site or contacting Resolve, Inc.

Smoking is strongly discouraged because it has an adverse effect on the success of assisted reproduction. Diet, exercise, stress reduction techniques, folic acid supplementation, health maintenance, and disease prevention are emphasized in many infertility programs. Couples may also consider adoption, child-free living, and gestational carriers (use of surrogate to carry the fetus for the infertile couple). Nurses can be helpful listeners and information resources in these deliberations.

# Preconception/Periconception Health Care

Nurses can be instrumental in encouraging all women of childbearing age, including those with chronic illness or disabilities, to consider issues that may affect health during pregnancy (Smeltzer, 2007; Smeltzer & Wetzel-Effinger,

2009). Women who plan their pregnancies and are healthy and well informed tend to have better outcomes. This is an important issue because half of all pregnancies in the United States are unplanned.

Nurses can make a difference through education and counseling; preconception counseling can decrease the incidence of birth defects. Women who smoke should be encouraged to stop smoking, and it may help to offer smoking cessation classes. Women should take folic acid supplements to prevent neural tube defects. Women with diabetes should have good glycemic control prior to conception. It is necessary to assess rubella immunity and other immunizations as well as a family history of genetic defects; genetic counseling may be appropriate. Women taking teratogenic medications and women concerned about genetic disorders should be encouraged to discuss effective contraception and childbearing plans with their health care provider (see Chart 46-2).

## Ectopic Pregnancy

The incidence of ectopic pregnancy and the risk of death due to ectopic pregnancy are decreasing. However, ectopic pregnancy remains the leading cause of pregnancy-related death in the first trimester. Ectopic pregnancy occurs when a fertilized ovum (a blastocyst) becomes implanted on any tissue other than the uterine lining (eg, the fallopian tube, ovary, abdomen, cervix or scar tissue from previous caesarean section). The most common site of ectopic implantation is the fallopian tube (Fig. 46-8).

Possible causes of ectopic pregnancy include salpingitis, peritubal adhesions (after pelvic infection, endometriosis, appendicitis), structural abnormalities of the fallopian tube (rare and usually related to DES exposure), previous ectopic pregnancy, previous tubal surgery, multiple previous induced abortions (particularly if followed by infection), tumors that distort the tube, and IUD and progestin-only contraceptives. PID appears to be the major risk factor. Improved antibiotic therapy for PID usually prevents total tubal closure but may leave a stricture or narrowing, predisposing to ectopic implantation. The odds of recurrent ectopic pregnancy are three times higher if an infectious pathology caused the first ectopic pregnancy. After a second ectopic pregnancy occurs, assisted reproduction is considered.

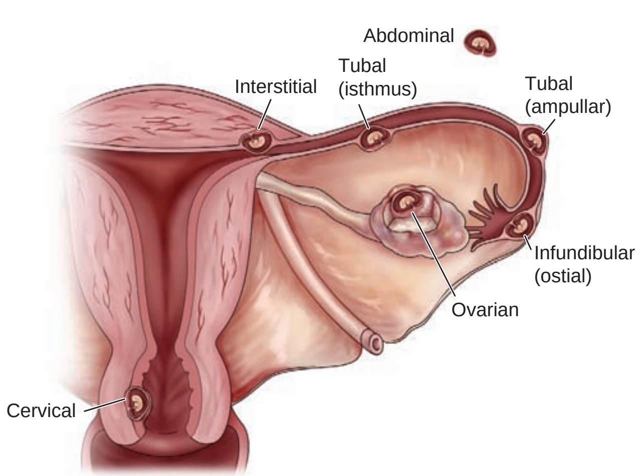



**Figure 46-8** Sites of ectopic pregnancy.

Risk factors are important, but all women need to be educated about early treatment and have a high index of suspicion in the case of a period that does not seem normal, the presence of pain, or pain with a suspected pregnancy. Women may have fatal hemorrhage with ruptured ectopic pregnancies if they delay seeking attention or if their health care providers are not alert to the possibility of this diagnosis.

### Clinical Manifestations

Signs and symptoms vary depending on whether tubal rupture has occurred. Delay in menstruation from 1 to 2 weeks followed by slight bleeding (spotting) or a report of a slightly abnormal period suggests the possibility of an ectopic pregnancy. Symptoms may begin late, with vague soreness on the affected side (probably due to uterine contractions and distention of the tube), and may proceed to sharp, colicky pain. Most patients experience some pelvic or abdominal pain and some spotting or bleeding. Gastrointestinal symptoms, dizziness, or lightheadedness may occur. Patients may think the abnormal bleeding is a menstrual period, especially if a recent period occurred and was normal.

If implantation occurs in the fallopian tube, the tube becomes more and more distended and can rupture if the ectopic pregnancy remains undetected for 4 to 6 weeks or longer after conception. When the tube ruptures, the ovum is discharged into the abdominal cavity, and the woman experiences agonizing pain, dizziness, faintness, and nausea and vomiting due to the peritoneal reaction to blood escaping from the tube. Air hunger and symptoms of shock may occur, and the signs of hemorrhage—rapid and thready pulse, decreased blood pressure, subnormal temperature, restlessness, pallor, and sweating—are evident. Later, the pain becomes generalized in the abdomen and radiates to the shoulder and neck because of accumulating intraperitoneal blood that irritates the diaphragm.

### Assessment and Diagnostic Findings

Ectopic pregnancies must be diagnosed promptly to prevent life-threatening hemorrhage, the major complication of rupture. During vaginal examination, a large mass of clotted blood that has collected in the pelvis behind the uterus or a tender adnexal mass may be palpable, although there are often no abnormal findings. If an ectopic pregnancy is suspected, the patient is evaluated by sonography and human chorionic gonadotropin (hCG) levels. If the ultrasound results are inconclusive, the hCG test is repeated. The levels of hCG (the diagnostic hormone of pregnancy) double in early normal pregnancies every 3 days but are reduced in abnormal or ectopic pregnancies. A less-than-normal increase is cause for suspicion. Serum progesterone levels are also measured. Levels less than 5 ng/mL are considered abnormal; levels greater than 25 ng/mL are associated with a normally developing pregnancy.

Ultrasound, the usual method of diagnosis, can detect a pregnancy between 5 and 6 weeks from the time of the last menstrual period. Detectable fetal heart movement outside

the uterus on ultrasound is firm evidence of an ectopic pregnancy. On occasion, an ultrasound study is not definitive and the diagnosis must be made with combined diagnostic aids (beta-hCG and progesterone levels, ultrasound, pelvic examination, and clinical judgment).

Occasionally, the clinical picture makes the diagnosis relatively easy. However, when the clinical signs and symptoms are inconclusive, which is often the case, other procedures may be needed. Laparoscopy can be used because the physician can visually detect an unruptured tubal pregnancy and thereby circumvent the risk of its rupture.

## Medical Management

### Surgical Management

When surgery is performed early, almost all patients recover rapidly; if tubal rupture occurs, mortality increases. The type of surgery is determined by the size and extent of local tubal damage. Conservative surgery includes "milking" an ectopic pregnancy from the tube. Resection of the involved fallopian tube with end-to-end anastomosis may be effective. Some surgeons attempt to salvage the tube with a salpingotomy, which involves opening and evacuating the tube and controlling bleeding. More extensive surgery includes removing the tube alone (salpingectomy) or with the ovary (salpingo-oophorectomy). Depending on the amount of blood lost, blood component therapy and treatment of hemorrhagic shock may be necessary before and during surgery. Surgery may also be indicated in women unlikely to comply with close monitoring or those who live too far away from a health care facility to obtain the monitoring needed with nonsurgical management.

Methotrexate (Trexall), a chemotherapeutic agent and folic acid antagonist, may be used after surgery to treat any remaining embryonic or early pregnancy tissue, as indicated by a persistent or increasing beta-hCG level. The beta-hCG test is repeated 2 weeks after surgery to ensure that the level is decreasing.

### Pharmacologic Therapy

Another option is the use of methotrexate without surgery. Because methotrexate stops the pregnancy from progressing by interfering with DNA synthesis and the multiplication of cells, it interrupts early, small, unruptured ectopic pregnancies. The patient must be hemodynamically stable, have no active renal or hepatic disease, have no evidence of thrombocytopenia or leukopenia, and have a very small, unruptured ectopic pregnancy on ultrasound. Other indications may include no fetal cardiac activity, no active bleeding, and a beta-hCG level of less than 2000 mIU/mL. The medication is administered intramuscularly or orally. Some patients may be treated with intratubal injection of methotrexate. Complete blood count and tests of liver and renal function are conducted to monitor the patient; blood typing is performed in anticipation of the need for transfusions.

Until the pregnancy is resolved, the patient is advised to refrain from alcohol, intercourse, and vitamins containing folic acid, because these may exacerbate the adverse effects of methotrexate. Abdominal pain may occur within 5 to 10 days and may indicate termination of the pregnancy. This requires careful assessment by the health care provider. Serum levels of beta-hCG are monitored carefully, and these levels should gradually decrease. Ultrasound may also be used for monitoring. Side effects of methotrexate include abdominal cramping, mucositis, and renal and hepatic damage. Allergic reactions have occurred in patients receiving high doses.

# NURSING PROCESS

## The Patient With an Ectopic Pregnancy

### Assessment

The health history includes the menstrual pattern and any (even slight) bleeding since the last menstrual period. The nurse elicits the patient's description of pain and its location. The nurse asks the patient whether any sharp, colicky pains have occurred. Then the nurse notes whether pain radiates to the shoulder and neck (possibly caused by rupture and pressure on the diaphragm).

In addition, the nurse monitors vital signs, level of consciousness, and the nature and amount of vaginal bleeding. If possible, the nurse assesses how the patient is coping with the abnormal pregnancy and likely loss.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include the following:

- Acute pain related to the progression of the tubal pregnancy
- Anticipatory grieving related to the loss of pregnancy and effect on future pregnancies
- Deficient knowledge related to the treatment and effect on future pregnancies

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, major complications may include the following:

- Hemorrhage
- Hemorrhagic shock

### Planning and Goals

The major goals may include relief of pain; acceptance and resolution of grief and pregnancy loss; increased knowledge about ectopic pregnancy, its treatment, and its outcome; and absence of complications.

### Nursing Interventions

#### *Relieving Pain*

The abdominal pain associated with ectopic pregnancy may be described as cramping or severe continuous pain. If the patient is to have surgery, preanesthetic medications may provide pain relief. Postoperatively, analgesic agents are administered liberally; this promotes early ambulation and enables the patient to cough and take deep breaths.

#### *Supporting the Grieving Process*

Patients' distress levels vary. If the pregnancy was desired, loss may or may not be expressed verbally by the patient and her partner. The impact may not be fully realized until much later. The nurse should be available to listen and provide support. The patient's partner, if appropriate, should participate in this process. Even if the pregnancy was unplanned, a loss has been experienced, and a grief reaction may occur.

#### *Monitoring and Managing Potential Complications*

Potential complications of ectopic pregnancy are hemorrhage and shock. Careful assessment is essential to detect the development of these complications. Continuous monitoring of vital signs, level of consciousness, amount of bleeding, and intake and output provides information about the possibility of hemorrhage and the need to prepare for intravenous (IV) therapy. Bed rest is indicated. Hematocrit, hemoglobin, and blood gases are monitored to assess hematologic status and adequacy of tissue perfusion. Significant deviations in these laboratory values are reported immediately, and the patient is prepared for possible surgery. Blood component therapy may be required if blood loss has been rapid and extensive. If hypovolemic shock occurs, the treatment is directed toward reestablishing tissue perfusion and adequate blood volume. See Chapter 15 for a discussion of the IV fluids and medications used in treating shock.

The nurse has an important role in prevention by being alert to patients with abnormal bleeding who may be at risk for an ectopic pregnancy and referring them immediately for care. It is necessary to keep a high index of suspicion in daily practice when a woman of childbearing age, particularly one who is not using an effective method of contraception consistently, reports abdominal discomfort or abnormal bleeding.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** If the patient has experienced life-threatening hemorrhage and shock, these complications are addressed and treated before any in-depth teaching can begin. At this time, the patient's and the nurse's attention is focused on the crisis, not on learning. At a later time, the patient begins to ask questions about what happened and why certain procedures were performed. Procedures are explained in terms that the distressed and apprehensive patient can understand. The patient's partner is included in teaching and explanations when possible. After the patient recovers from postoperative discomfort, it may be more appropriate to address any questions and concerns that she and her partner have, including the effect of this pregnancy or its treatment on future pregnancies. The patient should be advised that ectopic pregnancies may recur. The patient is informed about possible complications and instructed to report early signs and symptoms. It is important to review signs and symptoms with the patient and instruct her to report an abnormal menstrual period promptly.

**CONTINUING CARE.** Because of the risk of subsequent ectopic pregnancies, the patient is advised to seek preconception counseling before considering future pregnancies and to seek early prenatal care. Follow-up contact allows the nurse to answer questions and clarify information for the patient and her partner.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences relief of pain
   a. Reports a decrease in pain and discomfort
   b. Ambulates as prescribed; performs coughing and deep breathing
2. Begins to accept loss of pregnancy and expresses grief by verbalizing feelings and reactions to loss
3. Verbalizes an understanding of the causes of ectopic pregnancy
4. Experiences no complications
   a. Exhibits no signs of bleeding, hemorrhage, or shock
   b. Has decreased amounts of discharge (on perineal pad)
   c. Has normal skin color and turgor
   d. Exhibits stable vital signs and adequate urine output
   e. Levels of beta-hCG return to normal

## CRITICAL THINKING EXERCISES

EBP **1** A 50-year-old woman has been experiencing severe hot flashes and resultant insomnia. She is considering beginning hormone therapy (HT) but is concerned about its risks. What information would you give to her? What is the evidence base for that information? What criteria would you use to assess the strength of the evidence? What resources would you recommend to her?

**2** A 19-year-old female college student comes to the student health clinic for a gynecologic examination because she anticipates having sex with her new girlfriend. She asks you for advice about avoiding sexually transmitted diseases. What advice would you give her? How would you modify your teaching if she informed you that her new partner has other partners? What other teaching would you provide?

EBP **3** You are working in a women's health practice and are responsible for educating women about menopause and health promotion. Your 48-year-old patient has mild diabetes, and she is obese and has hypertension. She takes oral antidiabetic and antihypertensive medications. She reports that she has a strong family history of heart disease. She is concerned about menopause because her mother and sisters experienced "difficult" menopause. She indicates that she has little time for exercise and eats mostly fast food because of her high-pressure job. What health promotion strategies would you suggest to assist the patient in improving her health status as she approaches menopause? What is the evidence base for those strategies? How would you use that evidence to develop a teaching plan for her?

**4** At a health clinic, you meet a 45-year-old woman with postpolio syndrome who uses a battery-powered scooter most of the time because of increasing muscle weakness. She is approaching menopause and is concerned about how her physical limitations secondary to postpolio syndrome might affect her health related to menopause. Describe what health promotion issues would be relevant and the actions, including patient teaching, that are warranted.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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***Double asterisk indicates classic reference.*

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## RESOURCES

American College of Obstetricians and Gynecologists (ACOG), www.acog.org
American Society for Reproductive Medicine (ASRM), www.asrm.org
Amnesty International (resource for activists to end female genital mutilation), www.amnesty.org
Association of Reproductive Health Professionals, www.arhp.org
Association of Women's Health, Obstetrical and Neonatal Nurses (AWHONN), www.awhonn.org
DES Action USA, www.desaction.org
Emergency Contraception, opr.princeton.edu/ec
Family Violence Prevention Fund, www.endabuse.org
Female Genital Mutilation Education and Networking Project (provides fact sheets, state policies, periodicals), www.fgmnetwork.org
Guttmacher Institute, www.guttmacher.org
Health Promotion for Women with Disabilities Project, Villanova University College of Nursing, www.nurseweb.villanova.edu/womenwithdisabilities
National Association of Nurse Practitioners in Women's Health (NPWH), www.npwh.org
National Coalition Against Domestic Violence, www.ncadv.org
North American Menopause Society, www.menopause.org
Planned Parenthood Federation of America, www.plannedparenthood.org
Resolve National Headquarters, www.resolve.org
Sexuality Information and Education Council of the United States, www.siecus.org

chapter 47



# Management of Patients With Female Reproductive Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare the various types of vaginal infections and the signs, symptoms, and treatments of each.
2. Develop a teaching plan for the patient with a vaginal infection.
3. Use the nursing process as a framework for care of the patient with a vulvovaginal infection.
4. Use the nursing process as a framework for care of the patient with genital herpes.
5. Discuss the signs and symptoms, management, and nursing care implications of malignant disorders of the female reproductive tract.
6. Use the nursing process as a framework for care of the patient undergoing a hysterectomy.
7. Describe indications for a wide excision of the vulva, or vulvectomy, and the preoperative and postoperative nursing interventions.
8. Compare nursing interventions indicated for the patient undergoing radiation therapy and chemotherapy for cancer of the female reproductive tract.

## GLOSSARY

**abscess:** a collection of purulent material
**acquired immunodeficiency syndrome (AIDS):** a disease transmitted by body fluids that results in impaired immune response
**Bartholin's cyst:** a cyst in a paired vestibular gland in the vulva
**brachytherapy:** radiation delivered by an internal device placed close to the tumor
**candidiasis:** infection caused by *Candida* species or yeast; also referred to as monilial vaginitis or yeast infection
**colporrhaphy:** repair of the vagina
**condylomata:** warty growths indicative of the human papillomavirus (HPV)
**conization:** procedure in which a cone-shaped piece of cervical tissue is removed as a result of detection of abnormal cells; also called cone biopsy
**cryotherapy:** destruction of tissue by freezing (eg, with liquid nitrogen)
**cystocele:** bulging of the bladder downward into the vagina
**douche:** rinsing the vaginal canal with fluid
**dysplasia:** term related to abnormal cell changes found on Pap smear and cervical biopsy reports
**endocervicitis:** inflammation of the mucosa and the glands of the cervix

## GLOSSARY *(Continued)*

**endometriosis:** endometrial tissue in abnormal locations; causes pain with menstruation, scarring, and possible infertility
**enterocele:** is a protrusion of the intestinal wall into the vagina
**fibroid tumor:** usually benign tumor of the uterus that may cause irregular bleeding; also called myoma or leiomyoma
**fistula:** abnormal opening between two organs or sites (eg, vesicovaginal, between bladder and vagina; rectovaginal, between rectum and vagina)
**hyphae:** microscopic findings that indicate monilia
**hysterectomy:** surgical removal of the uterus
**lactobacilli:** vaginal bacteria that limit the growth of other bacteria by producing hydrogen peroxide
**laparoscope:** surgical device inserted through a periumbilical incision to facilitate visualization and surgical procedures
**lichen sclerosus:** benign disorder of the vulva that usually occurs when estrogen levels are low; characterized by itching
**liposomal therapy:** chemotherapy delivered in a liposome, a nontoxic drug carrier
**loop electrocautery excision procedure (LEEP):** procedure in which laser energy is used to remove a portion of cervical tissue after abnormal biopsy findings
**mucopurulent cervicitis:** inflammation of the cervix with exudate; almost always related to a chlamydial infection
**myomectomy:** removal of uterine fibroids though an abdominal incision
**oophorectomy:** surgical removal of an ovary
**pelvic exenteration:** major surgical procedure in which the pelvic organs are removed
**pelvic inflammatory disease (PID):** infection of uterus and fallopian tubes, usually from a sexually transmitted disease
**perineorrhaphy:** surgical repair of perineal lacerations
**polycystic ovary syndrome (PCOS):** disorder in the hypothalamic–pituitary and ovarian network, resulting in chronic anovulation, androgen excess, and polycystic ovaries
**rectocele:** bulging of the rectum into the vagina
**salpingitis:** inflammation of the fallopian tube
**salpingo-oophorectomy:** removal of the ovary and its fallopian tube (removal of the fallopian tube alone is a salpingectomy)
**vaginal vault:** term used to describe the vagina following a hysterectomy, which involves removal of the uterus including the cervix
**vaginitis:** inflammation of the vagina, usually secondary to infection
**vestibulitis:** inflammation of the vulvar vestibule, or tissue around the opening of the vagina, that often causes pain with intercourse (dyspareunia)
**vestibulodynia:** most common type of vulvodynia, characterized by sharp pain in response to pressure applied to the vestibular area of the vulva.
**vulvar dystrophy:** thickening or lesions of the vulva; usually causes itching and may require biopsy to exclude malignancy
**vulvectomy:** removal of the tissue of the vulva
**vulvitis:** inflammation of the vulva, usually secondary to infection or irritation
**vulvodynia:** painful condition that affects the vulva

Disorders of the female reproductive system can be minor or serious but are usually anxiety producing and often distressing. Some disorders are self-limited and cause only minor inconvenience to the woman; others are life-threatening and require immediate attention and long-term therapy. Many disorders are managed by the patient at home, whereas others require hospitalization and surgical intervention. All disorders require that nurses have knowledge, understanding, and skill in patient teaching. Nurses must also be sensitive to the woman's concerns and possible discomfort in discussing and dealing with these disorders.

## VULVOVAGINAL INFECTIONS

Vulvovaginal infections are common, and nurses have an important role in providing information that may prevent their occurrence. To help prevent these infections, women need to understand their own anatomy and vulvovaginal health.

The vagina is protected against infection by its normally low pH (3.5 to 4.5), which is maintained in part by the actions of *Lactobacillus acidophilus*, the dominant bacteria in a healthy vaginal ecosystem. These bacteria suppress the growth of anaerobes and produce lactic acid, which maintains normal pH. They also produce hydrogen peroxide, which is toxic to anaerobes. The risk of infection increases if a woman's resistance is reduced by stress or illness, if the pH is altered, or if a pathogen is introduced. Continued research into causes and treatments is needed, along with better ways to encourage growth of **lactobacilli.**

The epithelium of the vagina is highly responsive to estrogen, which induces glycogen formation. The subsequent breakdown of glycogen into lactic acid assists in producing a low vaginal pH. When estrogen decreases during lactation and menopause, glycogen also decreases. With reduced glycogen formation, infections may occur. In addition, as estrogen production ceases during the perimenopausal and postmenopausal periods, the vagina and labia may atrophy (thin), making the vaginal area more susceptible to infection. When patients are treated with antibiotics, the normal vaginal flora are reduced. This results in altered pH and growth of fungal organisms. Other factors that may initiate or predispose to infections include contact with an infected partner and wearing tight, nonabsorbent, and heat-retaining and moisture-retaining clothing (Chart 47-1).

**Vaginitis** (inflammation of the vagina) is a group of conditions that cause vulvovaginal symptoms such as itching, irritation, burning, and abnormal discharge. Bacterial vaginosis is the most common cause (22% to 50% of symptomatic women), followed by vulvovaginal candidiasis (17% to 39%) and trichomoniasis (4% to 35%) (American College of Obstetricians and Gynecologists [ACOG], 2006a). (Table 47-1). Other types include desquamative vaginitis, atrophic vaginitis, various vulvar dermatologic conditions, and vulvodynia. The normal vaginal discharge, which may occur in slight amounts during ovulation or just before the onset of menstruation, becomes more profuse when vaginitis occurs. Urethritis may accompany vaginitis because of the proximity of the urethra to the vagina. Discharge that occurs with vaginitis may produce itching, odor, redness, burning, or edema, which may be aggravated by voiding and defecation. After the causative organism has been identified, appropriate treatment (discussed later) is prescribed. This may include an oral medication or a local medication that is inserted into the vagina using an applicator.

**CHART 47-1 Risk Factors for Vulvovaginal Infections**

- Premenarche
- Pregnancy
- Perimenopause/Menopause
- Poor personal hygiene
- Tight undergarments
- Synthetic clothing
- Frequent douching
- Allergies
- Use of oral contraceptives
- Use of broad-spectrum antibiotics
- Diabetes mellitus
- Low estrogen levels
- Intercourse with infected partner
- Oral–genital contact (yeast can inhabit the mouth and intestinal tract)
- HIV infection

### Candidiasis

Vulvovaginal **candidiasis** is a fungal or yeast infection caused by strains of Candida (see Table 47-1). *Candida albicans* accounts for most cases, but other strains, such as *Candida glabrata*, may also be implicated. Many women with a healthy vaginal ecosystem harbor Candida but are asymptomatic. Certain conditions favor the change from an asymptomatic state to colonization with symptoms. For example, use of antibiotics decreases bacteria, thereby altering the natural protective organisms usually present in the vagina. Although infections can occur at any time, they occur more commonly in pregnancy or with a systemic condition such as diabetes mellitus or human immunodeficiency virus (HIV) infection, or when patients are taking medications such as corticosteroids or oral contraceptives.

#### Clinical Manifestations

Clinical manifestations include a vaginal discharge that causes pruritus (itching) and subsequent irritation. The discharge may be watery or thick but has a white, cottage cheese–like appearance. Symptoms are usually more severe just before menstruation and may be less responsive to treatment during pregnancy. Diagnosis is made by microscopic identification of spores and **hyphae** on a glass slide prepared from a discharge specimen mixed with potassium hydroxide. With candidiasis, the pH is 4.5 or less.

#### Medical Management

The goal of management is to eliminate symptoms. Treatments include antifungal agents such as miconazole (Monistat), nystatin (Mycostatin), clotrimazole (Gyne-Lotrimin), and terconazole (Terazol) cream. These agents are inserted into the vagina with an applicator at bedtime. There are

**Table 47-1 VAGINAL INFECTIONS AND VAGINITIS**

| Infection | Cause | Clinical Manifestations | Management Strategies |
|---|---|---|---|
| Candidiasis | *Candida albicans, glabrata,* or *tropicalis* | Inflammation of vaginal epithelium, producing itching, reddish irritation<br>White, cheeselike discharge clinging to epithelium | Eradicate the fungus by administering an antifungal agent. Frequently used brand names of vaginal creams and suppositories are Monistat, Femstat, Terazol, and Gyne-Lotrimin.<br>Review other causative factors (eg, antibiotic therapy, nylon underwear, tight clothing, pregnancy, oral contraceptives).<br>Assess for diabetes and HIV infection in patients with recurrent monilia. |
| *Gardnerella*-associated bacterial vaginosis | *Gardnerella vaginalis* and vaginal anaerobes | Usually no edema or erythema of vulva or vagina<br>Gray-white to yellow-white discharge clinging to external vulva and vaginal walls | Administer metronidazole (Flagyl), with instructions about avoiding alcohol while taking this medication.<br>If infection is recurrent may treat partner. |
| *Trichomonas vaginalis* vaginitis (STD) | *Trichomonas vaginalis* | Inflammation of vaginal epithelium, producing burning and itching<br>Frothy yellow-white or yellow-green vaginal discharge | Relieve inflammation, restore acidity, and reestablish normal bacterial flora; provide oral metronidazole for patient and partner. |
| Bartholinitis (infection of greater vestibular gland) | *Escherichia coli*<br>*Trichomonas vaginalis*<br>Staphylococcus<br>Streptococcus<br>Gonococcus | Erythema around vestibular gland<br>Swelling and edema<br>Abscessed vestibular gland | Drain the abscess; provide antibiotic therapy; excise gland of patients with chronic bartholinitis. |
| Cervicitis: acute and chronic | Chlamydia<br>Gonococcus<br>Streptococcus<br>Many pathogenic bacteria | Profuse purulent discharge<br>Backache<br>Urinary frequency and urgency | Determine the cause: perform cytologic examination of cervical smear and appropriate cultures.<br>Eradicate the gonococcal organism, if present: penicillin (as directed) or spectinomycin or tetracycline, if patient is allergic to penicillin.<br>Tetracycline, doxycycline (Vibramycin) to eradicate chlamydia.<br>Eradicate other causes. |
| Atrophic vaginitis | Lack of estrogen; glycogen deficiency | Discharge and irritation from alkaline pH of vaginal secretions | Provide topical vaginal estrogen therapy; improve nutrition if necessary; relieve dryness through use of moisturizing medications. |

1-night, 3-night, and 7-night treatment courses available. Oral medication (fluconazole [Diflucan]) is also available in a one-pill dose. Relief should be noted within 3 days.

Some vaginal creams are available without a prescription; however, patients are cautioned to use these creams only if they are certain that they have a yeast or monilial infection. Patients often use these remedies for problems other than yeast infections. If a woman is uncertain about the cause of her symptoms or if relief has not been obtained after using these creams, she should be instructed to seek health care promptly. Yeast infections can become recurrent or complicated. Women may have more than four infections in a year and severe symptoms due to preexisting conditions such as diabetes or immunosuppression. Cell-mediated immunity may be a factor. Women with recurrent yeast infections benefit from a comprehensive gynecologic assessment.

## Bacterial Vaginosis

Bacterial vaginosis is caused by an overgrowth of anaerobic bacteria and *Gardnerella vaginalis* normally found in the vagina and an absence of lactobacilli (see Table 47-1). Risk factors include douching after menses, smoking, multiple sex partners, and other sexually transmitted diseases (STDs) (also referred to as sexually transmitted infections [STIs]).

### Clinical Manifestations

Bacterial vaginosis can occur throughout the menstrual cycle and does not produce local discomfort or pain. More than half of patients with bacterial vaginosis do not notice any symptoms. Discharge, if noticed, is heavier than normal and gray to yellowish white in color. It is characterized by a fishlike odor that is particularly noticeable after sexual intercourse or during menstruation as a result of an increase in vaginal pH. The pH of the discharge is usually greater than 4.7 because of the amines that result from enzymes from anaerobes. The fishlike odor can be detected readily by adding a drop of potassium hydroxide to a glass slide with a sample of vaginal discharge, which releases amines; this is referred to as a positive "whiff" test. Under the microscope, vaginal cells are coated with bacteria and are described as "clue cells." Lactobacilli, which serve as a natural host defense, are usually absent. Bacterial vaginosis is not usually considered a serious condition, although it can be associated with premature labor, premature rupture of membranes, endometritis, and recurrent urinary tract infection.

### Medical Management

Metronidazole (Flagyl), administered orally twice a day for 1 week, is effective; a vaginal gel is also available. Clindamycin (Cleocin) vaginal cream or ovules (oval suppositories) are also effective. Treatment of patients' partners does not seem to be effective, but use of condoms may be helpful.

## Trichomoniasis

*Trichomonas vaginalis* is a flagellated protozoan that causes a common, usually sexually transmitted vaginitis that is often called "trich"; about 7.4 million cases occur each year (ACOG, 2006a). Trichomoniasis may be transmitted by an asymptomatic carrier who harbors the organism in the urogenital tract (see Table 47-1). It may increase the risk of contracting HIV from an infected partner and may play a role in development of cervical neoplasia, postoperative infections, adverse pregnancy outcomes, pelvic inflammatory disease (PID), and infertility.

### Clinical Manifestations

Clinical manifestations include a vaginal discharge that is thin (sometimes frothy), yellow to yellow-green, malodorous, and very irritating. An accompanying vulvitis may result, with vulvovaginal burning and itching. Diagnosis is made most often by microscopic detection of the motile causative organisms or less frequently by culture. Inspection with a speculum often reveals vaginal and cervical erythema (redness) with multiple small petechiae ("strawberry spots"). Testing of a trichomonal discharge demonstrates a pH greater than 4.5.

### Medical Management

The most effective treatment for trichomoniasis is metronidazole or tinidazole (Tindamax). Both partners receive a one-time loading dose or a smaller dose three times a day for 1 week. The one-time dose is more convenient; consequently, compliance tends to be greater. The week-long treatment has occasionally been noted to be more effective. Some patients complain of an unpleasant but transient metallic taste when taking metronidazole. Nausea and vomiting, as well as a hot, flushed feeling (disulfiram-like reaction), occur when this medication is taken with an alcoholic beverage. In view of these side effects, patients taking metronidazole are strongly advised to abstain from alcohol.

Metronidazole is not prescribed without examination. It is contraindicated in patients with some blood dyscrasias or central nervous system diseases, in the first trimester of pregnancy, and in women who are breastfeeding. Tinidazole is not considered safe in pregnancy.

## Gerontologic Considerations

After menopause, the vaginal mucosa becomes thinner and may atrophy. This condition can be complicated by infection from pyogenic bacteria, resulting in atrophic vaginitis (see Table 47-1). Leukorrhea (vaginal discharge) may cause itching and burning. Management is similar to that for bacterial vaginosis if bacteria are present. Estrogenic hormones, either taken orally or inserted into the vagina in a cream form, can also be effective in restoring the epithelium.

## NURSING PROCESS

### The Patient With a Vulvovaginal Infection

#### Assessment

The woman with vulvovaginal symptoms should be examined as soon as possible after the onset of symptoms. She should be instructed not to **douche** because doing so removes the vaginal discharge needed to make the diagnosis. The area is observed for erythema, edema, excoriation, and discharge. Each of the infection-producing organisms produces its own characteristic discharge and effect (see Table 47-1). The patient is asked to describe any discharge and other symptoms, such as odor, itching, or burning. Dysuria often occurs as a result of local irritation of the urinary meatus. A urinary tract infection may need to be ruled out by obtaining a urine specimen for culture and sensitivity testing.

The patient is asked about the occurrence of factors that may contribute to vulvovaginal infection:

- Physical and chemical factors, such as constant moisture from tight or synthetic clothing, perfumes and powders, soaps, bubble bath, poor hygiene, and use of feminine hygiene products
- Psychogenic factors (eg, stress, fear of STDs, abuse)
- Medical conditions or endocrine factors, such as a predisposition to *Monilia* in a patient who has diabetes
- Use of medications such as antibiotics, which may alter the vaginal flora and allow an overgrowth of monilial organisms
- New sex partner, multiple sex partners, previous vaginal infection

The patient is also asked about factors that could contribute to infection, including hygiene practices (douching), and use or nonuse of condoms and other barrier methods of birth control.

The nurse may prepare a vaginal smear (wet mount) to assist in diagnosing the infection. A common method for preparing the smear is to collect vaginal secretions with an applicator and place the secretions on two separate glass slides. A drop of saline solution is added to one slide and a drop of 10% potassium hydroxide is added to another slide for examination under a microscope. If bacterial vaginosis is present, the slide with normal saline solution added shows epithelial cells dotted with bacteria (clue cells). If *Trichomonas* species is present, small motile cells are seen. In the presence of yeast, the potassium hydroxide slide reveals typical characteristics. Discharge associated with bacterial vaginosis produces a strong odor when mixed with potassium hydroxide. Testing the pH of the discharge with Nitrazine paper assists in proper diagnosis.

## Diagnosis

### *Nursing Diagnoses*

Based on the nursing assessment and other data, major nursing diagnoses may include the following:

- Discomfort related to burning, odor, or itching from the infectious process
- Anxiety related to stressful symptoms
- Risk for infection or spread of infection
- Deficient knowledge about proper hygiene and preventive measures

## Planning and Goals

Major goals may include relief of discomfort, reduction of anxiety related to symptoms, prevention of reinfection or infection of sexual partner, and acquisition of knowledge about methods for preventing vulvovaginal infections and managing self-care.

## Nursing Interventions

### *Relieving Discomfort*

Treatment with the appropriate medication usually relieves discomfort. Sitz baths may be occasionally recommended and may provide temporary relief of symptoms.

### *Reducing Anxiety*

Vulvovaginal infections are upsetting and require treatment. The patient who experiences such an infection may be very anxious about the significance of the symptoms and possible causes. Explaining the cause of symptoms may reduce anxiety related to fear of a more serious illness. Discussing ways to help prevent vulvovaginal infections may help patients adopt specific strategies to decrease infection and the related symptoms.

### *Preventing Reinfection or Spread of Infection*

The patient needs to be informed about the importance of adequate treatment of herself and her partner, if indicated. Other strategies to prevent persistence or spread of infection include abstaining from sexual intercourse when infected, treatment of sexual partners, and minimizing irritation of the affected area. When medications such as antibiotic agents are prescribed for any infection, the nurse instructs the patient about the usual precautions related to using these agents. If vaginal itching occurs several days after use, the patient can be reassured that this is usually not an allergic reaction but may be a yeast or monilial infection resulting from altered vaginal bacteria. Treatment for monilial infection is prescribed.

Another goal of treatment is to reduce tissue irritation caused by scratching or wearing tight clothing. The area needs to be kept clean by daily bathing and adequate hygiene after voiding and defecation. The use of a hairdryer on a cool setting will dry the area and application of topical corticosteroids may decrease irritation.

When teaching the patient about medications such as suppositories and devices such as applicators to dispense cream or ointment, the nurse may demonstrate the procedure by using a plastic model of the pelvis and vagina. The nurse should also stress the importance of hand washing before and after each administration of medication. To prevent the medication from escaping from the vagina, the patient should recline for 30 minutes after it is inserted, if possible. The patient is informed that seepage of medication may occur, and the use of a perineal pad may be helpful.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Vulvovaginal conditions are treated on an outpatient basis unless a patient has other medical problems. Patient teaching, tact, and reassurance are important aspects of nursing care. Women may express embarrassment, guilt, or anger and may be concerned that the infection could be serious or that it may have been acquired from a sex partner. (In some instances, treatment plans include the partner.)

In addition to reviewing ways of relieving discomfort and preventing reinfection, the nurse assesses each patient's learning needs relative to the immediate problem. The patient needs to know the characteristics of normal as opposed to abnormal discharge. Questions often arise about douching. Normally, douching and use of feminine hygiene sprays are unnecessary because daily baths or showers and proper hygiene after voiding and defecating keep the perineal area clean. Douching tends to eliminate normal flora, reducing the body's ability to ward off infection. In addition, repeated douching may result in vaginal epithelial breakdown and chemical irritation and has been associated with other pelvic disorders. No studies show any benefit from douching (ACOG, 2006a). In the case of recurrent yeast infections, the perineum should be kept as dry as possible. Loose-fitting cotton instead of tight-fitting synthetic, nonabsorbent, heat-retaining underwear is recommended. Use of talcum powder should be discouraged.

Vulvar self-examination is a good health practice for all women. Becoming familiar with one's own anatomy and reporting anything that seems new or different may result in early detection and treatment of any new disorders. Nurses can also play a role in teaching women about the risks of unprotected intercourse, particularly with partners who have had sex with others.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences reduced discomfort
   a. Cleans the perineum as instructed
   b. Reports that itching is relieved
   c. Maintains urine output within normal limits and without dysuria
2. Experiences relief of anxiety
3. Remains free from infection
   a. Has no signs of inflammation, pruritus, odor, or dysuria
   b. Notes that vaginal discharge appears normal (thin, clear, not frothy)
4. Participates in self-care
   a. Takes medication as prescribed
   b. Wears absorbent underwear
   c. Avoids unprotected sexual intercourse
   d. Douches only as prescribed
   e. Performs vulvar self-examination regularly and reports any new findings to care provider

## Human Papillomavirus

Human papillomavirus (HPV) infection is sexually transmitted and is the most common STD in young, sexually active people. An estimated 6.2 million patients acquire these infections every year (Centers for Disease Control and Prevention [CDC], 2006a, 2007). Most infections are self-limiting and without symptoms, and others can cause cervical and anogenital cancers. Infections can be latent (asymptomatic and detected only by DNA hybridization tests for HPV), subclinical (visualized only after application of acetic acid followed by inspection under magnification), or clinical (visible condylomata acuminata).

### Pathophysiology

More than 100 types of HPV exist. The most common strains of HPV, 6 and 11, usually cause **condylomata** (warty growths) on the vulva. These are often visible or may be palpable by patients. Condylomata are rarely premalignant but are an outward manifestation of the virus. Strains 6 and 11 are associated with a low risk for cervical cancer. Some HPV strains (16, 18, 31, 33, and 45) may not cause condylomata but do affect the cervix, resulting in abnormal Papanicolaou (Pap) smears. The effects of these strains are usually invisible on examination but may be seen on colposcopy. They may cause cervical changes that may appear as koilocytosis on Pap smear. Seventy percent of all cervical cancers are caused by strains 16 and 18 (Wright, Massad, Dunton, et al., 2007). However, most women with HPV infection do not develop cervical cancer.

The incidence of HPV in young, sexually active women is high. The infection often disappears as the result of an effective immune system response. It is thought that two proteins produced by high-risk types of HPV interfere with tumor suppression by normal cells. Risk factors include being young, being sexually active, having multiple sex partners, and having sex with a partner who has or has had multiple partners.

In 2006, the Advisory Committee on Immunization Practices (ACIP) of the CDC recommended that a newly licensed vaccine (Gardasil) against the four strains of HPV that cause the majority of cases of cervical cancer be routinely administered to girls 11 to 12 years of age—that is, before they become sexually active. Although this vaccine is considered an important medical breakthrough, it does not replace other strategies important in prevention of HPV or the need for cervical cancer screening. It is administered in three intramuscular doses, with the initial dose followed by second dose in 2 months and a third dose 6 months after the first dose. This vaccine, along with regular Pap smears, has the potential to decrease the impact of HPV-related disease (ACOG, 2006b; CDC, 2006a, 2007; Markowitz, Dunne, Saraiya, et al., 2007).

### Medical Management

Treatment of external genital warts includes topical application of trichloroacetic acid, podophyllin (Podofin, Podocon), and chemotherapeutic agents, as well as injections of interferon administered by a health care provider. Topical agents that can be applied by patients to external lesions include podofilox (Condylox) and imiquimod (Aldara). Because the safety of podophyllin, imiquimod, and podofilox during pregnancy has not been determined, these agents should not be used during pregnancy. Electrocautery and laser therapy are alternative therapies that may be indicated for patients with a large number or area of genital warts (CDC, 2007).

Treatment usually eradicates perineal warts or condylomata. However, they may resolve spontaneously without treatment and may also recur even with treatment.

If the treatment includes application of a topical agent by the patient, she needs to be carefully instructed in the use of the agent prescribed and must be able to identify the warts and be able to apply the medication to them. The patient is instructed to anticipate mild pain or local irritation with the use of these agents.

Women with HPV should have annual Pap smears because of the potential of HPV to cause **dysplasia** (changes in cervical cells). Much remains unknown about subclinical and latent HPV disease. Women are often exposed to HPV by partners who are unknowing carriers. Use of condoms can reduce the likelihood of transmission, but transmission can also occur during skin-to-skin contact in areas not covered by condoms.

In many cases, patients are angry about having warts or HPV and do not know who infected them because the incubation period can be long and partners may have no symptoms. Acknowledging the emotional distress that occurs when an STD is diagnosed and providing support and facts are important nursing actions.

## Herpesvirus Type 2 Infection (Herpes Genitalis, Herpes Simplex Virus)

Herpes genitalis is a recurrent, life-long viral infection that causes herpetic lesions (blisters) on the external genitalia and occasionally the vagina and cervix. It is an STD but may also be transmitted asexually from wet surfaces or by self-transmission (ie, touching a cold sore and then touching the genital area). The initial infection is usually very painful and lasts about 1 week, but it can also be asymptomatic. Recurrences are less painful and usually produce minor itching and burning. Some patients have few or no recurrences, whereas others have frequent bouts. Recurrences are often associated with stress, sunburn, dental work, or inadequate rest or nutrition—all situations that may tax the immune system.

Since the late 1970s, the incidence of herpes infection has increased fivefold among Caucasian adolescents and young adults. At least 50 million people in the United States have genital herpes infection and most have not been diagnosed (CDC, 2006a). The prevalence of other STDs has decreased slightly, possibly because of increased condom use, but herpes can be transmitted by contact with skin not covered by a condom. Transmission is possible even when a carrier does not have symptoms (subclinical shedding). Lesions increase vulnerability to HIV infection and other STDs. Vaccines for herpes genitalis are in clinical trials.

## Pathophysiology

Of the known herpesviruses, six affect humans: (1) herpes simplex type 1 (HSV-1), which usually causes cold sores of the lips; (2) herpes simplex type 2 (HSV-2), or genital herpes; (3) varicella zoster, or shingles; (4) Epstein-Barr virus; (5) cytomegalovirus (CMV); and (6) human B-lymphotrophic virus. HSV-2 appears to be the cause of about 80% of genital and perineal lesions; HSV-1 may cause about 20%.

There is considerable overlap between HSV-1 and HSV-2, which are clinically indistinguishable. Close human contact by the mouth, oropharynx, mucosal surface, vagina, or cervix appears necessary to acquire the infection. Other susceptible sites are skin lacerations and conjunctivae. Usually, the virus is killed at room temperature by drying. When viral replication diminishes, the virus ascends the peripheral sensory nerves and remains inactive in the nerve ganglia. Another outbreak may occur when the host is subjected to stress. In pregnant women with active herpes, infants delivered vaginally may become infected with the virus. There is a risk of fetal morbidity and mortality if this occurs; therefore, a cesarean delivery may be performed if the virus recurs near the time of delivery.

## Clinical Manifestations

Itching and pain occur as the infected area becomes red and edematous. Primary infection may begin with macules and papules and progress to vesicles and ulcers. The vesicular state often appears as a blister, which later coalesces, ulcerates, and encrusts. In women, the labia are the usual primary site, although the cervix, vagina, and perianal skin may be affected. In men, the glans penis, foreskin, or penile shaft is typically affected. Influenza-like symptoms may occur 3 or 4 days after the lesions appear. Inguinal lymphadenopathy (enlarged lymph nodes in the groin), minor temperature elevation, malaise, headache, myalgia (aching muscles), and dysuria (pain on urination) are often noted. Pain is evident during the first week and then decreases. The lesions subside in about 1 to 2 weeks unless secondary infection occurs.

Rarely, complications may arise from extragenital spread, such as to the buttocks, upper thighs, or even the eyes as a result of touching lesions and then touching other areas. Patients should be advised to wash their hands after contact with lesions. Other potential problems are aseptic meningitis, neonatal transmission, and severe emotional stress related to the diagnosis.

## Medical Management

There is currently no cure for HSV-2 infection, but treatment is aimed at relieving the symptoms. Management goals include preventing the spread of infection, making patients comfortable, decreasing potential health risks, and initiating a counseling and education program. The antiviral agents acyclovir (Zovirax), valacyclovir (Valtrex), and famciclovir (Famvir) can suppress symptoms and shorten the course of the infection. These are effective at reducing the duration of lesions and preventing recurrences. Resistance and long-term side effects do not appear to be major problems. Recurrent episodes are often milder than the initial episode.

## NURSING PROCESS

## The Patient With a Genital Herpesvirus Infection

### Assessment

The health history and a physical and pelvic examination are important in establishing the nature of the infectious condition. In addition, patients are assessed for risk of STDs. The perineum is inspected for painful lesions. Inguinal nodes are assessed and are often enlarged and tender during an occurrence of HSV.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, major nursing diagnoses may include the following:

- Acute pain related to the genital lesions
- Risk for infection or spread of infection
- Anxiety related to the diagnosis
- Deficient knowledge about the disease and its management

### Planning and Goals

Major goals may include relief of pain and discomfort, control of infection and its spread, relief of anxiety, knowledge of and adherence to the treatment regimen and self-care, and knowledge about implications for the future.

### Nursing Interventions

#### *Relieving Pain*

The lesions should be kept clean, and proper hygiene practices are advocated. Sitz baths ease discomfort. Clothing should be clean, loose, soft, and absorbent. Aspirin and other analgesics are usually effective in controlling pain. Occlusive ointments and powders are avoided because they prevent the lesions from drying.

If there is considerable pain and malaise, bed rest may be required. The patient is encouraged to increase fluid intake, to be alert for possible bladder distention, and to contact her primary health care provider immediately if she cannot void because of discomfort. Painful voiding may occur if urine comes in contact with the herpes lesions. Discomfort with urination can be reduced by pouring warm water over the vulva during voiding or by sitz baths. When oral acyclovir or other antiviral agents are prescribed, the patient is instructed about when to take the medication and what side effects to note, such as rash and headache. Rest, fluids, and a nutritious diet are recommended to promote recovery.

#### *Preventing Infection and Its Spread*

The risk of reinfection and spread of infection to others or to other structures of the body can be reduced by hand washing, use of barrier methods with sexual contact, and adherence to prescribed medication regimens. Avoidance of contact when obvious lesions are present does not eliminate the risk because the virus can be shed in the absence of symptoms, and lesions may not be visible to women.

#### *Relieving Anxiety*

Concern about the presence of herpes infection, future occurrences of lesions, and the impact of the infection on future relationships and childbearing may cause considerable patient anxiety. Nurses can be an important support, listening to patients' concerns and providing information and instruction. The patient may be angry with her partner if the partner is the probable source of the infection. The patient may need assistance and support in discussing the infection and its implications with her current sexual partners and in future sexual relationships. The nurse can refer the patient to a support group to assist in coping with the diagnosis (see Resources at the end of the chapter).

#### *Increasing Knowledge About the Disease and Its Treatment*

Patient teaching is an essential part of nursing care of the patient with a genital herpes infection. This includes an adequate explanation about the infection and how it is transmitted, management and treatment strategies, strategies to minimize spread of infection, the importance of adherence to the treatment regimen, and self-care strategies. Because of the increased risk of HIV and other STDs in the presence of skin lesions, an important part of patient education involves instructing the patient to protect herself from exposure to HIV and other STDs (Chart 47-2).

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Self-care measures for people with genital herpes appear in Chart 47-2.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences a reduction in pain and discomfort
2. Keeps infection under control
   a. Demonstrates proper hygiene techniques
   b. Takes medication as prescribed
   c. Consumes adequate fluids
   d. Assesses own current lifestyle (diet, adequate fluid intake, safer sex practices, stress management)
3. Uses strategies to reduce anxiety
   a. Verbalizes issues and concerns related to genital herpes infection
   b. Discusses strategies to deal with issues and concerns with current and future sexual partners
   c. Initiates contact with support group if indicated

CHART 47-2 HOME CARE CHECKLIST
### *The Patient With Genital Herpes*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State that herpes is transmitted mainly by direct contact. | ✔ | ✔ |
| • State that abstinence from sex is required for a brief period (intercourse is avoided during treatment, but other options such as hand holding and kissing are acceptable). | ✔ | ✔ |
| • State that intercourse during a herpes outbreak not only increases the risk of transmission but also increases the likelihood of contracting HIV and other STDs. | ✔ | ✔ |
| • State that transmission is possible even in the absence of active lesions. | ✔ | ✔ |
| • State that condoms may provide some protection against viral transmission. | ✔ | ✔ |
| • Explain that obstetric care provider should be informed about the history of herpes. In cases of recurrence at time of delivery, cesarean section may be considered. | ✔ | ✔ |
| • Describe appropriate hygiene practices (hand washing, perineal cleanliness, gentle washing of lesions with mild soap and running water and lightly drying lesions) and importance of avoiding occlusive ointments, strong perfumed soaps, or bubble bath. | ✔ | ✔ |
| • State that control of the condition may require changes in sexual behavior and use of medications. | ✔ | ✔ |
| • Describe strategies to avoid self-infection (eg, avoid touching lesions during an outbreak). | ✔ | ✔ |
| • Explain rationale for avoiding self-infection (ie, lesions can become infected from germs on the hand, and the virus from the lesion can be transmitted from the hand to another area of the body or another person). | ✔ | ✔ |
| • Describe health promotion strategies: wear loose, comfortable clothing; eat a balanced diet; get adequate rest and relaxation. | ✔ | ✔ |
| • State rationale for avoiding exposure to the sun as it can cause recurrences (and skin cancer). | ✔ | ✔ |
| • Identify importance of taking medications as prescribed, keeping follow-up appointments with health care provider, and reporting repeated recurrences (may not be as severe as the initial episode). | ✔ | ✔ |
| • Describe possible benefits of joining a group to share solutions and experiences and hear about newer treatments, such as HELP (Herpetics Engaged in Living Productively). | ✔ | ✔ |

4. Demonstrates knowledge about genital herpes and strategies to control and minimize recurrences
   a. Identifies methods of transmission of herpes infection and strategies to prevent transmission to others
   b. Discusses strategies to reduce recurrence of lesions
   c. Takes medications as prescribed
   d. Reports no recurrence of lesions

## Endocervicitis and Cervicitis

**Endocervicitis** is an inflammation of the mucosa and the glands of the cervix that may occur when organisms gain access to the cervical glands after intercourse and, less often, after procedures such as abortion, intrauterine manipulation, or vaginal delivery. If untreated, the infection may extend into the uterus, fallopian tubes, and pelvic cavity. Inflammation can irritate the cervical tissue, resulting in spotting or bleeding and **mucopurulent cervicitis.**

### Chlamydia and Gonorrhea

Chlamydia and gonorrhea are the most common causes of endocervicitis, although *Mycoplasma* may also be involved. Chlamydia causes about 3 million infections every year in the United States; it is most commonly found in young, sexually active people with more than one partner and is transmitted through sexual intercourse. It can result in serious complications, including pelvic infection, an increased risk for ectopic pregnancy, and infertility. As many as 40% of untreated women develop PID. One in 20 women of reproductive age in the United States is infected (CDC, 2006a). Chlamydial infections of the cervix often produce no symptoms, but cervical discharge, dyspareunia, dysuria, and bleeding may occur. Other complications include conjunctivitis and perihepatitis. If pregnant women are infected, stillbirth, neonatal death, and premature labor may occur. Infants born to infected mothers may experience prematurity, conjunctivitis, and pneumonia.

Chlamydial infection and gonorrhea often coexist. As many as 25% of females who have chlamydial infections also have gonorrhea (CDC, 2006a). The inflamed cervix that results from this infection may leave a woman more vulnerable to HIV transmission from an infected partner. Gonorrhea is also a major cause of PID, tubal infertility, ectopic pregnancy, and chronic pelvic pain. Fifty percent of women with gonorrhea have no symptoms, but without treatment, 40% may develop PID. In males, urethritis and epididymitis may occur. Diagnosis can be confirmed by culture, smear, or other methods, using a swab to obtain a sample of cervical discharge or penile discharge from the patient's partner.

### Medical Management

The CDC recommends treating chlamydia with doxycycline (Vibramycin) for 1 week or with a single dose of azithromycin (Zithromax). Because of the high incidence of coinfection with chlamydia and gonorrhea, treatment for gonorrhea should include treatment for chlamydia as well (CDC, 2006a). Partners must also be treated. Pregnant women are cautioned not to take tetracycline because of potential adverse effects on the fetus. In these cases, erythromycin may be prescribed. Results are usually good if treatment begins early. Possible complications from delayed treatment are tubal disease, ectopic pregnancy, PID, and infertility.

The CDC no longer recommends fluoroquinolones (eg, ciprofloxacin [Cipro], ofloxacin [Floxin], or levofloxacin [Levaquin]) for the treatment of gonorrhea and associated conditions (eg, PID). Instead, the CDC (2007) recommends cephalosporins for the treatment of gonorrhea.

Cultures for chlamydia and other STDs should be obtained from all patients who have been sexually assaulted when they first seek medical attention; patients are treated prophylactically. Cultures should then be repeated in 2 weeks. Annual screening for chlamydia is recommended for all sexually active young women and older women with new sex partners or multiple partners (CDC, 2006a).

### Nursing Management

All sexually active women may be at risk for chlamydia, gonorrhea, and other STDs, including HIV. Nurses can assist patients in assessing their own risk. Recognition of risk is a first step before changes in behavior occur. Patients should be discouraged from assuming that a partner is "safe" without open, honest discussion. Nonjudgmental attitudes, educational counseling, and role playing may be helpful.

Because chlamydia, gonorrhea, and other STDs may have a serious effect on future health and fertility and because many of these disorders can be prevented by the use of condoms and spermicides and careful choice of partners, nurses can play a major role in counseling patients about safer sex practices. Exploring options with patients, addressing knowledge deficits, and correcting misinformation may reduce morbidity and mortality.

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

Nurses can educate women and help them develop communication skills and initiate discussions about sex with their partners. Communicating with partners about sex, risk, postponing intercourse, and using safer sex behaviors, including use of condoms, may be lifesaving. Some young women report having sex but not being comfortable enough to discuss sexual risk issues. Nurses can help women to advocate for their own health by discussing safety with partners prior to sexual activity.

Reinforcing the need for annual screening for chlamydia and other STDs is an important part of patient teaching. Instructions also include the need for the patient to abstain from sexual intercourse until all of her sex partners are treated (CDC, 2006a). The CDC recommends rescreening of all women with chlamydial infections 3 to 4 months after treatment is completed to reduce the risks of infertility.

## Pelvic Infection (Pelvic Inflammatory Disease)

**Pelvic inflammatory disease (PID)** is an inflammatory condition of the pelvic cavity that may begin with cervicitis and may involve the uterus (endometritis), fallopian tubes (**salpingitis**), ovaries (oophoritis), pelvic peritoneum, or pelvic vascular system. Infection, which may be acute, subacute, recurrent, or chronic and localized or widespread, is usually caused by bacteria but may be attributed to a virus, fungus, or parasite. Gonorrheal and chlamydial organisms are the most likely causes. CMV has also been implicated. This condition can result in the fallopian tubes becoming narrowed and scarred, which increases the risk of ectopic pregnancy (fertilized eggs become trapped in the tube), infertility, recurrent pelvic pain, tubo-ovarian **abscess,** and recurrent disease. Rupture of a tubo-ovarian abscess has a 5% to 10% mortality rate and usually necessitates a complete hysterectomy. PID is a common gynecologic cause of hospital admissions in the United States. The true incidence of PID is unknown because some cases are asymptomatic.

### Pathophysiology

The exact pathogenesis of PID has not been determined, but it is presumed that organisms usually enter the body through the vagina, pass through the cervical canal, colonize the endocervix, and move upward into the uterus. Under various conditions, the organisms may proceed to one or both fallopian tubes and ovaries and into the pelvis. In bacterial infections that occur after childbirth or abortion, pathogens are disseminated directly through the tissues that support the uterus by way of the lymphatics and blood vessels (Fig. 47-1). In pregnancy, the increased blood supply required by the placenta provides more pathways for infection. These postpartum and postabortion infections tend to be unilateral. Infections can cause perihepatic inflammation when the organism invades the peritoneum.

In gonorrheal infections, the gonococci pass through the cervical canal and into the uterus, where the environment, especially during menstruation, allows them to multiply rapidly and spread to the fallopian tubes and into the pelvis (see Fig. 47-1). The infection is usually bilateral.

In rare instances, organisms (eg, tuberculosis) gain access to the reproductive organs by way of the bloodstream from the lungs (see Fig. 47-1). One of the most common causes of salpingitis (inflammation of the fallopian tube) is chlamydia, possibly accompanied by gonorrhea.

Pelvic infection is most commonly caused by sexual transmission but can also occur with invasive procedures such as endometrial biopsy, surgical abortion, hysteroscopy, or insertion of an intrauterine device. Bacterial vaginosis, a vaginal infection, may predispose women to pelvic infection. Risk factors include early age at first intercourse, multiple sexual partners, frequent intercourse, intercourse without condoms, sex with a partner with an STD, and a history of STDs or previous pelvic infection.

### Clinical Manifestations

Symptoms of pelvic infection usually begin with vaginal discharge, dyspareunia, lower abdominal pelvic pain, and tenderness that occurs after menses. Pain may increase with voiding or with defecation. Other symptoms include fever, general malaise, anorexia, nausea, headache, and possibly vomiting. On pelvic examination, intense tenderness may be noted on palpation of the uterus or movement of the cervix (cervical motion tenderness). Symptoms may be acute and severe or low grade and subtle.

### Complications

Pelvic or generalized peritonitis, abscesses, strictures, and fallopian tube obstruction may develop. Obstruction may cause an ectopic pregnancy in the future if a fertilized egg cannot pass a tubal stricture, or scar tissue may occlude the tubes, resulting in sterility. Adhesions are common and often result in chronic pelvic pain; they eventually may require removal of the uterus, fallopian tubes, and ovaries. Other complications include bacteremia with septic shock and thrombophlebitis with possible embolization.

### Medical Management

Broad-spectrum antibiotic therapy is prescribed, usually a combination of ceftriaxone (Ceftin), azithromycin, or doxycycline. Women with mild infections may be treated as outpatients, but hospitalization may be necessary. Intensive therapy includes bed rest, intravenous (IV) fluids, and IV

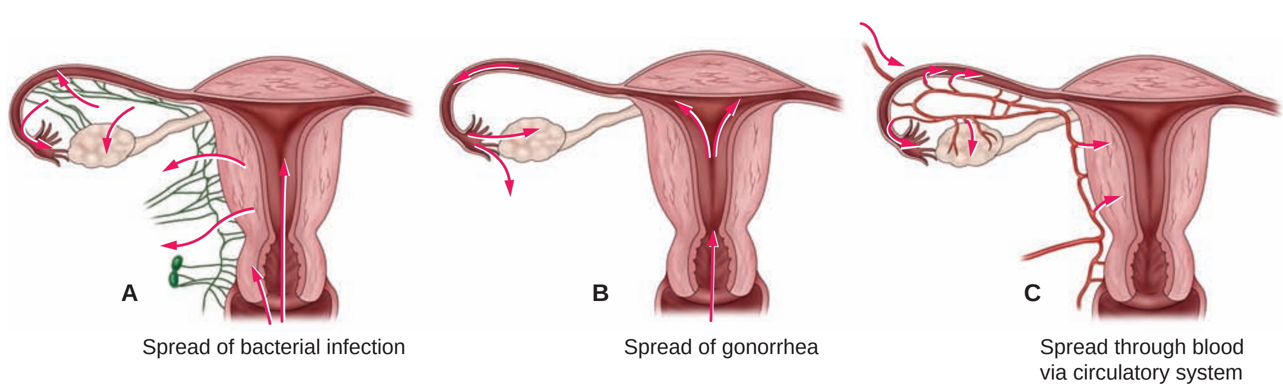



**Figure 47-1** Pathway by which micro-organisms spread in pelvic infections. **A,** Bacterial infection spreads up the vagina into the uterus and through the lymphatics. **B,** Gonorrhea spreads up the vagina into the uterus and then to the tubes and ovaries. **C,** Bacterial infection can reach the reproductive organs through the bloodstream (hematogenous spread).

antibiotic therapy. If the patient has abdominal distention or ileus, nasogastric intubation and suction are initiated. Careful monitoring of vital signs and symptoms assists in evaluating the status of the infection. Treatment of sexual partners is necessary to prevent reinfection.

## Nursing Management

Infection takes a toll, both physically and emotionally. The patient may feel well one day and experience vague symptoms and discomfort the next. She may also suffer from constipation and menstrual difficulties.

A hospitalized patient is maintained on bed rest and is usually placed in the semi-Fowler's position to facilitate dependent drainage. Accurate recording of vital signs and the characteristics and amount of vaginal discharge is necessary as a guide to therapy.

The nurse administers analgesic agents as prescribed for pain relief. Heat applied safely to the abdomen may also provide some pain relief and comfort. In addition, the nurse minimizes the transmission of infection to others by carefully handling perineal pads with gloves, discarding the soiled pad according to hospital guidelines for disposal of biohazardous material, and performing meticulous hand hygiene.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The patient must be informed of the need for precautions and must be encouraged to take part in procedures to prevent infecting others and protect herself from reinfection. If a partner is not well known or has had other sexual partners recently, use of condoms is essential to prevent infection and sequelae. If reinfection occurs or if the infection spreads, symptoms may include abdominal pain, nausea and vomiting, fever, malaise, malodorous purulent vaginal discharge, and leukocytosis. Patient teaching consists of explaining how pelvic infections occur, how they can be controlled and avoided, and their signs and symptoms. Guidelines and instructions provided to the patient are summarized in Chart 47-3.

All patients who have had PID need to be informed of the signs and symptoms of ectopic pregnancy (pain, abnormal bleeding, delayed menses, faintness, dizziness, and shoulder pain) because they are prone to this complication. (See Chapter 46 for a discussion of ectopic pregnancy.)

## *Human Immunodeficiency Virus Infection and Acquired Immunodeficiency Syndrome*

Any discussion of vulvovaginal infections and STDs must include the topic of HIV and **acquired immunodeficiency syndrome (AIDS),** which is described in Chapter 52. Because HIV infection may be detected through prenatal testing and screening for STDs, nurses and other women's health care clinicians are often the first professionals to provide care for a woman with HIV infection (ACOG, 2007a). Thus, they need to be knowledgeable about this disorder and sensitive to women's issues and concerns.

The incidence of HIV infection and AIDS in women is increasing. If rates of new cases of HIV infection continue to increase, infections in women will outnumber men with HIV (CDC, 2006b). Most women with HIV infection are in the reproductive age group. Heterosexual transmission is the leading cause of new HIV infection in women, surpassing IV/injection drug use as the most common mode of transmission. Younger women are disproportionately at higher risk; 25% to 50% of all women who acquire HIV heterosexually do so in adolescence or in their early 20s. Women are nine times more likely to contract HIV from men than men are from women. The presence of genital ulcers (eg, a herpetic or syphilitic lesion) or a friable cervix increases risk. Intercourse during menses may also increase risk. Syphilis appears to accelerate in HIV-positive patients and proceeds directly from primary to tertiary disease in some patients. Chlamydia is associated with a high risk of HIV (which may be related to inflammatory changes of the cervix, providing

CHART 47-3 — HOME CARE CHECKLIST

### *The Patient With Pelvic Inflammatory Disease*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State that any pelvic pain or abnormal discharge, particularly after sexual exposure, childbirth, or pelvic surgery, should be evaluated as soon as possible. | ✔ | ✔ |
| • State that antibiotics may be prescribed after insertion of intrauterine devices (IUDs). | ✔ | ✔ |
| • Describe proper perineal care procedures (wiping from front to back after defecation or urination). | ✔ | ✔ |
| • State that douching reduces the natural flora that combat infecting organisms and may introduce bacteria upward. | ✔ | ✔ |
| • Identify the importance of consulting a health care provider if unusual vaginal discharge or odor is noted. | ✔ | ✔ |
| • Discuss the importance of following health practices (ie, proper nutrition, exercise, and weight control), and safer sex practices (ie, using condoms, avoiding multiple sexual partners). | ✔ | ✔ |
| • Explain the importance of consistent use of condoms before intercourse or any penile–vaginal contact if there is any chance of transmitting infection. | ✔ | ✔ |
| • State that a gynecologic examination should be performed at least once a year. | ✔ | ✔ |

entry sites). HIV-positive women have a higher rate of HPV. Infections with HPV and HIV together increase the risk of malignant transformation and cervical cancer. Thus, women with HIV infection should have frequent Pap smears. HIV-positive women also have larger and more painful herpes lesions with more recurrences, probably related to immunosuppression from their disease. Many HIV-infected women have gynecologic disorders, including candidiasis, PID, anogenital warts, and cervical dysplasia (CDC, 2006a).

Women with HIV and women with partners who have HIV must be counseled about safer sex and informed about the dangers of unprotected sex. Inconsistent use of condoms results in a higher seroconversion rate. Because there is a risk of perinatal transmission, decisions to conceive or to use contraception must be based on teaching, accurate information, and care. Pregnant women are advised to have an HIV test. The use of antiretroviral agents by pregnant women significantly decreases perinatal transmission of HIV infection. Therefore, the use of these agents during pregnancy is critical and must also be discussed. For women who choose to avoid conception, use of condoms alone and with oral contraceptives are possible choices.

After informed consent is obtained, women who are at risk for HIV are offered testing by a nurse or counselor. Because patients may be reluctant to discuss risk-taking behavior, routine screening should be offered to all women. Early detection permits early treatment to delay progression of the disease.

Use of antiretroviral therapy has been improving, but barriers to use of health services by disadvantaged women include lack of insurance, current drug use, and difficulty keeping appointments. Depression and abuse are issues that affect women's use of health care services. Prevention of cervical neoplasia and PID need to be part of the teaching for women at risk. The nurse also needs to remember that many women do not see themselves as at risk for acquiring HIV infection. See Chapter 52 for further discussion of HIV infection and AIDS.

## STRUCTURAL DISORDERS

### *Fistulas of the Vagina*

A **fistula** is an abnormal, tortuous opening between two internal hollow organs or between an internal hollow organ and the exterior of the body. The name of the fistula indicates the two areas that are connected abnormally: a vesicovaginal fistula is an opening between the bladder and the vagina, and a rectovaginal fistula is an opening between the rectum and the vagina (Fig. 47-2). Fistulas may be congenital in origin. However, in adults, breakdown usually occurs because of tissue damage resulting from injury sustained during surgery, vaginal delivery, irritable bowel disease, radiation therapy, or disease processes such as carcinoma (Rivadeneira, Ruffo, Amrani, et al., 2007).

#### Clinical Manifestations

Symptoms depend on the specific defect. For example, in a patient with a vesicovaginal fistula, urine escapes continuously into the vagina. With a rectovaginal fistula, there is fecal incontinence, and flatus is discharged through the vagina. The combination of fecal discharge with leukorrhea results in malodor that is difficult to control.

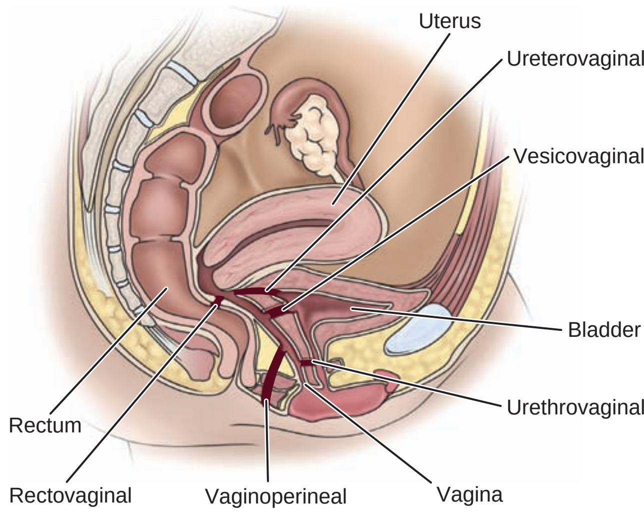



**Figure 47-2** Common sites for vaginal fistulas: *Vesicovaginal*—bladder and vagina. *Urethrovaginal*—urethra and vagina. *Vaginoperineal*—vagina and perineal area. *Ureterovaginal*—ureter and vagina. *Rectovaginal*—rectum and vagina.

#### Assessment and Diagnostic Findings

A history of the symptoms experienced by the patient is important to identify the structural alterations and to assess the impact of the symptoms on the patient's quality of life. In addition, the use of methylene blue dye helps delineate the course of the fistula. In vesicovaginal fistula, the dye is instilled into the bladder and appears in the vagina. After a negative methylene blue test result, indigo carmine is injected intravenously; the appearance of the dye in the vagina indicates a ureterovaginal fistula. Cystoscopy or IV pyelography may then be used to determine the exact location.

#### Medical Management

The goal is to eliminate the fistula and to treat infection and excoriation. A fistula may heal without surgical intervention, but surgery is often required. If the primary care provider determines that a fistula will heal without surgical intervention, care is planned to relieve discomfort, prevent infection, and improve the patient's self-concept and self-care abilities. Measures to promote healing include proper nutrition, cleansing douches and enemas, rest, and administration of prescribed intestinal antibiotics. A rectovaginal fistula heals faster when the patient eats a low-residue diet and when the affected tissue drains properly. Warm perineal irrigations promote healing.

Sometimes a fistula does not heal on its own and cannot be surgically repaired. In this situation, care must be planned and implemented on an individual basis. Cleanliness, frequent sitz baths, and deodorizing douches are required, as are perineal pads and protective undergarments. Meticulous skin care is necessary to prevent excoriation. Applying bland creams or lightly dusting with cornstarch may be soothing. In addition, attending to the patient's social and psychological needs is an essential aspect of care.

If the patient is to have a fistula repaired surgically, preoperative treatment of any existing vaginitis is important to ensure success. Usually, the vaginal approach is used to repair vesicovaginal and urethrovaginal fistulas; the abdominal approach is used to repair fistulas that are large or complex. Fistulas that are difficult to repair or that are very large may require surgical repair with a urinary or fecal diversion. Tissue transfer techniques (skin or tissue grafting) may be used (Rivadeneira, et al., 2007).

Because fistulas usually are typically related to obstetric, surgical, or radiation trauma, occurrence in a patient without previous vaginal delivery or a history of surgery must be evaluated carefully. Crohn's disease or lymphogranuloma venereum may be the cause.

Despite the best surgical intervention, fistulas may recur. After surgery, medical follow-up continues for at least 2 years to monitor for a possible recurrence.

## Pelvic Organ Prolapse: Cystocele, Rectocele, Enterocele

Age and parity can put strain on the ligaments and structures that make up the female pelvis and pelvic floor. Childbirth can result in tears of the levator sling musculature, resulting in structural weakness. Hormone deficiency also may play a role. Some degree of prolapse (weakening of the vaginal walls allowing the pelvic organs to descend and protrude into the vaginal canal) may be found in many older women. Risk factors include age, parity, and vaginal delivery, and there may also be a familial predisposition (Buschbaum, Duecy, Kerr, et al., 2006).

**Cystocele** is a downward displacement of the bladder toward the vaginal orifice (Fig. 47-3), resulting from damage to the anterior vaginal support structures. It usually results from injury and strain during childbirth. The condition usually appears some years later when genital atrophy associated with aging occurs, but younger, multiparous, premenopausal women may also be affected.

**Rectocele** is an upward pouching of the rectum that pushes the posterior wall of the vagina forward. Both rectoceles and perineal lacerations, which occur because of muscle tears below the vagina, may affect the muscles and tissues of the pelvic floor and may occur during childbirth. Sometimes the lacerations may completely sever the fibers of the anal sphincter (complete tear). An **enterocele** is a protrusion of the intestinal wall into the vagina. Prolapse results from a weakening of the support structures of the uterus itself; the cervix drops and may protrude from the vagina. (If complete prolapse occurs, it may also be referred to as procidentia.)

### Clinical Manifestations

Because a cystocele causes the anterior vaginal wall to bulge downward, the patient may report a sense of pelvic pressure, fatigue, and urinary problems such as incontinence, frequency, and urgency. Back pain and pelvic pain may occur as well. The symptoms of rectocele resemble those of cystocele, with one exception: instead of urinary symptoms, patients may experience rectal pressure. Constipation, uncontrollable gas, and fecal incontinence may occur in patients with complete tears. Prolapse can result in feelings of pressure and ulcerations and bleeding. Dyspareunia may occur with these disorders.

### Medical Management

Kegel exercises, which involve contracting or tightening the vaginal muscles, are prescribed to help strengthen these weakened muscles. The exercises are more effective in the early stages of a cystocele. Kegel exercises are easy to perform and are recommended for all women, including those with strong pelvic floor muscles (Chart 47-4).

A pessary can be used to avoid surgery. This device is inserted into the vagina and positioned to keep an organ, such as the bladder, uterus, or intestine, properly aligned when a cystocele, rectocele, or prolapse has occurred. Pessaries are usually ring shaped or doughnut shaped and are made of various materials, such as rubber or plastic (Fig. 47-4). Rubber pessaries must be avoided in women with latex allergy. The size and type of pessary are selected and fitted by a gynecologic health care provider. The patient should have the pessary removed, examined, and cleaned by her health care provider at prescribed intervals. At these checkups, vaginal walls should be examined for pressure points or

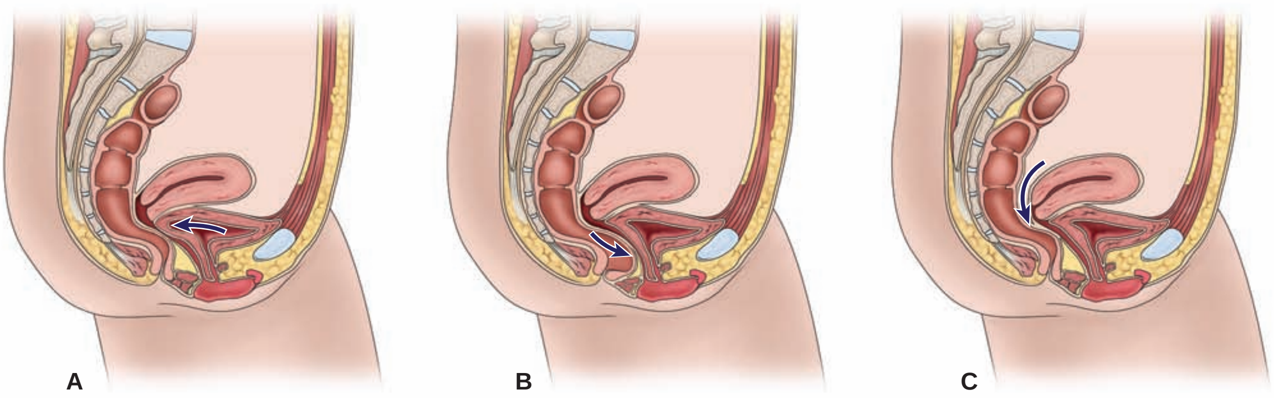



**Figure 47-3** Diagrammatic representation of the three most common types of pelvic floor relaxation: **A,** cystocele, **B,** rectocele, and **C,** enterocele. *Arrows* depict sites of maximum protrusion.

CHART 47-4

### PATIENT EDUCATION
### *Performing Kegel (Pelvic Muscle) Exercises*

*Purposes:* To strengthen and maintain the tone of the pubococcygeal muscle, which supports the pelvic organs; reduce or prevent stress incontinence and uterine prolapse; enhance sensation during sexual intercourse; and hasten postpartum healing

1. Become aware of pelvic muscle function by "drawing in" the perivaginal muscles and anal sphincter as if to control urine or defecation, but not contracting the abdominal, buttock, or inner thigh muscles.
2. Sustain contraction of the muscles for up to 10 seconds, followed by at least 10 seconds of relaxation.
3. Perform these exercises 30–80 times a day.

signs of irritation. Normally, the patient experiences no pain, discomfort, or discharge with a pessary, but if chronic irritation occurs, alternative measures may be needed.

A Colpexin sphere is another nonsurgical device used to treat pelvic organ prolapse. This intravaginal device is similar to a pessary, but it supports the pelvic floor muscles and facilitates exercise of these muscles. It is removed daily for cleaning.

### Surgical Management

In many cases, surgery helps correct structural abnormalities. The procedure to repair the anterior vaginal wall is called anterior **colporrhaphy,** repair of a rectocele is called a posterior colporrhaphy, and repair of perineal lacerations is called a **perineorrhaphy.** These repairs are frequently performed laparoscopically, resulting in short hospital stays and good outcomes. A **laparoscope** is inserted through a small abdominal incision, the pelvis is visualized, and surgical repairs are performed.

## *Uterine Prolapse*

Usually the uterus and the cervix lie at right angles to the long axis of the vagina with the body of the uterus inclined slightly forward. The uterus is normally freely movable on examination. Individual variations may result in an anterior, middle, or posterior uterine position. A backward positioning of the uterus, known as retroversion and retroflexion, is not uncommon (Fig. 47-5).

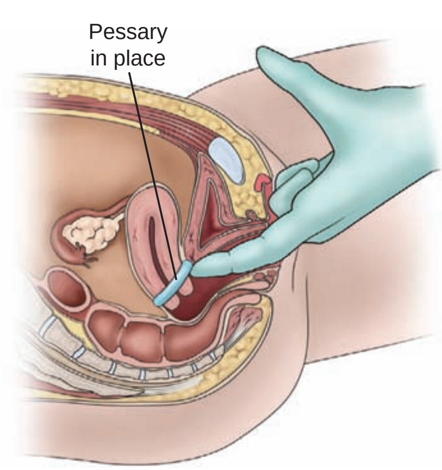
If the structures that support the uterus weaken (typically from childbirth), the uterus may work its way down the vaginal canal (prolapse) and even appear outside the vaginal orifice (procidentia) (Fig. 47-6). As the uterus descends, it may pull the vaginal walls and even the bladder and rectum with it. Symptoms include pressure and urinary problems (incontinence or retention) from displacement of the bladder. The symptoms are aggravated when a woman coughs, lifts a heavy object, or stands for a long time. Normal activities, even walking up stairs, may aggravate the symptoms.

### Medical Management

Surgery and pessaries are two options for treatment. With surgery, the uterus is sutured back into place and repaired to strengthen and tighten the muscle bands. In postmenopausal women, the uterus may be removed **(hysterectomy)** or repaired by colpopexy. Colpocleisis, or vaginal closure, may be an option for women who do not wish to have sexual intercourse or to bear children and want to avoid hysterectomy (ACOG, 2007b). Pessaries may be the treatment of choice in elderly women or those who are too ill to tolerate surgery.



A




B

**Figure 47-4** Examples of pessaries. **A,** Various shapes and sizes of pessaries available. **B,** Insertion of one type of pessary.

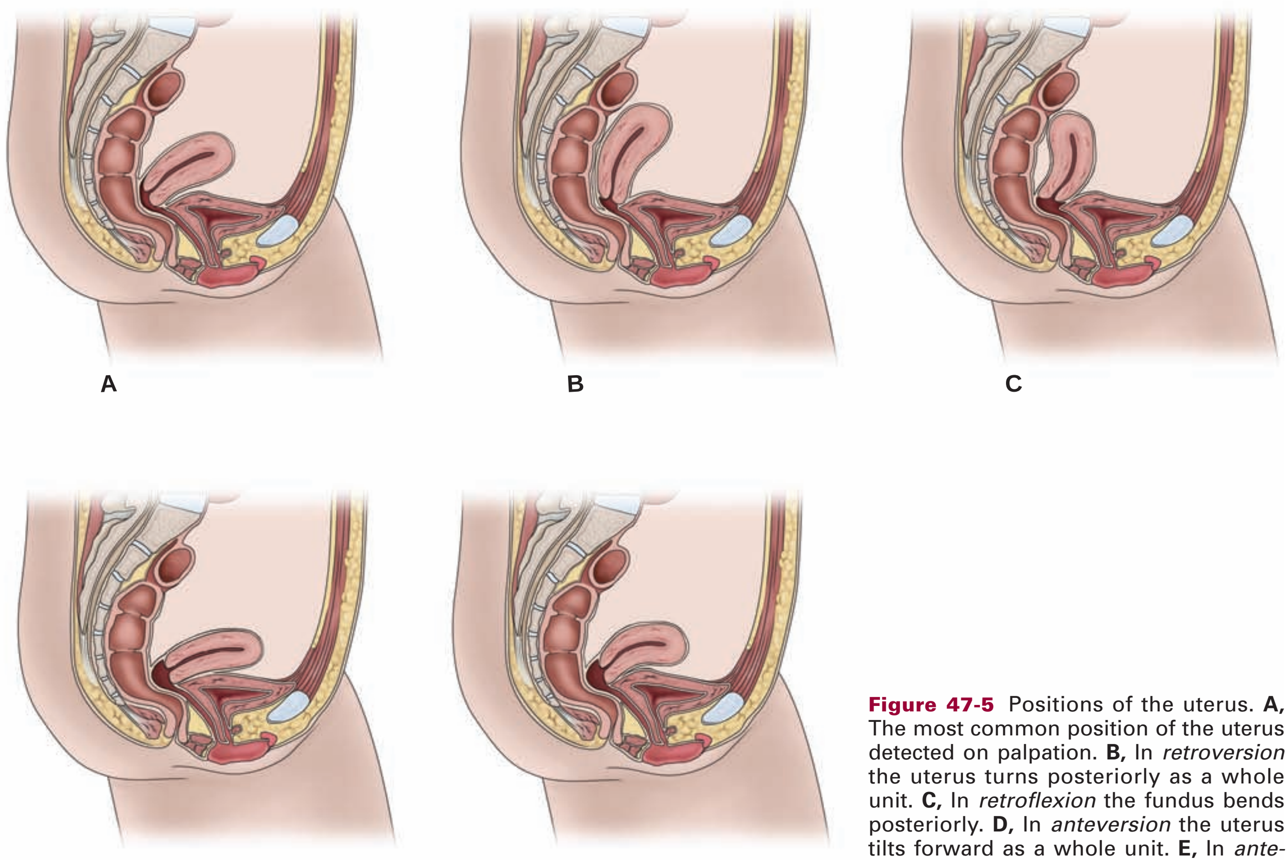



**Figure 47-5** Positions of the uterus. **A,** The most common position of the uterus detected on palpation. **B,** In *retroversion* the uterus turns posteriorly as a whole unit. **C,** In *retroflexion* the fundus bends posteriorly. **D,** In *anteversion* the uterus tilts forward as a whole unit. **E,** In *anteflexion* the uterus bends anteriorly.

## Nursing Management

### Implementing Preventive Measures

Some disorders related to "relaxed" pelvic muscles (cystocele, rectocele, and uterine prolapse) may be prevented.

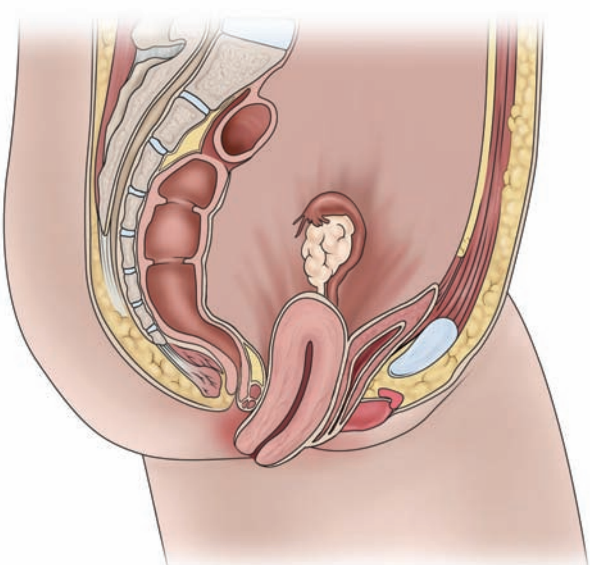


**Figure 47-6** Complete prolapse of the uterus through the introitus.

During pregnancy, early visits to the health care provider permit early detection of problems. During the postpartum period, the woman can be taught to perform Kegel exercises to strengthen the muscles that support the uterus and then to continue them as a preventive action.

Delays in obtaining evaluation and treatment may result in complications such as infection, cervical ulceration, cystitis, and hemorrhoids. The nurse encourages the patient to obtain prompt treatment for these structural disorders.

### Implementing Preoperative Nursing Care

Before surgery, the patient needs to know the extent of the proposed surgery, the expectations for the postoperative period, and the effect of surgery on future sexual function. In addition, the patient having a rectocele repair needs to know that before surgery, a laxative and a cleansing enema may be prescribed. She may be asked to administer these at home the day before surgery. A perineal shave may be prescribed as well. The patient is usually placed in a lithotomy position for surgery, with special attention given to moving both legs in and out of the stirrups simultaneously to prevent muscle strain and excess pressure on the legs and thighs. Other preoperative interventions are similar to those described in Chapter 18.

### Initiating Postoperative Nursing Care

Immediate postoperative goals include preventing infection and pressure on any existing suture line. This may require

perineal care and may preclude using dressings. The patient is encouraged to void within a few hours after surgery for cystocele and complete tear. If the patient does not void within this period and reports discomfort or pain in the bladder region after 6 hours, she needs to be catheterized. Some physicians prefer to leave an indwelling catheter in place for 2 to 4 days, so some women may return home with a catheter in place. Various other bladder care methods are described in Chapter 45. After each voiding or bowel movement, the perineum is cleansed with warm, sterile saline solution and dried with sterile absorbent material if a perineal incision has been made.

After an external perineal repair, the perineum is kept as clean as possible. Commercially available sprays containing combined antiseptic and anesthetic solutions are soothing and effective, and an ice pack applied locally may relieve discomfort. However, the weight of the ice bag must rest on the bed, not on the patient.

Routine postoperative care is similar to that given after abdominal surgery. The patient is positioned in bed with her head and knees elevated slightly. The patient may go home the day of or the day after surgery; the duration of the hospital stay depends on the surgical approach used.

After surgery for a complete perineal laceration (through the rectal sphincter), special care and attention are required. The bladder is drained through the catheter to prevent strain on the sutures. Throughout recovery, stool-softening agents are administered nightly after the patient begins a soft diet.

#### Promoting Home and Community-Based Care

##### Teaching Patients Self-Care

Predischarge instructions include information pertaining to the gynecologist's postoperative instructions related to cleanliness, prevention of constipation, recommended exercises, and avoiding lifting heavy objects or standing for prolonged periods. The patient is instructed to report any pelvic pain, unusual discharge, inability to carry out personal hygiene, and vaginal bleeding.

##### Continuing Care

The patient is advised to continue with perineal exercises, which are recommended to improve muscle strength and tone. She is reminded to return to the gynecologist for a follow-up visit and to consult with the physician about when it is safe to resume sexual intercourse.

# BENIGN DISORDERS

## Vulvitis and Vulvodynia

**Vulvitis,** an inflammation of the vulva, may occur with other disorders, such as diabetes, dermatologic problems, or poor hygiene, or it may be secondary to irritation from a vaginal discharge related to a specific vaginitis.

**Vulvodynia** is a chronic vulvar pain syndrome (ACOG, 2006c). Symptoms may include burning, stinging, irritation, or stabbing pain. The syndrome has been described as primary, with onset at first tampon insertion or sexual experience, or secondary, beginning months or years after first tampon insertion or sexual experience. It may affect more than 18% of women, usually between 18 and 25 years of age (Bachman, Rosen, Pinn, et al., 2006). Vulvodynia may be classified as organic if it has a known cause (infection, trauma, or irritants) or idiopathic if no cause is known. It can be chronic or unremitting, intermittent or episodic, or may occur only in response to contact. The pathophysiology is unknown. **Vestibulodynia** is the most frequent type of vulvodynia, producing sharp pain on pressure on the vestibule.

Treatment methods for vulvodynia vary. Topical treatments (ie, estrogens, corticosteroids, trichloroacetic acid), surgery, and interferon, as well as biofeedback and dietary changes (Bachman, et al., 2006), have been used. Some cases seem to be similar to peripheral neuralgia and may respond to treatment with tricyclic antidepressants.

## Vulvar Cysts

**Bartholin's cyst** results from the obstruction of a duct in one of the paired vestibular glands located in the posterior third of the vulva, near the vestibule. This cyst is the most common vulvar tumor. A simple cyst may be asymptomatic, but an infected cyst or abscess may cause discomfort. Infection may be due to a gonococcal organism, *Escherichia coli*, or *Staphylococcus aureus* and can cause an abscess with or without involving the inguinal lymph nodes. Skene's duct cysts may result in pressure, dyspareunia, altered urinary stream, and pain, especially if infection is present. Vestibular cysts, located inferior to the hymen, may also occur. Cysts can be treated by resection or with laser, ablation with silver nitrate, and puncture. Asymptomatic cysts do not require treatment. Malignancy can occur, usually in women older than 50 years of age, so drainage and biopsy may be considered.

### Medical Management

The usual treatment for a Bartholin's cyst is incision and drainage followed by antibiotic therapy. If a cyst is asymptomatic, treatment is unnecessary. Moist heat or sitz baths may promote drainage and resolution. If surgery is necessary, a Word Bartholin gland catheter is usually used. This catheter, a short latex stem with an inflatable bulb at the distal end, creates a tract that preserves the gland and allows for drainage. A nonopioid analgesic agent may be administered before this outpatient procedure. A local anesthetic agent is injected, and the cyst is incised or lanced and irrigated with normal saline; the catheter is inserted and inflated with 2 to 3 mL of water. The catheter stem is then tucked into the vagina to allow freedom of movement. The catheter is left in place for 4 to 6 weeks until the tract reepithelializes. The patient is informed that discharge should be expected, as the catheter allows drainage of the cyst. She is instructed to contact her primary health care provider if pain occurs because the bulb may be too large for the cavity and fluid may need to be removed. Routine hygiene is encouraged.

Skene's duct cysts can be excised or drained with a Word catheter. Vestibular cysts are excised if symptomatic.

## Vulvar Dystrophy

**Vulvar dystrophy** is a condition found in older women that causes dry, thickened skin on the vulva or slightly raised, whitish papules, fissures, or macules. Symptoms usually consist of varying degrees of itching, but some patients have no symptoms. A few patients with vulvar cancer have associated dystrophy (vulvar cancer is discussed later in this chapter). Biopsy with careful follow-up is the standard intervention. Benign dystrophies include lichen planus, simplex chronicus, **lichen sclerosus,** squamous cell hyperplasia, vulvar **vestibulitis,** and other dermatoses.

### Medical Management

Topical corticosteroids (ie, hydrocortisone creams) are the usual treatment. Petrolatum jelly may relieve pruritus. Use is decreased as symptoms resolve. Topical corticosteroids are effective in treating squamous cell hyperplasia. Treatment is often complete in 2 to 3 weeks; this condition is not likely to recur after treatment is completed.

If malignant cells are detected on biopsy, local excision, laser therapy, local chemotherapy, and immunologic treatment are used. Vulvectomy is avoided, if possible, to spare the patient from the stress of disfigurement and possible sexual dysfunction.

### Nursing Management

Key nursing responsibilities for patients with vulvar dystrophies focus on teaching. Important topics include hygiene and self-monitoring for signs and symptoms of complications.

#### Promoting Home and Community-Based Care

**Teaching Patients Self-Care**

Instructions for patients with benign vulvar dystrophies include the importance of maintaining good personal hygiene and keeping the vulva dry. Lanolin or hydrogenated vegetable oil is recommended for relief of dryness. Sitz baths may help but should not be overused because dryness may result or increase. The patient is instructed to notify her primary health care provider about any change or ulceration because biopsy may be necessary to rule out squamous cell carcinoma.

By encouraging all patients to perform genital self-examinations regularly and have any itching, lesions, or unusual symptoms assessed by a health care provider, nurses can help prevent complications and progression of vulvar lesions.

## Ovarian Cysts

The ovary is a common site for cysts, which may be simple enlargements of normal ovarian constituents, the graafian follicle, or the corpus luteum, or they may arise from abnormal growth of the ovarian epithelium. The risk of malignancy is much greater in postmenopausal women than in premenopausal patients. Almost all pelvic masses in premenopausal women are benign (ACOG, 2007c).

Ovarian cysts are often detected on routine pelvic examination. Although these cysts are typically benign, they nevertheless should be evaluated to exclude ovarian cancer, particularly in postmenopausal women (ACOG, 2007c).

The patient may or may not report acute or chronic abdominal pain. Symptoms of a ruptured cyst mimic various acute abdominal emergencies, such as appendicitis or ectopic pregnancy. Larger cysts may produce abdominal swelling and exert pressure on adjacent abdominal organs.

Postoperative nursing care after surgery to remove an ovarian cyst is similar to that after abdominal surgery, with one exception. The marked decrease in intra-abdominal pressure resulting from removal of a very large cyst usually leads to considerable abdominal distention. This may be prevented to some extent by applying a snug-fitting abdominal binder.

Some surgeons discuss the option of a hysterectomy when a woman is undergoing bilateral ovary removal because of a suspicious mass; it may increase life expectancy and avoid a later second surgery. Patient preference is a priority in determining its appropriateness.

**Polycystic ovary syndrome (PCOS)** is another type of cystic disorder that affects the ovaries. This complex endocrine condition involves a disorder in the hypothalamic–pituitary and ovarian network or axis, resulting in chronic anovulation and clinical androgen excess, along with multiple small ovarian cysts called polycystic ovaries. Onset of PCOS may be at menarche or later; it occurs in approximately 5% to 10% of women of childbearing age (Stankiewicz & Norman, 2006). Features include obesity, insulin resistance, impaired glucose tolerance, dyslipidemia, sleep apnea, and infertility. Symptoms are related to androgen excess. Irregular menstrual periods, resulting from lack of regular ovulation, infertility, obesity, and hirsutism, may be a presenting complaint. Cysts form in the ovaries because the hormonal milieu cannot cause ovulation on a regular basis. Women with PCOS may develop insulin resistance and metabolic syndrome, and they may be at higher risk for diabetes and cardiac disorders in later life. Metformin (Glucophage) is also used to decrease the hyperinsulinemia that occurs with PCOS.

### Medical Management

The treatment of large ovarian cysts is usually surgical removal. However, oral contraceptives may be used in young, healthy patients to suppress ovarian activity and resolve small cysts that appear to be fluid filled or physiologic.

Oral contraceptives are also usually prescribed to treat PCOS. When pregnancy is desired, medications to stimulate ovulation (clomiphene [Clomid]) are often effective. Lifestyle modification is critical, and weight management is part of the treatment plan.

## Benign Tumors of the Uterus: Fibroids (Leiomyomas, Myomas)

Myomatous or **fibroid tumors** of the uterus are estimated to occur in 20% to 40% of women during their reproductive years. It is thought that women are genetically predisposed to develop this condition, which is almost always benign. Fibroids arise from the muscle tissue of the uterus and can be solitary or multiple, in the lining (intracavitary), muscle wall (intramural), and outside surface (serosal) of the uterus. They usually develop slowly in women between 25

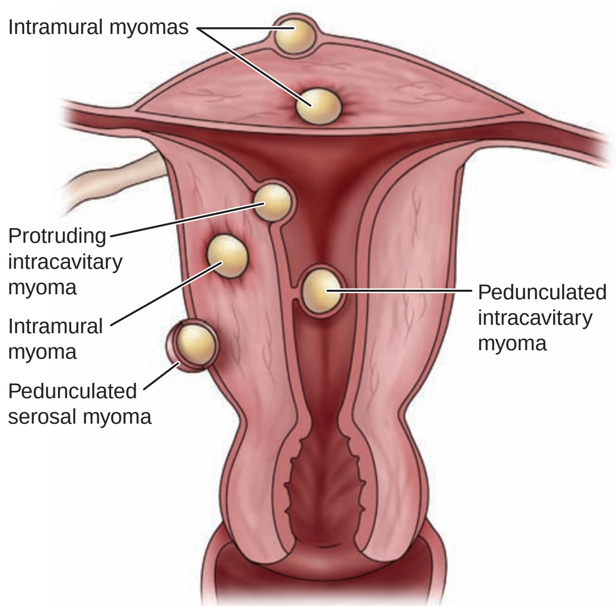



**Figure 47-7** Myomas (fibroids). Those that impinge on the uterine cavity are called intracavitary myomas.

and 40 years of age and may become quite large. A growth spurt with enlargement of the fibroid tumor may occur in the decade before menopause, possibly related to anovulatory cycles and high levels of unopposed estrogen. Fibroids are a common reason for hysterectomy because they often result in menorrhagia, which can be difficult to control.

## Clinical Manifestations

Fibroids may cause no symptoms, or they may produce abnormal vaginal bleeding. Other symptoms result from pressure on the surrounding organs and include pain, backache, pressure, bloating, constipation, and urinary problems. Menorrhagia (excessive bleeding) and metrorrhagia (irregular bleeding) may occur because fibroids may distort the uterine lining (Fig. 47-7). Fibroids may interfere with fertility.

## Medical Management

Treatment of uterine fibroids may include medical or surgical intervention and depends to a large extent on the size, symptoms, and location, as well as the woman's age and her reproductive plans. Fibroids usually shrink and disappear during menopause, when estrogen is no longer produced. Simple observation and follow-up may be all the management that is necessary. The patient with minor symptoms is closely monitored. If she plans to have children, treatment is as conservative as possible. As a rule, large tumors that produce pressure symptoms should be removed **(myomectomy)**. A hysterectomy may be performed if symptoms are bothersome and childbearing is completed (see later discussion of nursing care for a patient having a hysterectomy).

Several other alternatives to hysterectomy have been developed for the treatment of excessive bleeding due to fibroids (ACOG, 2007d). These include the following:

- Hysteroscopic resection of myomas: a laser is used through a hysteroscope passed through the cervix; no incision or overnight stay is needed
- Laparoscopic myomectomy: removal of a fibroid through a laparoscope inserted through a small abdominal incision
- Laparoscopic myolysis: a laser or electrical needles are used to cauterize and shrink the fibroid
- Laparoscopic cryomyolysis: electric current is used to coagulate the fibroid
- Uterine artery embolization (UAE): polyvinyl alcohol or gelatin particles are injected into the blood vessels that supply the fibroid via the femoral artery, resulting in infarction and resultant shrinkage. This percutaneous image–guided therapy offers an alternative to hormone therapy or surgery. UAE may result in infrequent but serious complications such as pain, infection, amenorrhea, necrosis, and bleeding. Although rare, deaths and ovarian failure may occur. Women need to weigh the risks and benefits carefully, especially if they have not completed childbearing. This procedure has been found to cause fewer complications than hysterectomy, but women may need further treatment in the future (Dutton, Hirst, McPherson, et al., 2008).
- Magnetic resonance–guided focused ultrasound surgery (MRgFUS): ultrasonic energy is passed through the abdominal wall to target and destroy the fibroid. Although not yet widely used, this noninvasive procedure is approved by the U.S. Food and Drug Administration for premenopausal women with bothersome symptoms due to fibroids and who do not want more children. It is an outpatient treatment (Stewart, Gostout, Rabinovici, et al., 2007).

Medications (eg, leuprolide [Lupron]) or other gonadotropin-releasing hormone (GnRH) analogues, which induce a temporary menopause-like environment, may be prescribed to shrink the fibroids. This treatment consists of monthly injections, which may cause hot flashes and vaginal dryness. Treatment is usually short term (ie, before surgery) to shrink the fibroids, allowing easier surgery, and to alleviate anemia, which may occur as a result of heavy menstrual flow. This treatment is used on a temporary basis because it leads to vasomotor symptoms and loss of bone density.

Antifibrotic agents are under investigation for long-term treatment of fibroids. Mifepristone (RU-486, Mifeprex), a progesterone antagonist, has also been prescribed; it appears to be effective (Fiscella, Eisinger, Meldrum, et al., 2006).

# *Endometriosis*

**Endometriosis** is a chronic disease that affects between 5% to 15% of women of reproductive age. A benign lesion or lesions with cells similar to those lining the uterus grow aberrantly anywhere in the pelvic cavity outside the uterus. Often, extensive endometriosis causes few symptoms, whereas an isolated lesion may produce severe symptoms. It is a major cause of chronic pelvic pain and infertility.

Endometriosis has been diagnosed more frequently as a result of the increased use of laparoscopy, but diagnosis can often be delayed, and women with this problem often feel as if their complaints are being dismissed. Before

laparoscopy became widely available, major surgery was necessary before a diagnosis could be made. There is a high incidence among patients who bear children late and among those who have fewer children. In countries where tradition favors early marriage and early childbearing, endometriosis is rare. There also appears to be a familial predisposition to endometriosis; it is more common in women whose close female relatives are affected. Other factors that may suggest increased risk include a shorter menstrual cycle (less than every 27 days), flow longer than 7 days, outflow obstruction, and younger age at menarche. Characteristically, endometriosis is found in young, nulliparous women between 25 and 35 years of age and in adolescents, particularly those with dysmenorrhea that does not respond to nonsteroidal anti-inflammatory drugs (NSAIDs) or oral contraceptives.

## Pathophysiology

Misplaced endometrial tissue responds to and depends on ovarian hormonal stimulation. During menstruation, this ectopic tissue bleeds, mostly into areas having no outlet, which causes pain and adhesions. The lesions are typically small and puckered, with a blue/brown/gray powder-burn appearance and brown or blue-black appearance, indicating concealed bleeding.

Endometrial tissue contained within an ovarian cyst has no outlet for the bleeding; this formation is referred to as a pseudocyst or chocolate cyst. Adhesions, cysts, and scar tissue may result, causing pain and infertility. Endometriosis may increase the risk of ovarian, renal, thyroid, and breast cancer (Melin, Sparén & Bergqvist, 2008).

Currently the best-accepted theory regarding the origin of endometrial lesions is the transplantation theory, which suggests that a backflow of menses (retrograde menstruation) transports endometrial tissue to ectopic sites through the fallopian tubes. Why some women with retrograde menstruation develop endometriosis and others do not is unknown. Endometrial tissue can also be spread by lymphatic or venous channels.

## Clinical Manifestations

Symptoms vary but include dysmenorrhea, dyspareunia, and pelvic discomfort or pain. Dyschezia (pain with bowel movements) and radiation of pain to the back or leg may occur. Depression, loss of work due to pain, and relationship difficulties may result. Infertility may occur because of fibrosis and adhesions or because of a variety of substances (prostaglandins, cytokines, other factors) produced by the implants.

## Assessment and Diagnostic Findings

A health history, including an account of the menstrual pattern, is necessary to elicit specific symptoms. On bimanual pelvic examination, fixed tender nodules are sometimes palpated, and uterine mobility may be limited, indicating adhesions. Laparoscopic examination confirms the diagnosis and helps stage the disease. In stage 1, patients have superficial or minimal lesions; stage 2, mild involvement; stage 3, moderate involvement; and stage 4, extensive involvement and dense adhesions, with obliteration of the cul-de-sac.

## Medical Management

Treatment depends on the symptoms, the patient's desire for pregnancy, and the extent of the disease. If the woman does not have symptoms, routine examination may be all that is required. Other therapy for varying degrees of symptoms may be NSAIDs, oral contraceptives, GnRH agonists, or surgery. Pregnancy often alleviates symptoms because neither ovulation nor menstruation occurs.

### *Pharmacologic Therapy*

Palliative measures include use of medications, such as analgesic agents and prostaglandin inhibitors, for pain. Hormonal therapy is effective in suppressing endometriosis and relieving dysmenorrhea (menstrual pain). Oral contraceptives are often used. Infrequently, side effects may occur with oral contraceptives, such as fluid retention, weight gain, and nausea. These can usually be managed by changing brands or formulations. Depo-Provera, an injectable contraceptive agent, may also be used.

Several types of hormonal therapy are also available in addition to oral contraceptives. A synthetic androgen, danazol (Danocrine), causes atrophy of the endometrium and subsequent amenorrhea. The medication inhibits the release of gonadotropin with minimal overt sex hormone stimulation. The drawbacks of this medication are that it is expensive and may cause troublesome side effects such as fatigue, depression, weight gain, oily skin, decreased breast size, mild acne, hot flashes, and vaginal atrophy. GnRH agonists decrease estrogen production and cause subsequent amenorrhea. Side effects are related to low estrogen levels (eg, hot flashes and vaginal dryness). Loss of bone density is often offset by concurrent use of estrogen. Leuprolide, an GnRH agonist, is injected monthly to suppress hormones and induce an artificial menopause, thus avoiding menstrual effects and relieving endometriosis. Some clinicians prescribe a combination of therapies. Most women continue treatment despite side effects, and symptoms diminish for 80% to 90% of women with mild to moderate endometriosis. Hormonal medications are not used in patients with a history of abnormal vaginal bleeding or liver, heart, or kidney disease. Bone density is followed carefully because of the risk of bone loss; hormone therapy is usually short term.

## Surgical Management

If conservative measures are not helpful, surgery may be necessary to relieve pain and enhance the possibility of pregnancy. Surgery may be combined with use of medical therapy. The procedure selected depends on the patient. Laparoscopy may be used to fulgurate (cut with high-frequency current) endometrial implants and to release adhesions. Laser surgery is another option made possible by laparoscopy. Laser therapy vaporizes or coagulates the endometrial implants, thereby destroying this tissue. Other surgical options include endocoagulation and electrocoagulation, laparotomy, abdominal hysterectomy, **oophorectomy,** bilateral **salpingo-oophorectomy,** and appendectomy. For women older than 35 years of age or those willing to sacrifice reproductive capability, total hysterectomy is an option. Endometriosis recurs in many women.

### Nursing Management

The health history and physical examination focus on specific symptoms (eg, pain) and when and how long they have been bothersome, the effect of prescribed medications, and the woman's reproductive plans. This information helps in determining the treatment plan. Explaining the various diagnostic procedures may help to alleviate the patient's anxiety. Patient goals include relief of pain, dysmenorrhea, dyspareunia, and avoidance of infertility.

As the treatment progresses, the woman with endometriosis and her partner may find that pregnancy is not easily possible, and the psychosocial impact of this realization must be recognized and addressed. Alternatives, such as in vitro fertilization or adoption, may be discussed at an appropriate time and referrals offered.

The nurse's role in patient education is to dispel myths and encourage the patient to seek care if dysmenorrhea or dyspareunia occurs. The Endometriosis Association (see Resources at the end of this chapter) is a helpful resource for patients seeking further information and support for this condition, which can cause disabling pain and severe emotional distress.

## Chronic Pelvic Pain

Chronic pelvic pain is a common disorder of women that may be related to several of the previously discussed gynecologic disorders. Fifteen percent to 20% of women have chronic pelvic pain—that is, pelvic pain that persists for more than 6 months. It may be cyclic or intermittent and noncyclic. Causes may be reproductive, genitourinary, or gastrointestinal. A history of abuse, PID, endometriosis, interstitial cystitis, musculoskeletal disorders, irritable bowel syndrome, and previous surgery resulting in abdominal adhesions may be associated with chronic pelvic pain. Dysmenorrhea, dyspareunia, and lower abdominal pain may also be associated with sexual and physical abuse (Pikarinen, Saisto, Schei, et al., 2007).

Chronic pelvic pain is often difficult to treat. Treatment depends on physical and diagnostic test results and may include antidepressants, analgesics, oral contraceptives, GnRH agonists, exercise, and surgery.

## Adenomyosis

In adenomyosis, the tissue that lines the endometrium invades the uterine wall. The incidence is highest in women 40 to 50 years of age. Symptoms include hypermenorrhea (excessive and prolonged bleeding), acquired dysmenorrhea, polymenorrhea (abnormally frequent bleeding), and premenstrual staining. Physical examination findings on palpation include an enlarged, firm, and tender uterus. Treatment depends on the severity of bleeding and pain. Hysterectomy may offer greater relief than more conservative therapies.

## Endometrial Hyperplasia

This condition, a build-up of endometrial tissue, can be a precursor to endometrial cancer and often results from unopposed estrogen from any source. Estrogen therapy alone without progesterone in a woman with a uterus can cause this condition. Women with anovulatory cycles, PCOS, or obesity may all have high circulating levels of estrogen. Tamoxifen (Nolvadex) may also be a causative factor (ACOG, 2006d). Diagnosis is by biopsy or ultrasound findings of thickness of the endometrium. Hyperplasia with atypia on a pathology or biopsy report indicates risk of progression. Progestin treatment may be effective, but hysterectomy may be advised if pathology from an endometrial biopsy shows atypia. Abnormal bleeding is the most common symptom.

# MALIGNANT CONDITIONS

The projected incidence and estimated mortality for female reproductive cancers in the United States are (American Cancer Society [ACS], 2009):

- Cervical cancer: about 11,300 new cases and 4,100 deaths
- Uterine cancer: about 42,100 new cases and 7,800 deaths
- Ovarian cancer: about 21,600 new cases and 14,600 deaths
- Vaginal cancer: about 2,160 new cases and 770 deaths
- Vulvar cancer: about 3,600 new cases and 900 deaths

Cervical cancer is the second most prevalent cancer in women worldwide and the fifth leading cause of cancer deaths. Worldwide, the incidence is declining. Pap smears in developed countries have resulted in increased detection of preinvasive lesions and decreased cancer death rates. Eighty percent of all cases of cervical cancer are found in developing countries, where early detection methods are often not available (U.S. Cancer Statistics Working Group, 2007).

Although death rates from all cancers are decreasing in the United States and other developed countries, cancer in developing countries is increasing. Many of these cases affect women. Although infectious diseases and HIV are often high priorities in these countries, the toll of increasing malignancies needs to be considered.

Although some cancers are difficult to detect or prevent, annual pelvic examination with a Pap smear is a painless and relatively inexpensive method of early detection. Health care providers can encourage women to follow this health practice by providing nonstressful examinations that are educational and supportive and offer women an opportunity to ask questions and clarify misinformation. If more women understood that gynecologic examinations and Pap smears do not have to be uncomfortable or embarrassing, early detection rates would likely improve and lives would be saved.

Many women diagnosed with gynecologic malignancies experience depression and anxiety. The occurrence of physical symptoms may cause psychological distress. Intervention directed toward physical and psychological symptoms requires a multidisciplinary approach.

Nurses should be aware of ongoing clinical trials that are being conducted to identify effective treatments for many conditions. They are often in a position to answer questions about clinical trials and to encourage patients to consider

participation if appropriate. Women's participation in cancer research may occur in part because women are unaware of ongoing relevant research.

## Cancer of the Cervix

Carcinoma of the cervix is predominantly squamous cell cancer. Cervical cancer is less common than it once was because of early detection of cell changes by Pap smear. However, it is still the third most common female reproductive cancer and is estimated to affect more than 11,300 women in the United States every year (ACS, 2009). Risk factors are presented in Chart 47-5.

Preventive measures include regular pelvic examinations and Pap tests for all women, especially older women past childbearing age. This decreases the chance of dying from cervical cancer from 1 in 250 to 1 in 2,000. Preventive counseling should encourage delaying first intercourse, avoiding HPV infection, participating in safer sex only, smoking cessation, and receiving HPV immunization (see earlier discussion).

There are several different types of cervical cancer. Most of these cancers are squamous cell carcinomas and the remainder are adenocarcinomas or mixed adenosquamous carcinomas. Adenocarcinomas begin in mucus-producing glands and are often due to HPV infection. Most cervical cancers, if not detected and treated, spread to regional pelvic lymph nodes, and local recurrence is not uncommon.

### Clinical Manifestations

Early cervical cancer rarely produces symptoms. If symptoms are present, they may go unnoticed as a thin watery vaginal discharge often noticed after intercourse or douching. When symptoms such as discharge, irregular bleeding, or pain or bleeding after sexual intercourse occur, the disease may be advanced. Advanced disease should not occur if all women have access to gynecologic care and avail themselves of it. The nurse's role in access to care and its utilization is crucial.

In advanced cervical cancer, the vaginal discharge gradually increases and becomes watery and, finally, dark and foul-smelling from necrosis and infection of the tumor. The bleeding, which occurs at irregular intervals between periods (metrorrhagia) or after menopause, may be slight (just enough to spot the undergarments) and occurs usually after mild trauma or pressure (eg, intercourse, douching, or bearing down during defecation). As the disease continues, the bleeding may persist and increase. Leg pain, dysuria, rectal bleeding, and edema of the extremities signal advanced disease.

As the cancer advances, it may invade the tissues outside the cervix, including the lymph glands anterior to the sacrum. In one third of patients with invasive cervical cancer, the disease involves the fundus. The nerves in this region may be affected, producing excruciating pain in the back and the legs that is relieved only by large doses of opioid analgesics. If the disease progresses, it often produces extreme emaciation and anemia, usually accompanied by fever due to secondary infection and abscesses in the ulcerating mass, and by fistula formation. Because the survival rate for in situ cancer is 100% and the rate for women with more advanced stages of cervical cancer decreases dramatically, early detection is essential.

**CHART 47-5 Risk Factors for Cervical Cancer**

- Sexual activity:
  Multiple sex partners
  Early age (younger than 20) at first coitus (exposes the vulnerable young cervix to potential viruses from a partner)
- Sex with uncircumcised males
- Sexual contact with males whose partners have had cervical cancer
- Early childbearing
- Exposure to human papillomavirus, types 16 and 18
- HIV infection and other causes of immunodeficiency
- Smoking and exposure to secondhand smoke
- Exposure to diethylstilbestrol (DES) in utero
- Family history of cervical cancer
- Low socioeconomic status (may be related to early marriage and early childbearing)
- Nutritional deficiencies (folate, beta-carotene, and vitamin C levels are lower in women with cervical cancer than in women without it)
- Chronic cervical infection
- Overweight status

### Assessment and Diagnostic Findings

Diagnosis may be made on the basis of abnormal Pap smear results, followed by biopsy results identifying severe dysplasia (cervical intraepithelial neoplasia type III [CIN III], high-grade squamous intraepithelial lesions [HGSIL; also referred to as HSIL], or carcinoma in situ; see below). HPV infections are usually implicated in these conditions. Carcinoma in situ is technically classified as severe dysplasia and is defined as cancer that has extended through the full thickness of the epithelium of the cervix, but not beyond. This is often referred to as preinvasive cancer.

In its very early stages, invasive cervical cancer is found microscopically by Pap smear. In later stages, pelvic examination may reveal a large, reddish growth or a deep, ulcerating lesion. The patient may report spotting or bloody discharge.

When the patient has been diagnosed with invasive cervical cancer, clinical staging estimates the extent of the disease so that treatment can be planned more specifically and prognosis reasonably predicted. The tumor, nodes, and metastases (TNM) system is the most widely used staging system. The TNM classification is also used in describing cancer stages. In this system, T refers to the extent of the primary tumor, N to lymph node involvement, and M to metastasis, or spread of the disease.

Signs and symptoms are evaluated, and x-rays, laboratory tests, and special examinations, such as punch biopsy and colposcopy, are performed. Depending on the stage of the cancer, other tests and procedures may be performed to determine the extent of disease and appropriate treatment. These tests may include dilation and curettage (D & C),

computed tomography (CT), magnetic resonance imaging (MRI), IV urography, cystography, positron emission tomography, and barium x-ray studies.

## Medical Management

### *Precursor or Preinvasive Lesions*

When precursor lesions, such as low-grade squamous intraepithelial lesion (LGSIL; also referred to as LSIL) (CIN I and II or mild to moderate dysplasia), are found by colposcopy and biopsy, careful monitoring by frequent Pap smears or conservative treatment is possible. Conservative treatment may consist of monitoring, **cryotherapy** (freezing with nitrous oxide), or laser therapy. A **loop electrocautery excision procedure (LEEP)** may also be used to remove abnormal cells. In this procedure, a thin wire loop with laser is used to cut away a thin layer of cervical tissue. LEEP is an outpatient procedure usually performed in a gynecologist's office; it takes only a few minutes. Analgesia is given before the procedure, and a local anesthetic agent is injected into the area. This procedure allows the pathologist to examine the removed tissue sample to determine if the borders of the tissue are disease free. Another procedure called a cone biopsy or **conization** (removing a cone-shaped portion of the cervix) is performed when biopsy findings demonstrate CIN III or HGSIL (equivalent to severe dysplasia) and carcinoma in situ.

If preinvasive cervical cancer (carcinoma in situ) occurs when a woman has completed childbearing, a simple hysterectomy (removal of the uterus only) is usually recommended. If a woman has not completed childbearing and invasion is less than 1 mm, conization may be sufficient. Frequent follow-up examinations are necessary to monitor for recurrence.

Patients who have precursor or premalignant lesions need reassurance that they do not have invasive cancer. However, the importance of close follow-up is emphasized because the condition, if untreated for a long time, may progress to cancer. Patients with cervical cancer in situ also need to know that this is usually a slow-growing and nonaggressive type of cancer that is not expected to recur after appropriate treatment.

### *Invasive Cancer*

Treatment of invasive cervical cancer depends on the stage of the lesion, the patient's age and general health, and the judgment and experience of the physician. Surgery and radiation treatment (intracavitary and external) are most often used. Surgical procedures that may be used to treat cervical cancer are summarized in Chart 47-6. When tumor invasion is less than 3 mm, a hysterectomy is often sufficient. Invasion exceeding 3 mm usually requires a radical hysterectomy with pelvic node dissection and aortic node assessment. Stage 1B1 tumors are treated with radical hysterectomy and radiation. Stage 1B2 tumors are treated individually, because no single correct course of treatment has been identified and many variable options may be considered.

A procedure called a radical trachelectomy is an alternative to hysterectomy in women with invasive cervical cancer who are young and want to have children. In this procedure, the cervix is gripped with retractors and pulled down into the vagina until it is visible. The affected tissue is excised while the rest of the cervix and uterus remain intact. A drawstring suture is used to close the cervix.

**Chart 47-6 • *Surgical Procedures for Cervical Cancer***

- Total hysterectomy—removal of the uterus, cervix, and ovaries
- Radical hysterectomy—removal of the uterus, ovaries, fallopian tubes, proximal vagina, and bilateral lymph nodes through an abdominal incision (*Note:* "radical" indicates that an extensive area of the paravaginal, paracervical, parametrial, and uterosacral tissues is removed with the uterus.)
- Radical vaginal hysterectomy—vaginal removal of the uterus, ovaries, fallopian tubes, and proximal vagina
- Bilateral pelvic lymphadenectomy—removal of the common iliac, external iliac, hypogastric, and obturator lymphatic vessels and nodes
- Pelvic exenteration—removal of the pelvic organs, including the bladder or rectum and pelvic lymph nodes, and construction of diversional conduit, colostomy, and vagina
- Radical trachelectomy—removal of the cervix and selected nodes to preserve childbearing capacity in a woman of reproductive age with cervical cancer

Frequent follow-up after surgery by a gynecologic oncologist is imperative because the risk of recurrence is 35% after treatment for invasive cervical cancer. Recurrence usually occurs within the first 2 years. Recurrences are often in the upper quarter of the vagina, and ureteral obstruction may be a sign. Weight loss, leg edema, and pelvic pain may be signs of lymphatic obstruction and metastasis. Micrometastases have been found in patients with negative lymph nodes.

Radiation, which is often part of treatment to reduce recurrent disease, may be delivered by an external beam or by **brachytherapy** (method by which the radiation source is placed near the tumor) or both. The field to be irradiated and dose of radiation are determined by stage, volume of tumor, and lymph node involvement. Treatment can be administered daily for 4 to 6 weeks followed by one or two treatments of intracavitary radiation. Interstitial therapy may be used when vaginal placement has become impossible because of tumor or stricture.

Platinum-based agents are being used to treat advanced cervical cancer. They are often used in combination with radiation therapy, surgery, or both. Studies are ongoing to find the best approach to treat advanced cervical cancer. Vaginal stenosis is a frequent side effect of radiation. Sexual activity, with lubrication, is preventive, as is use of a vaginal dilator to avoid severe permanent vaginal stenosis.

Some patients with recurrences of cervical cancer are considered for **pelvic exenteration,** in which a large portion of the pelvic contents is removed. This is a complex, extensive surgical procedure that is reserved for women with a high likelihood of cure. Unilateral leg edema, sciatica, and ureteral obstruction indicate likely disease progression. Patients with these symptoms have advanced disease and are not considered candidates for this major surgical procedure.

Surgery is often complex because it is performed close to the bowel, bladder, ureters, and great vessels. Complications can be considerable and include pulmonary emboli, pulmonary edema, myocardial infarction, cerebrovascular accident, hemorrhage, sepsis, small bowel obstruction, fistula formation, obstruction of the ileal conduit, bladder dysfunction, and pyelonephritis, most often in the first 18 months. Vein constriction must be avoided postoperatively. Patients with varicose veins or a history of thromboembolic disease may be treated prophylactically with heparin. Antiembolism stockings are prescribed to reduce the risk of deep vein thrombosis (DVT). Nursing care of these patients is complex and requires coordination and care by experienced health care professionals. Pelvic exenteration is discussed in further detail later in this chapter.

## Cancer of the Uterus (Endometrium)

Although the incidence of cancer of the uterine endometrium (fundus or corpus) has stabilized, the death rate from this cancer has increased, possibly because of increased lifespan and coexisting comorbidities. This cancer is the most frequently occurring gynecological cancer in the United States. After breast, colorectal, and lung cancer, endometrial cancer is the fourth most common cancer in women. More than 42,100 new cases of uterine cancer occur each year, with more than 7,800 deaths (ACS, 2009). Most women are diagnosed between 55 and 64 years of age. Seventy percent of women with endometrial cancer are obese; obesity increases the risk of morbidity and mortality from this disease. This disease occurs twice as often in Caucasian women as in African American women, who have a less favorable prognosis, and research is needed to explain this disparity (Sorosky, 2008). Cumulative exposure to estrogen is considered the major risk factor (Chart 47-7). This exposure occurs with the use of estrogen therapy without the use of progestin, early menarche, late menopause, nulliparity, and anovulation. Other risk factors include obesity, infertility, and diabetes, as well as use of tamoxifen. This medication, taken for treatment or prevention of breast cancer, may cause proliferation of the uterine lining (ACOG, 2006d). Women who take it should be monitored by their oncologists and gynecologic health care providers.

**CHART 47-7** *Risk Factors for Uterine Cancer*

- Age: at least 55 years; median age, 61 years
- Obesity that results in increased estrone levels (related to excess weight) resulting from conversion of androstenedione to estrone in body fat, which exposes the uterus to unopposed estrogen
- Unopposed estrogen therapy (estrogen used without progesterone, which offsets the risk of unopposed estrogen)
- Other: nulliparity, truncal obesity, late menopause (after 52 years of age) and use of tamoxifen

### Pathophysiology

Most uterine cancers are endometrioid (ie, originating in the lining of the uterus). There are three types. Type 1, which accounts for the majority of cases, is estrogen related and occurs in younger, obese, and perimenopausal women. It is usually low grade and endometrioid. Type 2, which occurs in about 10% of cases, is high grade and usually serous cell or clear cell. It affects older women and African American women. Type 3, which also occurs in about 10% of cases, is the hereditary and genetic types, some of which are related to Lynch II syndrome. (This syndrome is associated with the occurrence of breast, ovarian, colon, endometrial, and other cancers throughout a family.)

### Assessment and Diagnostic Findings

All women should be encouraged to have annual checkups, including a gynecologic examination. Any woman who is experiencing irregular bleeding should be evaluated promptly. If a menopausal woman experiences bleeding, an endometrial aspiration or biopsy is performed to rule out hyperplasia, a possible precursor of endometrial cancer. The procedure is quick and usually painless. Ultrasonography can also be used to measure the thickness of the endometrium. (Postmenopausal women should have a very thin endometrium due to low levels of estrogen; a thicker lining warrants further investigation.) A biopsy or aspiration for tissue pathology is diagnostic.

### Medical Management

Treatment of endometrial cancer consists of total or radical hysterectomy (discussed later in this chapter) and bilateral salpingo-oophorectomy and node sampling. It is necessary to monitor cancer antigen 125 (CA-125) levels, because elevated levels are a significant predictor of extrauterine disease or metastasis. Depending on the stage, the therapeutic approach is individualized and is based on stage, type, differentiation, degree of invasion, and node involvement. Adjuvant radiation may be used in a patient who is considered high risk. Vaginal brachytherapy is being studied as adjuvant therapy. Whole pelvis radiotherapy may be used if there is any spread beyond the uterus. Recurrent cancer usually occurs inside the **vaginal vault** or in the upper vagina, and metastasis usually occurs in lymph nodes or the ovary. Recurrent lesions in the vagina are treated with surgery and radiation. Recurrent lesions beyond the vagina are treated with hormonal therapy or chemotherapy. Progestin therapy is used frequently. Patients should be prepared for such side effects as nausea, depression, rash, or mild fluid retention with progestin therapy.

## Cancer of the Vulva

Primary cancer of the vulva represents 4% of all gynecologic malignancies and is seen mostly in postmenopausal women, although its incidence in younger women is increasing. The median age for cancer limited to the vulva is 50 years, whereas the median age for invasive vulvar cancer is 70 years. Possible risk factors include smoking, HPV infection, HIV infection, and immunosuppression. Squamous cell carcinoma

accounts for most primary vulvar tumors. Less common are Bartholin's gland cancer, vulvar sarcoma, and malignant melanoma. Little is known about what causes this disease; however, increased risk may be related to chronic vulvar irritation. In younger women, HPV infection may be implicated, especially types 16, 18, and 31. Prevention includes delaying onset of sexual activity to avoid early exposure to HPV and avoidance of smoking. Regular pelvic examinations, Pap smears, and vulvar self-examination are helpful in early detection. Women with persistent irritation or itching should be encouraged to seek evaluation.

## Clinical Manifestations

Long-standing pruritus and soreness are the most common symptoms of vulvar cancer. Itching occurs in half of all patients with vulvar malignancy. Bleeding, foul-smelling discharge, and pain may also be present and are usually signs of advanced disease. Cancerous lesions of the vulva are visible and accessible and grow relatively slowly. Early lesions appear as a chronic dermatitis; later, patients may note a lump that continues to grow and becomes a hard, ulcerated, cauliflower-like growth. Biopsy should be performed on any vulvar lesion that persists, ulcerates, or fails to heal quickly with proper therapy. Vulvar malignancies may appear as a lump or mass, redness, or a lesion that fails to heal.

Nurses are in an ideal position to encourage women to perform vulvar self-examinations regularly. Using a mirror, patients can see what constitutes normal female anatomy and learn about changes that should be reported (eg, lesions, ulcers, masses, and persistent itching). Nurses must urge women to seek health care if they notice anything abnormal, because vulvar cancer is one of the most curable of all malignant conditions.

## Medical Management

Vulvar intraepithelial lesions are preinvasive and are also called vulvar carcinoma in situ. They may be treated by local excision, laser ablation, application of chemotherapeutic creams, or cryosurgery.

When invasive vulvar carcinoma exists, primary treatment may include wide excision or removal of the vulva **(vulvectomy)**. An effort is made to individualize treatment, depending on the extent of the disease. A wide excision is performed only if lymph nodes are normal. More pervasive lesions require vulvectomy with deep pelvic node dissection. Vulvectomy is very effective at prolonging life but is frequently followed by complications (ie, scarring, wound breakdown, leg swelling, vaginal stenosis, or rectocele). To reduce complications, only necessary tissue is removed. External beam radiation may be used, resulting in sunburn-like irritation that usually resolves in 6 to 12 months. Laser therapy and chemotherapy are other possible treatment options.

If a widespread area is involved or the disease is advanced, a radical vulvectomy with bilateral groin dissection may be performed. Antibiotic and heparin prophylaxis may be prescribed preoperatively and continued postoperatively to prevent infection, DVT, and pulmonary emboli. Antiembolism stockings are applied to reduce the risk of DVT.

Although the role of systemic chemotherapy in the treatment of vulvar cancer remains to be determined, chemotherapy may be useful when used in combination with radiation therapy for the treatment of advanced disease. The combination of radiation and chemotherapy may reduce the size of the cancer, resulting in less extensive subsequent surgery (ACS, 2009).

Clinical trials to determine the most effective treatment are difficult to conduct because there are few patients with this condition. Morbidity with recurrence of the disease is high, and patterns of recurrence vary. Reconstruction after vulvectomy is performed by plastic surgeons when appropriate and desired.

## Nursing Management

### *Assessment*

The health history is a valuable tool for establishing rapport with the patient. The reason the patient is seeking health care is apparent. What the nurse can tactfully elicit is the reason why a delay, if any, occurred, in seeking health care—for example, because of modesty, economics, denial, neglect, or fear (abusive partners sometimes prevent women from seeking health care). Factors involved in any delay in seeking health care and treatment may also affect recovery. The patient's health habits and lifestyle are assessed, and her receptivity to teaching is evaluated. Psychosocial factors are also assessed. Preoperative preparation and psychological support begin at this time.

### *Preoperative Nursing Interventions*

#### Relieving Anxiety

Prior to surgery, the patient must be allowed time to talk and ask questions. Fear often decreases when a woman who is to undergo wide excision of the vulva or vulvectomy learns that the possibility for subsequent sexual relations is good and that pregnancy is possible after a wide excision. The nurse reinforces the information the physician has given to the patient and addresses the patient's questions and concerns.

#### Preparing Skin for Surgery

Skin preparation may include cleansing the lower abdomen, inguinal areas, upper thighs, and vulva with a detergent germicide for several days before the surgical procedure. The patient may be instructed to do this at home.

### *Postoperative Nursing Interventions*

#### Relieving Pain

Because of the wide excision, the patient may experience severe pain and discomfort even with minimal movement. Therefore, analgesic agents are administered preventively (ie, around the clock at designated times) to relieve pain, increase the patient's comfort level, and allow mobility. Patient-controlled analgesia (see Chapter 13) may be used to relieve pain and promote patient comfort. Careful positioning using pillows usually increases comfort, as do soothing back rubs. A low Fowler's position or, occasionally, a pillow placed under the knees reduces pain by relieving tension on the incision; however, efforts must be made to avoid pressure behind the knees, which increases the risk of DVT. Positioning the patient on her side, with pillows between her

legs and against the lumbar region, provides comfort and reduces tension on the surgical wound.

**Improving Skin Integrity**

A pressure-reducing mattress may be used to prevent pressure ulcers. Moving from one position to another requires time and effort; use of an overbed trapeze bar may help the patient move herself more easily. Ambulation may be attempted on the second day.

The extent of the surgical incision and the type of dressing are considered when choosing strategies to promote skin integrity. Intact skin needs to be protected from drainage and moisture. Dressings are changed as needed to ensure patient comfort, to perform wound care and irrigation (if prescribed), and to permit observation of the surgical site.

The wound is usually cleansed daily with warm, normal saline irrigations or other antiseptic solutions as prescribed, or a transparent dressing may be in place over the wound to minimize exposure to the air and subsequent pain. The appearance of the surgical site and the characteristics of drainage are assessed and documented. After the dressings are removed, a bed cradle may be used to keep the bed linens away from the surgical site. The patient is always protected from exposure when visitors arrive or someone else enters the room.

**Supporting Positive Sexuality and Sexual Function**

The patient who undergoes vulvar surgery usually experiences concerns about body image, sexual attractiveness, and functioning. Establishing a trusting nurse–patient relationship is important for the patient to feel comfortable expressing her concerns and fears. The patient is encouraged to discuss her concerns with her sexual partner.

Because alterations in sexual sensation and functioning depend on the extent of surgery, the nurse needs to know about any structural and functional changes resulting from the surgery. Referral of the patient and her partner to a sex counselor may help them address these changes and resume satisfying sexual activity.

**Monitoring and Managing Potential Complications**

Location, extent, and exposure of the surgical site and incision put the patient at risk for contamination of the site and infection and sepsis. The patient is monitored closely for local and systemic signs and symptoms of infection: purulent drainage, redness, increased pain, fever, and increased white blood cell count. The nurse assists in obtaining specimens for culture if infection is suspected and administers antibiotic agents as prescribed. Hand hygiene, always a crucial infection-preventing measure, is of particular importance along with wearing masks whenever there is an extensive area of exposed tissue. Catheters, drains, and dressings are handled carefully with gloves on to avoid cross-contamination. A low-residue diet prevents straining on defecation and wound contamination.

The patient is at risk for DVT because of the positioning required during surgery, postoperative edema, and the usually prolonged immobility needed to promote healing. Antiembolism stockings are applied, and the patient is encouraged and reminded to perform ankle exercises to minimize venous pooling, which leads to DVT. The patient is encouraged and assisted in changing positions by using the overhead trapeze bar. Pressure behind the knees is avoided when positioning the patient because this may increase venous pooling. The patient is assessed for signs and symptoms of DVT (leg pain, redness, warmth, edema) and pulmonary embolism (chest pain, tachycardia, dyspnea). Fluid intake is encouraged to prevent dehydration, which also increases the risk of DVT.

The extent of the surgical incision and possibly wide excision of tissue increase the risk of postoperative bleeding and hemorrhage. Although the pressure dressings that are applied after surgery minimize the risk, the patient must be monitored closely for signs of hemorrhage and resulting hypovolemic shock. These signs may include decreased blood pressure; increased pulse rate; decreased urine output; decreased mental status; and cold, clammy skin.

If hemorrhage and shock occur, interventions include fluid replacement, blood component therapy, and vasopressor medications. Laboratory results (eg, hematocrit and hemoglobin levels) and hemodynamic monitoring are used to assess the patient's response to treatment. Depending on the specific cause of hemorrhage, the patient may be returned to the operating room. See Chapter 15 for a detailed discussion of shock.

### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

Preparing the patient for hospital discharge begins before hospital admission. The patient and family are informed about what to expect during the immediate postoperative and recovery periods. Depending on the changes resulting from the surgery, the patient and her family may need instruction about wound care, urinary catheterization, and possible complications. The patient is encouraged to share her concerns and to assume increasing responsibility for her own care. She is encouraged and assisted in learning to care for the surgical site. A referral for home care is made as indicated.

**Continuing Care**

Shortened hospital stays may result in the patient's discharge during the early postoperative recovery stage to home or a subacute facility. During this phase, the patient's physical status and psychological responses to the surgery are assessed. In addition, the patient is assessed for complications and healing of the surgical site. During home visits, the nurse assesses the home to determine if modifications are needed to facilitate care. The home visit is used to reinforce previous teaching and to assess the patient's and the family's understanding of and adherence to the prescribed treatment strategies. Follow-up phone calls by the nurse to the patient between home visits are usually reassuring to the patient and family, who may be responsible for performing complex care procedures. Attention to the patient's psychological responses is important because the patient may become discouraged and depressed because of alterations in body image and a slow recovery. Communication between the nurse involved in the patient's immediate postoperative care and the home care nurse is essential to ensure continuity of care.

## Cancer of the Vagina

Cancer of the vagina is rare and usually takes years to develop. Primary cancer of the vagina is usually squamous in origin. Malignant melanoma and sarcomas can occur. Risk factors include previous cervical cancer, in utero exposure to diethylstilbestrol (DES), previous vaginal or vulvar cancer, previous radiation therapy, history of HPV, or pessary use. Any patient with previous cervical cancer should be examined regularly for vaginal lesions.

Before 1970, vaginal cancer occurred primarily in postmenopausal women. In the 1970s, it was shown that maternal ingestion of DES, prescribed from 1938 to 1971 to enhance pregnancy outcomes, affected female offspring who were exposed in utero. DES was prescribed under many brand names, and it is unclear how many pregnant women received it. All patients should be asked about DES exposure if they were born or were pregnant between 1938 and 1971. Benign genital tract abnormalities, such as vaginal adenosis (abnormal tissue growth), cervical irregularities (collars, hoods, septae, cockscombs), and uterine abnormalities, have occurred in approximately one third of exposed women. Clear cell carcinoma of the vagina or cervix may also occur as a result of DES exposure; the risk is 0.14 to 1.4 in 1000 women. However, most female offspring of mothers who took DES are now between 40 and 75 years of age, and diagnosis of this condition has been decreasing. Vigilance is still necessary because it is unknown how long women remain at risk (ACS, 2009). Colposcopy is indicated for all women exposed to DES in utero. If colposcopic examination discloses adenosis or a significant cervical or vaginal lesion, follow-up is essential. In addition, health care providers should be aware that men who were exposed to DES in utero may have an increased risk of developing epididymal cysts.

Vaginal pessaries, used to support prolapsed tissues, can be a source of chronic irritation. As such, they have been associated with vaginal cancer, but only when the devices were not cared for properly (ie, the device was not cleaned regularly or the patient did not return to the health care provider regularly for vaginal examinations).

Patients often do not have symptoms but may report slight bleeding after intercourse, spontaneous bleeding, vaginal discharge, pain, and urinary or rectal symptoms (or both). Diagnosis is often by Pap smear of the vagina. Encouraging close follow-up by health care providers is the primary focus of nursing interventions with women who were exposed to DES in utero. Emotional support for mothers who received DES before its risks were discovered and their daughters who were exposed to DES in utero is essential.

### Medical Management

Treatment of early lesions may include local excision, topical chemotherapy, or laser. Laser therapy is a common treatment option in early vaginal and vulvar cancer. Surgery for more advanced lesions depends on the size and the stage of the cancer. If radical vaginectomy is required, a vagina can be reconstructed with tissue from the intestine, muscle, or skin grafts. After vaginal reconstructive surgery and radiation, regular intercourse may be helpful in preventing vaginal stenosis. Water-soluble lubricants are helpful in reducing pain with intercourse (dyspareunia).

Following surgery, radiation therapy may be administered by a variety of methods, including external beam radiation, which is usually an outpatient procedure, or brachytherapy, which is internal radiation therapy. Internal radiation may be given with intracavitary radioactive material contained in a seed, wire, needle, or tube, which is placed into a cavity such as the uterus or vagina. Interstitial radiation is another type of internal radiation treatment in which the radioactive material is placed in or near the cancer but not into a body cavity and is used in cervical and ovarian malignancies. These treatments may be high dose for a short period or low dose, which may take longer. Treatment during hospitalization or during outpatient therapy depends on several factors, including the status of the patient and the mode of delivery.

## Cancer of the Fallopian Tubes

Malignancies of the fallopian tube are the least common type of genital cancer. Although this type of cancer can occur at any age, the average age at diagnosis is 55 years. Symptoms include abdominal pain, abnormal bleeding, and vaginal discharge. An enlarged fallopian tube may be found on sonogram if dilated and fluid filled or it may appear or be palpated as a mass. Surgery followed by radiation therapy is the usual treatment.

## Cancer of the Ovary

Ovarian cancer is the leading cause of gynecological cancer deaths in the United States (Jemal, Siegel, Ward, et al., 2007). Despite careful physical examination, ovarian tumors are often difficult to detect because they are usually deep in the pelvis. No early screening mechanism exists at present, although tumor markers are being explored. Transvaginal ultrasound and CA-125 antigen testing may be reassuring for women who have a high risk for this condition, and clinical trials are under way to evaluate the effect of these screening modalities on mortality from ovarian cancer. Tumor-associated antigens are helpful in determining follow-up care after diagnosis and treatment but not in early general screening.

### Epidemiology

One woman in 70 will develop ovarian cancer in her lifetime. The incidence of this type of cancer increases after 40 years of age and peaks in the early 80s; the median age of affected women is 63 years. The frequency of ovarian cancer is highest in industrialized countries, except for Japan, where it is low. The incidence seems to be remaining constant, and 5-year survival has improved (Bhoola & Hoskins, 2006). Pregnancy and use of oral contraceptives decrease risk. Mutations of *BRCA1* and *BRCA2* increase risk; the lifetime risk for women with these mutations is 28% to 40% (the higher percentage is in Ashkenazi Jews).

A woman with ovarian cancer has a threefold to fourfold increased risk of breast cancer, and a woman with breast

cancer has an increased risk of ovarian cancer. A family history, older age, low parity, and obesity may increase risk of ovarian cancer. However, most women who develop ovarian cancer have no known risk factors, and no definitive causative factors have been determined.

Genetic testing is indicated when three or more cases of closely related family members have premenopausal breast cancer or ovarian cancer. One member with cancer is tested, and if the results are positive, other members without cancer may undergo testing. This testing is available at centers with genetics counselors or nurses with expertise in genetics counseling. Many health care providers advocate pelvic examinations every 6 months for women who have one or two relatives with ovarian cancer. It is recommended that women with a family history of breast or ovarian cancer undergo periodic screening.

Much more needs to be learned about the risks associated with some mutations, the reliability of testing, and the efficacy of follow-up. Confidentiality and insurance risks are ethical issues that need clarification. Because there are no primary methods of preventing breast or ovarian cancer, emotional distress is also an issue. Patients with concerns about their family history should be referred to a cancer genetics center to obtain information and testing, if indicated. Women with inherited types of ovarian cancer tend to be younger when the diagnosis is made than the average age at the time of diagnosis. Prophylactic oophorectomy in women with genetic mutations has been found to be associated with decreased risk of ovarian and other gynecologic cancers as well as breast cancer and is an option for women who have completed childbearing (ACOG, 2008a). Hereditary nonpolyposis colon cancer increases the risk of uterine cancer and slightly increases the risk of ovarian cancer.

## Pathophysiology

Types of tumors include germ cell tumors, which arise from the cells that produce eggs; stromal cell tumors, which arise in connective tissue cells that produce hormones; and epithelial tumors, which originate from the outer surface of the ovary. Most ovarian cancers are epithelial in origin. Of the many different cell types in ovarian cancer, epithelial tumors constitute 90%. Germ cell tumors and stromal tumors make up the other 10%.

Primary peritoneal carcinoma is closely related to ovarian cancer. Extraovarian primary peritoneal carcinoma (EOPPC) resembles ovarian cancer histologically and can occur in women with and without ovaries. Symptoms and treatment are similar. Because of the possibility of EOPPC, oophorectomy does not guarantee that the patient will not develop carcinoma following hysterectomy.

## Clinical Manifestations

Symptoms of ovarian cancer are nonspecific and may include increased abdominal girth, pelvic pressure, bloating, back pain, constipation, abdominal pain, urinary urgency, indigestion, flatulence, increased waist size, leg pain, and pelvic pain. Symptoms are often vague, so many women tend to ignore them. Ovarian cancer is often silent, but enlargement of the abdomen from an accumulation of fluid is the most common sign. All women with gastrointestinal symptoms and without a known diagnosis must be evaluated for potential ovarian cancer. Vague, undiagnosed, persistent gastrointestinal symptoms should alert the nurse to the possibility of an early ovarian malignancy. A palpable ovary in a woman who has gone through menopause is investigated immediately because ovaries normally become smaller and less palpable after menopause.

## Assessment and Diagnostic Findings

Any enlarged ovary must be investigated. Pelvic examination often does not detect early ovarian cancer, and pelvic imaging techniques are not always definitive. Ovarian tumors are classified as benign if there is no proliferation or invasion, borderline if there is proliferation but no invasion, and malignant if there is invasion. Fifteen percent of all new cases of ovarian tumors are classified as borderline and have low malignancy potential. However, by the time of diagnosis, most ovarian cancers are advanced (Ryerson, Eheman, Burton, et al., 2007).

## Surgical Management

Surgical staging, exploration, and reduction of tumor mass are the basics of treatment. Surgical removal is the treatment of choice; the preoperative workup may include a barium enema or colonoscopy, upper gastrointestinal series, MRI, ultrasound, chest x-rays, and IV urography. CT may be used preoperatively to rule out intra-abdominal metastasis. Staging the tumor by the TNM system is performed to guide treatment (Chart 47-8). Likely treatment involves a total abdominal hysterectomy with removal of the fallopian tubes and ovaries and possibly the omentum (bilateral salpingo-oophorectomy and omentectomy); tumor debulking; para-aortic and pelvic lymph node sampling; diaphragmatic biopsies; random peritoneal biopsies; and cytologic washings. Postoperative management may include taxanes or platinum-based chemotherapy (discussed in next section).

Borderline tumors resemble ovarian cancer but have much more favorable outcomes. Women diagnosed with this type of cancer tend to be younger (early 40s). A conservative surgical approach is now used. The affected ovary is removed, but the uterus and the contralateral ovary may remain in place. Adjuvant therapy may not be warranted.

**Chart 47-8 • *Stages of Ovarian Cancer***

**I** Cancer is contained within the ovary (or ovaries).

**II** Cancer is in one or both ovaries and has involved other organs (ie, uterus, fallopian tubes, bladder, the sigmoid colon, or the rectum) within the pelvis.

**III** Cancer involves one or both ovaries, and one or both of the following are present: (1) cancer has spread beyond the pelvis to the lining of the abdomen; (2) cancer has spread to lymph nodes.

**IV** The most advanced stage of ovarian cancer. Cancer is in one or both ovaries. There is distant metastasis to the liver, lungs, or other organs outside the peritoneal cavity; ovarian cancer cells in the pleural cavity are evidence of stage IV disease.

## Pharmacologic Therapy

Chemotherapy is usually administered IV on an outpatient basis using a combination of platinum and taxane agents. Paclitaxel (Taxol) plus carboplatin (Paraplatin) are most often used because of their excellent clinical benefits and manageable toxicity. Leukopenia, neurotoxicity, and fever may occur.

Because paclitaxel often causes leukopenia, patients may need to take granulocyte colony-stimulating factor as well. Paclitaxel is contraindicated in patients with hypersensitivity to medications formulated in polyoxyethylated castor oil and in patients with baseline neutropenia. Because of possible adverse cardiac effects, paclitaxel is not used in patients with cardiac disorders. Hypotension, dyspnea, angioedema, and urticaria indicate severe reactions that usually occur soon after the first and second doses are administered. The nurse must be prepared to assist in treating anaphylaxis. Patients should be prepared for inevitable hair loss.

Carboplatin may be used in the initial treatment and in patients with recurrence. It should be used with caution in patients with renal impairment. Usually, six cycles are given. A positive clinical response is normalization of the tumor marker CA-125, negative CT results, and a normal physical and gynecologic examination.

**Liposomal therapy,** delivery of chemotherapy in a liposome, allows the highest possible dose of chemotherapy to the tumor target with a reduction in adverse effects. Liposomes are used as drug carriers because they are nontoxic, biodegradable, easily available, and relatively inexpensive. This encapsulated chemotherapy allows increased duration of action and better targeting. The encapsulation of doxorubicin (Doxil) lessens the incidence of nausea, vomiting, and alopecia. Patients must be monitored for bone marrow suppression and gastrointestinal and cardiac effects.

Combination IV and intraperitoneal chemotherapy is an option for some patients. However, this treatment may result in pain; fatigue; and hematologic, gastrointestinal, metabolic, and neurologic toxicities, thus decreasing the quality of life (ACOG, 2008b). Because of these effects, the decision to use intraperitoneal chemotherapy is individualized.

Genetic engineering and identification of cancer genes may make gene therapy a future possibility; gene therapy is under investigation. Emerging proteomic technologies (tissue-based protein analysis) look promising; they may allow earlier diagnosis and treatment decision making. New biomarkers need further validation, but protein signature patterns are now being tested. These technologies may result in individualized treatment strategies for epithelial ovarian cancer.

Recurrence of ovarian cancer is common, and many patients may require treatment with multiple agents. Therefore, ovarian cancer may be considered a chronic disease, with treatment directed toward control of the cancer, maintenance of quality of life, and palliation. Liposomal preparations, intraperitoneal drug administration, anti-cancer vaccines, monoclonal antibodies directed against cancer antigens, gene therapy, and antiangiogenic treatments (to prevent formation of new blood vessels in an effort to halt growth of ovarian cancer) may be used in the treatment of recurrence. Gemcitabine (Gemzar), topotecan (Hycamtin), paclitaxel, carboplatin, and doxorubicin are all being studied in clinical trials in advanced ovarian cancer (Bhoola & Hoskins, 2006).

## Nursing Management

Nursing measures include those related to the patient's treatment plan, which may include surgery, chemotherapy, palliative care, or a combination of these. Emotional support, comfort measures, and information, plus attentiveness and caring, are important components of nursing care for the patient and her family (Bohnenkamp, LeBaron & Yoder, 2007a).

Nursing interventions after pelvic surgery to remove the tumor are similar to those after other abdominal surgeries. If ovarian cancer occurs in a young woman and the tumor is unilateral, it is removed. Childbearing, if desired, is encouraged in the near future. After childbirth, surgical reexploration may be performed, and the remaining ovary may be removed. If both ovaries are involved, bilateral oophorectomy is performed and chemotherapy follows. Chart 47-9 describes symptom clusters in women who are survivors of ovarian cancer.

Patients with advanced ovarian cancer may develop ascites and pleural effusion. Nursing care may include administering IV fluids prescribed to alleviate fluid and electrolyte imbalances, administering parenteral nutrition to provide adequate nutrition, providing postoperative care after intestinal bypass to alleviate any obstruction, controlling pain, and managing drainage tubes. Comfort measures for women with ascites may include providing small frequent meals, decreasing fluid intake, administering diuretic agents, and providing rest. Patients with pleural effusion may experience shortness of breath, hypoxia, pleuritic chest pain, and cough. Thoracentesis is usually performed to relieve these symptoms. The patient with ovarian cancer often has complex needs and benefits from the assistance and support of an oncology nurse specialist (Bohnenkamp, LeBaron & Yoder, 2007b).

# Hysterectomy

Hysterectomy is the surgical removal of the uterus to treat cancer, dysfunctional uterine bleeding, endometriosis, nonmalignant growths, persistent pain, pelvic relaxation and prolapse, and previous injury to the uterus. In the United States, approximately 5.5 of every 1000 women undergo hysterectomy each year (Wu, Wechter, Geller, et al., 2007). The number is thought to be leveling off because the number of other therapeutic options (ie, laser therapy, endometrial ablation, UAE, and medications to shrink fibroid tumors) has increased.

A total hysterectomy involves removal of the uterus and the cervix. Hysterectomy can be supracervical or subtotal, in which the uterus is removed but the cervix is spared. Radical hysterectomy involves removal of the uterus as well as the surrounding tissue, including the upper third of the vagina and pelvic lymph nodes. The procedure can be performed through the vagina, through an abdominal incision,

CHART 47-9

**NURSING RESEARCH PROFILE**

## *Quality of Life in Survivors of Ovarian Cancer*

Fox, S. W. & Lyon, D. (2007). Symptom clusters and quality of life in survivors of ovarian cancer. *Cancer Nursing, 30*(5), 270–282.

**Purpose**

The purpose of this study was to identify relationships among depression, fatigue, and pain in survivors of ovarian cancer to determine if a possible cluster of symptoms exists in patients with ovarian cancer. Further, the researchers examined the relationship of a cluster of symptoms to quality of life (QOL) in women with ovarian cancer. Few studies have addressed symptoms in women with ovarian cancer, even though it is the fourth leading cause of cancer-related deaths in the United States.

**Design**

This correlational study involved secondary data analysis from 76 women with ovarian cancer. The study from which the data were obtained addressed the psychometric properties of a new health-related QOL instrument. The subjects were recruited from an online information and support group. The Short Form-36 Health Status Survey (SF-36) was used to address symptoms of depression, fatigue, and bodily pain. The Fox Simple Quality of Life Scale (FSQOLS) was used to measure QOL. The reliability and validity of both the SF-36 and the FSQOLS have been established. Statistical analysis, including multiple regression, was used to identify possible symptom clusters and the relationship of clusters with QOL.

**Findings**

Scores of women were compared to those of other groups. The scores on pain and depression of the ovarian cancer survivors were similar to those of a group of similar age of a well population; however, they had significantly greater fatigue than the well population. Depression was significantly correlated with fatigue ($r = .49$), and fatigue was significantly correlated with pain ($r = .35$). Although the sample of 76 women with ovarian cancer had a mean QOL score of 99 (on a scale of 25 to 125, with higher scores representing better QOL), depression ($r = .58$) and fatigue ($r = .51$) were significantly correlated with QOL. There was not a significant correlation of pain with QOL. Together, depression and fatigue explained 41% of the variance in QOL, with the depression accounting for most of the variance in QOL scores.

**Nursing Implications**

Because fatigue and depression are common in patients with ovarian cancer and significantly affect QOL, nurses need to address these issues in their care of patients who are ovarian cancer survivors. The results of this study may help nurses and other health care providers target the symptoms that have the greatest effect on QOL. Most women in this study were not actively engaged in treatment; thus, other symptom clusters might be more relevant in patients who are in different phases of treatment.

or laparoscopically (in which the uterus is removed in sections through small incisions using a laparoscope). Malignant conditions usually require a total abdominal hysterectomy and bilateral salpingo-oophorectomy (removal of fallopian tubes and ovaries).

A laparoscopically assisted approach can also be used for vaginal hysterectomy, with excellent results and rapid recovery. This procedure is performed as a short-stay procedure or ambulatory surgery in carefully selected patients.

### Preoperative Management

Patients are advised to discontinue anticoagulant medications, NSAIDs such as aspirin, and vitamin E prior to surgery to reduce the risk of bleeding. Pregnancy is ruled out on the day of surgery. Prophylactic antibiotics may be administered prior to surgery and discontinued the next day. Prevention of thromboembolic events is critical, and methods may include heparin and use of anti-embolism stockings or an intermittent pneumatic compression device.

### Postoperative Management

The principles of general postoperative care for abdominal surgery apply. Major risks are infection and hemorrhage. In addition, because the surgical site is close to the bladder, voiding problems may occur, particularly after a vaginal hysterectomy. Also, edema or nerve trauma may cause temporary loss of bladder tone (bladder atony), and an indwelling catheter may be inserted.

## NURSING PROCESS

### The Patient Undergoing a Hysterectomy

#### Assessment

The health history and the physical and pelvic examination are completed, and laboratory tests are performed. Additional assessment data include the patient's psychosocial responses, because the need for a hysterectomy may elicit strong emotional reactions. If the hysterectomy is performed to remove a malignant tumor, anxiety related to fear of cancer and its consequences adds to the stress of the patient and her family. Women who have had a hysterectomy may be at risk for psychological and physical symptoms. Alternatively, women may note improved physical and mental health after hysterectomy as troublesome symptoms may be alleviated.

#### Diagnosis

***Nursing Diagnoses***

Based on all the assessment data, the major nursing diagnoses may include the following:

- Anxiety related to the diagnosis of cancer, fear of pain, possible perception of loss of femininity or childbearing potential
- Disturbed body image related to altered fertility and fears about sexuality and relationships with partner and family

- Acute pain related to surgery and other adjuvant therapy
- Deficient knowledge of the perioperative aspects of hysterectomy and postoperative self-care

### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications may include the following:
- Hemorrhage
- DVT
- Bladder dysfunction
- Infection

## Planning and Goals

The major goals may include relief of anxiety, acceptance of loss of the uterus, absence of pain or discomfort, increased knowledge of self-care requirements, and absence of complications.

## Nursing Interventions

### *Relieving Anxiety*

Anxiety stems from several factors: unfamiliar environment, the effects of surgery on body image and reproductive ability, fear of pain and other discomfort, and, possibly, feelings of embarrassment about exposure of the genital area in the perioperative period. The nurse determines what the experience means to the patient and encourages her to verbalize her concerns. Throughout the preoperative, postoperative, and recovery periods, explanations are given about physical preparations and procedures that are performed.

Patient education addresses the outcomes of surgery, possible feelings of loss, and options for management of symptoms of menopause. Women vary in their preferences; many want a choice of treatment options, a part in decision making, accurate and useful information at the appropriate time, support from their health care providers, and access to professional and lay support systems (Bohnenkamp, et al., 2007a).

### *Improving Body Image*

The patient may have strong emotional reactions to having a hysterectomy and strong personal feelings related to the diagnosis, views of significant others who may be involved (family, partner), religious beliefs, and fears about prognosis. Concerns such as the inability to have children and the effect on femininity may surface, as may questions about the effects of surgery on sexual relationships, function, and satisfaction. The patient needs reassurance that she will still have a vagina and that she can experience sexual intercourse after temporary postoperative abstinence while tissues heal. Information that sexual satisfaction and orgasm arise from clitoral stimulation rather than from the uterus reassures many women. Most women note some change in sexual feelings after hysterectomy, but they vary in intensity. In some cases, the vagina is shortened by surgery, and this may affect sensitivity or comfort.

When hormonal balance is upset, as often occurs with reproductive system disorders, the patient may experience depression and heightened emotional sensitivity to people and situations. The nurse needs to approach and evaluate each patient individually in light of these factors. A nurse who exhibits interest, concern, and willingness to listen to the patient's fears will help the patient progress through the surgical experience.

### *Relieving Pain*

Postoperative pain and discomfort are common. Therefore, the nurse assesses the intensity of the patient's pain and assists the patient with analgesia as prescribed. Excision of a large tumor could cause edema because of the sudden release of pressure. In the postoperative period, fluids and food may be restricted for 1 or 2 days. If the patient has abdominal distention or flatus, a rectal tube and application of heat to the abdomen may be prescribed. When abdominal auscultation reveals return of bowel sounds and peristalsis, additional fluids and a soft diet are permitted. Early ambulation facilitates the return of normal peristalsis (Bohnenkamp, et al., 2007b).

### *Monitoring and Managing Potential Complications*

**HEMORRHAGE.** Vaginal bleeding and hemorrhage may occur after hysterectomy. To detect these complications early, the nurse counts the perineal pads used, assesses the extent of saturation with blood, and monitors vital signs. Abdominal dressings are monitored for drainage if an abdominal surgical approach was used. In preparation for hospital discharge, the nurse gives prescribed guidelines for activity restrictions to promote healing and to prevent postoperative bleeding. Because many women may go home the day of surgery or within a day or two, they are instructed to contact the nurse or surgeon if bleeding is excessive.

**DEEP VEIN THROMBOSIS.** Because of positioning during surgery, postoperative edema, and decreased activity postoperatively, the patient is at risk for DVT and pulmonary embolism (PE). To minimize the risk, anti-embolism stockings are applied. In addition, the patient is encouraged and assisted to change positions frequently, although pressure under the knees is avoided, and to exercise her legs and feet while in bed. The nurse helps the patient ambulate early in the postoperative period. In addition, the nurse assesses for DVT or phlebitis (leg pain, redness, warmth, edema) and PE (chest pain, tachycardia, dyspnea). If the patient is being discharged home soon after surgery, she is instructed to avoid prolonged sitting in a chair with pressure at the knees, sitting with crossed legs, and inactivity. Furthermore, she is instructed to contact her health care provider if symptoms of DVT or PE occur.

**BLADDER DYSFUNCTION.** Because of possible difficulty in voiding postoperatively, occasionally an indwelling catheter may be inserted before or during surgery and is left in place in the immediate postoperative period. If a catheter is in place, it is usually removed shortly after the patient begins to ambulate. After the catheter is removed, urinary output is monitored; additionally, the abdomen is assessed for distention. If the patient does not void within a prescribed time, measures are initiated to encourage voiding (eg, assisting the patient to the bathroom, pouring warm water over the perineum). If the patient cannot void, catheterization may be necessary. On rare occasions, the patient may be discharged home with the catheter in place and is instructed in its management.

*Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The information provided to the patient is tailored to her needs. She must know what limitations or restrictions, if any, to expect. She is instructed to check the surgical incision daily and to contact her primary health care provider if redness or purulent drainage or discharge occurs. She is informed that her periods are now over but that she may have a slightly bloody discharge for a few days; if bleeding recurs after this time, it should be reported immediately. The patient is instructed about the importance of an adequate oral intake and of maintaining bowel and urinary tract function. The patient is informed that she is likely to recover quickly, but that postoperative fatigue is not unusual.

The patient should resume activities gradually. This does not mean sitting for long periods, because doing so may cause blood to pool in the pelvis, increasing the risk of thromboembolism. The nurse explains that showers are preferable to tub baths to reduce the possibility of infection and to avoid the dangers of injury that may occur when getting in and out of the bathtub. The patient is instructed to avoid straining, lifting, having sexual intercourse, or driving until her surgeon permits these activities (Bohnenkamp, et al., 2007b). Vaginal discharge, foul odor, excessive bleeding, any leg redness or pain, or an elevated temperature should be reported to the primary health care provider promptly. The nurse reinforces information given to patients by their surgeons regarding activities and restrictions.

**CONTINUING CARE.** Follow-up telephone contact provides the nurse with the opportunity to determine whether the patient is recovering without problems and to answer any questions that may have arisen. The patient is reminded about postoperative follow-up appointments. If the patient's ovaries were removed and she finds vasomotor symptoms troublesome, hormone therapy (HT, previously referred to as hormone replacement therapy [HRT]) may be considered. Providing information about the findings of the Women's Health Initiative (2002) study about the benefits and risks of HT promotes informed decision making about its use. Estrogen alone does not seem to increase the risk of breast cancer and may decrease coronary plaques but may increase the risk of Alzheimer's dementia and thromboses (Heiss, Wallace, Anderson, et al., 2008). The patient is reminded to discuss risks and benefits of HT and alternative therapies with her primary care provider. Decisions about use of HT need to be made individually in consultation with this provider.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences decreased anxiety
2. Has improved body image
   a. Discusses changes resulting from surgery with her partner
   b. Verbalizes understanding of her disorder and the treatment plan
   c. Displays minimal depression or anxiety
3. Experiences minimal pain and discomfort
   a. Reports relief of abdominal pain and discomfort
   b. Ambulates without pain
4. Verbalizes knowledge and understanding of self-care
   a. Practices deep-breathing, turning, and leg exercises as instructed
   b. Increases activity and ambulation daily
   c. Reports adequate fluid intake and adequate urinary output
   d. Identifies reportable symptoms
   e. Schedules and keeps follow-up appointments
5. Absence of complications
   a. Has minimal vaginal bleeding and exhibits normal vital signs
   b. Ambulates early
   c. Notes no chest or calf pain and no redness, tenderness, or swelling in the extremities
   d. Reports no urinary problems or abdominal distention

# Radiation Therapy

Radiation may be used in the treatment of cervical, uterine, and ovarian cancers either alone or in combination with surgery and chemotherapy. Several approaches are used to deliver radiation to the female reproductive system: external radiation, intraoperative radiation therapy (IORT), and internal (intracavitary) irradiation or brachytherapy. The cervix and uterus can serve as a receptacle for radioactive sources for internal radiation therapy.

## Methods of Radiation Therapy

### *External Radiation Therapy*

This method of delivering radiation destroys cancerous cells at the skin surface or deeper in the body. Other methods of delivering radiation therapy are more commonly used to treat cancer of the female reproductive system than this method.

### *Intraoperative Radiation Therapy*

IORT allows radiation to be applied directly to the affected area during surgery. An electron beam is directed at the disease site. This direct-view irradiation may be used when para-aortic nodes are involved or for unresectable (inoperable) or partially resectable neoplasms. Benefits include accurate beam direction (which precisely limits the radiation to the tumor) and the ability during treatment to block sensitive organs from radiation. IORT is usually combined with external beam irradiation preoperatively or postoperatively.

### *Internal (Intracavitary) Irradiation*

After the patient receives an anesthetic agent and an examination, specially prepared applicators are inserted into the endometrial cavity and vagina. These devices are not loaded with radioactive material until the patient returns to her room. X-rays are obtained to verify the precise relationship of the applicator to the normal pelvic anatomy and to the tumor. When this step is completed, the radiation oncologist loads the applicators with predetermined amounts of radioactive material. This procedure, called afterloading,

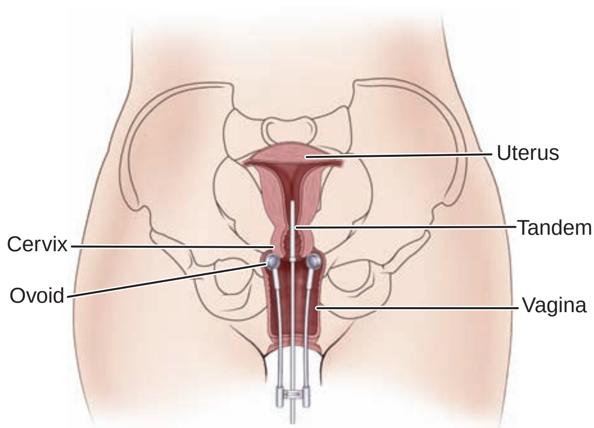



**Figure 47-8** Placement of tandem and ovoids for internal radiation therapy.

allows for precise control of the radiation exposure received by the patient, with minimal exposure of physicians, nurses, and other health care personnel. A patient undergoing internal radiation treatment remains isolated in a private room until the application is completed. Adjacent rooms may need to be evacuated and a lead shield placed at the doorway to the patient's room.

Of the various applicators developed for intracavitary treatment, some are inserted into the endometrial cavity and endocervical canal as multiple small irradiators (eg, Heyman capsules). Others consist of a central tube (a tandem or intrauterine "stem") placed through the dilated endocervical canal into the uterine cavity, which remains in a fixed relationship with the irradiators placed in the upper vagina on each side of the cervix (vaginal ovoids) (Fig. 47-8).

When the applicator is inserted, an indwelling urinary catheter is also inserted. Vaginal packing is inserted to keep the applicator in place and to keep other organs, such as the bladder and rectum, as far from the radioactive source as possible. The objective of the internal treatment is to maintain the distribution of internal radiation at a fixed dosage throughout the application, which may last 24 to 72 hours, depending on dose calculations made by the radiation physicist.

Automated high-dose rate (HDR) intracavitary brachytherapy systems have been developed that allow outpatient radiation therapy. Treatment time is shorter, thereby decreasing patient discomfort. Staff exposure to radiation is also avoided. Isotopes of radium and cesium are used for intracavitary irradiation.

## Nursing Considerations for Radiation Safety

Special precautions for the safety of the patient and the nurse are important considerations when the patient is receiving radiation therapy. The Radiation Safety Department will identify specific safety precautions to those people who will be in contact with the patient, including health care providers and family. Of the many nursing concerns, primary concerns include providing the patient with emotional support and physical comfort. Further details about nursing management are provided in Chapter 16.

## CRITICAL THINKING EXERCISES

EBP **1** A 55-year-old patient has been diagnosed with ovarian cancer. She reports that she has a strong family history of cancer; two sisters have breast cancer. Her mother died of cancer when the patient was a child, and she is not certain of the type of cancer. Because of her strong family history, she is concerned about the health status of her twin daughters who are in their early 30s. She has asked you to discuss the risks for cancer with them. Explain what counseling and education you will provide to the patient and her daughters. Identify the evidence base for the counseling and education and the strength of that evidence. How will you approach your counseling and education?

**2** A 65-year-old woman with rheumatoid arthritis who has had surgery for breast cancer is scheduled to undergo radical vulvectomy to treat vulvar cancer. She reports that she is very anxious because of her previous surgery. Describe the preoperative teaching for her and the postoperative care that can be anticipated. How will her history of breast cancer and rheumatoid arthritis affect her care? What modifications in care, postoperative teaching, and discharge planning may be necessary because of these health issues? How will your discharge planning be modified if the patient tells you that she provides care at home for her husband who has signs of early Alzheimer's disease?

**3** A 38-year-old woman with a diagnosis of fibroids has been admitted to the outpatient surgery center for uterine artery embolization. When you are completing the preoperative admission procedures, she asks you about the effect of the procedure on future sexual relationships and on her ability to become pregnant in the future. What teaching is indicated for this woman based on her concerns and on her risk for future fertility? What nursing care is important to minimize the risk of complications?

EBP **4** A 17-year-old patient is seeking contraception. She explains that she has not had a sexual relationship but wants to be prepared for future sexual relationships. She also asks you for your recommendation about receiving the new HPV vaccine. What recommendations would you give her about contraception and the HPV vaccine? What is the evidence base for your recommendations? How would you approach the topic of safer sex, contraception, and HPV vaccine with her in responding to her request for information?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Cancer Society, www.cancer.org

American Social Health Association, www.ashastd.org/hpv_overview.cfm

Association of Reproductive Health Professionals, www.arhp.org

Association of Women's Health, Obstetrical and Neonatal Nurses (AWHONN), www.awhonn.org

Centers for Disease Control and Prevention, Office of Women's Health, www.cdc.gov/women/

Endometriosis Association, www.endometriosisassn.org

Gay and Lesbian Medical Association, www.glma.org

Herpes Hotline: (919) 361-8488.

National Ovarian Cancer Coalition, www.ovarian.org

National STD Hotline: (800) 227-8922 or (800) 342-2437

Ovarian Cancer National Alliance, www.ovariancancer.org

Planned Parenthood Federation of America, www.plannedparenthood.org/sti

Resolve: The National Infertility Association, www.resolve.org

Women's Cancer Network, Gynecologic Cancer Foundation, www.wcn.org



# chapter 48 Assessment and Management of Patients With Breast Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Summarize the guidelines for the early detection of breast cancer.
2. Develop a teaching plan for breast self-examination for patients and consumer groups.
3. Identify and describe the different types of breast disorders, both benign and malignant.
4. Identify the examinations and biopsy procedures used to diagnose breast disorders.
5. Describe the different modalities used to treat breast cancer.
6. Use the nursing process as a framework for care of the patient undergoing surgery for the treatment of breast cancer.
7. Describe the physical, psychosocial, and rehabilitative needs of the patient who has had breast surgery for the treatment of breast cancer.

## GLOSSARY

**adjuvant chemotherapy:** use of anticancer medications in addition to other treatments to delay or prevent a recurrence of the disease
**adjuvant hormonal therapy:** use of synthetic hormones or other medications given after primary treatment to increase the chances of a cure by stopping or slowing the growth of certain cancers that are affected by hormone stimulation (sometimes called endocrine or antiestrogen therapy)
**aromatase inhibitors:** medications that block the production of estrogens by the adrenal glands
**atypical hyperplasia:** abnormal increase in the number of cells in a specific area within the ductal or lobular areas of the breast; this abnormal proliferation increases the risk for cancer
**benign proliferative breast disease:** various types of atypical, yet noncancerous, breast tissue that increase the risk for breast cancer
**brachytherapy:** form of partial breast radiation in which a radioactive source is placed within the lumpectomy site
***BRCA1*** and ***BRCA2:*** genes on chromosome 17 that, when damaged or mutated, increase a woman's risk for breast and/or ovarian cancer compared with women without the mutation
**breast conservation treatment:** surgery to remove a breast tumor and a margin of tissue around the tumor without removing any other part of the breast; may or may not include lymph node removal and radiation therapy
**dose-dense chemotherapy:** administration of chemotherapeutic agents at standard doses with shorter time intervals between each cycle of treatment
**ductal carcinoma in situ (DCIS):** cancer cells starting in the ductal system of the breast not penetrating surrounding tissue

## GLOSSARY *(Continued)*

**estrogen and progesterone receptor assay:** test to determine whether the breast tumor is nourished by hormones; this information helps to determine prognosis and treatment
**fibrocystic breast changes:** term used to describe certain benign changes in the breast, typically associated with palpable nodularity, lumpiness, swelling, or pain
**fine-needle aspiration (FNA):** removal of fluid for diagnostic analysis from a cyst or cells from a mass using a needle and syringe
**galactography:** use of mammography after an injection of radiopaque dye to diagnose problems in the ductal system of the breast
**gynecomastia:** overdeveloped breast tissue typically seen in adolescent boys
**lobular carcinoma in situ (LCIS):** atypical change and proliferation of the lobular cells of the breast; previously considered a premalignant condition but now considered a marker of increased risk for invasive breast cancer
**lymphedema:** chronic swelling of an extremity due to interrupted lymphatic circulation, typically from an axillary lymph node dissection
**mammoplasty:** surgery to reconstruct or change the size or shape of the breast; can be performed for reduction or augmentation
**mastalgia:** breast pain, usually related to hormonal fluctuations or irritation of a nerve
**mastitis:** inflammation or infection of the breast
**modified radical mastectomy:** removal of the breast tissue, nipple–areola complex, and a portion of the axillary lymph nodes
**Paget's disease:** form of breast cancer that begins in the ductal system and involves the nipple, areola, and surrounding skin
**prophylactic mastectomy:** removal of the breast to reduce the risk of breast cancer in women considered to be at high risk
**sentinel lymph node:** first lymph node(s) in the lymphatic basin that receives drainage from the primary tumor in the breast; identified by a radioisotope and/or blue dye
**stereotactic core biopsy:** computer-guided method of core needle biopsy that is useful when masses in the breast cannot be felt but can be visualized using mammography
**surgical biopsy:** Surgical removal of all or a portion of a mass for microscopic examination by a pathologist
**tissue expander followed by permanent implant:** series of breast-reconstructive surgeries after a mastectomy; involves stretching the skin and muscle before inserting the permanent implant
**total mastectomy:** removal of the breast tissue and nipple–areola complex
**transverse rectus abdominis myocutaneous (TRAM) flap:** method of breast reconstruction in which a flap of skin, fat, and muscle from the lower abdomen, with its attached blood supply, is rotated to the mastectomy site
**ultrasonography:** imaging method using high-frequency sound waves to diagnose whether masses are solid or fluid filled

In many cultures, the breast plays a significant role in a woman's sexuality and self-identity. A breast disorder, whether benign or malignant, can cause great anxiety and fear of potential disfigurement, loss of sexual attractiveness, and even death. Nurses, therefore, must have expertise in the assessment and management of not only the physical symptoms but also the psychosocial symptoms associated with breast disorders.

# BREAST ASSESSMENT

## Anatomic and Physiologic Overview

Male and female breasts mature comparably until puberty, when in females estrogen and other hormones initiate breast development. This development usually occurs from 10 to 16 years of age, although the range can vary from 9 to 18 years. Stages of breast development are described as Tanner stages 1 through 5.

- Stage 1 describes a prepubertal breast.
- Stage 2 is breast budding, the first sign of puberty in a female.
- Stage 3 involves further enlargement of breast tissue and the areola (a darker tissue ring around the nipple).
- Stage 4 occurs when the nipple and areola form a secondary mound on top of the breast tissue.
- Stage 5 is the continued development of a larger breast with a single contour.

The breasts are located between the second and sixth ribs over the pectoralis muscle from the sternum to the midaxillary line. An area of breast tissue, called the tail of Spence, extends into the axilla. Fascial bands, called Cooper's ligaments, support the breast on the chest wall. The inframammary fold (or crease) is a ridge of fat at the bottom of the breast.

Each breast contains 12 to 20 cone-shaped lobes, which are made up of glandular elements (lobules and ducts) and separated by fat and fibrous tissue that binds the lobes together. Milk is produced in the lobules and then carried through the ducts to the nipple. Figure 48-1 shows the anatomy of the fully developed breast.

## Assessment

### Health History

When a patient presents with a breast problem, the nurse conducts a general health assessment, including history of medical disorders and previous surgery; family history of diseases, particularly cancer; gynecologic and obstetric history; present medications (including prescriptions, vitamins, and herbal); past and present use of hormonal contraceptives, hormone therapy (HT) (formerly referred to as hormone replacement therapy [HRT]), or fertility treatments; and social habits (eg, smoking, drinking alcohol). Psychosocial information, such as the patient's marital status, occupation, and availability of resources and support people, is obtained. Any recent x-rays or other diagnostic tests are noted. Focused questions pertaining to the breast disorder are asked concerning the onset of the disorder and the length of time it has been present. In addition, the patient is asked if any masses are palpable and if there is any associated pain, swelling, redness, nipple discharge, or skin changes. Knowledge and comfort in practicing breast self-examination (BSE) should also be ascertained from the patient.

### Physical Assessment: Female Breast

A female breast examination can be conducted during any general physical or gynecologic examination or whenever the patient reports an abnormality. The American Cancer Society (ACS) recommends that women at average risk for breast cancer undergo a clinical breast examination at least every 3 years while in their 20s and 30s and then annually thereafter (Smith, Cokkinides & Brawley, 2008). A thorough breast examination, including instruction in BSE, takes at least 10 minutes.

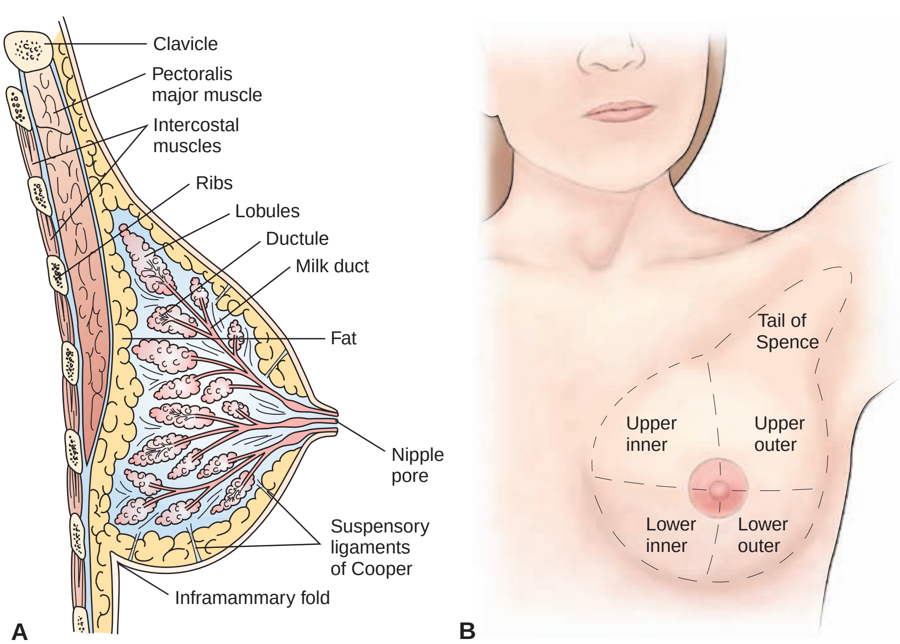



**Figure 48-1** **A,** Anatomy of the breast. **B,** Areas of breast, including the tail of Spence.

### Inspection

Examination begins with inspection. The patient is asked to disrobe to the waist and sit in a comfortable position facing the examiner. The breasts are inspected for size and symmetry. A slight variation in the size of each breast is common and generally normal. The skin is inspected for color, venous pattern, thickening, or edema. Erythema (redness) may indicate benign local inflammation or superficial lymphatic invasion by a neoplasm. A prominent venous pattern can signal increased blood supply required by a tumor. Edema and pitting of the skin may result from a neoplasm blocking lymphatic drainage, giving the skin an orange-peel appearance (peau d'orange), a classic sign of advanced breast cancer. Nipple inversion of one or both breasts is not uncommon and is significant only when of recent origin. Ulceration, rashes, or spontaneous nipple discharge requires evaluation. Examples of abnormal breast findings on inspection can be found in Chart 48-1.

To elicit skin dimpling or retraction that may otherwise go undetected, the examiner instructs the patient to raise both arms overhead. This maneuver normally elevates both breasts equally. The patient is then instructed to place her hands on her waist and push in. These movements, which cause contraction of the pectoral muscles, do not normally alter the breast contour or nipple direction. Any dimpling or retraction during these position changes suggests an underlying mass. The clavicular and axillary regions are inspected for swelling, discoloration, lesions, or enlarged lymph nodes.

### Palpation

The breasts are palpated with the patient sitting up (upright) and lying down (supine). In the supine position the patient's shoulder is first elevated with a small pillow to help balance the breast on the chest wall. Failure to do this allows the breast tissue to slip laterally, and a breast mass may be missed. The entire surface of the breast and the axillary tail is systematically palpated using the flat part (pads) of the second, third, and fourth fingertips, held together, making dime-size circles. The examiner may choose to proceed in a clockwise direction, following imaginary concentric circles from the outer limits of the breast toward the nipple. Other acceptable methods are to palpate from each number on the face of the clock toward the nipple in a clockwise fashion or along imaginary vertical lines on the breast (Fig. 48-2).

Palpation of the axillary and clavicular areas is easily performed with the patient seated (Fig. 48-3). To examine the axillary lymph nodes, the examiner gently abducts the patient's arm from the thorax. With the left hand, the patient's left forearm is grasped and supported. The right hand is then free to palpate the axillae. Any lymph nodes that may be lying against the thoracic wall are noted. Normally, these lymph nodes are not palpable, but if they are enlarged, their location, size, mobility, and consistency are noted. During palpation, the examiner notes any patient-reported tenderness or masses. If a mass is detected, it is described by its location (eg, left breast, 2 cm from the nipple at 2 o'clock position). Size, shape, consistency, border delineation, and mobility are included in the description.

The breast tissue of the adolescent is usually firm and lobular, whereas that of the postmenopausal woman is more likely to feel thinner and fattier. During pregnancy and lactation, the breasts are firmer and larger with lobules that are more distinct. Hormonal changes cause the areola to darken. Cysts are commonly found in menstruating women and are usually well defined and freely movable. Premenstrually, cysts may be larger and more tender. Malignant tumors, on the other hand, tend to be hard, poorly defined, and nontender. A physician should further evaluate any abnormalities detected during inspection and palpation.

## Physical Assessment: Male Breast

Breast cancer can occur in men. Examination of the male breast and axillae should be included in a physical examination. The nipple and areola are inspected for masses and nipple discharge. The same procedure for palpating the female axillae is used when assessing the male axillae.

**Gynecomastia** is the firm enlargement of glandular tissue beneath and immediately surrounding the areola of the male. This is different from the enlargement of soft, fatty tissue, which is caused by obesity.

# *Diagnostic Evaluation*

## Breast Self-Examination

The nurse plays an important role in BSE education, a modality used for the early detection of breast cancer. BSE can be taught in a variety of settings—either on a one-to-one basis or in a group. It can also be initiated by a health care practitioner during a patient's routine physical examination.

Variations in breast tissue occur during the menstrual cycle, pregnancy, and the onset of menopause. Women on HT can also experience fluctuations. Normal changes must be distinguished from those that may signal disease. Most women notice increased tenderness and lumpiness before their menstrual periods; therefore, BSE is best performed after menses (day 5 to day 7, counting the first day of menses as day 1). Also, many women have grainy-textured breast tissue, but these areas are usually less nodular after menses. Younger women may find BSE particularly difficult because of the density of their breast tissue. As women age, their breasts become fattier and may be easier to examine.

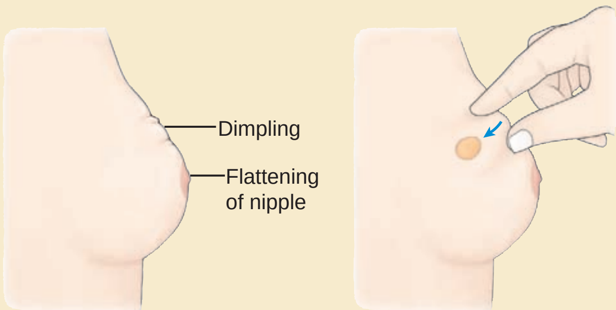
It is estimated that only 25% to 30% of women perform BSE proficiently and regularly each month. Some find BSE to be anxiety producing; others find it too difficult to differentiate between normal changes and worrisome findings. Even women who perform BSE and detect a change may delay seeking medical attention because of fear, economic factors, lack of education, and modesty. Despite these factors, many women discover their own breast cancers. For this reason, BSE should be taught and encouraged but not overemphasized. The ACS recommends that women, beginning in their early 20s, be told about the benefits and limitations of BSE. It is then up to the individual woman whether to perform BSE regularly, irregularly, or not at all (Smith, et al., 2008).

Instructions about BSE should also be provided to men if they have a family history of breast cancer, because they may have an increased risk of male breast cancer.

## Chart 48-1 • *Abnormal Findings During Inspection of the Breasts*

### Retraction Signs

- Signs include skin dimpling, creasing, or changes in the contour of the breast or nipple
- May be secondary to contraction of fibrotic tissue that can occur with underlying malignancy
- May be secondary to scar tissue formation after breast surgery
- Retraction signs may appear only with position changes




Retraction signs    Retraction with compression

### Increased Venous Prominence

- Unilateral localized increase in venous pattern associated with malignant tumors
- Normal with bilateral and symmetrical breast enlargement associated with pregnancy and lactation



Increased venous prominence

### Peau d'Orange (Edema)

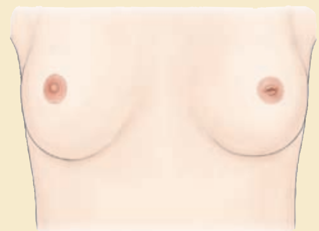
- Associated with inflammatory breast cancer
- Caused by interference with lymphatic drainage
- Breast skin has orange peel appearance
- Skin pores enlarge
- May be noted on the areola
- Skin becomes thick, hard, and immobile



Peau d'orange

### Nipple Inversion

- Considered normal if long-standing
- Associated with fibrosis and malignancy if recent development



Nipple inversion

### Acute Mastitis (Inflammation of the Breasts)

- Associated with lactation but may occur at any age
- Nipple cracks or abrasions noted
- Breast skin reddened and warm to touch
- Tenderness
- Systemic signs include fever and increased pulse

### Paget's Disease (Malignancy of Mammary Ducts)

- Early signs: erythema of nipple and areola
- Late signs: thickening, scaling, and erosion of the nipple and areola



Paget's disease

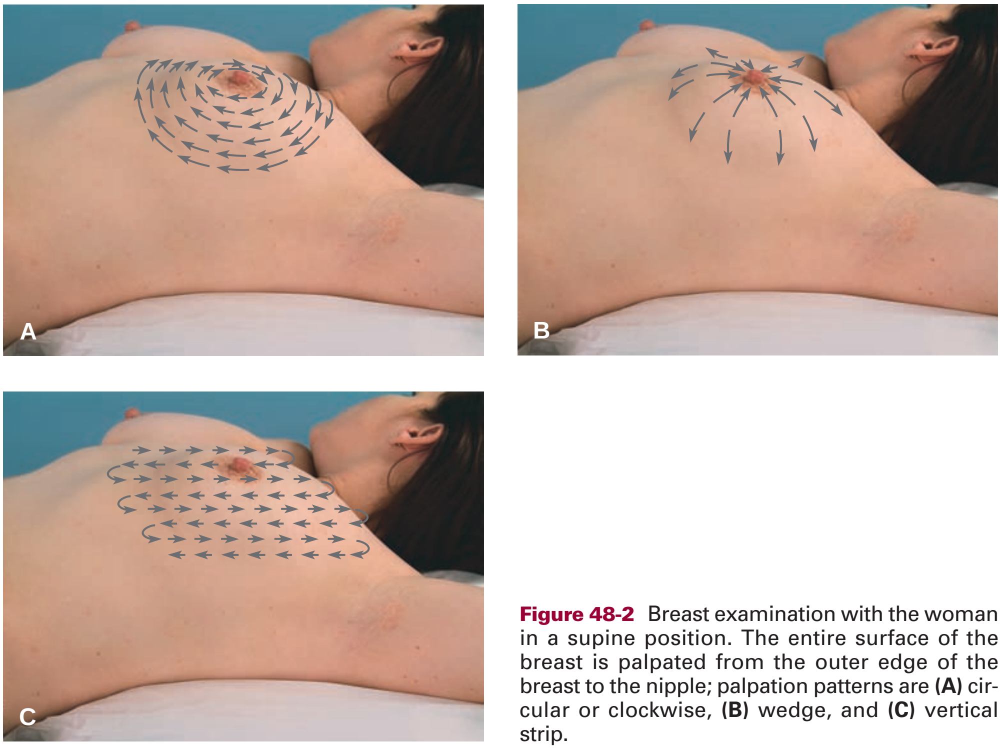



**Figure 48-2** Breast examination with the woman in a supine position. The entire surface of the breast is palpated from the outer edge of the breast to the nipple; palpation patterns are **(A)** circular or clockwise, **(B)** wedge, and **(C)** vertical strip.

Patients who elect to perform BSE should receive proper instruction on technique (Chart 48-2). They should be informed that routine BSE will help them become familiar with their "normal abnormalities." If a change is detected, they should seek medical attention.

Patients should be instructed about optimal timing for BSE (5 to 7 days after menses begin for premenopausal women and once monthly for postmenopausal women). When demonstrating examination techniques, the feel of normal breast tissue should be reviewed and ways to identify breast changes discussed. Patients should then perform a BSE demonstration on themselves or on a breast model. Patients who have had breast cancer surgery should be instructed to examine their breast or chest wall for any new changes or nodules that may indicate a recurrence of the disease.

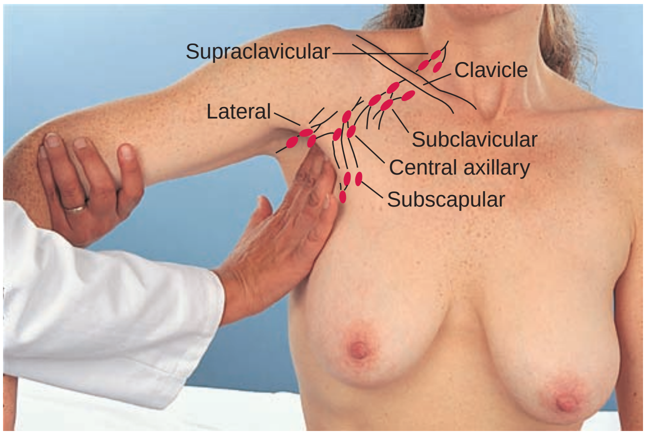



**Figure 48-3** Palpating axillary nodes in breast examination.

BSE videos, shower cards, and pamphlets can be obtained from local chapters of the ACS.

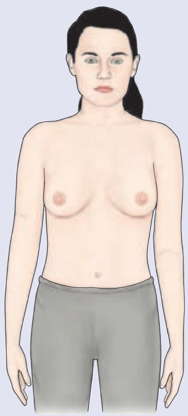
## Mammography

Mammography is a breast-imaging technique that has been shown to reduce breast cancer mortality rates. It can detect nonpalpable lesions and assist in diagnosing palpable masses. The procedure takes about 15 minutes and can be performed in a hospital radiology department or independent imaging center. Two views are taken of each breast. The breast is mechanically compressed from top to bottom (craniocaudal view) and side to side (mediolateral oblique view) (Fig. 48-4). Women may experience some fleeting discomfort because maximum compression is necessary for proper visualization. The new mammogram is compared with previous mammograms, and any changes may indicate a need for further investigation. Mammography may detect a breast tumor before it is clinically palpable (ie, smaller than 1 cm); however, it has limitations. The false-negative rate ranges between 5% and 10%. Younger women, or those taking HT, may have dense breast tissue, making it more difficult to detect lesions with mammography.

Patients scheduled for a mammogram may voice concern about exposure to radiation. The radiation exposure is equivalent to about 1 hour of exposure to sunlight, so patients would have to have many mammograms in a year to increase their cancer risk. The benefits of this test outweigh the risks. To ensure that a mammogram is reliable, it is important that a woman find a reputable facility. A facility that is certified by the Mammography Quality Standards Act must meet stringent quality standards, be accredited by the U.S. Food and Drug Administration (FDA) and be inspected annually.

CHART 48-2 PATIENT EDUCATION

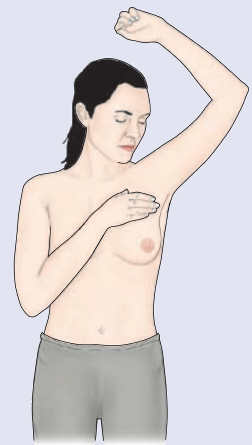
## Breast Self-Examination (BSE)

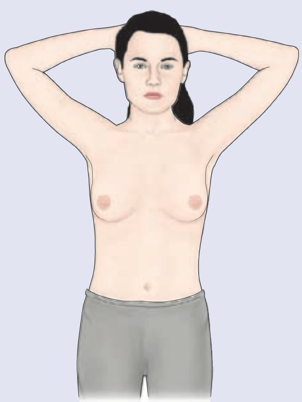


### Step 1

1. Stand in front of a mirror.
2. Check both breasts for anything unusual.
3. Look for discharge from the nipple, puckering, dimpling, or scaling of the skin.

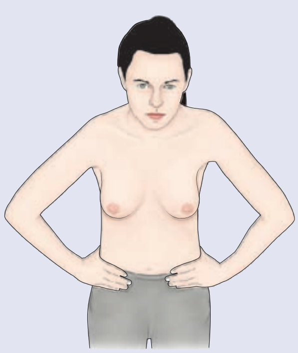
The next two steps are done to check for any changes in the contour of your breasts. As you do them, you should be able to feel your muscles tighten.





### Step 2

1. Watch closely in the mirror as you clasp your hands behind your head and press your hands forward.
2. Note any change in the contour of your breasts.



### Step 3

1. Next, press your hands firmly on your hips and bow slightly toward the mirror as you pull your shoulders and elbows forward.
2. Note any change in the contour of your breasts.

Some women do the next part of the examination in the shower. Your fingers will glide easily over soapy skin, so you can concentrate on feeling for changes inside the breast.

### Step 4

1. Raise your left arm.
2. Use three or four fingers of your right hand to feel your left breast firmly, carefully, and thoroughly.
3. Beginning at the outer edge, press the flat part of your fingers in small circles, moving the circles slowly around the breast.
4. Gradually work toward the nipple.
5. Be sure to cover the whole breast.
6. Pay special attention to the area between the breast and the underarm, including the underarm itself.
7. Feel for any unusual lumps or masses under the skin.
8. If you have any spontaneous discharge during the month—whether or not it is during your BSE—see your doctor.
9. Repeat the examination on your right breast.



### Step 5

1. Step 4 should be repeated lying down.
2. Lie flat on your back with your left arm over your head and a pillow or folded towel under your left shoulder. (This position flattens your breast and makes it easier to check.)
3. Use the same circular motion described above.
4. Repeat on your right breast.

Adapted from U.S. Department of Health and Human Services, Public Health Service, *What you need to know about breast cancer.* Bethesda, MD: National Institutes of Health.

Current mammographic screening guidelines of the ACS recommend a mammogram every year beginning at 40 years of age. There is no upper age limit at which mammography should be discontinued as long as the woman is in good health (Smith, et al., 2008). Women who are at increased risk because of a strong family history should seek the opinion of a breast specialist regarding the optimal age to begin screening mammography. A general guideline is to begin screening 10 years earlier than the age at which the youngest family member developed breast cancer but not before 25 years of age. In families with a history of breast cancer, a downward shift in age of diagnosis of about

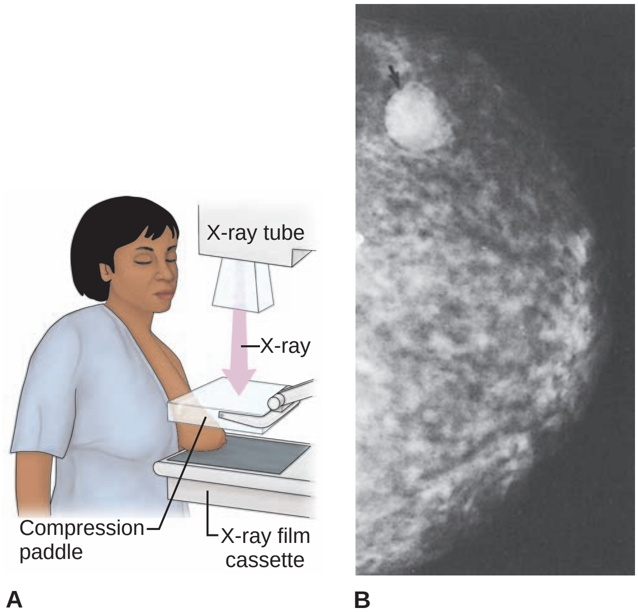



**Figure 48-4** The mammography procedure (**A**) relies on x-ray imaging to produce the mammogram (**B**), which in this case reveals a breast lump.

10 years is seen (eg, grandmother diagnosed with breast cancer at 48 years of age, mother diagnosed with breast cancer at 38 years of age, then daughter should begin screening at age 28 years of age).

Despite the decreased mortality rates associated with mammographic screening, many women are not undergoing this simple procedure. Only 52.9% of non-Hispanic white women older than 40 years of age reported having mammography within the past year. Recent data also suggest a decline in the use of mammography. The screening rate in 2000 was 70% and decreased to 66% in 2005 (Breen, Cronin, Meissner, et al., 2007). The percentage was even lower for women in racial and ethnic minority groups, particularly in those who immigrated to the United States in the past 10 years. Low rates of screening were also seen in women with less education and no health insurance. The implementation of screening programs such as the National Breast and Cervical Cancer Early Detection Program of the Centers for Disease Control and Prevention (CDC) helps low-income, uninsured, and underserved women gain access not only to mammograms but to clinical breast examinations, Papanicolaou (Pap) tests, diagnostic testing for abnormal screening tests, and surgical consultation (CDC, 2007). The program was established in 1991 and has provided more than 7 million screening examinations and diagnosed more than 30,000 patients with breast cancer. Nurses are in key positions to educate women about the current ACS screening guidelines and the benefits of mammography. They can also help identify and provide information to women who may benefit from such screening programs as the one operated by the CDC.

Newer techniques for breast screening include digital mammography and computer-assisted detection (CAD) programs. Digital mammography records x-ray images on a computer instead of on film, thus allowing radiologists to adjust the contrast and focus on an image without having to take additional x-rays. Compared with conventional film mammography, digital mammography has been shown to be significantly better at detecting breast cancer in women younger than 50 years of age, women with dense breast tissue, and premenopausal and perimenopausal women. CAD is designed to assist radiologists in the identification of suspicious areas on a mammogram. Trials of CAD programs have generally, but not always, shown improvements in detection rates (Helvie, 2007). The effectiveness of both digital mammography and CAD continues to be evaluated.

## Galactography

**Galactography** is a diagnostic procedure that involves injection of less than 1 mL of radiopaque material through a cannula inserted into a ductal opening on the areola, which is followed by a mammogram. It is performed to evaluate an abnormality within the duct when the patient has bloody nipple discharge on expression, spontaneous nipple discharge, or a solitary dilated duct noted on mammography.

## Ultrasonography

**Ultrasonography** (ultrasound) is used as a diagnostic adjunct to mammography to help distinguish fluid-filled cysts from other lesions. A thin coating of lubricating jelly is spread over the area to be imaged. A transducer is then placed on the breast. The transducer transmits high-frequency sound waves through the skin toward the area of concern. The sound waves that are reflected back form a two-dimensional image, which is then displayed on a computer screen. No radiation is emitted during the procedure.

Ultrasonography has advantages and disadvantages. Although it can diagnose cysts with great accuracy, it cannot definitively rule out malignant lesions. Microcalcifications, which are detectable on mammography, cannot be identified on ultrasonography. Finally, examination techniques and interpretation criteria are not standardized.

## Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) of the breast is rapidly gaining in popularity. This highly sensitive test has become a useful diagnostic adjunct to mammography. A magnet is linked to a computer that creates detailed images of the breast without exposure to radiation. An intravenous (IV) injection of gadolinium, a contrast dye, is given to improve visibility. The patient lies face down and the breast is placed through a depression in the table. A coil is placed around the breast, and the patient is placed inside the MRI machine. The entire procedure takes about 30 to 40 minutes.

MRI is most useful in patients with proven breast cancer when assessing for multifocal (more than one tumor in the same quadrant of the breast) or multicentric (more than one tumor in different quadrants of the breast) disease, chest wall involvement, tumor recurrence, or response to chemotherapy. The procedure can also identify occult (undetectable) breast cancer and determine the integrity of saline or silicone breast implants. Recent studies have shown that MRI is a highly sensitive screening tool that can be used to identify breast cancer in women at high risk for the disease (Orel, 2008). The ACS now recommends an annual MRI scan in addition to mammography in women at

high risk for breast cancer (ie, those with greater than 20% lifetime risk). Candidates include women who have a *BRCA1* or *BRCA2* mutation, a first-degree relative with either of these mutations, certain rare genetic syndromes, or radiation to the chest between 10 and 30 years of age (Saslow, Boetes, Burke, et al., 2007). MRI should be used in addition to mammography, not instead of it.

Some disadvantages of MRI include high cost, variations in technique and interpretation, and the potential for patient claustrophobia. The procedure cannot always accurately distinguish between malignant and benign breast conditions. MRI is contraindicated in patients with implantable metal devices (eg, aneurysm clips, pacemakers, ports of tissue expanders) because of the metallic force. Foil-backed medication patches (eg, nicotine, nitroglycerine, fentanyl) must be removed prior to MRI to avoid burns to the skin.

## Procedures for Tissue Analysis

### *Percutaneous Biopsy*

Percutaneous biopsy is performed on an outpatient basis to sample palpable and nonpalpable lesions. Less invasive than a surgical biopsy, percutaneous biopsy is a needle or core biopsy that obtains tissue by making a small puncture in the skin. Table 48-1 outlines the different types of biopsies that can be performed to obtain a tissue diagnosis.

#### Fine-Needle Aspiration

**Fine-needle aspiration (FNA)** is a noninvasive biopsy technique that is generally well tolerated by most women. A local anesthetic may or may not be used. A small gauge needle (25- or 22-gauge) attached to a syringe is inserted into the mass or area of nodularity. Suction is applied to the syringe, and multiple passes are made through the mass. A simple cyst often disappears on aspiration, and the fluid is usually discarded. If no fluid is obtained, any cellular material obtained in the hub of the needle is spread on a glass slide or placed in a preservative and sent to the laboratory for analysis. For nonpalpable masses, the same procedure can be performed by a radiologist using ultrasound guidance (ultrasound-guided FNA).

FNA is less expensive than other diagnostic methods and results are usually available quickly. However, false-negative or false-positive results are possible, and appropriate follow-up depends on the clinical judgment of the treating physician.

#### Core Needle Biopsy

Core needle biopsy is similar to FNA, except that a larger gauge needle is used (usually 14-gauge). A local anesthetic is applied, and tissue cores are removed via a spring-loaded device. This procedure allows for a more definitive diagnosis than FNA, because actual tissue, not just cells, is removed. It is often performed for relatively large tumors that are close to the skin surface.

#### Stereotactic Core Biopsy

**Stereotactic core biopsy** is performed on nonpalpable lesions detected by mammography. The patient lies prone on the stereotactic table. The breast is suspended through an opening in the table and compressed between two x-ray plates. Images are then obtained using digital mammography. The exact coordinates of the lesion to be sampled are located with the aid of a computer. Next, a local anesthetic is injected into the entry site on the breast. A small nick is made in the skin, a core needle is inserted, and samples of the tissue are taken for pathologic examination. Often, several passes are taken to ensure that the lesion is well sampled. Postbiopsy films are then taken to check that sampling has been adequate. A small titanium clip is often placed at the biopsy site so that the site can easily be located if further treatment is indicated.

Stereotactic biopsy is quite accurate and often allows the patient to avoid a surgical biopsy. However, there is a small false-negative rate. Appropriate follow-up depends on the final pathologic diagnosis and the clinical judgment of the treating physician. Use of a titanium clip does not preclude subsequent MRIs.

#### Ultrasound-Guided Core Biopsy

The principles for ultrasound-guided core biopsy are similar to those of stereotactic core biopsy, but by using ultrasound guidance, computer coordination and mammographic compression are not necessary. Ultrasound-guided core biopsy does not use radiation and is also faster and less expensive than stereotactic core biopsy.

#### Magnetic Resonance Imaging–Guided Core Biopsy

Recently, the technology has become available to perform core biopsies under MRI guidance. The number of facilities that are equipped to perform this procedure is increasing.

**Table 48-1 TYPES OF BREAST BIOPSIES**

| Procedure | Palpable Mass | Health Professional Who Performs Procedure | Nature of Breast Tissue Removed |
|---|---|---|---|
| Fine-needle aspiration | Yes | Surgeon | Cellular material |
| Core needle biopsy | Yes | Surgeon | Tissue core |
| Stereotactic core biopsy | No | Radiologist | Tissue core |
| Ultrasound-guided core biopsy | No | Radiologist | Tissue core |
| MRI-guided core biopsy | No | Radiologist | Tissue core |
| Excisional biopsy | Yes | Surgeon | Entire mass |
| Incisional biopsy | Yes | Surgeon | Tissue core |
| Wire needle localization biopsy; may be guided by mammogram, ultrasound, or MRI | No | Radiologist inserts wire, surgeon performs biopsy | Entire mass |

### Surgical Biopsy

**Surgical biopsy** is usually performed using local anesthesia and IV sedation. After an incision is made, the lesion is excised and sent to a laboratory for pathologic examination.

#### Types of Surgical Breast Biopsy

***Excisional Biopsy.*** Excisional biopsy is the standard procedure for complete pathological assessment of a palpable breast mass. The entire mass, plus a margin of surrounding tissue, is removed. This type of biopsy may also be referred to as a lumpectomy. Depending on the clinical situation, a frozen section analysis of the specimen may be performed at the time of the biopsy by the pathologist, who does an immediate reading intraoperatively and provides a provisional diagnosis. This can help confirm a diagnosis in a patient who had no previous tissue analysis performed.

***Incisional Biopsy.*** Incisional biopsy surgically removes a portion of a mass. This is performed to confirm a diagnosis and to conduct special studies (eg, ER/PR, HER-2/neu [also referred to as ERBB2]; see later discussion for explanation of these terms) that will aid in determining treatment, which are discussed later in this chapter. Complete excision of the area may not be possible or immediately beneficial to the patient, depending on the clinical situation. This procedure is often performed on women with locally advanced breast cancer or on women with suspected cancer recurrence, whose treatment may depend on the results of these special studies. However, pathological information may be easily obtained from core needle biopsy, and incisional biopsy is becoming less common.

***Wire Needle Localization.*** Wire needle localization is a technique used to locate nonpalpable masses or suspicious calcium deposits detected on a mammogram, ultrasound, or MRI that require an excisional biopsy. The radiologist inserts a long, thin wire through a needle, which is then inserted into the area of abnormality using x-ray or ultrasound guidance (whichever imaging technique originally identified the abnormality). The wire remains in place after the needle is withdrawn to ensure the precise location. The patient is then taken to the operating room, where the surgeon follows the wire to the tip and excises the area.

#### Nursing Management

During the preoperative visit, the nurse assesses the patient for any specific educational, physical, or psychosocial needs that she may have. This can be accomplished by reviewing her medical and psychosocial history and encouraging her to verbalize her fears, concerns, and questions. Patients are often worried not only about the procedure but also about the potential implications of the pathology results. Providing a thorough explanation about what to expect in a supportive manner can help alleviate anxiety. Patients often have difficulty absorbing all the information given to them; therefore, written materials should be provided to reinforce teaching.

The nurse instructs the patient to discontinue any agents that can increase the risk of bleeding, including products containing aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs), vitamin E supplements, herbal substances (such as ginkgo biloba and garlic supplements), and warfarin (Coumadin). The patient may be instructed not to eat or drink for several hours or after midnight the night before the procedure, depending on the type of biopsy planned. Most breast biopsy procedures today are performed with the use of moderate sedation and local anesthesia.

Immediate postoperative assessment includes monitoring the effects of the anesthesia and inspecting the surgical dressing for any signs of bleeding. Once the sedation has worn off, the nurse reviews the care of the biopsy site, pain management, and activity restrictions with the patient. Prior to discharge from the ambulatory surgical center or the office, the patient must be able to tolerate fluids, ambulate, and void. The patient must have somebody to accompany her home. The dressing covering the incision is usually removed after 48 hours, but the Steri-Strips, which are applied directly over the incision, should remain in place for approximately 7 to 10 days. The use of a supportive bra following surgery is encouraged to limit movement of the breast and reduce discomfort. A follow-up telephone call from the nurse 24 to 48 hours after the procedure can provide the patient with the opportunity to ask any questions and can be a source of great comfort and reassurance.

Most women return to their usual activities the day after the procedure but are encouraged to avoid jarring or high-impact activities for 1 week to promote healing of the biopsy site. Discomfort is usually minimal, and most women find acetaminophen (Tylenol) sufficient for pain relief, although a mild opioid may be prescribed if needed.

Follow-up after the biopsy includes a return visit to the surgeon for discussion of the final pathology report and assessment of the healing of the biopsy site. Depending on the results of the biopsy, the nurse's role varies. If the pathology report is benign, the nurse reviews incision care and explains what the patient should expect as the biopsy site heals (ie, changes in sensation may occur weeks or months after the biopsy due to nerve injury within the breast tissue). If a diagnosis of cancer is made, the nurse's role changes dramatically. This is discussed in depth later in this chapter.

## CONDITIONS AFFECTING THE NIPPLE

### Nipple Discharge

Nipple discharge in a woman who is not lactating may be related to many causes, such as carcinoma, papilloma, pituitary adenoma, cystic breasts, and various medications. Oral contraceptives, pregnancy, HT, chlorpromazine (Thorazine)-type medications, and frequent breast stimulation may be contributing factors. In some athletic women, nipple discharge may occur during running or aerobic exercises. Nipple discharge should be evaluated by a health care provider, but it is not often a cause for alarm. One in three women has clear discharge on expression, which is usually normal. A green discharge could indicate an infection. Any

discharge that is spontaneous, persistent, or unilateral is of more concern. Although bloody discharge can indicate a malignancy, it is often caused by a benign wartlike growth on the lining of the duct called an intraductal papilloma.

Nipple discharge should be evaluated for the presence of occult (hidden) blood by performing a guaiac test. A galactogram can also be performed to detect abnormalities within the duct that may be causing the discharge. If there is a high level of suspicion, a surgical biopsy called a duct excision may be indicated.

### *Fissure*

A fissure is a longitudinal ulcer that may develop in breastfeeding women. If the nipple becomes irritated, a painful, raw area may form and become a site of infection. Daily washing with water, massage with breast milk or lanolin, and exposure to air are helpful. Breastfeeding can be continued with the use of a nipple shield if necessary. If the fissure is severe or extremely painful, the woman is advised to stop breastfeeding. A breast pump can be used until breastfeeding can be resumed. Persistent ulceration requires further diagnosis and therapy. Guidance from a nurse or lactation consultant may be helpful because nipple irritation can result from improper positioning (ie, the infant has not grasped the areola fully) during breastfeeding.

## BREAST INFECTIONS

### *Mastitis*

**Mastitis,** an inflammation or infection of breast tissue, occurs most commonly in breastfeeding women, although it may also occur in nonlactating women. The infection may result from a transfer of micro-organisms to the breast by the patient's hands or from a breastfed infant with an oral, eye, or skin infection. Mastitis may also be caused by bloodborne organisms. As inflammation progresses, the breast texture becomes tough or doughy, and the patient complains of dull to severe pain in the infected region. A nipple that is discharging purulent material, serum, or blood should be investigated.

Treatment consists of antibiotics and local application of cold compresses to relieve discomfort. A broad-spectrum antibiotic agent may be prescribed for 7 to 10 days. The patient should wear a snug bra and perform personal hygiene carefully. Adequate rest and hydration are important aspects of management.

### *Lactational Abscess*

A breast abscess may develop as a consequence of acute mastitis. The area affected becomes tender and red. Purulent matter can usually be aspirated with a needle, but incision and drainage may be required. Specimens of the aspirated material are obtained for culture so that an organism-specific antibiotic can be prescribed.

## BENIGN CONDITIONS OF THE BREAST

### *Breast Pain*

Breast pain **(mastalgia)** may be cyclical or noncyclical. Cyclical pain is usually related to hormonal fluctuations and accounts for nearly 75% of all complaints. Noncyclical pain is far less common and does not vary with the menstrual cycle. Women who experience injury or trauma to the breast or those who had a breast biopsy may experience noncyclical pain. Patients should be reassured that breast pain is rarely indicative of cancer. However, if the pain persists after menses begins, the patient should see her primary health care provider.

#### Nursing Management

The nurse may recommend that the patient wear a supportive bra both day and night for a week, decrease her salt and caffeine intake, and take ibuprofen (Advil) as needed for its anti-inflammatory actions. Vitamin E supplements or oil of evening primrose (an over-the-counter herbal preparation) may also be helpful.

### *Cysts*

Cysts are fluid-filled sacs that develop as breast ducts dilate. Cysts occur most commonly in women 30 to 55 years of age and may be exacerbated during perimenopause. Although their cause is unknown, cysts usually disappear after menopause, suggesting that estrogen is a factor. Cystic areas often fluctuate in size and are usually larger premenstrually. They may be painless or may become very tender premenstrually. Occasionally, a patient may report an intermittent shooting sensation or a dull ache. Various breast masses are compared in Table 48-2. Cysts that are confirmed on an ultrasound and are not bothersome can often be left alone. To confirm a diagnosis or to relieve pain, FNA can be performed. Cysts do not increase the risk of breast cancer.

**Fibrocystic breast changes,** which is often called fibrocystic breast disease, is a nonspecific term used to describe an array of benign findings. The changes do not necessarily indicate a cystic process.

### *Fibroadenomas*

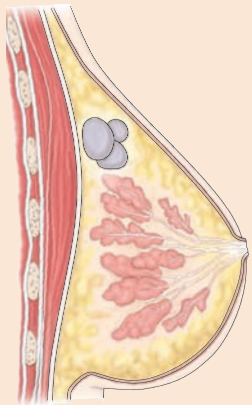
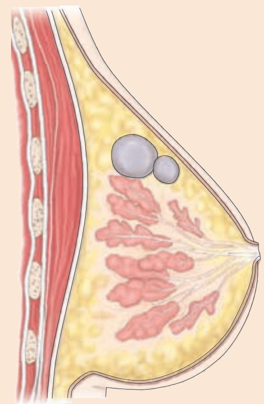
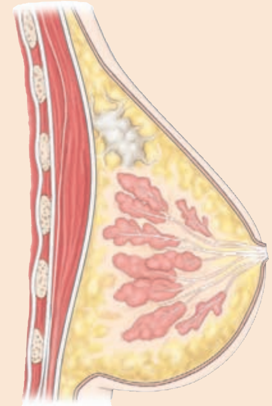
Fibroadenomas are firm, round, movable, benign tumors. They can occur from puberty to menopause with a peak incidence at 30 years of age. These masses are nontender and are sometimes removed for definitive diagnosis.

### *Benign Proliferative Breast Disease*

The two most common diagnoses of **benign proliferative breast disease** found on biopsy are atypical hyperplasia and lobular carcinoma in situ. These diagnoses increase a woman's risk of breast cancer.

**Table 48-2 COMPARISON OF VARIOUS BREAST MASSES**

The most common breast masses are due to cysts, fibroadenomas, or malignancy. Biopsy is usually needed for confirmation, but the following characteristics are diagnostic clues:

| Characteristics | Cysts | Fibroadenomas | Malignancy |
|---|---|---|---|
| |  |  |  |
| Age | 30–55 years, regress after menopause except with use of estrogen therapy | Puberty to menopause | 30–90 years; most common, 40–80 years |
| Number | Single or multiple | Usually single | Usually single |
| Shape | Round | Round, disk, or lobular | Irregular or stellate |
| Consistency | Soft to firm, usually elastic | Usually firm | Firm or hard |
| Mobility | Mobile | Mobile | May be fixed to skin or underlying tissues |
| Tenderness | Usually tender | Usually nontender | Usually nontender |
| Retraction signs | Absent | Absent | May be present |

## Atypical Hyperplasia

**Atypical hyperplasia** is an abnormal increase in the ductal (atypical ductal hyperplasia) or lobular (atypical lobular hyperplasia) cells in the breast and is usually found incidentally in mammographic abnormalities. Atypical hyperplasia increases a woman's risk of breast cancer about four to five times compared with that of the general population (Hanby & Hughes, 2008).

## Lobular Carcinoma in Situ

**Lobular carcinoma in situ (LCIS)** is characterized by a proliferation of cells within the breast lobules. LCIS is usually found incidentally on pathologic diagnosis because it cannot be seen on mammography and does not form a palpable lump. The term LCIS is misleading because it is not a carcinoma. Historically, LCIS was considered a premalignant condition but is now considered a marker for increased risk of invasive carcinoma. A patient with LCIS may later develop an invasive carcinoma in either breast that is either ductal or lobular in origin. LCIS increases a woman's risk of breast cancer about 8 to 10 times compared with that of the general population (Hanby & Hughes, 2008).

## *Other Benign Conditions*

Cystosarcoma phyllodes is a rare fibroepithelial lesion that tends to grow rapidly. It is rarely malignant and is treated with surgical excision. If it is malignant, mastectomy may follow. Lymph node removal is usually not performed because metastasis is rare.

Fat necrosis is a condition of the breast that is often associated with a history of trauma. Surgical procedures such as a breast biopsy can cause fat necrosis. It may be indistinguishable from carcinoma, and the entire mass is usually excised.

Intraductal papilloma is a wartlike growth that often involves the large milk ducts near the nipple, causing bloody nipple discharge. Surgery usually involves removal of the papilloma and a segment of the duct where the papilloma is found.

Superficial thrombophlebitis of the breast (Mondor disease) is an uncommon condition that is usually associated with pregnancy, trauma, or breast surgery. Pain and redness occur as a result of a superficial thrombophlebitis in the vein that drains the outer part of the breast. The mass is usually linear, tender, and erythematous. Treatment consists of analgesics and heat.

# MALIGNANT CONDITIONS OF THE BREAST

Breast cancer is a major health problem in the United States. At present, there is no cure. It is estimated that more than 190,000 women and 1900 men develop the disease and more than 40,000 die of it annually (ACS, 2009). Incidence rates, however, have decreased by 3.5% per year from 2001 to 2004 after increasing since 1980. Between 1990 and 2002, the mortality rate for breast cancer decreased by 2.2%, suggesting that the combination of early detection and improved treatment modalities had an effect on overall survival.

Current statistics indicate that over an entire lifetime (birth to death), a woman's risk of developing breast cancer is one in eight. When broken down by age, the risk by 39 years of age is 1 in 210, and it increases to 1 in 26 by 59 years of age. Approximately 80% of breast cancers are diagnosed in women older than 50 years of age (Jemal, et al., 2008).

## Types of Breast Cancer

### Ductal Carcinoma in Situ

The increased use of mammography as a screening tool has contributed to the dramatic increase in the diagnosis of **ductal carcinoma in situ (DCIS).** An estimated 67,000 new cases are diagnosed annually (Jemal, et al., 2008). DCIS is characterized by the proliferation of malignant cells inside the milk ducts without invasion into the surrounding tissue. Therefore, it is a noninvasive form of cancer (also called intraductal carcinoma). DCIS is frequently manifested on a mammogram with the appearance of calcifications, and it is considered breast cancer stage 0.

If DCIS is left untreated, there is an increased likelihood that it will progress to invasive cancer. Deciding on the best surgical treatment option can be very complex. DCIS can be categorized in terms of its aggressiveness depending on a variety of factors, including histological subtype (comedo is more aggressive than noncomedo), size of tumor, and whether it is multicentric (present in different quadrants of the breast). These factors, together with patient preference, are important determinants in making treatment decisions. The most traditional treatment is total or simple mastectomy (removal of the breast only), with a cure rate of 98% to 99% (Boughey, Gonzalez, Bonner, et al., 2007). The trend today is toward less aggressive surgery; **breast conservation treatment** (limited surgery followed by radiation) is being performed with increasing frequency. In rare cases, lumpectomy alone is an option. The National Surgical Adjuvant Breast and Bowel Project B-24 study demonstrated that the addition of tamoxifen (Nolvadex) significantly reduced local recurrence rates after surgery and radiation (Daly, 2006). The medication is usually prescribed for 5 years.

### Invasive Cancer

The National Comprehensive Cancer Network (NCCN), a nonprofit group of the world's 21 leading cancer centers, disseminates estimates for various types of cancer.

#### Infiltrating Ductal Carcinoma

Infiltrating ductal carcinoma, the most common histologic type of breast cancer, accounts for 80% of all cases. The tumors arise from the duct system and invade the surrounding tissues. They often form a solid irregular mass in the breast.

#### Infiltrating Lobular Carcinoma

Infiltrating lobular carcinoma accounts for 10% to 15% of breast cancers. The tumors arise from the lobular epithelium and typically occur as an area of ill-defined thickening in the breast. They are often multicentric and can be bilateral.

#### Medullary Carcinoma

Medullary carcinoma accounts for about 5% of breast cancers, and it tends to be diagnosed more often in women younger than 50 years of age. The tumors grow in a capsule inside a duct. They can become large and may be mistaken for a fibroadenoma. The prognosis is often favorable.

#### Mucinous Carcinoma

Mucinous carcinoma accounts for about 3% of breast cancers and often presents in postmenopausal women 75 years of age and older. A mucin producer, the tumor is also slow growing and thus the prognosis is more favorable than in many other types.

#### Tubular Ductal Carcinoma

Tubular ductal carcinoma accounts for about 2% of breast cancers. Because axillary metastases are uncommon with this histology, prognosis is usually excellent.

#### Inflammatory Carcinoma

Inflammatory carcinoma is a rare (1% to 3%) and aggressive type of breast cancer that has unique symptoms. The cancer is characterized by diffuse edema and brawny erythema of the skin, often referred to as peau d'orange (resembling an orange peel). This is caused by malignant cells blocking the lymph channels in the skin. An associated mass may or may not be present; if there is a mass, it is often a large area of indiscrete thickening. Inflammatory carcinoma can be confused with an infection because of its presentation. The disease can spread to other parts of the body rapidly. Chemotherapy often plays an initial role in controlling disease progression, but radiation and surgery may also be useful.

#### Paget's Disease

**Paget's disease** of the breast accounts for 1% of diagnosed cases of breast cancer. Symptoms typically include a scaly, erythematous, pruritic lesion of the nipple. Paget's disease often represents ductal carcinoma in situ of the nipple but may have an invasive component. If no lump can be felt in the breast tissue and the biopsy shows DCIS without invasion, the prognosis is very favorable.

## Risk Factors

There is no single, specific cause of breast cancer. A combination of genetic, hormonal, and possibly environmental factors may increase the risk of its development (Table 48-3). More than 80% of all cases of breast cancer are sporadic, meaning that patients have no known family history of the disease. The remaining cases are either familial (there is a family history of breast cancer but it is not passed on genetically) or genetically acquired. There is no evidence that smoking, silicone breast implants, use of antiperspirants, underwire bras, or abortion (induced or spontaneous) increases the risk of the disease.

As stated previously, breast cancer can be genetically inherited, resulting in significant risk. Approximately 5% to 10% of breast cancer cases develop as a result of genetic mutations. Factors that may indicate a genetic link include multiple first-degree relatives with early-onset breast

**Table 48-3 RISK FACTORS FOR BREAST CANCER**

| Risk Factor | Comments |
|---|---|
| Female gender | 99% of cases occur in women. |
| Increasing age | Increasing age is associated with an increased risk. |
| Personal history of breast cancer | Once treated for breast cancer, the risk of developing breast cancer in same or opposite breast is significantly increased. |
| Family history of breast cancer | Having first-degree relative with breast cancer (mother, sister, daughter) increases the risk twofold; having two first-degree relatives increases the risk fivefold. The risk is higher if the relative was premenopausal at the time of diagnosis. The risk is increased if a father or brother had breast cancer (exact risk is unknown). |
| Genetic mutation | *BRCA1* and *BRCA2* mutations account for the majority of inherited cases of breast cancer (see additional information in text). |
| Hormonal Factors | |
| • Early menarche | Before 12 years of age |
| • Late menopause | After 55 years of age |
| • Nulliparity | No full-term pregnancies |
| • Late age at first full-term pregnancy | After 30 years of age |
| • Hormone therapy (formerly referred to as hormone replacement therapy) | Current or recent use of combined postmenopausal hormone therapy (estrogen and progesterone) Long-term use (several years or more) |
| Exposure to ionizing radiation during adolescence and early adulthood | The risk is highest if breast tissue was exposed while still developing (during adolescence) such as women who received mantle radiation (to the chest area) for treatment of Hodgkin lymphoma in their younger years. |
| History of benign proliferative breast disease | Having had atypical ductal or lobular hyperplasia or lobular carcinoma in situ increases the risk. |
| Obesity | Obesity and weight gain during adulthood increases the risk of postmenopausal breast cancer. During menopause, estrogen is primarily produced in fat tissue. More fat tissue can increase estrogen levels, thereby increasing breast cancer risk. |
| High-fat diet (controversial) | More research is needed. |
| Alcohol intake (beer, wine, or liquor) | Two to five drinks daily increases the risk about one and a half times. |

cancer, breast and ovarian cancer in the same family, male breast cancer, and Ashkenazi Jewish background. ***BRCA1*** and ***BRCA2*** are tumor suppressor genes that normally function to identify damaged DNA and thereby restrain abnormal cell growth. Mutations in these genes are responsible for the majority of hereditary breast cancer in the United States. *BRCA1* mutations have been associated with a 65% to 87% estimated lifetime risk, and *BRCA2* mutations have been associated with a 45% to 84% risk. Carriers also have a significantly increased risk for ovarian cancer, approaching 30% (Turnbull & Rahman, 2008). Men with *BRCA* mutations, particularly the *BRCA2* mutation, also have an increased risk of breast cancer. A recent study reported that there is a broad variation in breast cancer risk among carriers of *BRCA1* and *BRCA2* when different variables are considered. A gene carrier was found to be at significantly higher risk if a relative was diagnosed with breast cancer at an early age (Begg, Haile & Borg, 2008).

## Protective Factors

Certain factors may be protective in relation to the development of breast cancer. A systematic review of 48 studies showed that physical activity reduced the risk of breast cancer in postmenopausal women by 20% to 80%; the evidence was much weaker for premenopausal women with the disease (Monninkhof, Elias, Vlems, et al., 2007). Studies to determine the most effective exercises and how often to perform them are ongoing.

Breastfeeding is also thought to decrease risk because it prevents the return of menstruation, thereby decreasing exposure to endogenous estrogen. Having completed a full-term pregnancy before 30 years of age is also thought to be protective.

## Breast Cancer Prevention Strategies in the High-Risk Patient

Patients often overestimate or underestimate their risk of developing breast cancer. A consultation with a breast specialist is of paramount importance prior to embarking on any of the prevention strategies that follow. Once patients have an accurate assessment of their risk, along with the knowledge of the pros and cons of each prevention strategy, they can make a decision that is most appropriate for their situation.

### *Long-Term Surveillance*

Long-term surveillance is a form of secondary prevention that focuses on early detection of the disease. As recommended by the ACS, women with a 20% or greater lifetime risk benefit from additional screening with MRI (Saslow, et al., 2007). Clinical breast examinations may be performed twice a year starting as early as 25 years of age. Mammograms may also be performed as early as 25 years of age. Data concerning the effectiveness of BSE are limited. In addition to yearly mammography and MRI, other screening tests, including ultrasonography, may be useful.

### *Chemoprevention*

Chemoprevention is a primary prevention modality that aims to prevent the disease. In April 1998, the results of the Breast Cancer Prevention Trial were released to the general public. This national, randomized, double-blind clinical trial evaluated tamoxifen (20 mg daily for 5 years) versus a placebo in more than 13,000 women considered to be at high risk for breast cancer. The women who received

tamoxifen had a 49% reduction in the incidence of breast cancer (Fisher, Constantino, Wickerham, et al., 1998), suggesting that tamoxifen was an effective chemopreventive agent. Subsequently, the FDA approved its use in high-risk women. Nurses can help women who are considering this option by providing them with information about the benefits, risks, and possible side effects of tamoxifen.

Raloxifene (Evista) is a medication that is used for the prevention and treatment of osteoporosis. The results of the Multiple Outcomes of Raloxifene Evaluation trial in postmenopausal women with osteoporosis showed that women who received raloxifene instead of placebo had a 76% reduction in invasive breast cancer (Cummings, Eckert, Krueger, et al., 1999).

A national, randomized clinical trial, the Study of Tamoxifen and Raloxifene (STAR), compared these two agents for the prevention of breast cancer in postmenopausal women (Vogel, Costantino, Wickerham, et al., 2006). Results showed that raloxifene is as effective as tamoxifen in reducing breast cancer risk and has fewer side effects, including fewer uterine cancers, blood clots, and cataracts. In September 2007 the FDA approved the use of raloxifene as a chemopreventive agent in postmenopausal women.

#### *Prophylactic Mastectomy*

**Prophylactic mastectomy** is another primary prevention modality. This procedure can reduce the risk of breast cancer by 90% (Alschuler, Nekhlyudov, Rolnick, et al., 2008) and is sometimes referred to as a "risk-reducing" mastectomy. The procedure consists of a total mastectomy (removal of breast tissue only) and is usually accompanied by immediate breast reconstruction. Possible candidates include women with a strong family history of breast cancer, a diagnosis of LCIS or atypical hyperplasia, a mutation in a *BRCA* gene, an extreme fear of cancer ("cancer phobia"), or previous cancer in one breast.

A patient who is considering prophylactic mastectomy is often faced with a very controversial and emotional decision. A multidisciplinary approach should be used to help the patient arrive at a decision that is best for her. Consultation with a genetics counselor, plastic surgeon, medical oncologist, and psychiatrist can be invaluable. The patient needs to understand that this surgery is elective and not emergent. The nurse can play a valuable role in providing the patient with information, clarification, and support during the decision-making process.

## Clinical Manifestations

Breast cancers can occur anywhere in the breast but are usually found in the upper outer quadrant, where the most breast tissue is located. Generally, the lesions are nontender, fixed rather than mobile, and hard with irregular borders. Complaints of diffuse breast pain and tenderness with menstruation are usually associated with benign breast disease.

With the increased use of mammography, more women are seeking treatment at earlier stages of the disease. These women often have no signs or symptoms other than a mammographic abnormality. Unfortunately, some women with advanced disease seek initial treatment after ignoring symptoms. Advanced signs may include skin dimpling, nipple retraction, or skin ulceration.

## Assessment and Diagnostic Findings

Techniques to determine the diagnosis of breast cancer include various types of biopsy, which have been described previously. Tumor staging and analysis of additional prognostic factors are used to determine the prognosis and optimal treatment regimen (see below).

## Staging

Staging involves classifying the cancer by the extent of disease. Clinical staging involves the physician's estimate of the size of the breast tumor and the extent of axillary lymph node involvement. Such staging is determined by physical examination and imaging studies. Pathological staging is done when the pathologist examines the surgically excised breast tissue under the microscope and determines the exact size of the breast tumor and the exact number of lymph nodes involved.

The staging of breast cancer has become complex. Classification of tumors that are stage 0 (DCIS, LCIS, or Paget's disease of the nipple with no invasion), stage I (tumors that are 2 cm or less with no involvement of axillary lymph nodes), and stage IV (tumors of any size, with distant metastases) is fairly straightforward. However, classification of tumors that are stage II and stage III, which represent a wide spectrum of breast cancers, is more difficult. Factors that play a role in determining stages II and III include the number and characteristics of axillary lymph nodes, the status of other regional lymph nodes such as internal mammary nodes or supraclavicular nodes, and the presence or absence of involvement of the skin or underlying muscle. Based on these factors, stage II and stage III breast cancers are further subdivided into stage IIA, IIB, IIIA, IIIB, and IIIC. For a detailed explanation of the staging system, the reader is referred to the *American Joint Committee on Cancer Staging Manual* (Greene, Page, Fleming, et al., 2002) or to the ACS Web site (see Resources below).

Other diagnostic tests may be performed before or after the surgery to help in the staging of the disease. The extent of testing often depends on the clinical presentation of the disease and may include chest x-rays, computed tomography (CT), MRI, positron emission tomography (PET) scan, bone scans, and blood work (complete blood count, comprehensive metabolic panel, tumor markers [ie, carcinoembryonic antigen, cancer antigen 15-3]).

## Prognosis

Several different factors must be taken into consideration when determining the prognosis of a patient with breast cancer. The two most important factors are tumor size and whether the tumor has spread to the lymph nodes under the arm (axilla).

Generally, the smaller the tumor, the better the prognosis. Carcinoma of the breast is not a pathologic entity that develops overnight. It starts with a genetic alteration in a single cell and takes time to divide and double in size. A carcinoma may double in size 30 times to become 1 cm or larger, at which point it becomes clinically apparent. Doubling time varies, but breast tumors are often present for several years before they become palpable. Nurses can reassure patients that once breast cancer is diagnosed, they have a safe period of several weeks to make decisions regarding treatment.

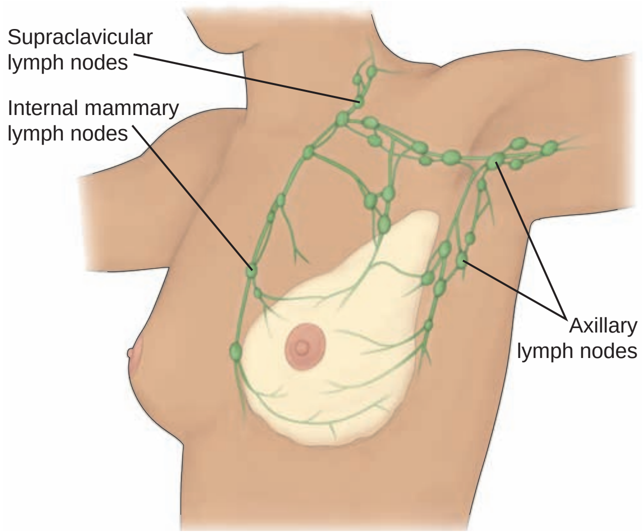



**Figure 48-5** Lymphatic drainage of the breast.

Prognosis also depends on the extent of spread of the breast cancer. The 5-year survival rate can be as high as 98.1% for a stage I breast cancer and as low as 27.1% for a stage IV breast cancer (National Cancer Institute, 2008). The most common route of regional spread is to the axillary lymph nodes. Other sites of lymphatic spread include the internal mammary and supraclavicular nodes (Fig. 48-5). Distant metastasis can affect any organ, but the most common sites are bone, lung, liver, pleura, adrenals, skin, and brain.

In addition to the type of breast cancer and the stage, other factors may help determine prognosis (Chart 48-3). Excessive number of copies of certain genes (amplification) or excessive amounts of their protein product (overexpression) may represent a poorer prognosis. The HER-2/neu (also known as ERBB2) oncogene is the classic example; approximately 25% to 30% of invasive breast cancers, which typically involve the more aggressive tumors, have amplification or overexpression of the HER-2/neu gene (Dawood, Broglio, Esteva, et al., 2008). Research concerning the prognostic usefulness of the proliferative rate (S-phase fraction) and DNA content (ploidy) of a tumor is ongoing.

## Surgical Management

The main goal of surgery is to gain local control of the disease. With breast cancer being diagnosed today at earlier stages, options for less invasive surgical procedures are available. Surgical treatment options for noninvasive and invasive breast cancer are summarized in Table 48-4.

### Chart 48-3 • *Pathologic Factors Associated With Favorable Prognosis for Breast Cancer*

- Noninvasive tumors or invasive tumors less than 1 cm
- Negative axillary lymph nodes
- Estrogen receptor (ER) and progesterone receptor (PR) proteins
- Well-differentiated tumors
- Low expression of HER-2/neu oncogene (also known as ERBB2)
- No vascular or lymphatic invasion
- Diploid tumors with low S-phase fraction

**Table 48-4 SURGICAL TREATMENT OPTIONS FOR NONINVASIVE AND INVASIVE BREAST CANCER**

| Noninvasive Breast Cancer | Invasive Breast Cancer |
|---|---|
| Breast conservation* alone | Breast conservation* with one of the following:<br>Sentinel lymph node biopsy<br>Axillary lymph node dissection |
| Total mastectomy alone | Total mastectomy with sentinel lymph node biopsy<br>or<br>Modified radical mastectomy |

*Breast conservation treatment includes lumpectomy, wide excision, partial or segmental mastectomy, and quadrantectomy. These are relatively synonymous terms that describe removal of varying amounts of breast tissue.

### Modified Radical Mastectomy

**Modified radical mastectomy** is performed to treat invasive breast cancer. The procedure involves removal of the entire breast tissue, including the nipple–areola complex. In addition, a portion of the axillary lymph nodes are also removed in axillary lymph node dissection (ALND). If immediate breast reconstruction is desired, the patient is referred to a plastic surgeon prior to the mastectomy so that she has the opportunity to explore all available options. In modified radical mastectomy, the pectoralis major and pectoralis minor muscles are left intact, unlike in radical mastectomy, in which the muscles are removed. Radical mastectomy is rarely performed today.

### Total Mastectomy

Like modified radical mastectomy, **total mastectomy** (ie, simple mastectomy) also involves removal of the breast and nipple–areola complex but does not include ALND. Total mastectomy may be performed in patients with noninvasive breast cancer (eg, DCIS), which does not have a tendency to spread to the lymph nodes. It may also be performed prophylactically in patients who are at high risk for breast cancer (eg, LCIS, *BRCA* mutation). A total mastectomy may also be performed in conjunction with sentinel lymph node biopsy (SLNB) for patients with invasive breast cancer.

### Breast Conservation Treatment

The goal of breast conservation treatment (ie, lumpectomy, wide excision, partial or segmental mastectomy, quadrantectomy) is to excise the tumor in the breast completely and obtain clear margins while achieving an acceptable cosmetic result. If the procedure is being performed to treat a noninvasive breast cancer, lymph node removal is not necessary. For an invasive breast cancer, lymph node removal (SLNB or ALND) is indicated. The lymph nodes are removed through a separate semicircular incision in the axilla. In 1990, the National Institutes of Health (NIH) issued a consensus statement that breast conservation along with radiation therapy in stage I and stage II breast cancer resulted in a survival rate equal to that of modified radical mastectomy.

**Table 48-5 COMPARISON OF SENTINEL LYMPH NODE BIOPSY AND AXILLARY LYMPH NODE DISSECTION**

| Sentinel Lymph Node Biopsy (SLNB) | Axillary Lymph Node Dissection (ALND) |
|---|---|
| Shorter operating room time (approximately 15 to 30 minutes) | Longer operating room time (approximately 60 to 90 minutes) |
| No surgical drain | Surgical drain |
| Local anesthesia with IV moderate sedation as outpatient surgery (unless being performed in conjunction with total mastectomy) | General anesthesia; usually overnight admission (sometimes done as outpatient surgery) |
| Lymphedema incidence approximately 0% to 8% | Lymphedema incidence approximately 10% to 30% |
| Presence of neuropathic sensations postoperatively (prevalence lower than after axillary lymph node dissection) | Presence of neuropathic sensations postoperatively |
| Decreased range of motion in affected arm unlikely postoperatively but may occur | Decreased range of motion likely postoperatively |
| Seroma (collection of serous fluid in the axilla) may occur postoperatively | Seroma may occur postoperatively |

### *Sentinel Lymph Node Biopsy*

As previously discussed, the status of the lymph nodes is the most important prognostic factor in breast cancer. Approximately two thirds of women with early-stage breast cancer who have an ALND have negative nodes. In the mid-1990s, SLNB emerged as a less invasive alternative to ALND and is now considered a standard of care for the treatment of early-stage breast cancer. ALND is associated with potential morbidity, including lymphedema, cellulitis, decreased arm mobility, and sensory changes. Studies have shown that SLNB is highly accurate and is associated with a local recurrence rate similar to that of ALND (Bergkvist, deBoniface, Jonsson, et al., 2008; Krag, Anderson, Julian, et al., 2007). Table 48-5 compares sentinel lymph node biopsy and axillary lymph node dissection.

The **sentinel lymph node,** which is the first node (or nodes) in the lymphatic basin that receives drainage from the primary tumor in the breast, is identified by injecting a radioisotope and/or blue dye into the breast; the radioisotope or dye then travels via the lymphatic pathways to the node. In SLNB, the surgeon uses a hand-held probe to locate the sentinel lymph node, excises it, and sends it for pathologic analysis, which is often performed immediately during the surgery using frozen section analysis. If the sentinel lymph node is positive, the surgeon can proceed with an immediate ALND, thus sparing the patient a return trip to the operating room and additional anesthesia. (The patient could also opt to return for additional surgery at a later time.) If the sentinel lymph node is negative, a standard ALND is not needed, thus sparing the patient the sequelae of the procedure. After the operation is complete, all the specimens are sent to pathology for more thorough analysis.

#### Nursing Management

Patients who undergo SLNB in conjunction with breast conservation are generally discharged the same day. Patients who undergo SLNB with total mastectomy usually stay in the hospital overnight, possibly longer if breast reconstruction is being performed. The patient must be informed that although frozen section analysis is highly accurate, false-negative results can occur. A negative sentinel lymph node on frozen section analysis may show metastatic disease on subsequent analysis, indicating that ALND is still necessary. The patient should also be reassured that the radioisotope and blue dye are generally safe. The patient may notice a blue-green discoloration in the urine or stool for the first 24 hours as the blue dye is excreted. The incidence of lymphedema, decreased arm mobility, and seroma formation (collection of serous fluid) in the axilla is generally low, but the patient should be prepared for this possibility. A recent study demonstrated that women who have SLNB alone have neuropathic sensations similar to those who undergo ALND, although the prevalence and severity of these sensations and the resulting distress are lower with SLNB (Baron, Fey, Borgen, et al., 2007).

The nurse must not overlook the psychosocial needs of the patient who has undergone SLNB. Although SLNB is a less invasive procedure than ALND and results in a shorter recovery period, a patient who has undergone SLNB also has many difficult issues surrounding her breast cancer diagnosis and treatment. The nurse must listen, provide emotional support, and refer the patient to appropriate specialists when indicated.

## NURSING PROCESS

### The Patient Undergoing Surgery for Breast Cancer

#### Assessment

The health history is a valuable tool to assess the patient's reaction to the diagnosis and her ability to cope with it. Pertinent questions include the following:

- How is the patient responding to the diagnosis?
- What coping mechanisms does she find most helpful?
- What psychological or emotional supports does she have and use?
- Is there a partner, family member, or friend available to assist her in making treatment choices?
- What are her educational needs?
- Is she experiencing any discomfort?

#### Diagnosis

##### *Preoperative Nursing Diagnoses*

Based on the health history and other assessment data, major preoperative nursing diagnoses may include the following:

- Deficient knowledge about the planned surgical treatments
- Anxiety related to the diagnosis of cancer
- Fear related to specific treatments and body image changes

- Risk for ineffective coping (individual or family) related to the diagnosis of breast cancer and related treatment options
- Decisional conflict related to treatment options

#### *Postoperative Nursing Diagnoses*

Based on the health history and other assessment data, major postoperative nursing diagnoses may include the following:

- Pain and discomfort related to surgical procedure
- Disturbed sensory perception related to nerve irritation in affected arm, breast, or chest wall
- Disturbed body image related to loss or alteration of the breast
- Risk for impaired adjustment related to the diagnosis of cancer and surgical treatment
- Self-care deficit related to partial immobility of upper extremity on operative side
- Risk for sexual dysfunction related to loss of body part, change in self-image, and fear of partner's responses
- Deficient knowledge: drain management after breast surgery
- Deficient knowledge: arm exercises to regain mobility of affected extremity
- Deficient knowledge: hand and arm care after ALND

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include the following:

- Lymphedema
- Hematoma/seroma formation
- Infection

## Planning and Goals

The major goals may include increased knowledge about the disease and its treatment; reduction of preoperative and postoperative fear, anxiety, and emotional stress; improvement of decision-making ability; pain management; improvement in coping abilities; improvement in sexual function; and the absence of complications.

## Preoperative Nursing Interventions

#### *Providing Education and Preparation about Surgical Treatments*

Patients with newly diagnosed breast cancer are expected to absorb an abundance of new information during a very emotionally difficult time. The nurse plays a key role in reviewing treatment options by reinforcing information provided to the patient and answering any questions. The nurse fully prepares the patient for what to expect before, during, and after surgery. Patients undergoing breast conservation with ALND, or a total or modified radical mastectomy, generally remain in the hospital overnight (or longer if they have immediate reconstruction). Surgical drains will be inserted in the mastectomy incision and in the axilla if the patient undergoes an ALND. A surgical drain is generally not needed after a SLNB. The patient should be informed that she will go home with the drain(s) and that complete instructions about drain care will be provided prior to discharge. In addition, the patient should be informed that she will often have decreased arm and shoulder mobility after an ALND and that she will be shown range-of-motion exercises prior to discharge. The patient should also be reassured that appropriate analgesia and comfort measures will be provided to alleviate any postoperative discomfort.

#### *Reducing Fear and Anxiety and Improving Coping Ability*

The nurse must help the patient cope with the physical as well as the emotional effects of surgery. Many fears may emerge during the preoperative phase. These can include fear of pain, mutilation (after mastectomy), and loss of sexual attractiveness; concern about inability to care for oneself and one's family; concern about taking time off from work; and coping with an uncertain future. Providing the patient with realistic expectations about the healing process and expected recovery can help alleviate fears. Maintaining open communication and assuring the patient that she can contact the nurse at any time with questions or concerns can be a source of comfort. The patient should also be made aware of available resources at the treatment facility as well as in the breast cancer community such as social workers, psychiatrists, and support groups. Some women find it helpful and reassuring to talk to a breast cancer survivor who has undergone similar treatments.

#### *Promoting Decision-Making Ability*

The patient may be eligible for more than one therapeutic approach; she may be presented with treatment options and then asked to make a choice. This can be very frightening for some patients, and they may prefer to have someone else make the decision for them (eg, surgeon, family member). The nurse can be instrumental in ensuring that the patient and family members truly understand their options. The nurse can then help the patient weigh the risks and benefits of each option. The patient may be presented with the option of having breast conservation treatment followed by radiation or a mastectomy. The nurse can explore the issues with the individual patient by asking questions such as the following:

- How would you feel about losing your breast?
- Are you considering breast reconstruction?
- If you choose to retain your breast, would you consider undergoing radiation treatments 5 days a week for 5 to 6 weeks?

Questions such as these can help the patient focus. Once the patient's decision is made, it is very important to support it.

## Postoperative Nursing Interventions

#### *Relieving Pain and Discomfort*

Many patients tolerate the breast surgery quite well and have minimal pain during the postoperative period. This is particularly true of the less invasive procedures such as breast conservation treatment with SLNB. However, all patients must be carefully assessed, because individual patients can have varying degrees of pain. Patients who have had more invasive procedures such as a modified radical mastectomy with immediate reconstruction may have considerably

more pain. All patients are discharged home with analgesic medication (eg, oxycodone and acetaminophen [Percocet] or propoxyphene and acetaminophen [Darvocet]) and are encouraged to take it if needed. An over-the-counter analgesic such as acetaminophen may provide sufficient relief. Sometimes patients complain of a slight increase in pain after the first few days of surgery; this may occur as patients regain sensation around the surgical site and become more active. However, patients who report excruciating pain must be evaluated to rule out any potential complications such as infection or a hematoma. Alternative methods of pain management such as taking warm showers and using distraction methods (eg, guided imagery) may also be helpful.

#### *Managing Postoperative Sensations*

Because nerves in the skin and axilla are often cut or injured during breast surgery, patients experience a variety of sensations. Common sensations include tenderness, soreness, numbness, tightness, pulling, and twinges. These sensations may occur along the chest wall, in the axilla, and along the inside aspect of the upper arm. After mastectomy, some patients experience phantom sensations and report a feeling that the breast or nipple is still present. Overall, patients do not find these sensations severe or distressing (Baron, et al., 2007). Chart 48-4 presents specific information from this study. Sensations usually persist for several months and then begin to diminish, although some may persist for as long as 5 years and possibly longer. Patients should be reassured that this is a normal part of healing and that these sensations are not indicative of a problem.

#### *Promoting Positive Body Image*

Patients who have undergone mastectomy often find it very difficult to view the surgical site for the first time. No matter how prepared the patient may think she is, the appearance of an absent breast can be very emotionally distressing. Ideally, the patient sees the incision for the first time when she is with the nurse or another health care provider who is available for support.

The nurse first assesses the patient's readiness and provides gentle encouragement. It is important to maintain the patient's privacy while assisting her as she views the incision; this allows her to express feelings safely to the nurse. Asking the patient what she perceives, acknowledging her feelings, and allowing her to express her emotions are important nursing actions. Reassuring the patient that her feelings are a normal response to breast cancer surgery may be comforting. If the patient has not had immediate reconstruction, providing her with a temporary breast form to place in her bra on discharge can help alleviate feelings of embarrassment or self-consciousness.

#### *Promoting Positive Adjustment and Coping*

Providing ongoing assessment of how the patient is coping with her diagnosis of breast cancer and her surgical treatment is important in determining her overall adjustment. Assisting the patient in identifying and mobilizing her support systems can be beneficial to her well-being. The patient's spouse or partner may also need guidance, support, and education. The patient and partner may benefit from a wide network of available community resources, including

### CHART 48-4 NURSING RESEARCH PROFILE
### *Sensory Morbidity After Breast Cancer Surgery*

Baron, R. H., Fey, J. V., Borgen, P. I., et al. (2007). Eighteen sensations after breast cancer surgery: A 5-year comparison of sentinel lymph node biopsy and axillary lymph node dissection. *Annals of Surgical Oncology, 14*(5), 1653–1661.

**Purpose**

Women with breast cancer often report a variety of sensations following surgery and question whether these sensations are normal. The purpose of this study was to compare the prevalence, severity, and level of distress associated with sensations after sentinel lymph node biopsy (SLNB) with axillary lymph node dissection (ALND) at 3 to 15 days (baseline) and 5 years after breast cancer surgery. Long-term differences in sensations after SLNB and ALND have rarely been addressed by researchers, making it difficult for clinicians to provide effective guidance and symptom management.

**Design**

This descriptive study prospectively evaluated sensations in 133 women who had SLNB and in 54 women who had more extensive ALND. Researchers used the Breast Sensation Assessment Scale, a Likert-type scale to assess the presence and severity of 18 sensations and posed an additional question about the prevalence, severity, and resulting distress of phantom sensations. Study participants completed the scale six times over a 5-year period, beginning 3 to 15 days after surgery during their initial postoperative visit and by mail at 3, 6, 12, 24, and 60 months after surgery. Although the investigators had conducted previous studies of women using a larger sample, only women described in the present study provided data at all six data collection points. These women represent 47% of the original sample; loss to follow-up from the previous studies was similar in the SLNB and ALND groups.

**Findings**

The prevalence and severity of sensations and the resulting level of distress were lower in women who had SLNB compared with those who had ALND. Tenderness and twinges were prevalent at baseline after SLNB and remained so over 5 years. Numbness and tightness were prevalent after ALND and continued over 5 years; however, these sensations decreased in prevalence over time. In general, the majority of sensations were reportedly neither severe nor distressing. In women who underwent mastectomy, the severity and resulting distress caused by phantom sensations were low.

**Nursing Implications**

Nurses can use the results of this study to provide women undergoing SLNB and ALND with accurate information about postoperative sensations. It is important to provide this information to help women anticipate these sensations and understand that they are a normal part of the healing process.

the Reach to Recovery program of the ACS, advocacy groups, or a spiritual advisor. Encouraging the patient to discuss issues and concerns with other patients who have had breast cancer may help her to understand that her feelings are normal and that other women who have had breast cancer can provide invaluable support and understanding.

The patient may also have considerable anxiety about the treatments that will follow surgery (ie, chemotherapy and radiation) and their implications. Providing her with information about the plan of care and referring her to the appropriate members of the health care team also promote coping during recovery. Some women require additional support to adjust to their diagnosis and the changes that it brings. If a woman displays ineffective coping, consultation with a mental health practitioner may be indicated.

### *Improving Sexual Function*

Once discharged from the hospital, most patients are physically allowed to engage in sexual activity. However, any change in the patient's body image, self-esteem, or the response of her partner may increase her anxiety level and affect sexual function. Some partners may have difficulty looking at the incision, whereas others may be completely unaffected. Encouraging the patient to openly discuss how she feels about herself and about possible reasons for a decrease in libido (eg, fatigue, anxiety, self-consciousness) may help clarify issues for her. Helpful suggestions for the patient may include varying the time of day for sexual activity (when the patient is less tired), assuming positions that are more comfortable, and expressing affection using alternative measures (eg, hugging, kissing, manual stimulation).

Most patients and their partners adjust with minimal difficulty if they openly discuss their concerns. However, if issues cannot be resolved, a referral for counseling (eg, psychologist, psychiatrist, psychiatric clinical nurse specialist, social worker, sex therapist) may be helpful. The ambulatory care nurse in the outpatient clinic or hospital should inquire whether the patient is having difficulty with sexuality issues because many patients are reluctant or embarrassed to bring it up themselves.

### *Monitoring and Managing Potential Complications*

LYMPHEDEMA. **Lymphedema** occurs in about 10% to 30% of patients who undergo ALND and in about 0% to 8% of patients who have SLNB (Langer, Guller, Berclaz, et al., 2007; Lucci, McCall, Beitsch, et al., 2007). Risk factors for lymphedema include increasing age, obesity, presence of extensive axillary disease, radiation treatment, and injury or infection to the extremity (Warren, Brorson, Borud, et al., 2007). Lymphedema results if functioning lymphatic channels are inadequate to ensure a return flow of lymph fluid to the general circulation. After axillary lymph nodes are removed, collateral circulation must assume this function. Transient edema in the postoperative period occurs until collateral circulation has completely taken over this function, which generally occurs within a month. Performing prescribed exercises, elevating the arm above the heart several times a day, and gentle muscle pumping (making a fist and releasing) can help reduce the transient edema. The patient needs reassurance that this transient swelling is not lymphedema.

Once lymphedema develops, it tends to be chronic, so preventive strategies are vital. After ALND, the patient is taught hand and arm care to prevent injury or trauma to the affected extremity, thus decreasing the likelihood for lymphedema development (Chart 48-5). The patient is instructed to follow these guidelines for the rest of her life. She is also instructed to contact the physician or a nurse immediately if she suspects that she has lymphedema, because early intervention provides the best chance for control. If allowed to progress without treatment, the swelling can become more difficult to manage. Treatment may consist of a course of antibiotics if an infection is present. A referral to a rehabilitation specialist (eg, occupational or physical therapist) may be necessary for a compression sleeve or glove, exercises, manual lymph drainage, and a discussion of ways to modify daily activities to avoid worsening lymphedema.

HEMATOMA OR SEROMA FORMATION. Hematoma formation (collection of blood inside a cavity) may occur after either mastectomy or breast conservation and usually develops within the first 12 hours after surgery. The nurse assesses for signs and symptoms of a hematoma at the surgical site, which may include swelling, tightness, pain, and bruising of the skin. The surgeon should be notified immediately if there is gross swelling or increased bloody output from the drain. Depending on the surgeon's assessment, a compression wrap may be applied to the incision for approximately 12 hours, or the patient may be returned to the operating room so that the incision may be reopened to identify the source of bleeding. Some hematomas are small, and the body absorbs the blood naturally. The patient may take warm showers or apply warm compresses to

CHART 48-5 PATIENT EDUCATION

### *Hand and Arm Care After Axillary Lymph Node Dissection*

- Avoid blood pressures, injections, and blood draws in affected extremity.
- Use sunscreen (higher than 15 SPF) for extended exposure to sun.
- Apply insect repellent to avoid insect bites.
- Wear gloves for gardening.
- Use cooking mitt for removing objects from oven.
- Avoid cutting cuticles; push them back during manicures.
- Use electric razor for shaving armpit.
- Avoid lifting objects greater than 5–10 pounds.
- If a trauma or break in the skin occurs, wash the area with soap and water, and apply an over-the-counter antibacterial ointment (Bacitracin or Neosporin).
- Observe the area and extremity for 24 hours; if redness, swelling, or a fever occurs, call the surgeon or nurse.

help increase the absorption. A hematoma usually resolves in 4 to 5 weeks.

A seroma, a collection of serous fluid, may accumulate under the breast incision after mastectomy or breast conservation or in the axilla. Signs and symptoms may include swelling, heaviness, discomfort, and a sloshing of fluid. Seromas may develop temporarily after the drain is removed or if the drain is in place and becomes obstructed. Seromas rarely pose a threat and may be treated by unclogging the drain or manually aspirating the fluid with a needle and syringe. Large, long-standing seromas that have not been aspirated could lead to infection. Small seromas that are not bothersome to the patient usually resolve on their own.

**INFECTION.** Although infection is rare, it is a risk after any surgical procedure. This risk may be higher in patients with conditions such as diabetes, immune disorders, and advanced age, as well as in those with poor hygiene. Patients are taught to monitor for signs and symptoms of infection (redness, warmth around incision, tenderness, foul-smelling drainage, temperature greater than 40°C [100.4°F], chills) and to contact the surgeon or nurse for evaluation. Treatment consists of oral or IV antibiotics (for more severe infections) for 1 or 2 weeks. Cultures are taken of any foul-smelling discharge.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients who undergo breast cancer surgery receive a tremendous amount of information preoperatively and postoperatively. It is often difficult for the patient to absorb all of the information, partly because of the emotional distress that often accompanies the diagnosis and treatment. Prior to discharge, the nurse must assess the patient's readiness to assume self-care responsibilities and identify any gaps in knowledge. A review of teaching, with reinforcement, may be required to ensure that the patient and family are prepared to manage the necessary care at home. The nurse reiterates symptoms the patient should report, such as infection, seroma, hematoma, or arm swelling. All teaching should be reinforced during office visits and by telephone.

Most patients are discharged 1 or 2 days after ALND or mastectomy (possibly later if they have had immediate reconstruction) with surgical drains in place. Initially, the drainage fluid appears bloody, but it gradually changes to a serosanguineous and then a serous fluid over the next several days. The patient is given instructions about drainage management at home (Chart 48-6). If the patient lives alone and drainage management is difficult, a referral for a home care nurse should be made. The drains are usually removed when the output is less than 30 mL in a 24-hour period (approximately 7 to 10 days). The home care nurse also reviews pain management and incision care.

Generally, the patient may shower on the second postoperative day and wash the incision and drain site with soap and water to prevent infection. If immediate reconstruction has been performed, showering may be contraindicated until the drain is removed. A dry dressing may be applied to the incision each day for 7 days. The patient should realize that sensation may be decreased in the operative area because the nerves were disrupted during surgery and should be informed that gentle care is needed to avoid injury. After the incision has completely healed (usually after 4 to 6 weeks), lotions or creams may be applied to the area to increase skin elasticity. The patient can begin to use deodorant on the affected side, although many women note that they no longer perspire as much as before the surgery.

After ALND, patients are taught arm exercises on the affected side to restore range of motion (Chart 48-7). After SLNB, patients may also benefit from these exercises, although they are less likely to have decreased range of motion than those who have undergone ALND. Range-of-motion exercises are initiated on the second postoperative day, although instruction often occurs on the first postoperative day. The goals of the exercise regimen are to increase circulation and muscle strength, prevent joint stiffness and contractures, and restore full range of motion. The patient is instructed to perform range-of-motion exercises at home three times a day for 20 minutes at a time until full range of motion is restored (generally 4 to 6 weeks). Most patients find that after the drain is removed, range of motion returns quickly if they have adhered to their exercise program.

If the patient is having any discomfort, taking an analgesic 30 minutes before beginning the exercises can be helpful. Taking a warm shower before exercising can also loosen stiff muscles and provide comfort. When exercising, the patient is encouraged to use the muscles in both arms and to maintain proper posture. Specific exercises may need to be prescribed and introduced gradually if the patient has had skin grafts; has a tense, tight surgical incision; or has

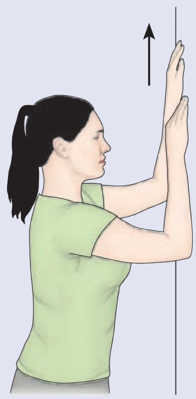
CHART 48-6 HOME CARE CHECKLIST

**Surgical Breast Cancer Patient With a Drainage Device**

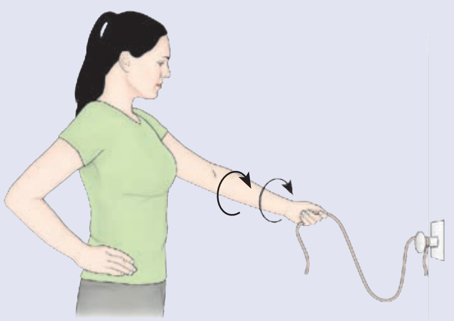
| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate how to empty and measure fluid from the drainage device. | ✔ | ✔ |
| • Demonstrate how to milk clots through the tubing of the drainage device. | ✔ | ✔ |
| • State observations that require contacting the physician or nurse (eg, sudden change in color of drainage, sudden cessation of drainage, signs or symptoms of an infection). | ✔ | ✔ |
| • Care for the drain site as per surgeon's recommendation. | ✔ | ✔ |
| • Identify when the drain is ready for removal (usually when draining less than 30 mL for a 24-hour period). | ✔ | ✔ |

CHART 48-7 PATIENT EDUCATION

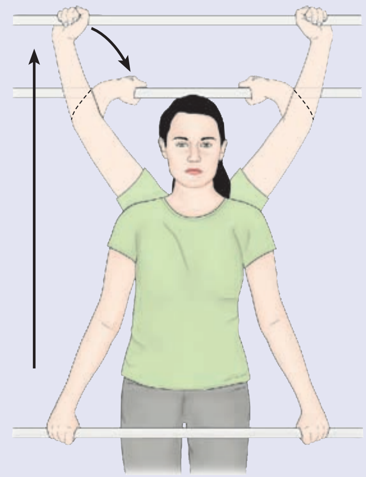
## Exercise After Breast Surgery



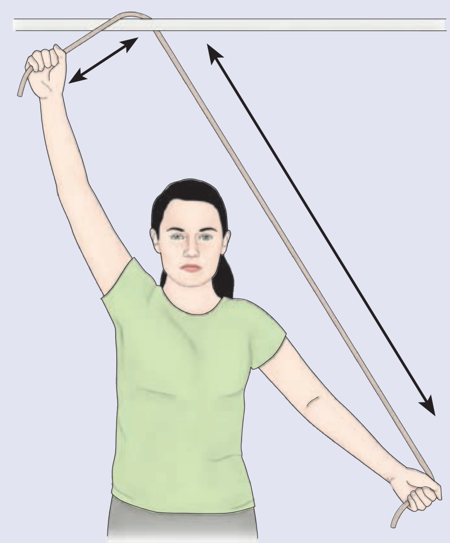
1. *Wall handclimbing.* Stand facing the wall with feet apart and toes as close to the wall as possible. With elbows slightly bent, place the palms of the hand on the wall at shoulder level. By flexing the fingers, work the hands up the wall until arms are fully extended. Then reverse the process, working the hands down to the starting point.



2. *Rope turning.* Tie a light rope to a doorknob. Stand facing the door. Take the free end of the rope in the hand on the side of surgery. Place the other hand on the hip. With the rope-holding arm extended and held away from the body (nearly parallel with the floor), turn the rope, making as wide swings as possible. Begin slowly at first; speed up later.



3. *Rod or broomstick lifting.* Grasp a rod with both hands, held about 2 feet apart. Keeping the arms straight, raise the rod over the head. Bend elbows to lower the rod behind the head. Reverse maneuver, raising the rod above the head, then return to the starting position.



4. *Pulley tugging.* Toss a light rope over a shower curtain rod or doorway curtain rod. Stand as nearly under the rope as possible. Grasp an end in each hand. Extend the arms straight and away from the body. Pull the left arm up by tugging down with the right arm, then the right arm up and the left down in a see-sawing motion.

had immediate reconstruction. Self-care activities, such as brushing the teeth, washing the face, and brushing the hair, are physically and emotionally therapeutic because they aid in restoring arm function and provide a sense of normalcy for the patient.

The patient is instructed about postoperative activity limitation. Generally, heavy lifting (more than 5 to 10 lb) is avoided for about 4 to 6 weeks, although normal household and work-related activities are promoted to maintain muscle tone. Brisk walking, use of stationary bikes and stepping machines, and stretching exercises may begin as soon as the patient feels comfortable. Once the drain is removed, the patient may begin to drive if she has full arm range of motion and is no longer taking opioid analgesics. General guidelines for activity focus on the gradual introduction of previous activities (eg, bowling, weight training) once fully

healed, although checking with the physician or nurse beforehand is recommended.

**CONTINUING CARE.** Patients who have difficulty managing their postoperative care at home may benefit from a home health care referral. The home care nurse assesses the patient's incision and surgical drain(s), adequacy of pain management, adherence to the exercise plan, and overall physical and psychological functioning. In addition, the home care nurse reinforces previous teaching and communicates important physiologic findings and psychosocial issues to the patient's primary care provider, nurse, or surgeon.

The frequency of follow-up visits after surgery may vary but generally should occur every 3 to 6 months for the first several years. The patient may alternate visits with the surgeon, medical oncologist, or radiation oncologist, depending on the treatment regimen. The ambulatory care nurse can also be a great source of comfort and security for the patient and family and should encourage them to telephone if they have any questions or concerns. It is common for people to ignore routine health care when a major health issue arises, so women who have been treated for breast cancer should be reminded of the importance of participating in routine health screening.

### Evaluation

#### *Expected Preoperative Patient Outcomes*

Expected preoperative patient outcomes may include:

1. Exhibits knowledge about diagnosis and surgical treatment options
   a. Asks relevant questions about diagnosis and available surgical treatments
   b. States rationale for surgery
   c. Describes advantages and disadvantages of treatment options
2. Verbalizes willingness to deal with anxiety and fears related to the diagnosis and the effects of surgery on self-image and sexual functioning
3. Demonstrates ability to cope with diagnosis and treatment
   a. Verbalizes feelings appropriately and recognizes normalcy of mood lability
   b. Proceeds with treatment in timely fashion
   c. Discusses impact of diagnosis and treatment on family and work
4. Makes decisions regarding treatment options in timely fashion

#### *Expected Postoperative Patient Outcomes*

Expected postoperative patient outcomes may include:

1. Reports that pain has decreased and states pain and discomfort management strategies are effective
2. Identifies postoperative sensations and recognizes that they are a normal part of healing
3. Exhibits clean, dry, and intact surgical incisions without signs of inflammation or infection
4. Lists the signs and symptoms of infection to be reported to the nurse or surgeon
5. Verbalizes feelings regarding change in body image
6. Discusses meaning of the diagnosis, surgical treatment, and fears appropriately
7. Participates actively in self-care measures
   a. Performs exercises as prescribed
   b. Participates in self-care measures as prescribed
8. Discusses issues of sexuality and resumption of sexual relations
9. Demonstrates knowledge of postdischarge recommendations and restrictions
   a. Describes follow-up care and activities
   b. Demonstrates appropriate care of incisions and drainage system
   c. Demonstrates arm exercises and describes exercise regimen and activity limitations during postoperative period
   d. Describes care of affected arm and hand and lists indications to contact the surgeon or nurse
10. Experiences no complications
    a. Identifies signs and symptoms of reportable complications (eg, redness, heat, pain, edema)
    b. Explains how to contact appropriate health care providers in case of complications

## Radiation Therapy

Radiation therapy is used to decrease the chance of a local recurrence in the breast by eradicating residual microscopic cancer cells. Breast conservation treatment followed by radiation therapy for stages I and II breast cancer results in a survival rate equal to that of a modified radical mastectomy (NCCN, 2009). If radiation therapy, which is part of breast conservation treatment (Chart 48-8), is contraindicated, a mastectomy would then be indicated.

External-beam radiation (the most common type) typically begins about 6 weeks after breast conservation to allow the surgical site to heal. If systemic chemotherapy is indicated, radiation therapy usually begins after its completion. Before radiation begins, the patient undergoes a planning session called a simulation in which the anatomic areas to be treated are mapped out and then identified with small permanent ink markings. External-beam radiation, which delivers high-energy photons from a linear accelerator, is administered to the entire breast region (whole breast radiation). Each treatment lasts only a few minutes and is

### Chart 48-8 • *Contraindications to Breast-Conservation Treatment*

*Note:* Breast-conservation treatment includes both surgery and radiation.

**Absolute Contraindications**

- First or second trimester of pregnancy
- Presence of multicentric disease in the breast
- Prior radiation to the breast or chest region

**Relative Contraindications**

- History of collagen vascular disease
- Large tumor-to-breast ratio
- Tumor beneath nipple

generally given 5 days a week for 5 to 6 weeks. After completion of radiation to the entire breast, many patients receive a "boost," a dose of radiation to the lumpectomy site where the cancer cells were located. The boost consists of the same dose of radiation but is less penetrating and directed to a smaller area. The treatments are not painful.

Because most breast cancer recurrences appear at or near the lumpectomy site, the need for whole breast radiation is now being questioned. Partial breast radiation (radiation to the lumpectomy site alone) is now being evaluated at some institutions in carefully selected patients. One approach is **brachytherapy,** which delivers partial breast radiation by placing a radioactive source within the lumpectomy site. This technique can lead to an improved quality of life because the treatments are administered over 4 to 5 days instead of 5 to 6 weeks. Another approach is intraoperative radiation therapy (IORT), in which a single intense dose of radiation is delivered to the surgical site in the operating room immediately following the lumpectomy. Short-term results of both of these approaches are promising with regard to rates of local recurrence and overall survival (Sauer, Sautter-Bihl, Budach, et al., 2007). Many questions remain unanswered, and longer follow-up with larger studies is needed to document the long-term effectiveness and potential side effects of these techniques. In the meantime, whole breast radiation remains the standard treatment of choice.

Although not widely used today after mastectomy, postoperative radiation is indicated for women at high risk for cancer recurrence (ie, chest wall involvement, four or more positive lymph nodes, tumors larger than 5 cm, positive surgical margins).

### Side Effects

Generally, radiation therapy is well tolerated. Acute side effects consist of mild to moderate erythema, breast edema, and fatigue. Occasionally, skin breakdown may occur in the inframammary fold or near the axilla toward the end of treatment. Fatigue can be depressing, as can the frequent trips to the radiation oncology unit for treatment. The patient needs to be reassured that the fatigue is normal and not a sign of recurrence. Side effects usually resolve within a few weeks to a few months after treatment is completed. Rare long-term effects of radiation therapy include pneumonitis, rib fracture, and breast fibrosis.

### Nursing Management

Self-care instructions for patients receiving radiation are provided to assist in the maintenance of skin integrity during the treatments and for several weeks after completion. They pertain only to the area being treated and not to the rest of the body.

- Use mild soap with minimal rubbing.
- Avoid perfumed soaps or deodorants.
- Use hydrophilic lotions (Lubriderm, Eucerin, Aquaphor) for dryness.
- Use a nondrying, antipruritic soap (Aveeno) if pruritus occurs.
- Avoid tight clothes, underwire bras, excessive temperatures, and ultraviolet light.

Follow-up care includes teaching the patient to minimize sun exposure to the treated area (ie, using sunblock with sun protection factor [SPF] 15 or above) and reassuring the patient that minor twinges and shooting pain in the breast are normal after radiation treatment.

## Systemic Treatments

### Chemotherapy

**Adjuvant chemotherapy** involves the use of anticancer agents in addition to other treatments (ie, surgery, radiation) to delay or prevent a recurrence of breast cancer. It is recommended for patients who have positive lymph nodes or who have invasive tumors greater than 1 cm in size, regardless of nodal status. It is considered in patients with tumors that are 0.6 cm to 1 cm, are moderately to poorly differentiated, or have unfavorable features (NCCN, 2009). Table 48-6 outlines general indications for adjuvant chemotherapy. A survival benefit has been shown in premenopausal and postmenopausal women who received chemotherapy, although data are limited in women older than 70 years of age. Chemotherapy is most commonly initiated after breast surgery and before radiation.

Chemotherapy regimens for breast cancer combine several agents (polychemotherapy), generally administered over a period of 3 to 6 months. Decisions regarding the optimal regimen are based on a variety of factors, including tumor characteristics (ie, tumor size, lymph node status, hormone receptor status, HER-2/neu status) and the patient's age, physical status, and existing comorbid conditions. A regimen that includes cyclophosphamide (Cytoxan), methotrexate (Trexall), and fluorouracil (Fluoroplex) (CMF) has been the most widely used adjuvant therapy. It is usually well tolerated and may be considered for patients with a low risk of recurrence. CMF also may be considered for use in patients who have a high risk for cardiac toxicity (a potential side effect of anthracycline-based regimens) or who have other limiting comorbidities. Anthracycline-based regimens (eg, doxorubicin [Adriamycin],

**Table 48-6 GENERAL INDICATIONS FOR ADJUVANT CHEMOTHERAPY FOR BREAST CANCER**

| Nodal Status, Tumor Size | Adjuvant Chemotherapy |
|---|---|
| Node negative, 0.5 cm or less | None |
| Node negative 0.6–1 cm (well differentiated) | None |
| Node negative, 0.6–1 cm (moderately or poorly differentiated and/or unfavorable features) | Consider chemotherapy |
| Node negative, greater than 1 cm | Chemotherapy |
| Node positive, any tumor size | Chemotherapy |

- In addition to chemotherapy, patients with HER-2/neu positive tumors will receive trastuzumab if they have node positive disease; or node negative disease with a tumor greater than 1 cm. Trastuzumab is a monoclonal antibody that targets and inactivates the HER-2/neu protein. HER-2/neu is overproduced in 25% to 30% of tumors and is associated with rapid growth and poor prognosis.
- Following chemotherapy, patients with hormone receptor positive (ER+/PR+) tumors will receive hormonal therapy (tamoxifen or aromatase inhibitor) if they have either node positive disease; node negative disease with a tumor >1cm; or node negative with a tumor 0.6cm–1cm and moderately or poorly differentiated and/or unfavorable features.

**Note:** These are only general guidelines. Recommendations may vary depending on factors such as prognostic variables, patient age, and comorbid conditions.

epirubicin [Ellence]) were associated with a decrease in the annual breast cancer death rate by 38% in women younger than 50 years and 20% in women ages 50 to 69 (McArthur & Hudis, 2007a). Cyclophosphamide, doxorubicin, and fluorouracil (CAF) and doxorubicin and cyclophosphamide (AC) are examples of combination regimens often administered to higher risk patients.

The taxanes (paclitaxel [Taxol], docetaxel [Taxotere]) are generally incorporated into treatment regimens for patients with larger, node-negative cancers and for those with positive axillary lymph nodes. The addition of four cycles of paclitaxel after a standard course of AC (regimen known as ACT) has been found to increase the disease-free period and improve overall survival in patients with operable breast cancer and positive lymph nodes (DeLaurentis, Cancello, D'Agostino, et al., 2008).

Much attention has been focused on **dose-dense chemotherapy,** the administration of chemotherapeutic agents at standard doses with shorter time intervals between each cycle of treatment. Patients who received ACT every 2 weeks, compared with those who received it on the conventional schedule of every 3 weeks, had an improved disease-free and overall survival (McArthur & Hurdis, 2007b). Long-term follow-up of this study and other clinical trials are ongoing to determine optimal treatment regimens, doses, and timing.

#### Side Effects

Today, many of the side effects of adjuvant chemotherapy can be managed well, allowing patients to maintain their daily routines and work schedules. In large part, this has been a result of the meticulous educational and psychological preparation provided to patients and their families by oncology nurses, oncologists, social workers, and other members of the health care team. In addition, strides have been made in the effectiveness of antiemetic agents used to alleviate nausea and vomiting and the use of hematopoietic growth factors to treat neutropenia and anemia.

Common physical side effects of chemotherapy for breast cancer may include nausea, vomiting, bone marrow suppression, taste changes, alopecia (hair loss), mucositis, neuropathy, skin changes, and fatigue. A weight gain of more than 10 lb occurs in about half of all patients; the cause is unknown. Premenopausal women may also experience temporary or permanent amenorrhea.

Specific side effects vary with the type of chemotherapeutic agent used. In general, CMF and the taxanes are better tolerated than the anthracyclines. However, the taxanes can cause peripheral neuropathy, arthralgias, and myalgias, particularly at high doses. During taxane administration, hypersensitivity reactions may occur; therefore, the patient must be premedicated. Alopecia is also common. The side effects of the anthracyclines may be severe and include cardiotoxicity in addition to nausea and vomiting, bone marrow suppression, and alopecia. Their vesicant properties can lead to tissue necrosis if infiltration of the medication infusion occurs.

#### Nursing Management

Nurses play an important role in helping patients manage the physical and psychosocial sequelae of chemotherapy. (Chapter 16 provides an in-depth discussion of side-effect management.) Instructing the patient about the use of antiemetics and reviewing the optimal dosage schedule can help minimize nausea and vomiting. The different classes of antiemetic agents include serotonin (5-HT-3) receptor antagonists (palonosetron [Aloxi], granisetron [Kytril], ondansetron [Zofran]); neurokinin-1 receptor antagonists (aprepitant [Emend]); dopamine receptor antagonists (prochlorperazine [Compazine], metoclopramide [Reglan]); benzodiazepines (lorazepam [Ativan]); and corticosteroids (dexamethasone [Decadron]). Measures to ease the symptoms of mucositis may include rinsing with normal saline or sodium bicarbonate solution, avoiding hot and spicy foods, and using a soft toothbrush.

Some patients may require hematopoietic growth factors to minimize the effects of chemotherapy-induced neutropenia and anemia. Granulocyte colony-stimulating factors (G-CSFs) boost the white blood cell count, helping reduce the incidence of neutropenic fever and infection. The short-acting form, filgrastim (Neupogen), is injected subcutaneously for 7 to 10 days after chemotherapy administration. The long-acting form, pegfilgrastim (Neulasta), is injected once, 24 hours after chemotherapy. Erythropoietin growth factor increases the production of red blood cells, thus decreasing the symptoms of anemia. The short-acting form, epoetin alfa (Epogen) is usually administered weekly. The long-acting form, darbepoetin alfa (Aranesp), can be administered every 2 to 3 weeks. The nurse instructs the patient and family on proper injection technique of hematopoietic growth factors and about symptoms that require follow-up with a physician (Chart 48-9).

To prevent some of the emotional trauma associated with alopecia, it often helps to have a patient obtain a wig before hair loss begins to occur. The nurse may provide a list of wig suppliers in the patient's geographic region. Familiarity with creative ways to use scarves and turbans may also help minimize the patient's distress. The patient needs reassurance that new hair will grow back when treatment is completed, although the color and texture may be different. The ACS offers a program called Look Good, Feel Better that provides useful tips for applying cosmetics during the period a patient is receiving chemotherapy.

Chemotherapy may negatively affect the patient's self-esteem, sexuality, and sense of well-being. This, combined with the stress of a potentially life-threatening disease, can be overwhelming. Providing support and promoting open communication are important aspects of nursing care. Referring the patient to the dietitian, social worker, psychiatrist, or spiritual advisor can provide additional support. Numerous community support and advocacy groups are available for patients and their families. Complementary therapies, such as guided imagery, meditation, and relaxation exercises, can also be used in conjunction with conventional treatments.

### *Hormonal Therapy*

The use of **adjuvant hormonal therapy,** with or without the addition of chemotherapy, is considered in women who have hormone receptor–positive tumors. Its use can be determined by the results of an **estrogen and progesterone receptor assay.** About two thirds of breast cancers are dependent

CHART 48-9

## HOME CARE CHECKLIST
### *Self-Administration of Hematopoietic Growth Factors*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State the purpose for the injections. | ✔ | ✔ |
| • Identify the equipment necessary for self-injection. | ✔ | ✔ |
| • Identify appropriate body sites for self-injection. | ✔ | ✔ |
| • Demonstrate how to draw up the solution in a syringe if indicated (note: darbepoetin and pegfilgrastim come in prefilled syringes). | ✔ | ✔ |
| • Demonstrate how to give an injection properly. | ✔ | ✔ |
| • State possible side effects of medication. | ✔ | ✔ |
| • Demonstrate correct disposal of sharps. | ✔ | ✔ |
| • Describe proper storage of supplies. | ✔ | ✔ |
| • State reasons for contacting the physician or nurse (eg, excessive pain, fever). | ✔ | ✔ |

on estrogen for growth and express a nuclear receptor that binds to the estrogen; thus, they are estrogen receptor–positive (ER+). Similarly, tumors that express the progesterone receptor are progesterone receptor–positive (PR+). Hormonal therapy involves the use of medications that compete with estrogen by binding to the receptor sites (selective estrogen receptor modulators [SERMs]), or by blocking estrogen production **(aromatase inhibitors)**. Generally, tumors that are ER+/PR+ have the greatest likelihood of responding to hormonal therapy and have a more favorable prognosis than those that are ER−/PR−. Premenopausal and perimenopausal women are more likely to have non–hormone-dependent lesions, whereas postmenopausal women are more likely to have hormone-dependent lesions.

Traditionally, the SERM tamoxifen has been the primary hormonal agent used in treatment of premenopausal and postmenopausal breast cancer and remains the mainstay in premenopausal women. As a SERM, tamoxifen has estrogen antagonistic (estrogen-blocking) and agonistic (estrogen-like) effects on certain tissues. Its antagonistic effects in the breast prevent estrogen from binding to the receptor sites, thus preventing tumor growth. Tamoxifen has positive agonistic effects on blood lipid profiles and bone mineral density in postmenopausal women. It also has agonistic effects on endometrial tissue and blood coagulation processes, leading to an increased incidence of endometrial cancer and thromboembolic events (eg, deep vein thrombosis, superficial phlebitis, pulmonary embolism). Nevertheless, the benefits of tamoxifen in most women with breast cancer outweigh the risks.

The aromatase inhibitors anastrazole (Arimidex), letrozole (Femara), and exemestane (Aromasin) are important components in the hormonal management of postmenopausal women. Most of the circulating estrogens in postmenopausal women are derived from the conversion of the adrenal androgen androstenedione to estrone and the conversion of testosterone to estradiol. Aromatase inhibitors work by blocking the enzyme aromatase from performing the conversion, thereby decreasing the level of circulating estrogen in peripheral tissues. Clinical trials have demonstrated that the aromatase inhibitors are superior to tamoxifen in terms of disease-free survival. Benefits were seen in patients who received an aromatase inhibitor as their initial adjuvant therapy, as therapy given after 2 to 3 years of tamoxifen, or when given for 5 years after receiving tamoxifen for 5 years (Carpenter, 2008). These data ensure that aromatase inhibitors will play an increasingly central role in the long-term management and follow-up of early-stage breast cancer. Trials are ongoing to determine the optimal treatment regimen and the timing of the treatment. Table 48-7 outlines the adverse effects of adjuvant hormonal therapy. Chart 48-10 outlines appropriate patient education to manage the adverse effects.

**Table 48-7 ADVERSE REACTIONS ASSOCIATED WITH ADJUVANT HORMONAL THERAPY USED TO TREAT BREAST CANCER**

| Therapeutic Agent | Adverse Reactions/Side Effects |
|---|---|
| **Selective Estrogen Receptor Modulator** | |
| Tamoxifen (Nolvadex) | Hot flashes, vaginal dryness/discharge/bleeding, irregular menses, nausea, mood disturbances; increased risk for endometrial cancer; increased risk for thromboembolic events (deep vein thrombosis, pulmonary embolism, superficial phlebitis) |
| **Aromatase Inhibitors** | |
| Anastrozole (Arimidex)<br>Letrozole (Femara)<br>Exemestane (Aromasin) | Musculoskeletal symptoms (arthritis, arthralgia, myalgia), increased risk of osteoporosis/fractures, nausea/vomiting, hot flashes, fatigue, mood disturbances |

CHART 48-10 PATIENT EDUCATION

**Managing Side Effects of Adjuvant Hormonal Therapy in Breast Cancer**

**Hot Flashes**

- Wear breathable, layered clothing.
- Avoid caffeine and spicy foods.
- Perform breathing exercises (paced respirations).
- Consider medications (vitamin E, antidepressants) or acupuncture.

**Vaginal Dryness**

- Use vaginal moisturizers for everyday dryness (eg, Replens, Vitamin E suppository).
- Apply vaginal lubrication during intercourse (eg, Astroglide, K-Y jelly).

**Nausea and Vomiting**

- Consume a bland diet.
- Try to take medication in the evening.

**Musculoskeletal Symptoms**

- Take nonsteroidal analgesics as recommended.
- Take warm baths.

**Risk of Endometrial Cancer**

- Report any irregular bleeding to a gynecologist for evaluation.

**Risk for Thromboembolic Events**

- Report any redness, swelling, or tenderness in the lower extremities, or any unexplained shortness of breath.

**Risk for Osteoporosis or Fractures**

- Undergo a baseline bone density scan.
- Perform regular weight-bearing exercises.
- Take calcium supplements with vitamin D.
- Take bisphosphonates (eg, alendronate) or calcitonin as prescribed.

#### *Targeted Therapy*

One of the most exciting areas of research in the systemic treatment of breast cancer involves the use of targeted therapies. Trastuzumab (Herceptin) is a monoclonal antibody that binds specifically to the HER-2/neu protein. This protein, which regulates cell growth, is present in small amounts on the surface of normal breast cells and in most breast cancers. Approximately 25% to 30% of tumors overexpress (overproduce) the HER-2/neu protein and are associated with rapid growth and poor prognosis. Trastuzumab targets and inactivates the HER-2/neu protein, thus slowing tumor growth.

Unlike chemotherapy, trastuzumab spares the normal cells and has limited adverse reactions, which may include fever, chills, nausea, vomiting, diarrhea, and headache. However, when trastuzumab is administered to patients who have previously been treated with an anthracycline, the risk of cardiac toxicity is increased. The medication has been shown to improve survival rates in women with HER-2/neu–positive metastatic breast cancer and is now regarded as standard therapy. It may be administered as a single agent or in combination with chemotherapy. More recently, trastuzumab has been shown to be effective in treating early-stage breast cancer that is HER-2/neu positive. Adding trastuzumab to standard chemotherapy reduces the risk of recurrence by 52% and death by 33% (Romond, Perez, Bryant, et al., 2005). Patients with node-positive disease or node-negative disease with a tumor greater than 1 cm in size should receive trastuzumab for 1 year (Piccart-Gebhart, Procter, Leyland-Jones, et al., 2005). Another monoclonal antibody, bevacizumab (Avastin), is used in combination with paclitaxel to treat metastatic breast cancer (NCCN, 2007). It interferes with the vascular endothelial growth factor (VEGF), thus preventing the growth of new blood vessels that supply tumor cells with blood, oxygen, and nutrients that they need to grow. It is generally well tolerated but can cause hypertension and proteinuria.

## Treatment of Recurrent and Metastatic Breast Cancer

Despite the advances made in the treatment of breast cancer, it may recur locally (on the chest wall or in the conserved breast), regionally (in the remaining lymph nodes), or systemically (in distant organs). In metastatic disease, the bone, usually the hips, spine, ribs, skull, or pelvis, is the most common site of spread. Other sites of metastasis include the lungs, liver, pleura, and brain.

The overall prognosis and optimal treatment are determined by a variety of factors such as the site and extent of recurrence, the time to recurrence from the original diagnosis, history of prior treatments, the patient's performance status, and any existing comorbid conditions. Patients with bone metastases generally have a longer overall survival compared with metastases in visceral organs.

Local recurrence in the absence of systemic disease is treated aggressively with surgery, radiation, and hormonal therapy. Chemotherapy may also be used for tumors that are not hormonally sensitive. Local recurrence may be an indicator that systemic disease will develop in the future, particularly if it occurs within 2 years of the original diagnosis.

Metastatic breast cancer involves control of the disease rather than cure. Treatment includes hormonal therapy, chemotherapy, and targeted therapy. Surgery or radiation may be indicated in select situations. Premenopausal women who have hormonally dependent tumors may eliminate the production of estrogen by the ovaries through oophorectomy (removal of the ovaries) or suppression of estrogen production by medications such as leuprolide (Lupron) or goserelin (Zoladex).

Patients with advanced breast cancer are monitored closely for signs of disease progression. Baseline studies are obtained at the time of recurrence. These may include complete blood count; comprehensive metabolic panel; tumor markers (ie, carcinoembryonic antigen, cancer antigen 15-3); bone scan; CT of the chest, abdomen, and pelvis;

and MRI of symptomatic areas. Additional x-rays may be performed to evaluate areas of pain or abnormal areas seen on bone scan (eg, long bones, pelvis). These studies are repeated at regular intervals to assess for effectiveness of treatment and to monitor progression of disease.

#### Nursing Management

Nurses play an important role in not only educating patients and managing their symptoms but also in providing emotional support. Many patients find that recurrence of the disease is more distressing than the initial cancer diagnosis. They not only have to contend with another round of treatments but are faced with a greater uncertainty about their future and long-term survival. The nurse can help the patient identify coping strategies and set priorities to optimize quality of life. Family members and significant others should be included in the treatment plan and follow-up care. Referrals to support groups, psychiatry or psychiatric clinical nurse specialist, social work, and complementary medicine programs (eg, guided imagery, meditation, yoga) should be made as indicated.

Nurses also play important roles in providing palliative care, if indicated. The highest priorities should include alleviating pain and providing comfort measures. A frank discussion with the patient and family regarding their preferences for end-of-life care should occur before the need arises to ensure a smooth transition without disruption of care. Referrals to hospice and home health care should be initiated as necessary. Chapter 16 provides more information on the general care of the patient with advanced cancer. Chapter 17 discusses end-of-life care.

## Reconstructive Procedures After Mastectomy

Breast reconstruction can provide a significant psychological benefit for women who are already struggling with the emotional distress of losing a breast. A consultation with a plastic surgeon can help the patient understand procedures for which she is a candidate and the pros and cons of each. Factors to consider include body size and shape, comorbid conditions (eg, hypertension, diabetes mellitus, obesity), personal habits such as smoking, and patient preference. The patient must be informed that although breast reconstruction can provide a good cosmetic result, it will never precisely duplicate the natural breast. Realistic preparation can help the patient avoid unrealistic expectations. Once reconstruction is complete, the opposite breast may require augmentation, reduction, or mastopexy to achieve symmetry on both sides. The patient must also be informed that breast reconstruction neither will interfere with breast cancer treatments nor affect the risk of cancer recurrence. Reconstruction is considered an integral component in the surgical treatment of breast cancer and is usually covered by insurance companies.

Many women elect immediate reconstruction at the time of the mastectomy operation. This can be beneficial in that it saves the woman from undergoing general anesthesia a second time and it saves the cost and stress of future hospitalizations. However, it does increase the length of the surgical procedure. Delayed reconstruction is preferable in women who are having a difficult time deciding on the type of reconstruction they desire. It may also be preferable in patients with advanced disease such as inflammatory breast cancer, where the breast cancer treatments should begin without delay. Any delays in healing after immediate reconstruction may interfere with the initiation of treatment.

#### Tissue Expander Followed by Permanent Implant

Breast reconstruction using a **tissue expander followed by a permanent implant** is the simplest and most common method used today (Fig. 48-6). To accommodate an implant, the skin remaining after a mastectomy and the underlying muscle must gradually be stretched by a process called tissue expansion. The surgeon places a balloonlike device called a tissue expander through the mastectomy incision underneath the pectoralis muscle. A small amount of saline is injected through a metal port intraoperatively to partially inflate the expander. Then, for about 6 to 8 weeks, at weekly intervals, the patient receives additional saline injections through the port until the expander is fully inflated. It remains fully expanded for about 6 weeks to allow the skin to loosen. The expander is then exchanged for a permanent implant. This is usually performed as an outpatient surgical procedure.

Advantages of this expansion procedure are a shorter operating time and a shorter recuperation period than for autologous reconstruction (see Tissue Transfer Procedures below). A disadvantage is a tendency for the implant to feel firm and round, with little natural ptosis (sag). Women with a small to medium opposite breast with little ptosis are good candidates for this procedure. Women who have had radiation or who have connective tissue disease are not good candidates because of the decreased elasticity of the skin.

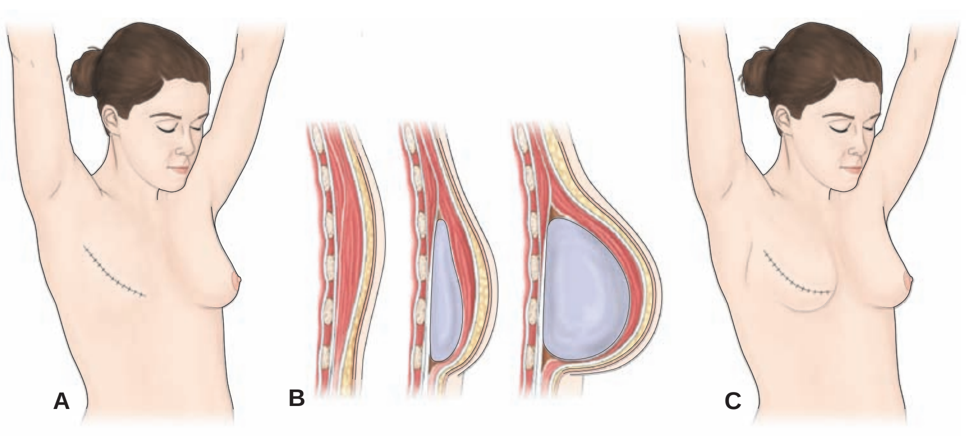



**Figure 48-6** Breast reconstruction with tissue expander. **A,** Mastectomy incision line prior to tissue expansion. **B,** The expander is placed under the pectoralis muscle and is gradually filled with saline solution through a port to stretch the skin enough to accept a permanent implant. **C,** The breast mound is restored. Although permanent, scars will fade with time. The nipple and areola are reconstructed later. (Adapted from *Breast reconstruction*. Arlington Heights, IL: American Society of Plastic and Reconstructive Surgeons.)

**NURSING ALERT**

**The patient must be cautioned not to have an MRI while the tissue expander is in place because the port contains metal. This is not an issue once the permanent implant is in place because it does not contain any metal.**

The patient should be informed that for the rest of her life she should not engage in any exercises that will develop the pectoralis muscle because this can result in distortion of the reconstructed breast.

### Tissue Transfer Procedures

Autologous reconstruction is the use of the patient's own tissue to create a breast mound. A flap of skin, fat, and muscle with its attached blood supply is rotated to the mastectomy site to create a mound that simulates the breast. Donor sites may include the **transverse rectus abdominis myocutaneous (TRAM) flap** (abdominal muscle) (Fig. 48-7), gluteal flap (buttock muscle), or the latissimus dorsi flap (back muscle) (Fig. 48-8). The results more closely resemble a real breast because the skin and fat from the donor sites are similar in consistency to a natural breast. These procedures avoid the use of synthetic material. However, they are far more complex and involve longer operative time (ranging from about 5 to 10 hours total time for the mastectomy and reconstruction) and longer recuperation than a tissue expander procedure. The risk of potential complications (eg, infection, bleeding, flap necrosis) is also greater. Therefore, patients must be in relatively good health, and those with medical conditions (eg, atherosclerosis, pulmonary disease, heart failure) that affect circulation or compromise oxygen delivery are not good candidates. Other poor candidates include those with uncontrolled type 1 diabetes mellitus or morbid obesity and heavy smokers.

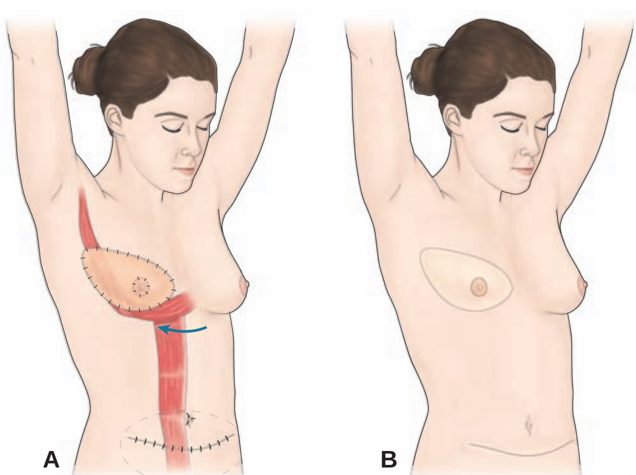


**Figure 48-7** Breast reconstruction: transverse rectus abdominis myocutaneous (TRAM) flap. **A,** A breast mound is created by tunneling abdominal skin, fat, and muscle to the mastectomy site. **B,** Final location of scars. (Adapted from *Breast reconstruction*. Arlington Heights, IL: American Society of Plastic and Reconstructive Surgeons.)

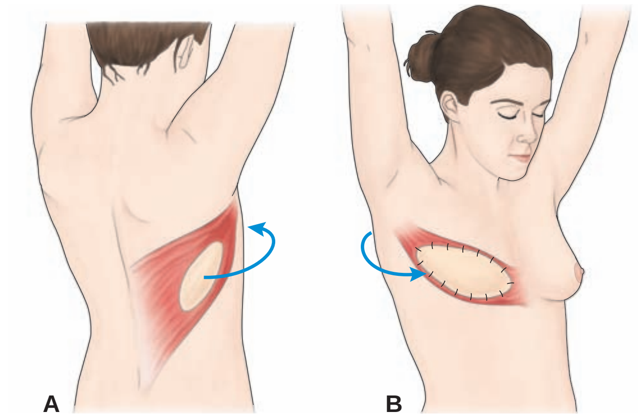


**Figure 48-8** Breast reconstruction: latissimus dorsi flap. **A,** The latissimus muscle with an ellipse of skin is rotated from the back to the mastectomy site. **B,** Because the flap is usually not bulky enough to provide an adequate breast mound, an implant is often also required. (Adapted from *Breast reconstruction*. Arlington Heights, IL: American Society of Plastic and Reconstructive Surgeons.)

The TRAM flap is the most commonly performed tissue transfer procedure. A free TRAM procedure may also be performed; in this case, the skin, fat, muscle, and blood supply are completely detached from the body and then transplanted to the mastectomy site using microvascular surgery (use of a microscope to reconnect the vessels). Postoperatively, patients who have undergone TRAM procedures often face a lengthy recovery (often 6 to 8 weeks) and have incisions both at the mastectomy site and at the donor site in the abdomen. The nurse must assess the newly constructed breast site for changes in color, circulation, and temperature because flap loss is a potential complication. Mottling or an obvious decrease in skin temperature is reported to the surgeon immediately. Breathing and leg exercises are essential because the patient is more limited in her activity and is at greater risk for respiratory complications and deep vein thrombosis. Measures to help the patient reduce tension on the abdominal incision during the first postoperative week include elevating the head of the bed 45 degrees and flexing the patient's knees.

Once the patient is able to ambulate, she can protect the surgical incision by splinting it and will gradually achieve a more upright position. The patient is instructed to avoid high-impact activities and lifting (more than 5 to 10 lb for 6 to 8 weeks after surgery) to prevent stress on the incision.

### Nipple–Areola Reconstruction

After the breast mound has been created and the site has healed, some women choose to have nipple–areola reconstruction. This is a minor surgical procedure carried out either in the physician's office or at an outpatient surgical facility. The most common method of creating a nipple is with the use of local flaps (skin and fat from the center of the new breast mound), which are wrapped around each other to create a projecting nipple. The areola is created using a skin graft. The most common donor site is the upper inner thigh because this skin has darker pigmentation than the skin on the reconstructed breast. After the nipple graft has healed, micropigmentation (tattooing) can be performed

to achieve a more natural color. The surgeon can usually match the reconstructed nipple–areola complex with that of the contralateral breast for an acceptable cosmetic result.

## Prosthetics

Not all patients desire or are candidates for reconstructive surgery. A breast prosthesis, an external form that simulates the breast, is another option. Prostheses are available in different shapes, sizes, colors, and materials, although they are most often made of silicone. They can be placed inside a pocket in a bra or can adhere directly to the chest wall. The nurse can provide the patient with the names of shops where she can be fitted for a prosthesis, or the patient can call the Reach to Recovery program of the ACS for appropriate referrals. The patient should be encouraged to find a shop with a comfortable, supportive atmosphere that employs a certified prosthetics consultant. Generally, medical supply shops are not recommended because often they do not have the appropriate resources to ensure the proper fitting of a prosthesis.

Prior to discharge from the hospital, the nurse usually provides the patient with a temporary, lightweight, cotton-filled form that can be worn until the surgical incision is well healed (4 to 6 weeks). After that, the patient can be fitted for a prosthesis. Insurance companies generally cover the cost of the prosthesis and the special bras that hold it in place. A breast prosthesis can provide a psychological benefit and assist the woman in resuming proper posture because it helps balance the weight of the remaining breast.

## Special Issues in Breast Cancer Management

### Implications of Genetic Testing

The rapid advancement in genetics has brought new knowledge about genetically inherited breast cancer, but it has also raised potential ethical and psychosocial issues. Although the actual testing for the *BRCA1* and *BRCA2* genes involves a simple blood test, it is these issues that must be addressed. Before undergoing genetic testing, a person should meet either with a clinician who has expertise in this area or with a certified genetics counselor to discuss risk factors as well as the benefits, sequelae, and limitations of testing.

How people react when they receive their actual test results is not always easy to predict. A negative test in a person who comes from a family with a known mutation may lead to enormous relief. However, a negative test in a family with no known mutation may be a source of undue reassurance; the possibility of existing genes that cannot yet be detected remains. A negative test may also lead to feelings of guilt in a person whose family members did not receive favorable test results; this is known as survivor's guilt. A positive test could act as a motivator in a person to pursue appropriate screening or treatment, or it could cause tremendous anxiety, depression, and worry.

In addition, test results may be ambiguous, leading to feelings of confusion and uncertainty. People must be informed that not all gene carriers develop breast cancer (incomplete penetrance) and that not all noncarriers are protected.

Other issues include those of cost: Who should pay for genetics testing and the services that relate to it? Difficult ethical questions arise concerning whether the person who is tested should disclose the test results. Is it ethical to withhold results from family members who may be at risk? If they are told, what effect will it have on them? People considering testing must be informed that there is no guarantee that test results will remain confidential. Once confidentiality is breached, it could unleash potential discrimination in employment and insurability. There are laws now, however, in many states to protect the individual if this should happen. People must be well informed of all of the issues and potential implications prior to undergoing genetics testing. Nurses play a role in educating and counseling patients and their family members about the implications of genetic testing. Nurses provide support and clarification and make referrals to appropriate specialists when indicated.

### Pregnancy and Breast Cancer

Breast cancer during pregnancy is defined as breast cancer diagnosed during gestation or within 1 year of childbirth and occurs in 1 in 3000 women (NCCN, 2007). Because of increased levels of hormones produced during pregnancy and subsequent lactation, the breast tissue becomes tender and swollen, making it more difficult to detect a mass. If a mass is found during pregnancy, ultrasound is the preferred diagnostic method because it involves no exposure to radiation. If indicated, mammography with appropriate shielding, FNA, and biopsy can be performed. Modified radical mastectomy remains the most common form of surgical treatment. SLNB is typically not performed because of the unknown effects of the radioisotope and the blue dye on the fetus. Breast conservation treatment may be considered if the breast cancer is diagnosed during the third trimester. Radiation can then be delayed until after delivery because it is contraindicated during pregnancy. Chemotherapy should be avoided during the first trimester; the fetal organs are still developing, and it poses a great risk for fetal malformations. However, chemotherapy has been administered during the second and third trimesters with few reported abnormalities. Long-term effects on the fetus are still being studied. If a woman is close to term, a cesarean section may be performed as soon as maturation of the fetus allows, and then treatment is initiated. If aggressive disease is detected early in pregnancy and chemotherapy is advised, termination of the pregnancy may be considered. If a mass is found while a woman is breastfeeding, she is urged to stop to allow the breast to involute (return to its baseline state) before any type of surgery is performed.

Fertility issues and the future desire for children are major concerns of young breast cancer survivors. Certain chemotherapeutic agents, particularly cyclophosphamide, can lead to amenorrhea. Even if the woman is still fertile, many physicians recommend postponing pregnancy for 2 to 3 years after primary treatment because recurrence rates are the highest during this time. Women taking tamoxifen for 5 years are cautioned to avoid pregnancy because of potential effects on the fetus. This waiting period may make it more difficult for the woman to later become pregnant as she advances in age. These issues should be discussed with the patient prior to initiating treatment. There are options

today that may help preserve a woman's fertility, and prior to the onset of chemotherapy she should seek the opinion of a reproductive specialist (Partridge & Ruddy, 2007). Fertile Hope, a national nonprofit organization, can also provide updated information on reproduction (see Resources at the end of the chapter).

### Quality of Life and Survivorship

With increased early detection and improved treatment modalities, women with breast cancer have become the largest group of cancer survivors. However, the treatment or simply the diagnosis of breast cancer may have long-term effects that negatively affect the patient and her family. The patient should be prepared early on for the potential long-term effects of the disease so she has realistic expectations and can make informed decisions.

Breast cancer survivors may experience a variety of issues as a result of their diagnosis and treatment. Estrogen withdrawal from chemotherapy-induced menopause and hormonal treatments can lead to a variety of symptoms, including hot flashes, vaginal dryness, urinary tract infections, weight gain, decreased sex drive, and increased risk of osteoporosis. HT to alleviate symptoms is contraindicated in women with breast cancer. Certain chemotherapeutic agents can cause long-term cardiac effects and neuropathy. In addition, patients may experience impaired cognitive functioning such as difficulty concentrating (often referred to as chemobrain). Rare long-term effects of radiation can include pneumonitis and rib fractures. Long-term sequelae after breast surgery may include lymphedema (mainly after ALND), pain, and sensory disturbances. Once lymphedema develops, it tends to be a chronic problem, so prevention strategies (discussed earlier) are vital. Patients have also reported sensations such as tenderness and soreness 5 years after their surgical procedure (Baron, et al., 2007).

Some of these symptoms can also lead to fatigue and sleep disturbances. Long-term psychosocial sequelae may include anxiety, depression, uncertainty about the future, and fear of recurrence. In the workplace, the patient may suffer from fear of discrimination, concern over coworkers' reactions, fear of losing insurance benefits, and lack of physical stamina. Studies have found, however, that many of these issues are not recognized or addressed (Khatcheressian & Swainey, 2008).

### Gerontologic Considerations

When deciding on the optimal treatment modality for an elderly patient, age alone should not be the single determining factor. Many older women, regardless of their advancing chronological age, remain in excellent health. Therefore, the woman's treatment preferences should play a strong role in the decision-making process. It should not be assumed that elderly women are less concerned about their appearance than their younger counterparts. One study surveyed 75 women who were 60 years of age or older about their thoughts on breast reconstruction (Bowman, Lennox, Clugston, et al., 2006). More than 90% of the women believed that age should not be taken into consideration before being offered the option of breast reconstruction. Of the women who were not told about immediate reconstruction at the time of their diagnosis, 100% believed that it should have been discussed. Research studies on women older than 70 years of age are lacking. Nurses can play an important role in conducting research on this older population, thus adding to the knowledge base.

A thorough assessment must be performed before any treatment is initiated, and careful monitoring must occur throughout the course of treatment to avoid complications. The physical and psychosocial assessment of the older woman should include general health, currently existing comorbidities, performance status, cognitive status, current medications, available resources, and support systems.

### Breast Health of Women With Disabilities

Women with a variety of disabilities may be unable to detect changes in their own breasts. Those with decreased sensation in their fingers may be unable to palpate even large breast masses, and those with vision loss may be unable to detect changes in the appearance of their breasts. Women with disabilities tend to undergo mammography less often than recommended (Poulos, Balandin, Llewellyn, et al., 2006). They may lack transportation to the imaging facility, and they may be unable to undress without assistance, stand, or maintain positioning for a mammogram. Many imaging facilities do not have accessible mammography equipment, and staff members may be unfamiliar with modifications in positioning needed to obtain acceptable scans (Smeltzer & Sharts-Hopko, 2005). Furthermore, health care providers often neglect to recommend health screening for women with disabilities, despite the fact that they have the same risks for breast cancer as other women and generally have a normal or near-normal life expectancy (U.S. Department of Human Services, 2005). The more severe the disability, the less likely that a woman will undergo mammography. For those women who cannot be adequately positioned for a mammogram, ultrasound may be used as an alternative; however, these women may need more frequent clinical breast examinations.

Women with disabilities who are diagnosed with breast cancer tend to be offered breast conservation surgery less often than other women. However, they have the same concerns about body image as other women.

An essential role of the nurse is to assist women with disabilities to identify accessible health screening and to advocate for greater accessibility of imaging centers and other health care facilities. Reminding women of the need for recommended clinical breast examinations and mammograms is an important part of nursing care.

## RECONSTRUCTIVE BREAST SURGERY

Breast reconstruction is elective surgery that can enhance a woman's self-image and sense of well-being. Women desire reconstruction for a variety of physical and psychological reasons. Therefore, it is important that the health care team conduct a thorough assessment prior to reconstructive surgery to evaluate the woman's underlying desire, motivation, and expectations. Preparing a woman realistically could help her to avoid potential disappointment. A variety of

reconstructive options are available today for women who desire a correction in the size or the shape of the breast, including reduction **mammoplasty** (breast reduction), augmentation mammoplasty (breast enlargement), and mastopexy (breast lift). Several options are also available to reconstruct the breast after a mastectomy.

### Reduction Mammoplasty

Reduction mammoplasty is usually performed on women who have breast hypertrophy (excessively large breasts). The weight of the enlarged breasts can cause discomfort, fatigue, embarrassment, and poor posture.

Reduction mammoplasty is an outpatient procedure that is performed under general anesthesia. Most commonly, an anchor-shaped incision that circles the areola is made, extending downward and following the natural curve of the crease beneath the breast (inframammary fold). Depending on the size of the breast, the nipple may be moved up to a higher position while still attached to the breast tissue or it may be separated and transplanted to a new location. Drains are placed in the incision and remain for 2 to 5 days.

During the preoperative consultation, the patient should be informed that there is a possibility that sensory changes of the nipple (such as numbness) may occur. These sensations are normal and usually resolve after several months but can sometimes persist. The procedure may also make breastfeeding impossible, although some women have breastfed successfully. The patient must also be aware that if she gains weight (usually more than 10 lb), her breasts may also enlarge.

After reduction mammoplasty, many women verbalize feelings of extreme satisfaction, possibly because of the relief they experience. The patient is instructed to wear a supportive bra 24 hours a day for 2 weeks to prevent tension on the swollen breast and incision line. Vigorous exercise (eg, jumping, jogging) should be avoided for about 6 weeks after surgery.

### Augmentation Mammoplasty

Augmentation mammoplasty is requested by women who desire larger or fuller breasts. The procedure is performed by placing a breast implant either under the pectoralis muscle (subpectoral) or under the breast tissue (subglandular). The subpectoral approach is preferred because it interferes less with clinical breast examinations and mammograms. The incision line can be placed in the inframammary fold, in the axilla, or around the areola. The procedure is performed as an outpatient procedure under general anesthesia. A drain is not necessary. Postoperative instructions are the same as for reduction mammoplasty.

Saline implants are typically used for augmentation mammoplasty. Because of concerns that silicone implants could cause autoimmune diseases, they were removed from the market in 1992. In November 2006 the FDA approved the use of silicone implants as long as they were manufactured by two specific companies. This approval covered women of all ages for breast reconstruction and women 22 years of age and older for breast augmentation (U.S. FDA, 2007). Women with breast implants should be aware that mammograms may be more difficult to read, and they should seek experienced breast radiologists.

### Mastopexy

Mastopexy is performed when the patient is happy with the size of her breasts but wishes to have the shape improved and a lift performed. This is also an outpatient surgical procedure, and postoperative instructions are the same as for reduction mammoplasty.

## DISEASES OF THE MALE BREAST

### *Gynecomastia*

Gynecomastia, or overdeveloped breast tissue, is the most common breast condition in the male. Adolescent boys can be affected by this condition because of hormones secreted by the testes. This type of gynecomastia is virtually always benign and resolves spontaneously in 1 to 2 years. Gynecomastia can also occur in older men and usually presents as a firm, tender mass underneath the areola. In these patients, gynecomastia may be diffuse and related to use of certain medications (eg, digitalis, ranitidine [Zantac]). It may also be associated with certain conditions, including feminizing testicular tumors, infection in the testes, and liver disease resulting from factors such as alcohol abuse or a parasitic infection.

Patients in their late teens to late 40s presenting with idiopathic (unknown cause) gynecomastia should have a testicular examination and possibly a testicular ultrasound. Treatment of the enlarged breast tissue is based on patient preference and is usually reserved for those men who cannot tolerate the cosmetic appearance of the breast or who have severe pain associated with the condition. Observation is acceptable in most cases because gynecomastia may resolve on its own. Surgical removal of the tissue through a small incision around the areola is the best treatment option. Liposuction performed by a plastic surgeon is another possibility, although this does not allow for pathologic examination of the tissue.

### *Male Breast Cancer*

Cancer of the male breast accounts for less than 1% of all cases of breast cancer. The average age at the time of diagnosis is 67 years, but the disease may occur in younger men, especially if there is a genetic link (Nahleh & Girnius, 2006). There is a well-documented link to mutations in the *BRCA2* gene in men with breast cancer; men 70 years of age with a *BRCA2* mutation have an estimated cumulative risk of breast cancer of 6.8% (Tai, Domchek, Parmigiani, et al., 2007). In sporadic cases of male breast cancer (no known family history), risk factors may include a history of mumps orchitis, radiation exposure, and Klinefelter's syndrome (a chromosomal condition reflecting decreased testosterone levels). Liver disease due to factors such as alcohol abuse or a parasitic infection, which compromises estrogen metabolism, may also lead to an increase in rates of male breast cancer. Symptoms include a painless lump beneath the areola, nipple retraction, bloody nipple discharge, or skin ulceration. Diagnostic tests and treatment modalities are similar to those used for women.

Early detection is uncommon in male breast cancer because of the rare nature of the disease. Neither patient nor physician suspects male breast cancer early in its development. Treatment generally consists of a total mastectomy with either SLNB or ALND. As in women with breast cancer, prognosis depends on the stage of disease at presentation. Involvement of the axillary lymph nodes is the most important prognostic indicator. Male breast cancers are very likely to be ER+, and tamoxifen, although it has several side effects, is a mainstay of treatment.

Because breast cancer is primarily a disease of women, men may feel that a certain stigma is attached to their diagnosis. Health care professionals must be sensitive to their needs and provide information and support.

## CRITICAL THINKING EXERCISES

EBP **1** You are reviewing early detection guidelines with a 65-year-old woman who has a *BRCA1* mutation. She had an MRI 1 week ago that was normal. Because of this, she asks you if she can skip having her mammogram. What would you advise? What screening modalities would you recommend to her on a yearly basis? What is the evidence base for your recommendations? How would you determine the strength of that evidence?

EBP **2** A 45-year-old woman tells you that nobody in her family has breast cancer. She is relieved, she says, because now she does not have to worry about getting it either. How would you respond to this woman? What is the evidence related to the risk of breast cancer with and without a family history? What is the strength of that evidence?

**3** A 50-year-old woman had a right lumpectomy and an axillary lymph node dissection for breast cancer 12 years ago. She calls you in a panic because she accidentally burned her right hand while cooking. What advice would you give her?

**4** A 28-year-old woman was just diagnosed with breast cancer. She will need surgery and most likely chemotherapy. She desperately wants to have children. How would you address this issue? What resources would be appropriate to provide to the patient?

EBP **5** A 54-year-old woman with breast cancer has completed surgery, chemotherapy, and radiation treatment. She tolerated the treatments very well both physically and emotionally. She is now taking tamoxifen, which she started 6 months ago, and she feels very depressed and anxious. What would you recommend for this woman? What is the evidence base for the recommendations you would provide? How would you determine the strength of that evidence?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American Cancer Society, www.cancer.org

American Society of Plastic and Reconstructive Surgeons, www.plasticsurgery.org

Cancer Care, Inc. (provides free professional support services to anyone affected by cancer), www.cancercare.org

Fertile Hope, www.fertilehope.org

National Breast Cancer Coalition (This activist group has raised funds and consciousness levels regarding breast cancer and was instrumental in obtaining funds for research on prevention), www.natlbcc.org.

National Cancer Institute, www.cancer.gov/cancertopics/types/breast

National Lymphedema Network, www.lymphnet.org

Oncology Nursing Society, www.ons.org

Reach to Recovery Program—I Can Cope Program. (Information available through local American Cancer Society chapters).

Susan G. Komen for the Cure, ww5.komen.org

Y-ME Breast Cancer Organization, www.y-me.org

Young Survival Coalition, www.youngsurvival.org



chapter 49

# Assessment and Management of Problems Related to Male Reproductive Processes

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe structures and function of the male reproductive system.
2. Discuss nursing assessment of the male reproductive system and identify diagnostic tests that complement assessment.
3. Discuss the causes and management of male sexual dysfunction.
4. Compare the types of prostatectomy with regard to advantages and disadvantages.
5. Use the nursing process as a framework for care of the patient undergoing prostatectomy.
6. Describe the nursing management of patients with testicular cancer.
7. Describe the various conditions affecting the penis, including pathophysiology, clinical manifestations, and management.

## GLOSSARY

**androgen deprivation therapy (ADT):** surgical (orchiectomy) or medical castration (eg, with luteinizing hormone–releasing hormone agonists)

**benign prostatic hyperplasia (BPH):** noncancerous enlargement or hypertrophy of the prostate; the most common pathologic condition in older men

**brachytherapy:** delivery of radiation therapy through internal implants called seeds to a localized area of tissue

**circumcision:** excision of the foreskin, or prepuce, of the glans penis

**cryosurgery of the prostate:** localized treatment of the prostate by application of freezing temperatures

**cystostomy:** surgical creation of an opening into the urinary bladder

**cryptorchidism:** most common congenital defect in males; characterized by failure of one or both of the testes to descend into the scrotum

**epididymitis:** infection of the epididymis that usually descends from an infected prostate or urinary tract; also may develop as a complication of gonorrhea

**erectile dysfunction:** also called impotence; the inability to either achieve or maintain an erection sufficient to accomplish sexual intercourse

**hydrocele:** a collection of fluid, generally in the tunica vaginalis of the testis, although it also may collect within the spermatic cord

## GLOSSARY *(Continued)*

**minimally invasive therapy:** treatments such as laparoscopic and robotic prostatectomy, cryotherapy, and high-intensity focused ultrasound (HIFU); are less invasive than other procedures with less morbidity, lower blood loss, and more rapid recovery

**orchiectomy:** surgical removal of one or both of the testes

**orchitis:** inflammation of the testes (testicular congestion) caused by pyogenic, viral, spirochetal, parasitic, traumatic, chemical, or unknown factors

**penile cancer:** malignancy that can involve the glans, the body of the penis, the urethra, and regional or distant lymph nodes

**Peyronie's disease:** buildup of fibrous plaques in the sheath of the corpus cavernosum, causing curvature of the penis when it is erect

**phimosis:** condition in which the foreskin is constricted so that it cannot be retracted over the glans; can occur congenitally or from inflammation and edema

**priapism:** an uncontrolled, persistent erection of the penis from either neural or vascular causes, including medications, sickle cell thrombosis, leukemic cell infiltration, spinal cord tumors, and tumor invasion of the penis or its vessels

**prostate cancer:** A common type of cancer in men; involves the prostate gland

**prostatectomy:** open or laparoscopic surgical removal of the entire prostate, the prostate urethra, the attached seminal vesicles plus the ampulla of the vas deferens

**prostate-specific antigen (PSA):** substance that is produced by the prostate gland; is used in combination with digital rectal examination to screen for prostate cancer

**prostatism:** obstructive and irritative symptom complex that includes increased frequency and hesitancy in starting urination, a decrease in the volume and force of the urinary stream, acute urinary retention, and recurrent urinary tract infections

**prostatitis:** inflammation of the prostate gland caused by infectious agents (bacteria, fungi, mycoplasma) or various other problems (eg, urethral stricture, prostatic hyperplasia)

**spermatogenesis:** production of sperm in the testes

**testicular cancer:** cancer of one or both testes

**testosterone:** male sex hormone secreted by the testes; induces and preserves the male sex characteristics

**transurethral resection of the prostate (TURP):** resection of the prostate through endoscopy; the surgical and optical instrument is introduced directly through the urethra to the prostate, and the gland is then removed in small chips with an electrical cutting loop

**varicocele:** an abnormal dilation of the veins of the pampiniform venous plexus in the scrotum (the network of veins from the testis and the epididymis, which constitute part of the spermatic cord)

**vasectomy:** also called male sterilization; ligation and transection of part of the vas deferens, with or without removal of a segment of the vas, to prevent the passage of the sperm from the testes

Disorders of the male reproductive system include a wide variety of conditions that usually affect both urinary and reproductive systems. Because these disorders involve the genitalia and often affect sexuality, the patient may experience anxiety and embarrassment. The nurse must be aware of the patient's need for privacy as well as his need for education and support. This requires an openness to discuss critical and sensitive issues with the patient, including his partner when appropriate, as well as effective assessment, management, and communication. Nurses must be comfortable when examining male genitalia and must recognize their own attitudes and perceptions about male reproductive problems. Education of the patient and partner about treatment and self-care strategies is essential (Zang, Chung & Wong, 2008).

# ASSESSMENT OF THE MALE REPRODUCTIVE SYSTEM

## *Anatomic and Physiologic Overview*

In the male, several organs serve as parts of both the urinary tract and the reproductive system. Disorders in the male reproductive organs may interfere with the functions of one or both of these systems. As a result, diseases of the male reproductive system are usually treated by a urologist. The structures in the male reproductive system include the (1) external male genitalia, consisting of the testes, epididymides, scrotum, and penis, and the (2) internal male genitalia, consisting of the vas deferens (ductus deferens), ejaculatory duct, and prostatic and membranous sections of the urethra, seminal vesicles, and certain accessory glands, such as the prostate gland and Cowper glands (bulbourethral glands) (Fig. 49-1).

The testes have a dual function: **spermatogenesis** (production of sperm) and secretion of the male sex hormone **testosterone,** which induces and preserves the male sex characteristics. The testes are formed in the embryo, within the abdominal cavity, near the kidney. During the last month of fetal life, they descend posterior to the peritoneum and pierce the abdominal wall in the groin. Later, they progress along the inguinal canal into the scrotal sac. In this descent, they are accompanied by blood vessels, lymphatics, nerves, and ducts, which support the tissue and make up the spermatic cord. This cord extends from the internal inguinal ring through the abdominal wall and the inguinal canal to the scrotum. As the testes descend into the scrotum, a tubular extension of peritoneum accompanies them. Normally, this tissue is obliterated during fetal development; only the tunica vaginalis, which covers the testes, remains. If the peritoneal process remains open into the abdominal cavity, a potential sac remains into which abdominal contents may enter to form an indirect inguinal hernia.

The testes, or ovoid sex glands, are encased in the scrotum, which keeps them at a slightly lower temperature than the rest of the body to facilitate spermatogenesis. The testes consist of numerous seminiferous tubules in which the spermatozoa form. Collecting tubules transmit the spermatozoa into the epididymis, a hoodlike structure lying on the testes and containing winding ducts that lead into the vas deferens. This firm, tubular structure passes upward through the inguinal canal to enter the abdominal cavity behind the peritoneum. It then extends downward toward the base of the bladder. An outpouching from this structure is the seminal vesicle, which acts as a reservoir for testicular secretions. The tract is continued as the ejaculatory duct, which passes through the prostate gland to enter the urethra. Testicular secretions take this pathway when they exit the penis during ejaculation.

The penis is the organ for both copulation and urination. It consists of the glans penis, the body, and the root. The glans penis is the soft, rounded portion at the distal end of the penis. The urethra, the tube that carries urine, opens at the tip of the glans. The glans is naturally covered by elongated penile skin—the foreskin—which may be retracted to expose the glans. However, many men as newborns have had the foreskin removed **(circumcision)**. The body of the

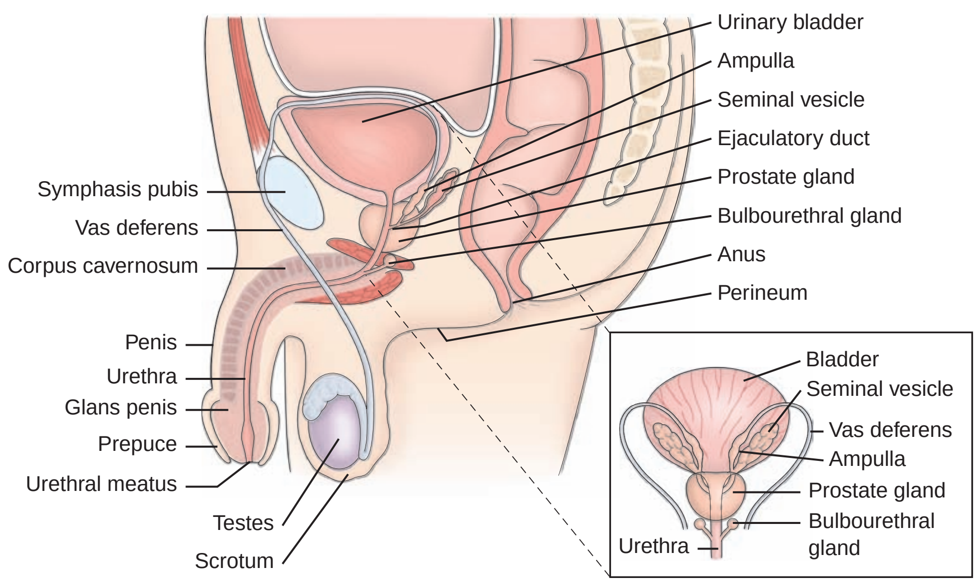



**Figure 49-1** Structures of the male reproductive system.

penis is composed of erectile tissues containing numerous blood vessels that become dilated, leading to an erection during sexual excitement. The urethra, which passes through the penis, extends from the bladder through the prostate to the distal end of the penis.

The prostate gland, lying just below the neck of the bladder, is composed of four zones and four lobes. It surrounds the urethra and is traversed by the ejaculatory duct, a continuation of the vas deferens. This gland produces a secretion that is chemically and physiologically suitable to the needs of the spermatozoa in their passage from the testes. Cowper glands lie below the prostate, within the posterior aspect of the urethra. This gland empties its secretions into the urethra during ejaculation, providing lubrication.

### Gerontologic Considerations

As men age, the prostate gland enlarges, prostate secretion decreases; the scrotum hangs lower; the testes decrease in weight, atrophy, and become softer; and pubic hair becomes sparser and stiffer. Changes in gonadal function include a decline in plasma testosterone levels and reduced production of progesterone (Table 49-1). Other changes include decreasing sexual function, decreased libido (sexual desire), slower sexual response, longer time before sexual arousal can occur again, increased incidence of genitourinary tract cancer, and urinary incontinence. Libido and potency often decrease in as many as two thirds of men older than 70 years of age (Tabloski, 2006). Vascular problems cause about half of the cases of impotence in men older than 50 years of age.

However, male reproductive capability is maintained with advancing age. Although degenerative changes occur in the seminiferous tubules and sperm production decreases, spermatogenesis continues, allowing men to produce viable sperm throughout their lives (McCance & Huether, 2005).

Male hypogonadism (decreased function of the testes) starts gradually at approximately 50 years of age, resulting in decreased testosterone production. The older man notices that the sexual response slows, erection takes longer, full erections may not be attained, and ejaculation takes longer to occur and control or resolution may occur without orgasm. Sexual function can be affected by psychological problems, illnesses, and medications. In general, the entire sexual act takes longer. Sexual activity is closely correlated with the man's sexual activity in his earlier years; if he was more active than average as a young man, he will most likely continue to be more active than average in his later years.

Men older than 50 years of age are at risk for cancer of the kidney, bladder, prostate, and penis. The digital rectal examination (DRE), prostate-specific antigen (PSA) test, and urinalysis, which screens for hematuria, may uncover a higher percentage of malignancies at earlier stages and lead to lower treatment-associated morbidity as well as a lower mortality.

Urinary incontinence occurs in one fifth of community-dwelling older men and rises to nearly 50% in men in long-term care settings (Tabloski, 2006). Therefore, older adults admitted to acute care settings should be screened for this problem. Urinary incontinence may have many causes, including medications, neurologic disease, or benign prostatic hyperplasia (BPH). Diagnostic tests are performed to exclude reversible causes. New-onset urinary incontinence is a nursing priority that requires evaluation.

## Assessment

### Health History

Male sexuality is a complex phenomenon that is strongly influenced by personal, cultural, religious, and social factors. Sexuality and male reproductive function become concerns in the presence of illness and disability (Bruner & Calvano, 2007). Throughout the assessment process, the nurse must recognize the importance of sexuality to the patient. Assessment of male reproductive function begins with an evaluation of urinary function and symptoms. The patient is asked about his usual state of health and any recent change in general physical and sexual activity. Any symptoms or changes in function are explored fully and described in detail. Symptoms related to bladder function and urination, collectively referred to as **prostatism,** are explored further. They may occur with an obstruction caused by an enlarged prostate gland: increased urinary frequency, decreased force of urine stream, and "double" or "triple" voiding (the patient needs to urinate two or three times over a period of several minutes to completely empty his bladder). The patient is also assessed for dysuria (painful urination), hematuria (blood in the urine), nocturia (urination during the night), and hematospermia (blood in the ejaculate).

Assessment also involves addressing sexual function, including manifestations of sexual dysfunction. The extent of

**Table 49-1 AGE-RELATED CHANGES IN THE MALE REPRODUCTIVE SYSTEM**

| Age-Related Changes | Physiologic Changes | Manifestations |
|---|---|---|
| Decrease in sex hormone secretion, especially testosterone | Decreased muscle strength and sexual energy | Changes in sexual response: prolonged time to reach full erection, rapid penile detumescence and prolonged refractory period<br>Decrease in number of viable sperm |
| | Shrinkage and loss of firmness of testes; thickening of seminiferous tubules | Smaller testes |
| | Fibrotic changes of corpora cavernosa | Erectile dysfunction |
| | Enlargement of prostate gland | Weakening of prostatic contractions<br>Hyperplasia of prostate gland<br>Signs and symptoms of obstruction of lower urinary tract (urgency, frequency, nocturia) |

the history depends on the patient's presenting symptoms and the presence of factors that may affect sexual function such as chronic illnesses or disability (eg, diabetes, multiple sclerosis, stroke, cardiac disease), use of medications that affect sexual function (eg, antihypertensive and anticholesterolemic medications, psychotropic agents), stress, use of alcohol, and patient's willingness to discuss sexual issues.

By initiating an assessment about sexual concerns, the nurse conveys the message that changes in sexual functioning are valid topics and provides a safe environment for discussing these sensitive topics. A number of models are available to assist in assessing patient's problems and concerns. The PLISSIT (*p*ermission, *l*imited *i*nformation, *s*pecific *s*uggestions, *i*ntensive *t*herapy) model of sexual assessment and intervention may be used to provide a framework for nursing interventions (Annon, 1976). It provides a graded counseling approach that allows health care professionals to deal with sexual issues with a level of comfort and expertise. The model begins by asking the patient's permission (P) to discuss sexual functioning. Limited information (LI) about sexual function may then be provided to the patient. As the discussion progresses, the nurse may offer specific suggestions (SS) for interventions. A professional who specializes in sex therapy may provide more intensive therapy (IT) as needed. The BETTER (*b*ringing up the topic, *e*xplaining, *t*elling, *t*iming, *e*ducate about treatment-related sexual side effects, *r*ecording) model was developed more recently to assist health care professionals to include sexuality in the assessment of patients with cancer (Katz, 2005, 2007).

Patients may find it difficult to express their feelings and concerns regarding their sexuality, especially after a body image change. Discussing sexuality with patients who have an illness or disability can be uncomfortable for nurses and other health care providers; this, in turn, makes discussion of these issues more difficult and uncomfortable for patients. Health care professionals may unconsciously have stereotypes about the sexuality of people who are ill or have a disability (eg, the belief that people with disabilities are asexual or should be sexually inactive). In addition, patients are often embarrassed to initiate a discussion about sexual issues with their health care providers (Zang, et al., 2008).

## Physical Assessment

In addition to the usual aspects of the physical examination, two essential components address disorders of the male genital or reproductive system: the DRE and the testicular examination.

### *Digital Rectal Examination*

The DRE is used to screen for prostate cancer and is recommended annually for every man older than 50 years of age (45 years of age for men at high risk [African American men and men with a strong family history of prostate cancer]) annually (American Cancer Society [ACS], 2009). The DRE enables the skilled examiner, using a lubricated, gloved finger placed in the rectum, to assess the size, symmetry, shape, and consistency of the posterior surface of the prostate gland (Fig. 49-2). The clinician assesses for tenderness of the prostate gland on palpation and for the presence and consistency of any nodules. The DRE may be performed with the patient leaning over an examination table or positioning the man in a side-lying position with legs flexed toward the abdomen or supine with legs resting in stirrups. To minimize discomfort and relax the anal sphincter during the rectal examination, the patient is instructed to take a deep breath and exhale slowly as the practitioner inserts a finger. If possible, he should turn his feet inward so his toes are touching. Although this examination may be uncomfortable and embarrassing for the patient, it is an important screening tool.

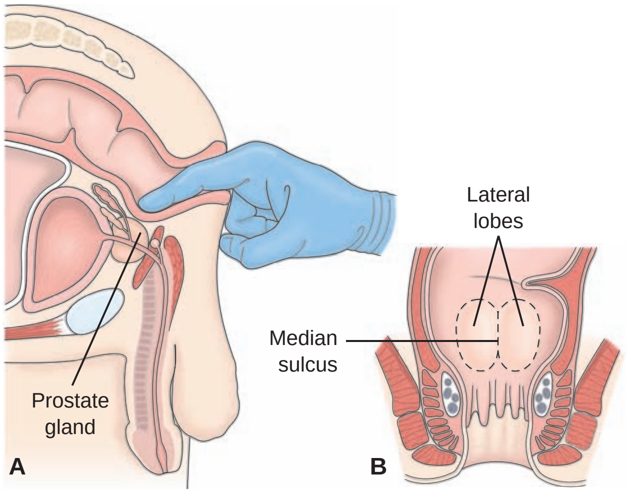



**Figure 49-2** **A,** Palpation of the prostate gland during digital rectal examination (DRE) enables the examiner to assess the size, shape, and texture of the gland. **B,** The prostate is round, with a palpable median sulcus or groove separating the lateral lobes. It should feel rubbery and free of nodules and masses.

### *Testicular Examination*

The male genitalia are inspected for abnormalities and palpated for masses. The scrotum is palpated carefully for nodules, masses, or inflammation. Examination of the scrotum can reveal such disorders as hydrocele, inguinal hernia, testicular torsion, orchitis, epididymitis, or a tumor of the testis. The penis is inspected and palpated for ulcerations, nodules, inflammation, discharge, and curvature. If the patient is uncircumcised, the foreskin should be retracted for visualization of the glans penis. The testicular examination provides an excellent opportunity to instruct the patient on how to perform a testicular self-examination (TSE) and its importance in early detection of testicular cancer. TSE should begin during adolescence.

# *Diagnostic Evaluation*

## Prostate-Specific Antigen Test

The cells within the prostate gland produce a protein that can be measured in the blood called the **prostate-specific antigen (PSA).** It is a sensitive but not specific test for prostate cancer. In the absence of prostate cancer, serum PSA levels vary with age, race, and prostate volume. Increased levels may indicate prostate cancer. However, a number of other conditions such as BPH, acute urinary retention, and acute prostatitis may cause high PSA levels. Values of PSA may also increase after ejaculation. PSA levels

are measured in nanograms per milliliter (ng/mL). In most laboratories, values less than 4.0 ng/mL are generally considered normal, and values greater than 4.0 ng/mL are considered elevated. The use of age-specific reference ranges for populations with a low incidence of prostate cancers (eg, Chinese) helps minimize unnecessary biopsies.

A serum PSA level and a DRE, which are recommended by the American Cancer Society (2009), are used to screen for prostate cancer for men with at least a 10-year life expectancy and for men at high risk, including those with a strong family history of prostate cancer and of African American ethnicity. The PSA test is also used to monitor patients for recurrence after treatment for cancer of the prostate, based on evidence-based guidelines (National Comprehensive Cancer Network [NCCN], 2009). Neither the DRE nor PSA is 100% accurate, but when used together, their accuracy increases.

### Ultrasonography

Transrectal ultrasound (TRUS) may be performed in patients with abnormalities detected by DRE and in those with elevated PSA levels. After DRE has been completed, a lubricated, condom-covered, rectal probe transducer is inserted into the rectum, along the anterior wall. Water may be introduced into the condom to help transmit sound waves to the prostate. TRUS may be used in detecting nonpalpable prostate cancers and in staging localized prostate cancer. Needle biopsies of the prostate are commonly guided by TRUS.

### Prostate Fluid or Tissue Analysis

Specimens of prostate fluid or tissue may be obtained for culture if disease or inflammation of the prostate gland is suspected. A biopsy of the prostate gland may be necessary to obtain tissue for histologic examination. This may be performed at the time of prostatectomy or by means of a perineal or transrectal needle biopsy. Six to 12 biopsies from all four prostate zones may be obtained during a TRUS-guided biopsy.

### Tests of Male Sexual Function

If the patient cannot engage in sexual intercourse to his satisfaction, a detailed history is obtained. Nocturnal erections occur in healthy males of all ages. Nocturnal penile tumescence tests may be conducted in a sleep laboratory to monitor changes in penile circumference during sleep using various methods to determine number, duration, rigidity, and circumference of penile erections; the results help identify whether the erectile dysfunction is caused by physiologic or psychologic factors. Additional tests, including psychological evaluations, are also part of the diagnostic workup and are usually conducted by a specialized team of health care providers.

# DISORDERS OF MALE SEXUAL FUNCTION

## *Erectile Dysfunction*

**Erectile dysfunction,** also called impotence, is the inability to achieve or maintain an erect penis (Seftel, Miner, Kloner, et al., 2007). The man may report decreased frequency of erections, inability to achieve a firm erection, or rapid detumescence (subsiding of erection). In the United States, 30 million men experience erectile dysfunction; more than half of men 40 to 70 years of age are unable to attain or maintain an erection sufficient for satisfactory sexual performance (Tanagho & McAninch, 2008). The physiology of erection and ejaculation is complex and involves parasympathetic and sympathetic components. Erection involves the release of nitric oxide into the corpus cavernosum during sexual stimulation. Its release activates cyclic guanosine monophosphate (cGMP), causing smooth muscle relaxation. This allows flow of blood into the corpus cavernosum, resulting in erection (Beckman, Abu-Lebdeh & Mynderse, 2006; Porth & Matfin, 2009).

Erectile dysfunction has both psychogenic and organic causes. Psychogenic causes include anxiety, fatigue, depression, pressure to perform sexually, negative body image, absence of desire, privacy, and trust and relationship issues. Organic causes include cardiovascular disease, endocrine disease (diabetes, pituitary tumors, testosterone deficiency, hyperthyroidism, and hypothyroidism), cirrhosis, chronic renal failure, genitourinary conditions (radical pelvic surgery), hematologic conditions (Hodgkin lymphoma, leukemia), neurologic disorders (neuropathies, parkinsonism, spinal cord injury, multiple sclerosis), trauma to the pelvic or genital area, alcohol, smoking, medications (Chart 49-1), and drug abuse.

#### CHART 49-1 PHARMACOLOGY
#### *Classes of Medications Associated With Erectile Dysfunction*

- Antiadrenergics and antihypertensives: guanethidine (Ismelin), clonidine (Catapres), hydralazine (Apresoline), metoprolol (Lopressor)
- Anticholinergics and phenothiazines: prochlorperazine (Compazine), trihexyphenidyl (Artane)
- Antiseizure agents: carbamazepine (Tegretol)
- Antifungals: ketoconazole (Nizoral)
- Antihormone (prostate cancer treatment): flutamide (Eulexin), leuprolide (Lupron)
- Antipsychotics: haloperidol (Haldol), chlorpromazine (Thorazine)
- Antispasmodics: oxybutynin (Ditropan)
- Anxiolytics, sedative–hypnotics, tranquilizers: lorazepam (Ativan), triazolam (Halcion)
- Beta-blockers: nadolol (Corgard)
- Calcium channel blockers: nifedipine (Adalat, Procardia)
- Carbonic anhydrase inhibitors: acetazolamide (Diamox)
- $H_2$ antagonists: nizatidine (Axid)
- Nonsteroidal anti-inflammatory drugs: naproxen (Naprosyn)
- Diuretics: hydrochlorothiazide (HydroDIURIL), furosemide (Lasix), spironolactone (Aldactone)
- Antidepressants: tricyclic antidepressants: amitriptyline (Elavil), desipramine (Norpramin); selective serotonin reuptake inhibitors: fluoxetine (Prozac), sertraline (Zoloft)
- Parkinson's disease medications: levodopa (Sinemet)
- Antihistamines: diphenhydramine (Benadryl)

## Assessment and Diagnostic Findings

The diagnosis of erectile dysfunction requires a sexual and medical history; an analysis of presenting symptoms; a physical examination, including a neurologic examination; a detailed assessment of all medications, alcohol, and drugs used; and various laboratory studies. Nocturnal penile tumescence tests are conducted to monitor changes in penile circumference. This test can help to determine if erectile impotence has an organic or a psychological cause. In healthy men, nocturnal penile erections closely parallel rapid eye movement (REM) sleep in occurrence and duration. Organically impotent men show inadequate sleep-related erections that correspond to their waking performance. Arterial blood flow to the penis is measured using a Doppler probe. In addition, nerve conduction tests and extensive psychological evaluations may be carried out. Figure 49-3 describes the evaluation and treatment of erectile dysfunction.

## Medical Management

Treatment can be medical, surgical, or both, depending on the cause. The American Urological Association (AUA) guidelines on treatment of erectile dysfunction suggest that therapy for associated disorders (eg, alcoholism, diabetes) or adjustment of medications may be necessary (AUA, 2005). Endocrine therapy instituted to treat erectile dysfunction secondary to hypothalamic-pituitary-gonadal dysfunction may reverse the condition. Insufficient penile blood flow may be treated with vascular surgery. Patients with erectile dysfunction from psychogenic causes are referred to a health care provider or therapist who specializes in sexual dysfunction. Patients with erectile dysfunction secondary to organic causes may be candidates for penile implants.

Currently available therapies for the treatment of erectile dysfunction include pharmacologic therapy (including urethral suppositories), penile implants, and vacuum constriction devices (Table 49-2). These options should be considered in a stepwise fashion, with increasing invasiveness and risk balanced against the likelihood of efficacy. The patient and, if possible, his partner, should be informed of the relevant treatment options and their associated risks and benefits. The choice of treatment is made jointly by the physician, patient, and partner, taking into consideration patient preferences and expectations.

### Pharmacologic Therapy

Phosphodiesterase-5 (PDE-5) inhibitors, oral medications that are used to treat erectile dysfunction, are first-line therapy (AUA, 2005). Currently available PDE-5 inhibitors include sildenafil (Viagra), vardenafil (Levitra), and tadalafil (Cialis). Each of these agents has a similar mechanism of action but a different pharmacologic action and clinical use. Erection involves the release of nitrous oxide in the vasculature of the corpus cavernosum as a result of sexual stimulation. This subsequently leads to smooth muscle relaxation in blood vessels supplying the corpus cavernosum, resulting in increased blood flow and an erection. During sexual stimulation, PDE-5 inhibitors increase blood flow to the penis (Carson, 2007; Porth & Matfin, 2009).

When PDE-5 inhibitors are taken about 1 hour before sexual activity, they are effective in producing an erection with

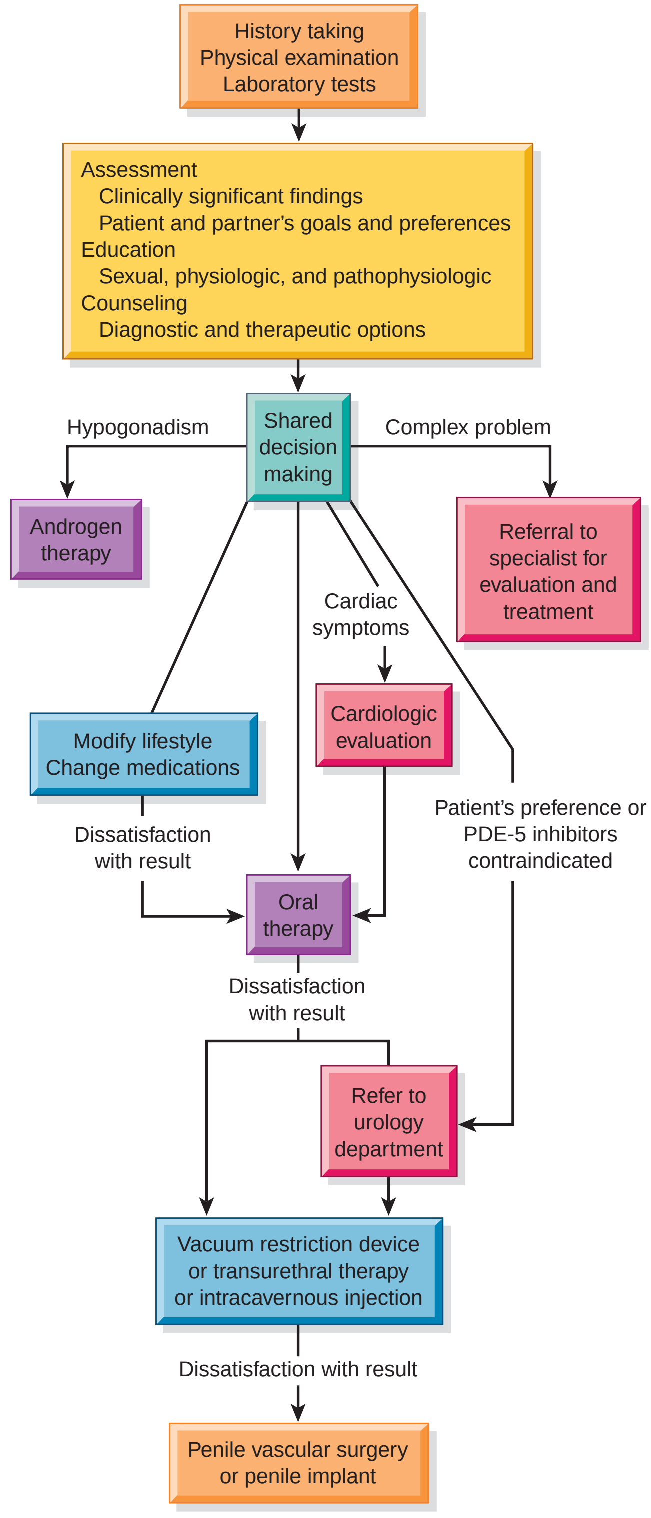



**Figure 49-3** Evaluation and treatment of men with erectile dysfunction. (Redrawn from Lue, T. F. (2000). Erectile dysfunction. *New England Journal of Medicine, 342*(24), 1807. © 2000 Massachusetts Medical Society. All rights reserved. Used with permission.)

sexual stimulation; the erection can last about 1 to 2 hours. The most common side effects of these medications include headache, flushing, dyspepsia, diarrhea, nasal congestion, and lightheadedness. These agents are contraindicated in men

**Table 49-2 TREATMENTS FOR ERECTILE DYSFUNCTION**

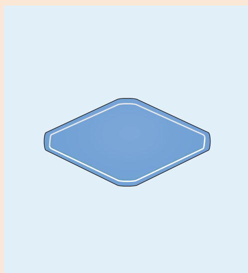
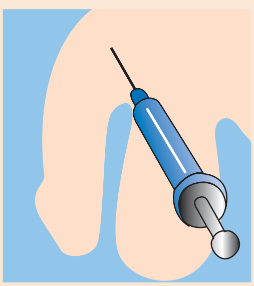
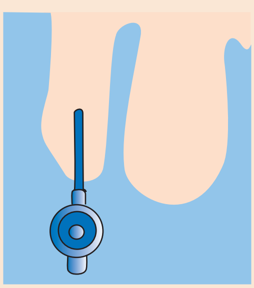
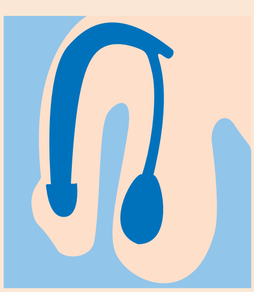
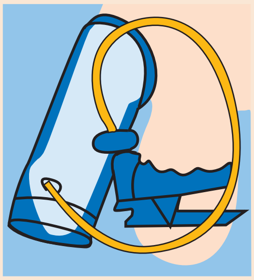
| Method | Description | Advantages and Disadvantages | Duration |
|---|---|---|---|
| Pharmacologic therapy<br>• Oral medication (sildenafil [Viagra]; vardenafil [Levitra]; tadalafil [Cialis])<br><br>Oral medication | Smooth muscle relaxant causing blood to flow into penis | Can cause headache and diarrhea<br>Contraindicated for men taking nitrate medications<br>Used with caution in patients with retinopathy, especially diabetic retinopathy | Taken orally 1 hour before intercourse<br>Stimulation is required to achieve erection<br>Erection can last 1 hour |
| • Injection (alprostadil, papaverine, phentolamine)<br><br>Penile injection | Smooth muscle relaxant causing blood to flow into penis | Firm erections are achievable in more than 50% of cases<br>Pain at injection site; plaque formation, risk of priapism | Injection 20 minutes before intercourse<br>Erection can last up to 1 hour |
| • Urethral suppository (alprostadil)<br><br>Penile suppository | Smooth muscle relaxant causing blood to flow into penis | May be used twice a day<br>Urethral and genital pain; risk of hypertension and syncope<br>Not recommended with pregnant partners | Inserted 10 minutes before intercourse<br>Erection can last up to 1 hour |
| Penile implants<br>• Semi-rigid rod<br>• Inflatable<br>• Soft silicone<br><br>Penile implant | Surgically implanted into corpus cavernosum | Reliable<br>Requires surgery<br>Healing takes up to 3 weeks<br>Subsequent cystoscopic surgery is difficult<br>Semirigid rod results in permanent semierection | Indefinite<br>Inflatable prosthesis: saline returns from penile receptacle to reservoir |

**Table 49-2 TREATMENTS FOR ERECTILE DYSFUNCTION (Continued)**

| Method | Description | Advantages and Disadvantages | Duration |
|---|---|---|---|
| Negative-pressure (vacuum) devices  Penile vacuum pump | Induction of erection with vacuum; maintained with constriction band around base of penis | Few side effects<br>Cumbersome to use before intercourse<br>Vasocongestion of penis can cause pain or numbness | To prevent penile injury, constriction band must not be left in place for longer than 1 hour |

who take organic nitrates (eg, isosorbide [Isordil, Nitro-Dur], nitroglycerin), because taken together, these medications can cause side effects such as severe hypotension (Beckman, et al., 2006; Carson, 2007; Porth & Matfin, 2009). In addition, PDE-5 inhibitors must be used with caution in patients with retinopathy, especially in those with diabetic retinopathy. Patient teaching about the use of these medications and their side effects is summarized in Table 49-3.

For patients in whom PDE-5 inhibitors are contraindicated or ineffective, other pharmacologic measures to induce erections include injecting vasoactive agents, such as alprostadil, papaverine, and phentolamine, directly into the penis. Complications include **priapism** (a persistent abnormal erection) and development of fibrotic plaques at the injection sites. Alprostadil is also formulated in a gel pellet that can be inserted into the tip of the urethra using an applicator to create an erection.

#### *Penile Implants*

Two general types of penile implants are available: the malleable, noninflatable, nonhydraulic prosthesis (also called the semirigid rod); and the inflatable, hydraulic prostheses (AUA, 2006; Henry & Wilson, 2007). The semirigid rod (eg, the Small-Carrion prosthesis) results in a permanent semierection but can be bent into an unnoticeable position when appropriate. The inflatable prosthesis simulates natural erections and natural flaccidity. Complications after implantation include infection, erosion of the prosthesis through the skin (more common with the semirigid rod than with the inflatable prosthesis), and persistent pain, which may require removal of the implant. Subsequent cystoscopic surgery, such as transurethral resection of the prostate (TURP), is more difficult with a semirigid rod than with the inflatable prosthesis.

Factors to consider in choosing a penile prosthesis are the patient's activities of daily living, social activities, and the expectations of the patient and his partner. Ongoing counseling for the patient and his partner is usually necessary to help them adapt to the prosthesis.

#### *Negative-Pressure Devices*

Negative-pressure (vacuum) devices may also be used to induce an erection. A plastic cylinder is placed over the flaccid penis, and negative pressure is applied. When an erection is attained, a constriction band is placed around the base of the penis to maintain the erection. The patient is instructed not to leave the constricting band in place for longer than 1 hour to avoid penile injury. Only devices with a vacuum limiter are recommended for use (AUA, 2005). Although many men find this method satisfactory, others experience premature loss of penile rigidity or pain when applying suction or during intercourse.

### Nursing Management

Personal satisfaction and the ability to sexually satisfy a partner are common concerns of patients. Men with illnesses and disabilities may need the assistance of a sex therapist to identify, implement, and integrate their sexual beliefs and behaviors into a healthy and satisfying lifestyle. The nurse can inform patients about support groups for men with erectile dysfunction and their partners. Information about Impotence Anonymous for patients and I-Anon for their partners can be found at the end of this chapter.

## *Disorders of Ejaculation*

Premature ejaculation (PE) is defined as the occurrence of ejaculation sooner than desired, either before or shortly after penetration, causing distress to either one or both partners (AUA, 2004). It is one of the most common complaints of men or couples, affecting 20% to 30% of men (Schuster, 2006; Waldinger, 2007). The spectrum of responses ranges from occasional ejaculation with intercourse or self-stimulation to complete inability to ejaculate under any circumstances. A variety of forms of PE have been identified: (1) lifelong PE caused by neurobiological or genetic conditions, (2) acquired PE (medical or psychological), (3) natural variable PE (normal variation), and (4) premature-like ejaculatory dysfunction (psychological). Other ejaculatory problems may include inhibited (delayed or retarded) ejaculation, which is the involuntary inhibition of the ejaculatory reflex. Retrograde ejaculation occurs when semen travels toward the bladder instead of exiting through the penis, resulting in infertility. This form of PE may occur after prior prostate or urethral surgery or with diabetes and use of medications such as antihypertensives.

**Table 49-3 PHARMACOLOGIC TREATMENT OF ERECTILE DYSFUNCTION**

| | Sildenafil (Viagra) | Vardenafil (Levitra) | Tadalafil (Cialis) |
|---|---|---|---|
| Recommended dose | Initial dose is 25 mg<br>Usual dose is 50 mg<br>Maximal dose is 100 mg/24 hours | Usual dose is 10 mg<br>Maximum dose is 20 mg/24 hours<br>If you are 65 years of age or older, the starting dose is 5 mg | Dosage range is 5–20 mg, based on individual response<br>Maximum dose is 20 mg/24 hours<br>Maximum dose is 10 mg every 48 hours if you have decreased liver or kidney function |
| When to take | Take the medication 30 minutes to 4 hours before intercourse. *There must be sexual stimulation to produce an erection.* | Follow the same directions as with sildenafil; take the medication 1 hour before intercourse. The peak action occurs in 30 to 120 minutes. *There must be sexual stimulation to produce an erection.* | Take the medication before sexual activity. Effect peaks at 30 minutes to 6 hours; effect may last up to 36 hours. *There must be sexual stimulation to produce an erection.* |
| Frequency of use | If you take this medication more than once a day, it will not have an increased effect. You may take it 7 days per week if you wish, but only once in 24 hours. It does not build up in your bloodstream. Remember to take it only when you want to have intercourse. | The recommended frequency for this medication is 10 mg in 24 hours. | The effects of this medication may last up to 36 hours. This allows for increased spontaneity in the sexual experience. |
| Side effects | Side effects include headache, flushing, indigestion, nasal congestion, abnormal vision, diarrhea, dizziness, and rash. You may also have low blood sugar and abnormal liver function tests; your physician can determine this. | Side effects include headache, flushing, runny nose, indigestion, sinusitis, flulike syndrome, dizziness, nausea, back pain, and joint pain. Tell your physician if you experience any of these effects. You may also have abnormally elevated liver enzymes; your physician can determine this. | Side effects are similar to those of sildenafil and vardenafil. Tadalafil may also cause back pain and muscle aches. Tell your physician if you experience any of these side effects. |
| Contraindications | Do not take if you are taking nitrate medications such as nitroglycerine (eg, Nitro-Bid) or isosorbide mononitrate (eg, Imdur).<br>Do not take if you have high uncontrolled blood pressure, coronary artery disease, or have had a heart attack within the past 6 months.<br>Do not take if you have been diagnosed with a cardiac dysrhythmia or kidney or liver dysfunction. | | |
| Drug interactions | This medication can react with other medications that you may be taking. Provide your physician and pharmacist with a complete list of all prescribed as well as over-the-counter medications that you are using. | | |
| Use of PDE-5 inhibitors with penile injections or urethral suppositories | The use of PDE-5 inhibitors with other forms of therapy for erectile dysfunction has not been tested and should be avoided. | | |

Evaluation of PE involves a thorough sexual history focusing on the duration of symptoms, time to ejaculation, degree of voluntary control over ejaculation, frequency of occurrence, and course of the problem since the first sexual encounter (Schuster, 2006; Waldinger, 2007). Treatment, which depends on the nature and severity of PE and perceived distress it causes, includes behavioral and psychological approaches, as well as pharmacologic therapy that attempts to alter the sensory input or retard the ejaculatory response. Behavioral therapy (eg, counseling, sex therapy, psychoeducation, and couples therapy) often involves both the man and his sexual partner. The couple is encouraged to identify their sexual needs and to communicate those needs to each other. Pharmacologic management involves selective serotonin reuptake inhibitors, alpha$_1$ adrenoceptor antagonists, the tricyclic antidepressant clomipramine (Anafranil), and topical anesthetics. In some cases, a combination of pharmacologic and behavioral therapy may be effective.

Inhibited ejaculation is most often caused by psychological factors, neurologic disorders (eg, spinal cord injury [SCI], multiple sclerosis, neuropathy secondary to diabetes), surgery (prostatectomy), and medications. Chemical, vibratory, and electrical methods of stimulation have been used with some success. Treatment usually addresses the physical and psychological factors involved in inhibited ejaculation (Schuster, 2006). Although outpatient therapy may involve numerous sessions (12 to 18), it often results in a success rate of 70% to 80%. The outcome depends on a previous satisfying sexual experience history, a short duration of the ejaculatory problem, feelings of sexual desire, feelings of attraction to one's sexual partner, motivation for treatment, and absence of serious psychological problems.

For men with retrograde ejaculation, the urine may be collected shortly after ejaculation, revealing a large amount of sperm in the urine. This urine may also be collected to obtain adequate viable sperm for use in artificial insemination. In men with SCI, techniques that may be used to

obtain sperm for artificial insemination include self-stimulation, vibratory stimulation, or electroejaculation. Electroejaculation involves the use of a specially designed probe that is inserted into the rectum next to the prostate. The probe delivers a current that stimulates the nerves and produces contraction of the pelvic muscles and ejaculation. However, spontaneous or stimulated ejaculation may cause autonomic dysreflexia (AD) (overstimulation of the autonomic nervous system) in patients with SCI at T6 or above, creating a life-threatening situation. If this disorder is not treated promptly, it may lead to seizures, stroke, and even death.

## INFECTIONS OF THE MALE GENITOURINARY TRACT

Acute uncomplicated cystitis in adult men is uncommon but occasionally occurs in men whose sexual partners have vaginal infections with *Escherichia coli*. Asymptomatic bacteriuria may also result from genitourinary manipulation, catheterization, or instrumentation. Urinary tract infections (UTIs) are discussed in Chapter 45.

According to the Centers for Disease Control and Prevention (CDC, 2008), more than 19 million people develop sexually transmitted diseases (STDs) or sexually transmitted infections (STIs) annually in the United States; almost half of all STDs occur in people 18 to 24 years of age. The incidence of STDs has declined over the past several years, except in specific populations, including men who have sex with men. STDs affect people from all walks of life—from all social, educational, economic, and racial backgrounds. The single greatest risk factor for contracting an STD is the number of sexual partners. As the number of partners increases, so does the risk of exposure to a person infected with an STD. For men who have sex with men, the CDC recommends annual testing for human immunodeficiency virus (HIV), syphilis, *Chlamydia*, and gonorrhea (CDC, 2006).

Several diseases are classified as STDs: urethritis (gonococcal and nongonococcal), genital ulcers (genital herpes infections, primary syphilis, chancroid, granuloma inguinale, and lymphogranuloma venereum), genital warts (human papillomavirus [HPV]), scabies, pediculosis pubis, molluscum contagiosum, hepatitis and enteric infections, proctitis, and acquired immunodeficiency syndrome (AIDS). Trichomoniasis and STDs characterized by genital ulcers are thought to increase susceptibility to HIV infection. Trichomoniasis is associated with nonchlamydial, nongonococcal urethritis.

Current treatment guidelines for STDs are available from the CDC (2006, 2007). Treatment must target the patient as well as his sexual partners and sometimes an unborn child. A thorough history, including a sexual history, is crucial to identify patients at risk and to direct care and teaching. Partners of men with STDs must also be examined, treated, and counseled to prevent reinfection and complications in both partners and to limit the spread of the disease. Sexual abstinence during treatment and recovery is advised to prevent the transmission of STDs. Use of synthetic condoms for at least 6 months after completion of treatment is recommended to decrease transmission of HPV infection as well as other STDs. It is important to assess and test for other STDs because patients who have one STD may also have another. Use of spermicides with nonoxynol 9 (known as N-9) is discouraged; these agents do not protect against HIV infection and may increase the risk of transmission of the virus. See Chapters 52 and 70 for more detailed discussions of HIV infection and AIDS and other STDs.

## CONDITIONS OF THE PROSTATE

### *Prostatitis*

**Prostatitis** is an inflammation of the prostate gland that is often associated with lower urinary tract symptoms and symptoms of sexual discomfort and dysfunction. The condition affects 5% to 10% of men. It is the most common urologic diagnosis in men younger than 50 years of age and the third most common such diagnosis in men older than 50 years (Potts & Payne, 2007; Wein, Kavoussi, Novick, et al., 2007). Prostatitis may be caused by infectious agents (bacteria, fungi, mycoplasma) or other conditions (eg, urethral stricture, benign prostatic hyperplasia). *E. coli* is the most commonly isolated organism, although *Klebsiella* and *Proteus* species are also found (Potts & Payne, 2007). The micro-organisms colonize the urinary tract and ascend to the prostate, ultimately causing infection. The causal pathogen is usually the same in recurrent infections.

There are four types of prostatitis: acute bacterial prostatitis (type I); chronic bacterial prostatitis (type II); chronic prostatitis/chronic pelvic pain syndrome (CP/CPPS) (type III), and asymptomatic inflammatory prostatitis (type IV). Type III, which occurs in more than 90% of cases, is further classified as type IIIA or type IIIB, depending on the presence (type IIIA) or absence (type IIIB) of white blood cells in semen after prostate massage.

#### Clinical Manifestations

Acute prostatitis is characterized by the sudden onset of fever, dysuria, perineal prostatic pain and severe lower urinary tract symptoms: dysuria, frequency, urgency, hesitancy, and nocturia. Approximately 5% of cases of type I prostatitis (acute prostatitis) progress to type II prostatitis (chronic bacterial prostatitis) (Wein, et al., 2007). Patients with type II disease are typically asymptomatic between episodes. Patients with type III prostatitis often have no bacteria in the urine in the presence of genitourinary pain. Patients with type IV prostatitis are usually diagnosed incidentally during a workup for infertility, an elevated PSA test, or other disorders.

#### Medical Management

The goal of treatment is to eradicate the causal organisms. Hospital admission may be necessary for patients with unstable vital signs, sepsis, or intractable pelvic pain; those who are frail or immunosuppressed; or those who have diabetes or renal insufficiency. Specific treatment is based on the type of prostatitis and on the results of culture and sensitivity testing of the urine (Potts & Payne, 2007). If

bacteria are cultured from the urine, antibiotics, including trimethoprim-sulfamethoxazole (TMP-SMZ) or a fluoroquinolone (eg, ciprofloxacin [Cipro]), may be prescribed, and continuous therapy with low-dose antibiotics may be used to suppress the infection. If the patient is afebrile and has a normal urinalysis, anti-inflammatory agents may be used. Alpha-adrenergic blocker therapy (eg, tamsulosin [Flomax]), may be prescribed to promote bladder and prostate relaxation.

Factors contributing to prostatitis, including stress, neuromuscular factors, and myofascial pain, are also addressed. Supportive, nonpharmacologic therapies may be prescribed. These include biofeedback, pelvic floor training, physical therapy, reduction of prostatic fluid retention by ejaculation through sexual intercourse or masturbation, sitz baths, stool softeners, and evaluation of sexual partners to reduce the possibility of cross-infection.

## Nursing Management

If the patient experiences symptoms of acute prostatitis (fever, severe pain and discomfort, inability to urinate, malaise), he may be hospitalized for intravenous (IV) antibiotic therapy. Nursing management includes administration of prescribed antibiotics and provision of comfort measures, including prescribed analgesic agents and sitz baths.

The patient with chronic prostatitis is usually treated on an outpatient basis and needs to be instructed about the importance of continuing antibiotic therapy and recognizing recurrent signs and symptoms of prostatitis.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The nurse instructs the patient to complete the prescribed course of antibiotics. If IV antibiotics are to be administered at home, the nurse instructs the patient and family about correct and safe administration. Arrangements for a home care nurse to oversee administration may be needed. Hot sitz baths (10 to 20 minutes) may be taken several times daily. Fluids are encouraged to satisfy thirst but are not "forced," because an effective medication level must be maintained in the urine. Foods and liquids with diuretic action or that increase prostatic secretions, such as alcohol, coffee, tea, chocolate, cola, and spices, should be avoided. A suprapubic catheter may be necessary for severe urinary retention. During periods of acute inflammation, sexual arousal and intercourse should be avoided. To minimize discomfort, the patient should avoid sitting for long periods. Medical follow-up is necessary for at least 6 months to 1 year because prostatitis caused by the same or different organisms can recur. The patient is advised that the UTI may recur and is taught to recognize its symptoms.

# *Benign Prostatic Hyperplasia (Enlarged Prostate)*

**Benign prostatic hyperplasia (BPH)** is one of the most common diseases in aging men. It can cause bothersome lower urinary tract symptoms that affect quality of life by interfering with normal daily activities and sleep patterns (AUA, 2006; Kaplan, 2006). BPH typically occurs in men older than 40 years of age. By the time they reach 60 years of age, 50% of men have BPH. It affects as many as 90% of men by 85 years of age. BPH is the second most common cause of surgical intervention in men older than 60 years of age.

## Pathophysiology

The cause of BPH is not well understood, but testicular androgens have been implicated. Dihydrotestosterone (DHT), a metabolite of testosterone, is a critical mediator of prostatic growth. Estrogens may also play a role in the cause of BPH; BPH generally occurs when men have elevated estrogen levels and when prostate tissue becomes more sensitive to estrogens and less responsive to DHT. Smoking, heavy alcohol consumption, obesity, reduced activity level, hypertension, heart disease, diabetes, and a Western diet (high in animal fat and protein and refined carbohydrates, low in fiber) are risk factors for BPH (Parsons, 2007).

BPH develops over a prolonged period; changes in the urinary tract are slow and insidious. BPH is a result of complex interactions involving resistance in the prostatic urethra to mechanical and spastic effects, bladder pressure during voiding, detrusor muscle strength, neurologic functioning, and general physical health (McCance & Huether, 2005). The hypertrophied lobes of the prostate may obstruct the bladder neck or urethra, causing incomplete emptying of the bladder and urinary retention. As a result, a gradual dilation of the ureters (hydroureter) and kidneys (hydronephrosis) can occur. Urinary retention may result in UTIs because urine that remains in the urinary tract serves as a medium for infective organisms.

## Clinical Manifestations

BPH may or may not lead to lower urinary tract symptoms; if symptoms occur, they may range from mild to severe. Severity of symptoms increases with age, and half of men with BPH report having moderate to severe symptoms. Obstructive and irritative symptoms may include urinary frequency, urgency, nocturia, hesitancy in starting urination, decreased and intermittent force of stream and the sensation of incomplete bladder emptying, abdominal straining with urination, a decrease in the volume and force of the urinary stream, dribbling (urine dribbles out after urination), and complications of acute urinary retention (more than 60 mL of urine remaining in the bladder after urination), and recurrent UTIs. Ultimately, chronic urinary retention and large residual volumes can lead to azotemia (accumulation of nitrogenous waste products) and renal failure.

Generalized symptoms may also be noted, including fatigue, anorexia, nausea, vomiting, and pelvic discomfort. Other disorders that produce similar symptoms include urethral stricture, prostate cancer, neurogenic bladder, and urinary bladder stones.

## Assessment and Diagnostic Findings

The health history focuses on the urinary tract, previous surgical procedures, general health issues, family history of prostate disease, and fitness for possible surgery (AUA, 2006).

A patient voiding diary is used to record voiding frequency and urine volume. A DRE often reveals a large, rubbery, and nontender prostate gland. A urinalysis to screen for hematuria and UTI is recommended. A PSA level is obtained if the patient has at least a 10-year life expectancy and for whom knowledge of the presence of prostate cancer would change management. The AUA Symptom Index or International Prostate Symptom Score (IPSS) can be used to assess the severity of symptoms (AUA, 2006).

Other diagnostic tests may include urinary flow-rate recording and the measurement of postvoid residual (PVR) urine. If invasive therapy is considered, urodynamic studies, urethrocystoscopy, and ultrasound may be performed. Complete blood studies are performed. Cardiac status and respiratory function are assessed because a high percentage of patients with BPH have cardiac or respiratory disorders because of their age.

## Medical Management

The goals of medical management of BPH are to improve quality of life, improve urine flow, relieve obstruction, prevent disease progression, and minimize complications. Treatment depends on the severity of symptoms, the cause of disease, the severity of the obstruction, and the patient's condition.

If a patient is admitted on an emergency basis because he is unable to void, he is immediately catheterized. The ordinary catheter may be too soft and pliable to advance through the urethra into the bladder. In such cases, a thin wire (stylet) is introduced (by a urologist) into the catheter to prevent the catheter from collapsing when it encounters resistance. A metal catheter with a pronounced prostatic curve may be used if obstruction is severe. An incision into the bladder (a suprapubic **cystostomy**) may be needed to provide urinary drainage.

Discussion of all treatment options by the physician enables the patient to make an informed decision based on symptom severity, the effect of BPH on his quality of life, and preference. Patients with mild symptoms and patients with moderate or severe symptoms who are not bothered by them and have not developed complications may be managed with watchful waiting. With this approach, the patient is monitored and reexamined annually but receives no active intervention (Kaplan, 2006). Other therapeutic choices include pharmacologic treatment, minimally invasive procedures, and surgery.

### Pharmacologic Therapy

Pharmacologic treatment for BPH includes use of alpha-adrenergic blockers and 5-alpha-reductase inhibitors (AUA, 2006). Alpha-adrenergic blockers, which include alfuzosin (Uroxatral), terazosin (Hytrin), doxazosin (Cardura), and tamsulosin, relax the smooth muscle of the bladder neck and prostate. This improves urine flow and relieves symptoms of BPH. Side effects include dizziness, headache, asthenia/fatigue, postural hypotension, rhinitis, and sexual dysfunction (Kaplan, 2006; Lepor, 2007).

Another method of treatment involves hormonal manipulation with antiandrogen agents. The 5-alpha-reductase inhibitors, finasteride (Proscar) and dutasteride (Avodart), are used to prevent the conversion of testosterone to DHT and decrease prostate size. Side effects include decreased libido, ejaculatory dysfunction, erectile dysfunction, gynecomastia (breast enlargement), and flushing. Combination therapy (doxazosin and finasteride) has decreased symptoms and reduced clinical progression of BPH (AUA, 2006; Kaplan, 2006).

Use of phytotherapeutic agents and other dietary supplements (*Serenoa repens* [saw palmetto berry] and *Pygeum africanum* [African plum]) are not recommended, although they are commonly used. They may function by interfering with the conversion of testosterone to DHT. In addition, *S. repens* may directly block the ability of DHT to stimulate prostate cell growth. These agents should not be used with finasteride, dutasteride, or estrogen-containing medications.

### Surgical Treatment

Other treatment options include minimally invasive procedures and resection of the prostate gland.

#### Minimally Invasive Therapy

Several forms of **minimally invasive therapy** may be used to treat BPH. Transurethral microwave heat treatment (TUMT) involves the application of heat to prostatic tissue. High-energy TUMT devices (CoreTherm, Prostatron, Targis) and low-energy devices (TherMatrx) are available (AUA, 2006). A transurethral probe is inserted into the urethra, and microwaves are directed to the prostate tissue. The targeted tissue becomes necrotic and sloughs. To minimize damage to the urethra and decrease the discomfort from the procedure, some systems have a water-cooling apparatus.

Other minimally invasive treatment options include (transurethral needle ablation [TUNA]) by radiofrequency energy and the UroLume stent. TUNA uses low-level radiofrequencies delivered by thin needles placed in the prostate gland to produce localized heat that destroys prostate tissue while sparing other tissues. The body then resorbs the dead tissue. Prostatic stents are associated with significant complications (eg, eucrustation, infection, chronic pain); therefore, they are used only for patients with urinary retention and in patients who are poor surgical risks (AUA, 2006).

#### Surgical Resection

Surgical resection of the prostate gland is another option for patients with moderate to severe lower urinary tract symptoms of BPH and for those with acute urinary retention or other complications. The specific surgical approach (open or endoscopic) and the energy source (electrocautery versus laser) are based on the surgeon's experience, the size of the prostate gland, the presence of other medical disorders, and the patient's preference. If surgery is to be performed, all clotting defects must be corrected and medications for anticoagulation withheld because bleeding is a complication of prostate surgery.

**Transurethral resection of the prostate (TURP)** remains the benchmark for surgical treatment of BPH. It involves the surgical removal of the inner portion of the prostate through an endoscope inserted through the urethra; no external skin incision is made. It can be performed with

ultrasound guidance. The treated tissue either vaporizes or becomes necrotic and sloughs. The procedure is performed in the outpatient setting and usually results in less postoperative bleeding than a traditional surgical prostatectomy.

Other surgical options for BPH include transurethral incision of the prostate (TUIP), transurethral electrovaporization, laser therapy, and open prostatectomy (AUA, 2006; Kaplan, 2006). TUIP is an outpatient procedure used to treat smaller prostates. One or two cuts are made in the prostate and prostate capsule to reduce constriction of the urethra and decrease resistance to flow of urine out of the bladder, and no tissue is removed. Open prostatectomy involves the surgical removal of the inner portion of the prostate via a suprapubic, retropubic, or perineal (rare) approach for large prostate glands. Prostatectomy may also be performed laparoscopically or by a robot-assisted laparoscopy.

Nursing management of patients undergoing these procedures is described later in this chapter.

## Cancer of the Prostate

**Prostate cancer** is the most common cancer in men other than nonmelanoma skin cancer. It is the second most common cause of cancer death in American men, exceeded only by lung cancer, and is responsible for 10% of cancer-related deaths in men. Among men diagnosed with prostate cancer, 98% survive at least 5 years, 84% survive at least 10 years, and 56% survive 15 years (ACS, 2009).

Prostate cancer is common in the United States and northwestern Europe but is rare in Africa, Central America, South America, China, and other parts of Asia. African American men have a high risk of prostate cancer; furthermore, they are twice as likely to die of prostate cancer than men of any other racial or ethnic group. The findings of the African-American Hereditary Prostate Cancer Study suggest that a strong genetic link increases the risk of early-onset disease (Jones, Underwood & Rivers, 2007). Other risk factors in African American men include their lower level of engagement in the health care system, disparities in health care, and cultural and structural barriers. These findings support the need for education about prostate cancer and screening in African American men (Weinrich, Vijayakumar, Powell, et al., 2007). Culturally sensitive promotional campaigns, teaching and counseling about prostate cancer, screening, and treatment are important in increasing awareness of the high incidence of prostate cancer and mortality rates in African American men (Chart 49-2).

Other risk factors for prostate cancer include increasing age; the incidence of prostate cancer increases rapidly after the age of 50 years. More than 70% of cases occur in men older than 65 years of age. A familial predisposition may occur in men who have a father or brother previously diagnosed with prostate cancer, especially if their relatives were

### CHART 49-2 NURSING RESEARCH PROFILE
### *Knowledge About Hereditary Prostate Cancer in African American Men*

Weinrich, S., Vijayakumar, S., Powell, I. J., et al. (2007). Knowledge of hereditary prostate cancer among high-risk African American men. *Oncology Nursing Forum, 34*(4), 854–860.

**Purpose**

Because African American men develop prostate cancer 50% to 60% more often than Caucasians and die from it at twice the rate of any other ethnic group, it is critical for this group to be aware of their increased risk and the need for screening for early detection of prostate cancer. The purpose of this study was to measure the level of knowledge about hereditary prostate cancer in a group of high-risk African American men.

**Design**

For this cross-sectional, correlational pilot study, investigators recruited a sample of 79 high-risk African American men (defined as those with four or more men in their families with prostate cancer) from four geographic areas. These men, who were also participants in the African American Hereditary Prostate Cancer Study, came from all educational levels, and their average age was 54 years. Almost half ($n = 38$, 48%) of them had received a diagnosis of prostate cancer. Researchers conducted telephone interviews using a scripted telephone protocol and a true-false, nine-item questionnaire, called the "Knowledge of Hereditary Prostate Cancer Scale," developed by the first author. Each man's individual answers were scored as correct or incorrect, with a range of possible total scores ranging from 0 to 9. To reach each participant, an average of 2.5 calls was needed; each call lasted an average of 15 minutes.

**Findings**

Data analysis revealed a range of scores from 3.5 to 9, with a mean score of 6.34 (standard deviation = 1.11). The authors interpreted this as a low level of knowledge about hereditary prostate cancer; answering six of nine questions correctly would produce a score of 67%.

**Nursing Implications**

The authors interpreted the high percentage of incorrect responses to questions about genetic testing, prevention, and risk based on a positive family history as indicating a need for education. They proposed that cancer fatalism (eg, the belief that death is inevitable when cancer is present) may account for a high percentage of incorrect or unanswered responses to a question measuring risk probability based on a positive prostate cancer test. In the current genomic health care system, a critical need exists for nurses to have a sound understanding of genetics and to educate high-risk African American men and their families about hereditary prostate cancer. The lack of knowledge exhibited by the participants in this study suggests a decreased likelihood of prostate cancer screening. The American Cancer Society recommends prostate cancer screening at 45 years of age for African American men and men with a positive family history (5 years earlier than the recommended age for men in the general population). Nurses can encourage early prostate screening. They have a valuable role in promoting healthy behaviors among high-risk African American men through education and other innovative strategies.

diagnosed at a young age. Genes that may be associated with increased risk of prostate cancer include hereditary prostate cancer 1 (*HPC1*) and *BRCA1* and *BRCA2* mutations (Jones, et al., 2007; Lessick & Katz, 2006). The risk of prostate cancer is also greater in men whose diet contains excessive amounts of red meat or dairy products that are high in fat (ACS, 2009). Endogenous hormones, such as androgens and estrogens, also may be associated with the development of prostate cancer.

Several large-scale studies have examined the ability of 5-alpha reductase inhibitors (finasteride and dutasteride) to delay or prevent prostate cancer (Tindall & Rittmaster, 2008).

## Clinical Manifestations

Cancer of the prostate in its early stages rarely produces symptoms. Usually symptoms that develop from urinary obstruction occur in advanced disease. Prostate cancer tends to vary in its course. If the cancer is large enough to encroach on the bladder neck, signs and symptoms of urinary obstruction occur (difficulty and frequency of urination, urinary retention, and decreased size and force of the urinary stream). Other symptoms may include blood in the urine or semen and painful ejaculation. Hematuria may occur if the cancer invades the urethra or bladder. Sexual dysfunction is common before the diagnosis is made.

Prostate cancer can spread to lymph nodes and bone. Symptoms of metastases include backache, hip pain, perineal and rectal discomfort, anemia, weight loss, weakness, nausea, oliguria (decreased urine output), and spontaneous pathologic fractures. These symptoms may be the first indications of prostate cancer.

## Assessment and Diagnostic Findings

If prostate cancer is detected early, the likelihood of cure is high. It can be diagnosed through an abnormal finding with the DRE, serum PSA, and ultrasound-guided TRUS with biopsy. Detection is more likely with use of combined diagnostic procedures. Routine repeated DRE (preferably by the same examiner) is important because early cancer may be detected as a nodule within the gland or as an extensive hardening in the posterior lobe. The more advanced lesion is "stony hard" and fixed. DRE also provides useful clinical information about the rectum, anal sphincter, and quality of stool.

The diagnosis of prostate cancer is confirmed by a histologic examination of tissue removed surgically by TURP, open prostatectomy, or ultrasound-guided transrectal needle biopsy. Fine-needle aspiration is a quick, painless method of obtaining prostate cells for cytologic examination and determining the stage of disease.

Most prostate cancers are detected when a man seeks medical attention for symptoms of urinary obstruction or are found by routine DRE and PSA testing. Cancer detected incidentally when TURP is performed for clinically benign disease and lower urinary tract symptoms occurs in about 1 of 10 cases. Abnormal DRE and elevated levels of PSA may raise suspicion of prostate cancer, but detection requires confirmation with a prostate biopsy.

TRUS helps detect nonpalpable prostate cancers and assists with staging of localized prostate cancer. Needle biopsies of the prostate are commonly guided by TRUS. The biopsies are examined by a pathologist to both determine if cancer is present and to grade the tumor. The most commonly used tumor grading system is the Gleason score. This system assigns a grade of 1 to 5 for the most predominant architectural pattern of the glands of the prostate and a secondary grade of 1 to 5 to the second most predominant pattern. The Gleason score is then reported as, for example, 2 + 4; the combined value can range from 2 to 10. With each increase in Gleason score, there is an increase in tumor aggressiveness. Lower Gleason scores indicate well-differentiated and less aggressive tumor cells; higher Gleason scores indicate undifferentiated cells and more aggressive cancer. A total score of 8 to 10 indicates a high-grade cancer (AUA, 2007).

Categorization of low-risk, intermediate-risk, and high-risk prostate cancer is determined by the extent of cancer in the prostate gland, whether or not the cancer is localized to the prostate, the aggressiveness of the cells, and the spread to the lymph nodes and beyond. Level of risk, in turn, is used to determine treatment options.

Bone scans, skeletal x-rays, and magnetic resonance imaging (MRI) may be used to identify metastatic bone disease. Pelvic computed tomography (CT) may be performed to determine if the cancer has spread to the lymph nodes. The radiolabeled monoclonal antibody capromab pendetide with indium 111 (ProstaScint) is an antibody that can be used to detect either recurrent prostate cancer at low PSA levels or metastatic disease (NCCN, 2008).

## Medical Management

Treatment is based on the patient's life expectancy, symptoms, risk of recurrence after definitive treatment, size of the tumor, Gleason score, PSA level, likelihood of complications, and patient preference. Therapy is often guided by the use of a nomogram or risk stratification scheme suggested by the NCCN (2008) and AUA (2007) clinical practice guidelines. A multidisciplinary team approach is essential for the development of appropriate treatment. Management may be nonsurgical and involve watchful waiting or be surgical and entail **prostatectomy.** Nursing care of the patient with cancer of the prostate is summarized in the plan of nursing care in Chart 49-3.

Patients with prostate cancer may also choose nonsurgical watchful waiting. This approach involves actively monitoring the course of disease and intervening only if the cancer progresses or if symptoms warrant other intervention. It is an option for patients with life expectancy of less than 5 years and low-risk cancers. Advantages include absence of side effects of more aggressive treatment, improved quality of life, avoidance of unnecessary treatment, and decreased initial costs. Disadvantages include missed chance at cure, risk of metastasis, subsequent need for more aggressive treatment, anxiety about living with untreated cancer, and need for frequent monitoring (Bailey, Wallace & Mishel, 2007; NCCN, 2008).

### *Surgical Management*

Radical prostatectomy is considered the standard first-line treatment for prostate cancer and is used with patients whose tumor is confined to the prostate. It is the complete surgical removal of the prostate, seminal vesicles, tips of the vas deferens, and often the surrounding fat, nerves, and

CHART 49-3

## PLAN OF NURSING CARE
## *The Patient With Prostate Cancer*

**NURSING DIAGNOSIS:** Anxiety related to concern and lack of knowledge about the diagnosis, treatment plan, and prognosis
**GOAL:** Reduced stress and improved ability to cope

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Obtain health history to determine the following:<br>a. Patient's concerns<br>b. His level of understanding of his health problem<br>c. His past experience with cancer<br>d. Whether he knows his diagnosis of malignancy and its prognosis<br>e. His support systems and coping methods | 1. Nurse clarifies information and facilitates patient's understanding and coping. | • Appears relaxed<br>• States that anxiety has been reduced or relieved<br>• Demonstrates understanding of illness, diagnostic tests, and treatment when questioned<br>• Engages in open communication with others |
| 2. Provide education about diagnosis and treatment plan:<br>a. Explain in simple terms what diagnostic tests to expect, how long they will take, and what will be experienced during each test.<br>b. Review treatment plan and allow patient to ask questions. | 2. Helping the patient to understand the diagnostic tests and treatment plan will help decrease his anxiety and promote cooperation. | |
| 3. Assess his psychological reaction to his diagnosis/prognosis and how he has coped with past stresses. | 3. This information provides clues in determining appropriate measures to facilitate coping. | |
| 4. Provide information about institutional and community resources for coping with prostate cancer: social services, support groups, community agencies. | 4. Institutional and community resources can help the patient and family cope with the illness and treatment on an ongoing basis. | |

**NURSING DIAGNOSIS:** Urinary retention related to urethral obstruction secondary to prostatic enlargement or tumor and loss of bladder tone due to prolonged distention/retention
**GOAL:** Improved pattern of urinary elimination

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Determine patient's usual pattern of urinary function. | 1. Provides a baseline for comparison and goal to work toward | • Voids at normal intervals<br>• Reports absence of frequency, urgency, or bladder fullness<br>• Displays no palpable suprapubic distention after voiding<br>• Maintains balanced intake and output |
| 2. Assess for signs and symptoms of urinary retention: amount and frequency of urination, suprapubic distention, complaints of urgency and discomfort. | 2. Voiding 20 to 30 mL frequently and output less than intake suggest retention. | |
| 3. Catheterize patient to determine amount of residual urine. | 3. Determines amount of urine remaining in bladder after voiding. | |
| 4. Initiate measures to treat retention:<br>a. Encourage assuming normal position for voiding.<br>b. Recommend using Valsalva maneuver preoperatively, if not contraindicated.<br>c. Administer prescribed cholinergic agent.<br>d. Monitor effects of medication. | 4. Promotes voiding:<br>a. Usual position provides relaxed conditions conducive to voiding.<br>b. Valsalva maneuver exerts pressure to force urine out of bladder.<br>c. Stimulates bladder contraction.<br>d. If unsuccessful, another measure may be required. | |
| 5. Consult with physician regarding intermittent or indwelling catheterization; assist with procedure as required. | 5. Catheterization will relieve urinary retention until the specific cause is determined; it may be an obstruction that can be corrected only surgically. | |
| 6. Monitor catheter function; maintain sterility of closed system; irrigate as required. | 6. Adequate functioning of catheter is to be ensured to empty bladder and to prevent infection. | |
| 7. Prepare patient for surgery if indicated. | 7. Surgical removal of obstruction may be necessary. | |

*Continued*

CHART 49-3

## PLAN OF NURSING CARE
## *The Patient With Prostate Cancer (Continued)*

**NURSING DIAGNOSIS:** Deficient knowledge related to the diagnosis of: cancer, urinary difficulties, and treatment modalities
**GOAL:** Understanding of the diagnosis and ability to care for self

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage communication with the patient. | 1. This is designed to establish rapport and trust. | • Discusses his concerns and problems freely<br>• Asks questions and shows interest in his disorder<br>• Describes activities that help or hinder recovery<br>• Identifies ways of attaining/maintaining bladder control<br>• Demonstrates satisfactory technique and understanding of catheter care<br>• Lists signs and symptoms that must be reported should they occur |
| 2. Review the anatomy of the involved area. | 2. Orientation to one's anatomy is basic to understanding its function. | |
| 3. Be specific in selecting information that is relevant to the patient's particular treatment plan. | 3. This is based on the treatment plan; as it varies with each patient, individualization is desirable. | |
| 4. Identify ways to reduce pressure on the operative area after prostatectomy:<br>a. Avoid prolonged sitting (in a chair, long automobile rides), standing, walking.<br>b. Avoid straining, such as during exercises, bowel movement, lifting, and sexual intercourse. | 4. This is to prevent bleeding; such precautions are in order for 6 to 8 weeks postoperatively. | |
| 5. Familiarize patient with ways of attaining/maintaining bladder control. | 5. These measures will help control frequency and dribbling and aid in preventing retention. | |
| a. Encourage urination every 2 to 3 hours; discourage voiding when supine. | a. By sitting or standing, patient is more likely to empty his bladder. | |
| b. Avoid drinking cola and caffeine beverages; urge a cutoff time in the evening for drinking fluids to minimize frequent voiding during the night. | b. Spacing the kind and amount of liquid intake will help to prevent frequency. | |
| c. Describe perineal exercises to be performed every hour. | c. Exercises will assist him in starting and stopping the urinary stream. | |
| d. Develop a schedule with patient that will fit into his routine. | d. A schedule will assist in developing a workable pattern of normal activities. | |
| 6. Demonstrate catheter care; encourage his questions; stress the importance of position of urinary receptacle. | 6. By requiring a return demonstration of care, collection, and emptying of the device, he will become more independent and also can prevent backflow of urine, which can lead to infection. | |

**NURSING DIAGNOSIS:** Imbalanced nutrition: less than body requirements related to decreased oral intake because of anorexia, nausea, and vomiting caused by cancer or its treatment
**GOAL:** Maintain optimal nutritional status

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess the amount of food eaten. | 1. This assessment will help determine nutrient intake. | • Responds positively to his favorite foods<br>• Assumes responsibility for his oral hygiene<br>• Reports absence of nausea and vomiting<br>• Notes increase in weight after improved appetite |
| 2. Routinely weigh patient. | 2. Weighing the patient on the same scale under similar conditions can help monitor changes in weight. | |
| 3. Elicit patient's explanation of why he is unable to eat more. | 3. His explanation may present easily corrected practices. | |
| 4. Cater to his individual food preferences (eg, avoiding foods that are too spicy or too cold). | 4. He will be more likely to consume larger servings if food is palatable and appealing. | |
| 5. Recognize effect of medication or radiation therapy on appetite. | 5. Many chemotherapeutic agents and radiation therapy promote anorexia. | |

*Continued on following page*

CHART 49-3

## PLAN OF NURSING CARE
## *The Patient With Prostate Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 6. Inform patient that alterations in taste can occur. | 6. Aging and the disease process can reduce taste sensitivity. In addition, smell and taste can be altered as a result of the body's absorption of byproducts of cellular destruction (brought on by malignancy and its treatment). | |
| 7. Use measures to control nausea and vomiting:<br>a. Administer prescribed anti-emetics, around the clock if necessary.<br>b. Provide oral hygiene after vomiting episodes.<br>c. Provide rest periods after meals. | 7. Prevention of nausea and vomiting can stimulate appetite. | |
| 8. Provide frequent small meals and a comfortable and pleasant environment. | 8. Smaller portions of food are less overwhelming to the patient. | |
| 9. Assess patient's ability to obtain and prepare foods. | 9. Disability or lack of social support can hinder the patient's ability to obtain and prepare foods. | |

**NURSING DIAGNOSIS:** Sexual dysfunction related to effects of therapy: chemotherapy, hormonal therapy, radiation therapy, surgery
**GOAL:** Ability to resume/enjoy modified sexual functioning

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Determine from nursing history what effect patient's medical condition is having on his sexual functioning. | 1. Usually decreased libido and, later, impotence may be experienced. | • Describes the reasons for changes in sexual functioning<br>• Discusses with appropriate health care personnel alternative approaches and methods of sexual expression<br>• Includes partner in discussions related to changes in sexual function |
| 2. Inform patient of the effects of prostate surgery, orchiectomy (when applicable), chemotherapy, irradiation, and hormonal therapy on sexual function. | 2. Treatment modalities may alter sexual function, but each is evaluated separately with regard to its effect on a particular patient. | |
| 3. Include his partner in developing understanding and in discovering alternative, satisfying close relations with each other. | 3. The bonds between a couple may be strengthened with new appreciation and support that had not been evident before the current illness. | |

**NURSING DIAGNOSIS:** Pain related to progression of disease and treatment modalities
**GOAL:** Relief of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Evaluate nature of patient's pain, its location and intensity using pain rating scale. | 1. Determining nature and causes of pain and its intensity helps to select proper pain-relief modality and provide baseline for later comparison. | • Reports relief of pain<br>• Expects exacerbations, reports their quality and intensity, and obtains relief<br>• Uses pain relief strategies appropriately and effectively<br>• Identifies strategies to avoid complications of analgesic use (eg, constipation) |
| 2. Avoid activities that aggravate or worsen pain. | 2. Bumping the bed is an example of an action that can intensify the patient's pain. | |
| 3. Because pain is usually related to bone metastasis, ensure that patient's bed has a bed board on a firm mattress. Also, protect the patient from falls/injuries. | 3. This will provide added support and is more comfortable. Protecting the patient from injury protects him from additional pain. | |
| 4. Provide support for affected extremities. | 4. More support, coupled with reduced movement of the part, helps in pain control. | |
| 5. Prepare patient for radiation therapy if prescribed. | 5. Radiation therapy may be effective in controlling pain. | |

*Continued*

CHART 49-3

## PLAN OF NURSING CARE
### *The Patient With Prostate Cancer (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 6. Administer analgesics or opioids at regularly scheduled intervals as prescribed. | 6. Analgesics alter perception of pain and provide comfort. Regularly scheduled analgesics around the clock rather than PRN provide more consistent pain relief. | |
| 7. Initiate bowel program to prevent constipation. | 7. Opioid analgesics and inactivity contribute to constipation. | |

**NURSING DIAGNOSIS:** Impaired physical mobility and activity intolerance related to tissue hypoxia, malnutrition, and exhaustion and to spinal cord or nerve compression from metastases
**GOAL:** Improved physical mobility

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess for factors causing limited mobility (eg, pain, hypercalcemia, limited exercise tolerance). | 1. This information offers clues to the cause; if possible, cause is treated. | • Achieves improved physical mobility<br>• Relates that short-term goals are encouraging him because they are attainable |
| 2. Provide pain relief by administering prescribed medications. | 2. Analgesics/opioids allow the patient to increase his activity more comfortably. | |
| 3. Encourage use of assistive devices: cane, walker. | 3. Support may offer the security needed to become mobile. | |
| 4. Involve significant others in helping patient with range-of-motion exercises, positioning, and walking. | 4. Assistance from partner or others encourages patient to repeat activities and achieve goals. | |
| 5. Provide positive reinforcement for achievement of small gains. | 5. Encouragement stimulates improvement of performance. | |
| 6. Assess nutritional status. | 6. See Nursing Diagnosis: Imbalanced nutrition: less than body requirements. | |

**COLLABORATIVE PROBLEMS:** Hemorrhage, infection, bladder neck obstruction
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Alert the patient to changes that may occur (after discharge) and that need to be reported: | 1. Certain changes signal beginning complications, which call for nursing and medical interventions. | • Experiences no bleeding or passage of blood clots<br>• Reports no pain around the catheter<br>• Experiences normal frequency or urination<br>• Reports normal urinary output<br>• Maintains bladder control |
| a. Continued bloody urine; passing blood clots. | a. Hematuria with or without blood clot formation may occur postoperatively. | |
| b. Pain; burning around the catheter. | b. Indwelling urinary catheters may be a source of infections. | |
| c. Frequency of urination. | c. Urinary frequency may be caused by urinary tract infections or by bladder neck obstruction, resulting in incomplete voiding. | |
| d. Diminished urinary output. | d. Bladder neck obstruction decreases the amount of urine that is voided. | |
| e. Increasing loss of bladder control. | e. Urinary incontinence may be a result of urinary retention. | |

blood vessels. Laparoscopic radical prostatectomy and robotic-assisted laparoscopic radical prostatectomy have become the standard surgical approaches for localized cancer of the prostate. Although sexual impotence is a common side effect, these laparoscopic radical prostatectomy approaches result in low morbidity and more favorable postoperative outcomes, including improved quality of life and less sexual dysfunction if the nerves are spared. (Surgical approaches are discussed in detail later in this chapter.)

#### *Radiation Therapy*

Two major forms of radiation therapy are used to treat cancer of the prostate: teletherapy (external) and brachytherapy (internal). Teletherapy (external beam radiation therapy [EBRT]) may be given for 5 days per week for 7 to 8 weeks. It is a treatment option for patients with low-risk prostate cancer; progression-free survival is similar to that of low-risk patients treated with radical prostatectomy.

Patients with intermediate-risk and high-risk cancers receive higher doses of EBRT and may be candidates for both pelvic lymph node irradiation and androgen deprivation therapy (NCCN, 2008). Intensity modulated radiation therapy (IMRT) is one method of delivery of EBRT. IMRT sets a dose for the target volume and restricts the dose to surrounding tissue. A new approach to delivery of radiation uses a computer-controlled robotic arm to deliver a course of radiotherapy (ie, stereotactic radiosurgery) to localized prostate cancer. This method, referred to as the CyberKnife, is being evaluated in clinical trials and compared with other methods of delivering radiation to treat prostate cancer.

**Brachytherapy** (internal implants) involves the implantation of interstitial radioactive seeds under anesthesia. It has become a commonly used monotherapy treatment option for early, clinically organ-confined prostate cancer. The surgeon uses ultrasound guidance to place 80 to 100 seeds (depending on the prostate volume), and the patient returns home after the procedure. Exposure of others to radiation is minimal, but the patient should avoid close contact with pregnant women and infants for up to 2 months. Radiation safety guidelines include straining urine for seeds and using a condom during sexual intercourse for 2 weeks after implantation to catch any seeds that pass through the urethra. This approach can be completed in one day, with little lost time from normal activities. Brachytherapy may be combined with EBRT with or without neoadjuvant androgen deprivation therapy for patients considered at intermediate risk. High-risk patients are considered poor candidates for permanent brachytherapy (NCCN, 2008).

Although cure rates with radiation are comparable to those of radical prostatectomy, radiation therapy possesses its own unique set of side effects, which differ depending on the method of radiation administration. Patients receiving EBRT or brachytherapy may experience inflammation of the rectum, bowel, and bladder (proctitis, enteritis, and cystitis) because of the proximity of these structures to the prostate and the radiation doses. Inflammation and mucosal loss at the bladder neck, prostate, and urethra can cause acute urinary dysfunction. Both irritative and obstructive urinary symptoms can cause pain with urination and ejaculation until the irritation subsides. Rectal urgency, diarrhea, and tenesmus may occur as a result of radiation of the anterior rectal wall. Late side effects include rectal proctitis, bleeding, and rectal fistula, painless hematuria, chronic interstitial cystitis, urethral stricture erectile dysfunction, and, rarely, secondary cancers of the rectum and bladder (Michaelson, Cotter, Gargollo, et al., 2008).

### Hormonal Strategies

The number of survivors of prostate cancer in the United States is estimated at 2 million; approximately one third of these men currently receive **androgen deprivation therapy (ADT)** (Michaelson, et al., 2008). ADT is commonly used to suppress androgenic stimuli to the prostate by decreasing the level of circulating plasma testosterone or interrupting the conversion to or binding of DHT. As a result, the prostatic epithelium atrophies (decreases in size). This effect is accomplished either by surgical castration (bilateral **orchiectomy,** removal of the testes), which has traditionally been the mainstay of hormonal treatment, or by medical castration with the administration of medications, such as luteinizing hormone–releasing hormone (LHRH) agonists. Bilateral orchiectomy decreases plasma testosterone levels significantly because approximately 93% of circulating testosterone is of testicular origin (7% is from the adrenal glands). Thus, the testicular stimulus required for continued prostatic growth is removed, resulting in prostatic atrophy.

However, orchiectomy often results in significant morbidity. Although the procedure does not cause the side effects associated with other hormonal therapies (described later), it is associated with considerable emotional impact. Because patients who have prostate cancer are living longer with the disease, health care providers have now begun to focus their attention on effective therapeutic modalities that promote an acceptable quality of life. Patients may be given the option for testicular prostheses to be placed during surgery.

LHRH agonists include leuprolide (Lupron) and goserelin (Zoladex). Additional hormonal manipulation with antiandrogens may be prescribed for patients who do not show adequate serum testosterone suppression (less than 50 ng/mL) with medical or surgical castration. Antiandrogen receptor antagonists include flutamide (Eulexin), bicalutamide (Casodex), and nilutamide (Nilandron). LHRH agonists suppress testicular androgen, whereas antiandrogen receptor antagonists cause adrenal androgen suppression. When LHRH agonists are initiated, a testosterone flare may occur, causing pain in bony metastatic disease. Antiandrogens given for the first 7 days may reduce this uncomfortable symptom. The most common uses of LHRH agonists are the following: (1) in the adjuvant and neoadjuvant setting in combination with radiation therapy; (2) after radical prostatectomy; and (3) in the treatment of recurrence indicated by an elevation in the PSA but without clinical or x-ray evidence. Medical and surgical castration causes hot flushing because these treatment modalities increase hypothalamic activity, which stimulates the thermoregulatory centers of the body.

The management of hormone-refractory prostate cancer remains somewhat controversial. Another category of medication used as a second-line hormonal intervention is called adrenal ablating drugs. Ketoconazole (Nizoral) is used to inhibit cytochrome P450 enzymes, which are required for the synthesis of androgens and other steroids. High-dose ketoconazole lowers testosterone by decreasing both testicular and endocrine production of androgen. Administration of this medication requires steroid supplementation to prevent adrenal insufficiency.

Hypogonadism is responsible for the adverse effects of ADT, which include vasomotor flushing, loss of libido, decreased bone density (resulting in osteoporosis and fractures), anemia, fatigue, increased fat mass, lipid alterations, decreased muscle mass, gynecomastia (increased breast tissue), and mastodynia (breast/nipple tenderness). Hypogonadism is associated with an increased risk of diabetes, resulting from insulin resistance, metabolic syndrome, and cardiovascular disease (Michaelson, et al., 2008).

### Chemotherapy

Recent studies have shown clear benefits in terms of survival with chemotherapy treatment that includes a

docetaxel-based regimen for non–androgen-dependent prostate cancer (NCCN, 2008; Pienta & Smith, 2005). Other studies are under way to determine the importance of the vascular endothelial growth factor system. Tumor angiogenesis is essential for tumor growth, including growth of prostate carcinomas and other high-grade cancers. Therefore, antiangiogenic treatment in combination with conventional therapies may play a future role in treatment. Gene-based therapy in prostate cancer is an emerging and promising adjuvant to conventional treatment strategies.

Complications related to chemotherapy are specific to the type of chemotherapy administered. These are discussed in detail in Chapter 16.

#### Other Therapies

**Cryosurgery of the prostate** is used to ablate prostate cancer in patients who cannot tolerate surgery and in those with recurrent prostate cancer. Transperineal probes are inserted into the prostate under ultrasound guidance to freeze the tissue directly.

Keeping the urethral passage patent may require repeated TURPs. If this is impractical, catheter drainage is instituted by way of the suprapubic or transurethral route. For men with advanced prostate cancer, palliative measures are indicated. Although cure is unlikely with advanced prostate cancer, many men survive for long periods, free of debilitating symptoms.

Bone lesions that result from metastasis of prostate cancer can be very painful and result in pathologic fractures. Opioid and nonopioid medications are used to control bone pain. EBRT can be delivered to skeletal lesions to relieve pain. Radiopharmaceuticals, such as strontium or samarium, can be injected intravenously to treat multiple sites of bone metastasis. Antiandrogen therapies are used in an effort to reduce the circulating androgens. If antiandrogen therapies are not effective, medications such as prednisone have been effective in reducing pain and improving quality of life. Bisphosphonate therapy with pamidronate (Aredia) can be administered to reduce the risk of pathologic fracture. In advanced prostate cancer, blood transfusions are administered to maintain adequate hemoglobin levels when bone marrow is replaced by tumor.

More than one third of men with a diagnosis of prostate cancer elect to use some form of complementary and alternative medicine (CAM). Because of lack of research on many forms of CAM, patients often rely on anecdotal information to make decisions about its use. Nurses play a vital role in assisting patients to locate and evaluate available information about CAM to ensure that harmful forms are avoided. The National Center for Complementary and Alternative Medicine's Web site (see Resources at the end of the chapter) can assist nurses in providing patients with evidence-based information.

## The Patient Undergoing Prostate Surgery

Prostate surgery may be indicated for the patient with BPH or prostate cancer. The objectives before prostate surgery are to assess the patient's general health status and to establish optimal renal function. Prostate surgery should be performed before acute urinary retention develops and damages the upper urinary tract and collecting system or, in the case of prostate cancer, before cancer progresses.

### Surgical Procedures

Several approaches can be used to remove the hypertrophied portion of the prostate gland: TURP, suprapubic prostatectomy, perineal prostatectomy, retropubic prostatectomy, TUIP, and laparoscopic radical prostatectomy and robotic-assisted laparoscopic radical prostatectomy (Table 49-4). With these approaches, the surgeon removes all cancerous or hyperplastic tissue, leaving behind only the capsule of the prostate. The transurethral approaches (TURP, TUIP) are closed procedures; the other three are open procedures (ie, a surgical incision is required) and the two laparoscopic approaches are minimally invasive. The procedure chosen depends on the underlying disorder, the patient's age and physical status, patient preference, and the skill of the surgeon.

#### Transurethral Resection of the Prostate

TURP, the most common procedure used, can be carried out through endoscopy. The surgical and optical instrument is introduced directly through the urethra to the prostate, which can then be viewed directly. The gland is removed in small chips with an electrical cutting loop (Fig. 49-4A). This procedure eliminates the risk of transurethral resection syndrome (hyponatremia, hypovolemia). Transurethral resection syndrome is a potential but rare complication of TURP that occurs in approximately 2% of men who undergo the procedure (Chart 49-4).

TURP usually requires an overnight hospital stay. Urethral strictures are more frequent than with nontransurethral procedures, and repeated procedures may be necessary because the residual prostatic tissue grows back. TURP rarely causes erectile dysfunction but may trigger retrograde ejaculation, because removal of prostatic tissue at the bladder neck can cause the seminal fluid to flow backward into the bladder rather than forward through the urethra during ejaculation.

#### Suprapubic Prostatectomy

In suprapubic prostatectomy, an incision is made into the bladder, and the prostate gland is removed from above (Fig. 49-4B). Such an approach can be used for a gland of any size, and few complications occur, although blood loss may be greater than with the other methods. Another disadvantage is the need for an abdominal incision, which has the risks associated with any major abdominal surgical procedure.

#### Perineal Prostatectomy

In perineal prostatectomy, the prostate gland is removed through an incision in the perineum (Fig. 49-4C). This procedure is practical when other approaches are not possible and is useful for an open biopsy. However, incontinence, sexual dysfunction, and rectal injury are more likely with this approach.

#### Retropubic Prostatectomy

Retropubic prostatectomy is used more commonly than the suprapubic approach. The surgeon makes a low abdominal incision and approaches the prostate gland between the

**Table 49-4 COMPARING SURGICAL APPROACHES FOR TREATMENT OF PROSTATE DISORDERS**

The surgical approach of choice depends on (1) the size of the gland, (2) the severity of the obstruction, (3) the age of the patient, (4) the condition of the patient, and (5) the presence of associated diseases.

| Surgical Approach | Advantages | Disadvantages | Nursing Implications |
|---|---|---|---|
| **Transurethral resection (TURP)**<br>(Removal of prostatic tissue by instrument introduced through urethra; used for glands of varying size. Ideal for patients who are poor surgical risks.) | Avoids abdominal incision<br>Safer for surgical-risk patient<br>Shorter hospitalization and recovery periods<br>Lower morbidity rate<br>Causes less pain<br>Can be used as a palliative approach with history of radiation therapy | Requires highly skilled surgeon<br>Recurrent obstruction, urethral trauma, and stricture may develop<br>Delayed bleeding may occur | Monitor for hemorrhage<br>Observe for symptoms of urethral stricture (dysuria, straining, weak urinary stream) |
| **Open surgical removal** | | | |
| Suprapubic approach<br>(Removal of prostatic tissue through abdominal incision; can be used for gland of any size.) | Technically simple<br>Offers wide area of exploration<br>Permits exploration for cancerous lymph nodes<br>Allows more complete removal of obstructing gland<br>Permits treatment of associated bladder lesions | Requires surgical approach through the bladder<br>Control of hemorrhage difficult<br>Urine may leak around the suprapubic tube.<br>Recovery may be prolonged and uncomfortable. | Monitor for indications of hemorrhage and shock.<br>Provide meticulous aseptic care to the area around suprapubic tube. |
| Perineal approach<br>(Removal of gland through an incision in the perineum; preferred approach for obese patients.) | Offers direct anatomic approach<br>Permits gravity drainage<br>Particularly effective for radical cancer therapy<br>Allows hemostasis under direct vision<br>Low mortality rate<br>Low incidence of shock<br>Ideal for very old, frail, and poor surgical-risk patients with large prostate | Higher postoperative incidence of impotence and urinary incontinence<br>Possible damage to rectum and external sphincter<br>Restricted operative field<br>Greater potential for contamination and infection of incision | Avoid using rectal tubes or thermometers and enemas after perineal surgery<br>Use drainage pads to absorb excess urinary drainage<br>Provide foam rubber ring for patient comfort in sitting<br>Anticipate urinary leakage around the wound for several days after the catheter is removed |
| Retropubic approach<br>(Low abdominal incision; bladder is not entered.) | Avoids incision into the bladder<br>Permits surgeon to see and control bleeding<br>Shorter recovery period<br>Less bladder sphincter damage<br>Suitable for removal of large glands | Cannot treat associated bladder disease<br>Increased incidence of hemorrhage from prostatic venous plexus; pubic osteitis | Monitor for hemorrhage<br>Anticipate posturinary leakage for several days after removing the catheter |
| **Transurethral incision (TUIP)**<br>(Urethral approach; 1–2 cuts are made in the prostate and prostate capsule to reduce pressure on the urethra and to reduce urethral constriction.) | Results comparable to TURP<br>Low incidence of erectile dysfunction and retrograde ejaculation<br>No bladder neck contracture | Requires highly skilled surgeon<br>Recurrent obstruction and urethral trauma<br>Delayed bleeding | Monitor for hemorrhage |
| **Laparoscopic radical prostatectomy** | Minimally invasive technique<br>Improved patient satisfaction and quality of life<br>Shorter hospital stay<br>Short convalescence<br>More rapid return to normal activity<br>Short indwelling catheter duration<br>Decreased blood loss to 400 mL<br>Reduced infection risk<br>Less scarring<br>Better visualization of surgical field than other approaches | Lack of tactile sensation available with open prostatectomy<br>Inability to palpably assess for induration and palpable nodules<br>Inability to delineate the proximity of involvement of the neurovascular bundles due to lack of palpation<br>Technically demanding<br>Long surgical time (4–5 hours) | Observe for symptoms of urethral stricture (dysuria), straining, weak urinary stream<br>Monitor for hemorrhage and shock<br>Provide meticulous aseptic care to the area around suprapubic tube<br>Monitor for changes in bowel function<br>Avoid using rectal tubes or thermometers and enemas after perineal surgery<br>Use drainage pads to absorb excess urinary drainage<br>Provide foam rubber ring for patient comfort in sitting<br>Anticipate urinary leakage around the wound for several days after the catheter is removed |

**Table 49-4 COMPARING SURGICAL APPROACHES FOR TREATMENT OF PROSTATE DISORDERS (Continued)**

| Surgical Approach | Advantages | Disadvantages | Nursing Implications |
|---|---|---|---|
| **Robotic-assisted laparoscopic radical prostatectomy** (Involves using computer console and da Vinci robotic system. Six small incisions are made in the abdomen; laparoscopic instruments inserted through the incisions are used to dissect the prostate.) | Minimally invasive technique<br>Improved patient satisfaction and quality of life<br>Shorter hospital stay<br>Short convalescence<br>More rapid return to normal activity<br>Short indwelling catheter duration<br>Decreased blood loss to 150 mL<br>Improved magnification of operative field, using a 3-dimensional view (includes, magnification, high resolution and depth perception)<br>Less postoperative pain<br>Reduced infection risk<br>Less scarring<br>Laparoscopic instruments have six degrees of movement with joints, allowing extensive range of motion and precision<br>Nerve-sparing with less incontinence and sexual dysfunction | Lack of tactile sensation available with open prostatectomy<br>Inability to palpably assess for induration and palpable nodules<br>Inability to delineate the proximity of involvement of the neurovascular bundles due to lack of palpation<br>Technically demanding | Observe for symptoms of urethral stricture (dysuria), straining, weak urinary stream<br>Monitor for hemorrhage and shock<br>Provide meticulous aseptic care to the area around suprapubic tube<br>Monitor for changes in bowel function<br>Avoid using rectal tubes or thermometers and enemas after perineal surgery<br>Use drainage pads to absorb excess urinary drainage<br>Provide foam rubber ring for patient comfort in sitting<br>Anticipate urinary leakage around the wound for several days after the catheter is removed |

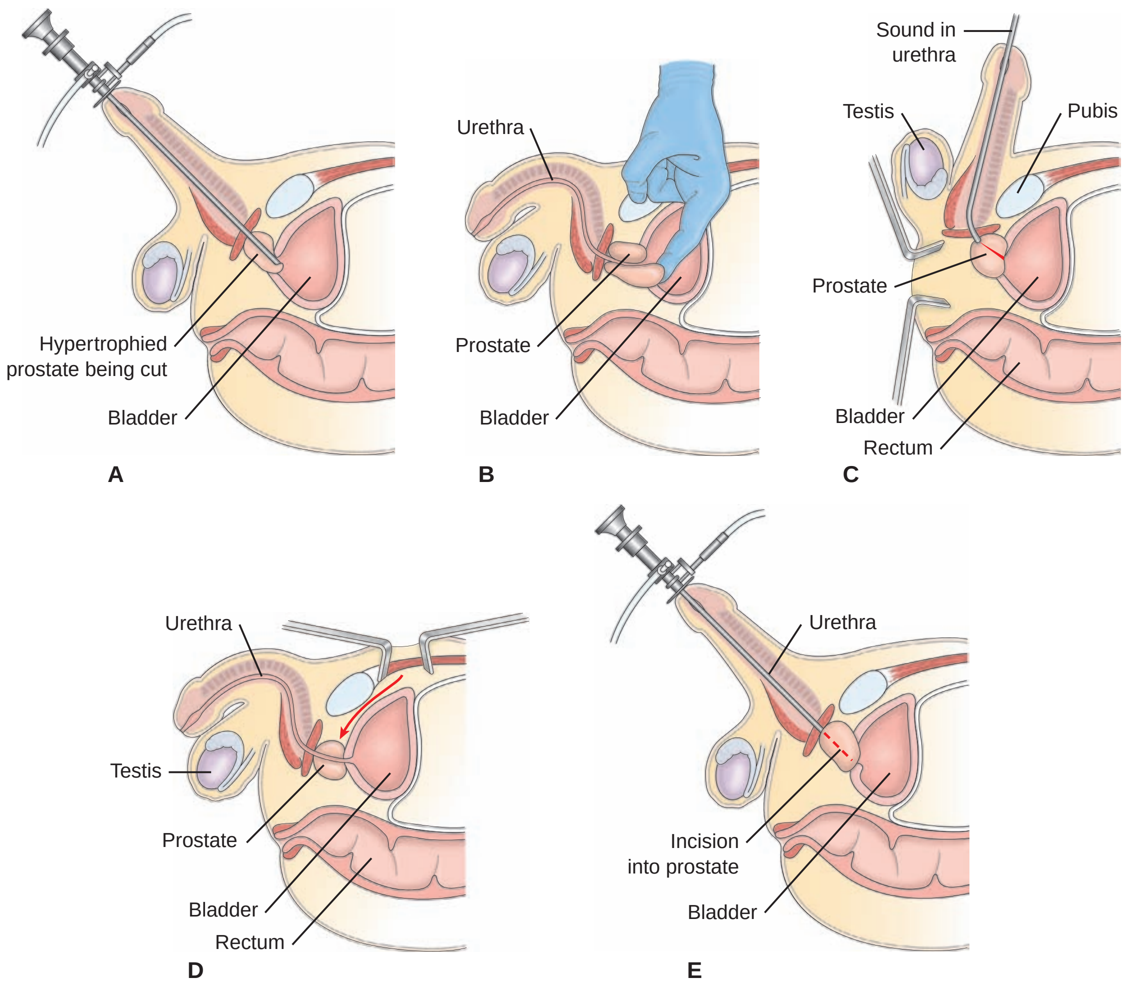



**Figure 49-4** Prostate surgery procedures. **A,** Transurethral resection (TUR). A loop of wire connected with a cutting current is rotated in the cystoscope to remove shavings of prostate at the bladder orifice. **B,** Suprapubic prostatectomy. With an abdominal approach, the prostate is shelled out of its bed. **C,** Perineal prostatectomy. Two retractors on the left spread the perineal incision to provide a view of the prostate. **D,** Retropubic prostatectomy is performed through a low abdominal incision. Note two abdominal retractors and arrow pointing to the prostate gland. **E,** Transurethral incision of prostate (TUIP) involves one or two incisions into the prostate to reduce pressure on the urethra.

## Chart 49-4 • *Transurethral Resection Syndrome*

Transurethral resection syndrome is a rare but potentially serious complication of transurethral prostatectomy (TURP). Signs and symptoms are caused by neurologic, cardiovascular, and electrolyte imbalances associated with absorption of the solution used to irrigate the surgical site during the surgical procedure. Hyponatremia, hypovolemia, and occasionally hyperammonemia may occur (Eaton, 2003).

**Signs and Symptoms**

- Lethargy and confusion
- Hypotension
- Tachycardia
- Nausea and vomiting
- Collapse
- Headache
- Muscle spasms
- Seizures

**Interventions**

- Discontinue irrigation
- Administer diuretics as prescribed
- Replace bladder irrigation with normal saline
- Monitor intake and output
- Monitor the patient's vital signs and level of consciousness
- Differentiate lethargy and confusion of TUR syndrome from postoperative disorientation and hyponatremia
- Maintain patient safety during times of confusion
- Assess lung and heart sounds for indications of pulmonary edema, heart failure, or both as fluid moves back into the intravascular space

pubic arch and the bladder without entering the bladder (Fig. 49-4D). This procedure is suitable for large glands located high in the pelvis. Although blood loss can be better controlled and the surgical site is easier to visualize, infections can readily start in the retropubic space.

#### *Transurethral Incision of the Prostate*

TUIP is another procedure used to treat BPH. An instrument is passed through the urethra (Fig. 49-4E). TUIP is indicated when the prostate gland is small (30 g or less), and it is an effective treatment for many cases of BPH. TUIP can be performed on an outpatient basis and has a lower complication rate than other invasive prostate procedures.

#### *Laparoscopic Radical Prostatectomy*

In contrast to the single abdominal incision made for the radical prostatectomy, a laparoscopic radical prostatectomy is performed through four to six small (0.5 in [1 cm]) incisions in the midabdomen. Instruments, including a lighted viewing instrument (laparoscope), are inserted and allow the surgeon to remove the prostate gland. The laparoscopic approach reduces the risk of postoperative erectile dysfunction and urinary dysfunction. Laparoscopic radical prostatectomy results in less bleeding, reduced need for blood transfusion, a shorter hospital stay, less postoperative pain, and more rapid return to normal activity compared with open radical prostatectomy (Rigdon, 2006). Further research is needed to assess long-term outcomes.

#### *Robotic-Assisted Laparoscopic Radical Prostatectomy*

Robotic-assisted laparoscopic radical prostatectomy is a new minimally invasive approach that uses a computer console and da Vinci robot to move the tips of microscopic instruments, replicating the movements of the surgeon's hands (Rigdon, 2006; Starnes & Sims, 2006).

#### *Pelvic Lymph Node Dissection*

Pelvic lymph node dissection (PLND) is not always performed. It may be used in some patients to provide information for staging the tumor and to remove an area of microscopic metastasis. The planned treatment may influence the surgeon's decision to perform PLND and the extent (limited versus extended) of the dissection. Dissection of nodes anterior and lateral to the external iliac vessels is associated with an increased risk of lymphedema (NCCN, 2009).

### Complications

Postoperative complications depend on the type of prostatectomy performed and may include hemorrhage, clot formation, catheter obstruction, and sexual dysfunction. All prostatectomies carry a risk of impotence because of potential damage to the pudendal nerves. In most instances, sexual activity may be resumed in 6 to 8 weeks, the time required for the prostatic fossa to heal. During ejaculation, the seminal fluid goes into the bladder and is excreted with the urine. The anatomic changes in the posterior urethra lead to retrograde ejaculation. A vasectomy may be performed during surgery to prevent infection from spreading from the prostatic urethra through the vas and into the epididymis.

After total prostatectomy (usually for cancer), the risk for impotence is high. For the patient for whom this is unacceptable, options are available to produce erections sufficient for sexual intercourse: prosthetic penile implants, negative-pressure (vacuum) devices, and pharmacologic interventions (see earlier discussion and Table 49-2).

## NURSING PROCESS

### Patient Undergoing Prostatectomy

#### Assessment

The nurse assesses how the underlying disorder (BPH or prostate cancer) has affected the patient's lifestyle. Questions to ask during assessment include the following: Has the patient's activity level or activity tolerance changed? What is his presenting urinary problem (described in the patient's own words)? Has he experienced decreased force of urinary flow, decreased ability to initiate voiding, urgency, frequency, nocturia, dysuria, urinary retention, or hema-

turia? Does the patient report back pain, flank pain, and lower abdominal or suprapubic discomfort? Possible causes of such discomfort include infection, retention, and renal colic. Has the patient experienced erectile dysfunction or changes in frequency or enjoyment of sexual activity?

The nurse obtains further information about the patient's family history of cancer and heart or kidney disease, including hypertension. Has he lost weight? Does he appear pale? Can he raise himself out of bed and return to bed without assistance? Can he perform usual activities of daily living? This information helps determine how soon the patient will be able to return to normal activities after prostatectomy.

## Diagnosis

### *Preoperative Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following.

- Anxiety about surgery and its outcome
- Acute pain related to bladder distention
- Deficient knowledge about factors related to the disorder and the treatment protocol

### *Postoperative Nursing Diagnoses*

- Acute pain related to the surgical incision, catheter placement, and bladder spasms
- Deficient knowledge about postoperative care

### *Collaborative Problems/Potential Complications*

Based on the assessment data, the potential complications may include the following:

- Hemorrhage and shock
- Infection
- Deep vein thrombosis
- Catheter obstruction
- Sexual dysfunction

## Planning and Goals

The major preoperative goals for the patient may include reduced anxiety and learning about his prostate disorder and the perioperative experience. The major postoperative goals may include maintenance of fluid volume balance, relief of pain and discomfort, ability to perform self-care activities, and absence of complications.

## Preoperative Nursing Interventions

### *Reducing Anxiety*

The patient is frequently admitted to the hospital or surgical center on the morning of surgery. Because contact with the patient may be limited before surgery, the nurse must establish communication with the patient to assess his understanding of the diagnosis and of the planned surgical procedure. The nurse clarifies the nature of the surgery and expected postoperative outcomes. In addition, the nurse familiarizes the patient with the preoperative and postoperative routines and initiates measures to reduce anxiety. Because the patient may be sensitive and embarrassed discussing problems related to the genitalia and sexuality, the nurse provides privacy and establishes a trusting and professional relationship. Guilt feelings often surface if the patient falsely assumes a cause-and-effect relationship between sexual practices and his current problems. He is encouraged to verbalize his feelings and concerns.

### *Relieving Discomfort*

If the patient experiences discomfort before surgery, bed rest is prescribed, analgesic agents are administered, and measures are initiated to relieve anxiety. If he is hospitalized, the nurse monitors his voiding patterns, watches for bladder distention, and assists with catheterization if indicated. An indwelling catheter is inserted if the patient has continuing urinary retention or if close monitoring is needed because of laboratory test results that indicate azotemia (accumulation of nitrogenous waste products in the blood). The catheter can help decompress the bladder gradually over several days, especially if the patient is elderly and hypertensive and has diminished renal function or urinary retention that has existed for many weeks. For a few days after the bladder begins draining, the blood pressure may fluctuate and renal function may decline. If the patient cannot tolerate a urinary catheter, he is prepared for a cystostomy (and insertion of a suprapubic catheter).

### *Providing Instruction*

Before surgery, the nurse reviews with the patient the anatomy of the affected structures and their function in relation to the urinary and reproductive systems, using diagrams and other teaching aids if indicated. This instruction often takes place during the preadmission testing visit or in the urologist's office. The nurse explains what will take place while the patient is prepared for diagnostic tests and then for surgery (depending on the type of prostatectomy planned). The nurse also reinforces information given by the surgeon about the type of incision, which varies with the surgical approach (directly over the bladder, low on the abdomen, or in the perineal area; four to six small incisions with laparoscopic and robotic-assisted approaches; and no incision with a transurethral procedure), and describes the likely type of urinary drainage system (urethral or suprapubic) and the recovery room procedure. The amount of information given is based on the patient's needs and questions. The nurse explains procedures expected to occur during the immediate perioperative period, answers questions the patient or family may have, and provides emotional support. In addition, the nurse provides the patient with information about postoperative pain management.

### *Preparing the Patient*

If the patient is scheduled for a prostatectomy, the preoperative preparation described in Chapter 18 is provided. Antiembolism stockings are applied before surgery and are particularly important to prevent deep vein thrombosis (DVT) if the patient is placed in a lithotomy position during surgery. An enema is usually administered at home on the evening before surgery or on the morning of surgery to prevent postoperative straining, which can induce bleeding.

## Postoperative Nursing Interventions

### *Maintaining Fluid Balance*

During the postoperative period, the patient is at risk for imbalanced fluid volume because of the irrigation of the surgical site during and after surgery. With irrigation of the

urinary catheter to prevent its obstruction by blood clots, fluid may be absorbed through the open surgical site and retained, increasing the risk of excessive fluid retention, fluid imbalance, and water intoxication. The urine output and the amount of fluid used for irrigation must be closely monitored to determine whether irrigation fluid is being retained and to ensure an adequate urine output. An intake and output record, including the amount of fluid used for irrigation, must be maintained. The patient is also monitored for electrolyte imbalances (eg, hyponatremia), increasing blood pressure, confusion, and respiratory distress. These signs and symptoms are documented and reported to the surgeon. The risk of fluid and electrolyte imbalance is greater in elderly patients with preexisting cardiovascular or respiratory disease.

#### *Relieving Pain*

After a prostatectomy, the patient is assisted to sit and dangle his legs over the side of the bed on the day of surgery. The next morning, he is assisted to ambulate. If pain is present, the cause and location are determined and the severity of pain and discomfort is assessed. The pain may be related to the incision or may be the result of excoriation of the skin at the catheter site. It may be in the flank area, indicating a kidney problem, or it may be caused by bladder spasms. Bladder irritability can initiate bleeding and result in clot formation, leading to urinary retention.

Patients experiencing bladder spasms may report an urgency to void, a feeling of pressure or fullness in the bladder, and bleeding from the urethra around the catheter. Medications that relax the smooth muscles can help ease the spasms, which can be intermittent and severe; these medications include flavoxate (Urispas) and oxybutynin (Ditropan). Warm compresses to the pubis or sitz baths may also relieve the spasms.

The nurse monitors the drainage tubing and irrigates the system as prescribed to relieve any obstruction that may cause discomfort. Usually, the catheter is irrigated with 50 mL of irrigating fluid at a time. It is important to make sure that the same amount is recovered in the drainage receptacle. Securing the catheter drainage tubing to the leg or abdomen can help decrease tension on the catheter and prevent bladder irritation. Discomfort may be caused by dressings that are too snug, saturated with drainage, or improperly placed. Analgesic agents are administered as prescribed. The nurse notifies the physician if the analgesic medications do not relieve the patient's pain and obtains a prescription for new doses or different medications.

After the patient is ambulatory, he is encouraged to walk but not to sit for prolonged periods, because this increases intra-abdominal pressure and the possibility of discomfort and bleeding. Prune juice and stool softeners are provided to ease bowel movements and to prevent excessive straining. An enema, if prescribed, is administered with caution to avoid rectal perforation.

#### *Monitoring and Managing Potential Complications*

After prostatectomy, the patient is monitored for major complications such as hemorrhage, infection, DVT, catheter obstruction, and sexual dysfunction.

**HEMORRHAGE.** Although patients have discontinued all aspirin, nonsteroidal anti-inflammatory drugs, and platelet inhibitors 10 to 14 days before the surgery to prevent excessive bleeding, bleeding and hemorrhagic shock remain the greatest risks. The risk is increased with BPH because a hyperplastic prostate gland is very vascular. Bleeding may occur from the prostatic bed. Bleeding may also result in the formation of clots, which then obstruct urine flow. The drainage normally begins as reddish-pink and then clears to a light pink within 24 hours after surgery. Bright red bleeding with increased viscosity and numerous clots usually indicates arterial bleeding. Venous blood appears darker and less viscous. Arterial hemorrhage usually requires surgical intervention (eg, suturing or transurethral coagulation of bleeding vessels), whereas venous bleeding may be controlled by applying prescribed traction to the catheter so that the balloon holding the catheter in place applies pressure to the prostatic fossa. The surgeon applies traction by securely taping the catheter to the patient's thigh if hemorrhage occurs. Less blood loss (150 mL) is expected with robotic-assisted laparoscopic radical prostatectomy, compared with 500 to 900 mL, which may occur with open prostatectomy.

Nursing management includes assistance in implementing strategies to stop the bleeding and to prevent or reverse hemorrhagic shock. If blood loss is extensive, fluids and blood component therapy may be administered. If hemorrhagic shock occurs, treatments described in Chapter 15 are initiated.

Nursing interventions include closely monitoring vital signs; administering medications, IV fluids, and blood component therapy as prescribed; maintaining an accurate record of intake and output; and carefully monitoring drainage to ensure adequate urine flow and patency of the drainage system. The patient who experiences hemorrhage and his family are often anxious and benefit from explanations and reassurance about the event and the procedures that are performed.

**INFECTION.** After perineal prostatectomy, the surgeon usually changes the dressing on the first postoperative day. Further dressing changes may become the responsibility of the nurse or home care nurse. Careful aseptic technique is used because the potential for infection is great. Dressings can be held in place by a double-tailed, T-binder bandage or a padded athletic supporter. The tails cross over the incision to give double thickness, and then each tail is drawn up on either side of the scrotum to the waistline and fastened.

Rectal thermometers, rectal tubes, and enemas are avoided because of the risk of injury and bleeding in the prostatic fossa. After the perineal sutures are removed, the perineum is cleansed as indicated. A heat lamp may be directed to the perineal area to promote healing. The scrotum is protected with a towel while the heat lamp is in use. Sitz baths are also used to promote healing.

UTIs and epididymitis are possible complications after prostatectomy. The patient is assessed for their occurrence; if they occur, the nurse administers antibiotics as prescribed. Because the risk of infection continues after discharge from the hospital, the patient and family need to be instructed to monitor for signs and symptoms of infection (fever, chills, sweating, myalgia, dysuria, urinary frequency, and urgency). The patient and family are instructed to contact the urologist if these symptoms occur.

**DEEP VEIN THROMBOSIS.** Patients undergoing prostatectomy are at risk for DVT and pulmonary embolism; therefore, the nurse assesses the patient frequently after surgery for manifestations of DVT. Further, anti-embolism stockings are used to reduce the risk of DVT and pulmonary embolism. Early postoperative ambulation is essential to reduce the risk of DVT. Nursing and medical management of DVT and pulmonary embolism are described in Chapters 31 and 23, respectively. In addition, if the patient is at high risk for clot formation, IV heparin or subcutaneous enoxaparin (Lovenox) may be administered.

**OBSTRUCTED CATHETER.** After a TURP, the catheter must drain well; an obstructed catheter produces distention of the prostatic capsule and resultant hemorrhage. Furosemide (Lasix) may be prescribed to promote urination and initiate postoperative diuresis, thereby helping to keep the catheter patent.

The nurse observes the lower abdomen to ensure that the catheter has not become blocked. A distinct, rounded swelling above the pubis is a manifestation of an overdistended bladder.

The drainage bag, dressings, and surgical incision are examined for bleeding. The color of the urine is noted and documented; a change in color from pink to amber indicates reduced bleeding. Blood pressure, pulse, and respirations are monitored and compared with baseline preoperative vital signs to detect hypotension. The nurse also observes the patient for restlessness, diaphoresis, pallor, any drop in blood pressure, and an increasing pulse rate.

Drainage of the bladder may be accomplished by gravity through a closed sterile drainage system. A three-way drainage system is useful in irrigating the bladder and preventing clot formation (Fig. 49-5). Continuous irrigation may be used with TURP. Some urologists leave an indwelling catheter attached to a dependent drainage system. Gentle irrigation of the catheter may be prescribed to remove any obstructing clots.

If the patient complains of pain, the tubing is examined. The drainage system is irrigated with irrigating fluid (usually 50 mL), if indicated and prescribed, to clear any obstruction. The amount of fluid recovered in the drainage bag must equal the amount of fluid instilled. Overdistention of the bladder is avoided because it can induce secondary hemorrhage by stretching the coagulated blood vessels in the prostatic capsule.

To prevent traction on the bladder, the drainage tube (not the catheter) is taped to the shaved inner thigh. If a cystostomy catheter is in place, it is taped to the abdomen. The nurse explains the purpose of the catheter to the patient and assures him that the urge to void results from the presence of the catheter and from bladder spasms. He is cautioned not to pull on the catheter because this causes bleeding and subsequent catheter blockage, which leads to urinary retention.

**COMPLICATIONS WITH CATHETER REMOVAL.** After the catheter is removed (usually when the urine appears clear), urine may leak around the wound for several days in the patient who has undergone perineal, suprapubic, or retropubic surgery. The cystostomy tube may be removed before or after the urethral catheter is removed. Some urinary incontinence may occur after catheter removal, and the patient is informed that this is likely to subside over time (see below).

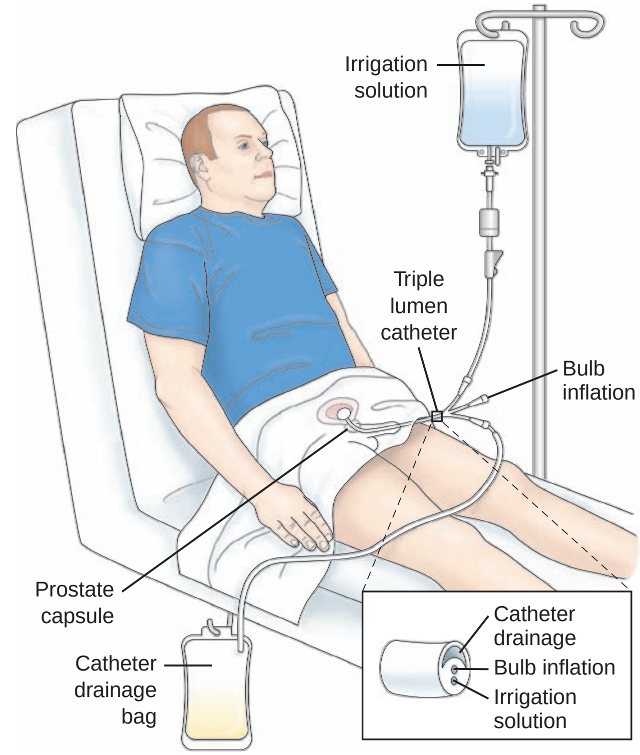



**Figure 49-5** A three-way system for bladder irrigation.

**URINARY INCONTINENCE.** Postoperative urinary incontinence, a devastating complication of prostatectomy, occurs in 80% to 95% of patients. Urinary incontinence often decreases over time—although it may last as long as 1 to 2 years following surgery. Factors associated with postoperative continence are younger age, preservation of both neurovascular bundles, absence of an anastomotic stricture, eversion of the bladder neck, and a smaller prostate volume. The nurse can encourage the patient who experiences incontinence to take steps to prevent incontinence, improve continence, anticipate leakage, and cope with lack of complete control (Yu Ko & Sawatzky, 2008). Preventing incontinence involves increasing voiding frequency, avoiding positions that encourage the urge to void, and decreasing fluid intake prior to activities. Promoting continence involves pelvic floor exercises (see Teaching Patients Self-Care below), biofeedback, and electrical stimulation. Anticipating leakage may entail lifestyle modifications such as using absorbent pads and carrying extra clothes to prevent urinary accidents; this can improve confidence when bathroom access is limited. It also helps to know the location of public bathrooms. Coping long term with complete lack of control may involve collagen injections, artificial sphincter implants, medications, and leg bags (Michaelson, et al., 2008; Yu Ko & Sawatzky, 2008).

**SEXUAL DYSFUNCTION.** Depending on the type of surgery, the patient may experience sexual dysfunction related to erectile dysfunction, decreased libido, and fatigue.

These issues may become a concern to the patient soon after surgery or in the weeks to months of rehabilitation. With nerve-sparing radical prostatectomy, the likelihood of recovering the ability to have erections is better for men who are younger and men in whom both neurovascular bundles are spared. A decrease in libido is usually related to the impact of the surgery on the body. Reassurance that the usual level of libido will return after recuperation from surgery is often helpful for the patient and his partner. The patient should be aware that he may experience fatigue during rehabilitation from surgery. This fatigue may also decrease his libido and alter his enjoyment of usual activities.

Several options to restore erectile function are discussed with the patient by the surgeon or urologist. These options may include medications, surgically placed implants, or negative-pressure devices. PDE-5 inhibitors (see Table 49-3) may be effective for treatment of erectile dysfunction in men after radical prostatectomy, especially if the neurovascular bundles have been preserved. They may also improve erectile function in men with partial or moderate erectile dysfunction after radiation therapy for localized prostate cancer.

Nursing interventions include assessing for sexual dysfunction after surgery. Providing a private and confidential environment to discuss issues of sexuality is important. The emotional challenges of prostate surgery and its consequences need to be carefully explored with the patient and his partner. Providing the opportunity to discuss these issues can be very beneficial to the patient. For patients who have significant difficulty adjusting to sexual dysfunction, a referral to a sex therapist may be indicated.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient undergoing prostatectomy may be discharged within several days. The length of the hospital stay depends on the surgical approach used and may range from 1 to 2 days for robotic-assisted laparoscopic prostatectomy to 3 to 5 days for open prostatectomy. The patient and family require instructions about how to manage the drainage system, how to assess for complications, and how to promote recovery. The nurse provides verbal and written instructions about the need to maintain the drainage system and to monitor urinary output, about wound care, and about strategies to prevent complications, such as infection, bleeding, and thrombosis. In addition, the patient and family need to know about signs and symptoms that should be reported to the physician (eg, blood in urine, decreased urine output, fever, change in wound drainage, calf tenderness).

As the patient recovers and drainage tubes are removed, he may become discouraged and depressed because he cannot regain bladder control immediately. Furthermore, urinary frequency and burning may occur after the catheter is removed. Teaching the patient the following exercises may help him regain urinary control:

- Tense the perineal muscles by pressing the buttocks together, hold this position, and then relax. This exercise can be performed 10 to 20 times each hour while sitting or standing.
- Try to interrupt the urinary stream after starting to void; wait a few seconds and then continue to void.

Perineal exercises should continue until the patient gains full urinary control. The patient is instructed to urinate as soon as he feels the first urge to do so. It is important that the patient know that regaining urinary control is a gradual process; he may continue to "dribble" after being discharged from the hospital, but this should gradually diminish (usually within 1 year). The urine may be cloudy for several weeks after surgery but should clear as the prostate area heals.

While the prostatic fossa heals (6 to 8 weeks), the patient should avoid activities that produce Valsalva effects (straining, heavy lifting) because this may increase venous pressure and produce hematuria. He should avoid long motor trips and strenuous exercise, which increase the tendency to bleed. He should also know that spicy foods, alcohol, and coffee may cause bladder discomfort. The patient should be cautioned to drink enough fluids to avoid dehydration, which increases the tendency for a blood clot to form and obstruct the flow of urine. Signs of complications, such as bleeding, passage of blood clots, a decrease in the urinary stream, urinary retention, or symptoms of UTIs, should be reported to the physician (Chart 49-5). Patients who have undergone robotic-assisted prostatectomy are often able to return to their usual activities in approximately 7 to 10 days (Rigdon, 2006).

CHART 49-5

HOME CARE CHECKLIST

**Postprostatectomy Care**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate appropriate measures to relieve postoperative pain and discomfort. | ✔ | ✔ |
| • Demonstrate appropriate care of urinary catheter and collection receptacle. | ✔ | ✔ |
| • Demonstrate appropriate wound care. | ✔ | ✔ |
| • Demonstrate performance of perineal muscle exercises to facilitate bladder control. | ✔ | |
| • Demonstrate increased activity and ambulation. | ✔ | |
| • Identify activities to avoid, such as lifting heavy objects. | ✔ | ✔ |
| • Identify signs and symptoms of complications that should be reported to surgeon. | ✔ | ✔ |

**CONTINUING CARE.** Referral for home care may be indicated if the patient is elderly or has other health problems, if the patient and family cannot provide care in the home, or if the patient lives alone without available supports. The home care nurse assesses the patient's physical status (cardiovascular and respiratory status, fluid and nutritional status, patency of the urinary drainage system, wound and nutritional status) and provides catheter and wound care, if indicated. The nurse reinforces previous teaching and assesses the ability of the patient and family to manage required care. The home care nurse encourages the patient to ambulate and to carry out perineal exercises as prescribed. The patient may need to be reminded that return of bladder control may take time.

The patient is reminded about the importance of routine health screening and other health promotion activities. If the prostatectomy was performed to treat prostate cancer, the patient and family are also instructed about the importance of follow-up and monitoring with the physician.

### Evaluation

#### *Expected Preoperative Patient Outcomes*

Expected preoperative patient outcomes may include the following:

1. Demonstrates reduced anxiety
2. States that pain and discomfort are decreased
3. Relates understanding of the surgical procedure and postoperative course and practices perineal muscle exercises and other techniques useful in facilitating bladder control

#### *Expected Postoperative Patient Outcomes*

Expected postoperative patient outcomes may include the following:

1. Reports relief of discomfort
2. Exhibits fluid and electrolyte balance
    a. Irrigation fluid and urinary output are within parameters determined by surgeon
    b. Experiences no signs or symptoms of fluid retention
3. Participates in self-care measures
    a. Increases activity and ambulation daily
    b. Produces urine output within normal ranges and consistent with intake
    c. Performs perineal exercises and interrupts urinary stream to promote bladder control
    d. Avoids straining and lifting heavy objects
4. Is free of complications
    a. Maintains vital signs within normal limits
    b. Exhibits wound healing, without signs of inflammation or hemorrhage
    c. Maintains acceptable level of urinary elimination
    d. Maintains optimal drainage of catheter and other drainage tubes
    e. Reports understanding of changes in sexual function

# CONDITIONS AFFECTING THE TESTES AND ADJACENT STRUCTURES

## *Orchitis*

**Orchitis** is a rare, acute inflammatory response of one or both testes as a complication of systemic infection or as an extension of an associated epididymitis caused by bacterial, viral, spirochetal, or parasitic organisms. Micro-organisms may reach the testes through the blood, lymphatic system, or, more commonly, by traveling through the urethra, vas deferens, and epididymis; bacteria usually spread from an associated epididymitis in sexually active men. Causative organisms include *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, *E. coli*, *Klebsiella*, *Pseudomonas aeruginosa*, *Staphylococcus* species, and *Streptococcus* species. A more common cause of isolated orchitis is mumps. Orchitis develops in approximately 30% of postpubertal men with mumps 4 to 6 days after parotitis starts, and one third of men have some testicular atrophy.

Signs and symptoms of orchitis include fever; pain, which may range from mild to severe; tenderness in one or both testicles; bilateral or unilateral testicular swelling; penile discharge; blood in the semen; and leukocytosis.

Treatment of orchitis is based on whether the causative organism is bacterial or viral. Bacterial orchitis is treated with antibiotics and supportive comfort measures. If the cause of the orchitis is an STD, the partner should be treated as well. Viral orchitis is treated using supportive treatments of rest, elevation of the scrotum, ice packs to reduce scrotal edema, analgesic agents, and anti-inflammatory medications. Bilateral orchitis can cause sterility in some men. Mumps vaccination is recommended for postpubertal men who have not had mumps or received inadequate immunization in childhood.

## *Epididymitis*

**Epididymitis** is an infection of the epididymis, which usually spreads from an infected urethra, bladder, or prostate. The incidence is less than 1 in 1000 males per year. Prevalence is greatest in men 19 to 35 years of age. Acute epididymitis occurs bilaterally in 5% to 10% of affected patients. Risk factors for epididymitis include recent surgery or a procedure involving the urinary tract, participation in high-risk sexual practices, personal history of an STD, past prostate infections or UTIs, lack of circumcision, history of an enlarged prostate, and the presence of a chronic indwelling urinary catheter.

### Pathophysiology

A causative organism can be identified in 80% of patients. In prepubertal males, older men, and homosexual men, the predominate causal organism is *E. coli*, although in older men, the condition may also be a result of urinary obstruction. In sexually active men ages 35 years of age and younger, the pathogens usually are related to bacteria associated with STDs (eg, *C. trachomatis*, *N. gonorrhoeae*). The

infection moves in an upward direction, through the urethra and the ejaculatory duct, and then along the vas deferens to the epididymis.

### Clinical Manifestations

Epididymitis often slowly develops over 1 to 2 days, beginning with a low-grade fever, chills, and heaviness in the affected testicle. The testicle becomes increasingly tender to pressure and traction. The patient may report unilateral pain, soreness in the inguinal canal along the course of the vas deferens, and pain and swelling in the scrotum and the groin. The epididymis becomes increasingly swollen, with extreme pain in the lower abdomen and pelvis. Occasionally, there may be discharge from the urethra, blood in the semen, pus (pyuria) and bacteria (bacteriuria) in the urine, and pain during intercourse and ejaculation. The patient may report urinary frequency, urgency, or dysuria, and testicular pain aggravated by bowel movement.

### Assessment and Diagnostic Findings

Laboratory assessment includes urinalysis, complete blood cell count, Gram stain of urethral drainage, urethral culture or DNA probe, and referral for syphilis and HIV testing in sexually active patients. Acute testicular pain should never be ignored, and it should be distinguished from testicular torsion, which is a surgical emergency.

### Medical Management

The selection of an antibiotic depends on the causative organism; if epididymitis is associated with an STD, the patient's partner should also receive antimicrobial therapy. The spermatic cord may be infiltrated with a local anesthetic agent to relieve pain if the patient is seen within the first 24 hours after onset of pain. Supportive interventions also include reduction in physical activity, scrotal support and elevation, ice packs, anti-inflammatory agents, analgesics, including nerve blocks, and sitz baths. Urethral instrumentation (eg, catheter insertion) is avoided. The patient is observed for scrotal abscess formation as well.

In chronic epididymitis, a 4- to 6-week course of antibiotics for bacterial pathogens is prescribed. An epididymectomy (excision of the epididymis from the testis) may be performed for patients who have recurrent, refractory, incapacitating episodes of this infection. With long-term epididymitis, the passage of sperm may be obstructed. If the obstruction is bilateral, infertility may result.

### Nursing Management

Bed rest is prescribed, and the scrotum is elevated with a scrotal bridge or folded towel to prevent traction on the spermatic cord, to promote venous drainage, and to relieve pain. Antimicrobial agents are administered as prescribed until the acute inflammation subsides. Intermittent cold compresses to the scrotum may help ease the pain. Later, local heat or sitz baths may help resolve the inflammation. Analgesic medications are administered for pain relief as prescribed.

The nurse instructs the patient to avoid straining, lifting, and sexual stimulation until the infection is under control. He should continue taking analgesic agents and antibiotics as prescribed and using ice packs if necessary to relieve discomfort. He needs to know that it may take 4 weeks or longer for the inflammation to resolve.

## Testicular Torsion

Testicular torsion is a surgical emergency requiring immediate diagnosis to avoid loss of the testicle. Torsion of the testis is rotation of the testis, which twists the blood vessels in the spermatic cord, and, therefore, impedes the arterial and venous supply to the testicle and surrounding structures in the scrotum. The patient presents with sudden pain in the testicle, developing over 1 to 2 hours, with or without a predisposing event. Nausea, lightheadedness, and swelling of the scrotum may develop. On physical examination, testicular tenderness, an elevated testis, a thickened spermatic cord, and a swollen, painful scrotum may be present. If the torsion cannot be reduced manually, surgery to untwist the spermatic cord and anchor both testes in their correct position to prevent recurrence should occur within 6 hours of the onset of symptoms in order to save the testis. After 6 hours of impaired blood supply, the risk for loss of the testicle increases.

## Testicular Cancer

Although only accounting for about 1% of all cancers in men, **testicular cancer** is the most common cancer diagnosed in men between 15 and 35 years of age; approximately 8400 new cases and 380 deaths occur in the United States annually (ACS, 2009). It is the second most common malignancy in those 35 to 39 years of age. For unknown reasons, worldwide incidence of testicular tumors has more than doubled in the past 40 years. Because of advances in cancer therapy, testicular cancer is a highly treatable and usually curable form of cancer. The 5-year relative survival rate for all testicular cancers is more than 95% and approaches 99% if the cancer has not spread outside of the testes (ACS, 2009). After treatment, most patients with testicular cancer have a near-normal life expectancy.

### Classification of Testicular Tumors

The testicles contain several types of cells, each of which may develop into one or more types of cancer. The type of cancer cell determines the appropriate treatment and affects the prognosis. Testicular cancer is classified as germinal or nongerminal (stromal). Secondary testicular cancers may also occur.

#### Germinal Tumors

Germinal tumors make up approximately 90% of all cancers of the testis; germinal tumors are further classified as seminomas or nonseminomas. These cancers grow from the germ cells that produce sperm, thus the name germinal tumors. Seminomas are slow-growing forms of testicular cancer that are usually found in men in their 30s and 40s. Although seminomas can spread to the lymph nodes, the cancer is usually localized in the testes. Nonseminomas are more common and tend to grow more quickly than seminomas. Nonseminomas are often made up of different cell

types and are identified according to the cells in which they start to grow. Nonseminoma testicular cancers include choriocarcinomas (rare), embryonal carcinomas, teratomas, and yolk sac tumors. It is crucial to distinguish between seminomas and nonseminomas because the differences affect prognosis and treatment.

#### Nongerminal Tumors

Nongerminal tumors account for less than 10% of testicular cancers. These cancers may develop in the supportive and hormone-producing tissues, or stroma, of the testicles. The two main types of stromal tumors are Leydig cell tumors and Sertoli cell tumors. Although these tumors infrequently spread beyond the testicle, a small number metastasize and tend to be resistant to chemotherapy and radiation therapy.

#### Secondary Testicular Tumors

Secondary testicular tumors are those that have metastasized to the testicle from other organs. Lymphoma is the most common cause of secondary testicular cancer. Cancers may also spread to the testicles from the prostate gland, lung, skin (melanoma), kidney, and other organs. The prognosis with these cancers is usually poor because they typically also spread to other organs. Treatment depends on the specific type of cancer (ACS, 2009).

### Risk Factors

Risk factors for testicular cancer include undescended testicles **(cryptorchidism)**, family history of testicular cancer, and personal history of testicular cancer (ACS, 2009; Gilligan, 2007). Other risk factors include race and ethnicity: Caucasian American men have a five times greater risk than African American men and more than two to three times greater risk than Asian, Native American, and Hispanic American men. The risk of developing testicular cancer is higher in HIV-positive men (ACS, 2009). Occupational hazards, including exposure to chemicals encountered in mining, oil and gas production, and leather processing, have been suggested as possible risk factors. No evidence has linked testicular cancer to prenatal exposure to diethylstilbestrol or to vasectomy (ACS, 2009).

### Clinical Manifestations

The symptoms appear gradually, with a mass or lump on the testicle and usually painless enlargement of the testis. The patient may report heaviness in the scrotum, inguinal area, or lower abdomen. Backache (from retroperitoneal node extension), abdominal pain, weight loss, and general weakness may result from metastasis. Enlargement of the testis without pain is a significant diagnostic finding. Some testicular tumors tend to metastasize early, spreading from the testis to the lymph nodes in the retroperitoneum and to the lungs.

### Assessment and Diagnostic Findings

At this time, screening for testicular cancer is not recommended; however, educating young men about testicular cancer and the need for urgent evaluation of any mass or enlargement or unexplained testicular pain is key to early detection (Gilligan, 2007). Teaching TSE, starting in adolescence, alerts men to the importance of seeking medical attention if a testicle becomes indurated, enlarged, atrophied, nodular, or painful (Chart 49-6). TSE should be performed monthly. Testicular cancers generally grow rapidly and are easily detected against a typically smooth and homogeneous texture. Annual testicular examination by a clinician can reveal signs and lead to early diagnosis and treatment of testicular cancer. Promoting awareness of this disease is an important health promotion intervention; men should seek medical evaluation for signs or symptoms of testicular cancer without delay (Gilligan, 2007). Any suspicious testicular mass warrants prompt evaluation with a thorough history and physical examination, focusing on palpation of the affected testicle.

The tumor markers alpha-fetoprotein (AFP) and beta-human chorionic gonadotropin (beta-hCG) may be elevated in patients with testicular cancer. Tumor marker levels in the blood are used for diagnosis, staging, and monitoring the response to treatment. Blood chemistry, including lactate dehydrogenase, is also necessary.

A chest x-ray to assess for metastasis in the lungs and a transscrotal testicular ultrasound will be performed. Microscopic analysis of tissue is the only definitive way to determine if cancer is present, but it is usually performed at the time of surgery rather than as a part of the diagnostic workup to reduce the risk of promoting spread of the cancer (ACS, 2009). Inguinal orchiectomy is the standard way to establish the diagnosis of testicular cancer. Other staging tests to determine the extent of the disease in the retroperitoneum, pelvis, and chest include an abdominal/pelvic CT and chest CT (if the abdominal CT or chest x-ray is abnormal). A brain MRI and bone scan may be obtained if indicated (NCCN, 2008). Discussion of the option to bank sperm should take place prior to orchiectomy and treatment.

### Medical Management

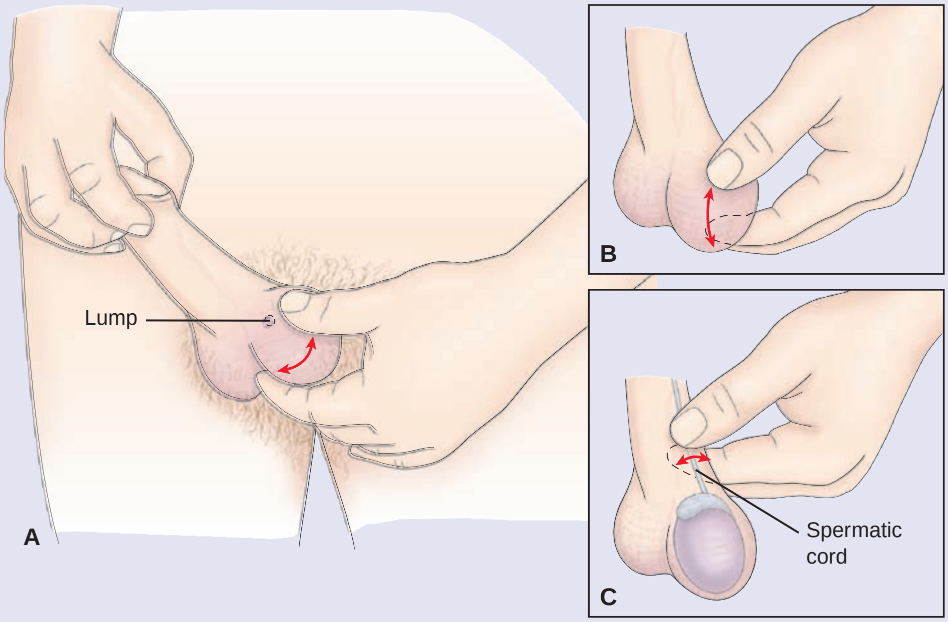
Testicular cancer, one of the most curable solid tumors, is highly responsive to treatment. Early-stage disease is curable more than 95% of the time; thus, prompt diagnosis and treatment are essential. The NCCN practice consensus guidelines for testicular cancer are used to guide diagnostic workup, primary treatment, follow-up, and salvage therapy (treatment given when the cancer does not respond to standard treatment) for both seminomas and nonseminomas (NCCN, 2008). The goals of management are to eradicate the disease and achieve a cure. Therapy is based on the cell type, the stage of the disease, and risk classification tables (determined as good, intermediate, and poor risk). Primary treatment includes removal of the affected testis by orchiectomy through an inguinal incision with a high ligation of the spermatic cord. The patient is offered the option of implantation of a testicular prosthesis during the orchiectomy. Although most patients experience no impairment of endocrine function after unilateral orchiectomy for testicular cancer, some patients have decreased hormonal levels, suggesting that the unaffected testis is not functioning normally. Retroperitoneal lymph node dissection (RPLND) may be performed after orchiectomy to diagnose and prevent lymphatic spread of the cancer. Alternatives to the more invasive open RPLND for

CHART 49-6

**PATIENT EDUCATION**

## *Testicular Self-Examination*

Testicular self-examination (TSE) is to be performed once a month. The test is neither difficult nor time-consuming. A convenient time is usually after a warm bath or shower when the scrotum is more relaxed.




1. Use both hands to palpate the testis. The normal testicle is smooth and uniform in consistency.
2. With the index and middle fingers under the testis and the thumb on top, roll the testis gently in a horizontal plane between the thumb and fingers **(A).**
3. Feel for any evidence of a small lump or abnormality.
4. Follow the same procedure and palpate upward along the testis **(B).**
5. Locate and palpate the epididymis **(C),** a cordlike structure on the top and back of the testicle that stores and transports sperm. Also locate and palpate the spermatic cord.
6. Repeat the examination for the other testis, epididymis, and spermatic cord. It is normal to find that one testis is larger than the other.
7. If you find any evidence of a small, pealike lump or if the testis is swollen (possibly from an infection or tumor), consult your physician.

early-stage germ cell testicular cancer include nerve-sparing and laparoscopic RPLND, which improve sexual function and promote rapid recovery (Tanagho & McAninch, 2008). Although libido and orgasm are usually unimpaired after RPLND, ejaculatory dysfunction with resultant infertility may develop. Two thirds of men who are newly diagnosed with testicular cancer may be considering future fatherhood, and sperm quality is reduced in men with testicular cancer; therefore, sperm banking before treatment may be considered (Fossa & Dahl, 2008; Girasole, Cookson, Smith, et al., 2006). Half of patients will not recover fertility as a result of radiation therapy, cytotoxic therapy, unilateral excision of a testis, and RPLND. Counseling about fertility issues may help the patient make the appropriate choices (Brydøy, Fosså, Klepp, et al., 2005; Gospodarowicz, 2008).

Radiation therapy is more effective with seminomas than with nonseminomas. Postoperatively, radiation may be used in early-stage seminomas. It is delivered only to the affected side; the other testis is shielded from radiation to preserve fertility. Radiation is also used in patients whose disease does not respond to chemotherapy and in those for whom lymph node surgery is not recommended.

Chemotherapy may be used for seminomas, nonseminomas, and advanced metastatic disease. Cisplatin (Platinol-AQ) can be used in combination with other chemotherapeutic agents, such as etoposide (Toposar), bleomycin (Blenoxane), paclitaxel (Taxol), ifosfamide (Ifex), and vinblastine (Velban), and results in a high percentage of complete remissions. With nonseminomas, aggressive surgical resection of all residual masses following chemotherapy is standard therapy. Good results may also be obtained by combining different types of treatment, including surgery, radiation therapy, and chemotherapy. Even with metastatic testicular cancer, the prognosis is favorable because of advances in treatment. However, for patients who do not respond to high-dose salvage chemotherapy, the cancer is nearly always incurable.

A patient with a history of one testicular tumor has a greater chance of developing subsequent tumors. Late

relapse of testicular cancer is currently defined as tumor recurrence more than 2 years after complete remission following primary treatment that included chemotherapy. The most common site of recurrence is the retroperitoneum. Follow-up studies include chest x-rays, excretory urography, radioimmunoassay of beta-hCG and AFP levels, and examination of lymph nodes.

Long-term side effects associated with treatment for testicular cancer include renal insufficiency from kidney damage, hearing problems, gonadal damage, peripheral neuropathy, and, rarely, secondary cancers. Management of a patient with testicular carcinoma is therapy aimed at cure followed by close monitoring to detect and promptly treat any recurrences (NCCN, 2008). Investigations of new medications, combinations of chemotherapeutic agents, and stem cell transplantation are ongoing.

### Nursing Management

Nursing management includes assessment of the patient's physical and psychological status and monitoring of the patient for response to and possible effects of surgery, chemotherapy, and radiation therapy (see Chapter 16). Preoperative and postoperative care is described in Chapters 18 and 20, respectively. In addition, because the patient may have difficulty coping with his condition, issues related to body image and sexuality should be addressed.

Patients may be required to endure a long course of therapy and will need encouragement to maintain a positive attitude. Once patients complete treatment, they enter a follow-up surveillance period. Nurses educate these cancer survivors about the importance of adhering to follow-up appointments for early detection of cancer recurrence (most often occurring within 2 years posttreatment), evaluation of late effects of treatment, including secondary cancers, infertility, cardiotoxicity, neurotoxicity, nephrotoxicity, pulmonary toxicity, metabolic syndrome, and alterations in quality of life (Gospodarowicz, 2008; Zoltick, Jacobs & Vaughn, 2005). The nurse reminds the patient about the importance of performing TSE in the treated or remaining testis. The patient is encouraged to participate in healthy behaviors, including smoking cessation, healthy diet, minimization of alcohol intake, and cancer screening activities (Shinn, Basen-Engquist, Thornton, et al., 2007). Most experts agree that couples should use birth control for 18 to 24 months after the last cycle of chemotherapy (Paduch, 2006).

## Hydrocele

A **hydrocele** is a collection of fluid most commonly located between the visceral and parietal layers of the tunica vaginalis of the testis, although it may also collect within the spermatic cord. This condition is the most common cause of scrotal swelling. At birth, 1 in 10 infants has a hydrocele, which usually resolves without treatment within the first year of life. Acute hydroceles primarily develop in adults older than 40 years of age; they may occur in association with inflammation (eg, radiation therapy), infection, epididymitis, local injury, or systemic infectious disease (eg, mumps). Chronic hydroceles may occur related to the imbalance between fluid secretion and reabsorption in the tunica vaginals. On physical examination, an easily transilluminated, painless, extratesticular mass is found. Hydrocele can be differentiated from a hernia by transillumination; a hydrocele transmits light, whereas a hernia does not. Ultrasonography is recommended for large hydroceles to differentiate them from testicular tumors.

Treatment is usually not required unless the hydrocele is large, bulky, tense, or uncomfortable; compromises testicular circulation; or causes an undesirable appearance. Treatment may involve surgical excision or needle aspiration. Surgical excision (hydrocelectomy) may be performed in an outpatient setting under general or spinal anesthesia with the goal of prevention of recurrence by excising the tunica vaginalis or sclerosing the visceral and parietal layers. Surgical excision involves resection or suturing together the two layers. A drainage tube may be required, and the patient is advised to wear a bulky dressing over the incisional site for a few days after the procedure. To reduce swelling, ice packs are applied to the scrotal area during the first 24 hours. A scrotal athletic supporter may be worn for a period of time postoperatively for comfort and support. Surgical risks include hematoma in the loose scrotal tissues, infection, or injury to the scrotum.

Needle aspiration is another option used to remove the fluid in the scrotum. Because it is common for fluid to reaccumulate, this treatment may be followed by the injection of a sclerosing agent to prevent this recurrence. This option may be used for men who are poor surgical risks. Potential risks include infection and scrotal pain.

## Varicocele

A **varicocele** is an abnormal dilation of the pampiniform venous plexus and the internal spermatic vein in the scrotum (the network of veins from the testis and the epididymis that constitute part of the spermatic cord). Varicoceles occur in approximately 15% to 20% of healthy adult men and 40% of infertile men, the large majority (95%) in the left testicle. Although men may report scrotal pain, tenderness, heaviness in the inguinal area, and infertility, varicoceles are often asymptomatic.

If the varicocele is mild and fertility is not an issue, no treatment is required, and a scrotal support is usually sufficient to relieve symptoms of heaviness. If the condition results in ongoing, distressing symptoms or fertility is an issue, the varicocele can be corrected surgically. Postprocedural education and care include an ice pack applied to the scrotum for the first few hours after surgery to relieve edema, dressing removal after 48 hours, nonstrenuous exercise for the first 2 days, scrotal support, pain control, and reporting complications such as infection and hematoma.

## Vasectomy

**Vasectomy,** or male sterilization, involves the surgical interruption of both vas deferens, which are the tubes that carry the sperm from the testicles and epididymis to the

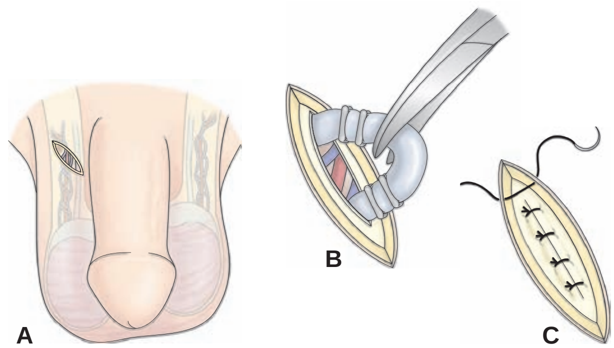



**Figure 49-6** A vasectomy is a resection of the vas deferens to prevent passage of sperm from the testes to the urethra during ejaculation. **A,** An incision or small puncture is made to expose the vas deferens. **B,** The vas deferens is isolated and severed. **C,** The severed ends are occluded with ligatures or clips, or the lumen of each vas is sealed by electrocautery and the incision is sutured closed. (Suturing may not be required if a puncture approach has been used.)

seminal vesicles, to prevent fertilization of an egg after ejaculation. During the outpatient procedure, the surgeon exposes the vas deferens through a small surgical opening or puncture in the scrotum using a sharp, curved hemostat (Fig. 49-6). The vas is then ligated (cut) or cauterized (burned), with the severed ends occluded by ties or clips to seal the lumens and then placed back into the scrotum. A section of the vas deferens may or may not be removed. The spermatozoa, which are manufactured in the testes, cannot travel up the vas deferens after this surgery.

Because seminal fluid is manufactured predominantly in the seminal vesicles and prostate gland, which are unaffected by vasectomy, no noticeable decrease in the amount of ejaculate occurs (volume decreases approximately 3%), even though it contains no spermatozoa. Because the sperm cells have no exit, they are resorbed into the body. A vasectomy usually has no effect on sexual potency, erection, ejaculation, or production of male hormones and provides no protection against STDs.

Couples who were once worried about pregnancy resulting from contraceptive failure often report a decrease in concern and an increase in spontaneous sexual arousal after vasectomy. Concise and factual preoperative explanations may minimize or relieve the patient's concerns related to pain and reduced masculinity. The patient is advised that he will be sterile but that potency will not be altered after a bilateral vasectomy. On rare occasions, a spontaneous reanastomosis of the vas deferens occurs, making it possible to impregnate a partner.

Complications of vasectomy include scrotal ecchymoses and swelling, superficial wound infection, vasitis (inflammation of the vas deferens), epididymitis or epididymo-orchitis, hematomas, chronic pain, and spermatic granuloma. A spermatic granuloma is an inflammatory response to the collection of sperm leaking from the severed end of the proximal vas deferens into the scrotal tissue. A painless small lump is formed, which usually does not require surgical intervention.

### Nursing Management

Nursing education focuses on self-management of swelling and discomfort postvasectomy. Applying ice bags intermittently to the scrotum for several hours after surgery can reduce swelling and relieve discomfort. The nurse advises the patient to wear snug, cotton underwear or a scrotal support for added comfort and support. Explanation of expected discoloration of the scrotal skin and superficial swelling may alleviate anxiety and concerns. These conditions may be relieved by sitz baths.

Sexual intercourse may be resumed as desired, usually after 1 week. Fertility remains for a varying time after vasectomy until the spermatozoa stored distally in the seminal vesicles have been evacuated. Sterility is often achieved after 10 to 20 ejaculations after the vasectomy procedure but may take longer. A reliable method of contraception should be used until infertility is confirmed by examination of an ejaculate specimen in the urologist's office at a follow-up appointment, usually 4 to 8 weeks after the vasectomy.

### Vasovasostomy (Sterilization Reversal)

Although men choosing to undergo vasectomy should not consider the surgical procedure as reversible, microsurgical techniques can be used to reverse a vasectomy (vasovasostomy) and restore patency to the vas deferens. Many men have sperm in their ejaculate after a reversal, and 50% to 70% can impregnate a partner. The success of the procedure depends on the vasectomy method performed and the amount of time since the vasectomy. The procedure can be very costly, is not covered by insurance, is not permanent with occlusion of the vas recurring 2 or more years after vasovasotomy, and results in sperm counts at lower than prevasectomy levels.

### Semen Cryopreservation (Sperm Banking)

Storing fertile semen in a sperm bank before a vasectomy is an option for men who experience a major life change and may want to father a child at a later time. In addition, if a man is about to undergo a procedure or treatment (eg, radiation therapy to the pelvis, chemotherapy, orchiectomy) that may affect his fertility, sperm banking may be considered. This procedure usually requires several visits to the facility where the sperm is stored under hypothermic conditions. The semen is obtained by masturbation and collected in a sterile container for storage. Insurance carriers rarely cover the cost of semen collection and banking. The costs of semen cryopreservation vary according to facility, method of sperm retrieval, number of specimens, and length of time in storage, making the process cost-prohibitive for some men.

## CONDITIONS AFFECTING THE PENIS

### *Phimosis*

**Phimosis** is a condition in which the foreskin (prepuce) cannot be retracted over the glans in uncircumcised males. With the trend away from routine circumcision of newborns,

early instruction should be given to parents about cleansing the foreskin and the need for retraction to cleanse the glans. If the glans is not cleaned, secretions accumulate, causing inflammation of the glans penis (balanitis), which can later lead to adhesions and fibrosis. Phimosis often develops in adults as a result of inflammation, edema, and constriction because of poor hygiene or underlying medical conditions such as diabetes mellitus. The thickened secretions (smegma) can become encrusted with urinary salts and calcify, forming calculi in the prepuce and increasing the risk of penile carcinoma. Treatment for phimosis secondary to inflammation is the application of steroidal cream to the foreskin to soften and correct the narrowness, resulting in decreased constriction. Although phimosis is the most common indication for adult circumcision, it is rarely necessary to surgically correct the condition by loosening or removing the foreskin.

Paraphimosis is a condition in which the foreskin, once retracted over the glans, cannot be returned to its usual position. Chronic inflammation under the foreskin leads to formation of a tight ring of skin when the foreskin is retracted behind the glans, causing venous congestion, edema, and enlargement of the glans, which makes the condition worse. As the condition progresses, arterial occlusion and necrosis of the glans may occur. Paraphimosis usually can be treated by firmly compressing the glans for 5 minutes to reduce the tissue edema and size and then pushing the glans back while simultaneously moving the foreskin forward (manual reduction). The constricting skin ring may require incision under local anesthesia. Circumcision is usually indicated after the inflammation and edema subside (Tanagho & McAninch, 2008).

## *Cancer of the Penis*

**Penile cancer** is rare, occurring in less than 1% of cancers among men in the United States. It accounts for an estimated 1290 new cancer cases and 300 expected deaths each year (ACS, 2009). The 5-year survival rates for cancer localized to the penis approaches 80%, but this statistic drops to 52% if the lymph nodes are involved and to 18% if the cancer has spread beyond the inguinal lymph nodes (Tanagho & McAninch, 2008). Penile cancer is much more common in some parts of Africa and South America, where it accounts for up to 10% of cancers in men. Because the penis contains different cell types, penile cancer can arise in each type of cell, which determines the prognosis. Types of penile cancer include squamous cell carcinoma (most common; 95% of cases), epidermoid penile cancer, verrucous carcinoma, adenocarcinoma, in situ carcinomas (erythroplasia of Queyrat and Bowen's disease), basal cell penile cancer, melanoma, and sarcomas (Blanco-Yarosh, 2007). Several risk factors for penile cancer have been identified, including lack of circumcision, poor genital hygiene, phimosis, HPV, smoking, ultraviolet light treatment of psoriasis on the penis, increasing age (two thirds of cases occur in men older than 65 years of age), lichen sclerosus, and balanitis xerotica obliterans. However, the exact cause remains unclear. Because of the rarity of penile cancer, there has been little improvement in diagnostic and staging tests, understanding of risk factors, and development of treatment modalities.

### Clinical Manifestations

The penile lesion usually alerts the patient to the presence of penile cancer; however, a man may delay seeking treatment for more than a year because of embarrassment, fear, or lack of understanding. Common clinical presentations are a painless lump, ulcer, or wartlike growth on the skin of the penis; a change in skin color such as a red rash, bluish growths, or whitish patches; and malodorous and persistent discharge in late stages.

### Assessment and Diagnostic Findings

Penile cancer involves the glans most frequently (48%), followed by lesions of the foreskin (21%), the coronal sulcus (6%), the penile shaft (less than 2%), the urethra, and regional or distant lymph nodes (Wein, et al., 2007). A thorough physical examination is necessary, including assessment and palpation of the penis and the inguinal lymph nodes. The size, location, borders, consistency, fixation, and character and time of onset of the penile lesions should be noted. Incisional or excisional biopsy is performed to determine the cell types of the penile cancer. Further staging tests using ultrasonography, MRI, or CT may be obtained to determine the extent of local lesions, if metastatic disease is present, and treatment options.

### Prevention

The best way to reduce the risk of penile cancer is to avoid known risk factors whenever possible (ACS, 2009). Avoidance of sexual practices that are likely to result in HPV infection may reduce the risk of penile cancer. Gardasil, a vaccine that protects against infection with HPV, the cause of 90% of genital warts, is being evaluated for possible use in males. Although uncircumcised men have a greater incidence of penile cancer than circumcised men, the more important factor in preventing penile cancer is good genital hygiene. Circumcision is not recommended as a prevention strategy (ACS, 2009).

### Medical Management

Treatment varies depending on the type and stage of penile cancer, location of the lesion, overall physical health, and personal preferences about treatments and side effects. During the past 25 years, therapeutic options have largely remained unchanged (Busby & Pettaway, 2005). The goal of treatment in invasive penile cancer is complete excision with adequate margins. Surgery is the most common treatment method used in all forms of the disease. Depending on the stage and invasiveness of the cancer, therapeutic options may include simple excision, electrodesiccation and curettage, cryosurgery, Mohs' surgery (microscopically controlled surgery), yttrium aluminum garnet (YAG) laser surgery, wide local excision, circumcision, and surgical removal of part of the penis or the entire penis (penectomy). Organ-sparing surgical approaches are

preferable. Partial penectomy is preferred to total penectomy because patients can then participate in sexual intercourse, stand for urination, and maintain cosmesis. Modern reconstructive surgical techniques are providing more options for patients. The shaft of the penis can still respond to sexual arousal with an erection and has the sensory capacity for orgasm and ejaculation. Total penectomy is indicated if the tumor is not amenable to conservative treatment. After a total penectomy, the patient may still experience orgasm with stimulation of the perineum and scrotal area.

Topical chemotherapy with 5-fluorouracil cream or biologic therapy may also be effective. Radiation therapy is used to treat small squamous cell carcinomas of the penis and for palliation in advanced tumors or cases of lymph node metastasis.

Penile cancer spreads primarily to the inguinal lymph nodes; thus, appropriate lymph node management plays a significant role in survival. Because enlarged inguinal lymph nodes are caused by inflammation in 50% of cases, patients who present with enlarged lymph nodes should undergo treatment of the primary lesion followed by a 4- to 6-week course of oral broad-spectrum antibiotics. Persistent enlarged lymph nodes after antibiotic therapy should be considered to be metastatic disease and treated with either a sentinel lymph node biopsy (to determine presence of cancer) or with bilateral inguinal and PLND. If extensive pelvic lymph node involvement is present, the patient should receive adjuvant or neoadjuvant chemotherapy and postoperative radiation therapy (Micali, Nasca, Innocenzi, et al., 2006).

## Priapism

Priapism, a relatively uncommon disorder, is defined as a persistent penile erection that may or may not be related to sexual stimulation. The penis becomes large, hard, and painful. Priapism results from either neural or vascular causes, including sickle cell disease, leukemic cell infiltration, polycythemia, spinal cord tumors or injury, and tumor invasion of the penis or its vessels. It may also occur with use of vasoactive agents that affect the central nervous system, antihypertensive agents, antipsychotic and antidepressant medications, substances injected into the penis to treat erectile dysfunction, alcohol, and cocaine. There are three forms of priapism: ischemic (veno-occlusive; low flow), nonischemic (high flow), and stuttering (intermittent).

The ischemic form, which is described as nonsexual, persistent erection with little or no cavernous blood flow, must be treated promptly to prevent permanent damage to the penis. The goal of therapy is to improve venous drainage of the corpora cavernosa to prevent ischemia, fibrosis, and impotence. The initial treatment is directed at relieving the erection, preventing penile damage and simultaneously treating the underlying disease. Recommended treatment is aspiration of the corpora cavernosa (with or without irrigation) or intracavernous injection of sympathomimetics (eg, phenylephrine). Repeated injections may be needed to resolve priapism. Surgical shunts are used to reestablish penile circulation if repeated injections of the sympathomimetic are ineffective (Burnett & Bivalacqua, 2007).

Nonischemic priapism and stuttering are generally not considered emergencies and often resolve without treatment. Conservative treatment (eg, application of ice and site-specific compression to the injury) may be used. If repeated episodes occur, surgical shunting is considered. Patients with the intermittent form of priapism may be instructed in intracavernosal self-injection of phenylephrine.

## Peyronie's Disease

**Peyronie's disease** is an acquired, benign condition that involves the buildup of fibrous plaques in the sheath of the corpus cavernosum. These plaques are not visible when the penis is relaxed. However, when the penis is erect, curvature occurs that can be painful and can make sexual intercourse difficult or impossible. Peyronie's disease typically begins between 45 and 65 years of age. Medical management in the first year of active disease includes systemic, topical, intralesional, or extracorporeal techniques, with 50% of men experiencing spontaneous resolution. Surgical removal of mature plaques is used to treat severe disease. Patients should be fully informed of available treatment options and their likely outcomes (Taylor & Levine, 2007).

## Urethral Stricture

Urethral stricture is a condition in which a section of the urethra is narrowed. It can occur congenitally or from a scar along the urethra. Traumatic injury to the urethra (eg, from instrumentation or infections) can result in strictures that restrict urine flow and decrease the urinary stream, leading to spraying or double stream, postvoiding dribbling, and dilation of the proximal urethra and prostatic ducts. Prostatitis is a common complication. Treatment involves dilation of the urethra or, in severe cases, urethrotomy (surgical removal of the stricture). Antimicrobial agents are necessary for resolution of UTIs, followed by long-term prophylactic therapy until the stricture is corrected. Treatment should not be considered successful until at least 1 year has passed, because strictures may recur anytime during that period (Tanagho & McAninch, 2008).

## Circumcision

Circumcision is the surgical excision of the foreskin (prepuce) of the glans penis. One of the oldest surgical procedures, it is the fifth most common procedure preformed in the United States. In adults, circumcision may be indicated as part of treatment for phimosis, paraphimosis, and recurrent infections of the glans and foreskin. It also may be performed at the patient's request.

The primary method of circumcision in adults is surgical excision. Postoperatively, a petrolatum (Vaseline) gauze dressing is applied and changed as indicated. The patient is observed for bleeding. Because considerable pain may occur

after circumcision, analgesic agents are administered as needed.

## CRITICAL THINKING EXERCISES

**1** One of your patients, a 59-year-old man who has diabetes and a history of cardiac disease, asks about various treatments of erectile dysfunction. How would you respond, and what information would you give him about medications and nonpharmacologic methods to treat erective dysfunction? How would your approach differ if your patient was a 32-year-old man with sexual dysfunction caused by multiple sclerosis and who has limited hand dexterity?

EBP **2** During a community health fair, you are approached by a 44-year-old African American man who asks you about his risk of prostate cancer and the risk to his 20-year-old son. His father has been recently diagnosed with prostate cancer and is scheduled for surgery the following week. How would you address this issue with him at the health fair? Provide a rationale for your plan. How would your responses differ if you saw the patient during an office visit to follow-up an elevated prostate-specific antigen (PSA) test result? What health counseling is indicated for the man and his son? What is the evidence base for the health advice you develop?

EBP **3** A 63-year-old biology professor has been diagnosed with prostate cancer. His Gleason score is 6 and he is currently undergoing tests to determine if there is any metastasis of the cancer beyond the prostate gland. He is struggling to make a decision about treatment and has asked for further information about strategies that he has discussed with his physician: radical prostatectomy, suprapubic prostatectomy, and robotic-assisted radical prostatectomy. Compare the advantages and disadvantages of these three treatment strategies with watchful waiting. Identify the evidence for each of these strategies and how you would explain them to the patient.

**4** A 26-year-old patient is scheduled for surgery to treat testicular cancer. He is depressed and apprehensive about the outcomes of surgery related to sexual function and fertility. Describe your approach to caring for this patient preoperatively and postoperatively. What recommendations for follow-up health care and preventive screening are relevant for this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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American Urological Association Foundation, www.auafoundation.org, www.urologyhealth.org
CancerCare, www.cancercare.org
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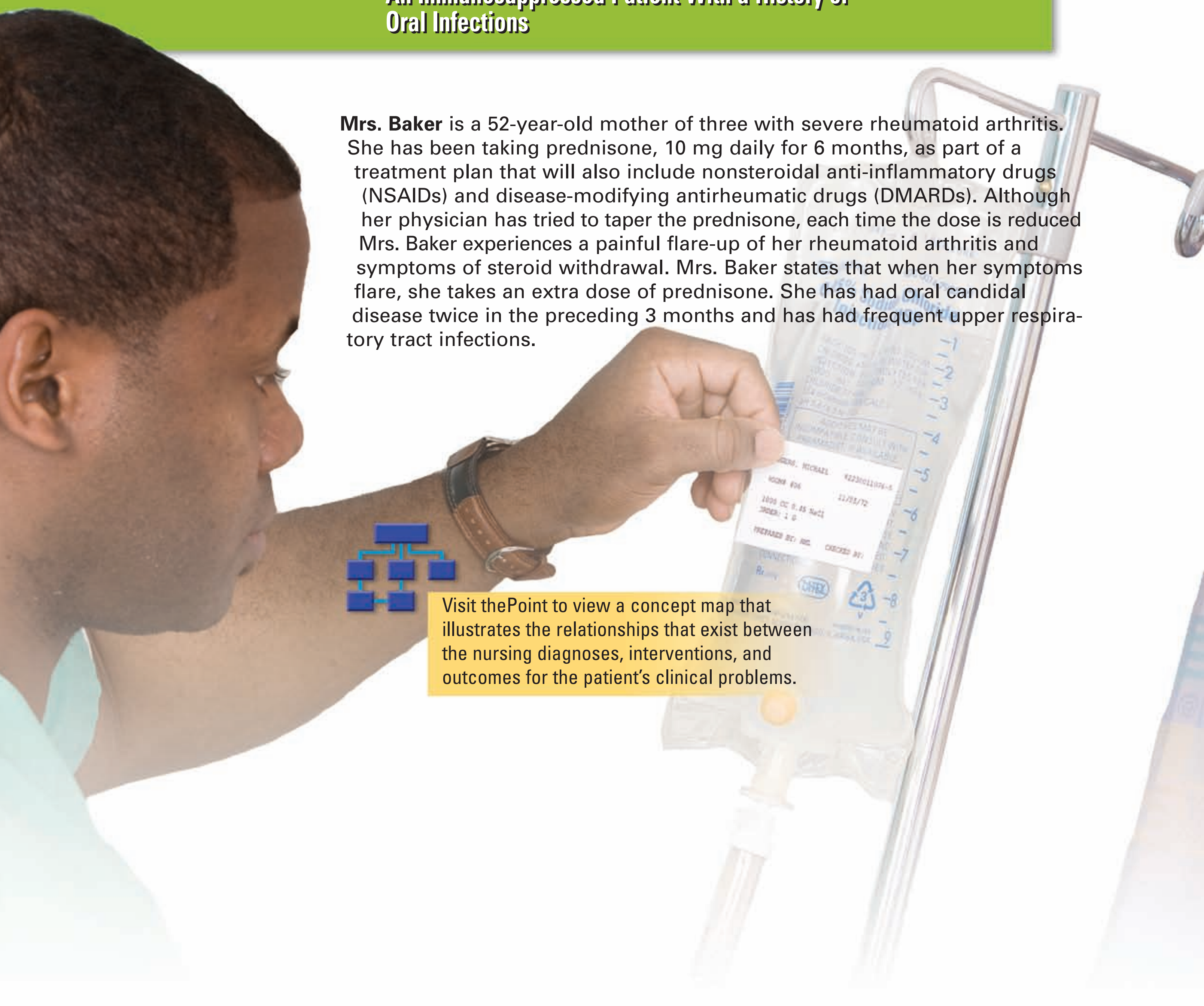
# unit 11

# Immunologic Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### An Immunosuppressed Patient With a History of Oral Infections

**Mrs. Baker** is a 52-year-old mother of three with severe rheumatoid arthritis. She has been taking prednisone, 10 mg daily for 6 months, as part of a treatment plan that will also include nonsteroidal anti-inflammatory drugs (NSAIDs) and disease-modifying antirheumatic drugs (DMARDs). Although her physician has tried to taper the prednisone, each time the dose is reduced Mrs. Baker experiences a painful flare-up of her rheumatoid arthritis and symptoms of steroid withdrawal. Mrs. Baker states that when her symptoms flare, she takes an extra dose of prednisone. She has had oral candidal disease twice in the preceding 3 months and has had frequent upper respiratory tract infections.



Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **RISK FOR INFECTION**—At risk for being invaded by pathogenic organisms | **INFECTION PROTECTION**—Prevention and early detection of infection in a patient at risk | **INFECTION SEVERITY**—Severity of infection and associated symptoms |
| **IMPAIRED ORAL MUCOUS MEMBRANE**—Disruption of the lips and soft tissues of the oral cavity | **INFECTION CONTROL**—Minimizing the acquisition and transmission of infectious agents | **TISSUE INTEGRITY: SKIN AND MUCOUS MEMBRANES**—Structural intactness and normal physiologic function of skin and mucous membranes |
| **RISK FOR INEFFECTIVE THERAPEUTIC REGIMEN MANAGEMENT**—Having the potential for developing a pattern of regulating and integrating into daily living a program for treatment of illness and the sequelae of illness that is unsatisfactory for meeting specific health goals | **ORAL HEALTH MAINTENANCE**—Maintenance and promotion of oral hygiene and dental health for the patient at risk for developing oral or dental lesions | **KNOWLEDGE: TREATMENT REGIMEN**—Extent of understanding conveyed about the safe use of medication |
| | **TEACHING: PRESCRIBED MEDICATION**—Preparing a patient to safely take prescribed medications and monitor their effects | |


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chapter 50

# Assessment of Immune Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the body's general immune responses.
2. Discuss the stages of the immune response.
3. Differentiate between cellular and humoral immune responses.
4. Describe the effects of selected variables on function of the immune system.
5. Use assessment parameters for determining the status of patients' immune function.

## GLOSSARY

**agglutination:** clumping effect occurring when an antibody acts as a cross-link between two antigens

**antibody:** a protein substance developed by the body in response to and interacting with a specific antigen

**antigen:** substance that induces the production of antibodies

**antigenic determinant:** the specific area of an antigen that binds with an antibody combining site and determines the specificity of the antigen–antibody reaction

**apoptosis:** programmed cell death that results from the digestion of deoxyribonucleic acid by endonucleases

**B cells:** cells that are important for producing a humoral immune response

**cellular immune response:** the immune system's third line of defense, involving the attack of pathogens by T cells

**complement:** series of enzymatic proteins in the serum that, when activated, destroy bacteria and other cells

**cytokines:** generic term for nonantibody proteins that act as intercellular mediators, as in the generation of immune response

**cytotoxic T cells:** lymphocytes that lyse cells infected with virus; also play a role in graft rejection

**epitope:** any component of an antigen molecule that functions as an antigenetic determinant by permitting the attachment of certain antibodies

## GLOSSARY *(Continued)*

**genetic engineering:** emerging technology designed to enable replacement of missing or defective genes

**helper T cells:** lymphocytes that attack foreign invaders (antigens) directly

**humoral immune response:** the immune system's second line of defense; often termed the antibody response

**immune response:** the coordinated response of the components of the immune system to a foreign agent or organism

**immune system:** the collection of organs, cells, tissues, and molecules that mediate the immune response

**immunity:** the body's specific protective response to a foreign agent or organism; resistance to disease, specifically infectious diseases

**immunopathology:** study of diseases resulting in dysfunctions within the immune system

**immunoregulation:** complex system of checks and balances that regulates or controls immune responses

**interferons:** proteins formed when cells are exposed to viral or foreign agents; capable of activating other components of the immune system

**lymphokines:** substances released by sensitized lymphocytes when they come in contact with specific antigens

**memory cells:** cells that are responsible for recognizing antigens from previous exposure and mounting an immune response

**natural killer (NK) cells:** lymphocytes that defend against microorganisms and malignant cells

**null lymphocytes:** lymphocytes that destroy antigens already coated with the antibody

**opsonization:** the coating of antigen–antibody molecules with a sticky substance to facilitate phagocytosis

**phagocytic cells:** cells that engulf, ingest, and destroy foreign bodies or toxins

**phagocytic immune response:** the immune system's first line of defense, involving white blood cells that have the ability to ingest foreign particles

**stem cells:** precursors of all blood cells; reside primarily in bone marrow

**suppressor T cells:** lymphocytes that decrease B-cell activity to a level at which the immune system is compatible with life

**T cells:** cells that are important for producing a cellular immune response

The term **immunity** refers to the body's specific protective response to a foreign agent or organism. The **immune system** functions as the body's defense mechanism against invasion and allows a rapid response to foreign substances in a specific manner. Genetic and cellular responses result. Any qualitative or quantitative change in the components of the immune system can produce profound effects on the integrity of the human organism. Immune function is affected by a variety of factors, such as central nervous system integrity, general physical and emotional status, medications, dietary patterns, and the stress of illness, trauma, or surgery. Dysfunctions involving the immune system occur across the lifespan. Many are genetically based; others are acquired. Immune memory is a property of the immune system that provides protection against harmful microbial agents despite the timing of re-exposure to the agent. Tolerance is the mechanism by which the immune system is programmed to eliminate foreign substances such as microbes, toxins, and cellular mutations but maintains the ability to accept self-antigens. Some credence is given to the concept of surveillance, in which the immune system is in a perpetual state of vigilance, screening and rejecting any invader that is recognized as foreign to the host. The term **immunopathology** refers to the study of diseases that result from dysfunctions within the immune system. Disorders of the immune system may stem from excesses or deficiencies of immunocompetent cells, alterations in the function of these cells, immunologic attack on self-antigens, or inappropriate or exaggerated responses to specific antigens (Table 50-1).

A growing number of patients with immunologic disorders live to adulthood. Thus, nurses in many practice settings need to understand how the immune system functions as well as immunopathologic processes. In addition, knowledge about assessment and care of people with immunologic disorders enables nurses to make appropriate management decisions.

## Anatomic and Physiologic Overview

### Anatomy of the Immune System

The immune system is composed of an integrated collection of various cell types, each with a designated function in defending against infection and invasion by other organisms.

**Table 50-1 IMMUNE SYSTEM DISORDERS**

| Disorder | Description |
|---|---|
| Autoimmunity | Normal protective immune response paradoxically turns against or attacks the body, leading to tissue damage |
| Hypersensitivity | Body produces inappropriate or exaggerated responses to specific antigens |
| Gammopathies | Immunoglobulins are overproduced |
| Immune deficiencies | |
| Primary | Deficiency results from improper development of immune cells or tissues; usually congenital or inherited |
| Secondary | Deficiency results from some interference with an already developed immune system; usually acquired later in life |

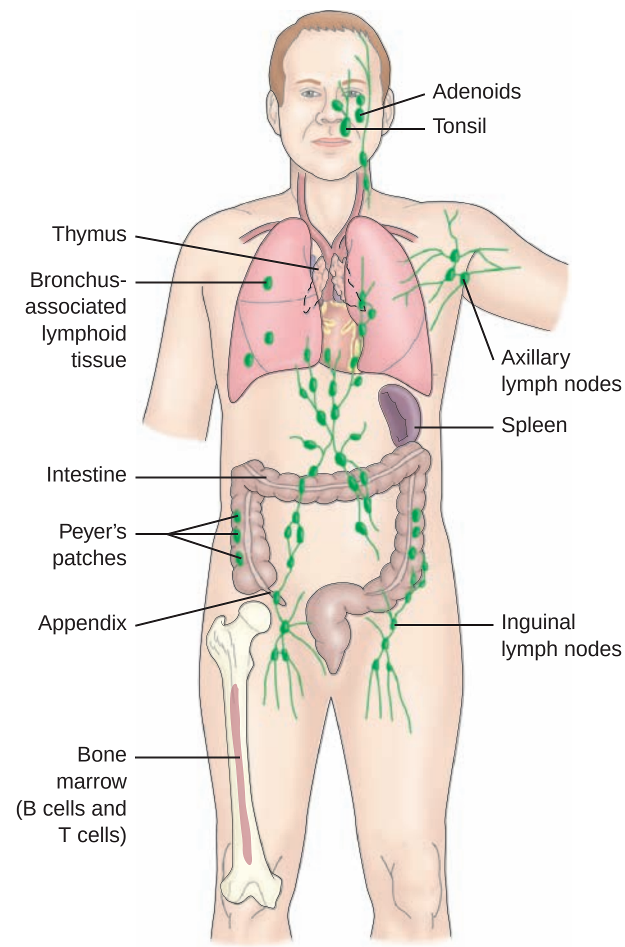



**Figure 50-1** Central and peripheral lymphoid organs, tissues, and cells. Adapted from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed., p. 371). Philadelphia: Lippincott Williams & Wilkins.

Supporting this system are molecules that are responsible for the interactions, modulations, and regulation of the system. These molecules and cells participate in specific interactions with immunogenic **epitopes** (antigenic determinants) present on foreign materials, initiating a series of actions in a host, including the inflammatory response, the lysis of microbial agents, and the disposal of foreign toxins. The major components of the immune system include central and peripheral organs, tissues, and cells (Fig. 50-1).

#### *Bone Marrow*

The white blood cells (WBCs) involved in immunity are produced in the bone marrow (Fig. 50-2). Like other blood cells, lymphocytes are generated from **stem cells**, which are undifferentiated cells. There are two types of lymphocytes—B lymphocytes **(B cells)** and T lymphocytes **(T cells)** (Fig. 50-3). B lymphocytes mature in the bone marrow and then enter the circulation. T lymphocytes move from the bone marrow to the thymus, where they mature into several kinds of cells with different functions.

#### *Lymphoid Tissues*

The spleen, composed of red and white pulp, acts somewhat like a filter. The red pulp is the site where old and injured

## Physiology ■■■ Pathophysiology

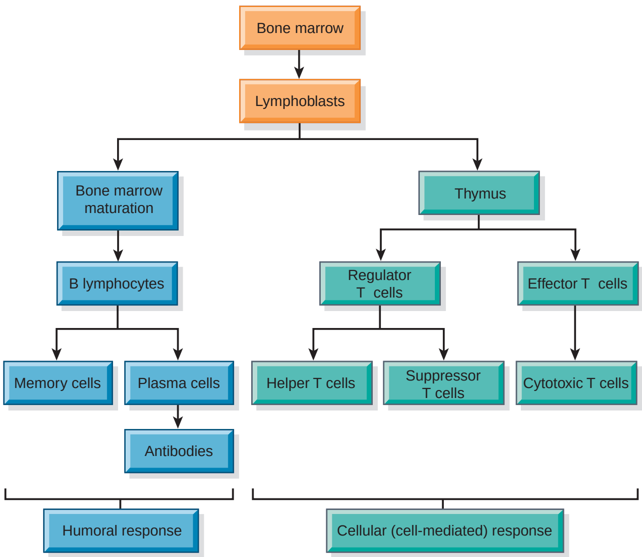



**Figure 50-2** Development of cells of the immune system.

red blood cells (RBCs) are destroyed. The white pulp contains concentrations of lymphocytes. The lymph nodes, which are connected by lymph channels and capillaries, are distributed throughout the body. They remove foreign material from the lymph system before it enters the bloodstream. The lymph nodes also serve as centers for immune

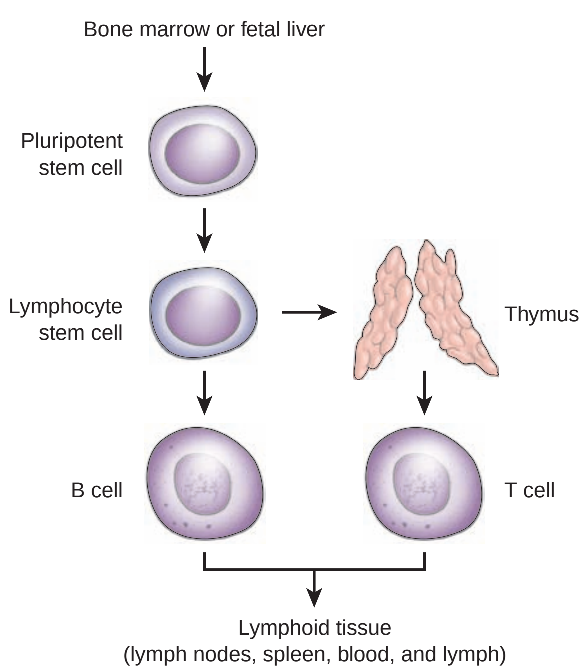



**Figure 50-3** Lymphocytes originate from stem cells in the bone marrow. B lymphocytes mature in the bone marrow before entering the bloodstream, whereas T lymphocytes mature in the thymus, where they also differentiate into cells with various functions. Redrawn from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed., p. 362). Philadelphia: Lippincott Williams & Wilkins.

cell proliferation. The remaining lymphoid tissues contain immune cells that defend the body's mucosal surfaces against microorganisms (Levinson, 2008).

## Function of the Immune System

The basic function of the immune system is to remove foreign antigens such as viruses and bacteria to maintain homeostasis. There are two general types of immunity, natural (innate) and acquired (adaptive). Natural immunity or nonspecific immunity is present at birth. Acquired or specific immunity develops after birth. Each type of immunity has a distinct role in defending the body against harmful invaders, but the various components are usually interdependent (Levinson, 2008).

### *Natural Immunity*

Natural immunity, which is nonspecific, provides a broad spectrum of defense against and resistance to infection. It is considered the first line of host defense following antigen exposure, because it protects the host without "remembering" prior contact with an infectious agent (Kin & Sanders, 2006). Responses to a foreign invader are very similar from one encounter to the next, regardless of the number of times the invader is encountered. Natural (innate) immunity co-coordinates the initial response to pathogens through the production of cytokines and other effector molecules, which either activate cells for control of the pathogen (by elimination) or promote the development of the acquired **immune response.** The cells involved in this response are monocytes, macrophages, dendritic cells, **natural killer (NK) cells,** basophils, eosinophils, and granulocytes. The early events in this process are critical in determining the nature of the adaptive immune response. Natural immune mechanisms can be divided into two stages: immediate (generally occurring within 4 hours) and delayed (occurring between 4 and 96 hours after exposure) (Madoff & Kasper, 2008).

#### White Blood Cell Action

Cellular response is key to the effective initiation of the immune response. WBCs, or leukocytes, participate in both the natural and the acquired immune responses. Granular leukocytes, or granulocytes (so called because of granules in their cytoplasm), fight invasion by foreign bodies or toxins by releasing cell mediators, such as histamine, bradykinin, and prostaglandins, and engulfing the foreign bodies or toxins. Granulocytes include neutrophils, eosinophils, and basophils.

Neutrophils (polymorphonuclear leukocytes [PMNs]) are the first cells to arrive at the site where inflammation occurs. Eosinophils and basophils, other types of granulocytes, increase in number during allergic reactions and stress responses. Nongranular leukocytes include monocytes or macrophages (referred to as histiocytes when they enter tissue spaces) and lymphocytes. Monocytes also function as **phagocytic cells,** engulfing, ingesting, and destroying greater numbers and quantities of foreign bodies or toxins than granulocytes do. Lymphocytes, consisting of B cells and T cells, play major roles in humoral and cell-mediated

immune responses. About 60% to 70% of lymphocytes in the blood are T cells, and about 10% to 20% are B cells (Abbas, Lichtman & Baker, 2008).

**Inflammatory Response**

The inflammatory response is a major function of the natural immune system that is elicited in response to tissue injury or invading organisms. Chemical mediators assist this response by minimizing blood loss, walling off the invading organism, activating phagocytes, and promoting formation of fibrous scar tissue and regeneration of injured tissue. The inflammatory response (discussed further in Chapter 6) is facilitated by physical and chemical barriers that are part of the human organism.

**Physical and Chemical Barriers**

Activation of the natural immunity response is enhanced by processes inherent in physical and chemical barriers. Physical surface barriers include intact skin, mucous membranes, and cilia of the respiratory tract, which prevent pathogens from gaining access to the body. The cilia of the respiratory tract, along with coughing and sneezing responses, filter and clear pathogens from the upper respiratory tract before they can invade the body further. Chemical barriers, such as mucus, acidic gastric secretions, enzymes in tears and saliva, and substances in sebaceous and sweat secretions, act in a nonspecific way to destroy invading bacteria and fungi. Viruses are countered by other means, such as interferon (see discussion later in chapter).

**Immune Regulation**

Regulation of the immune response involves balance and counterbalance. Dysfunction of the natural immune system can occur when the immune components are inactivated or when they remain active long after their effects are beneficial. A successful immune response eliminates the responsible antigen. If an immune response fails to develop and clear an antigen sufficiently, the host is considered to be immunocompromised or immunodeficient. If it is overtly robust or misdirected, allergies, asthma, or autoimmune disease results. The immune system's recognition of one's own tissues as "foreign" rather than as self is the basis of many autoimmune disorders. Despite the fact that the immune response is critical to the prevention of disease, it must be well controlled to curtail immunopathology. Most microbial infections induce an inflammatory response mediated by T cells and cytokines, which, in excess, can cause tissue damage. Therefore, regulatory mechanisms must be in place to suppress or halt the immune response. This is mainly achieved by the production of cytokines and transformation of growth factor that inhibits macrophage activation. In some cases, T-cell activation is so overwhelming that these mechanisms fail, and pathology develops. Ongoing research on **immunoregulation** holds the promise of preventing graft rejection and aiding the body in eliminating cancerous or infected cells (Kin & Sanders, 2006). Although natural immunity can effectively combat infections, many pathogenic microbes have evolved that resist natural immunity. Acquired immunity is necessary to defend against these resistant agents.

### Acquired Immunity

Acquired (adaptive) immunity usually develops as a result of prior exposure to an antigen through immunization (vaccination) or by contracting a disease, both of which generate a protective immune response. Weeks or months after exposure to the disease or vaccine, the body produces an immune response that is sufficient to defend against the disease on re-exposure. In contrast to the rapid but nonspecific natural immune response, this form of immunity relies on the recognition of specific foreign antigens. The acquired immune response is broadly divided into two mechanisms: (1) the cell-mediated response, involving T-cell activation, and (2) effector mechanisms, involving B-cell maturation and production of antibodies.

The two types of acquired immunity are known as active and passive and are strongly interrelated. Active acquired immunity refers to immunologic defenses developed by the person's own body. This immunity typically lasts many years or even a lifetime. Passive acquired immunity is temporary immunity transmitted from a source outside the body that has developed immunity through previous disease or immunization. Examples are immune globulin or immunity resulting from the transfer of antibodies from the mother to an infant in utero or through breast-feeding. Active and passive acquired immunity involve humoral and cellular (cell-mediated) immunologic responses (described later).

### Response to Invasion

When the body is invaded or attacked by bacteria, viruses, or other pathogens, it has three means of defense:

- The phagocytic immune response
- The humoral or antibody immune response
- The cellular immune response

The first line of defense, the **phagocytic immune response,** primarily involves the WBCs (granulocytes and macrophages), which have the ability to ingest foreign particles and destroy the invading agent; eosinophils are only weakly phagocytic. Phagocytes also remove the body's own dying or dead cells. Cells in necrotic tissue that are dying release substances that trigger an inflammatory response. **Apoptosis,** or programmed cell death, is the body's way of destroying worn-out cells such as blood or skin cells or cells that need to be renewed.

A second protective response, the **humoral immune response** (sometimes called the **antibody** response), begins with the B lymphocytes, which can transform themselves into plasma cells that manufacture antibodies. These antibodies are highly specific proteins that are transported in the bloodstream and attempt to disable invaders. The third mechanism of defense, the **cellular immune response,** also involves the T lymphocytes, which can turn into special cytotoxic (or killer) T cells that can attack the pathogens.

The structural part of the invading or attacking organism that is responsible for stimulating antibody production is called an **antigen** (or an immunogen). For example, an antigen can be a small patch of proteins on the outer surface of a microorganism. Not all antigens are naturally immunogenic; some must be coupled to other molecules to stimulate the immune response. A single bacterium or large molecule, such as a diphtheria or tetanus toxin, may have several

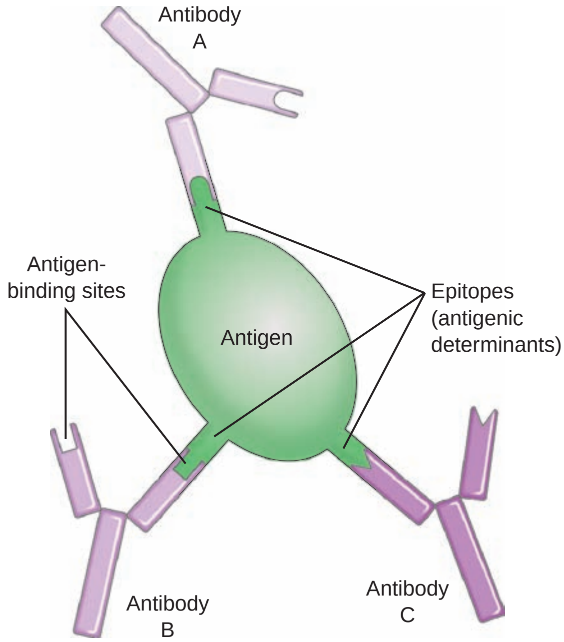



**Figure 50-4** Complement-mediated immune responses. Redrawn from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

antigens, or markers, on its surface, thus inducing the body to produce a number of different antibodies. Once produced, an antibody is released into the bloodstream and carried to the attacking organism. There, it combines with the antigen, binding with it like an interlocking piece of a jigsaw puzzle (Fig. 50-4). There are four well-defined stages in an immune response: recognition, proliferation, response, and effector (Fig. 50-5).

### Recognition Stage

Recognition of antigens as foreign, or non-self, by the immune system is the initiating event in any immune response. Recognition involves the use of lymph nodes and lymphocytes for surveillance. Lymph nodes are widely distributed internally throughout the body and in the circulating blood, as well as externally near the body's surfaces. They continuously discharge small lymphocytes into the bloodstream. These lymphocytes patrol the tissues and vessels that drain the areas served by that node. Lymphocytes recirculate from the blood to lymph nodes and from the lymph nodes back into the bloodstream, in a continuous circuit. The exact way in which they recognize antigens on foreign surfaces is not known; however, recognition is thought to depend on specific receptor sites on the surface of the lymphocytes. Macrophages play an important role in helping the circulating lymphocytes process the antigens. Both macrophages and neutrophils have receptors for antibodies and complement; as a result, they coat microorganisms with antibodies, complement, or both, thereby enhancing phagocytosis.

In a streptococcal throat infection, for example, the streptococcal organism gains access to the mucous membranes of the throat. A circulating lymphocyte moving through the tissues of the throat comes in contact with the organism. The lymphocyte recognizes the antigens on the microbe as different (non-self) and the streptococcal organism as antigenic (foreign). This triggers the second stage of the immune response—proliferation.

### Proliferation Stage

The circulating lymphocytes containing the antigenic message return to the nearest lymph node. Once in the node, these sensitized lymphocytes stimulate some of the resident T and B lymphocytes to enlarge, divide, and proliferate. T lymphocytes differentiate into cytotoxic (or killer) T cells, whereas B lymphocytes produce and release antibodies. Enlargement of the lymph nodes in the neck in conjunction with a sore throat is one example of the immune response.

### Response Stage

In the response stage, the differentiated lymphocytes function in either a humoral or a cellular capacity. This stage begins with the production of antibodies by the B lymphocytes in response to a specific antigen. The cellular response stimulates the resident lymphocytes to become cells that attack microbes directly rather than through the action of antibodies. These transformed lymphocytes are known as cytotoxic (killer) T cells.

Viral rather than bacterial antigens induce a cellular response. This response is manifested by the increasing number of T lymphocytes (lymphocytosis) seen in the blood tests of people with viral illnesses such as infectious mononucleosis. (Cellular immunity is discussed in further detail later in this chapter.) Most immune responses to antigens involve both humoral and cellular responses, although one usually predominates. For example, during transplant rejection, the cellular response predominates, whereas in the bacterial pneumonias and sepsis, the humoral response plays the dominant protective role (Chart 50-1).

### Effector Stage

In the effector stage, either the antibody of the humoral response or the cytotoxic (killer) T cell of the cellular response reaches and connects with the antigen on the surface of the foreign invader. This initiates activities involving interplay of antibodies (humoral immunity), complement, and action by the cytotoxic T cells (cellular immunity).

## *Humoral Immune Response*

The humoral response is characterized by the production of antibodies by B lymphocytes in response to a specific antigen. While B lymphocytes are responsible for the production of antibodies, both the macrophages of natural immunity and the special T lymphocytes of cellular immunity are involved in recognition.

### Antigen Recognition

Several theories explain the mechanisms by which B lymphocytes recognize the invading antigen and respond by producing antibodies. It is known that B lymphocytes recognize and respond to invading antigens in more than one way.

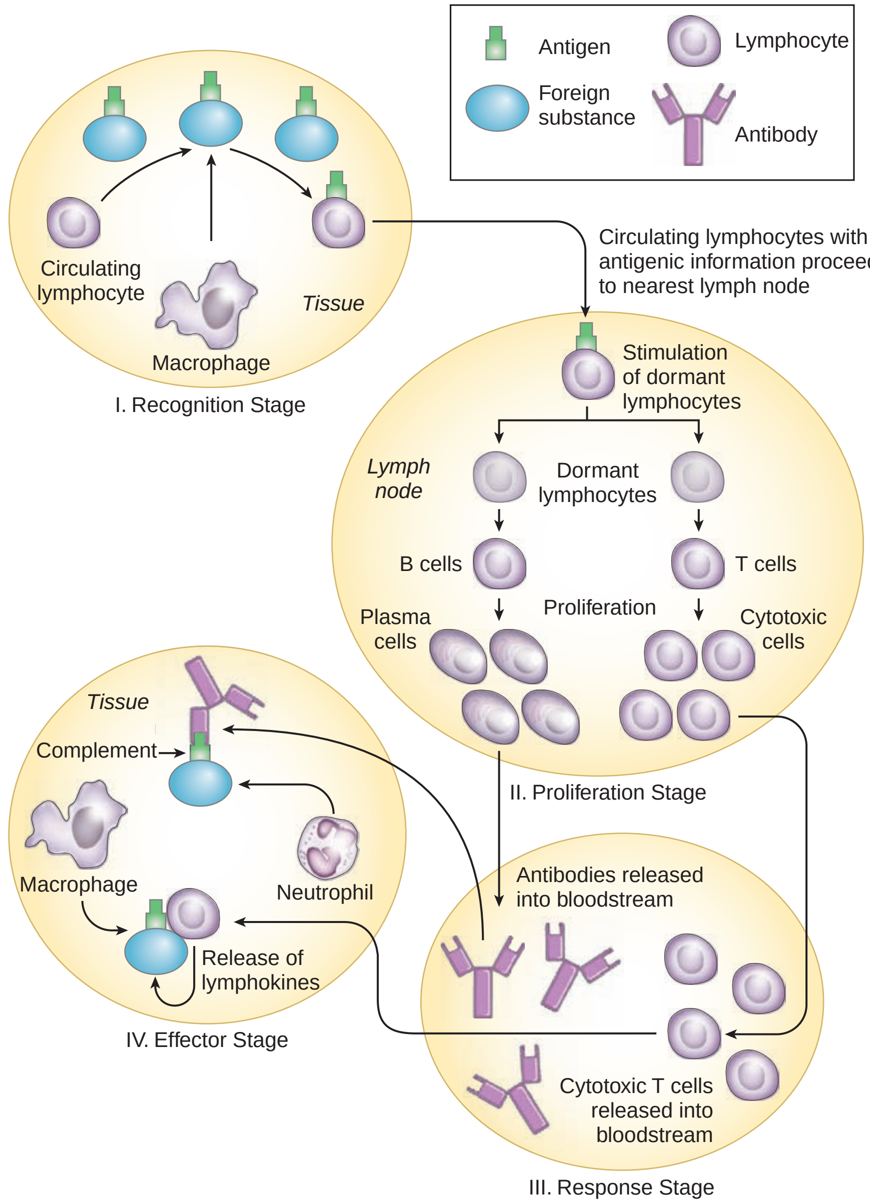



**Figure 50-5** Stages of the immune response. **I,** In the *recognition stage,* antigens are recognized by circulating lymphocytes and macrophages. **II,** In the *proliferation stage,* the dormant lymphocytes proliferate and differentiate into cytotoxic (killer) T cells or B cells responsible for formation and release of antibodies. **III,** In the *response stage,* the cytotoxic T cells and the B cells perform cellular and humoral functions, respectively. **IV,** In the *effector stage,* antigens are destroyed or neutralized through the action of antibodies, complement, macrophages, and cytotoxic T cells.

## Chart 50-1 • *Comparison of Cellular and Humoral Immune Responses*

### Humoral Responses (B Cells)

- Bacterial phagocytosis and lysis
- Anaphylaxis
- Allergic hay fever and asthma
- Immune complex disease
- Bacterial and some viral infections

### Cellular Responses (T Cells)

- Transplant rejection
- Delayed hypersensitivity (tuberculin reaction)
- Graft-versus-host disease
- Tumor surveillance or destruction
- Intracellular infections
- Viral, fungal, and parasitic infections

The B lymphocytes respond to some antigens by directly triggering antibody formation; however, in response to other antigens, they need the assistance of T cells to trigger antibody formation. With the help of macrophages, the T lymphocytes are believed to recognize the antigen of a foreign invader. The T lymphocyte picks up the antigenic message, or "blueprint," of the antigen and returns to the nearest lymph node with that message. B lymphocytes stored in the lymph nodes are subdivided into thousands of clones, which are stimulated to enlarge, divide, proliferate, and differentiate into plasma cells capable of producing specific antibodies to the antigen. Other B lymphocytes differentiate into B-lymphocyte clones with a memory for the antigen. These memory cells are responsible for the more exaggerated and rapid immune response in a person who is repeatedly exposed to the same antigen.

### Role of Antibodies

Antibodies are large proteins, called immunoglobulins, that consist of two subunits, each containing a light and a heavy peptide chain held together by a chemical link composed of disulfide bonds. Each subunit has one portion that serves as a binding site for a specific antigen and another portion that allows the antibody molecule to take part in the complement system.

Antibodies defend against foreign invaders in several ways, and the type of defense used depends on the structure and composition of both the antigen and the immunoglobulin. The antibody molecule has at least two combining sites, or Fab fragments (Fig. 50-6). One antibody can act as a cross-link between two antigens, causing them to bind or clump together. This clumping effect, referred to as **agglutination,** helps clear the body of the invading organism by facilitating phagocytosis. Some antibodies assist in removal of offending organisms through **opsonization.** In this process, the antigen–antibody molecule is coated with a sticky substance that also facilitates phagocytosis.

Antibodies also promote the release of vasoactive substances, such as histamine and slow-reacting substances, two of the chemical mediators of the inflammatory response. Antibodies do not function in isolation; rather, they mobilize other components of the immune system to defend against the invader.

The body can produce five different types of immunoglobulins (Ig). Each of the five types, or classes, is identified by a specific letter of the alphabet, IgA, IgD, IgE, IgG, and IgM. Classification is based on the chemical structure and biologic role of the individual immunoglobulin. Major characteristics of the immunoglobulins are summarized in Chart 50-2. The normal laboratory values for the three major immunoglobulins (IgA, IgG and IgM) can be found in Table 54-1 and Appendix A.

### Antigen–Antibody Binding

The portion of the antigen involved in binding with the antibody is referred to as the **antigenic determinant.** The most efficient immunologic responses occur when the antibody and antigen fit like a lock and key. Poor fit can occur with an antibody that was produced in response to a different antigen. This phenomenon is known as cross-reactivity. For example, in acute rheumatic fever, the antibody produced against *Streptococcus pyogenes* in the upper respiratory tract may cross-react with the patient's heart tissue, leading to heart valve damage.

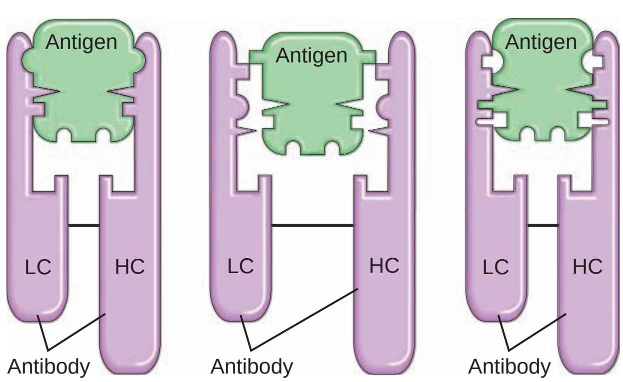



**Figure 50-6** Antigen–antibody binding. (*Left*) A highly specific antigen–antibody complex. (*Center*) No match and, therefore, no immune response. (*Right*) Poor fit or match with low specificity; antibody reacts to antigen with similar characteristics, producing cross-reactivity. HC = heavy chain; LC = light chain.

## Chart 50-2 • *Major Characteristics of the Immunoglobulins*

**IgG (75% of Total Immunoglobulin)**

- Appears in serum and tissues (interstitial fluid)
- Assumes a major role in bloodborne and tissue infections
- Activates the complement system
- Enhances phagocytosis
- Crosses the placenta

**IgA (15% of Total Immunoglobulin)**

- Appears in body fluids (blood, saliva, tears, breast milk, and pulmonary, gastrointestinal, prostatic, and vaginal secretions)
- Protects against respiratory, gastrointestinal, and genitourinary infections
- Prevents absorption of antigens from food
- Passes to neonate in breast milk for protection

**IgM (10% of Total Immunoglobulin)**

- Appears mostly in intravascular serum
- Appears as the first immunoglobulin produced in response to bacterial and viral infections
- Activates the complement system

**IgD (0.2% of Total Immunoglobulin)**

- Appears in small amounts in serum
- Possibly influences B-lymphocyte differentiation, but role is unclear

**IgE (0.004% of Total Immunoglobulin)**

- Appears in serum
- Takes part in allergic and some hypersensitivity reactions
- Combats parasitic infections

### *Cellular Immune Response*

The T lymphocytes are primarily responsible for cellular immunity. Stem cells continuously migrate from the bone marrow to the thymus gland, where they develop into T cells. Despite the partial degeneration of the thymus gland that occurs at puberty, T cells continue to develop here. Several types of T cells exist, each with designated roles in the defense against bacteria, viruses, fungi, parasites, and malignant cells. T cells attack foreign invaders directly rather than by producing antibodies.

Cellular reactions are initiated, with or without the assistance of macrophages, by the binding of an antigen to an antigen receptor located on the surface of a T cell. The T cells then carry the antigenic message, or blueprint, to the lymph nodes, where the production of other T cells is stimulated. Some T cells remain in the lymph nodes and retain a memory for the antigen. Other T cells migrate from the lymph nodes into the general circulatory system and

ultimately to the tissues, where they remain until they either come in contact with their respective antigens or die (Sompayrac, 2008).

### Types of T Lymphocytes

T cells include effector T cells, suppressor T cells, and memory T cells. The two major categories of effector T cells—helper T cells and cytotoxic T cells—participate in the destruction of foreign organisms. T cells interact closely with B cells, indicating that humoral and cellular immune responses are not separate, unrelated processes, but rather branches of the immune response that interact.

**Helper T cells** are activated on recognition of antigens and stimulate the rest of the immune system. When activated, helper T cells secrete **cytokines,** which attract and activate B cells, cytotoxic T cells, NK cells, macrophages, and other cells of the immune system. Separate subpopulations of helper T cells produce different types of cytokines and determine whether the immune response will be the production of antibodies or a cell-mediated immune response. Helper T cells also produce **lymphokines,** one category of cytokines (Table 50-2).

**Cytotoxic T cells** (killer T cells) attack the antigen directly by altering the cell membrane and causing cell lysis (disintegration) and by releasing cytolytic enzymes and cytokines. Lymphokines can recruit, activate, and regulate other lymphocytes and WBCs. These cells then assist in destroying the invading organism. Delayed-type hypersensitivity is an example of an immune reaction that protects the body from antigens through the production and release of lymphokines (see later discussion).

**Suppressor T cells** have the ability to decrease B-cell production, thereby keeping the immune response at a level that is compatible with health (eg, sufficient to fight infection adequately without attacking the body's healthy tissues). **Memory cells** are responsible for recognizing antigens from previous exposure and mounting an immune response (Table 50-3).

### Null Lymphocytes and Natural Killer Cells

Null lymphocytes and NK cells are other lymphocytes that assist in combating organisms. These cells are distinct from B cells and T cells and lack the usual characteristics of those cells. **Null lymphocytes,** a subpopulation of lymphocytes, destroy antigens already coated with antibody. These cells have special receptor sites on their surface that allow them to connect with the end of antibodies; this is known as antibody-dependent, cell-mediated cytotoxicity.

NK cells are a class of lymphocytes that recognize infected and stressed cells and respond by killing these cells and by secreting macrophage-activating cytokine. The helper T cells contribute to the differentiation of null and NK cells.

## *Complement System*

Circulating plasma proteins, known as **complement,** are made in the liver and activated when an antibody connects with its antigen. Complement plays an important role in

**Table 50-2 CYTOKINES AND THEIR BIOLOGIC ACTIVITY**

| Cytokine* | Biologic Activity |
|---|---|
| Interleukin-1 (α and β) | Promotes differentiation of T and B lymphocytes, natural killer (NK) cells, and null cells |
| Interleukin-2 | Stimulates growth of T lymphocytes and special activated killer lymphocytes (known as lymphocyte-activated killer cells [LAK cells]) |
| Interleukin-3 | Stimulates growth of mast cells and other blood cells |
| Interleukin-4 | Stimulates growth of T and B lymphocytes, mast cells, and macrophages |
| Interleukin-5 | Stimulates antibody responses |
| Interleukin-6 | Stimulates growth and function of B lymphocytes and antibodies |
| Interleukin-7 | Stimulates growth of pre-B, CD4+ and CD8+ T lymphocytes and activates mature T lymphocytes |
| Interleukin-8 | Promotes chemotaxis and activation of neutrophils |
| Interleukin-9 | Stimulates growth and proliferation of T lymphocytes |
| Interleukin-10 | Inhibits interferon-gamma and mononuclear cell inflammation |
| Interleukin-11 | Promotes induction of acute phase proteins |
| Interleukin-12 | Introduces helper T lymphocytes |
| Interleukin-13 | Inhibits mononuclear phagocyte inflammation and promotes differentiation of B cells |
| Interleukin-16 | Promotes chemotaxis CD4+ T lymphocytes and eosinophils |
| Permeability factor | Increases vascular permeability, allowing white cells into area |
| Interferon-γ | Activates macrophages; increases expression of class I and II MHC antigen processing and presentation |
| Interferon (type 1α and type β) | Exerts antiviral activity in body cells; induces class I antigen expression; activates NK cells |
| Migration inhibitory factor | Suppresses movement of macrophages, keeping macrophages in area of foreign cells |
| Skin reactive factor | Induces inflammatory response |
| Cytotoxic factor (lymphotoxin) | Kills certain antigenic cells |
| Macrophage chemotactic factor | Attracts macrophages into the area |
| Lymphocyte blastogenic factor | Stimulates more lymphocytes, recruiting additional lymphocytes into the area |
| Macrophage aggregation factor | Causes clumping of macrophages and lymphocytes |
| Macrophage activation factor | Allows macrophages to adhere to surfaces more readily |
| Proliferation inhibitor factor | Inhibits growth of certain antigenic cells |
| Cytophilic antibody | Binds to an Fc receptor on macrophages, thereby permitting macrophages to bind to antigens |
| Tumor necrosis factor-alpha | Stimulates inflammation, wound healing, and tissue remodeling |
| Tumor necrosis factor-beta | Mediates inflammation and graft rejection |

*Cytokines are biologically active substances that are released by cells to regulate growth and function of other cells within the immune system.
Lymphocytes produce lymphokines, and monocytes and macrophages produce monokines. This table lists some of the cytokines that play a role in immune system functioning. MHC = major histocompatibility complex.

**Table 50-3 LYMPHOCYTES INVOLVED IN IMMUNE RESPONSES**

| Type of Immune Response | Cell Type | Function |
|---|---|---|
| **Humoral** | B lymphocyte | Produces antibodies or immunoglobulins (IgA, IgD, IgE, IgG, IgM) |
| **Cellular** | T lymphocyte | |
| | Helper T | Attacks foreign invaders (antigens) directly<br>Initiates and augments inflammatory response |
| | Helper $T_1$ | Increases activated cytotoxic T cells |
| | Helper $T_2$ | Increases B cell antibody production |
| | Suppressor T | Suppresses the immune response |
| | Memory T | Remembers contact with an antigen and on subsequent exposures mounts an immune response |
| | Cytotoxic T (killer T) | Lyses cells infected with virus; plays a role in graft rejection |
| **Nonspecific** | Non-T or non-B lymphocyte | |
| | Null cell | Destroys antigens already coated with antibody |
| | Natural killer (NK) cell (granular lymphocyte) | Defends against microorganisms and some types of malignant cells; produces cytokines |

the defense against microbes. Destruction of an invading or attacking organism or toxin is not achieved merely by the binding of the antibody and antigens; it also requires activation of complement, the arrival of killer T cells, or the attraction of macrophages. Complement has three major physiologic functions: defending the body against bacterial infection, bridging natural and acquired immunity, and disposing of immune complexes and the byproducts associated with inflammation (Porth & Matfin, 2009).

The proteins that comprise complement interact sequentially with one another in a cascading effect. The complement cascade is important to modifying the effector arm of the immune system. Activation of complement allows important events, such as removal of infectious agents and initiation of the inflammatory response, to take place. These events involve active parts of the pathway that enhance chemotaxis of macrophages and granulocytes, alter blood vessel permeability, change blood vessel diameters, cause cells to lyse, alter blood clotting, and cause other points of modification. These macrophages and granulocytes continue the body's defense by devouring the antibody-coated microbes and by releasing bacterial products.

The complement cascade may be activated by any of three pathways: classic, lectin, and alternative. The classic pathway is triggered after antibodies bind to microbes or other antigens and is part of the humoral type of adaptive immunity. The lectin pathway is activated when a plasma protein (mannose-binding lectin) binds to terminal mannose residue on the surface glycoproteins of microbes. The alternative pathway is triggered when complement proteins are activated on microbial surfaces. This pathway is part of natural immunity.

Complement components, prostaglandins, leukotrienes, and other inflammatory mediators all contribute to the recruitment of inflammatory cells, as do chemokines, a group of cytokines. The activated neutrophils pass through the vessel walls to accumulate at the site of infection, where they phagocytose complement-coated microbes (Abbas, et al., 2008). This response is usually therapeutic and can be lifesaving if the cell attacked by the complement system is a true foreign invader. However, if that cell is part of the human organism, the result can be devastating disease and even death. Many autoimmune diseases and disorders characterized by chronic infection are thought to be caused in part by continued or chronic activation of complement, which in turn results in chronic inflammation. The RBCs and platelets have complement receptors and, as a result, play an important role in the clearance of immune complexes that consist of antigen, antibody, and components of the complement system (Abbas, et al., 2008).

### *Immunomodulators*

While antimicrobial agents and vaccines have yielded considerable therapeutic success and the immune system usually works effectively, many infectious diseases remain difficult clinical challenges. Treatment success may be compromised by defects of the immune system; in this case, enhancement of the host immune response may be therapeutically beneficial. An immunomodulator (also known as a biologic response modifier) affects the host via direct or indirect effects on one or more components of the immunoregulatory network. Interferons and colony-stimulating factors are two of the more commonly used immunomodulators (Liles, 2005).

#### Interferons

**Interferon,** one type of biologic response modifier, is a nonspecific viricidal protein that is naturally produced by the body and is capable of activating other components of the immune system. These substances continue to be investigated to determine their roles in the immune system and their potential therapeutic effects in disorders characterized by disturbed immune responses. Interferons have antiviral and antitumor properties. In addition to responding to viral infection, interferons are produced by T lymphocytes, B lymphocytes, and macrophages in response to antigens. They are thought to modify the immune response by suppressing antibody production and cellular immunity. They also facilitate the cytolytic role of macrophages and NK cells. Interferons are used to treat immune-related disorders (eg, multiple sclerosis) and chronic inflammatory conditions (eg, chronic hepatitis). Research continues to evaluate the effectiveness of interferons in treating tumors and acquired immunodeficiency syndrome (AIDS).

#### Colony-Stimulating Factors

Colony-stimulating factors are a group of naturally occurring glycoprotein cytokines that regulate production, differentiation, survival, and activation of hematopoietic cells. Erythropoietin stimulates RBC production. Thrombopoietin plays a key regulatory role in the growth and differentiation of bone marrow cells. Interleukin-5 (IL-5) stimulates the growth and survival of eosinophils and basophils.

Stem cell factor and IL-3 serve as stimuli for multiple hematopoietic cell lines. Granulocyte colony-stimulating factor, granulocyte-macrophage colony-stimulating factor, and macrophage colony-stimulating factor all serve as growth factors for specific cell lines. These cytokines have attracted considerable interest for their potential role in immunomodulation (McInnes, 2005; Nelson, 2007).

## Advances in Immunology

### Genetic Engineering

One of the more remarkable evolving technologies is **genetic engineering,** which uses recombinant deoxyribonucleic acid (DNA) technology. Two facets of this technology exist. The first permits scientists to combine genes from one type of organism with genes of a second organism. This type of technology allows cells and microorganisms to manufacture proteins, monokines, and lymphokines, which can alter and enhance immune system function. The second facet of recombinant DNA technology involves gene therapy. If a particular gene is abnormal or missing, experimental recombinant DNA technology may be capable of restoring normal gene function. For example, a recombinant gene is inserted onto a virus particle. When the virus particle splices its genes, the virus automatically inserts the missing gene and theoretically corrects the genetic anomaly. Extensive research into recombinant DNA technology and gene therapy is ongoing (Abbas, et al., 2008).

### Stem Cells

Stem cells are capable of self-renewal and differentiation; they continually replenish the body's entire supply of both RBCs and WBCs. Some stem cells, described as totipotent cells, have tremendous capacity to self-renew and differentiate. Embryonic stem cells, described as pluripotent, give rise to numerous cell types that are able to form tissues. Research has shown that stem cells can restore an immune system that has been destroyed. Stem cell transplantation has been carried out in humans with certain types of immune dysfunction, such as severe combined immunodeficiency (SCID); clinical trials using stem cells are under way in patients with a variety of disorders having an autoimmune component, including systemic lupus erythematosus, rheumatoid arthritis, scleroderma, and multiple sclerosis. Research with embryonic stem cells has enabled investigators to make substantial gains in developmental biology, gene therapy, therapeutic tissue engineering, and the treatment of a variety of diseases. However, along with these remarkable opportunities, many ethical challenges arise, which are largely based on concerns about safety, efficacy, resource allocation, and human cloning (Goldman, 2007).

## Assessment of the Immune System

An assessment of immune function begins during the health history and physical examination. Areas to be assessed include nutritional status; infections and immunizations; allergies; disorders and disease states, such as autoimmune disorders, cancer, and chronic illnesses; surgeries; medications; and blood transfusions. In addition to inspection of general characteristics, palpation of the lymph nodes and examinations of the skin, mucous membranes, and respiratory, gastrointestinal, musculoskeletal, genitourinary, cardiovascular, and neurosensory systems are performed (Moorhead, Johnson, Mass, et al., 2008) (Chart 50-3).

### Health History

The history should note the patient's age along with information about past and present conditions and events that may provide clues to the status of the patient's immune system.

**CHART 50-3** *Assessing for Immune Dysfunction*

Be alert for the following signs and symptoms:

**Respiratory System**

- Changes in respiratory rate
- Cough (dry or productive)
- Abnormal lung sounds (wheezing, crackles, rhonchi)
- Rhinitis
- Hyperventilation
- Bronchospasm

**Cardiovascular System**

- Hypotension
- Tachycardia
- Dysrhythmia
- Vasculitis
- Anemia

**Gastrointestinal System**

- Hepatosplenomegaly
- Colitis
- Vomiting
- Diarrhea

**Genitourinary System**

- Frequency and burning on urination
- Hematuria
- Discharge

**Musculoskeletal System**

- Joint mobility, edema, and pain

**Skin**

- Rashes
- Lesions
- Dermatitis
- Hematomas or purpura
- Edema or urticaria
- Inflammation
- Discharge

**Neurosensory System**

- Cognitive dysfunction
- Hearing loss
- Visual changes
- Headaches and migraines
- Ataxia
- Tetany

### Gender

There are differences in the immune system functions of men and women. For example, many autoimmune diseases have a higher incidence in females than in males, a phenomenon believed to be correlated with sex hormones. Sex hormones have long been recognized for their role in reproductive function, and in the past two decades research has revealed that these hormones are integral signaling modulators of the immune system. Sex hormones play definitive roles in lymphocyte maturation, activation, and synthesis of antibodies and cytokines. In autoimmune disease, expression of sex hormones is altered, and this change contributes to immune dysregulation (Ackerman, 2006).

### Gerontologic Considerations

Immunosenescence is a complex route in which the aging process stimulates changes in the immune system. The immune system undergoes age-associated alterations that lead to a progressive deterioration in the ability to respond to infections. The capacity for self-renewal of hematopoietic stem cells diminishes. There is a notable decline in the total number of phagocytes, coupled with an intrinsic reduction in their activity. The cytotoxicity of NK cells decreases, contributing to a decline in humoral immunity (Kovalou & Gribeck-Loebenstein, 2006). Acquired immunity may be negatively affected; the efficacy of vaccines is frequently decreased in older adults. Natural immunity, however, continues to function reasonably well, perhaps as an adaptive response to the deterioration of cell-mediated immunity in old age (Aw, Silva & Palmer, 2007).

The incidence of autoimmune diseases also increases with age, possibly from a decreased ability of antibodies to differentiate between self and non-self. Failure of the surveillance system to recognize mutant or abnormal cells also may be responsible, in part, for the high incidence of cancer associated with increasing age.

Age-related changes in many body systems also contribute to impaired immunity (Table 50-4). Decreased gastric secretions and motility allow normal intestinal flora to proliferate and produce infection, causing gastroenteritis and diarrhea. Decreased renal circulation, filtration, absorption, and excretion contribute to the risk for urinary tract infections. Moreover, prostatic enlargement or a neurogenic bladder can impede urine passage and impair bacterial clearance through the urinary system. Urinary stasis permits the growth of microorganisms (Bengmark, 2006). Prolonged exposure to tobacco and environmental toxins impairs pulmonary function and decreases the elasticity of lung tissue, the effectiveness of cilia, and the ability to cough effectively. These impairments hinder the removal of infectious organisms and toxins, increasing the older person's susceptibility to pulmonary infections and cancers. The skin becomes thinner and less elastic. Impaired skin integrity predisposes older people to infection from organisms that are part of normal skin flora. Secondary changes, including malnutrition and poor circulation, as well as the breakdown of natural mechanical barriers such as the skin, place the aging immune system at even greater disadvantage against infection. In addition, the increased incidence of peripheral neuropathy and the accompanying decreased sensation and circulation may lead to stasis ulcers, pressure ulcers, abrasions, and burns.

The effects of the aging process and psychological stress interact, with the potential to negatively influence immune integrity (Graham, Christian & Kiecolt-Glaser, 2006; Sandman-Goddard, Peeva & Shoenfeld, 2007). Consequently, continual assessment of the physical and emotional status of the elderly is imperative, because early recognition and management of factors influencing immune response

**Table 50-4 AGE-RELATED CHANGES IN IMMUNOLOGIC FUNCTION**

| Body System | Changes | Consequences |
|---|---|---|
| Immune | Impaired function of B and T lymphocytes<br>Failure of lymphocytes to recognize mutant or abnormal cells<br>Decreased antibody production<br>Failure of immune system to differentiate "self" from "non-self"<br>Suppressed phagocytic immune response | Suppressed responses to pathogenic organisms with increased risk for infection<br>Increased incidence of cancers<br>Anergy (lack of response to antigens applied to the skin [allergens])<br>Increased incidence of autoimmune diseases<br>Absence of typical signs and symptoms of infection and inflammation<br>Dissemination of organisms usually destroyed or suppressed by phagocytes (eg, reactivation or spread of tuberculosis) |
| Gastrointestinal | Decreased gastric secretions and motility<br>Decreased phagocytosis by the liver's Kupffer cells<br>Altered nutritional intake with inadequate protein intake | Proliferation of intestinal organisms resulting in gastroenteritis and diarrhea<br>Increased incidence and severity of hepatitis B; increased incidence of liver abscesses<br>Suppressed immune response |
| Urinary | Decreased kidney function and changes in lower urinary tract function (enlargement of prostate gland, neurogenic bladder). Altered genitourinary tract flora | Urinary stasis and increased incidence of urinary tract infections |
| Pulmonary | Impaired ciliary action due to exposure to smoke and environmental toxins | Impaired clearance of pulmonary secretions; increased incidence of respiratory infections |
| Integumentary | Thinning of skin with less elasticity; loss of adipose tissue | Increased risk of skin injury, breakdown, and infection |
| Circulatory | Impaired microcirculation | Stasis and pressure ulcers |
| Neurologic function | Decreased sensation and slowing of reflexes | Increased risk of injury, skin ulcers, abrasions, and burns |

may prevent or mitigate the high morbidity and mortality seen with illness in the elderly population (Pawelec, 2006; Woodland & Blackman, 2006).

### Nutrition

The relationship of infection to nutritional status is a key determinant of human health. Traditionally, this relationship focused on the effect of nutrients on host defenses and the effect of infection on nutritional needs. This has expanded in scope to encompass the role of specific nutrients in acquired immune function—the modulation of inflammatory processes and the virulence of the infectious agent itself. Iron may have beneficial or deleterious effects on the immune system, and further research is needed (Munoz, Rios, Olivos, et al., 2007). The list of nutrients affecting infection, immunity, inflammation, and cell injury has expanded from traditional proteins to several vitamins, multiple minerals, and more recently specific lipid components of the diet (Puertollano, Puertollano, Alvarez de Cienfuegos, et al., 2007). Vitamin D deficiency has been associated with increased risk of common cancers, autoimmune diseases, and infectious diseases (Maggini, Wintergerst, Beveridge, et al., 2007). More recently, the role of micronutrients and fatty acids on the response of cells and tissues to hypoxic and toxic damage has been recognized, suggesting that there is another dimension to the relationship. Micronutrients such as zinc, copper, manganese, and selenium may have widespread negative effects on the immune response, which can be reversed by supplementation (Overbeck, Rink & Hasse, 2008).

The effects exerted by polyunsaturated fatty acids on immune system functions are under investigation. Studies show that these elements play a role in diminishing the incidence and severity of inflammatory disorders. Recent studies show that diets high in olive oil are not as immunosuppressive as diets rich in fish oil. The contribution of immune modulation by lipids to the high risk of infectious complications associated with the use of parenteral nutrition is unclear (Hise, Compher, Harlan, et al., 2006).

Depletion of protein reserves results in atrophy of lymphoid tissues, depression of antibody response, reduction in the number of circulating T cells, and impaired phagocytic function. As a result, susceptibility to infection is greatly increased. During periods of infection or serious illness, nutritional requirements may be further altered, potentially contributing to depletion of protein, fatty acid, vitamin, and trace elements and causing even greater risk of impaired immune response and sepsis. Nutritional intake that supports a competent immune response plays an important role in reducing the incidence of infections; patients whose nutritional status is compromised have a delayed postoperative recovery and often experience more severe infections and delayed wound healing. The nurse must assess the patient's nutritional status, caloric intake, and quality of foods ingested. There is evidence that nutrition plays a role in the development of cancer and that diet and lifestyle can alter the risk of cancer development as well as other chronic diseases (Valdes-Ramos, Benitez & Alejandra, 2007). The nurse is responsible for assuming a proactive role in ensuring the best possible nutritional intake for all patients as a vital step in preventing disease and poor outcomes (Morse & High, 2005).

### Infection and Immunization

The patient is asked about childhood and adult immunizations, including vaccinations, to provide protection against influenza, pneumococcal disease (Pneumovax), pertussis, herpes simplex, and the usual childhood diseases (eg, measles, mumps). Herpes simplex virus (HSV) infections have a significant impact on health, causing a wide range of diseases (eg, oral and genital herpes). Teaching about the importance of adhering to the recommended schedule for these vaccines should be initiated. Known past or present exposure to tuberculosis is assessed, and the dates and results of any tuberculin tests (purified protein derivative [PPD] or tine test) and chest x-rays are documented. Recent exposure to any infections and the exposure dates are elicited. It is important for the nurse to assess whether the patient has been exposed to any sexually transmitted diseases (STDs) or bloodborne pathogens such as hepatitis A, B, C, D, and E viruses and human immunodeficiency virus (HIV). A history of STDs such as gonorrhea, syphilis, human papillomavirus (HPV) infection, and chlamydia can alert the nurse that the patient may have been exposed to HIV or hepatitis. A history of past and present infections and the dates and types of treatments, along with a history of any multiple persistent infections, fevers of unknown origin, lesions or sores, or any type of drainage, as well as the response to treatment are obtained.

### Allergy

The patient is asked about any allergies, including types of allergens (eg, pollens, dust, plants, cosmetics, food, medications, vaccines, latex), the symptoms experienced, and seasonal variations in occurrence or severity in the symptoms. A history of testing and treatments, including prescribed and over-the-counter medications that the patient has taken or is currently taking for these allergies and the effectiveness of the treatments, is obtained. All medication and food allergies are listed on an allergy alert sticker and placed on the front of the patient's health record or chart to alert others. Continued assessment for potential allergic reactions in the patient is vital.

### Disorders and Diseases

#### Autoimmune Disorders

Autoimmune disorders affect people of both genders of all ages, ethnicities, and social classes. Specific autoimmune disorders affect approximately 5% of the U.S. population. As mentioned previously, they tend to be more common in women because estrogen tends to enhance immunity. Androgen, on the other hand, tends to be immunosuppressive. Autoimmune diseases are the fifth leading cause of death by disease in females of reproductive age.

The patient is asked about any autoimmune disorders, such as lupus erythematosus, rheumatoid arthritis, multiple sclerosis, or psoriasis. The onset, severity, remissions and exacerbations, functional limitations, treatments that the patient has received or is currently receiving, and effectiveness of the treatments are described. The occurrence of different autoimmune diseases within a family strongly suggests a genetic predisposition to more than one autoimmune disease (Hawker, 2008; Yurasov & Nussenzweig, 2007).

### Neoplastic Disease

If there is a history of cancer in the family, the type of cancer, age at onset, and relationship (maternal or paternal) of the patient to the affected family members is noted. Dates and results of any cancer screening tests for the patient are documented. A history of cancer in the patient is also obtained, along with the type of cancer, date of diagnosis, and treatment modalities used. Immunosuppression contributes to the development of cancers; however, cancer itself is immunosuppressive, as is the treatment for cancer. Large tumors can release antigens into the blood, and these antigens combine with circulating antibodies and prevent them from attacking the tumor cells. Furthermore, tumor cells may possess special blocking factors that coat tumor cells and prevent their destruction by killer T lymphocytes. During the early development of tumors, the body may fail to recognize the tumor antigens as foreign and subsequently fail to initiate destruction of the malignant cells. Hematologic cancers, such as leukemia and lymphoma, are associated with altered production and function of WBCs and lymphocytes.

All treatments that the patient has received or is currently receiving, such as radiation or chemotherapy, are recorded in the health history. In addition, the nurse should elicit information related to complementary or alternative modalities that have been used and the response to these efforts. Radiation destroys lymphocytes and decreases the ability to mount an effective immune response. The size and extent of the irradiated area determine the extent of immunosuppression. Whole-body irradiation may leave the patient totally immunosuppressed. Chemotherapy also affects bone marrow function, destroying cells that contribute to an effective immune response and resulting in immunosuppression (Sompayrac, 2008).

### Chronic Illness and Surgery

The health assessment includes a history of chronic illness, such as diabetes mellitus, renal disease, chronic obstructive pulmonary disease (COPD), or fibromyalgia. The onset and severity of illnesses, as well as treatment that the patient is receiving for the illness, are obtained. Chronic illness may contribute to immune system impairments in various ways. Renal failure is associated with a deficiency in circulating lymphocytes. In addition, immune defenses may be altered by acidosis and uremic toxins. In diabetes, an increased incidence of infection has been associated with vascular insufficiency, neuropathy, and poor control of serum glucose levels. Recurrent respiratory tract infections are associated with COPD as a result of altered inspiratory and expiratory function and ineffective airway clearance. Additionally, a history of organ transplantation or surgical removal of the spleen, lymph nodes, or thymus is noted, because these conditions may place the patient at risk for impaired immune function (Doering, Martinez-Maza, Vredevoe, et al., 2008).

### Special Problems

Conditions such as burns and other forms of injury and infection may contribute to altered immune system function. Major burns cause impaired skin integrity and compromise the body's first line of defense. Loss of large amounts of serum occurs with burn injuries and depletes the body of essential proteins, including immunoglobulins. The physiologic and psychological stressors associated with surgery or injury stimulate cortisol release from the adrenal cortex; increased serum cortisol also contributes to suppression of normal immune responses (Shankar, Melstrom & Gamelli, 2007).

### *Medications and Blood Transfusions*

A list of past and present medications is obtained. In large doses, antibiotics, corticosteroids, cytotoxic agents, salicylates, nonsteroidal anti-inflammatory drugs (NSAIDs), and anesthetic agents can cause immune suppression (Table 50-5).

A history of blood transfusions is obtained, because previous exposure to foreign antigens through transfusion may be associated with abnormal immune function. Additionally, although the risk of HIV transmission through blood transfusion is extremely low in patients who received a transfusion after 1985 (when testing of blood for HIV was initiated in the United States), a small risk remains.

The patient is also asked about use of herbal agents and over-the-counter medications. Because many of these products have not been subjected to rigorous testing, their effects have not been fully identified. It is important, therefore, to ask patients about their use of these substances, to document their use, and to educate patients about untoward effects that may alter immune responsiveness.

### *Lifestyle Factors*

Like any other body system, the functions of the immune system depend on other body systems. Poor nutritional status, smoking, excessive consumption of alcohol, illicit drug use, STDs, and occupational or residential exposure to environmental radiation and pollutants have been associated with impaired immune function and are assessed in a detailed patient history. Although factors that are not consistent with a healthy lifestyle are predominately responsible for ineffective immune function, positive lifestyle factors can also negatively affect immune function and require assessment. For example, rigorous exercise or competitive exercise—usually considered a positive lifestyle factor—can be a physiologic stressor and cause negative effects on immune response (Friedrich, 2008). This outcome is compounded if the person also faces stressful environmental conditions while undergoing exercise. Given the cumulative impact of various environmental stressors on the immune system, every effort should be made to minimize the person's exposure to stressors other than the exercise performed (Raso, Benard, Da Silva Duarte, et al., 2007).

### *Psychoneuroimmunologic Factors*

Patient assessment must also address psychoneuroimmunologic factors. The bidirectional pathway between the brain and immune system is referred to as psychoneuroimmunology, a field that has been the focus of research and discussion over the last several decades (Starkweather, Witek-Janusek, Peterson, et al., 2006; Steel, Geller, Gamblin, et al., 2007). It is thought that the immune response is regulated and modulated in part by neuroendocrine influences. Lymphocytes and macrophages have receptors that are capable of responding to neurotransmitters and endocrine hormones.

**Table 50-5 SELECTED MEDICATIONS AND EFFECTS ON THE IMMUNE SYSTEM**

| Drug Classification (and Examples) | Effects on the Immune System |
|---|---|
| **Antibiotics (in large doses)** | **Bone Marrow Suppression** |
| ceftriaxone (Rocefin) | Eosinophilia, hemolytic anemia, hypoprothrombinemia, neutropenia, thrombocytopenia |
| cefuroxime sodium (Ceftin) | Eosinophilia, hemolytic anemia, hypoprothrombinemia, neutropenia, thrombocytopenia |
| chloramphenicol (Chloromycetin) | Leukopenia, aplastic anemia |
| dactinomycin (Cosmogen) | Agranulocytosis, neutropenia |
| fluoroquinolones (Cipro, Levaquin, Tequin) | Hemolytic anemia, methemoglobinemia, eosinophilia, leukopenia, pancytopenia |
| gentamicin sulfate (Garamycin) | Agranulocytosis, granulocytosis |
| macriolides (erythromycin, Zithromax, Biaxin) | Neutropenia, leukopenia |
| penicillins | Agranulocytosis |
| streptomycin | Leukopenia, neutropenia, pancytopenia |
| vancomycin (Vancocin, Vancoled) | Transient leukopenia |
| **Antithyroid Drugs** | |
| propylthiouracil (PTU) | Agranulocytosis, leukopenia |
| **Nonsteroidal Anti-inflammatory Drugs (NSAIDs) (in large doses)** | **Inhibit Prostaglandin Synthesis or Release** |
| aspirin | Agranulocytosis |
| COX-2 inhibitors | Anemia, allergy, no major other adverse affects to the immune system |
| ibuprofen (Advil, Motrin) | Leukopenia, neutropenia |
| indomethacin (Indocid, Indocin) | Agranulocytosis, leukopenia |
| phenylbutazone | Pancytopenia, agranulocytosis, aplastic anemia |
| **Adrenal Corticosteroids** | **Immunosuppression** |
| prednisone | |
| **Antineoplastic Agents (cytotoxic agents)** | **Immunosuppression** |
| alkylating agents | Leukopenia, bone marrow suppression |
| cyclophosphamide (Cytoxan) | Leukopenia, neutropenia |
| mechlorethamine HCl (Mustargen) | Agranulocytosis, neutropenia |
| cyclosporine | Leukopenia, inhibits T-lymphocyte function |
| **Antimetabolites** | **Immunosuppression** |
| fluorouracil (pyrimidine antagonist) | Leukopenia, eosinophilia |
| methotrexate (folic acid antagonist) | Leukopenia, aplastic bone marrow |
| mercaptopurine (6-MP) (purine antagonist) | Leukopenia, pancytopenia |

Lymphocytes can produce and secrete adrenocorticotropic hormone and endorphinlike compounds. Cells in the brain, especially in the hypothalamus, can recognize prostaglandins, interferons, and interleukins as well as histamine and serotonin, which are released during the inflammatory process. Like all other biologic systems functioning to maintain homeostasis, the immune system is integrated with other psychophysiologic processes and is subject to regulation and modulation by the brain. These relationships may have immunologic consequences (Chart 50-4).

Conversely, the immune processes can affect neural and endocrine function, including behavior. Growing evidence indicates that a measurable immune system response can be positively influenced by biobehavioral strategies such as relaxation and imagery techniques, biofeedback, humor, hypnosis, and conditioning (Stephenson, Swanson, Dalton, et al., 2007). Therefore, the assessment should address the patient's general psychological status and the patient's use of and response to these strategies.

### Physical Assessment

On physical examination (see Chart 50-3), the skin and mucous membranes are assessed for lesions, dermatitis, purpura (subcutaneous bleeding), urticaria, inflammation, or any discharge. Any signs of infection are noted. The patient's temperature is recorded, and the patient is observed for chills and sweating. The anterior and posterior cervical, axillary, and inguinal lymph nodes are palpated for enlargement; if palpable nodes are detected, their location, size, consistency, and reports of tenderness on palpation are noted. Joints are assessed for tenderness, swelling, increased warmth, and limited range of motion. The patient's respiratory, cardiovascular, genitourinary, gastrointestinal, and neurosensory systems are evaluated for signs and symptoms indicative of immune dysfunction. Any functional limitations or disabilities the patient may have are also assessed.

## Diagnostic Evaluation

A series of blood tests and skin tests and a bone marrow biopsy may be performed to evaluate the patient's immune competence. Specific laboratory and diagnostic tests are discussed in greater detail along with individual disease processes in subsequent chapters in this unit. Selected laboratory and diagnostic tests used to evaluate immune competence are summarized in Chart 50-5.

CHART 50-4

NURSING RESEARCH PROFILE

## *Factors Affecting Immune Responses in Breast Cancer*

Von Ah, D., Hang, D. & Carpenter, J. (2007). Stress, optimism and social support: Impact on immune responses in breast cancer. *Research in Nursing and Health, 30*(1), 72–83.

### Purpose

The stress of a breast cancer diagnosis and initial surgical treatment can produce a variety of negative sequelae and impaired immune responses. The purpose of this study was to examine the roles of stress, optimism, and satisfaction with social support and their interactions in relation to immune responses in women who had been diagnosed with breast cancer and who had undergone surgical treatment.

### Design

Researchers used a correlational, cross-sectional design to study the hypothesized relationships. They recruited, from one outpatient breast health center, a convenience sample of 54 women, 19 years of age and older, newly diagnosed with stage 0 or ductal carcinoma in situ, who were postsurgery (at least 7 days) and who had not received any other treatment. To collect demographic and medical data, investigators relied on self-report questionnaires and verified the results using medical record review. They used various measures of psychological factors: the Impact of Event Scale for perceived stress, the Life Orientation Test for optimism, and the Social Support Questionnaire for satisfaction with social support. Immunologic assessments measured natural killer cells and cytokine levels that are known to promote cell-mediated immunity and enhance natural killer cell activity.

### Findings

The mean age of the participants was 55 years. They represented the racial diversity of the local population, and the majority of women were married and well educated, with a middle-income level. Women had stage I or II breast cancer and were surgically treated with either lumpectomy or modified mastectomy. Although they reported moderately significant levels of stress, the women were generally optimistic and had exceptionally high levels of satisfaction with their social support. Women with higher levels of perceived stress had lower natural killer cell activity and cytokine levels than women with lower levels of stress. Optimism and satisfaction with social support did not have direct main effects on any of the immune responses examined.

The most robust finding was the significant negative relationship between stress and natural killer cell activity and cytokine level that underscores the negative sequelae of cancer-specific stress on immune responses in women following breast cancer surgery. In addition, the study partially supported the hypothesis that optimism and social support moderated the relationship of stress on natural killer cell activity and cytokine level. Stress significantly interacted with optimism to predict natural killer cell activity. In the significant interaction between stress and optimism, natural killer cell activity was lowest when the participant reported greater stress and lower optimism. Satisfaction with social support did not have a stress-buffering effect on any of the immune indices examined in the study.

### Nursing Implications

This study illustrates the need to identify supportive interventions that will have a positive effect on the issues faced by women who are undergoing surgical treatment for breast cancer. Interventions directed to the reduction of stress and enhancing optimism in women with breast cancer are warranted to achieve quality outcomes in these patients.

## Nursing Management

The nurse needs to be aware that patients undergoing evaluation for possible immune system disorders experience not only physical pain and discomfort with certain types of diagnostic procedures, but also many psychological reactions. It is the nurse's role to counsel, educate, and support patients throughout the diagnostic process. Many patients may be extremely anxious about the results of diagnostic tests and the possible implications of those results for their employment, insurance, and personal relationships. This is an ideal time for the nurse to provide counseling and education, should these interventions be warranted.

## Chart 50-5 • *Selected Tests for Evaluating Immunologic Status*

Various laboratory tests may be performed to assess immune system activity or dysfunction. The studies assess leukocytes and lymphocytes, humoral immunity, cellular immunity, phagocytic cell function, complement activity, hypersensitivity reactions, specific antigen–antibodies, or human immunodeficiency virus (HIV) infection.

### Humoral (Antibody-mediated) Immunity Tests

- B-cell quantification with monoclonal antibody
- In vivo immunoglobulin synthesis with T-cell subsets
- Specific antibody response
- Total serum globulins and individual immunoglobulins (electrophoresis, immunoelectrophoresis, single radial immunodiffusion, nephelometry, and isohemagglutinin techniques)

### Cellular (Cell-mediated) Immunity Tests

- Total lymphocyte count
- T-cell and T-cell-subset quantification with monoclonal antibody
- Delayed hypersensitivity skin test
- Cytokine production
- Lymphocyte response to mitogens, antigens, and allogenic cells
- Helper and suppressor T-cell functions

## CRITICAL THINKING EXERCISES

**1** A 70-year-old woman is referred to the allergy and immunology clinic for evaluation of her immune status. In addition to the eight medications she routinely takes, she has received several courses of antibiotics in the previous months for recurrent infections. What diagnostic tests would you expect to be ordered? What is the rationale for these? What further assessment data would you want to obtain from this patient?

EBP **2** A 38-year-old woman is hospitalized for a heart transplant, and immunosuppressant medications are prescribed. Describe how her altered immune function would affect the care that you provide. Develop an evidence-based teaching plan for the patient and her family before hospital discharge. Discuss the criteria used to assess the strength of the evidence for your teaching plan.

**3** A 24-year-old woman is diagnosed with systemic lupus erythematosus (SLE), and corticosteroids are prescribed. What nursing observations and assessments are indicated? Identify patient teaching that is appropriate for the new diagnosis and prescription of steroids.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

Centers for Disease Control and Prevention, www.cdc.gov
National Institute of Allergy and Infectious Disease, www3.niaid.nih.gov/
National Institutes of Health, www.nih.gov/health/infoline.htm
U.S. Department of Health and Human Services, www.hhs.gov



chapter 51

# Management of Patients With Immunodeficiency

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Compare the different types of primary immunodeficiency disorders and their causes, clinical manifestations, potential complications, and treatment modalities.
2. Describe the nursing management of the patient with an immunodeficiency.
3. Identify the essential teaching needs for a patient with an immunodeficiency.

## GLOSSARY

**agammaglobulinemia:** disorder marked by an almost complete lack of immunoglobulins or antibodies

**angioneurotic edema:** condition marked by development of urticaria and an edematous area of skin, mucous membranes, or viscera

**ataxia:** loss of muscle coordination

**ataxia-telangiectasia:** autosomal recessive disorder affecting T- and B-cell immunity primarily seen in children and resulting in a degenerative brain disease

**hypogammaglobulinemia:** lack of one or more of the five immunoglobulins; caused by B-cell deficiency

**immunocompromised host:** person with a secondary immunodeficiency and associated immunosuppression

**panhypoglobulinemia:** general lack of immunoglobulins in the blood

**severe combined immunodeficiency disease:** disorder involving a complete absence of humoral and cellular immunity resulting from an X-linked or autosomal genetic abnormality

**telangiectasia:** vascular lesions caused by dilated blood vessels

**thymic hypoplasia:** T-cell deficiency that occurs when the thymus gland fails to develop normally during embryogenesis; also known as DiGeorge syndrome

**Wiskott-Aldrich syndrome:** immunodeficiency characterized by thrombocytopenia and the absence of T and B cells

Immunodeficiency disorders may be caused by a defect in or a deficiency of phagocytic cells, B lymphocytes, T lymphocytes, or the complement system. The specific symptoms and their severity, age at onset, and prognosis depend on the immune system components affected and their degree of functional impairment. Regardless of the underlying cause, the cardinal symptoms of immunodeficiency include chronic or recurrent and severe infections, infections caused by unusual organisms or by organisms that are normal body flora, poor response to standard treatment for infections, and chronic diarrhea. In addition, the patient is susceptible to a variety of secondary disorders, including autoimmune disease and lymphoreticular malignancies (Cooper & Schroeder, 2008).

Immunodeficiencies may be acquired spontaneously or as a consequence of medical treatment. These disorders can be classified as either primary or secondary and by the affected components of the immune system. Primary immunodeficiency diseases are genetic in origin and result from intrinsic defects in the cells of the immune system. In contrast, secondary immunodeficiencies result from external factors such as infection. Effective nursing care reflects knowledge of the immune system, potential secondary disorders, relevant assessment parameters, and strategies for symptom management, as well as sensitivity and responsiveness to the learning needs of the patient and caregiver.

## PRIMARY IMMUNODEFICIENCIES

Primary immunodeficiencies represent inborn errors of immune function that predispose people to frequent, severe infections; autoimmunity; and cancer. Advances in medical treatment have meant that patients with primary immunodeficiencies live longer, thus increasing their overall risk of developing cancer (Salavoura, Koloalexi, Tsangaris, et al., 2008). The type of malignancy depends on the immunodeficiency, the age of the patient, and possible viral infection, which suggests that different pathogenic mechanisms are implicated in each case. Non-Hodgkin lymphomas account for the majority of cancers. The primary immunodeficiencies known to be associated with increased incidence of malignancy are common variable immunodeficiency, immunoglobulin A (IgA) deficiency, and deoxyribonucleic acid (DNA) repair disorders. More recently, investigators have shown that **severe combined immunodeficiency disease (SCID)** and **Wiskott-Aldrich syndrome** (thrombocytopenia and the absence of T and B cells) may also lead to cancer (Salavoura, et al., 2008). People with various primary immunodeficiencies, who are predisposed to cancer, exhibit immune deficits that also increase their susceptibility to fungal infections. A number of yeasts, molds, and fungi may cause infections in patients with chronic granulomatous disease, SCID, chronic mucocutaneous candidiasis, and common variable immunodeficiency (CVID); these infections may occasionally be the presenting clinical manifestation of a primary immunodeficiency. If the immune condition is misdiagnosed or mistreated, it can lead to significant morbidity and mortality (Antachopoulos, Walsh & Rollides, 2007).

The majority of primary immunodeficiencies are diagnosed in infancy, with a male-to-female ratio of 5 to 1. However, a large fraction of primary immunodeficiencies are not diagnosed until adolescence or early adulthood, when the gender distribution equalizes. Diagnosis at this stage frequently is confounded by frequent use of antibiotics that mask symptoms. On occasion, adults present with clinical episodes of infectious diseases that are beyond the scope of normal immunocompetence. Examples include infections that are unusually persistent, recurrent, or resistant to treatment and those involving unexpected dissemination of disease or atypical pathogens. To date, more than 120 immunodeficiencies of genetic origin have been identified (Verbsky & Grossman, 2006).

Common primary immunodeficiencies include disorders of humoral immunity (affecting B-cell differentiation or antibody production), T-cell defects, combined B- and T-cell defects, phagocytic disorders, and complement deficiencies. These disorders may involve one or more components of the immune system. Symptoms of immune deficiency disorders are related to the deficient component (Table 51-1). Major signs and symptoms include multiple infections despite aggressive treatment, infections with unusual or opportunistic organisms, failure to thrive or poor growth, and a positive family history (Cooper & Schroeder, 2008).

## *Phagocytic Dysfunction*

### Pathophysiology

A variety of primary defects of phagocytes may occur; almost all of them are genetic in origin and affect the natural (innate) immune system. In some types of phagocytic disorders, the neutrophils are impaired so that they cannot exit the circulation and travel to sites of infection. As a result, the person cannot initiate a normal inflammatory response against pathogenic organisms. In some disorders, the neutrophil count may be very low; in others, it may be very high because the neutrophils remain in the vascular system. Phagocytic cell disorders are characterized by disease-specific infections, such as chronic granulomatous disease (Abbas, Lichtman & Baker, 2008).

### Clinical Manifestations

In phagocytic cell disorders there is an increased incidence of bacterial and fungal infections caused by organisms that are normally nonpathogenic. People with these disorders may also develop fungal infections from *Candida* organisms and viral infections from herpes simplex or herpes zoster. These patients experience recurrent cutaneous abscesses, chronic eczema, bronchitis, pneumonia, chronic otitis media, and sinusitis. In one rare type of phagocytic disorder, hyperimmunoglobulinemia E syndrome (formerly known as Job syndrome), white blood cells cannot initiate an inflammatory response to infectious organisms. This results in recurrent bacterial infections of the skin and lung; abnormalities of connective tissue, skeleton, and dentition; and extremely elevated levels of IgE (Freeman & Holland, 2008).

Although patients with phagocytic cell disorders may be asymptomatic, severe neutropenia may present and may be accompanied by deep and painful mouth ulcers, gingivitis, stomatitis, and cellulitis. Death from overwhelming infection

**Table 51-1 SELECTED PRIMARY IMMUNODEFICIENCY DISORDERS**

| Immune Component | Disorder | Major Symptoms | Treatment |
|---|---|---|---|
| Phagocytic cells | Hyperimmunoglobulinemia E (HIE) syndrome | Bacterial, fungal, and viral infections; deep-seated cold abscesses | Antibiotic therapy and treatment for viral and fungal infections<br>Granulocyte-macrophage colony-stimulating factor (GM-CSF); granulocyte colony-stimulating factor (G-CSF) |
| B lymphocytes | Sex-linked agammaglobulinemia (Bruton's disease) | Severe pyogenic infections soon after birth | Passive pooled plasma or gamma-globulin |
| | Common variable immunodeficiency (CVID) | Bacterial infections, infection with *Giardia lamblia* | Intravenous immunoglobulin (IVIG)<br>Metronidazole (Flagyl)<br>Quinacrine HCl (Atabrine) |
| | | Pernicious anemia | Vitamin $B_{12}$ |
| | | Chronic respiratory infections | Antimicrobial therapy |
| | Immunoglobulin A (IgA) deficiency | Predisposition to recurrent infections, adverse reactions to blood transfusions or immunoglobulin, autoimmune diseases, hypothyroidism | None |
| | $IgC_2$ deficiency | Heightened incidence of infectious diseases | Pooled immunoglobulin |
| T lymphocytes | Thymic hypoplasia (DiGeorge syndrome) | Recurrent infections; hypoparathyroidism, hypocalcemia, tetany, convulsions, congenital heart disease, possible renal abnormalities; abnormal facies | Thymus graft |
| | Chronic mucocutaneous candidiasis | *Candida albicans* infections of mucous membrane, skin, and nails; endocrine abnormalities (hypoparathyroidism, Addison's disease) | Antifungal agents:<br>Topical: miconazole<br>Oral: clotrimazole, ketoconazole<br>IV: amphotericin B |
| B and T lymphocytes | Ataxia-telangiectasia | Ataxia with progressive neurologic deterioration, telangiectasia (vascular lesions), recurrent infections; malignancies | Antimicrobial therapy; management of presenting symptoms; fetal thymus transplant, IVIG |
| | Nezelof's syndrome | Severe infections, malignancies | Antimicrobial therapy; IVIG, bone marrow transplantation; thymus transplantation; thymus factors |
| | Wiskott-Aldrich syndrome | Thrombocytopenia, resulting in bleeding, infections; malignancies | Antimicrobial therapy; splenectomy with continuous antibiotic prophylaxis; IVIG and bone marrow transplantation |
| | Severe combined immunodeficiency disease (SCID) | Overwhelming severe fatal infections soon after birth (also includes opportunistic infections) | Antimicrobial therapy; IVIG and bone marrow transplantation |
| Complement system | Angioneurotic edema | Episodes of edema in various parts of the body, including respiratory tract and bowels | Pooled plasma, androgen therapy |
| | Paroxysmal nocturnal hemoglobinuria (PNH) | Lysis of erythrocytes due to lack of decay-accelerating factor (DAF) on erythrocytes | None |

occurs in about 10% of patients with severe neutropenia. Chronic granulomatous disease, another type of primary phagocytic disorder, produces recurrent or persistent infections of the soft tissues, lungs, and other organs; these are resistant to aggressive treatment with antibiotics (Tierney, McPhee & Papadakis, 2008).

## Assessment and Diagnostic Findings

Diagnosis is based on the history, signs and symptoms (see Chart 50-3), and laboratory analysis by the nitroblue tetrazolium reductase test, which indicates the cytocidal (causing death of cells) activity of the phagocytic cells. A history of recurrent infection and fever, including the treatment given, in a child, and occasionally in an adult, is an important key to diagnosis; timely intervention can prevent morbidity and mortality (DeSilva, Gunawardena, Wickremesinghe, et al., 2007). Failure of an infection to resolve with the usual treatment is an important indicator. Warning signs of primary immunodeficiency disorders are summarized in Figure 51-1.

## Medical Management

Patients with neutropenia continue to be at increased risk for development of severe infections despite substantial advances in supportive care. Epidemiologic shifts occur periodically and need to be detected early because they influence prophylactic, empiric, and specific strategies for medical management. Attention to infection control practices is

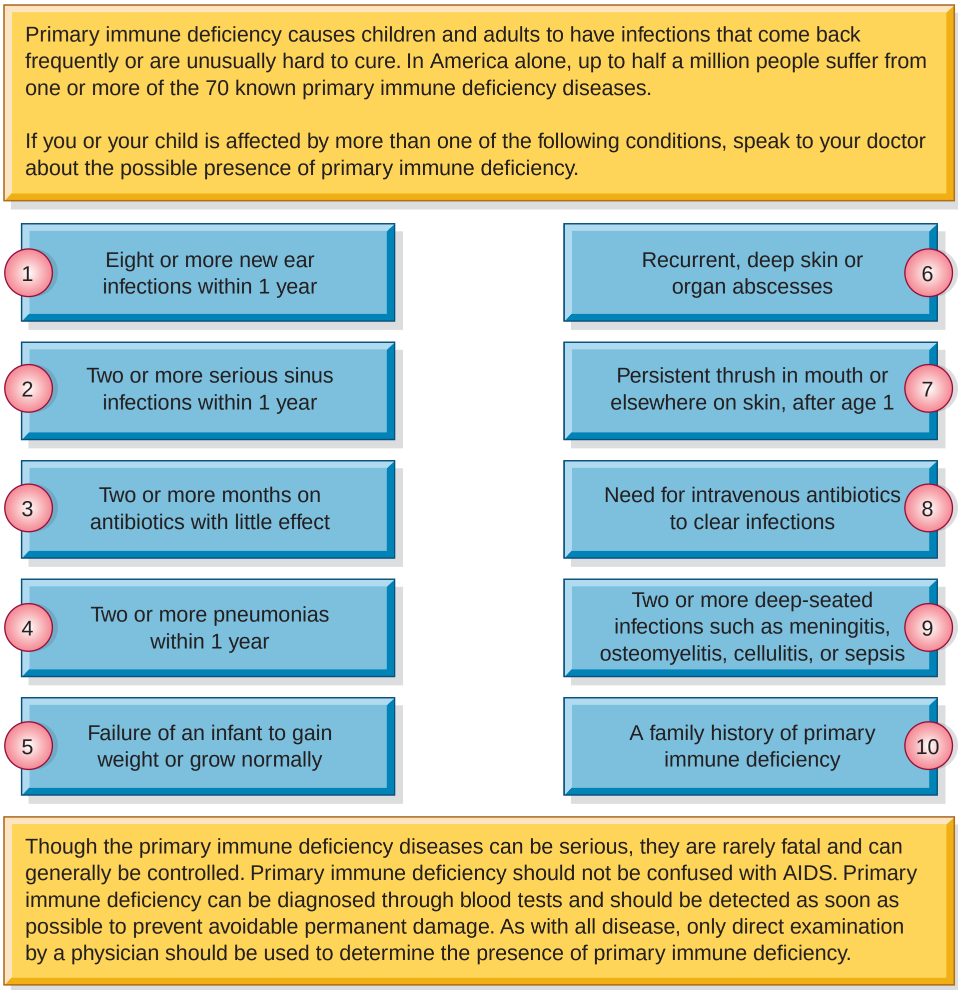



**Figure 51-1** The 10 warning signs of primary immune deficiency. Education materials developed by the Jeffrey Modell Foundation Medical Advisory Board, New York. Used with permission.

important, especially with the emergence of multidrug-resistant organisms. Although it is effective in preventing some bacterial and some fungal infections, prophylactic drug treatment must be used with caution, because it has been implicated in the emergence of resistant organisms. The choices for empiric therapy include combination regimens and monotherapy. Specific choices depend on local factors (epidemiology, susceptibility/resistance patterns, availability, cost). Home and inpatient settings are also available and the selection of setting depends on the patient's risk category. Early diagnosis and appropriate treatment of many fungal and viral infections remains suboptimal in many cases (Saria & Gosselin-Acomb, 2007).

While granulocyte transfusions are used as a medical treatment, they are seldom successful because of the short half-life of these cells. Treatment with granulocyte-macrophage colony-stimulating factor (GM-CSF) or granulocyte colony-stimulating factor (G-CSF) may prove successful, because these proteins draw nonlymphoid stem cells from the bone marrow and hasten their maturation. Cell therapy, which refers to the provision of living cells to patients for the prevention of human disease, may be effective. (The infusion of blood and blood products is the best established and most widely practiced form of cell therapy.) Hematopoietic stem cell transplantation (HSCT), another form of cell therapy, has proven to be a successful curative modality. The stem cells may be from embryos or adults. However, toxicity and reduced efficacy are frequent limitations of HSCT (Antachopoulos, et al., 2007; DeSilva, et al., 2007). Another emerging therapy involves the use of cells as vehicles for the delivery of genes or gene products. However, gene therapy has many side effects and needs further improvement (Santilli, Thompson, Kinnon, et al., 2008).

## B-Cell Deficiencies

### Pathophysiology

Two types of inherited B-cell deficiencies exist. The first type results from lack of differentiation of B-cell precursors into mature B cells. As a result, plasma cells are absent, and the germinal centers from all lymphatic tissues disappear, leading to a complete absence of antibody production against invading bacteria, viruses, and other pathogens. This syndrome is called X-linked **agammaglobulinemia** (Bruton's disease), because all antibodies disappear from the patient's plasma. B cells in the peripheral blood and IgG,

IgM, IgA, IgD, and IgE are low or absent. Infants born with this disorder suffer from severe infections starting soon after birth. Males are at a high risk for having X-linked agammaglobulinemia if they have an affected male relative. More than 10% of patients with X-linked agammaglobulinemia are hospitalized for infection when they are younger than 6 months of age; prognosis depends on prompt recognition and treatment (Levinson, 2008).

Autosomal agammaglobulinemia refers to a rare instance in which normal hypogammaglobulinemia of infancy is prolonged. It can result from mutations in a variety of genes whose products are required for differentiation of B cells. However, IgG levels do rise eventually. Periodic immunologic assessment is needed to differentiate transient hypogammaglobulinemia from other forms of antibody deficiency.

The second type of B-cell deficiency results from a lack of differentiation of B cells into plasma cells. Only diminished antibody production occurs with this disorder. Although plasma cells are the most vigorous producers of antibodies, affected patients have normal lymph follicles and many B lymphocytes that produce some antibodies. This syndrome, called **hypogammaglobulinemia,** is a frequently occurring immunodeficiency. It is also called CVID; this disorder encompasses a variety of defects ranging from IgA deficiency, in which only the plasma cells that produce IgA are absent, to the other extreme, in which there is severe **panhypoglobulinemia** (general lack of immunoglobulins in the blood) (Stewart, Tian, Notorangelo, et al., 2008).

CVID is the most common primary immunodeficiency seen in adults; it can occur in people of either gender. Although it usually presents within the first two decades of life, most patients are diagnosed as adults, because CVID often goes unrecognized. Several T- and B-cell defects have been described, but the underlying cause is still unknown; the etiology is believed to be multifactorial. Patients usually have normal B-cell lymphocyte counts, but the cells are clinically diverse and immature. Although they can recognize antigens and mount a response, their ability to become memory B cells and mature plasma cells is impaired.

## Clinical Manifestations

Infants with X-linked agammaglobulinemia usually become symptomatic after the natural loss of maternally transmitted immunoglobulins, which occurs at about 5 to 6 months of age. Symptoms of recurrent pyogenic infections usually occur by that time.

Besides recurrent infection, patients with CVID are at increased risk for autoimmune disease, granulomatous disease, and malignancy, indicating that CVID is a disease of abnormal immune regulation as well as of immunodeficiency. Approximately 20% to 22% of patients develop autoimmune diseases, notably autoimmune thrombocytopenic purpura and autoimmune hemolytic anemia (Seve, Bourdillon, Sarrot-Reynauld, et al., 2008). Other autoimmune diseases, such as arthritis and hypothyroidism, frequently occur. Associated fever, weight loss, anemia, thrombocytopenia, splenomegaly, lymphadenopathy, and lymphocytosis may suggest underlying lymphoid malignancy.

More than 50% of patients with CVID develop pernicious anemia. Lymphoid hyperplasia of the small intestine and spleen as well as gastric atrophy, which is detected by biopsy of the stomach, are common findings. Gastrointestinal malabsorption may occur. Young adults who develop the disease also have an increased incidence of chronic lung disease, hepatitis, gastric cancer, and malabsorption that results in chronic diarrhea. CVID must be distinguished from secondary immunodeficiency diseases caused by protein-losing enteropathy, nephrotic syndrome, or burns.

Patients with CVID are susceptible to infections with encapsulated bacteria, such as *Haemophilus influenzae, Streptococcus pneumoniae,* and *Staphylococcus aureus.* Frequent respiratory tract infections typically lead to chronic progressive bronchiectasis and pulmonary failure. Commonly, infection with *Giardia lamblia* occurs. Opportunistic infections with *Pneumocystis jiroveci* pneumonia (PCP), however, are seen only in patients who have a concomitant deficiency in T-cell immunity.

## Assessment and Diagnostic Findings

X-linked agammaglobulinemia may be diagnosed by the marked deficiency or complete absence of all serum immunoglobulins. The diagnosis of CVID is based on the history of repeated bacterial infections, quantification of B-cell activity, and reported signs and symptoms. The number of B lymphocytes as well as the total and specific immunoglobulin levels are measured. Measuring only the total serum globulin level is inadequate, because a compensatory overproduction of one globulin may mask the loss of another globulin or the deficiency of a globulin that is present in very low amounts. Antibody titers to confirm successful childhood vaccination are determined by specific serologic tests. Previous successful childhood immunization indicates that B cells were functioning adequately earlier in life. If the patient exhibits signs and symptoms suggestive of pernicious anemia, hemoglobin and hematocrit levels are also obtained. Biopsies of the small intestine, spleen, and stomach may also be obtained to assess for lymphoid hyperplasia.

## Medical Management

Patients with primary phagocytic disorders may be treated with intravenous immunoglobulin (IVIG) (Chart 51-1). Its administration is an essential part of the prevention and treatment of complications of CVID (Kishiyama, 2005). Antibody replacement therapy is recommended for severe, recurrent infections. Other interventions aimed at overcoming the immunologic defects in CVID, such as interleukin-2 therapy, are being studied (Garcia, Espanol, Gurbindo, et al., 2007).

# *T-Cell Deficiencies*

## Pathophysiology

Defects in T cells lead to opportunistic infections. Most primary T-cell immunodeficiencies are genetic in origin. Partial T-cell immunodeficiencies constitute a heterogeneous cluster of disorders characterized by an incomplete reduction in T-cell number or activity. Unlike severe T-cell immunodeficiencies, however, partial immunodeficiencies are commonly associated with hyperimmune dysregulation,

CHART 51-1

PHARMACOLOGY

## *Managing an Intravenous Immunoglobulin (IVIG) Infusion*

IVIG has become an important treatment for a variety of disease states that are characterized by deficient production of antibodies. It may have other indications but is commonly used for the treatment of DiGeorge syndrome, common variable immunodeficiency disease (CVID), severe combined immunodeficiency disease (SCID), Wiskott-Aldrich syndrome, and idiopathic thrombocytopenic purpura. Previously available only for intramuscular injection, immunoglobulin can now be administered for replacement therapy as an IV infusion in greater, more effective doses without painful side effects, and it can safely be given in outpatient as well as inpatient settings. Variables affecting the risk and intensity of adverse events associated with the administration of IVIG include patient age, underlying condition, history of migraine, and cardiovascular and/or renal disease; dose, concentration, and rate of infusion; and specific data related to the precise lot of the product. The nurse must assess all of these variables before starting the IVIG infusion and during the infusion process. He or she must anticipate adverse effects if any of these variables are present (Shelton, et al., 2006).

### How Supplied

Immunoglobulin is supplied in a 5% solution or a lyophilized powder with a reconstituting diluent prepared from Cohn fraction II obtained from pools of 1000 to 10,000 donors. Currently, a number of different IV preparations are approved for use and have been shown to be effective and safe by the U.S. Food and Drug Administration.

### Dosage

The optimal dose is determined by the patient's response. In most instances, an IV dose of 100 to 400 mg/kg of body weight is administered monthly or more frequently to ensure adequate serum levels of immunoglobulin G.

### Adverse Effects

- Complaints of flank and back pain, shaking chills, dyspnea, and tightness in the chest; headache, fever, and local reaction at the infusion site
- Serious conditions, including aseptic meningitis, renal failure, thromboembolic events, and anaphylaxis. Anaphylactic reactions typically occur 30 to 60 minutes after the start of the infusion. The potential increases as the dose of IVIG increases.
- Hypotension (possible with severe reactions)

### Guidelines for Nursing Management

- Pretreatment assessments should be performed before each infusion.
- Obtain height and weight before treatment to verify accurate dosing.
- Assess baseline vital signs before, during, and after treatment. An elevated temperature at the beginning of treatment may be an indication to delay the infusion to avoid misinterpretation as a reaction to the infusion.
- Premedicate with acetaminophen and diphenhydramine as prescribed 30 minutes before the start of the infusion.
- Understand that long-term tolerance of an older IVIG product does not necessarily imply tolerance to a newer product, even if it is technically superior. Caution should be exercised when changing IVIG products because they are not biologically equivalent.
- Be aware that corticosteroids may be used to prevent possible severe reactions in patients who are perceived to be at risk.
- Administer the IV infusion at a slow rate, not to exceed 3 mL/min.
- Continually assess the patient for adverse reactions; be especially aware of complaints of a tickle or lump in the throat as the precursor to laryngospasm that precedes bronchoconstriction.
- Stop the infusions at the first sign of reaction and initiate the institutional protocol to be followed in this emergent situation.
- Be aware that patients with low gammaglobulin levels have more severe reactions than those with normal levels (eg, patients who receive gammaglobulin for thrombocytopenia or Kawasaki disease).
- Keep in mind that patients who have an immunoglobulin A (IgA) deficiency have IgE antibodies to IgA, which requires administration of plasma or immunoglobulin replacement from IgA-deficient patients. Because all IV immunoglobulin preparations contain some IgA, they may cause an anaphylactic reaction in patients with IgE anti-IgA antibodies.
- Recognize that the pharmacokinetics of IgG differ when smaller doses are given more frequently, as is commonly done with subcutaneous regimens. Differences include lower peaks and higher troughs, which may be preferable for some patients.
- Remember that the risk of transmission of hepatitis, HIV, or other known viruses is extremely low.

including autoimmune disorders, inflammatory diseases, and elevated IgG production (Liston, Enders & Siggs, 2008). Although an increased susceptibility to infection is common, symptoms can vary considerably, depending on the type of T-cell defect. Because the T cells play a regulatory role in immune system function, the loss of T-cell function is usually accompanied by some loss of B-cell activity.

DiGeorge syndrome, or **thymic hypoplasia,** is an example of a primary T-cell immunodeficiency. This rare, complex, multisystem genetic abnormality, which affects multiple organ systems, has been mapped to chromosomes 10 or 22. The symptom variation is a result of differences in the amount of genetic material affected. T-cell deficiency occurs when the thymus gland fails to develop normally during embryogenesis. The syndrome often manifests in the neonatal period as a cardiac anomaly, although hypocalcemic tetany and facial abnormalities may also occur. It is one of the few immunodeficiency disorders with symptoms that manifest almost immediately after birth (McLean-Tooke, Barge, Spickett, et al., 2008; Sullivan, 2008).

Chronic mucocutaneous candidiasis is a rare T-cell disorder, which is thought to be an autosomal recessive disorder that affects both males and females. It is considered an autoimmune disorder involving the thymus and other

endocrine glands. The disease causes extensive morbidity resulting from endocrine dysfunction.

## Clinical Manifestations

Infants born with DiGeorge syndrome have hypoparathyroidism with resultant hypocalcemia resistant to standard therapy, congenital heart disease, cleft palate and lip, dysmorphic facial features, and possibly renal abnormalities. These infants are susceptible to yeast, fungal, protozoan, and viral infections and are particularly susceptible to childhood diseases (chickenpox, measles, rubella), which are usually severe and may be fatal. Infection with *Candida albicans* is almost universal in patients with severe deficiencies in T cell–mediated immunity. Many affected infants are also born with congenital heart defects, which can result in heart failure. The most frequent presenting sign in patients with DiGeorge syndrome is hypocalcemia that is resistant to standard therapy. It usually occurs within the first 24 hours of life (McLean-Tooke, et al., 2008; Sullivan, 2008).

The initial presentation of chronic mucocutaneous candidiasis may be a result of either chronic candidal infection or idiopathic endocrinopathy. The disease is characterized by persistent or recurrent candidal infections of the skin, nails, and mucous membranes or by a variable combination of endocrine failure as well as immunodeficiency (Liu & Hua, 2007). Patients may survive to the second or third decade of life. Problems may include hypocalcemia and tetany secondary to hypofunction of the parathyroid glands (see Chapter 14). Hypofunction of the adrenal cortex (Addison's disease) is the major cause of death in these patients; it may develop suddenly and without any history of previous symptoms.

## Assessment and Diagnostic Findings

Prompt diagnosis is necessary for appropriate management. A comprehensive immunologic laboratory analysis is necessary. Findings in children with DiGeorge syndrome include cardiac, nutritional, and developmental abnormalities (Sullivan, 2008).

## Medical Management

Patients with T-cell deficiency should receive prophylaxis for PCP. General care includes management of hypocalcemia and correction of cardiac abnormalities. Hypocalcemia is controlled by oral calcium supplementation in conjunction with administration of vitamin D or parathyroid hormone. Congenital heart disease frequently results in heart failure, and these patients may require immediate surgical intervention in a tertiary care center. Transplantation of fetal thymus, postnatal thymus, or human leukocyte antigen (HLA)-matched bone marrow has been used for permanent reconstitution of T-cell immunity (Mazzolari, Forino, Guerci, et al, 2007). In children with DiGeorge syndrome, attention must be given to cardiac, nutritional, and developmental needs (Sullivan, 2008). IVIG may be used if an antibody deficiency exists. This therapy may also be used to control recurrent infections. T-cell function improves with age and often is normal by 5 years of age. Prolonged survival has been reported after spontaneous remission of immunodeficiency, which occurs in some patients (Markert, 2008).

# Combined B-Cell and T-Cell Deficiencies

## Pathophysiology

T-cell and B-cell immune deficiencies comprise a heterogeneous group of disorders, all characterized by profound impairment in the development or function of the cellular, the humoral, or both parts of the immune system. A variety of inherited (autosomal recessive and X-linked) conditions fit this description. These conditions are typified by disruption of the normal communication system of B cells and T cells and impairment of the immune response, and they appear early in life (Cooper & Schroeder, 2008).

**Ataxia-telangiectasia** is an autosomal recessive neurodegenerative disorder characterized by cerebellar **ataxia** (loss of muscle coordination), **telangiectasia** (vascular lesions caused by dilated blood vessels), and immune deficiency. The immunologic defects reflect abnormalities of the thymus. The disorder is characterized by some degree of T-cell deficiency, which becomes more severe with advancing age. In 40% of patients, a selective IgA deficiency exists. In addition, IgG and IgE deficiencies have been identified. Immunodeficiency is manifested by recurrent and chronic sinus and pulmonary infections, leading to bronchiectasis. Frequent causes of death are chronic pulmonary disease and malignancy. While lymphomas are most common, other carcinomas occur. The disease is also associated with neurologic, vascular, endocrine, hepatic, and cutaneous abnormalities (Levinson, 2008).

**Severe combined immunodeficiency disease** is a disorder in which both B cells and T cells are missing. Consequently, both cell-mediated and humoral functions are affected. In addition, SCID is marked by susceptibility to serious fungal, bacterial, and viral infections. It refers to a wide variety of congenital and hereditary immunologic defects characterized by early onset of infections, defects in both B-cell and T-cell systems, lymphoid aplasia, and thymic dysplasia. It is one of the most common causes of primary immunodeficiencies. Inheritance of this disorder can be X linked, autosomal recessive, or sporadic. The exact incidence of SCID is unknown; it is recognized as a rare disease in most population groups, with an incidence of about 1 case in 1,000,000. This illness occurs in all racial groups and both genders.

**Wiskott-Aldrich syndrome (WAS),** a variation of SCID, is an inherited immunodeficiency caused by a variety of mutations in the gene encoding the WAS protein. It is characterized by frequent infections, thrombocytopenia with small platelets, eczema, and increased risk of autoimmune disorders and malignancies. Vasculitides and autoimmune hemolytic anemia are the two most common autoimmune manifestations and often cause considerable morbidity and mortality. The prognosis is poor, because most affected people develop overwhelming fatal infections.

## Clinical Manifestations

The onset of ataxia and telangiectasia occurs in the first 4 years of life. Many patients, however, remain symptom-free for 10 years or longer. As the patient approaches the

second decade of life, chronic lung disease, cognitive impairment, neurologic symptoms, and physical disability become severe. Long-term survivors develop progressive deterioration of immunologic and neurologic functions. Some affected patients have lived until the fifth decade of life. The primary causes of death in these patients are overwhelming infection and lymphoreticular or epithelial cancer.

The onset of symptoms occurs within the first 3 months of life in most patients with SCID. Symptoms include respiratory infections and pneumonia (often secondary to PCP infection), thrush, diarrhea, and failure to thrive. Many of these infections are resistant to treatment. Shedding of viruses such as respiratory syncytial virus or cytomegalovirus from the respiratory and gastrointestinal tracts is persistent. Maculopapular and erythematous skin rashes may occur. Vomiting, fever, and a persistent rash are also common manifestations (Geha & Rosen, 2007).

## Medical Management

Treatment of ataxia-telangiectasia includes early management of infections with antimicrobial therapy, management of chronic lung disease with postural drainage and physical therapy, and management of other presenting symptoms. Other treatments include transplantation of fetal thymus tissue and IVIG administration (see Chart 51-1).

Treatment options for SCID include stem cell and bone marrow transplantation. HSCT is the definitive therapy for SCID; the best outcome is achieved if the disease is recognized and treated early in life. Improvements continue in the use of HSCT to treat patients with SCID, as well as other primary immunodeficiencies. The ideal donor is an HLA-identical sibling. Evidence demonstrates that transplantation of allogeneic hematopoietic stem cells can cause an enhanced improvement over time. Other treatment options include administration of IVIG or thymus-derived factors and thymus gland transplantation. Gene therapy has been used, but the results have been disappointing (Dvorak & Cowan, 2008). For the most common forms of combined immune deficiency, gene therapy can lead to immune reconstitution in most patients, but a minority derive minimal clinical benefit and some have suffered severe adverse effects, including death (Santilli, et al., 2008; Sokolic, Kesserwan & Candotti, 2008). As treatment improves, an increasing number of patients who previously would have died in infancy are living to adulthood. Newborn screening is proposed as a means to make a prompt diagnosis and initiate treatment in all affected infants (Puck, 2007).

## Nursing Management

Many patients require immunosuppression to ensure engraftment of depleted bone marrow during transplantation procedures. For this reason, nursing care must be meticulous. Appropriate infection control precautions and thorough hand hygiene are essential (Chart 51-2). Institutional policies and procedures related to protective care must be followed scrupulously until definitive evidence demonstrates that precautions are unnecessary. Continual monitoring of the patient's condition is critical, so early signs of impending infection may be detected and treated before they seriously compromise the patient's status. It also is imperative that attention be given to appropriate application of standard precautions (previously known as universal precautions), which have become one of the first-line tools for decreasing transmission of disease, whether from nurse to patient, patient to patient, or patient to nurse. Standard precautions are based on the principle that all blood and body fluids, secretions, and excretions may contain transmissible infectious agents. Some of the key elements of

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CHART 51-2 NURSING RESEARCH PROFILE

### *Implementation of New Hygiene Practices and the Resultant Impact on Infection Rates*

Larson, E., Quiros, D. & Lin, S. (2007). Dissemination of the CDC's hand hygiene guideline and impact on infection rates. *American Journal of Infection Control, 35*(10), 666–675.

#### Purpose

Most hospitalized patients are at high risk for infection. This study was undertaken to measure the impact of national evidence-based guidelines on practice. The objectives were to (1) evaluate implementation and compliance with clinical practices recommended in the hand hygiene guidelines of the Centers for Disease Control and Prevention (CDC), (2) compare rates of health care–associated infections (HAIs) before and after implementation of the guidelines, and (3) examine the patterns and correlates of changes in the rates of HAIs.

#### Design

The investigators used pre- and postguideline implementation site visits and surveys in 40 U.S. hospitals that were members of the national nosocomial infections surveillance system. They measured HAI rates 1 year before and after publication of the CDC guidelines. In addition, they used hand hygiene compliance and guideline implementation scores as outcome measures.

#### Findings

The 40 hospitals had changed their policies and procedures and provided products in compliance with the recommended guidelines. Of 1359 staff members surveyed anonymously, 89.8% reported that they were familiar with the guidelines. However, in 44.2% of the hospitals, there was no evidence of a multidisciplinary program to improve compliance. Hand hygiene rates remained low (56.6%), similar to the rates reported for the past few decades. Rates of central line–associated bloodstream infections were significantly lower in hospitals with higher rates of hand hygiene compliance ($p < .001$). No impact of guideline implementation or hand hygiene compliance on other HAI rates was identified.

#### Nursing Implications

This study confirms the observation that institutional adoption of a guideline does not guarantee practice changes. The incidence of health care–associated infections has grown significantly and has resulted in increased patient morbidity and mortality. This increase has contributed to escalating costs of hospital care. It is the professional responsibility of every practitioner to deliver care consistent with standards of safety and quality.

standard precautions include performing hand hygiene, as previously mentioned; using appropriate personal protective equipment, depending on the expected type of exposure; and using safe injection practices (Tarrac, 2008).

## Deficiencies of the Complement System

The complement system is an integral part of the immune system, and deficiencies in normal levels of C2 and C3 complement result in increased susceptibility to infectious diseases and immune-mediated disorders. Improved techniques to identify the individual components of the complement system have led to a steady increase in the number of deficiencies identified.

Hereditary **angioneurotic edema** results from the deficiency of C1-esterase inhibitor, which opposes the release of inflammatory mediators. The clinical picture of this autosomal dominant disorder includes recurrent attacks of edema formation in the subcutaneous tissue, gastrointestinal tract, and upper airway (Farkas, Varga, Szeplaki, et al., 2007). Although the disease is mild in childhood and becomes more severe after puberty, first episodes have been reported later in life. Food allergy has often been linked to this disorder, although recent evidence has implicated a C1-esterase inhibitor deficiency. The fluctuations in hormone levels at the beginning of adolescence, in the perimenopausal period, during pregnancy, and during the use of oral contraceptives can precipitate edematous attacks that usually disappear after the onset of menopause. Fresh-frozen plasma has been used as a treatment option, with variable results (Prematta, Gibbs, Pratt, et al., 2007).

Paroxysmal nocturnal hemoglobinuria is an acquired clonal stem cell disorder resulting from a somatic mutation in the hematopoietic stem cell. An absent glycosylphosphatidylinositol (GPI)-anchored receptor prevents several proteins from binding to the erythrocyte membrane. These include the complement-regulatory proteins, CD55 and CD59, the absence of which results in enhanced complement-mediated lysis. Clinical manifestations may be indolent or life-threatening. The disorder is characterized by hemoglobinuria that increases during sleep, as well as intravascular hemolysis, cytopenia, infections, bone marrow hyperplasia, and a high incidence of life-threatening venous thrombosis, which occurs most commonly in the abdominal and cerebral veins. Severe fatigue, abdominal pain, and esophageal spasm may also be present. Leukopenia, thrombocytopenia, and episodic crises are common. Severe infection can occur as a result of aplastic bone marrow and splenic thrombosis. Laboratory diagnosis can include specialized tests, such as the sucrose hemolysis test, Ham acid hemolysis test, and fluorescent-activated cell analysis. A coagulation profile is also indicated.

## SECONDARY IMMUNODEFICIENCIES

Secondary immunodeficiencies are more common than primary immunodeficiencies and frequently occur as a result of underlying disease processes or the treatment of these disorders. The immune system can be affected by a variety of intrinsic factors, including immunosuppressive agents, harsh environmental conditions, hereditary disorders other than primary immunodeficiencies, and acquired metabolic disorders that cause secondary immunodeficiencies. Common causes of secondary immunodeficiencies include chronic stress, burns, uremia, diabetes mellitus, certain autoimmune disorders, certain viruses, exposure to immunotoxic medications and chemicals, and self-administration of recreational drugs and alcohol. Perhaps the best-known secondary immunodeficiency results from human immunodeficiency virus (HIV) infection, which causes acquired immunodeficiency syndrome (AIDS); however, the most prevalent cause of immunodeficiency worldwide is severe malnutrition. AIDS, the most common secondary disorder, is discussed in detail in Chapter 52.

In secondary immunodeficiencies, abnormalities of the immune system affect both natural and acquired immunity, may be subtle, and are usually heterogeneous in their clinical manifestations. Patients with secondary immunodeficiencies are known as **immunocompromised hosts.**

### Medical Management

Medical management of secondary immunodeficiencies includes diagnosis and treatment of the underlying disease process. Treatment of the primary condition often results in the improvement of the affected immune components (Chinen & Shearer, 2008). Factors that contribute to immunosuppression are identified and infection is treated. Additional treatment includes HSCT, monoclonal antibody therapy, and anticoagulation therapy as indicated. HSCT may be curative (Brodsky, 2008; Woolhead, Deepak, Patel, et al., 2008).

## NURSING MANAGEMENT FOR PATIENTS WITH IMMUNODEFICIENCIES

Nursing management includes assessment, patient teaching, selected interventions, and supportive care. Assessment of the patient for infection and timely initiation of treatment are essential. Nursing care of patients with primary and secondary immunodeficiencies depends on the underlying cause of the immunodeficiency, the type of immunodeficiency, and its severity. Because immunodeficiencies result in a compromised immune system and pose a high risk for infection, careful assessment of the patient's immune status is essential. The assessment focuses on the history of past infections, particularly the type and frequency of infection; methods of and response to past treatments; signs and symptoms of any current skin, respiratory, oral, gastrointestinal, or genitourinary infection; and measures taken by the patient to prevent infection. The nurse assesses and monitors the patient for signs and symptoms of infection (Chart 51-3).

Many patients develop oral manifestations and need education about promoting good dental hygiene to diminish the oral discomfort and complications that frequently result in inadequate nutritional intake. Involving patients in their daily oral assessment and care helps them become proactive in preventing complications. To implement individualized care strategies, it is essential to provide patients with the skills to promote health and limit the incidence of disease.

Because the inflammatory response may be blunted, the patient is observed for subtle and unusual signs and changes in physical status. Vital signs and the development of pain,

CHART 51-3

## *Assessing for Infection*

Be alert for the following signs and symptoms:

- Fever with or without chills
- Cough with or without sputum
- Shortness of breath
- Difficulty breathing
- Difficulty swallowing
- White patches in the oral cavity
- Swollen lymph nodes
- Nausea with or without vomiting
- Persistent diarrhea
- Frequency, urgency, or pain on urination
- Change in the character of the urine
- Lesions on the face, lips, or perianal area
- Redness, swelling, or drainage from skin lesions
- Persistent vaginal discharge with or without perianal itching
- Persistent abdominal pain

neurologic signs, cough, and skin and oral lesions are monitored and reported immediately. Pulse rate and respiratory rate should be counted for a full minute, because subtle changes can signal deterioration in the patient's clinical status. Auscultation of the breath sounds is important to detect changes in respiratory status that signal an existing or impending infection. Any unusual response to treatment or a significant change in the patient's clinical condition must be promptly reported to the physician (Jarvis, 2008).

The nurse continuously monitors laboratory values for changes indicative of infection. Culture and sensitivity reports from wound drainage, lesions, sputum, stool, urine, and blood are monitored to identify pathogenic organisms and appropriate antimicrobial therapy. Changes in laboratory results and subtle changes in clinical status must be reported to the physician, because the immunocompromised patient may fail to develop typical signs and symptoms of infection.

Assessment also focuses on nutritional status; stress level and coping skills; use of alcohol, drugs, or tobacco; and general hygiene practices, all of which may affect immune function. Strategies the patient has used to reduce the risk of infection are identified and evaluated for their appropriateness and effectiveness (Dudek, 2006). Other aspects of nursing care are directed toward reducing the patient's risk for infection, assisting with medical measures aimed at improving immune status and treating infection, achieving optimal nutritional status, and maintaining respiratory, bowel, and bladder function. The patient's ability to demonstrate good hand hygiene must be assessed, and the patient is encouraged to cough and perform deep-breathing exercises at regular intervals. Teaching good dental hygiene measures reduces the potential for oral lesions, as do instructions on measures to protect the integrity of the skin. Attention to strict aseptic technique when performing invasive procedures, such as dressing changes, venipunctures, and bladder catheterizations, is essential. Other aspects of nursing care include assisting the patient to manage stress, to incorporate lifelong patterns of physiologic safety, and to adopt behaviors that strengthen immune system function.

Gene defects that cause many of the currently recognized immunodeficiency disorders are being identified, and genetic testing is becoming available for many of these disorders. Although this testing is rarely indicated in the initial workup for immunodeficiency (Lehman, Hernandez-Trujillo & Ballow, 2008), nurses should be aware of it and

CHART 51-4

HOME CARE CHECKLIST

## *Infection Prevention for the Patient With Immunodeficiency*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Identify signs and symptoms of infection to report to the health care provider, such as fever; chills; wet or dry cough; breathing problems; white patches in the mouth; swollen glands; nausea; vomiting; persistent abdominal pain; persistent diarrhea; problems with urination or changes in the character of the urine; red, swollen, or draining wounds; sores or lesions on the body; persistent vaginal discharge with or without itching; and severe fatigue. | ✔ | ✔ |
| • Demonstrate correct handwashing procedure. | ✔ | ✔ |
| • State rationale for thorough handwashing before eating, after using the bathroom, and before and after performing health care procedures. | ✔ | ✔ |
| • State rationale for use of cream and emollients to prevent or manage dry, chafed, or cracked skin. | ✔ | ✔ |
| • Demonstrate recommended personal hygiene in bathing and foot care to prevent bacterial and fungal diseases. | ✔ | ✔ |
| • State rationale for avoiding contact with people who have known illness or who have recently been vaccinated. | ✔ | ✔ |
| • Verbalize understanding of ways to maintain a well-balanced diet and adequate calories. | ✔ | ✔ |
| • State the reason for avoiding the eating of raw fruits and vegetables, cooking all foods thoroughly, and immediately refrigerating all leftover food. | ✔ | ✔ |
| • Identify the rationale for frequent cleaning of kitchen and bathroom surfaces with disinfectant. | ✔ | ✔ |
| • Identify rationale and benefits of avoiding alcohol, tobacco, and unprescribed medications. | ✔ | ✔ |
| • State rationale for taking prescribed medications as directed. | ✔ | ✔ |
| • Verbalize ways to cope with stress successfully, plans for regular exercise, and rationale for obtaining adequate rest. | ✔ | ✔ |

CHART 51-5

HOME CARE CHECKLIST

**Home Infusion of Intravenous Immunoglobulin (IVIG)**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Identify the benefits and expected outcome of IVIG. | ✔ | ✔ |
| • Demonstrate how to check for patency of the IV access device. | ✔ | ✔ |
| • Demonstrate how to prepare IVIG. | ✔ | ✔ |
| • Demonstrate how to infuse IVIG. | ✔ | ✔ |
| • Demonstrate how to clean and maintain IV equipment. | ✔ | ✔ |
| • Identify side effects and adverse effects of IVIG. | ✔ | ✔ |
| • State rationale for prophylactic use of acetaminophen (Tylenol) and diphenhydramine (Benadryl) before treatment begins. | ✔ | ✔ |
| • Verbalize understanding of emergency measures for anaphylactic shock. | ✔ | ✔ |

knowledgeable about it. Some deficiencies can be diagnosed by phenotype and functional assays. Genetic testing can establish or confirm a suspected diagnosis of some primary immune deficiencies. In addition, it also may predict future disease risk prior to the onset of clinical signs and symptoms and guide clinicians in selecting the most appropriate therapeutic options (Morra, Geigenmuller, Curran, et al., 2008). Genetic testing is not typically required in CVID because known genetic defects cause only a small number of cases of CVID, and results would not alter treatment. To perform genetic testing, informed consent from the patient or legal guardian is necessary. It can be accomplished using whole blood samples and mouth swab samples.

If the patient is a candidate for any of the newer or experimental therapies (gene therapy, bone marrow transplantation, immunomodulators such as interferon-γ), the patient and family must be informed about the potential risks and benefits of the treatment regimen. A major role of the nurse is to develop and maintain a knowledge base in these evolving treatment modalities, to help the patient and family understand the treatment options and cope with the uncertainties of treatment outcomes.

## Promoting Home and Community-Based Care

### Teaching Patients Self-Care

The patient and caregivers require instruction about the signs and symptoms that indicate infection and about the potential for occurrence of atypical symptoms secondary to underlying immunosuppression. They must be informed of the need for continuous monitoring for subtle changes in the patient's physical health status and of the importance of seeking immediate health care if changes are detected. Patients should be advised that they know themselves best; therefore, whenever they experience a symptom that is not typical for them, they should contact their health care provider, who will determine and initiate appropriate therapy. Instruction needs to be provided about prophylactic medication regimens, including dosage, indications, times, actions, potential interactions, and side effects. Patients and their families are also instructed about the importance of continuing treatment regimens without interruption and incorporating these routines into their daily living patterns. The patient is instructed about the importance of avoiding others with infections and avoiding crowds, and about other ways to prevent infection (Chart 51-4).

The patient who is to receive IVIG at home will need information about the expected benefits and outcomes of the treatment as well as expected adverse reactions and their management (Chart 51-5). Patients who can perform self-infusion at home must be instructed in sterile technique, medication dosages, administration rate, and detection and management of adverse reactions (Shelton, Griffin & Goldman, 2006).

### Continuing Care

Encouraging the patient and family to be active partners in the management of the immunodeficiency is the key to successful outcomes and a favorable prognosis. The patient must be made aware that all health-related instructions are lifelong, that follow-up with all scheduled appointments is essential, and that it is the patient's responsibility to notify the primary care provider of any early signs or symptoms of infection, however subtle they may be. If the patient's treatment includes IVIG and the patient or family cannot administer treatment, a referral for home care or an infusion service is warranted.

## CRITICAL THINKING EXERCISES

EBP **1** You are the charge nurse on a medical critical care unit. A new nurse approaches you for advice on the best infection control practices to use with a patient with cancer who has just been admitted and is immunosuppressed. Identify the infection control measures that are indicated. Describe the evidence base for the infection control measures you identified and the criteria used to evaluate the strength of that evidence.

**2** The mother of your 7-year-old neighbor contacts you to discuss his frequent illnesses. She asks whether there may be something serious underlying the nine ear infections he has had in the previous year. Identify the 10 warning signs of primary immune deficiency that you would consider when responding to this mother's dilemma.

**3** You are caring for a 20-year-old man who has an immunodeficiency and has been hospitalized multiple times. Describe the assessment parameters and the nursing plan of care for this patient. Identify the laboratory values that are important to monitor and report. Describe the plan for continuing care for this patient.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

Centers for Disease Control and Prevention, www.cdc.gov

Immune Deficiency Foundation (IDF), www.primaryimmune.org

National Institute of Allergy and Infectious Disease (NIAID), www.niaid.nih.gov

National Institutes of Health, www.nih.gov

National Library of Medicine, www.nlm.nih.gov

National Primary Immunodeficiency Resource Center/Jeffrey Modell Foundation, www.info4pi.org

U.S. Department of Health and Human Services, www.hhs.gov



chapter 52

# Management of Patients With HIV Infection and AIDS

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Describe the modes of transmission of HIV infection and prevention strategies.

**2** Describe the host/HIV interaction during primary infection.

**3** Explain the pathophysiology associated with the clinical manifestations of HIV/AIDS.

**4** Describe the clinical management of patients with HIV/AIDS.

**5** Discuss the nursing interventions appropriate for patients with HIV/AIDS.

**6** Use the nursing process as a framework for care of the patient with HIV/AIDS.

## GLOSSARY

**alpha-interferon:** protein substance that the body produces in response to infection

**B-cell lymphoma:** common malignancy in patients with HIV/AIDS

**candidiasis:** yeast infection of skin or mucous membrane

**CCR5:** along with the CD4+ receptor, this cell surface molecule is used by HIV to fuse with the host's cell membranes

**cytomegalovirus:** a species-specific herpes virus that may cause retinitis in people with AIDS

**EIA (enzyme immunoassay):** a blood test that can determine the presence of antibodies to HIV in the blood or saliva; also referred to as **enzyme-linked immunosorbent assay (ELISA)**. Positive results must be validated, usually with Western blot test.

**HIV-1:** retrovirus isolated and recognized as the etiologic agent of AIDS

**HIV-2:** retrovirus identified in 1986 in AIDS patients in West Africa

**HIV encephalopathy:** degenerative neurologic condition characterized by a group of clinical presentations including loss of coordination, mood swings, loss of inhibitions, and widespread cognitive dysfunctions; formerly referred to as AIDS dementia complex (ADC)

**human papillomavirus (HPV):** viruses that cause various warts, including plantar and genital warts; some strains of HPV can also cause cervical cancer

**immune reconstitution inflammatory syndrome:** a syndrome that results from rapid restoration of pathogen-specific immune responses to opportunistic infections; most often occurs after starting antiretroviral therapy

**Kaposi's sarcoma:** malignancy that involves the epithelial layer of blood and lymphatic vessels

**latent reservoir:** the integrated HIV provirus within the CD4+ T cell during the resting memory state; does not express viral proteins and is invisible to the immune system and antiviral medications.

## GLOSSARY *(Continued)*

**macrophage:** large immune cell that devours invading pathogens and other intruders; can harbor large quantities of HIV without being killed, acting as a reservoir of the virus

**monocyte:** large white blood cell that ingests microbes or other cells and foreign particles. When a monocyte enters tissues, it develops into a macrophage.

***Mycobacterium avium* complex:** opportunistic infection caused by mycobacterial organisms that commonly causes a respiratory illness but can also infect other body systems

**opportunistic infection:** illness caused by various organisms, some of which usually do not cause disease in people with normal immune systems

**p24 antigen:** blood test that measures viral core protein; accuracy of test is limited because the p24 antibody binds with the antigen and makes it undetectable

**peripheral neuropathy:** disorder characterized by sensory loss, pain, muscle weakness, and wasting of muscles in the hands or legs and feet

***Pneumocystis* pneumonia or *Pneumocystis jiroveci* pneumonia (PCP):** common opportunistic lung infection caused by an organism, believed to be a fungus based on its structure

**polymerase chain reaction:** a sensitive laboratory technique that can detect and quantify HIV in a person's blood or lymph nodes

**primary infection:** 4- to 7-week period of rapid viral replication immediately following infection; also known as acute HIV infection

**progressive multifocal leukoencephalopathy:** opportunistic infection that infects brain tissue and causes damage to the brain and spinal cord

**protease inhibitor:** medication that inhibits the function of protease, an enzyme needed for HIV replication

**provirus:** viral genetic material in the form of DNA that has been integrated into the host genome. When it is dormant in human cells, HIV is in a proviral form.

**retrovirus:** a virus that carries genetic material in RNA instead of DNA and contains reverse transcriptase

**reverse transcriptase:** enzyme that transforms single-stranded RNA into a double-stranded DNA

**viral load test:** measures the quantity of HIV RNA in the blood

**viral set point:** amount of virus present in the blood after the initial burst of viremia and the immune response that follows

**wasting syndrome:** involuntary weight loss of 10% of baseline body weight with chronic diarrhea or chronic weakness and documented fever

**Western blot assay:** a blood test that identifies antibodies to HIV and is used to confirm the results of an EIA (ELISA) test

**window period:** time from infection with HIV until seroconversion detected on HIV antibody test

Although advances have been made in treating human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS), the epidemic remains a critical public health issue in all communities across the country and around the world. Prevention, early detection, and ongoing treatment remain important aspects of care for people with HIV infection and AIDS. Nurses in all settings encounter people who are positive for HIV infection; therefore, nurses need an understanding of the pathophysiology, knowledge of the physical and psychological consequences associated with the diagnosis, and expert assessment and clinical management skills to provide optimal care for people with HIV infection and AIDS.

In 1987, just 6 years after the first cases of AIDS were reported, the U.S. Food and Drug Administration (FDA) approved the first antiretroviral agent. In 1988, the first randomized controlled trial of primary prophylaxis of *Pneumocystis jiroveci* pneumonia (PCP; formerly *Pneumocystis carinii* pneumonia) appeared in the literature. Currently, more than 25 antiviral agents are approved for use in the United States (Eron, 2008); these agents interfere with the life cycle of HIV in variety of ways. HIV/AIDS is a chronic condition that requires daily medication. Although damage to the immune system is significant, survival rates have increased dramatically.

## HIV INFECTION AND AIDS

Since AIDS was first identified almost 30 years ago, remarkable progress has been made in improving the quality and duration of life for people living with HIV disease. During the first decade, this progress was associated with the recognition and treatment of opportunistic diseases and introduction of prophylaxis against common **opportunistic infections.** The second decade witnessed progress in the development of highly active antiretroviral therapies (HAARTs) as well as continuing progress in the treatment of opportunistic infections. The third decade has focused on issues of adherence to antiretroviral therapy, development of second-generation medications that affect different stages of the viral life cycle, and continued need for an effective vaccine. The HIV antibody test, an enzyme immunoassay (EIA; formerly enzyme-linked immunosorbent assay [ELISA]), became available in 1984, allowing early diagnosis of the infection before onset of symptoms. Since then, HIV infection has been best managed as a chronic disease, most appropriately in an outpatient care setting, whereas AIDS may involve acute conditions that require hospital treatment.

### Epidemiology

In the fall of 1982, after the first 100 cases were reported, the Centers for Disease Control and Prevention (CDC) issued a case definition of AIDS. Since then, the CDC has revised the case definition a number of times (1985, 1987, and 1993). All 50 states, the District of Columbia, U.S. dependencies and possessions, and independent nations in free association with the United States report AIDS cases to the CDC using a uniform surveillance case definition and case report form (CDC, 2005). Starting in the late 1990s, many more states began to implement HIV case reporting in response to the changing epidemic and the need for information on the numbers and characteristics of people with HIV infection who had not yet developed AIDS. The demographic characteristics of people with HIV and AIDS are changing; increasing numbers of women, non-Hispanic blacks, residents of the southern United States, and adults older than 45 years of age are dying from AIDS (Coates, 2008).

The CDC now uses a new and precise method to identify cases of HIV. In 2008, the CDC reported that approximately 56,300 new HIV infections occurred in the United States in 2006. This figure was roughly 40% higher than their former estimate of 40,000 HIV infections per year, which was based on limited data and less precise methods (CDC, 2008).

Almost 7000 people around the world still contract HIV infection every day (McConnell, 2008). Although the global percentage of people living with HIV has stabilized since 2000, the level remains unacceptably high. An estimated 33 million people are living with HIV/AIDS; however, the number of new infections declined from 3 million in 2001 to 2.7 million in 2007. Globally, the percentage of women among people with HIV/AIDS remains stable at 50% but is increasing in several countries (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2008). Although there has been considerable progress worldwide in providing treatment to people with HIV/AIDS, there are still significant gaps. Sub-Saharan Africa continues to be most heavily affected by HIV/AIDS, with 67% of all people living with the disease. In 2007, 72% of the deaths from HIV/AIDS occurred in this region (UNAIDS, 2008).

### HIV Transmission

**HIV-1** is transmitted in body fluids that contain free virions and infected CD4+ T cells. These fluids include blood, seminal fluid, vaginal secretions, amniotic fluid, and breast milk. Inflammation and breaks in the skin or mucosa result in the increased probability that an exposure to HIV will lead to infection. The amount of HIV and infected cells in the body fluid is associated with the probability that the exposure will result in infection. Mother-to-child transmission of HIV-1 may occur in utero, at the time of delivery, or through breast-feeding, but most perinatal infections are thought to occur after exposure during delivery. HIV is not transmitted through casual contact (Chart 52-1).

Blood and blood products can transmit HIV to recipients. However, the risk associated with transfusions has been virtually eliminated as a result of voluntary self-deferral, completion of a detailed health history, extensive testing, heat treatment of clotting factor concentrates, and more

**CHART 52-1 *Risk Behaviors Associated With HIV Infection and AIDS***

- Sharing infected injection drug use equipment
- Having sexual relations with infected individuals (both male and female)

Also at risk are people who received HIV-infected blood or blood products (especially before blood screening was instituted in 1985) and infants born to mothers with HIV infection.

effective virus inactivation methods. Donated blood is tested for antibodies to HIV-1, **HIV-2,** and **p24 antigen;** in addition, since 1999, nucleic acid amplification testing (NAT) has been performed.

## Gerontologic Considerations

The number of people between the ages of 55 and 64 years living with AIDS more than doubled between the years 1998 and 2003 (from 19,258 to 38,997) (CDC, 2005). HIV infection in middle-aged and older populations may be underreported and underdiagnosed because health care professionals erroneously believe that older adults are not at risk for HIV infection. Also, HIV-related dementia in the older adult may mimic Alzheimer's disease and may be misdiagnosed. The characteristics of older people living with HIV infection reflect those of others in their country of origin who have HIV infection (Nokes, Rivero-Mendez, Valencia, et al., 2006).

Several factors put older adults at risk for HIV infection:

- Many older adults are sexually active but do not use condoms, viewing them only as a means of unneeded birth control.
- Many older adults do not consider themselves at risk for HIV infection.
- Older gay men, who grew up and lived in an era when disclosure of their sexual orientation was not acceptable and who have lost long-time partners, may begin new relationships with younger men.
- Older adults may be intravenous (IV)/injection drug users.
- Older adults may have received HIV-infected blood through transfusions before 1985.
- Normal age-related changes include a reduction in immune system function, which puts the older adult at greater risk for infections, cancers, and autoimmune disorders. Many older adults also experience the loss of loved ones, resulting in depression and bereavement, factors that are associated with depressed immune function.

## Prevention of HIV Infection

Until an effective vaccine is developed, nurses need to prevent HIV infection by teaching patients how to eliminate or reduce risky behaviors. Although HIV prevention strategies have focused on individual behaviors, political, economic, and social determinants of risk also need to be considered (Horton & Das, 2008). A combination of evidence-based prevention strategies that include behavioral, structural, and biomedical approaches tempered by the wisdom and ownership of communities offers the best hope for prevention (Merson, O'Malley, Serwadda, et al., 2008).

### *Preventive Education*

Evidence-based programs have been used to educate the public regarding safer sexual practices to decrease the risk of transmitting HIV infection to sexual partners (Chart 52-2). The CDC, through the HIV/AIDS Prevention Research Synthesis Project, has identified evidence-based behavioral interventions that can be applied in a number of settings. Other than abstinence, consistent and correct use of condoms (Chart 52-3) is the only effective method to decrease the risk of sexual transmission of HIV infection. When male condoms are used consistently during vaginal or anal intercourse, their effectiveness can be as high as 95% (Padian, Buve, Balkus, et al., 2008). Nonlatex condoms made of natural materials such as lambskin are available for people with latex allergy but will not protect against HIV infection. A male condom should be used for oral contact with the penis, and a dental dam (a flat piece of latex used by dentists to isolate a tooth for treatment) should be used for oral contact with the vagina or rectum. The polyurethane female condom, which is an effective contraceptive, provides a physical barrier that also prevents exposure to genital secretions containing HIV such as semen and vaginal fluid (Padian, et al., 2008). The female condom is the only barrier method that can be controlled by the woman (see Chapter 46).

Microbicides are chemical products such as gels, creams, films, or suppositories that are inserted into the vagina or

CHART 52-2 **HEALTH PROMOTION**

***Safer Sexual Behaviors***

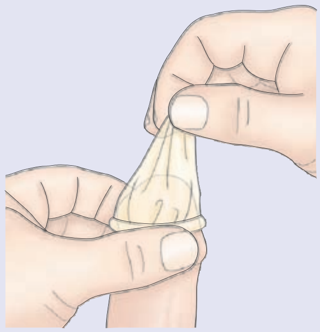
- Advise patients to abstain from sharing sexual fluids.
- Advise patients to reduce the number of sexual partners to one.
- Advise patients to always use latex condoms. If the patient is allergic to latex, nonlatex condoms should be used.
- Advise patients to avoid reusing condoms.
- Advise patients to avoid using cervical caps or diaphragms without using a condom as well.
- Advise patients to always use dental dams for oral– genital or anal stimulation.
- Advise patients to avoid anal intercourse because this practice may injure tissues.
- Advise patients to avoid manual–anal intercourse ("fisting").
- Advise patients not to ingest urine or semen.
- Educate patients about nonpenetrative sexual activities, such as body massage, social kissing (dry), mutual masturbation, fantasy, and sex films.
- Advise patients to avoid sharing needles, razors, toothbrushes, sex toys, or blood-contaminated articles.
- Advise HIV-seropositive patients to inform previous, present, and prospective sexual and drug-using partners of their HIV-positive status. If the patient is concerned for his or her safety, advise the patient that many states have established mechanisms through the public health department in which professionals are available to notify exposed people.
- Advise HIV-seropositive patients to avoid having unprotected sex with another HIV-seropositive person. Cross-infection with that person's HIV can increase the severity of infection.
- Advise HIV-seropositive patients to avoid donating blood, plasma, body organs, or sperm.

CHART 52-3

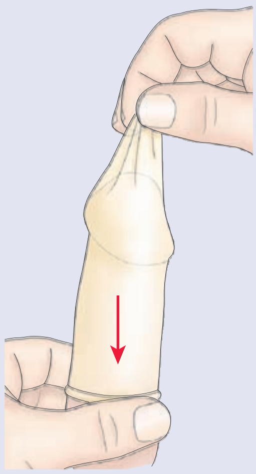
**PATIENT EDUCATION**

***The Right Way to Use a Male Condom***

1. Put on a new condom before any kind of sex.
2. Hold the condom by the tip to squeeze out the air.



3. Unroll the condom all the way over the erect penis



4. Have sex.
5. Hold the condom so it cannot come off the penis.
6. Pull out.
7. Use a new condom if you want to have sex again or if you want to have sex in a different place (eg, in the anus and then in the vagina).

Keep condoms cool and dry. Never use skin lotions, baby oil, petroleum jelly, or cold cream with condoms. The oil in these products will cause the condom to break. Products made with water (such as K-Y jelly or glycerin) are safer to use.

rectum before sexual intercourse to prevent HIV transmission (Padian, et al., 2008). Nonoxynol-9 (N-9) was widely advocated to reduce the risk of HIV infection until a clinical trial conducted in almost 1000 female commercial sex workers in African countries revealed that those who used N-9 intravaginally along with condoms were 50% more likely to be infected with HIV than those who did not use the N-9 gel. Microbicide research is moving in three directions: (1) new microbicides that contain antiretroviral agents such as tenofovir gel or dapivirine gel and ring (International Partnership for Microbicides, 2009); (2) long-acting dispersal methods such as vaginal rings that remain in place or do not require frequent applications; and (3) combination products with different mechanisms of action (Padian, et al., 2008).

In March 2007, based on the results of three clinical trials, the World Health Organization (WHO) and UNAIDS recommended that circumcision be recognized as an effective strategy to reduce the risk of HIV acquisition in men because the presence of the foreskin, which harbors HIV target cells, might facilitate survival and entry of the virus (Padian, et al., 2008). Other topics important in preventive education include the importance of avoiding sexual practices that might cut or tear the lining of the rectum, penis, or vagina and avoiding sexual contact with multiple partners or people who are known to be HIV positive or IV/injection drug users. In addition, people who are HIV positive or who use injection drugs should be instructed not to donate blood or share drug equipment with others.

The Harm Reduction Model recognizes that total abstinence from addictive drugs might not be a realistic short-term goal. This model recommends working with drug users to assist them to increase their healthy behaviors. Needle exchange programs are available in some locations so that IV/injection drug users can obtain sterile drug equipment at no cost. Extensive research has demonstrated that needle exchange programs do not promote increased drug use; on the contrary, they have been found to decrease the incidence of bloodborne infections in people who use IV/injection drugs. Nurses should refer clients to needle exchange programs in their neighborhood whenever available. In the absence of needle exchange programs, IV/injection drug users should be instructed on methods to clean their syringes and advised to avoid sharing cotton and other drug use equipment. Drug users interested in treatment programs should be referred to those programs.

### Related Reproductive Education

Because HIV infection in women often occurs during the childbearing years, family planning issues need to be addressed. Attempts to achieve pregnancy by couples in which only one partner has HIV expose the unaffected partner to the virus. Efforts at artificial insemination using processed semen from an HIV-infected partner continue. Studies are needed, because HIV has been found in the spermatozoa of patients with AIDS, and it is possible that HIV can replicate in the male germ cell. Women considering pregnancy need to have accurate information about the risks of transmitting HIV infection to themselves, their partner, and their future children, and about the benefits of taking antiretroviral agents to reduce perinatal HIV transmission. Women who are HIV positive should be instructed not to breast-feed their infants, because HIV is transmitted through breast milk.

Certain contraceptive methods may pose additional health risks for women. Estrogen in oral contraceptives may increase a woman's risk of HIV infection. In addition, HIV-infected women who use estrogen-containing oral contraceptives have shown increased shedding of HIV in vaginal and cervical secretions. The intrauterine contraceptive device (IUD) may also increase the risk of HIV transmission because the string of the IUD may serve as a means to transmit the virus.

## Transmission to Health Care Providers

### Standard Precautions

To reduce the risk of exposure of health care workers to HIV, the CDC developed standard precautions (Chart 52-4). Specifically, standard precautions are designed to reduce the risk of transmission of bloodborne pathogens and of pathogens from moist body substances. Standard precautions are used when working with all patients in all health care settings, regardless of their diagnosis or presumed infectious status (Siegel, Rhinehart, Jackson, et al., 2007).

### Postexposure Prophylaxis for Health Care Providers

Postexposure prophylaxis in response to the exposure of health care personnel to blood or other body fluids reduces the risk of HIV infection. The CDC recommends that all health care providers who have sustained a significant exposure to HIV be counseled and offered anti-HIV postexposure prophylaxis, if appropriate (Chart 52-5). Some clinicians are considering the use of postexposure prophylaxis for patients exposed to HIV as a result of high-risk sexual behavior or IV/injection drug use. This use of postexposure prophylaxis is controversial because of concern that it may be substituted for safer sex practices and safer IV/injection drug use. However, it may be advocated in high-risk situations, especially when the uninfected person has few options because of economic constraints and cultural norms.

Guidelines for treatment of health care workers with possible occupational exposure to HIV are available from the CDC. Treatment should be started as quickly as possible after exposure. Those who choose postexposure prophylaxis must be prepared for the side effects of the medications, as well as the unknown long-term risks, because HIV often becomes resistant to the medications used to treat it. The cost may be of concern; the cost of a medication regimen ranges from $500 to more than $1000, in addition to the costs of testing and counseling. However, the health care institution where the provider is employed usually covers these costs.

### Vaccination

Despite enormous international efforts to develop an effective vaccine, the complexity of the science and challenges of HIV are proving formidable obstacles. Hopes were dashed when a vaccine efficacy trial was halted in September 2007, after interim results showed that the vaccine being tested did not protect against HIV and did not reduce viral load after infection (Senior, 2008). Cooperation among all nations continues to grow, and resources are being allocated to develop a vaccine and to create and support the infrastructure needed to facilitate vaccine testing.

## Pathophysiology

Because HIV infection is an infectious disease, it is important to understand how HIV-1 integrates itself into a person's immune system and how immunity plays a role in the course of HIV disease. This knowledge is also essential for understanding medication therapy and vaccine development.

Viruses are intracellular parasites. HIV belongs to a group of viruses known as **retroviruses,** which carry their genetic material in the form of ribonucleic acid (RNA) rather than deoxyribonucleic acid (DNA). As shown in Figure 52-1A, HIV consists of a viral core containing the viral RNA, surrounded by an envelope consisting of protruding glycoproteins.

### Chart 52-4 • *Recommendations for Standard Precautions*

1. **Hand hygiene:** Use after touching blood, body fluids, secretions, excretions, or contaminated items; immediately after removing gloves; and between patient contacts.
2. **Personal protective equipment (PPE)**
   - Gloves: Use for touching blood, body fluids, secretions, excretions, and contaminated items, and for touching mucous membranes and nonintact skin.
   - Gown: Use during procedures and patient care activities when contact of clothing/exposed skin with blood or body fluids, secretions, and excretions is anticipated.
   - Mask, eye protection (goggles), face shield*: Use during procedures and patient care activities likely to generate splashes or sprays of blood, body fluids, and secretions, especially suctioning or endotracheal intubation.
3. **Soiled patient care equipment:** Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; and perform hand hygiene.
4. **Environmental control:** Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient care areas.
5. **Textiles and laundry:** Handle in a manner that prevents transfer of microorganisms to others and to the environment.

   Needles and other sharps: Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; and place used sharps in a puncture-resistant container.
6. **Patient resuscitation:** Use mouthpiece, resuscitation bag, and other ventilation devices to prevent contact with mouth and oral secretions.
7. **Patient placement:** Prioritize for single-patient room if patient is at increased risk of transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk of acquiring infection or developing adverse outcome following infection.
8. **Respiratory hygiene/cough etiquette** (source containment of infectious respiratory secretions in symptomatic patients, beginning at initial point of encounter, such as triage and reception areas in emergency departments and physician offices): Instruct symptomatic people to cover mouth and nose when sneezing or coughing; use tissues and dispose in no-touch receptacle; observe hand hygiene after soiling of hands with respiratory secretions; and wear surgical mask if tolerated.

*During aerosol-generating procedures on patients with suspected or proven infections transmitted by respiratory aerosols (eg, severe acute respiratory syndrome [SARS]), wear a fit-tested N95 or higher respirator in addition to gloves, gown, and face/eye protection.

From the Centers for Disease Control and Prevention. www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007.pdf

## Chart 52-5 • *Postexposure Prophylaxis for Health Care Providers*

According to the Centers for Disease Control and Prevention (CDC; 2005), the average risk for HIV transmission to health care providers after a percutaneous exposure to HIV-infected blood is estimated to be approximately 0.3% and after a mucous membrane exposure, approximately 0.09%. If you sustain an occupational exposure to HIV, take the following actions immediately:

- Alert your supervisor/nursing faculty and initiate the injury-reporting system used in the setting.
- Identify the source patient, who may need to be tested for HIV, hepatitis B, and hepatitis C. State laws will determine whether written informed consent must be obtained from the source patient before his or her testing. OraQuick rapid testing should be used if possible if the HIV status of the source patient is unknown, because results can be available within 20 minutes.
- Report as quickly as possible to the employee health services, the emergency department, or other designated treatment facility. This visit should be documented in the health care worker's confidential medical record.
- Give consent for baseline testing for HIV, hepatitis B, and hepatitis C. Confidential HIV testing can be performed up to 72 hours after the exposure but should be performed as soon as the health care worker can give informed consent for baseline testing.
- Get postexposure prophylaxis for HIV in accordance with CDC guidelines. Start the prophylaxis medications within 2 hours after exposure. Make sure that you are being monitored for symptoms of toxicity. Practice safer sex until follow-up testing is complete. Continue the HIV medications for the full 4 weeks after exposure. The majority of HIV exposures will warrant a combination of antiretroviral agents. Combinations that may be prescribed for postexposure prophylaxis include zidovudine (ZDV) and lamivudine (3TC) or emtricitabine (FTC); stavudine (d4T) and 3TC or FTC; and tenofovir (TDF) and 3TC or FTC.
- Follow up with postexposure testing at 1 month, 3 months, and 6 months, and perhaps 1 year.
- Document the exposure in detail for your own records as well as for the employer.

Centers for Disease Control and Prevention. (2005). Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. *MMWR–Morbidity and Mortality Weekly Report, 54*(RR-9), 1–17.

### Physiology ■■■ Pathophysiology

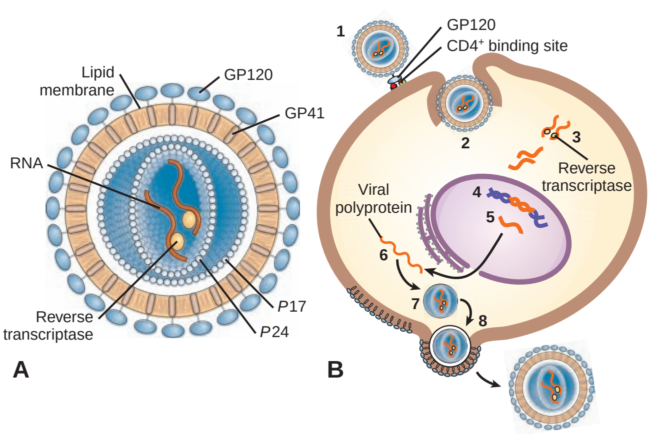



**Figure 52-1** **A,** Structure of HIV-1. A glycoprotein envelope surrounds the virus, which carries its genetic material in RNA. Knobs, consisting of proteins GP120 and GP41, protrude from the envelope. These proteins are essential for binding the virus to the CD4+ T lymphocyte. **B,** Life cycle of HIV-1: (1) Attachment of the HIV virus to a CD4+ receptor; (2) internalization and uncoating of the virus with viral RNA and reverse transcriptase; (3) reverse transcription, which produces a mirror image of the viral RNA and double-stranded DNA molecule; (4) integration of viral DNA into host DNA using the integrase enzyme; (5) transcription of the inserted viral DNA to produce viral messenger RNA; (6) translation of viral messenger RNA to create viral polyprotein; (7) cleavage of viral polyprotein into individual viral proteins that make up the new virus; and (8) assembly and release of the new virus from the host cell. Redrawn from Porth, C. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (7th ed.). Philadelphia: Lippincott Williams & Wilkins.

All viruses target specific cells. HIV targets cells with CD4 receptors, which are expressed on the surface of T lymphocytes, **monocytes,** dendritic cells, and brain microglia. Mature T cells (T lymphocytes) are composed of two major subpopulations that are defined by cell surface receptors of CD4 or CD8. Approximately two thirds of peripheral blood T cells are CD4+, and approximately one third are CD8+. Most people have about 700 to 1000 CD4+ cells/mm$^3$, but a level as low as 500 cells/mm$^3$ can be considered within normal limits. During acute/recent infection, most varieties of HIV-1 use the chemokine receptor **CCR5** (R5 virus) for entry to T cells in addition to the CD4+ receptor, which suggests that the R5 variant is preferred to a different variant (CXCR4). Over the course of infection, viruses in the majority of untreated patients eventually exhibit a shift in coreceptor from CCR5 to either CXCR4 or both CCR5 and CXCR4 (dual- or mixed-tropic) receptors (1st International Reference Panel for HIV-1 RNA Genotypes Panel, 2004). The glycoproteins of HIV (GP120 and GP41) must attach to both the CD4+ and the CCR5 binding sites in order to bind to the CD4+ cell membrane, which results in fusion of HIV with the T cell.

Once HIV has attached to the host cell, the virus can replicate. The HIV life cycle is complex (see Fig. 52-1B) and consists of the following steps (Porth & Matfin, 2009):

1. Attachment. In this first step, the GP120 and GP41 glycoproteins of HIV bind with the host's uninfected CD4+ receptor and chemokine coreceptors, usually CCR5, which results in fusion of HIV with the CD4+ T-cell membrane.
2. Uncoating. The contents of HIV's viral core (two single strands of viral RNA and three viral enzymes: **reverse transcriptase,** integrase, and protease) are emptied into the CD4+ T cell.

3. DNA synthesis. HIV changes its genetic material from RNA to DNA through action of reverse transcriptase, resulting in double-stranded DNA that carries instruction for viral replication.
4. Integration. New viral DNA enters the nucleus of the CD4+ T cell and through action of integrase is blended with the DNA of the CD4+ T cell, resulting in permanent, lifelong infection. Prior to this step, the uninfected person has been only exposed to, not infected with, HIV. With this step, HIV infection is permanent.
5. Transcription. When the CD4+ T cell is activated, the double-stranded DNA forms single-stranded messenger RNA (mRNA), which builds new viruses.
6. Translation. The mRNA creates chains of new proteins and enzymes (polyproteins) that contain the components needed in the construction of new viruses.
7. Cleavage. The HIV enzyme protease cuts the polyprotein chain into the individual proteins that make up the new virus.
8. Budding. New proteins and viral RNA migrate to the membrane of the infected CD4+ T cell, exit from the cell, and start the process all over.

In resting (nondividing) CD4+ cells, HIV can survive in a latent state as an integrated **provirus** that produces few or no viral particles. These resting CD4+ T cells can be stimulated to produce new particles if something activates them. When a T cell that harbors this integrated DNA (also known as provirus) becomes activated against HIV or other microbes, the cell begins to produce new copies of both RNA and viral proteins. Activation of the infected cell may be achieved by antigens, mitogens, certain cytokines (tumor necrosis factor-alpha [TNF-α] or interleukin-1 [IL-1]), or virus gene products of such viruses as **cytomegalovirus (CMV)**, Epstein-Barr virus, herpes simplex virus, and hepatitis viruses. Consequently, whenever the infected CD4+ cell is activated, HIV replication and budding occur, which can destroy the host cell. Newly formed HIV released into the blood can infect other CD4+ cells (see Fig. 52-1B).

HIV-1 mutates quickly, at a relatively constant rate, with about 1% of the virus's genetic material changing annually. HIV-1 exhibits substantial genetic diversity and several different genotypes of HIV-1 exist. There is a major group (group M), which consists of subtypes A through L, and a more diverse collection of outliers, which has been referred to as groups N and O. Many of the early nucleic acid–based tests had a fairly narrow band of specificity targeted mainly at subtype B viruses, because these predominated in the western world (1st International Reference Panel for HIV-1 RNA Genotypes, 2004).

A mutation of CCR5 that is common in Caucasians, but not other ethnic groups, has been identified. About 1% of Caucasians lack functional CCR5 and are highly protected against HIV infection even if exposed (although protection is not absolute); about 18% are not markedly protected against infection but, if infected, demonstrate significantly slower rates of disease progression.

## Stages of HIV Disease

The stage of HIV disease is based on clinical history, physical examination, laboratory evidence of immune dysfunction, signs and symptoms, and infections and malignancies. The CDC standard case definition of AIDS categorizes HIV infection and AIDS in adults and adolescents on the basis of clinical conditions associated with HIV infection and CD4+ T-cell counts. The classification system (Table 52-1) groups clinical conditions into one of three categories, denoted A, B, and C.

### *Primary Infection (Acute/Recent HIV Infection, Acute HIV Syndrome)*

The period from infection with HIV to the development of HIV-specific antibodies is known as **primary infection.** Initially, there is a **window period** during which an HIV-positive person tests negative on the HIV antibody blood test, although he or she is infected and highly infectious, because his or her viral load is very high. After 2 to 3 weeks, antibodies to the glycoproteins of the HIV envelope can be detected in the sera of HIV-infected people, but most of these antibodies lack the ability to totally control the virus. By the time neutralizing antibodies can be detected, HIV-1 is firmly established in the host.

Primary infection is characterized by high levels of viral replication, widespread dissemination of HIV throughout the body, and destruction of CD4+ T cells. This leads to dramatic drops in CD4+ T-cell counts, which are normally 500 to 1500 cells/mm$^3$ of blood. The host is responding to the HIV infection through a CD4+ T-cell response that causes other immune cells, such as CD8+ lymphocytes, to increase their killing of infected, virus-producing cells. The body produces antibody molecules in an effort to contain the free HIV particles (outside cells) and assist in their removal. The remaining amount of virus in the body after this initial immune response is referred to as the **viral set point,** which results in a steady state of infection that lasts for years. The final level of the viral set point is inversely correlated with disease prognosis; that is, the higher the viral set point, the poorer the prognosis.

The primary infection stage is part of CDC category A and includes the acute symptomatic and early infection phases. During this stage, the virus is widely disseminated in lymphoid tissue, and a **latent reservoir** within resting memory CD4+ T cells is created (Zack & Park, 2008). An estimated 40% to 90% of patients who are acutely infected with HIV experience symptoms of acute retroviral syndrome characterized by fever, lymphadenopathy, pharyngitis, skin rash, myalgias/arthralgias, and other conditions (Panel on Antiretroviral Guidelines for Adults and Adolescents (Guidelines) (2008)).

### *HIV Asymptomatic (CDC Category A: More Than 500 CD4+ T Lymphocytes/mm$^3$)*

After the viral set point is reached, HIV-positive people enter into a chronic stage in which the immune system cannot eliminate the virus despite its best efforts. This set point varies greatly from patient to patient and dictates the subsequent rate of disease progression; on average, 8 to 10 years pass before a major HIV-related complication develops. In

**Table 52-1 CLASSIFICATION SYSTEM FOR HIV INFECTION AND EXPANDED AIDS SURVEILLANCE CASE DEFINITION FOR ADOLESCENTS AND ADULTS**

| Diagnostic Categories CD4+ T-Cell Category | Clinical Categories: A Asymptomatic, Acute (Primary) HIV or PGL | Clinical Categories: B Symptomatic, Not (A) or (C) Conditions | Clinical Categories: C AIDS-Indicator Conditions |
|---|---|---|---|
| (1) ≥500/μL | A1 | B1 | C1 |
| (2) 200–499/μL | A2 | B2 | C2 |
| (3) <200/μL AIDS-indicator T-cell count | A3 | B3 | C3 |

*People with AIDS-indicator conditions (clinical category C) and those in categories A3 or B3 are considered to have AIDS.*

**Clinical Category A**

Includes one or more of the following in an adult or adolescent with confirmed HIV infection and without conditions in clinical categories B and C:

- Asymptomatic HIV infection
- Persistent generalized lymphadenopathy (PGL)
- Acute (primary) HIV infection with accompanying illness or history of acute HIV infection

**Clinical Category B**

Examples of conditions in clinical category B include, but are not limited to, the following:

- Bacillary angiomatosis
- Candidiasis, oropharyngeal (thrush) or vulvovaginal (persistent, frequent, or poorly responsive to therapy)
- Cervical dysplasia (moderate or severe)/cervical carcinoma in situ
- Constitutional symptoms, such as fever (38.5°C) or diarrhea exceeding 1 mo in duration
- Hairy leukoplakia, oral
- Herpes zoster (shingles), involving at least two distinct episodes or more than one dermatome
- Idiopathic thrombocytopenic purpura
- Listeriosis
- Pelvic inflammatory disease, particularly if complicated by tubo-ovarian abscess
- Peripheral neuropathy

**Clinical Category C**

Examples of conditions in adults and adolescents include the following:

- Candidiasis of bronchi, trachea, or lungs; esophagus
- Cervical cancer, invasive
- Coccidioidomycosis, disseminated or extrapulmonary
- Cryptococcosis, extrapulmonary
- Cryptosporidiosis, chronic intestinal (exceeding 1 mo's duration)
- Cytomegalovirus disease (other than liver, spleen, or lymph nodes)
- Cytomegalovirus retinitis (with loss of vision)
- Encephalopathy, HIV related
- Herpes simplex: chronic ulcer(s) (exceeding 1 mo's duration); or bronchitis, pneumonitis, or esophagitis
- Histoplasmosis, disseminated or extrapulmonary
- Isosporiasis, chronic intestinal (exceeding 1 mo's duration)
- Kaposi's sarcoma
- Lymphoma, Burkitt's (or equivalent term); immunoblastic (or equivalent term); primary, of brain
- *Mycobacterium avium* complex or *M. kansasii*, disseminated or extrapulmonary
- *Mycobacterium tuberculosis*, any site (pulmonary or extrapulmonary)
- *Mycobacterium*, other species or unidentified species, disseminated or extrapulmonary
- *Pneumocystis jiroveci* pneumonia
- Pneumonia, recurrent
- Progressive multifocal leukoencephalopathy
- *Salmonella* septicemia, recurrent
- Toxoplasmosis of brain
- Wasting syndrome due to HIV

Adapted from Centers for Disease Control, U.S. Department of Health and Human Services. (1992). 1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. *MMWR Morbidity and Mortality Weekly Report*, *41*(RR-17), 1–19.

this prolonged, chronic stage, patients feel well and have few, if any, symptoms. Apparent good health continues because CD4+ T-cell levels remain high enough to preserve immune defensive responses.

#### HIV Symptomatic (CDC Category B: 200 to 499 CD4 + T Lymphocytes/$mm^3$)

Over time, the number of CD4+ T cells gradually falls. Category B consists of symptomatic conditions in HIV-infected patients that are not included in the conditions listed in category C. These conditions must also meet one of the following criteria: (1) the condition is caused by HIV infection or a defect in cellular immunity, or (2) the condition is considered to have a clinical course or to require management that is complicated by HIV infection. If a person was once treated for a category B condition and has not developed a category C disease but is now symptom-free, that person's stage of HIV disease is considered category B.

#### AIDS (CDC Category C: Fewer Than 200 CD4+ T Lymphocytes/$mm^3$)

When the CD4+ T-cell level drops below 200 cells/$mm^3$ of blood, the person is said to have AIDS. As levels decrease to fewer than 100 cells/$mm^3$, the immune system is significantly impaired. Once a patient has had a category C condition, he or she remains in category C even if CD4+ T cells rebound with treatment. This classification has implications for entitlements (ie, disability benefits, housing, and food stamps), because these programs are often linked to an AIDS diagnosis. Although the 1993 classification emphasizes CD4+ T-cell counts, it allows for CD4+ percentages (percentage of CD4+ T cells compared with total lymphocytes). The CD4+ percentage is less subject to variation on repeated measurements than is the absolute CD4+ T-cell count. A CD4+ percentage of less than 14% of the total lymphocytes is consistent with a diagnosis of AIDS. The percentage, as compared with the absolute number of CD4+ T cells, becomes particularly important when the patient has a heightened immune response to infections in addition to HIV.

## Assessment and Diagnostic Findings in HIV Infection

During the first stage of HIV infection, the patient may be asymptomatic or may exhibit various signs and symptoms. The patient's health history should alert the health care

**Table 52-2 SELECTED LABORATORY TESTS FOR DIAGNOSING AND TRACKING HIV AND ASSESSING IMMUNE STATUS**

| Test | Findings in HIV Infection |
|---|---|
| EIA (enzyme immunoassay) | Antibodies are detected, resulting in positive results and marking the end of the window period |
| Western blot | Also detects antibodies to HIV; used to confirm EIA |
| Viral load | Measures HIV RNA in the plasma |
| CD4/CD8 | These are markers found on lymphocytes. HIV kills CD4+ cells, which results in a significantly impaired immune system. |

provider about the need for HIV screening based on the patient's sexual practices, IV/injection drug use, and receipt of blood transfusions. Additionally, exposure to body fluids containing infected blood while providing care to others with HIV infection (eg, through needlesticks) should alert health care providers to possible HIV infection. Patients who are in later stages of HIV infection may have a variety of symptoms related to their immunosuppressed state. Several screening tests are used to diagnose HIV infection. Others are used to assess the stage and severity of the infection. Table 52-2 identifies common blood tests.

### HIV Antibody Tests

In 2006, the CDC issued recommendations for HIV testing in public and private health care settings (CDC, 2006), including hospital emergency departments, inpatient facilities, urgent care clinics, primary care settings, public health clinics, community clinics, substance abuse treatment clinics, and correctional health care facilities. The objectives of those recommendations were to increase HIV screening of patients, including pregnant women, in health care settings; foster earlier detection of HIV infection; identify and counsel people with unrecognized HIV infection and refer them to clinical and preventive services; and further reduce perinatal transmission of HIV. The major changes from previously published guidelines are:

1. HIV screening is recommended for patients (18 to 64 years of age) in all health care settings after the patient is notified that testing will be performed unless he or she declines (opt-out screening).
2. People at high risk for HIV infection should be screened for the disease at least annually.
3. Separate written consent for HIV testing should not be required; general consent for medical care should be considered sufficient to encompass consent for HIV testing.
4. Prevention counseling should not be required with HIV diagnostic testing or as part of HIV screening programs in health care settings.

Although these guidelines are already in effect in some states, they have not been implemented in others because they violate the states' existing HIV confidentiality laws.

Before an HIV antibody test is performed, the meaning of the test and possible test results are explained, and informed consent for the test is obtained from the patient. When the result of the HIV antibody test is received, it is carefully explained to the patient in private (Chart 52-6). All test results are kept confidential. Education and counseling about the test result and about preventing transmission are essential. The patient's psychological response to a positive test result may include feelings of panic, depression, and hopelessness. The social and interpersonal consequences of a positive test result can be devastating. The patient may lose his or her sexual partner, housing, and health insurance because of disclosure. He or she may experience discrimination in employment and housing, as well as social ostracism. For these reasons and others, patients who test positive may need ongoing counseling as well as referrals for social, financial, medical, and psychological support services. Patients whose test results are seronegative may develop a false sense of security, possibly resulting in continued high-risk behaviors or feelings that they are immune to the virus. These patients may need ongoing counseling to help modify high-risk behaviors and to encourage returns for repeated testing. Other patients may experience anxiety regarding the uncertainty of their status.

When a person is infected with HIV, the immune system responds by producing antibodies against the virus, usually within 3 to 12 weeks after infection. In 1985, the FDA licensed an HIV-1 antibody assay that uses approximately 5 to 7 mL of blood. Samples are tested using two different laboratory techniques to determine the presence of antibodies to HIV. The **EIA (enzyme immunoassay)** test, formerly referred to as the **ELISA (enzyme-linked immunosorbent assay)** test, identifies antibodies directed specifically against HIV. The **Western blot assay** is used to confirm seropositivity when the EIA result is positive. Adults whose blood contains antibodies for HIV are seropositive.

In addition to this HIV-1 antibody assay, two additional techniques are now available. The OraSure test uses saliva to perform an EIA antibody test. Using less than a drop of

**Chart 52-6 • *HIV Test Results: Implications for Patients***

**Interpretation of Positive Test Results**

- Antibodies to HIV are present in the blood (the patient has been infected with the virus, and the body has produced antibodies).
- HIV is active in the body, and the patient can transmit the virus to others.
- Despite HIV infection, the patient does not necessarily have AIDS.
- The patient is not immune to HIV (the antibodies do not indicate immunity).

**Interpretation of Negative Test Results**

- Antibodies to HIV are not present in the blood at this time, which can mean that the patient has not been infected with HIV or, if infected, the body has not yet produced antibodies (window period—usually 3 weeks to 6 months).
- The patient should continue taking precautions. The test result does not mean that the patient is immune to the virus, nor does it mean the patient is not infected; it just means that the body may not have produced antibodies yet.

blood, the OraQuick Rapid HIV-1 Antibody Test quickly (approximately 20 minutes) and reliably (99.6% accuracy) detects antibodies to HIV-1. The OraQuick test is becoming the standard method of testing in settings where a delay would seriously affect treatment, such as in labor and delivery rooms or in emergency departments when the HIV status of a sexual abuser is unknown.

Home-based testing for HIV antibodies using a small amount of blood was first proposed in 1985 and approved by the FDA in 1995. However, use of home testing kits raises concerns because of the lack of counseling and possible inaccurate results, including both false-positive and false-negative results.

### *Viral Load Tests*

Target amplification methods quantify HIV RNA or DNA levels in the plasma and have replaced p24 antigen capture assays. Target amplification methods include reverse transcriptase–**polymerase chain reaction** (RT-PCR) and nucleic acid sequence–based amplification. A widely used **viral load test** measures plasma HIV RNA levels. Currently, these tests are used to track viral load and response to treatment of HIV infection. RT-PCR is also used to detect HIV in high-risk seronegative people before antibodies are measurable, to confirm a positive EIA result, and to screen neonates. HIV culture or quantitative plasma culture and plasma viremia are additional tests that measure viral burden, but they are used infrequently. Viral load is a better predictor of the risk of HIV disease progression than the CD4+ count. The lower the viral load, the longer the time to AIDS diagnosis and the longer the survival time.

## Treatment of HIV Infection

Protocols on how and when to start treatment for HIV disease change relatively often. The U.S. Department of Health and Human Services Panel on Antiretroviral Guidelines for Adults and Adolescents (Guidelines, 2008) is composed of HIV specialists from across the country who meet periodically to review the latest scientific evidence. The CD4+ T-cell count is usually the most important consideration in deciding whether antiretroviral medications should be started. In general, antiretroviral medications should be offered to people with a T-cell count of less than 350 cells/mm$^3$ or plasma HIV RNA levels exceeding 100,000 copies/mL (Guidelines, 2008). Some clinicians and patients, however, are choosing not to start medications until the CD4+ cell count decreases to approximately 200 cells/mm$^3$. Monitoring the National Institutes of Health (NIH) Web site (see Resources at the end of the chapter) for frequent updates of the recommendations is essential before caring for patients with HIV/AIDS (Guidelines, 2008).

Clinicians, in partnership with patients, make treatment decisions based on a number of factors, including CD4+ T-cell count, viral load, severity of HIV/AIDS-related symptoms, and willingness of the patient to adhere to the lifelong treatment regimen. The increasing number of antiretroviral agents (Table 52-3) and the rapid evolution of new information have introduced extraordinary complexity into the treatment of HIV infection. More than 25 agents have been approved in the United States. Drugs from established classes (nucleoside/nucleotide reverse transcriptase inhibitors [NRTIs], non-nucleoside reverse transcriptase inhibitors [NNRTIs], and **protease inhibitors [PIs]**) continue to serve as the mainstays of antiretroviral therapy (Kuritzkes, 2008). In 2008, the integrate inhibitor (raltegravir [Isentress]) and the CCR5 antagonist (maraviroc [Selzentry]), a novel entry inhibitor, were approved and joined the other fusion inhibitors such as enfuvirtide (T-20), which inhibits entry of HIV into the CD4+ T cell (Moyle, Gatell, Perno, et al., 2008). In patients with resistant HIV disease, these new classes of antiretroviral agents offer considerable potential benefit because of the absence of cross-resistance (Cooper, Steigbiegel, Gatell, et al., 2008).

To achieve sustained viral suppression, patients must take more than one antiretroviral medication. Although HAART was defined originally as a regimen that included at least one PI, it has evolved to include any regimen with at least two to three different medications. Some pharmaceutical companies have combined two to three agents into one tablet or capsule, such as Kaletra (lopinavir and ritonavir) and Atripla (efavirenz, emtricitabine, and tenofovir) in a single tablet for once-a-day use. Simplifying treatment regimens and decreasing the number of medications that must be taken each day may increase patients' adherence to therapy.

Adherence to long-term treatment is required to manage HIV infection and many other chronic illnesses; however, overall adherence rates remain low (30% to 50%). Although antiretroviral regimens have become less complex, side effects create barriers to adherence, and this can lead to viral resistance. The goals of treatment include maximal and sustained suppression of viral load to a nondetectable level, restoration or preservation of immunologic function, improved quality of life, and reduction of HIV-related morbidity and mortality. Viral load testing is recommended at the time of diagnosis of HIV disease and every 3 to 4 months thereafter in the untreated person; T-cell counts should be measured at diagnosis and usually every 3 to 6 months thereafter (Guidelines, 2008). In the majority of patients, HAART leads to sustained reductions in HIV replication, a rise in CD4+ T-cell counts with reconstitution of immune function, and significant reductions in morbidity and mortality.

It is difficult to predict patients' adherence to medication regimens, but a positive relationship between the patient and health care provider is associated with better adherence. Individualized plans of care that take into consideration housing and social support issues, in addition to health indicators, are essential. Adherence to the antiretroviral treatment plan involves very complex behavior that can change over the duration of the medication regimen. Self-reported adherence measures can distinguish clinically meaningful patterns of medication-taking behaviors; therefore, nurses should ask patients if they are taking their medications as prescribed. Factors associated with nonadherence include active substance abuse, depression, and lack of social support. Gender, race, pregnancy, and history of past substance use have not been associated with nonadherence (Guidelines, 2008). Chart 52-7 summarizes various strategies that health care providers can encourage to promote

**Table 52-3 ANTIRETROVIRAL AGENTS***

| Generic Name (Abbreviation) and Trade Names | Food Interactions | Adverse Events |
|---|---|---|
| **Nucleoside Reverse Transcriptase Inhibitors (NRTIs)** | | |
| Abacavir (ABC)<br>*Ziagen*<br>*Trizivir* (ABC + ZDV, + 3TC)<br>*Epzicom* (ABC + 3TC) | Can be taken without regard to meals. Alcohol increases abacavir levels 41%. Abacavir has no effect on alcohol. | Hypersensitivity reaction, which can be fatal; symptoms may include fever, rash, nausea, vomiting, malaise or fatigue, loss of appetite, and respiratory symptoms such as sore throat, cough, shortness of breath. |
| Didanosine (ddI)<br>*Videx*<br>*Videx EC* | Levels decrease 55%; take half hour before or 2 h after meals. | Pancreatitis; peripheral neuropathy; nausea; diarrhea. Lactic acidosis with fatty degeneration of the liver (rare but potentially life-threatening toxicity associated with use of NRTIs) |
| Emtricitabine (FTC)<br>*Emtriva*<br>*Truvada* (FTC + TDF) | Can be taken without regard to meals | Minimal toxicity; lactic acidosis with hepatic steatosis (rare but potentially life-threatening toxicity with use of NRTIs) |
| Lamivudine (3TC)<br>*Epivir*<br>*Combivir* (3TC + ZDV)<br>*Trizivir* (3TC + ZDV, + ABC) | Can be taken without regard to meals | Minimal toxicity; lactic acidosis with hepatic steatosis (rare but potentially life-threatening toxicity with use of NRTIs) |
| Stavudine (d4T)<br>*Zerit* | Can be taken without regard to meals | Peripheral neuropathy; lipodystrophy; rapidly progressive ascending neuromuscular weakness (rare); pancreatitis; lactic acidosis with hepatic steatosis (higher incidence with d4T than with other NRTIs); hyperlipidemia |
| Tenofovir disoproxil fumarate (TDF)<br>*Viread*<br>*Truvada* (TDF + FTC) | Can be taken without regard to meals | Asthenia, headache, diarrhea, nausea, vomiting, and flatulence; renal insufficiency; lactic acidosis with hepatic steatosis (rare but potentially life-threatening toxicity with use of NRTIs) |
| Zalcitabine (ddC)<br>*Hivid* | Can be taken without regard to meals | Peripheral neuropathy; stomatitis; lactic acidosis with hepatic steatosis (rare but potentially life-threatening toxicity with use of NRTIs); pancreatitis |
| Zidovudine (AZT or ZDV)<br>*Retrovir*<br>Combivir (AZT + 3TC)<br>*Trizivir* (AZT + 3TC, + ABC) | Can be taken without regard to meals | Bone marrow suppression; macrocytic anemia or neutropenia; gastrointestinal intolerance, headache, insomnia, asthenia; lactic acidosis with hepatic steatosis (rare but potentially life-threatening toxicity with use of NRTIs) |
| **Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)** | | |
| Delavirdine (DLV)<br>*Rescriptor* | Can be taken without regard to meals | Rash (rare cases of Stevens-Johnson syndrome have been reported); increased transaminase levels; headaches |
| Efavirenz (EFV)<br>*Sustiva* | High-fat/high-caloric meals increase peak plasma concentrations of capsules by 39% and tablets by 79%; take on an empty stomach. | Rash (rare cases of Stevens-Johnson syndrome have been reported); central nervous system symptoms (dizziness, somnolence, insomnia, abnormal dreams, confusion, abnormal thinking, impaired concentration, amnesia, agitation, depersonalization, hallucinations, and euphoria); increased transaminase levels; false-positive cannabinoid test; teratogenic in monkeys |
| Nevirapine (NVP)<br>*Viramune* | Take without regard to meals. | Rash including Stevens-Johnson syndrome, symptomatic hepatitis including fatal hepatic necrosis has been reported. Single dose used in developing countries to prevent vertical transmission |
| Etravirine (TMC 125)<br>*Intelence* | Take after a meal with water. | Serious side effects of this medication include severe skin rash<br>Mild to moderate rash occurs in the second week of therapy and generally resolves within 1–2 weeks of continued therapy.<br>Nausea, diarrhea, abdominal pain, vomiting, fatigue, peripheral neuropathy, headache, and high blood pressure |
| **Protease Inhibitors (PIs)** | | |
| Amprenavir (APV)<br>*Agenerase* | High-fat meal decreases blood concentration 21%; can be taken with or without food, but high-fat meal should be avoided | GI intolerance; nausea; vomiting; diarrhea; rash; oral paresthesias; hyperlipidemia; transaminase elevation; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia |
| Atazanavir (ATV)<br>*Reyataz* | Administration with food increases bioavailability.<br>Should be taken with food; avoid taking with antacids. | Indirect hyperbilirubinemia; prolonged PR interval—some patients experience asymptomatic first-degree AV block; use with caution in patients with underlying conduction defects or on concomitant medications that can cause PR prolongation; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia |
| Fosamprenavir (FOS-APV)<br>*Lexiva* | Can be taken without regard to meals | Skin rash (19%); diarrhea; nausea; vomiting; headache; hyperlipidemia; transaminase elevation; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia |
| Indinavir (IDV)<br>*Crixivan* | For unboosted IDV: Should be taken 1 h before or 2 h after meals; may take with skim or low-fat meal<br>For RTV-boosted IDV: Can be taken with or without food | Nephrolithiasis; GI intolerance; nausea; indirect hyperbilirubinemia; hyperlipidemia; headache, asthenia; blurred vision; dizziness; rash; metallic taste; thrombocytopenia; alopecia; hemolytic anemia; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia |

*Continued on following page*

**Table 52-3 ANTIRETROVIRAL AGENTS* (Continued)**

| Generic Name (Abbreviation) and Trade Names | Food Interactions | Adverse Events |
|---|---|---|
| Lopinavir + ritonavir (LPV/RTV) *Kaletra* | Should be taken with food | GI intolerance; nausea; vomiting; diarrhea; asthenia; hyperlipidemia (especially hypertriglyceridemia); elevated serum transaminase; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia |
| Nelfinavir (NFV) *Viracept* | Should be taken with a meal or snack | Diarrhea; hyperlipidemia; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia; serum transaminase elevation |
| Ritonavir (RTV) *Norvir* | Should be taken with food if possible; may improve tolerability | GI intolerance; nausea; vomiting; diarrhea; paresthesias—circumoral and extremities; hyperlipidemia, especially hypertriglyceridemia; hepatitis; asthenia; taste perversion; hyperglycemia; fat maldistribution; possible increased bleeding in patients with hemophilia. Lower doses used as a booster |
| Saquinavir (SQV) *Invirase* | | GI intolerance; nausea; diarrhea; abdominal pain and dyspepsia; headache; hyperlipidemia; elevated transaminase enzymes; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia. Take with RTV as booster, if prescribed. |
| Tipranavir (TPV) *Aptivus* | Take with food | Serious liver problems, bleeding on the brain, rash, increased cholesterol and triglyceride levels, and changes in body fat; women taking birth control pills that contain estrogen may be more likely to develop a rash. Individuals with hemophilia may have increased bleeding. Take with RTV, if prescribed. |
| Darunavir *Prezista* | | Diarrhea; nausea; headache; and coldlike symptoms, including runny nose or sore throat; inflammation of the liver; abnormal liver function tests; severe skin rash; fever; and abnormally high cholesterol and triglyceride levels have been reported. Take with RTV. |
| **Fusion Inhibitors** | | |
| Enfuvirtide (T-20) *Fuzeon* | Injected subcutaneously, so meals are not an issue | Local injection site reactions—almost 100% of patients (pain, erythema, induration, nodules and cysts, pruritus, ecchymosis); increased rate of bacterial pneumonia; hypersensitivity reaction—symptoms may include rash, fever, nausea, vomiting, chills, rigors, hypotension, or elevated serum transaminases; may recur on challenge |
| Maraviroc *Selzentry* | Taken with or without food; requires CCR5 tropism blood test before starting | Cough, fever, dizziness, headache, lowered blood pressure, nausea, and bladder irritation; possible liver problems and cardiac events; an increased risk for some infections; a slight increase in cholesterol levels |
| **Integrase Strand Transfer Inhibitor** | | |
| Raltegravir *Isentress* | No food restrictions identified | Diarrhea, nausea, headache, and fever have been reported. |
| **Multiclass Combination Products** | | |
| Efavirenz, emtricitabine, and tenofovir *Atripla* | | |

*This information changes often. Check the U.S. Food and Drug Administration Web site (www.fda.gov/oashi/aids/virals.html) and www.aidsinfo.nih.gov/DrugsNew/Default.aspx?MenuItem=Drugs for current information when caring for people with HIV/AIDS.

treatment regimen adherence. Every health care encounter should be used as an opportunity to briefly review the treatment regimen, identify any new issues, and reinforce successful behaviors.

Results of therapy are evaluated with viral load tests (Guidelines, 2008). Viral load levels should be measured immediately before initiation of antiretroviral therapy and again after 2 to 8 weeks, because in most patients adherence to a regimen of potent antiretroviral agents should result in a large decrease in the viral load by 2 to 8 weeks. The viral load should continue to decline over the following weeks, and in most individuals it will drop below detectable levels (currently defined as less than 50 RNA copies/mL) by 16 to 20 weeks. The rate of viral load decline toward undetectable levels is affected by the baseline T-cell count, the initial viral load, the potency of the medication, adherence to the medication regimen, prior exposure to antiretroviral agents, and the presence of any opportunistic infections. The confirmed absence of a viral load response should prompt the health care team to reevaluate the regimen. The CD4+ count should increase by 100 to 150 cells/mm$^3$ per year, with an accelerated response in the first 3 months of treatment (Guidelines, 2008).

Adverse effects associated with all HIV treatment regimens include hepatotoxicity, nephrotoxicity, and osteopenia, along with increased risk of cardiovascular disease and myocardial infarction (Moyle, et al., 2008) (see Table 52-3). Many of the antiretroviral agents that prolong life may

CHART 52-7

HOME CARE CHECKLIST

*Adhering to Medication Therapy for HIV*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Verbalize knowledge of each medication name. | ✔ | ✔ |
| • State the action of each medication. | ✔ | ✔ |
| • State the correct times that medications are to be taken. | ✔ | ✔ |
| • Identify special guidelines to follow when taking medications (eg, with meals, on an empty stomach, medications that are not to be taken together). | ✔ | ✔ |
| • Demonstrate methods of keeping track of the medication regimen and storage of the prescribed medications and use reminders such as beepers and/or pill boxes. | ✔ | ✔ |
| • Identify specific laboratory tests such as viral load that are necessary to monitor the effectiveness of the prescribed medication regimen. | ✔ | ✔ |
| • List expected side effects of each medication. | ✔ | ✔ |
| • Identify side effects that should be reported to health care providers. | ✔ | ✔ |
| • Explain the importance of and necessity for adherence with prescribed medication regimen. | ✔ | ✔ |
| • Demonstrate correct administration of IM, SC, or IV medications. | ✔ | ✔ |
| • Demonstrate correct use and safe disposal of needles, syringes, and other IV equipment. | ✔ | ✔ |
| • Discuss with health care providers any problems that he or she is having with side effects and adherence. | ✔ | ✔ |
| • Discuss episodes of nonadherence to the medication regimen. | ✔ | ✔ |

simultaneously cause fat redistribution syndrome and metabolic alterations such as dyslipidemia and insulin resistance, which put the patient at risk for early-onset heart disease and diabetes (Calza, Manfredi, Pocaterra, et al., 2008). The fat redistribution syndrome consists of lipoatrophy (localized subcutaneous fat loss in the face, arms, legs, and buttocks) and lipohypertrophy (central visceral fat [lipomata] accumulation in the abdomen, although possibly in the breasts, dorsocervical region [buffalo hump], and within the muscle and liver) (Calza, et al., 2008). These changes can be very disturbing to the body image of people living with HIV/AIDS and may be a reason that they decline treatment, especially with regimens that include a PI.

Facial wasting, characterized as a sinking of the cheeks, eyes, and temples caused by the loss of fat tissue under the skin, may be treated by injectable fillers such as poly-L-lactic acid (Sculptra) (Fig. 52-2). Hepatotoxicity associated with certain protease inhibitors may limit the use of these agents, especially in patients with underlying liver dysfunction (Guidelines, 2008).

### Drug Resistance

Drug resistance can be broadly defined as the ability of pathogens to withstand the effects of medications that are intended to be toxic to them. There are two major components of antiretroviral drug resistance: (1) transmission of drug-resistant HIV at the time of initial infection and (2) selective drug resistance in patients who are receiving nonsuppressive regimens (Kuritzkes, 2008). Factors associated with the development of drug resistance include monotherapy (taking one medication), difficulty with adherence to complex and toxic regimens, and initiation of therapy late in the course of HIV/AIDS.

Resistance testing has a number of limitations and is more helpful in determining which antiretroviral agents should be eliminated rather than which ones should be used. Genotypic testing determines the sequence of viral RNA encoding relevant genes, which allows detection of amino acid mutations that are either proven or suspected to

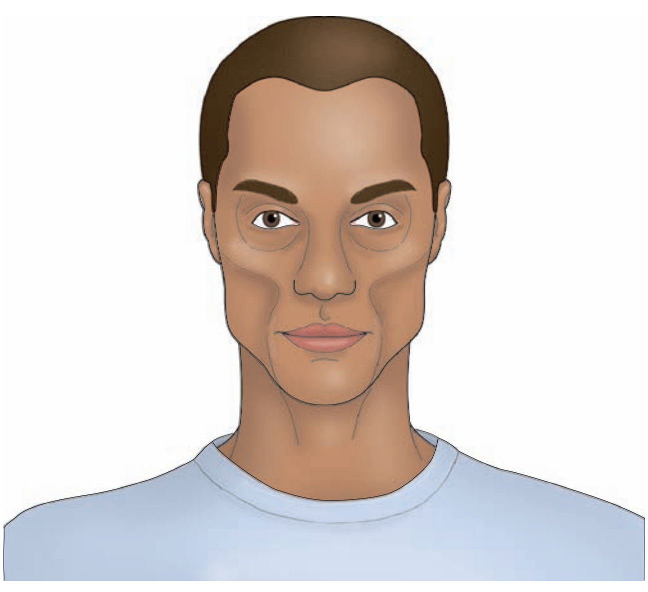


**Figure 52-2** Facial lipoatrophy.

be associated with phenotypic resistance. Phenotypic testing determines the drug concentration needed to inhibit replication of a recombinant virus by 50% of a patient's isolate, when compared with a susceptible reference. Resistance testing is of greatest value when it is performed before drugs are discontinued or immediately afterward (within 4 weeks). Drug resistance testing is not advised for patients with a viral load of less than 1000 copies/mL, because the amount of the virus in the blood is too small to ensure reliable results (Guidelines, 2008).

In addition to resistance testing, several factors must be considered in choosing medications for a new regimen, once the prior regimen has failed. These factors include the patient's past treatment history, viral load, and medication tolerance; the likelihood of the patient's adhering to the medication regimen; and concomitant medical conditions or medications.

#### Treatment Interruption

Discontinuation of antiretroviral therapy may result in viral rebound, immune decompensation, and clinical progression. Unplanned interruption of antiretroviral therapy may become necessary because of severe drug toxicity, intervening illness, surgery that precludes oral therapy, pregnancy, or unavailability of antiretroviral medications. Planned treatment interruption, outside of clinical research trials, is not recommended (Guidelines, 2008).

#### Immune Reconstitution Inflammatory Syndrome

**Immune reconstitution inflammatory syndrome (IRIS)** results from rapid restoration of pathogen-specific immune responses to opportunistic infections that cause either the deterioration of a treated infection or new presentation of a subclinical infection. This syndrome typically occurs during the initial months after beginning antiretroviral treatment and is associated with a wide spectrum of pathogens, most commonly mycobacteria, herpes viruses, and deep fungal infections (Meintjes, Lawn, Scano, et al., 2008). IRIS is characterized by fever, respiratory and/or abdominal symptoms, and worsening of the clinical manifestations of an opportunistic infection or the appearance of new manifestations. The nurse should be alert to the possibility of IRIS, especially in the 3-month period after treatment with antiretroviral agents is initiated, because this syndrome is associated with significant morbidity and patients often require hospital admission. Rates of morbidity and mortality attributable to paradoxical tuberculosis-associated IRIS may be higher in settings with limited diagnostic and treatment options (eg, South Africa).

## Clinical Manifestations

Patients with HIV/AIDS experience a number of symptoms related to the disease, side effects of treatment, and other illnesses such as hepatitis (Bova, Jaffarian, Himlan, et al., 2008). The clinical manifestations of HIV/AIDS are widespread and may involve virtually any organ system. Diseases associated with HIV infection and AIDS result from infections, malignancies, or the direct effect of HIV on body tissues. Nurses need to understand the causes, signs and symptoms, and interventions, including self-care strategies, that can enhance the quality of life for patients throughout the illness. Symptom assessment tools can be used to assess patients' symptom intensity and severity. People with HIV/AIDS use a variety of self-care strategies to minimize common symptoms, which can arise from HIV disease, comorbidities, or the effects of medications used to treat HIV and opportunistic infections.

Fatigue is frequently cited by people living with HIV/AIDS as one of the most bothersome symptoms. It has a multifactorial etiology. For more information about fatigue in HIV, see Chart 52-8.

#### Respiratory Manifestations

Shortness of breath, dyspnea (labored breathing), cough, chest pain, and fever are associated with various opportunistic infections, such as those caused by *P. jiroveci*, *Mycobacterium avium-intracellulare*, CMV, and *Legionella* species.

##### *Pneumocystis* Pneumonia

The most common infection in people with AIDS is ***Pneumocystis* pneumonia (PCP),** which is caused by *P. jiroveci*. It is the most common opportunistic infection associated with AIDS. Without prophylactic therapy (discussed later), 80% of all people infected with HIV will develop PCP.

The clinical presentation of PCP in HIV infection is generally less acute than in people who are immunosuppressed as a result of other conditions. The time between the onset of symptoms and the actual documentation of disease may be weeks to months. Patients with AIDS initially develop nonspecific signs and symptoms, such as nonproductive cough, fever, chills, shortness of breath, dyspnea, and occasionally chest pain. PCP may be present despite the absence of crackles. Arterial oxygen concentrations in patients who are breathing room air may be mildly decreased, indicating minimal hypoxemia.

If left untreated, PCP eventually progresses and causes significant pulmonary impairment and, ultimately, respiratory failure. A few patients have a dramatic onset and a fulminating course involving severe hypoxemia, cyanosis, tachypnea, and altered mental status. Respiratory failure can develop within 2 to 3 days after the initial appearance of symptoms.

PCP can be diagnosed definitively by identifying the organism in lung tissue or bronchial secretions. This is accomplished by such procedures as sputum induction, bronchial-alveolar lavage, and transbronchial biopsy (by fiberoptic bronchoscopy).

##### *Mycobacterium avium* Complex

***Mycobacterium avium* complex (MAC)** disease is a common opportunistic infection in people with AIDS. MAC comprises a group of acid-fast bacilli (mycobacteria) that includes M. *avium*, M. *intracellulare*, and M. *scrofulaceum*. MAC usually causes respiratory infection but is also commonly found in the gastrointestinal tract, lymph nodes, and bone marrow. Most patients with AIDS who have T-cell counts lower than 100 cells/mm$^3$ have widespread disease at diagnosis and are debilitated. MAC infections are associated with rising mortality rates.

##### Tuberculosis

In HIV-negative people with latent tuberculosis (TB) infection, the *lifetime* risk of developing active TB disease is

CHART 52-8

NURSING RESEARCH PROFILE

## HIV-Related Fatigue

Barroso, J., Pence, B., Salahuddin, N., et al. (2008). Physiological correlates of HIV-related fatigue. *Clinical Nursing Research, 17*(1), 5–19.

### Purpose

Symptom management in people with HIV infection is an increasingly pressing concern. The most frequent and debilitating symptom of HIV is fatigue, which has been defined as "awareness of a decreased capacity for physical and/or mental activity due to an imbalance in the availability, utilization, and/or restoration of resources needed to perform activity" (p. 6).

### Design

This study used a longitudinal, repeated-measures design over a 3-year period with a total of seven study visits. The researchers investigated the cross-sectional relationship between fatigue and a wide range of physiologic characteristics in a sample of 128 HIV-positive individuals. Participants completed the HIV-related Fatigue Scale (HRFS), which consists of two subscales: (1) fatigue intensity and (2) impact of fatigue on daily functioning. After completion of the HRFS, blood was drawn to measure hepatic function, thyroid function, HIV viral load, immunologic function, gonadal function, hematologic function, and cellular injury.

### Findings

None of the physiologic variables was significantly correlated with the HRFS scales in multivariate linear regression after controlling for income and years since HIV diagnosis. Income and years of HIV infection were more correlated with fatigue than any of the physiologic measures. Most of the participants had moderate fatigue.

### Nursing Implications

Although fatigue is a common symptom that affects daily functioning and quality of life, and it was expected that physiologic variables such as viral load, liver function, and thyroid levels would be associated with fatigue, no statistically significant relationship was found. Fatigue affects the patient's ability to participate in activities of daily living such as grocery shopping and house cleaning and affects the patient's ability to maintain social relationships. Less income for people with HIV often means there are fewer choices and more energy is required to meet basic needs. The relationship between the length of time that patients have been HIV positive and have had fatigue might be a result of patients simply growing tired of living with the day-to-day challenges of HIV infection.

Until a better cause of fatigue is identified and treatments are developed, nurses need to help patients cope with this feeling of profound exhaustion. Nurses need to assist patients to create daily schedules around their periods of maximum energy and to assure them that fatigue is not necessarily associated with getting sicker. Nurses can support patients in accessing resources and also provide the emotional support needed to cope with an unpredictable chronic illness.

5% to 10%, whereas in HIV-positive people with latent TB, the *annual* risk is 10%. TB can develop in the lungs as well as in extrapulmonary sites such as the central nervous system (CNS), bone, pericardium, stomach, peritoneum, and scrotum. The CD4 T-cell count influences both the frequency and clinical picture of active TB disease. Important issues in the use of antiretroviral therapy in patients with active TB disease are (1) the sequencing of treatments, (2) the value of directly observed therapy, (3) risk of significant drug interactions with rifamycins, (4) the additive risk of hepatotoxicity and neuropathy associated with agents used to treat HIV and TB, (5) development of IRIS with TB after initiation of antiretroviral therapy, (6) the effect of antiretroviral therapy on results of tuberculin skin testing, and (7) the need for integration of therapy for HIV and TB (Guidelines, 2008).

### Gastrointestinal Manifestations

The gastrointestinal manifestations of AIDS include loss of appetite, nausea, vomiting, oral and esophageal candidiasis, and chronic diarrhea. Diarrhea is a problem in 50% to 90% of all AIDS patients. Gastrointestinal symptoms may be related to the direct effect of HIV on the cells lining the intestines. Some of the enteric pathogens that occur most frequently, identified by stool cultures or intestinal biopsy, are *Cryptosporidium muris*, *Salmonella* species, *Isospora belli*, *Giardia lamblia*, CMV, *Clostridium difficile*, and M. *avium-intracellulare*. In patients with AIDS, the effects of diarrhea can be devastating in terms of profound weight loss (more than 10% of body weight), fluid and electrolyte imbalances, perianal skin excoriation, weakness, and inability to perform the usual activities of daily living.

#### Oral Candidiasis

**Candidiasis,** a fungal infection, occurs in almost all patients with AIDS and AIDS-related conditions. Commonly preceding other life-threatening infections, it is characterized by creamy-white patches in the oral cavity. If left untreated, oral candidiasis progresses to involve the esophagus and stomach. Associated signs and symptoms include difficult and painful swallowing and retrosternal pain. Some patients also develop ulcerating oral lesions and are particularly susceptible to dissemination of candidiasis to other body systems.

#### Wasting Syndrome

**Wasting syndrome** is part of the category C case definition for AIDS. Diagnostic criteria include profound involuntary weight loss exceeding 10% of baseline body weight and either chronic diarrhea for more than 30 days or chronic weakness and documented intermittent or constant fever in the absence of any concurrent illness that could explain these findings. This protein–energy malnutrition is multifactorial. In some AIDS-associated illnesses, patients experience a hypermetabolic state in which excessive calories are burned and lean body mass is lost. This state is similar to that seen in sepsis or trauma and can lead to organ failure. The distinction between cachexia (wasting) and

malnutrition, or between cachexia and simple weight loss, is important, because the metabolic derangement seen in wasting syndrome may not be modified by nutritional support alone.

Anorexia, diarrhea, gastrointestinal malabsorption, and lack of nutrition in chronic disease all contribute to wasting syndrome. Progressive tissue wasting, however, may occur with only modest gastrointestinal involvement and without diarrhea. TNF and IL-1 are cytokines that play important roles in AIDS-related wasting syndrome. Both act directly on the hypothalamus to cause anorexia. Cytokine-induced fever accelerates the body's metabolism by 14% for every 1°F increase in temperature. TNF causes inefficient use of lipids by reducing enzymes that are needed for fat metabolism, whereas IL-1 triggers the release of amino acids from muscle tissue. People with AIDS generally experience increased protein metabolism in relation to fat metabolism, which results in significant decreases in lean body mass due to muscle and protein breakdown.

Hypertriglyceridemia, seen in people with AIDS and attributed to chronically elevated cytokine levels, can persist for months without tissue wasting and loss of lean body mass. It is believed that infections and sepsis lead to transient increases in TNF, IL-1, and other cell mediators above the chronically elevated levels that are often seen with AIDS. These transient increases in TNF and IL-1 trigger muscle wasting.

### *Oncologic Manifestations*

Certain types of cancer occur often in people with AIDS. As a result, these cancers are considered AIDS-defining conditions; that is, their presence in a person infected with HIV is a clear sign that AIDS has developed. These AIDS-related cancers include Kaposi's sarcoma, lymphoma (especially non-Hodgkin lymphoma and primary central nervous system lymphoma), and invasive cervical cancer. With HAART, the incidence of both Kaposi's sarcoma and non-Hodgkin lymphoma has decreased considerably (Levine, 2008). Kaposi's sarcoma and lymphoma are discussed below. Cervical carcinoma is described later in Gynecologic Manifestations.

#### Kaposi's Sarcoma

**Kaposi's sarcoma** (KS), the most common HIV-related malignancy, is a disease that involves the endothelial layer of blood and lymphatic vessels. In people with AIDS, epidemic KS is most often seen among male homosexuals and bisexuals. AIDS-related KS exhibits a variable and aggressive course, ranging from localized cutaneous lesions to disseminated disease involving multiple organ systems. Cutaneous signs may be the first manifestation of HIV, appearing in more than 90% of HIV-infected patients as immune functions deteriorate. These skin signs correlate to low CD4+ counts. They can appear anywhere on the body and are usually brownish pink to deep purple. They may be flat or raised and surrounded by ecchymoses (hemorrhagic patches) and edema (Fig. 52-3). Rapid development of lesions involving large areas of skin is associated with extensive disfigurement. The location and size of some lesions can lead to venous stasis, lymphedema, and pain. Ulcerative lesions disrupt skin integrity and increase discomfort and



**Figure 52-3** Lesions of the AIDS-related Kaposi's sarcoma. Whereas some patients may have lesions that remain flat, others experience extensively disseminated, raised lesions with edema. From DeVita Jr., V. T., Hellman, S. & Rosenberg, S. (Eds.). (1993). *AIDS: Etiology, diagnosis, treatment, and prevention* (4th ed.). Philadelphia: Lippincott Williams & Wilkins.

susceptibility to infection. The most common sites of visceral involvement are the lymph nodes, gastrointestinal tract, and lungs. Involvement of internal organs may eventually lead to organ failure, hemorrhage, infection, and death.

Diagnosis of KS is confirmed by biopsy of suspected lesions. Prognosis depends on the extent of the tumor, the presence of other symptoms of HIV infection, and the CD4+ count. Death may result from tumor progression. More often, however, it results from other complications of HIV infection.

#### B-Cell Lymphomas

**B-cell lymphomas** are the second most common malignancy occurring in people with AIDS. Lymphomas associated with AIDS usually differ from those occurring in the general population. Patients with AIDS are typically much younger than the usual population affected by non-Hodgkin lymphoma. In addition, AIDS-related lymphomas tend to develop outside the lymph nodes, most commonly in the brain, bone marrow, and gastrointestinal tract. These types of lymphomas are characteristically of a higher grade, indicating aggressive growth and resistance to treatment. The course of AIDS-related lymphomas includes multiple sites of organ involvement and complications related to opportunistic infections. Although aggressive combination chemotherapy is frequently successful in the treatment of non-Hodgkin lymphoma that is not associated with HIV infection, treatment is less successful in people with AIDS because of severe hematologic toxicity and complications of opportunistic infections that can occur from treatment.

### *Neurologic Manifestations*

The advent of HAART greatly lowered the incidence of HIV dementia and increased the survival of people with HIV-associated neurocognitive disorders (McArthur, 2008). These disorders consist of cognitive impairment that is often accompanied by motor dysfunction and behavioral change. Neurologic dysfunction results from direct effects of

HIV on nervous system tissue, opportunistic infections, primary or metastatic neoplasms, cerebrovascular changes, metabolic encephalopathies, or complications secondary to therapy. Immune system response to HIV infection in the CNS includes inflammation, atrophy, demyelination, degeneration, and necrosis.

### Peripheral Neuropathy

HIV-associated **peripheral neuropathy** is common across the trajectory of HIV disease and may occur in a variety of patterns, with distal sensory polyneuropathy (DSPN) or distal symmetric polyneuropathy the most frequently occurring type. DSPN occurs in advanced HIV disease as a result of immunosuppression, antiretroviral drug toxicity, and/or mitochondrial toxicity. It can lead to significant pain and decreased function (Nicholas, Voss, Corless, et al., 2007).

### HIV Encephalopathy

**HIV encephalopathy** was formerly referred to as AIDS dementia complex (Chart 52-9). It is a clinical syndrome that is characterized by a progressive decline in cognitive, behavioral, and motor functions. Substantial evidence exists that HIV encephalopathy is a direct result of HIV infection. HIV has been found in the brain and cerebrospinal fluid (CSF) of patients with HIV encephalopathy. The brain cells infected by HIV are predominantly the CD4+ cells of monocyte-**macrophage** lineage. HIV infection is thought to trigger the release of toxins or lymphokines that result in cellular dysfunction or interference with neurotransmitter function rather than cellular damage.

Signs and symptoms may be subtle and difficult to distinguish from fatigue, depression, or the adverse effects of treatment for infections and malignancies. Early manifestations include memory deficits, headache, difficulty concentrating, progressive confusion, psychomotor slowing, apathy, and ataxia. Later stages include global cognitive impairments, delay in verbal responses, a vacant stare, spastic paraparesis, hyperreflexia, psychosis, hallucinations, tremor, incontinence, seizures, mutism, and death.

Confirming the diagnosis of HIV encephalopathy can be difficult. Extensive neurologic evaluation includes a computed tomography scan, which may indicate diffuse cerebral atrophy and ventricular enlargement. Other tests that may detect abnormalities include magnetic resonance imaging, analysis of CSF through lumbar puncture, and brain biopsy.

### *Cryptococcus neoformans*

A fungal infection, *C. neoformans* is another common opportunistic infection among patients with AIDS, and it causes neurologic disease. Cryptococcal meningitis is characterized by symptoms such as fever, headache, malaise, stiff neck, nausea, vomiting, mental status changes, and seizures. Diagnosis is confirmed by CSF analysis.

## Chart 52-9 • *Care of the Patient With HIV Encephalopathy*

#### Disturbed Thought Processes

- Assess mental status and neurologic functioning.
- Monitor for medication interactions, infections, electrolyte imbalance, and depression.
- Frequently orient the patient to time, place, person, reality, and the environment.
- Use simple explanations.
- Teach the patient to perform tasks in incremental steps.
- Provide memory aids (clocks and calendars).
- Provide memory aids for medication administration.
- Post activity schedule.
- Give positive feedback for appropriate behavior.
- Teach caretakers how to orient patient to time, place, person, reality, and the environment.
- Encourage the patient to designate a responsible person to assume power of attorney.

#### Disturbed Sensory Perception

- Assess sensory impairment.
- Decrease amount of stimuli in the patient's environment.
- Correct inaccurate perceptions.
- Provide reassurance and safety if the patient displays fear.
- Provide a secure and stable environment.
- Teach caregivers how to recognize inaccurate sensory perceptions.
- Teach caregivers techniques to correct inaccurate perceptions.
- Teach the patient and caregivers to report any changes in the patient's vision to the patient's health care provider.

#### Risk for Injury

- Assess the patient's level of anxiety, confusion, or disorientation.
- Assess the patient for delusions or hallucinations.
- Remove potentially dangerous objects from the patient's environment.
- Structure the environment for safety (ensure adequate lighting, avoid clutter, provide bed rails if needed).
- Supervise smoking.
- Do not let the patient drive a car if confusion is present.
- Instruct the patient and caregiver in home safety.
- Provide assistance as needed for ambulation and in getting in and out of bed.
- Pad headboard and side rails if the patient has seizures.

#### Self-Care Deficits

- Encourage activities of daily living within the patient's level of ability.
- Encourage independence but assist if the patient cannot perform an activity.
- Demonstrate any activity that the patient is having difficulty accomplishing.
- Monitor food and fluid intake.
- Weigh patient weekly.
- Encourage the patient to eat, and offer nutritious meals, snacks, and adequate fluids.
- If patient is incontinent, establish a routine toileting schedule.
- Teach caregivers how to meet the patient's self-care needs.

#### Progressive Multifocal Leukoencephalopathy

**Progressive multifocal leukoencephalopathy** (PML) is a demyelinating CNS disorder that affects the oligodendroglia. Clinical manifestations often begin with mental confusion and rapidly progress to include blindness, aphasia, muscle weakness, paresis (partial or complete paralysis), and death. Treatments have greatly reduced the threat of mortality associated with this disorder.

#### Other Neurologic Disorders

Other common infections involving the nervous system include *Toxoplasma gondii*, CMV, and *Mycobacterium tuberculosis* infections. Additional neurologic manifestations include both central and peripheral neuropathies. Vascular myelopathy is a degenerative disorder that affects the lateral and posterior columns of the spinal cord, resulting in progressive spastic paraparesis, ataxia, and incontinence.

### Depressive Manifestations

The prevalence of depression among people with HIV infection is unknown. The causes of depression are multifactorial and may include a history of preexisting mental illness, neuropsychiatric disturbances, and psychosocial factors. Depression also occurs in people with HIV infection in response to the physical symptoms, including pain and weight loss, and the lack of someone to talk with about their concerns. People with HIV/AIDS who are depressed may experience irrational guilt and shame, loss of self-esteem, feelings of helplessness and worthlessness, and suicidal ideation.

### Integumentary Manifestations

Cutaneous manifestations are associated with HIV infection and the accompanying opportunistic infections and malignancies. KS (described earlier) and opportunistic infections such as herpes zoster and herpes simplex are associated with painful vesicles that disrupt skin integrity. Molluscum contagiosum is a viral infection characterized by deforming plaque formation. Seborrheic dermatitis is associated with an indurated, diffuse, scaly rash involving the scalp and face. Patients with AIDS may also exhibit a generalized folliculitis associated with dry, flaking skin or atopic dermatitis, such as eczema or psoriasis. Up to 60% of patients treated with the antibacterial agent trimethoprim-sulfamethoxazole (TMP-SMZ) develop a drug-related rash that is pruritic with pinkish-red macules and papules. Patients with any of these rashes experience discomfort and are at increased risk for infection from disrupted skin integrity.

### Endocrine Manifestations

The endocrine manifestations of HIV infection are not completely understood. At autopsy, endocrine glands show infiltration and destruction from opportunistic infections or neoplasms. Endocrine function may also be affected by therapeutic agents.

### Gynecologic Manifestations

Persistent, recurrent vaginal candidiasis may be the first sign of HIV infection in women. Past or present genital ulcers are a risk factor for the transmission of HIV infection. Women with HIV infection are more susceptible to genital ulcers and venereal warts and have increased rates of incidence and recurrence of these conditions. Ulcerative sexually transmitted diseases (STDs) such as chancroid, syphilis, and herpes are more severe in women with HIV infection. **Human papillomavirus (HPV)** causes venereal warts and is a risk factor for cervical intraepithelial neoplasia, a cellular change that is frequently a precursor to cervical cancer. Women with HIV are 10 times more likely to develop cervical intraepithelial neoplasia than those not infected with HIV. There is a strong association between abnormal Papanicolaou (Pap) smears and HIV seropositivity. HIV-seropositive women with cervical carcinoma present at a more advanced stage of disease and have more persistent and recurrent disease and a shorter interval to recurrence and death than women without HIV infection.

A significant percentage of women who require hospitalization for pelvic inflammatory disease have HIV infection. Women with HIV are at increased risk for pelvic inflammatory disease, and the associated inflammation may potentiate the transmission of HIV infection. Moreover, women with HIV infection appear to have a higher incidence of menstrual abnormalities, including amenorrhea or bleeding between periods, than do women without HIV infection. The failure of health care providers to consider HIV infection in women may lead to a later diagnosis, thereby denying these patients appropriate treatment.

## Medical Management

### Treatment of Opportunistic Infections

Guidelines for the treatment of opportunistic infections should be consulted for the most current recommendations (Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents [OI Guidelines], 2009). Despite the availability of antiretroviral medications, opportunistic infections (OIs) continue to cause considerable morbidity and mortality for three main reasons: (1) many patients are unaware of their HIV infection and present with an OI as the initial indicator of their disease, (2) some patients are aware of their HIV infection but do not take antiretroviral agents because of psychosocial or economic factors, and (3) others receive prescriptions for antiretroviral medications but fail to attain adequate virologic and immunologic response as a result of issues related to adherence, pharmacokinetics, or unexplained biologic factors (OI Guidelines, 2009).

Immune function should improve with initiation of HAART, resulting in faster resolution of the OI. This has been most clearly shown for OIs for which effective therapy does not exist, such as cryptosporidiosis, microsporidiosis, and PML. These conditions may resolve or at least stabilize after the institution of antiretroviral therapy as well as resolution of lesions of KS (OI Guidelines, 2009).

#### *Pneumocystis* Pneumonia

TMP-SMZ is the treatment of choice for PCP; it is as effective as parenteral pentamidine and more effective than other regimens. Oral outpatient therapy using TMP-SMZ is highly effective among patients with mild t-moderate PCP. Adjunctive corticosteroids should be started as early as possible and certainly within 72 hours after starting specific

PCP therapy. Alternative therapeutic regimens for patients with mild to moderate disease include (1) dapsone and TMP, (2) primaquine plus clindamycin, and (3) atovaquone suspension. Alternatives for patients with moderate to severe disease include (1) primaquine plus clindamycin or (2) IV pentamidine (generally the drug of second choice for severe disease; it can cause severe hypotension if it is administered too rapidly). Aerosolized pentamidine should not be used for the treatment of PCP because of limited efficacy and more frequent relapse. The recommended duration of therapy for PCP is 21 days (OI Guidelines, 2009). Adverse effects, in addition to hypotension, include impaired glucose metabolism leading to the development of diabetes mellitus from damage to the pancreas, renal damage, hepatic dysfunction, and neutropenia.

#### Mycobacterium Avium Complex

HIV-infected adults and adolescents should receive chemoprophylaxis against disseminated MAC disease if they have a CD4+ count less than 50 cells/μL. Azithromycin (Zithromax) or clarithromycin (Biaxin) are the preferred prophylactic agents. If azithromycin or clarithromycin cannot be tolerated, rifabutin is an alternative prophylactic agent for MAC disease, although drug interactions may make this agent difficult to use (OI Guidelines, 2009). Secondary prophylaxis for disseminated MAC may be discontinued in patients who have sustained increases in CD4 counts (greater than 100 cells/$mm^3$; longer than 3 months) in response to HAART, have completed 12 months of MAC therapy, and have no signs or symptoms attributable to MAC.

#### Cryptococcal Meningitis

Cryptococcosis among patients with HIV infection most commonly occurs as a subacute meningitis or meningoencephalitis with fever, malaise, and headache. Current primary therapy for cryptococcal meningitis is IV amphotericin B with or without oral flucytosine (5-FC, Ancobon) or fluconazole (Diflucan). Serious potential adverse effects of amphotericin B include anaphylaxis, renal and hepatic impairment, electrolyte imbalances, anemia, fever, and severe chills (OI Guidelines, 2009).

#### Cytomegalovirus Retinitis

Retinitis caused by CMV is a leading cause of blindness in patients with AIDS. Oral valganciclovir, IV ganciclovir, IV ganciclovir followed by oral valganciclovir, IV foscarnet, IV cidofovir, and the ganciclovir intraocular implant coupled with valganciclovir are all effective treatments for CMV retinitis (OI Guidelines, 2009). A common adverse reaction to ganciclovir is severe neutropenia, which limits the concomitant use of zidovudine (AZT, Compound S, Retrovir). Common adverse reactions to foscarnet are nephrotoxicity, including acute renal failure, and electrolyte imbalances, including hypocalcemia, hyperphosphatemia, and hypomagnesemia, which can be life-threatening. Other common adverse effects include seizures, gastrointestinal disturbances, anemia, phlebitis at the infusion site, and low back pain. Possible bone marrow suppression (producing a decrease in white blood cell and platelet counts), oral candidiasis, and liver and renal impairments require close monitoring.

#### Other Infections

Oral acyclovir, famciclovir, or valacyclovir may be used to treat infections caused by herpes simplex or herpes zoster. Esophageal or oral candidiasis is treated topically with clotrimazole (Mycelex) oral troches or nystatin suspension. Chronic refractory infection with candidiasis (thrush) or esophageal involvement is treated with ketoconazole (Nizoral) or fluconazole (Diflucan).

### Prevention of Opportunistic Infections

TMP-SMZ (Bactrim, Cotrim, Septra) is an antibacterial agent used to treat various organisms causing infection. It also confers cross-protection against toxoplasmosis and some common respiratory bacterial infections. People with HIV infection who have a T-cell count of less than 200 cells/$mm^3$ should receive chemoprophylaxis with TMP-SMZ to prevent PCP. PCP prophylaxis can be safely discontinued in patients who are responding to HAART with a sustained increase in T lymphocytes.

### Antidiarrheal Therapy

Although many forms of diarrhea respond to treatment, it is not unusual for this condition to recur and become a chronic problem for the patient with HIV infection. Therapy with octreotide acetate (Sandostatin), a synthetic analogue of somatostatin, has been shown to be effective in managing chronic severe diarrhea. High concentrations of somatostatin receptors have been found in the gastrointestinal tract and in other tissues. Somatostatin inhibits many physiologic functions, including gastrointestinal motility and intestinal secretion of water and electrolytes.

### Chemotherapy

#### Kaposi's Sarcoma

Management of KS is usually difficult because of the variability of symptoms and the organ systems involved. KS is rarely life-threatening except when there is pulmonary or gastrointestinal involvement. The treatment goals are to reduce symptoms by decreasing the size of the skin lesions, to reduce discomfort associated with edema and ulcerations, and to control symptoms associated with mucosal or visceral involvement. No one treatment has been shown to increase survival. Radiation therapy is effective as a palliative measure to relieve localized pain due to tumor mass (especially in the legs) and for KS lesions that are in sites such as the oral mucosa, conjunctiva, face, and soles of the feet.

Interferon is known for its antiviral and antitumor effects. Patients with cutaneous KS treated with **alpha-interferon** have experienced tumor regression and improved immune system function. Alpha-interferon is administered by the IV, intramuscular, or subcutaneous route. Patients may self-administer interferon at home or receive interferon in an outpatient setting.

#### Lymphoma

Successful treatment of AIDS-related lymphomas has been limited because of the rapid progression of these malignancies. Combination chemotherapy and radiation therapy regimens may produce an initial response, but it is usually short-lived. Because standard regimens for non-AIDS

lymphomas have been ineffective, many clinicians suggest that AIDS-related lymphomas should be studied as a separate group in clinical trials.

### Antidepressant Therapy

Treatment for depression in people with HIV infection involves psychotherapy integrated with pharmacotherapy. If depressive symptoms are severe and of sufficient duration, treatment with antidepressants may be initiated. Antidepressants such as imipramine (Tofranil), desipramine (Norpramin), and fluoxetine (Prozac) may be used, because these medications also alleviate the fatigue and lethargy that are associated with depression. A psychostimulant such as methylphenidate (Ritalin) may be used in low doses in patients with neuropsychiatric impairment. Electroconvulsive therapy may be an option for patients with severe depression who do not respond to pharmacologic interventions.

### Nutrition Therapy

Malnutrition increases the risk of infection and the incidence of opportunistic infections. Nutrition therapy should be part of the overall management plan and should be tailored to meet the nutritional needs of the patient, whether by oral diet, enteral tube feedings, or parenteral nutritional support, if needed. As with all patients, a healthy diet is essential for the patient with HIV infection. For patients with diarrhea, a diet low in fat, lactose, insoluble fiber, and caffeine and high in soluble fiber is helpful (Anastasi, Capili, Kim, et al., 2006). For all patients with AIDS who experience unexplained weight loss, calorie counts should be obtained to evaluate nutritional status and initiate appropriate therapy. The goal is to maintain the ideal weight and, when necessary, to increase weight.

Appetite stimulants have been successfully used in patients with AIDS-related anorexia. Megestrol acetate (Megace), a synthetic oral progesterone preparation, promotes significant weight gain and inhibits cytokine IL-1 synthesis. In patients with HIV infection, it increases body weight primarily by increasing body fat stores. Dronabinol (Marinol), which is a synthetic tetrahydrocannabinol (THC), the active ingredient in marijuana, has been used to relieve nausea and vomiting associated with cancer chemotherapy. After beginning dronabinol therapy, almost all patients with HIV infection experience a modest weight gain. The effects on body composition are unknown.

Oral supplements may be used to supplement diets that are deficient in calories and protein. Ideally, oral supplements should be lactose-free (many people with HIV infection are intolerant to lactose), high in calories and easily digestible protein, low in fat with the fat easily digestible, palatable, inexpensive, and tolerated without causing diarrhea. Advera is a nutritional supplement that has been developed specifically for people with HIV infection and AIDS. Parenteral nutrition is the final option because of its prohibitive cost and associated risks, including risk of infections.

## Complementary and Alternative Modalities

Traditional Western medicine focuses on the treatment of disease. These treatments or interventions are taught in medical schools and are used by physicians in the care of patients. Complementary and alternative medicine (CAM) is often viewed as consisting of unconventional and unorthodox treatments or interventions that are not traditionally taught in medical schools. These modalities and therapies stress the need to treat the whole person, recognizing the interaction of the body, mind, and spirit. What is considered to be CAM in one culture may actually be a traditional therapy in another. People with HIV infection report substantial use of CAM for symptom management (Andrade & Anderson, 2008). The use of CAM in HIV infection and AIDS often results because of disillusionment with standard medical treatment, which to date has provided no cure. Combined with traditional therapies, CAM may improve the patient's overall well-being. However, there can be adverse drug–drug interactions between certain CAM therapies (eg, St. John's wort) and some antiretroviral medications.

CAM can be divided into four categories:

- Spiritual or psychological therapies may include humor, hypnosis, faith healing, guided imagery, and positive affirmations.
- Nutritional therapies may include vegetarian or macrobiotic diets, vitamin C or beta-carotene supplements, and turmeric, which contains curcumin, a food spice supplement. Chinese herbs, such as traditional herbal mixtures, are also used, in addition to compound Q (a Chinese cucumber extract) and *Momordica charantia* (bitter melon), which is given as an enema.
- Drug and biologic therapies include medications and other substances not approved by the FDA. Examples are *N*-acetylcysteine, pentoxifylline (Trental), and 1-chloro-2, 4-dinitrobenzene. Also included in this category are oxygen therapy, ozone therapy, and urine therapy.
- Treatment with physical forces and devices may include acupuncture, acupressure, massage therapy, reflexology, therapeutic touch, yoga, and crystals.

Although there is insufficient research on the effects of CAM, there is a growing body of literature reporting benefits for modalities involving nutrition, exercise, psychosocial treatment, and Chinese medicine.

Many patients who use these therapies do not report use of CAM to their health care providers. To obtain a complete health history, the nurse should ask about the patient's use of alternative therapies. Patients may need to be encouraged to report their use of CAM to their primary health care provider. Problems may arise, for example, when patients are using CAM while participating in clinical drug trials; alternative therapies can have significant adverse side effects, making it difficult to assess the effects of the medications in the clinical trial. The nurse needs to become familiar with the potential adverse side effects of these therapies. The nurse who suspects that CAM is causing a side effect needs to discuss this with the patient, the alternative therapy provider, and the primary health care provider. It is important for the nurse to view CAM with an open mind and to try to understand the importance of this treatment to the patient. This approach will improve communication with the patient and reduce conflict.

## Supportive Care

Patients who are weak and debilitated as a result of chronic illness associated with HIV infection typically require many kinds of supportive care. Nutritional support may be as simple as providing assistance in obtaining or preparing meals. For patients with more advanced nutritional impairment resulting from decreased intake, wasting syndrome, or gastrointestinal malabsorption associated with diarrhea, parenteral feedings may be required. Imbalances that result from nausea, vomiting, and profuse diarrhea often necessitate IV fluid and electrolyte replacement.

Management of skin breakdown associated with KS, perianal skin excoriation, or immobility entails thorough and meticulous skin care that involves regular turning, cleansing, and applications of medicated ointments and dressings. To combat pain associated with skin breakdown, abdominal cramping, peripheral neuropathy, or KS, it is necessary to administer analgesic agents at regular intervals around the clock. Relaxation and guided imagery may be helpful in reducing pain and anxiety.

Pulmonary symptoms, such as dyspnea and shortness of breath, may be related to infection, KS, or fatigue. For patients with these symptoms, oxygen therapy, relaxation training, and energy conservation techniques may be effective. Patients with severe respiratory dysfunction may require mechanical ventilation. Before mechanical ventilation is instituted, the procedure is explained to the patient and the caregiver. If the patient decides to forgo mechanical ventilation, his or her wishes should be followed. Ideally, the patient has prepared an advance directive identifying preferences for treatments and end-of-life care, including hospice care. If the patient has not identified preferences in advance, treatment options are described so that the patient can make informed decisions and have those wishes respected.

## NURSING PROCESS

### The Patient With HIV/AIDS

The nursing care of patients with AIDS is challenging because of the potential for any organ system to be the target of infections or cancer. In addition, this disease is complicated by many emotional, social, and ethical issues. The plan of care for the patient with AIDS (Chart 52-10) is individualized to meet the needs of the patient.

The scope and standards of HIV/AIDS nursing developed by the Association of Nurses in AIDS Care (2007) guide nursing practice. Care includes many of the interventions and concerns cited in the section on supportive care.

### Assessment

Nursing assessment includes identification of potential risk factors, including a history of risky sexual practices or IV/injection drug use. The patient's physical status and psychological status are assessed. All factors affecting immune system functioning are thoroughly explored.

#### *Nutritional Status*

Nutritional status is assessed by obtaining a dietary history and identifying factors that may interfere with oral intake, such as anorexia, nausea, vomiting, oral pain, or difficulty swallowing. In addition, the patient's ability to purchase and prepare food is assessed. Weight history (ie, changes over time); anthropometric measurements; and blood urea nitrogen (BUN), serum protein, albumin, and transferrin levels provide objective measurements of nutritional status.

#### *Skin Integrity*

The skin and mucous membranes are inspected daily for evidence of breakdown, ulceration, or infection. The oral cavity is monitored for redness, ulcerations, and the presence of creamy-white patches indicative of candidiasis. Assessment of the perianal area for excoriation and infection in patients with profuse diarrhea is important. Wounds are cultured to identify infectious organisms.

#### *Respiratory Status*

Respiratory status is assessed by monitoring the patient for cough, sputum production (ie, amount and color), shortness of breath, orthopnea, tachypnea, and chest pain. The presence and quality of breath sounds are investigated. Other measures of pulmonary function include chest x-ray results, arterial blood gas values, pulse oximetry, and pulmonary function test results.

#### *Neurologic Status*

Neurologic status is determined by assessing level of consciousness; orientation to person, place, and time; and memory lapses. Mental status is assessed as early as possible to provide a baseline. The patient is also assessed for sensory deficits (visual changes, headache, or numbness and tingling in the extremities), motor involvement (altered gait, paresis, or paralysis), and seizure activity.

#### *Fluid and Electrolyte Balance*

Fluid and electrolyte status is assessed by examining the skin and mucous membranes for turgor and dryness. Dehydration may be indicated by increased thirst, decreased urine output, postural hypotension, weak and rapid pulse, and urine specific gravity of 1.025 or more. Electrolyte imbalances, such as decreased serum sodium, potassium, calcium, magnesium, and chloride, typically result from profuse diarrhea. The patient is assessed for signs and symptoms of electrolyte deficits, including decreased mental status, muscle twitching, muscle cramps, irregular pulse, nausea and vomiting, and shallow respirations.

#### *Knowledge Level*

The patient's level of knowledge about the disease and the modes of disease transmission is evaluated. In addition, the level of knowledge of family and friends is assessed. The patient's psychological reaction to the diagnosis of HIV infection or AIDS is important to explore. Reactions vary among patients and may include denial, anger, fear, shame, withdrawal from social interactions, and depression. It is often helpful to gain an understanding of how the patient has dealt with illness and major life stresses in the past. The patient's resources for support are also identified.

CHART 52-10

## PLAN OF NURSING CARE
### *Care of the Patient With AIDS*

**NURSING DIAGNOSIS:** Diarrhea related to enteric pathogens or HIV infection
**GOAL:** Resumption of usual bowel habits

#### Nursing Interventions

1. Assess patient's normal bowel habits.
2. Assess for diarrhea: frequent, loose stools; abdominal pain or cramping, volume of liquid stools, and exacerbating and alleviating factors.
3. Obtain stool cultures and administer antimicrobial therapy as prescribed.
4. Initiate measures to reduce hyperactivity of bowel:
   a. Maintain food and fluid restrictions as prescribed. Suggest BRAT diet (*b*ananas, *r*ice, *a*pplesauce, *t*ea and *t*oast).
   b. Discourage smoking.
   c. Avoid bowel irritants such as fatty or fried foods, raw vegetables, and nuts. Offer small, frequent meals.
5. Administer anticholinergic antispasmodics and opioids or other medications as prescribed.
6. Maintain fluid intake of at least 3 L/day unless contraindicated.

#### Rationale

1. Provides baseline for evaluation
2. Detects changes in status, quantifies loss of fluid, and provides basis for nursing measures
3. Identifies pathogenic organism; therapy targets specific organism
4. Promotes bowel rest, which may decrease acute episodes
   a. Reduces stimulation of bowel
   b. Eliminates nicotine, which acts as bowel stimulant
   c. Prevents stimulation of bowel and abdominal distention and promotes adequate nutrition
5. Decreases intestinal spasms and motility
6. Prevents hypovolemia

#### Expected Outcomes

- Exhibits return to normal bowel patterns
- Reports decreasing episodes of diarrhea and abdominal cramping
- Identifies and avoids foods that irritate the gastrointestinal tract
- Appropriate therapy is initiated as prescribed
- Exhibits normal stool cultures
- Maintains adequate fluid intake
- Maintains body weight and reports no additional weight loss
- States rationale for avoiding smoking
- Enrolls in program to stop smoking
- Uses medication as prescribed
- Maintains adequate fluid status
- Exhibits normal skin turgor, moist mucous membranes, adequate urine output, and absence of excessive thirst

**NURSING DIAGNOSIS:** Risk for infection related to immunodeficiency
**GOAL:** Absence of infection

#### Nursing Interventions

1. Monitor for infection: fever, chills, and diaphoresis; cough; shortness of breath; oral pain or painful swallowing; creamy-white patches in oral cavity; urinary frequency, urgency, or dysuria; redness, swelling, or drainage from wounds; vesicular lesions on face, lips, or perianal area.
2. Teach patient or caregiver about need to report possible infection.
3. Monitor white blood cell count and differential.
4. Obtain cultures of wound drainage, skin lesions, urine, stool, sputum, mouth, and blood as prescribed. Administer antimicrobial therapy as prescribed.
5. Instruct patient in ways to prevent infection:
   a. Clean kitchen and bathroom surfaces with disinfectants.
   b. Clean hands thoroughly after exposure to body fluids.
   c. Avoid exposure to others' body fluids or sharing eating utensils.
   d. Turn, cough, and deep breathe, especially when activity is decreased.

#### Rationale

1. Allows for early detection of infection, essential for prompt initiation of treatment. Repeated and prolonged infections contribute to patient's debilitation.
2. Allows early detection of infection
3. Identifies elevated WBC possibly associated with infection
4. Assists in determining offending organism to initiate appropriate treatment
5. Minimizes exposure to infection and transmission of HIV infection to others

#### Expected Outcomes

- Identifies reportable signs and symptoms of infection
- Reports signs and symptoms of infection if present
- Exhibits and reports absence of fever, chills, and diaphoresis
- Exhibits normal (clear) breath sounds without adventitious breath sounds
- Maintains weight
- Reports adequate energy level without excessive fatigue
- Reports absence of shortness of breath and cough
- Exhibits pink, moist oral mucous membranes without fissures or lesions
- Takes appropriate therapy as prescribed
- Experiences no infection
- States rationale for strategies to avoid infection
- Modifies activities to reduce exposure to infection or infectious persons
- Practices "safer sex"
- Avoids sharing eating utensils and toothbrush
- Exhibits normal body temperature

*Continued*

CHART 52-10

## PLAN OF NURSING CARE
### *Care of the Patient With AIDS* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| e. Maintain cleanliness of perianal area.<br>f. Avoid handling pet excreta or cleaning litter boxes, bird cages, or aquariums.<br>g. Cook meat and eggs thoroughly. | | • Uses recommended techniques to maintain cleanliness of skin, skin lesions, and perianal area<br>• Has others handle pet excreta and cleanup<br>• Uses recommended cooking techniques |
| 6. Maintain aseptic technique when performing invasive procedures such as venipunctures, bladder catheterizations, and injections. | 6. Prevents hospital-acquired infections | |

**NURSING DIAGNOSIS:** Ineffective airway clearance related to *Pneumocystis* pneumonia, increased bronchial secretions, and decreased ability to cough related to weakness and fatigue
**GOAL:** Improved airway clearance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess and report signs and symptoms of altered respiratory status, tachypnea, use of accessory muscles, cough, color and amount of sputum, abnormal breath sounds, dusky or cyanotic skin color, restlessness, confusion, or somnolence. | 1. Indicates abnormal respiratory function | • Maintains normal airway clearance:<br>Respiratory rate <20 breaths/min<br>Unlabored breathing without use of accessory muscles and flaring nares (nostrils)<br>Skin color pink (without cyanosis)<br>Alert and aware of surroundings<br>Arterial blood gas values normal<br>Normal breath sounds without adventitious breath sounds |
| 2. Obtain sputum sample for culture prescribed. Administer antimicrobial therapy as prescribed. | 2. Aids in identification of pathogenic organisms | • Begins appropriate therapy<br>• Takes medication as prescribed |
| 3. Provide pulmonary care (cough, deep breathing, postural drainage, and vibration) every 2 to 4 hours. | 3. Prevents stasis of secretions and promotes airway clearance | • Reports improved breathing<br>• Maintains clear airway<br>• Coughs and takes deep breaths every 2–4 hours as recommended<br>• Demonstrates appropriate positions and practices postural drainage every 2–4 hours |
| 4. Assist patient in attaining semi- or high Fowler's position. | 4. Facilities breathing and airway clearance | • Reports reduced breathing difficulty when in semi- or high Fowler's position |
| 5. Encourage adequate rest periods. | 5. Maximizes energy expenditure and prevents excessive fatigue | • Practices energy-conserving strategies and alternates rest with activity |
| 6. Initiate measures to decrease viscosity of secretions:<br>a. Maintain fluid intake of at least 3 L/day unless contraindicated.<br>b. Humidify inspired air as prescribed.<br>c. Consult with physician concerning use of mucolytic agents delivered through nebulizer or IPPB treatment. | 6. Facilitates expectoration of secretions; prevents stasis of secretions | • Demonstrates reduction in thickness (viscosity) of pulmonary secretions<br>• Reports increased ease in coughing up sputum<br>• Uses humidified air or oxygen as prescribed and indicated |
| 7. Perform tracheal suctioning as needed. | 7. Removes secretions if patient is unable to do so | • Indicates need for assistance with removal of pulmonary secretions |
| 8. Administer oxygen therapy as prescribed. | 8. Increases availability of oxygen | |
| 9. Assist with endotracheal intubation; maintain ventilator settings as prescribed. | 9. Maintains ventilation | • Understands need for and cooperates with endotracheal intubation and use of a mechanical ventilator<br>• Verbalizes concerns about respiratory difficulty, intubation, and mechanical ventilation |

**NURSING DIAGNOSIS:** Imbalanced nutrition, less than body requirements, related to decreased oral intake
**GOAL:** Improvement of nutritional status

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess for malnutrition with height, weight, age, BUN, serum protein, albumin, and transferrin levels, hemoglobin, hematocrit, and cutaneous anergy. | 1. Provides objective measurement of nutritional status | • Identifies factors limiting oral intake and uses resources to promote adequate dietary intake |

*Continued on following page*

CHART 52-10

**PLAN OF NURSING CARE**

## *Care of the Patient With AIDS* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Obtain dietary history, including likes and dislikes and food intolerances. | 2. Defines need for nutritional education; helps individualize interventions | • Reports increased appetite<br>• States understanding of nutritional needs |
| 3. Assess factors that interfere with oral intake. | 3. Provides basis and directions for interventions | • Identifies ways to reduce factors that limit oral intake |
| 4. Consult with dietitian to determine patient's nutritional needs. | 4. Facilitates meal planning | • Rests before meals |
| 5. Reduce factors limiting oral intake: | 5. Addresses factors limiting intake: | • Eats in pleasant, odor-free environment |
| a. Encourage patient to rest before meals. | a. Minimizes fatigue, which can decrease appetite | • Arranges meals to coincide with visitors' visits |
| b. Plan meals so that they do not occur immediately after painful or unpleasant procedures. | b. Decreases noxious stimuli | • Reports increased dietary intake<br>• Uses oral hygiene before meals |
| c. Encourage patient to eat meals with visitors or others when possible. | c. Limits social isolation | • Takes analgesic agents before meals as prescribed<br>• Identifies ways to increase protein and caloric intake |
| d. Encourage patient to prepare simple meals or to obtain assistance with meal preparation if possible. | d. Limits energy expenditure | • Identifies foods high in protein and calories |
| e. Serve small, frequent meals: 6 per day. | e. Prevents overwhelming patient | • Consumes foods high in protein and calories |
| f. Limit fluids 1 hour before meals and with meals. | f. Reduces satiety | • Reports decreased rate of weight loss<br>• Maintains adequate intake |
| 6. Instruct patient in ways to supplement nutrition: consume protein-rich foods (meat, poultry, fish) and carbohydrates (pasta, fruit, breads). | 6. Provides additional proteins and calories | • States rationale for enteral or parenteral nutrition if needed<br>• Demonstrates skill in preparing alternate sources of nutrition |
| 7. Consult with physician and dietitian about alternative feeding (enteral or parenteral nutrition). | 7. Provides nutritional support if patient is unable to take sufficient amounts by mouth | |
| 8. Consult with social worker or community liaison about financial assistance if patient cannot afford food. | 8. Increases availability of resources and nutrition | |

**NURSING DIAGNOSIS:** Deficient knowledge related to means of preventing HIV transmission
**GOAL:** Increased knowledge concerning means of preventing disease transmission

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Instruct patient, family, and friends about routes of transmission of HIV. | 1. Knowledge about disease transmission can help prevent spread of disease; may also alleviate fears. | • Patient, family, and friends state means of transmission. |
| 2. Instruct patient, family, and friends about means of preventing transmission of HIV: | 2. Reduces transmission risk | • Reports and demonstrates practices to reduce exposure of others to HIV<br>• Demonstrates knowledge of safer sexual practices |
| a. Avoid sexual contact with multiple partners, and use precautions if sexual partner's HIV status is not certain. | a. The risk of infection increases with the number of sexual partners, male or female, and sexual contact with those who engage in high-risk behaviors. | • Identifies means of preventing disease transmission<br>• States that sexual partners are informed about patient's positive HIV status in blood |
| b. Use condoms during sexual intercourse (vaginal, anal, oral–genital); avoid mouth contact with the penis, vagina, or rectum; avoid sexual practices that can cause cuts or tears in the lining of the rectum, vagina, or penis. | b. Risk of HIV transmission is reduced. | • Avoids IV/injection drug use and sharing of drug equipment with others |
| c. Avoid sex with sex workers and others at high risk. | c. Many sex workers are infected with HIV through sexual contact with multiple partners or IV/injection drug use. | |

*Continued*

CHART 52-10

PLAN OF NURSING CARE

## *Care of the Patient With AIDS* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| d. Do not use IV/injection drugs; if addicted and unable or unwilling to change behavior, use clean needles and syringes. | d. Clean needles and syringes are the only way to prevent HIV transmission for those who continue to use drugs. Taking precautions is important for those who are antibody positive to prevent transmitting HIV. | |
| e. Women who may have been exposed to HIV through sexual or drug practices should consult with a physician before becoming pregnant; consider use of antiretroviral agents if pregnant. | e. HIV can be transmitted from mother to child in utero; use of antiretroviral agents during pregnancy significantly reduces perinatal transmission of HIV. | |

**NURSING DIAGNOSIS:** Social isolation related to stigma of the disease, withdrawal of support systems, isolation procedures, and fear of infecting others
**GOAL:** Decreased sense of social isolation

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's usual patterns of social interaction. | 1. Establishes basis for individualized interventions | • Shares with others the need for valued social interaction<br>• Demonstrates interest in events, activities, and communication<br>• Verbalizes feelings and reactions to diagnosis, prognosis, and life changes<br>• Identifies modes of transmission of HIV<br>• States ways of preventing transmission of AIDS virus to others while maintaining contact with valued friends and relatives<br>• Reveals AIDS diagnosis to others when appropriate<br>• Identifies resources (ie, family, friends, and support groups)<br>• Uses resources when appropriate<br>• Accepts offers of assistance and support<br>• Reports decreased sense of isolation<br>• Maintains contacts with those of importance to him or her<br>• Develops or continues hobbies that effectively serve as diversion or distraction |
| 2. Observe for behaviors indicative of social isolation, such as decreased interaction with others, hostility, noncompliance, sad affect, and stated feelings of rejection or loneliness. | 2. Promotes early detection of social isolation, which may be manifested in several ways | |
| 3. Provide instruction concerning modes of transmission of HIV. | 3. Provides accurate information, corrects misconceptions, and alleviates anxiety | |
| 4. Assist patient to identify and explore resources for support and positive mechanisms for coping (eg, contact with family, friends, AIDS task force). | 4. Enables mobilization of resources and supports | |
| 5. Allow time to be with patient other than for medications and procedures. | 5. Promotes feelings of self-worth and provides social interaction | |
| 6. Encourage participation in diversional activities such as reading, television, or hand crafts. | 6. Provides distraction | |

**COLLABORATIVE PROBLEMS:** Opportunistic infections; impaired breathing; wasting syndrome and fluid and electrolyte imbalances; adverse reaction to medications
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Opportunistic Infections** | | |
| 1. Monitor vital signs. | 1. Changes in vital signs such as increases in pulse rate, respirations, blood pressure, and temperature may indicate infection. | • Exhibits stable vital signs<br>• Experiences control of infection<br>• Identifies signs and symptoms correctly and experiences no complications<br>• Identifies signs and symptoms that are reportable to the physician<br>• Takes medications as prescribed |
| 2. Obtain laboratory specimens and monitor test results. | 2. Smears and cultures can identify causative agents such as bacteria, fungi, and protozoa, and sensitivity studies can identify antibiotics or other medications effective against the causative agent. | |

*Continued on following page*

CHART 52-10

PLAN OF NURSING CARE

## *Care of the Patient With AIDS* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Instruct the patient and caregiver about signs and symptoms of infection and the need to report them early. | 3. Early recognition of symptoms facilitates prompt treatment and avoids extra complications. | |
| **Impaired Breathing** | | |
| 1. Monitor respiratory rate and pattern. | 1. Rapid shallow breathing, diminished breath sounds, and shortness of breath may indicate respiratory failure resulting in hypoxia. | • Maintains stable respiratory rate and pattern within the normal limits<br>• Exhibits no adventitious lung sounds; normal breath sounds<br>• Has stable pulse rate and blood pressure within normal limits, and exhibits no evidence of hypoxia<br>• Oxygen saturation levels within acceptable range |
| 2. Auscultate the chest for breath sounds and abnormal lung sounds. | 2. Crackles and wheezes may indicate fluid in the lungs, which disrupts respiratory function and alters the blood's oxygen-carrying capacity. | |
| 3. Monitor pulse rate, blood pressure, and oxygen saturation levels. | 3. Changes in pulse rate, blood pressure, and oxygen levels may indicate the development of respiratory or cardiac failure. | |
| **Wasting Syndrome and Fluid and Electrolyte Disturbances** | | |
| 1. Monitor weight and laboratory values for nutritional status. | 1. Weight loss, malnutrition, and anemia are common in HIV infection and increase risk for superinfection. | • Maintains stable weight<br>• Eats a nutritious diet<br>• Attains and maintains hemoglobin, hematocrit, and ferritin levels within normal limits<br>• Sustains fluid and electrolyte balance within normal limits<br>• Exhibits no signs and symptoms of dehydration |
| 2. Monitor intake and output and laboratory values for fluid and electrolyte imbalance (potassium, sodium, calcium, phosphorus, magnesium, and zinc). | 2. Chronic diarrhea, inadequate oral intake, vomiting, and profuse sweating deplete electrolytes. Small intestine inflammation may impair the absorption of fluids and electrolytes. | |
| 3. Monitor for and report signs and symptoms of dehydration. | 3. Fluid loss results in decreased circulating volume leading to tachycardia, dry skin and mucous membranes, poor skin turgor, elevated urine specific gravity, and thirst. Early detection allows early treatment. | |
| **Reactions to Medications** | | |
| 1. Monitor for medication interactions. | 1. People with HIV infection receive many medications for HIV and for disease complications. Early detection of medication interactions is necessary to prevent complications. | • Experiences no serious side effects or complications from medications<br>• Correctly describes medication regimen and complies with therapy, including adaptations in eating routines and type of food used with prescribed medications |
| 2. Monitor for and promptly report side effects from antiretroviral agents. | 2. Side effects from antiretroviral agents can be life-threatening. Serious side effects include anemia, pancreatitis, peripheral neuropathy, mental confusion, and persistent nausea and vomiting. Corrective measures need to be instituted. | |
| 3. Instruct the patient and caregiver in the medication regimen. | 3. Knowledge of the medication purpose, correct administration, side effects, and strategies to manage or prevent side effects promote safety and greater compliance with treatment. | |

## Diagnosis

### *Nursing Diagnoses*

The list of potential nursing diagnoses is extensive because of the complex nature of this disease. However, based on assessment data, major nursing diagnoses for the patient may include the following:

- Impaired skin integrity related to cutaneous manifestations of HIV infection, excoriation, and diarrhea
- Diarrhea related to enteric pathogens or HIV infection
- Risk for infection related to immunodeficiency
- Activity intolerance related to weakness, fatigue, malnutrition, impaired fluid and electrolyte balance, and hypoxia associated with pulmonary infections

- Disturbed thought processes related to shortened attention span, impaired memory, confusion, and disorientation associated with HIV encephalopathy
- Ineffective airway clearance related to PCP, increased bronchial secretions, and decreased ability to cough related to weakness and fatigue
- Pain related to impaired perianal skin integrity secondary to diarrhea, KS, and peripheral neuropathy
- Imbalanced nutrition, less than body requirements, related to decreased oral intake
- Social isolation related to stigma of the disease, withdrawal of support systems, isolation procedures, and fear of infecting others
- Anticipatory grieving related to changes in lifestyle and roles and unfavorable prognosis
- Deficient knowledge related to HIV infection, means of preventing HIV transmission, and self-care

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, possible complications may include the following:

- Opportunistic infections
- Impaired breathing or respiratory failure
- Wasting syndrome and fluid and electrolyte imbalance
- Adverse reaction to medications

### Planning and Goals

Goals for the patient may include achievement and maintenance of skin integrity, resumption of usual bowel patterns, absence of infection, improved activity tolerance, improved thought processes, improved airway clearance, increased comfort, improved nutritional status, increased socialization, expression of grief, increased knowledge regarding disease prevention and self-care, and absence of complications.

### Nursing Interventions

#### *Promoting Skin Integrity*

The skin and oral mucosa are assessed routinely for changes in appearance, location and size of lesions, and evidence of infection and breakdown. The patient is encouraged to maintain a balance between rest and mobility whenever possible. Patients who are immobile are assisted to change position every 2 hours. Devices such as alternating-pressure mattresses and low-air-loss beds are used to prevent skin breakdown. Patients are encouraged to avoid scratching; to use nonabrasive, nondrying soaps; and to apply nonperfumed skin moisturizers to dry skin. Regular oral care is also encouraged.

Medicated lotions, ointments, and dressings are applied to affected skin surfaces as prescribed. Adhesive tape is avoided. Skin surfaces are protected from friction and rubbing by keeping bed linens free of wrinkles and avoiding tight or restrictive clothing. Patients with foot lesions are advised to wear cotton socks and shoes that do not cause the feet to perspire. Antipruritic, antibiotic, and analgesic agents are administered as prescribed.

The perianal region is assessed frequently for impairment of skin integrity and infection. The patient is instructed to keep the area as clean as possible. The perianal area is cleaned after each bowel movement with nonabrasive soap and water to prevent further excoriation and breakdown of the skin and infection. If the area is very painful, soft cloths or cotton sponges may be less irritating than washcloths. In addition, sitz baths or gentle irrigation may facilitate cleaning and promote comfort. The area is dried thoroughly after cleaning. Topical lotions or ointments may be prescribed to promote healing. Wounds are cultured if infection is suspected, so that the appropriate antimicrobial treatment can be initiated. Debilitated patients may require assistance in maintaining hygienic practices.

#### *Promoting Usual Bowel Patterns*

Bowel patterns are assessed for diarrhea. The nurse monitors the frequency and consistency of stools and the patient's reports of abdominal pain or cramping associated with bowel movements. Factors that exacerbate frequent diarrhea are also assessed. The quantity and volume of liquid stools are measured to document fluid volume losses. Stool cultures are obtained to identify pathogenic organisms.

The patient is counseled about ways to decrease diarrhea. The physician may recommend restriction of oral intake to rest the bowel during periods of acute inflammation associated with severe enteric infections. As the patient's dietary intake is increased, foods that act as bowel irritants, such as raw fruits and vegetables, popcorn, carbonated beverages, spicy foods, and foods of extreme temperatures, should be avoided. Small, frequent meals help to prevent abdominal distention. Medications, such as anticholinergic agents, antispasmodic, agents, or opioids, can be prescribed to decrease diarrhea by decreasing intestinal spasms and motility. Administering antidiarrheal agents on a regular schedule may be more beneficial than administering them on an as-needed basis. Antibiotics and antifungal agents may also be prescribed to combat pathogens identified by stool cultures. Assessment of self-care strategies being used is essential.

#### *Preventing Infection*

The patient and caregivers are instructed to monitor for signs and symptoms of infection: fever; chills; night sweats; cough with or without sputum production; shortness of breath; difficulty breathing; oral pain or difficulty swallowing; creamy-white patches in the oral cavity; unexplained weight loss; swollen lymph nodes; nausea; vomiting; persistent diarrhea; frequency, urgency, or pain on urination; headache; visual changes or memory lapses; redness, swelling, or drainage from skin wounds; and vesicular lesions on the face, lips, or perianal area. The nurse also monitors laboratory test results that indicate infection, such as the white blood cell count and differential. Cultures of specimens from wound drainage, skin lesions, urine, stool, sputum, mouth, and blood are obtained to identify pathogenic organisms and the most appropriate antimicrobial therapy. The patient is instructed to avoid others with active infections such as upper respiratory infections.

#### *Improving Activity Tolerance*

Activity tolerance is assessed by monitoring the patient's ability to ambulate and perform activities of daily living. Patients may be unable to maintain their usual levels of

activity because of weakness, fatigue, shortness of breath, dizziness, and neurologic involvement. Assistance in planning daily routines that maintain a balance between activity and rest may be necessary. In addition, patients benefit from instructions about energy conservation techniques, such as sitting while washing or while preparing meals. Personal items that are frequently used should be kept within the patient's reach. Measures such as relaxation and guided imagery may be beneficial because they decrease anxiety, which contributes to weakness and fatigue.

Collaboration with other members of the health care team may uncover other factors associated with increasing fatigue and strategies to address them. For example, if fatigue is related to anemia, administering epoetin alfa (Epogen) as prescribed may relieve fatigue and increase activity tolerance.

#### *Maintaining Thought Processes*

The patient is assessed for alterations in mental status that may be related to neurologic involvement, metabolic abnormalities, infection, side effects of treatment, and coping mechanisms. Manifestations of neurologic impairment may be difficult to distinguish from psychological reactions to HIV infection, such as anger and depression.

If the patient experiences altered mental or cognitive status, family and support network members are instructed to speak to the patient in simple, clear language and give the patient sufficient time to respond to questions. The patient's support network is encouraged to orient the patient to the daily routine by talking about what is taking place during daily activities and encouraged to provide the patient with a regular daily schedule for medication administration, grooming, meal times, bedtimes, and awakening times. Posting the schedule in a prominent area (eg, on the refrigerator), providing night lights for the bedroom and bathroom, and planning safe leisure activities allow the patient to maintain a regular routine in a safe manner. Activities that the patient previously enjoyed are encouraged. These should be easy to accomplish and fairly short in duration. The nurse encourages the social support network to remain calm and not to argue with the patient while protecting the patient from injury. Around-the-clock supervision may be necessary, and strategies can be implemented to prevent the patient from engaging in potentially dangerous activities, such as driving, using the stove, or mowing the lawn. Strategies for improving or maintaining functional abilities and for providing a safe environment are used for patients with HIV encephalopathy (see Chart 52-9).

#### *Improving Airway Clearance*

Respiratory status, including rate, rhythm, use of accessory muscles, and breath sounds; mental status; and skin color must be assessed at least daily. Any cough and the quantity and characteristics of sputum are documented. Sputum specimens are analyzed for infectious organisms. Pulmonary therapy (coughing, deep breathing, postural drainage, percussion, and vibration) is provided as often as every 2 hours to prevent stasis of secretions and to promote airway clearance. Because of weakness and fatigue, many patients require assistance in attaining a position (such as a high Fowler's or semi-Fowler's position) that facilitates breathing and airway clearance. Adequate rest is essential to minimize energy expenditure and prevent excessive fatigue. The fluid volume status is evaluated so that adequate hydration can be maintained. Unless contraindicated because of renal or cardiac disease, daily intake of 3 L of fluid is encouraged. Humidified oxygen may be prescribed, and nasopharyngeal or tracheal suctioning, intubation, and mechanical ventilation may be necessary to maintain adequate ventilation.

#### *Relieving Pain and Discomfort*

The patient is assessed for the quality and severity of pain associated with impaired perianal skin integrity, the lesions of KS, and peripheral neuropathy. In addition, the effects of pain on elimination, nutrition, sleep, affect, and communication are explored, along with exacerbating and relieving factors. Cleaning the perianal area, as previously described, can promote comfort. Topical anesthetic medications or ointments may be prescribed. Use of soft cushions or foam pads may increase comfort while sitting. The patient is instructed to avoid foods that act as bowel irritants. Antispasmodic and antidiarrheal medications may be prescribed to reduce the discomfort and frequency of bowel movements. If necessary, systemic analgesic agents may also be prescribed. Pain from KS is frequently described as a sharp, throbbing pressure, and heaviness, if lymphedema is present. Pain management may include use of nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids plus nonpharmacologic approaches such as relaxation techniques. When NSAIDs are administered to patients who are receiving zidovudine, hepatic and hematologic status must be monitored.

The patient with pain related to peripheral neuropathy frequently describes it as burning, numbness, and "pins and needles." Pain management approaches may include opioids, tricyclic antidepressants, and anti-embolism stockings to equalize pressure. Tricyclic antidepressants have been found to be helpful in controlling the symptoms of neuropathic pain. They also potentiate the actions of opioids and can be used to relieve pain without increasing the dose of the opioid.

#### *Improving Nutritional Status*

Nutritional status is assessed by monitoring weight, dietary intake, and serum albumin, BUN, protein, and transferrin levels. The patient is also assessed for factors that interfere with oral intake, such as anorexia, oral and esophageal candidal infection, nausea, pain, weakness, fatigue, and lactose intolerance (Dudek, 2006). Based on the results of assessment, the nurse can implement specific measures to facilitate oral intake. The dietitian is consulted to determine the patient's nutritional requirements.

Control of nausea and vomiting with antiemetic medications administered on a regular basis may increase the patient's dietary intake. Inadequate food intake resulting from pain caused by oral lesions or a sore throat may be managed by administering prescribed opioids and viscous lidocaine (the patient is instructed to rinse the mouth and swallow). Additionally, the patient is encouraged to eat foods that are easy to swallow and to avoid rough, spicy, or sticky food items and foods that are excessively hot or cold. Oral hygiene before and after meals is encouraged. If fatigue

and weakness interfere with intake, the nurse encourages the patient to rest before meals. If the patient is hospitalized, meals should be scheduled so that they do not occur immediately after painful or unpleasant procedures. The patient with diarrhea and abdominal cramping is encouraged to avoid foods that stimulate intestinal motility and abdominal distention, such as fiber-rich foods or lactose, if the patient is intolerant to lactose. The patient is instructed about ways to enhance the nutritional value of meals. Adding eggs, butter, or fortified milk (milk to which powdered skim milk has been added to increase the caloric content) to gravies, soups, or milkshakes can provide additional calories and protein. Supplements such as puddings, powders, milkshakes, and Advera (previously described) may also be useful (Dudek, 2006). Patients who cannot maintain their nutritional status through oral intake may require enteral feedings or parenteral nutrition.

#### *Decreasing the Sense of Isolation*

People with AIDS are at risk for double stigmatization. They have what society refers to as a "dreaded disease," and they may have a lifestyle that differs from what is considered acceptable by many people. Many people with AIDS are young adults at a developmental stage that is usually associated with establishing intimate relationships, personal goals, and career goals, as well as having and raising children. Their focus changes as they are faced with a disease that threatens their life expectancy with no cure. In addition, they may be forced to reveal hidden lifestyles or behaviors to family, friends, coworkers, and health care providers. As a result, people with HIV infection may be overwhelmed with emotions such as anxiety, guilt, shame, and fear. They also may be faced with multiple losses, such as loss of financial security; normal roles and functions; self-esteem; privacy; ability to control bodily functions; ability to interact meaningfully with the environment; and sexual functioning, as well as rejection by sexual partners, family, and friends. Some patients may harbor feelings of guilt because of their lifestyle or because they may have infected others in current or previous relationships. Other patients may feel anger toward sexual partners who transmitted the virus to them. Infection control measures used in the hospital or at home may further contribute to the patient's emotional isolation. Any or all of these stressors may cause the patient with AIDS to withdraw both physically and emotionally from social contact.

Nurses are in a key position to provide an atmosphere of acceptance and understanding for people with AIDS and their families and partners. The patient's usual level of social interaction is assessed as early as possible to provide a baseline for monitoring changes in behaviors that suggest social isolation (eg, decreased interaction with staff or family, hostility, nonadherence). Patients are encouraged to express feelings of isolation and loneliness, with the assurance that these feelings are not unique or abnormal.

Providing information about how to protect themselves and others may help patients avoid social isolation. Patients, family, and friends must be reassured that AIDS is not spread through casual contact. Education of ancillary personnel, nurses, and physicians helps reduce factors that might contribute to patients' feelings of isolation. Patient care conferences that address the psychosocial issues associated with AIDS may help sensitize the health care team to patients' needs.

#### *Coping With Grief*

The nurse can help the patient verbalize feelings and explore and identify resources for support and mechanisms for coping, especially when the patient is grieving anticipated losses. The patient is encouraged to maintain contact with family, friends, and coworkers and to use local or national AIDS support groups and hotlines. If possible, losses are identified and addressed. The patient is encouraged to continue usual activities whenever possible. Consultations with mental health counselors are useful for many patients.

#### *Monitoring and Managing Potential Complications*

**OPPORTUNISTIC INFECTIONS.** Patients who are immunosuppressed are at risk for opportunistic infections. Therefore, anti-infective agents may be prescribed and laboratory tests obtained to monitor their effect. Signs and symptoms of opportunistic infections, including fever, malaise, difficulty breathing, nausea or vomiting, diarrhea, difficulty swallowing, and any occurrences of swelling or discharge, should be reported as treated as indicated.

**RESPIRATORY FAILURE.** Impaired breathing is a major complication that increases the patient's discomfort and anxiety and may lead to respiratory and cardiac failure. The respiratory rate and pattern are monitored, and the lungs are auscultated for abnormal breath sounds. The patient is instructed to report shortness of breath and increasing difficulty in carrying out usual activities. Pulse rate and rhythm, blood pressure, and oxygen saturation are monitored. Suctioning and oxygen therapy may be prescribed to ensure an adequate airway and to prevent hypoxia. Mechanical ventilation may be necessary for the patient who cannot maintain adequate ventilation as a result of pulmonary infection, fluid and electrolyte imbalance, or respiratory muscle weakness. Arterial blood gas values are used to guide ventilator settings. If the patient is intubated, methods must be established to allow communication with the nurse and others. Attention must be given to assisting the patient receiving mechanical ventilation to cope with the stress associated with intubation and ventilator assistance. The possible need for mechanical ventilation in the future should be discussed early in the course of the disease, when the patient is able to make known his or her preferences about treatment. The use of mechanical ventilation should be consistent with the patient's decisions about end-of-life treatment. (Further discussion of end-of-life care can be found in Chapter 17.)

**CACHEXIA AND WASTING.** Wasting syndrome and fluid and electrolyte disturbances, including dehydration, are common complications of HIV infection and AIDS. The patient's nutritional and electrolyte status is evaluated by monitoring weight gains or losses, skin turgor, ferritin levels, hemoglobin and hematocrit values, and electrolyte levels. Fluid and electrolyte status is monitored on an ongoing basis; fluid intake and output and urine specific gravity may be monitored daily if the patient is hospitalized with complications. The skin is assessed for dryness and adequate

turgor. Vital signs are monitored for decreased systolic blood pressure or increased pulse rate on sitting or standing. Signs and symptoms of electrolyte disturbances, such as muscle cramping, weakness, irregular pulse, decreased mental status, nausea, and vomiting, are documented and reported to the physician. Serum electrolyte values are monitored, and abnormalities are reported.

The nurse helps the patient select foods that will replenish electrolytes, such as oranges and bananas (potassium) and cheese and soups (sodium) (Dudek, 2006). A fluid intake of 3 L or more per day, unless contraindicated, is encouraged to replace fluid lost with diarrhea, and measures to control diarrhea are initiated. If fluid and electrolyte imbalances persist, the nurse administers IV fluids and electrolytes as prescribed. Effects of parenteral therapy are monitored.

**SIDE EFFECTS OF MEDICATIONS.** Adverse reactions are of concern in patients who receive many medications to treat HIV infection or its complications. Many medications can cause severe toxic effects. Information about the purpose of the medications, their correct administration, side effects, and strategies to manage or prevent side effects is provided. Patients and their caregivers need to know which signs and symptoms of side effects should be reported immediately to their primary health care provider (see Table 52-3).

In addition to medications used to treat HIV infection, other medications that may be required include opioids, tricyclic antidepressants, and NSAIDs for pain relief; medications for treatment of opportunistic infections; antihistamines (diphenhydramine [Benadryl]) for relief of pruritus; acetaminophen (Tylenol) or aspirin for management of fever; and antiemetic agents for control of nausea and vomiting. Concurrent use of these medications can cause many drug interactions, resulting in hepatic and hematologic abnormalities. Therefore, careful monitoring of laboratory test results is essential.

During each contact with the patient, it is important for the nurse to ask not only about side effects but also about how well the patient is managing the medication regimen. The nurse may be able to assist the patient in organizing and planning the medication schedule to promote adherence to the treatment regimen.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients, families, and friends are instructed about the routes of transmission of HIV. As discussed earlier, the nurse discusses precautions the patient can use to avoid transmitting HIV sexually (see Charts 52-2 and 52-3) or through sharing of body fluids. Patients and their families or caregivers must receive instructions about how to prevent disease transmission, including handwashing techniques and methods for safely handling and disposing of items soiled with body fluids. Clear guidelines about avoiding and controlling infection, regular health care appointments, symptom management, nutrition, rest, and exercise are necessary. The importance of personal and environmental hygiene is emphasized. Caregivers are taught many of the guidelines (standard precautions) described in Chart 52-4. Kitchen and bathroom surfaces should be cleaned regularly with disinfectants to prevent growth of fungi and bacteria. Patients with pets are encouraged to have another person clean areas soiled by animals, such as bird cages and litter boxes. If this is not possible, patients should use gloves and should wash their hands after they clean the area. Patients are advised to avoid exposure to others who are sick or who have been recently vaccinated. The importance of avoiding smoking, excessive alcohol, and over-the-counter and street drugs is emphasized. Patients who are HIV positive or who inject drugs are instructed not to donate blood. IV/injection drug users who are unwilling to stop using drugs are advised to avoid sharing drug equipment with others.

Caregivers in the home are taught how to administer medications, including IV preparations. The medication regimens used for patients with HIV infection and AIDS are often complex and expensive. Patients receiving combination therapies for treatment of HIV infection and its complications require careful teaching about the importance of taking medications as prescribed and explanations and assistance in fitting the medication regimen into their lives (see Chart 52-7). If the patient requires enteral or parenteral nutrition, instruction is provided to the patient and family about how to administer nutritional therapies at home. Home care nurses provide ongoing teaching and support for the patient and family.

**CONTINUING CARE.** Many people with AIDS remain in their community and continue their usual daily activities, whereas others can no longer work or maintain their independence. Families or caregivers may need assistance in providing supportive care. There are many community-based organizations that provide a variety of services for people living with HIV infection and AIDS; nurses can help identify these services.

Community health nurses, home care nurses, and hospice nurses are in an excellent position to provide the support and guidance so often needed in the home setting. As hospital costs continue to rise and insurance coverage continues to decline, the complexity of home care increases. Home care nurses are key to the safe and effective administration of parenteral antibiotics, chemotherapy, and nutrition in the home.

During home visits, the nurse assesses the patient's physical and emotional status and home environment. The patient's adherence to the therapeutic regimen is assessed, and strategies are suggested to assist with adherence. The patient is assessed for progression of disease and for adverse side effects of medications. Previous teaching is reinforced, and the importance of keeping follow-up appointments is stressed.

Complex wound care or respiratory care may be required in the home. Patients and families are often unable to meet these skilled care needs without assistance. Nurses may refer patients to community programs that offer a range of services for patients, friends, and families, including help with housekeeping, hygiene, and meals; transportation and shopping; individual and group therapy; support for caregivers; telephone networks for the homebound; and legal and financial assistance. These services are typically provided by both professionals and nonprofessional volunteers. A social worker may be consulted to identify sources of financial support, if needed.

Home care and hospice nurses are increasingly called on to provide physical and emotional support to patients and families as patients with AIDS enter the terminal stages of disease. This support takes on special meaning when people with AIDS lose friends and when family members fear the disease or feel anger concerning the patient's lifestyle. The nurse encourages the patient and family to discuss end-of-life decisions and to ensure that care is consistent with those decisions, all comfort measures are employed, and the patient is treated with dignity at all times.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Maintains skin integrity
2. Resumes usual bowel habits
3. Experiences no infections
4. Maintains adequate level of activity tolerance
5. Maintains usual level of thought processes
6. Maintains effective airway clearance
7. Experiences increased sense of comfort and less pain
8. Maintains adequate nutritional status
9. Experiences decreased sense of social isolation
10. Progresses through grieving process
11. Reports increased understanding of AIDS and participates in self-care activities as possible
12. Remains free of complications

Detailed outcomes are included in the plan of nursing care for a patient with AIDS (see Chart 52-10).

# EMOTIONAL AND ETHICAL CONCERNS

Nurses in all settings are called on to provide care for patients with HIV infection. In doing so, they encounter not only the physical challenges of this epidemic but also emotional and ethical concerns. The concerns raised by health care professionals involve issues such as fear of infection, responsibility for giving care, values clarification, confidentiality, developmental stages of patients and caregivers, and poor prognostic outcomes.

Many patients with HIV infection have engaged in "stigmatized" behaviors. Because these behaviors challenge some traditional religious and moral values, nurses may feel reluctant to care for these patients. In addition, health care providers may still have fear and anxiety about disease transmission despite education concerning infection control and the low incidence of transmission to health care providers (see Chart 52-5). Nurses are encouraged to examine their personal beliefs and to use the process of values clarification to approach controversial issues. The American Nurses Association's Code of Ethics for Nurses (2008) can also be used to help resolve ethical dilemmas that might affect the quality of care given to patients with HIV infection and AIDS.

Nurses are responsible for protecting the patient's right to privacy by safeguarding confidential information. Inadvertent disclosure of confidential patient information may result in personal, financial, and emotional hardships for the patient. The controversy surrounding confidentiality concerns the circumstances in which information may be disclosed to others. Health care team members need accurate patient information to conduct assessment, planning, implementation, and evaluation of patient care. Failure to disclose HIV status could compromise the quality of patient care. Sexual partners of HIV-infected patients should know about the potential for infection and the need to engage in safer sex practices, as well as the possible need for testing and health care. Nurses are advised to discuss concerns about confidentiality with nurse administrators and to consult professional nursing organizations such as the Association of Nurses in AIDS Care and legal experts in their state to identify the most appropriate course of action. Chart 52-11 explores issues related to revealing one's HIV status.

AIDS has had a high mortality rate, but advances in antiretroviral and multidrug therapy have demonstrated promise in slowing or controlling disease progression. It is not known whether current treatment regimens will remain effective, because viral drug resistance has developed with

CHART 52-11

## *Ethics and Related Issues: Revealing One's HIV Status*

**Should All People Who Are Infected With HIV Be Required to Reveal This Status to All Their Sexual and Drug-Sharing Contacts?**

**Situation**

The human immunodeficiency virus (HIV) causes HIV infection, which progresses to AIDS. Because sexual contacts and needle-sharing partners are at risk for developing the disease, would a policy that requires notification of contacts infringe on the liberty and privacy of the known HIV-infected person?

**Dilemma**

The person's right to privacy conflicts with notifying all people who are contacts either through sexual or needle-sharing behavior (autonomy versus justice). The person's right to privacy conflicts with society's need to contain the deadly virus and stem a deadly epidemic (autonomy versus justice).

**Discussion**

1. What arguments would you offer in favor of notifying all the person's contacts?
2. What arguments would you offer against notifying all or some of the person's contacts?
3. Each state has various laws that pertain to whether contacts can be notified and who is responsible for notifying contacts. Is there a law for contact notification in the state in which you live? If there is such a law in your state, who is responsible for contact notification?
4. What would you do if the person responsible for contact notification refuses to do so based on his or her own beliefs for confidentiality of HIV infection status?
5. How would you respond if the HIV-positive person said that he or she is afraid to notify his or her contact because of fear of a violent response?

most previous medications. Most nurses in the United States have never faced an epidemic in which so many young and middle-aged adults experience serious illness and may die during the usual course of the disease process. Nurses may struggle with the value and meaning of their professional roles as they witness repeated instances of deterioration. Exposure to so many deaths among patients at the same developmental stage as many nurses can create stress. Contributing to this stress are personal fears of contagion or disapproval of the patient's lifestyle and behaviors. Unlike cancer or other diseases, AIDS is associated with controversies challenging our legal and political systems as well as religious and personal beliefs. Nurses who feel stressed and overburdened may experience physical and mental distress in the form of fatigue, headache, changes in appetite and sleep patterns, helplessness, irritability, apathy, negativity, and anger.

Many strategies have been used by nurses to cope with the stress associated with caring for AIDS patients. Education and provision of up-to-date information help to alleviate apprehension and prepare nurses to deliver safe, high-quality patient care. Interdisciplinary meetings allow participants to support one another and provide comprehensive patient care. Staff support groups give nurses an opportunity to solve problems and explore values and feelings about caring for AIDS patients and their families; they also provide a forum for grieving. Other sources of support include nursing administrators, peers, and spiritual advisors.

## CRITICAL THINKING EXERCISES

EBP **1** A 43-year-old woman who has been using IV/injection drugs regularly for 20 years says that she is not going to stop using drugs but wants to reduce her risk of HIV infection. How would you counsel her? What is the evidence base on safer sex and strategies to reduce risk from use of IV/injection drugs? Is there evidence about the effectiveness of needle exchange programs? How would you determine the strength of the evidence and how would you present information to her?

**2** During a code response in the intensive care unit (ICU), a nursing student is inadvertently stuck with a needle used on a patient with AIDS who has a high viral load. The student is apprehensive. What should the clinical instructor, in consultation with the nurse manager of the ICU, do? What reporting and documentation are needed (be sure to consider the student's health record)? What testing, treatment, and counseling are indicated for the student? Who should pay for the treatment?

EBP **3** During a home visit to a family in which two adolescents are HIV positive through vertical transmission, you are instructing the adolescents, their siblings, and their adult caregivers about strategies to protect the teens from other infections and to protect other family members from HIV transmission. What is the evidence for strategies that you plan to discuss with the adolescents and their family members? What is the strength of that evidence, and what criteria would you use to evaluate the strength of the evidence?

**4** A 48-year-old man who is bleeding from several stab wounds presents to the emergency department. He is intoxicated and combative. An OraQuick Rapid HIV-1 Antibody Test is performed as part of routine health care. What are the implications of this test? How would care in the emergency department be modified because of a positive test result? What are the ethical and legal ramifications of obtaining this test if the patient's ability to consent to testing is questioned?

**5** You are making a home visit to a patient with AIDS who is exhibiting early signs of dementia and encephalopathy. Describe the aspects of the home environment that you would assess to ensure safety and adequate care. How would you modify your assessment if the patient lived alone in a third-floor apartment without an elevator? If the patient lived in a rural setting? If the patient had a physical disability that limited his ability to leave his apartment?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

AIDS Action, www.aidsaction.org

AIDS Community Research Initiative of America, www.acria.org

AIDS Education and Training Centers (ETCs) Program (regional, national, and international training opportunities), www.aidsetc.org

American Red Cross, www.redcross.org

Antiretroviral medication information Web sites: www.AIDSmeds.com; www.projectinform.org; www.sfaf.org; http://hivinsite.ucsf.edu; www.amfAR.org; www.natap.org; www.thebody.com (many of these sites are coordinated by people living with HIV/AIDS

Centers for Disease Control and Prevention (2008): HIV/AIDS Prevention Research Synthesis Project, www.cdc.gov/hiv/topics/research/prs/evidence-based-interventions.htm; www.cdc.gov

Gay Men's Health Crisis Network, www.gmhc.org

Hemophilia and AIDS/HIV Network for the Dissemination of Information, www.hemophilia.org

HIV/AIDS Treatment, Prevention, and Research, ContactUs@aidsinfo.nih.gov, www.aidsinfo.nih.gov

HRSA National Clinician's Postexposure Prophylaxis hotline (health care providers only): 888-HIV-4911

HRSA National HIV Telephone Consultation Service, 800-933-3413

International AIDS Vaccine Initiative, www.iavi.org; e-mail: pubs@iavi.org

International Partnership for Microbicides, www.ipm-microbicides.org

Living with HIV/AIDS: Centers for Disease Control and Prevention, www.cdc.gov/hiv/pubs/brochure/livingwithhiv.htm

National Association of People with AIDS, www.napwa.org

National Pediatric and Family HIV Resource Center, www.womenchildrenhiv.org

Office of Minority Health Resource Center, www.omhrc.gov.

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Pharmaceutical Research and Manufacturers of America, www.phrma.orgx




# Assessment and Management of Patients With Allergic Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Explain the physiologic events involved with allergic reactions.
2. Describe the types of hypersensitivity.
3. Describe the management of patients with allergic disorders.
4. Describe measures to prevent and manage anaphylaxis.
5. Use the nursing process as a framework for care of the patient with allergic rhinitis.
6. Discuss the different allergic disorders according to type.

## GLOSSARY

**allergen:** substance that causes manifestations of allergy
**allergy:** inappropriate and often harmful immune system response to substances that are normally harmless
**anaphylaxis:** clinical response to an immediate immunologic reaction between a specific antigen and antibody
**angioneurotic edema:** condition characterized by urticaria and diffuse swelling of the deeper layers of the skin
**antibody:** protein substance developed by the body in response to and interacting with a specific antigen
**antigen:** substance that induces the production of antibodies
**antihistamine:** medication that opposes the action of histamine
**atopic dermatitis:** type I hypersensitivity involving inflammation of the skin evidenced by itching, redness, and a variety of skin lesions
**atopy:** term often used to describe immunoglobulin E–mediated diseases (ie, atopic dermatitis, asthma, and allergic rhinitis) with a genetic component
**B lymphocytes:** cells that are important in producing circulating antibodies
**bradykinin:** a substance that stimulates nerve fibers and causes pain
**eosinophil:** granular leukocyte
**erythema:** diffuse redness of the skin
**hapten:** incomplete antigen
**histamine:** substance in the body that causes increased gastric secretion, dilation of capillaries, and constriction of the bronchial smooth muscle
**hypersensitivity:** abnormal heightened reaction to a stimulus of any kind
**immunoglobulins:** a family of closely related proteins capable of acting as antibodies
**leukotrienes:** a group of chemical mediators that initiate the inflammatory response
**mast cells:** connective tissue cells that contain heparin and histamine in their granules
**prostaglandins:** unsaturated fatty acids that have a wide assortment of biologic activity
**rhinitis:** inflammation of the nasal mucosa
**serotonin:** chemical mediator that acts as a potent vasoconstrictor and bronchoconstrictor
**T lymphocytes:** cells that can cause graft rejection, kill foreign cells, or suppress production of antibodies
**urticaria:** hives

The human body is menaced by a host of potential invaders—allergens as well as microbial organisms—that constantly threaten its defenses. After penetrating those defenses, these allergens and organisms, if allowed to continue unimpeded, disrupt the body's enzyme systems and destroy its vital tissues. To protect against these agents, the body is equipped with an elaborate defense system.

The epithelial cells that coat the skin and make up the lining of the respiratory, gastrointestinal, and genitourinary tracts provide the first line of defense against microbial invaders. The structure and continuity of these surfaces and their resistance to penetration are initial deterrents to invaders.

One of the most effective defense mechanisms is the body's capacity to equip itself rapidly with weapons (antibodies) individually designed to meet each new invader, namely, specific protein antigens. Antibodies react with antigens in a variety of ways: (1) by coating the antigens' surfaces if they are particular substances, (2) by neutralizing the antigens if they are toxins, and (3) by precipitating the antigens out of solution if they are dissolved. The antibodies prepare the antigens so that the phagocytic cells of the blood and the tissues can dispose of them. However, although this system is normally protective, in some cases the body produces inappropriate or exaggerated responses to specific antigens, and the result is an allergic or hypersensitivity disorder.

# ALLERGIC ASSESSMENT

## Physiologic Overview

An allergic reaction is a manifestation of tissue injury resulting from interaction between an antigen and an **antibody.** **Allergy** is an inappropriate and often harmful response of the immune system to normally harmless substances, called **allergens** (eg, dust, weeds, pollen, dander). Chemical mediators released in allergic reactions may produce symptoms that range from mild to life-threatening.

In allergic reactions, the body encounters **antigens,** usually proteins that the body's defenses recognize as foreign, and a series of events occurs in an attempt to render the invaders harmless, destroy them, and remove them from the body. When lymphocytes respond to the antigens, **antibodies** (protein substances that protect against antigens) are produced.

Antibodies combine with antigens in a special way, which has been likened to keys fitting into a lock. Antigens (the keys) fit only certain antibodies (the locks). Hence, the term *specificity* refers to the specific reaction of an antibody to an antigen. There are many variations and complexities in these patterns.

### Function of Immunoglobulins

Antibodies that are formed by lymphocytes and plasma cells in response to an immunogenic stimulus constitute a group of serum proteins called **immunoglobulins.** Grouped into five classes (IgE, IgD, IgG, IgM, and IgA), immunoglobulins can be found in the lymph nodes, tonsils, appendix, and Peyer's patches of the intestinal tract or circulating in the blood and lymph. These antibodies are capable of binding with a wide variety of antigens. Immunoglobulins of the IgE class are involved in allergic disorders and some parasitic infections. IgE-producing cells are located in the respiratory and intestinal mucosa. Two or more IgE molecules bind together to an allergen and trigger **mast cells** or basophils to release chemical mediators, such as histamine, serotonin, kinins, slow-reacting substances of anaphylaxis, and the neutrophil factor, which produces allergic skin reactions, asthma, and hay fever. **Atopy** refers to IgE-mediated diseases such as allergic rhinitis that have a genetic component.

#### Role of B Cells

B cells, or **B lymphocytes,** are programmed to produce one specific antibody. On encountering a specific antigen, B cells stimulate production of plasma cells, the site of antibody production. The result is the outpouring of antibodies for the purpose of destroying and removing the antigens.

#### Role of T Cells

T cells, or **T lymphocytes,** assist the B cells in producing antibodies. T cells secrete substances that direct the flow of cell activity, destroy target cells, and stimulate the macrophages. The macrophages present the antigens to the T cells and initiate the immune response. They also digest antigens and assist in removing cells and other debris. Unlike a specific antibody, a T cell does not bind free antigens.

### Function of Antigens

Antigens are divided into two groups: complete protein antigens and low-molecular-weight substances. Complete protein antigens, such as animal dander, pollen, and horse serum, stimulate a complete humoral response. (See Chapter 50 for a discussion of humoral immunity.) Low-molecular-weight substances, such as medications, function as **haptens** (incomplete antigens), binding to tissue or serum proteins to produce a carrier complex that initiates an antibody response. In an allergic reaction, the production of antibodies requires active communication between cells. When the allergen is absorbed through the respiratory tract, gastrointestinal tract, or skin, allergen sensitization occurs. Macrophages process the antigen and present it to the appropriate cells. These cells mature into allergen-specific secreting plasma cells that synthesize and secrete antigen-specific antibodies.

### Function of Chemical Mediators

Mast cells, which are located in the skin and mucous membranes, play a major role in IgE-mediated immediate hypersensitivity. When mast cells are stimulated by antigens, powerful chemical mediators are released, causing a sequence of physiologic events that results in symptoms of immediate hypersensitivity (Fig. 53-1). There are two types of chemical mediators: primary and secondary. Primary mediators are preformed and are found in mast cells or basophils. Secondary mediators are inactive precursors that are formed or released in response to primary mediators. Table 53-1 summarizes the actions of primary and secondary chemical mediators.

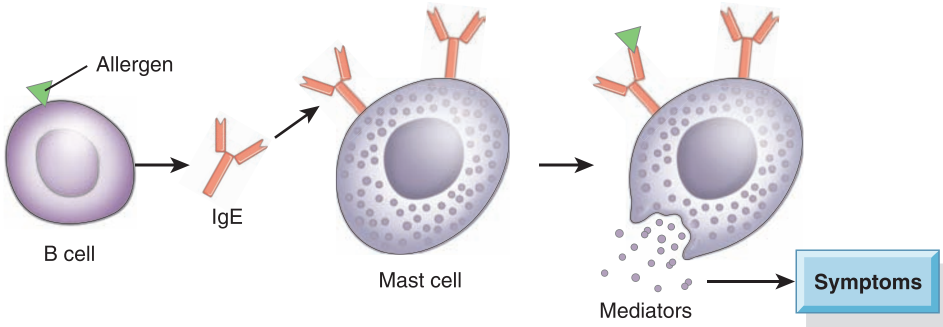



**Figure 53-1** Allergen triggers the B cell to make IgE antibody, which attaches to the mast cell. When that allergen reappears, it binds to the IgE and triggers the mast cell to release its chemicals. Courtesy of U.S. Department of Health and Human Services, National Institutes of Health.

## *Primary Mediators*

### Histamine

**Histamine,** which is released by mast cells, plays an important role in the immune response. Its effects, which are greatest within about 15 minutes after antigen contact, include erythema; localized edema in the form of wheals; pruritus; contraction of bronchial smooth muscle, resulting in wheezing and bronchospasm; dilation of small venules and constriction of larger vessels; and increased secretion of gastric and mucosal cells, resulting in diarrhea. Histamine action results from stimulation of histamine-1 ($H_1$) and histamine-2 ($H_2$) receptors. $H_1$ receptors are found predominantly on bronchiolar and vascular smooth muscle cells; $H_2$ receptors are found on gastric parietal cells.

Certain medications are categorized by their action at these receptors. Diphenhydramine (Benadryl) is an example of an **antihistamine,** a medication that displays an affinity for $H_1$ receptors. Cimetidine (Tagamet) and ranitidine (Zantac) target $H_2$ receptors to inhibit gastric secretions in peptic ulcer disease.

### Eosinophil Chemotactic Factor of Anaphylaxis

Eosinophil chemotactic factor of anaphylaxis affects movement of **eosinophils** (granular leukocytes) to the site of allergens. It is preformed in the mast cells and is released from disrupted mast cells.

### Platelet-Activating Factor

Platelet-activating factor is responsible for initiating platelet aggregation and leukocyte infiltration at sites of immediate hypersensitivity reactions. It also causes bronchoconstriction and increased vascular permeability (Porth & Matfin, 2009).

### Prostaglandins

**Prostaglandins** produce smooth muscle contraction as well as vasodilation and increased capillary permeability (Porth, 2009). The fever and pain that occur with inflammation in allergic responses are caused in part by the prostaglandins.

## *Secondary Mediators*

### Leukotrienes

**Leukotrienes** are chemical mediators that initiate the inflammatory response. Many manifestations of inflammation can be attributed in part to leukotrienes. In addition, leukotrienes cause smooth muscle contraction, bronchial constriction, mucus secretion in the airways, and the typical wheal-and-flare reactions of the skin. Compared with

**Table 53-1 CHEMICAL MEDIATORS OF HYPERSENSITIVITY**

| Mediators | Action |
|---|---|
| **Primary Mediators**<br>*Preformed and Found in Mast Cells or Basophils* | |
| Histamine (preformed in mast cells) | Vasodilation<br>Smooth muscle contraction, increased vascular permeability, increased mucus secretions |
| Eosinophil chemotactic factor of anaphylaxis (ECF-A) (preformed in mast cells) | Attracts eosinophils |
| Platelet-activating factor (PAF) (requires synthesis by mast cells, neutrophils, and macrophages) | Smooth muscle contraction<br>Incites platelets to aggregate and release serotonin and histamine |
| Prostaglandins (chemically derived from arachidonic acid; require synthesis by cells) | D and F series → bronchoconstriction<br>E series → bronchodilation<br>D, E, and F series → vasodilation |
| Basophil kallikrein (preformed in mast cells) | Frees bradykinin, which causes bronchoconstriction, vasodilation, and nerve stimulation |
| **Secondary Mediators**<br>*Inactive Precursors Formed or Released in Response to Primary Mediators* | |
| Bradykinin (derived from precursor kininogen) | Smooth muscle contraction, increased vascular permeability, stimulates pain receptors, increased mucus production |
| Serotonin (preformed in platelets) | Smooth muscle contraction, increased vascular permeability |
| Heparin (preformed in mast cells) | Anticoagulant |
| Leukotrienes (derived from arachidonic acid and activated by mast cell degranulation) C, D, and E or slow-reacting substance of anaphylaxis (SRS-A) | Smooth muscle contraction, increased vascular permeability |

histamine, leukotrienes are 100 to 1000 times more potent in causing bronchospasm.

**Bradykinin**

**Bradykinin** is a substance that has the ability to cause increased vascular permeability, vasodilation, hypotension, and contraction of many types of smooth muscle, such as the bronchi. Increased permeability of the capillaries results in edema. Bradykinin stimulates nerve cell fibers and produces pain.

**Serotonin**

**Serotonin** acts as a potent vasoconstrictor and causes contraction of bronchial smooth muscle.

## Hypersensitivity

Although the immune system defends the host against infections and foreign antigens, immune responses can themselves cause tissue injury and disease. **Hypersensitivity** is a reflection of excessive or aberrant immune response to any type of stimulus (Abbas & Lichtman, 2008). It usually does not occur with the first exposure to an allergen. Rather, the reaction follows a re-exposure after sensitization, or buildup of antibodies, in a predisposed person. To promote understanding of the immunopathogenesis of disease, hypersensitivity reactions have been classified into four specific types of reactions (Fig. 53-2). Most allergic reactions are either type I or type IV hypersensitivity reactions.

### *Anaphylactic (Type I) Hypersensitivity*

The most severe hypersensitivity reaction is **anaphylaxis.** An unanticipated severe allergic reaction that is often explosive in onset, anaphylaxis is characterized by edema in many tissues, including the larynx, and is often accompanied by hypotension, bronchospasm, and cardiovascular collapse in severe cases. Type I or anaphylactic hypersensitivity is an immediate reaction beginning within minutes of exposure to an antigen. Primary chemical mediators are responsible for the symptoms of type I hypersensitivity because of their effects on the skin, lungs, and gastrointestinal tract. If chemical mediators continue to be released, a delayed reaction may occur and may last for up to 24 hours.

Clinical symptoms are determined by the amount of the allergen, the amount of mediator released, the sensitivity of the target organ, and the route of allergen entry. Type I hypersensitivity reactions may include both local and systemic anaphylaxis. Examples include allergic rhinitis, asthma, and severe allergic response in people sensitized to penicillin or latex.

### *Cytotoxic (Type II) Hypersensitivity*

Type II, or cytotoxic, hypersensitivity occurs when the system mistakenly identifies a normal constituent of the body as foreign. This reaction may be the result of a cross-reacting antibody, possibly leading to cell and tissue damage.

Type II hypersensitivity reactions are associated with several disorders. For example, in myasthenia gravis, the body mistakenly generates antibodies against normal nerve ending receptors. In Goodpasture syndrome, it generates antibodies against lung and renal tissue, producing lung damage and renal failure. A type II hypersensitivity reaction resulting in red blood cell destruction is associated with drug-induced immune hemolytic anemia, Rh-hemolytic disease of the newborn, and incompatibility reactions in blood transfusions (see Chapter 33).

### *Immune Complex (Type III) Hypersensitivity*

Type III, or immune complex, hypersensitivity involves immune complexes that are formed when antigens bind to antibodies. These complexes are cleared from the circulation by phagocytic action. If these type III complexes are deposited in tissues or vascular endothelium, two factors contribute to injury: the increased amount of circulating complexes and the presence of vasoactive amines. As a result, there is an increase in vascular permeability and tissue injury.

The joints and kidneys are particularly susceptible to this type of injury. Type III hypersensitivity is associated with systemic lupus erythematosus, rheumatoid arthritis, certain types of nephritis, and some types of bacterial endocarditis. These are discussed elsewhere in this text.

### *Delayed-Type (Type IV) Hypersensitivity*

Type IV, or delayed-type, hypersensitivity, also known as cellular hypersensitivity, occurs 24 to 72 hours after exposure to an allergen. It is mediated by sensitized T cells and macrophages rather than antibodies.

An example of a type IV hypersensitivity reaction is contact dermatitis resulting from exposure to allergens such as cosmetics, adhesive tape, topical agents (eg, povidone-iodine), medication additives, and plant toxins. Symptoms include itching, erythema, and raised lesions.

# *Assessment*

## Health History

A comprehensive allergy history and a thorough physical examination provide useful data for the diagnosis and management of allergic disorders. An assessment form is useful for obtaining and organizing this information (Chart 53-1).

The degree of difficulty and discomfort experienced by the patient because of allergic symptoms and the degree of improvement in those symptoms with and without treatment are assessed and documented. The relationship of symptoms to exposure to possible allergens is noted.

# *Diagnostic Evaluation*

Diagnostic evaluation of the patient with allergic disorders commonly includes blood tests, smears of body secretions, skin tests, and the radioallergosorbent test (RAST). Results of laboratory blood studies provide supportive data for various diagnostic possibilities; however, they are not the major criteria for the diagnosis of allergic disease.

## Complete Blood Count With Differential

The white blood cell (WBC) count is usually normal except with infection. Eosinophils, which are granular leukocytes, normally make up 1% to 3% of the total number of

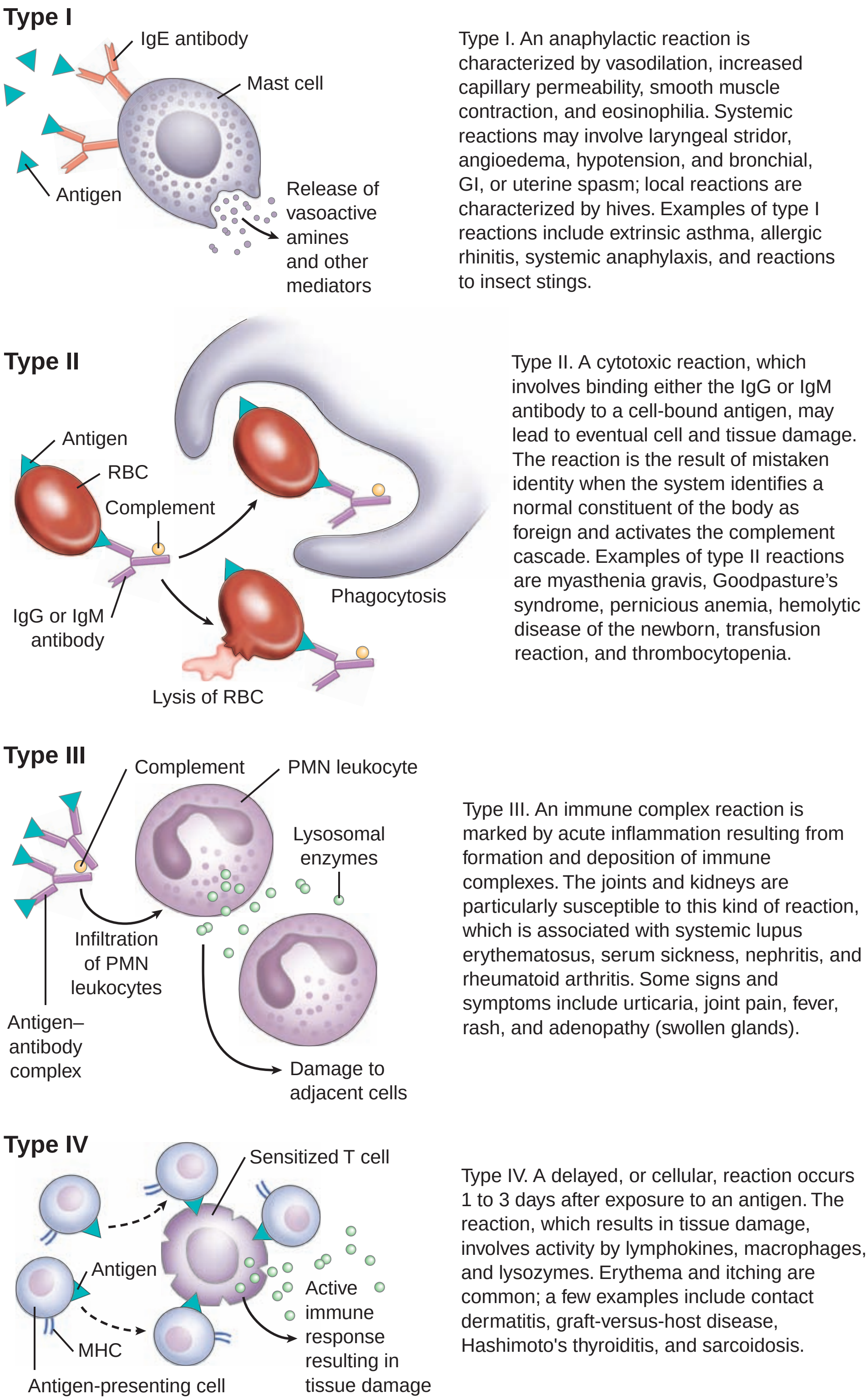



**Figure 53-2** Four types of hypersensitivity reactions. (Ig, immunoglobulin; PMN, polymorphonuclear; RBC, red blood cell.)

WBCs. A level between 5% and 15% is nonspecific but does suggest allergic reaction. Higher percentages of eosinophils are considered to represent moderate to severe eosinophilia. Moderate eosinophilia is defined as 15% to 40% eosinophils and may be found in patients with allergic disorders.

## Eosinophil Count

An actual count of eosinophils can be obtained from blood samples or smears of secretions. During symptomatic episodes, smears obtained from nasal secretions, conjunctival secretions, and sputum of allergic patients usually reveal eosinophils, indicating an active allergic response.

CHART 53-1

## Allergy Assessment Form

Name ____________ Age ________ Sex ________ Date ________

I. Chief complaint: ____________

II. Present illness: ____________

III. Collateral allergic symptoms: ____________

Eyes: Pruritus ______ Burning ______ Lacrimation ______
Swelling ______ Injection ______ Discharge ______

Ears: Pruritus ______ Fullness ______ Popping ______
Frequent infections ______

Nose: Sneezing ______ Rhinorrhea ______ Obstruction ______
Pruritus ______ Mouth-breathing ______
Purulent discharge ______

Throat: Soreness ______ Postnasal discharge ______
Palatal pruritus ______ Mucus in the morning ______

Chest: Cough ______ Pain ______ Wheezing ______
Sputum ______ Dyspnea ______
Color ______ Rest ______
Amount ______ Exertion ______

Skin: Dermatitis ______ Eczema ______ Urticaria ______

IV. Family allergies

V. Previous allergic treatment or testing: ____________
Prior skin testing: ____________

Medications:
Antihistamines Improved ______ Unimproved ______
Bronchodilators Improved ______ Unimproved ______
Nose drops Improved ______ Unimproved ______
Hyposensitization Improved ______ Unimproved ______
Duration ______
Antigens ______
Reactions ______
Antibiotics Improved ______ Unimproved ______
Corticosteroids Improved ______ Unimproved ______

VI. Physical agents and habits: ____________

*Bothered by:*

Tobacco for ____ years — Alcohol ______ — Air conditioning ______
Cigarettes ____ packs/day — Heat ______ — Muggy weather ______
Cigars ____ per day — Cold ______ — Weather changes ______
Pipes ____ per day — Perfumes ______ — Chemicals ______
Never smoked ______ — Paints ______ — Hair spray ______
Bothered by smoke ______ — Insecticides ______ — Newspapers ______
Cosmetics ______ — Latex ______

VII. When symptoms occur: ____________
Time and circumstances of 1st episode: ____________
Prior health: ____________
Course of illness over decades: progressing ______ regressing ______
Time of year: ____________ Exact dates: ____________
Perennial ______
Seasonal ______
Seasonally exacerbated ______
Monthly variations (menses, occupation): ____________
Time of week (weekends vs. weekdays): ____________
Time of day or night: ____________
After insect stings: ____________

VIII. Where symptoms occur: ____________
Living where at onset: ____________
Living where since onset: ____________
Effect of vacation or major geographic change: ____________
Symptoms better indoors or outdoors: ____________
Effect of school or work: ____________
Effect of staying elsewhere nearby: ____________
Effect of hospitalization: ____________
Effect of specific environments: ____________

*Continued on following page*

CHART 53-1 **Allergy Assessment Form** (Continued)

Do symptoms occur around: ______
old leaves _____ hay _____ lakeside _____ barns _____
summer homes _____ damp basement _____ dry attic _____
lawnmowing _____ animals _____ other _____
Do symptoms occur after eating:
cheese _____ mushrooms _____ beer _____ melons _____
bananas _____ fish _____ nuts _____ citrus fruits _____
other foods (list)______
Home: city _____ rural _____
house _____ age _____
apartment _____ basement _____ damp _____ dry _____
heating system _____
pets (how long) _____ dog _____ cat _____ other _____

| *Bedroom:* | Type | Age | *Living room:* | Type | Age |
|---|---|---|---|---|---|
| Pillow | _____ | _____ | Rug | _____ | _____ |
| Mattress | _____ | _____ | Matting | _____ | _____ |
| Blankets | _____ | _____ | Furniture | _____ | _____ |
| Quilts | _____ | _____ | | | |
| Furniture | _____ | _____ | | | |

Anywhere in home symptoms are worse: ______
IX. What does patient think makes symptoms worse? ______
X. Under what circumstances is patient free of symptoms? ______
XI. Summary and additional comments: ______

## Total Serum Immunoglobulin E Levels

High total serum IgE levels support the diagnosis of allergic disease. However, a normal IgE level does not exclude the diagnosis of an allergic disorder. IgE levels are not as sensitive as the paper radioimmunosorbent test (PRIST) or the enzyme-linked immunosorbent assay (ELISA), also referred to as enzyme immunoessay (EIA).

## Skin Tests

Skin testing entails the intradermal injection or superficial application (epicutaneous) of solutions at several sites. Depending on the suspected cause of allergic signs and symptoms, several different solutions may be applied at separate sites. These solutions contain individual antigens representing an assortment of allergens most likely to be implicated in the patient's disease. Positive (wheal-and-flare) reactions are clinically significant when correlated with the history, physical findings, and results of other laboratory tests.

The results of skin tests complement the data obtained from the history. They indicate which of several antigens are most likely to provoke symptoms and provide some clue to the intensity of the patient's sensitization. The dosage of the antigen (allergen) injected is also important. Most patients are hypersensitive to more than one allergen. Under testing conditions, they may not react (although they usually do) to the specific allergens that induce their attacks.

In cases of doubt about the validity of the skin tests, a RAST or a provocative challenge test may be performed. If a skin test is indicated, there is a reasonable suspicion that a specific allergen is producing symptoms in an allergic patient. However, several precautionary steps must be observed before skin testing with allergens is performed:

- Testing is not performed during periods of bronchospasm.
- Epicutaneous tests (scratch or prick tests) are performed before other testing methods, in an effort to minimize the risk of systemic reaction.
- Emergency equipment must be readily available to treat anaphylaxis.

### Types of Skin Tests

The methods of skin testing include prick skin tests, scratch tests, and intradermal skin testing (Fig. 53-3). After negative prick or scratch tests, intradermal skin testing is

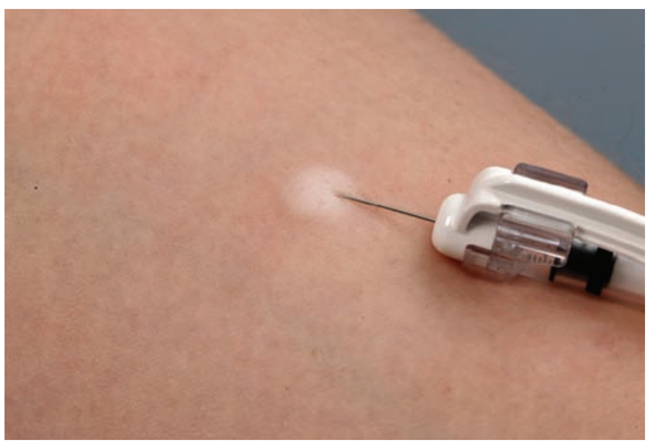


**Figure 53-3** Intradermal testing. A 0.5-mL or 1-mL sterile syringe with a 26/27-gauge intradermal needle is used to inject 0.02 to 0.03 mL of intradermal allergen. The needle is inserted with the bevel facing upward and the syringe parallel to the skin. The skin is penetrated superficially, and a small amount of the allergen solution is injected to create a bleb (raised area) approximately 5 mm in diameter. A separate sterile syringe and needle are used for each injection. From Taylor, C., Lillis C. & LeMone, P. (2005). *Fundamentals of nursing: The art and science of nursing care* (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

performed with allergens that are suggested by the patient's history to be problematic. The back is the most suitable area of the body for skin testing because it permits the performance of many tests. A multitest applicator with multiple test heads is commercially available for simultaneous administration of antigens by multiple punctures at different sites. A negative response on a skin test cannot be interpreted as an absence of sensitivity to an allergen. Such a response may occur with insufficient sensitivity of the test or with use of an inappropriate allergen in testing. Therefore, it is essential to observe the patient undergoing skin testing for an allergic reaction even if the previous response was negative.

### Interpretation of Skin Test Results

Familiarity with and consistent use of a grading system are essential. The grading system used should be identified on a skin test record for later interpretation. A positive reaction, evidenced by the appearance of an urticarial wheal (round, reddened skin elevation) (Fig. 53-4), localized **erythema** (diffuse redness) in the area of inoculation or contact, or pseudopodia (irregular projection at the end of a wheal) with associated erythema is considered indicative of sensitivity to the corresponding antigen. False-positive results may occur because of improper preparation or administration of allergen solutions.

*NURSING ALERT*

**Corticosteroids and antihistamines, including over-the-counter allergy medications, suppress skin test reactivity and should be stopped 48 to 96 hours before testing, depending on the duration of their activity. False-positive results may occur because of improper preparation or administration of allergen solutions.**

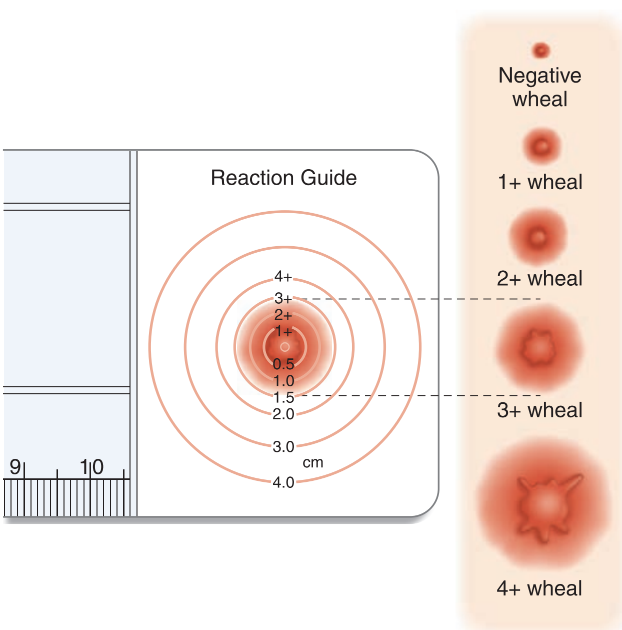



**Figure 53-4** Interpretation of reactions: Negative = wheal soft with minimal erythema. 1+ = wheal present (5 to 8 mm) with associated erythema. 2+ = wheal (7 to 10 mm) with associated erythema. 3+ = wheal (9 to 15 mm), slight pseudopodia possible with associated erythema. 4+ = wheal (12 mm+) with pseudopodia and diffuse erythema.

Interpretation of positive or negative skin tests must be based on the history, physical examination, and other laboratory test results. The following guidelines are used for the interpretation of skin test results:

- Skin tests are more reliable for diagnosing atopic sensitivity in patients with allergic rhinoconjunctivitis than in patients with asthma.
- Positive skin tests correlate highly with food allergy.
- The use of skin tests to diagnose immediate hypersensitivity to medications is limited, because metabolites of medications, not the medications themselves, are usually responsible for causing hypersensitivity.

## Provocative Testing

Provocative testing involves the direct administration of the suspected allergen to the sensitive tissue, such as the conjunctiva, nasal or bronchial mucosa, or gastrointestinal tract (by ingestion of the allergen), with observation of target organ response. This type of testing is helpful in identifying clinically significant allergens in patients who have a large number of positive tests. Major disadvantages of this type of testing are the limitation of one antigen per session and the risk of producing severe symptoms, particularly bronchospasm, in patients with asthma.

## Radioallergosorbent Test

RAST is a radioimmunoassay that measures allergen-specific IgE. A sample of the patient's serum is exposed to a variety of suspected allergen particle complexes. If antibodies are present, they will combine with radiolabeled allergens. Test results are then compared with control values. In addition to detecting an allergen, RAST indicates the quantity of allergen necessary to evoke an allergic reaction. Values are reported on a scale from 0 to 5. Values of 2 or greater are considered significant. The major advantages of RAST over other tests include decreased risk of systemic reaction, stability of antigens, and lack of dependence on skin reactivity modified by medications. The major disadvantages include limited allergen selection and reduced sensitivity compared with intradermal skin tests, lack of immediate results, and higher cost.

# ALLERGIC DISORDERS

There are two types of IgE-mediated allergic reactions: atopic and nonatopic disorders. Although the underlying immunologic reactions of the two types of disorders are the same, the predisposing factors and manifestations are different. The atopic disorders are characterized by a hereditary predisposition and production of a local reaction to IgE antibodies, which manifests in one or more of the following three atopic disorders: allergic rhinitis, asthma, and atopic dermatitis/eczema. The nonatopic disorders lack the genetic component and organ specificity of the atopic disorders (Porth & Matfin, 2009). Latex allergy (see later discussion) may be a type I or type IV hypersensitivity reaction, although

true latex allergy is considered to be a type I hypersensitivity reaction (Rolland & O'Hehir, 2008). Contact dermatitis is considered to be a type IV hypersensitivity reaction.

## Anaphylaxis

Anaphylaxis is a clinical response to an immediate (type I hypersensitivity) immunologic reaction between a specific antigen and an antibody. The reaction results from a rapid release of IgE-mediated chemicals, which can induce a severe, life-threatening allergic reaction. It is estimated that between 3.3 and 43 million people in the United States are at risk for anaphylaxis (Lieberman, 2006; Porth & Matfin, 2009).

### Pathophysiology

Anaphylaxis is caused by the interaction of a foreign antigen with specific IgE antibodies found on the surface membrane of mast cells and peripheral blood basophils. The subsequent release of histamine and other bioactive mediators causes activation of platelets, eosinophils, and neutrophils. Histamine, prostaglandins, and inflammatory leukotrienes are potent vasoactive mediators that are implicated in the vascular permeability changes, flushing, urticaria, angioedema, hypotension, and bronchoconstriction that characterize anaphylaxis. Smooth muscle spasm, bronchospasm, mucosal edema and inflammation, and increased capillary permeability result. These systemic changes characteristically produce clinical manifestations within seconds or minutes after antigen exposure (Lieberman, 2006; Porth & Matfin, 2009). Closely related to anaphylaxis is a nonallergenic anaphylaxis (anaphylactoid) reaction, which is described in Chart 53-2.

Substances that most commonly cause anaphylaxis include foods, medications, insect stings, and latex (Chart 53-3). Foods that are common causes of anaphylaxis include peanuts, tree nuts, shellfish, fish, milk, eggs, soy, and wheat. Many medications have been implicated in anaphylaxis. Those that are most frequently reported include antibiotics (eg, penicillin), radiocontrast agents, intravenous (IV) anesthetic agents, aspirin and other nonsteroidal anti-inflammatory drugs (NSAIDs), and opioids. Antibiotics and radiocontrast agents cause the most serious anaphylactic reactions, producing reactions in about 1 of every 5000 exposures. Penicillin is the most common cause of anaphylaxis and accounts for about 75% of fatal anaphylactic reactions in the United States each year. The actual prevalence of penicillin allergy in the general population is unknown; however, the incidence of self-reported penicillin allergy ranges from 1% to 10%. It has been reported that 80% to 90% of those patients with self-reported penicillin allergy have no evidence of IgE antibodies to penicillin on skin testing (Adkinson, Busse, Bochner, et al., 2009; Walker, 2007).

The diagnosis of risk of anaphylaxis is determined by prick and intradermal skin testing. Skin testing of patients who have clinical symptoms consistent with a type I, IgE-mediated reaction has been recommended (Adkinson, et al., 2009).

#### Chart 53-2 • *Nonallergenic Anaphylaxis (Anaphylactoid Reaction)*

Closely resembling anaphylaxis is an anaphylactoid reaction, which is caused by the release of mast cell and basophil mediators triggered by non–IgE-mediated events. This nonallergenic anaphylaxis reaction may occur with medications, food, exercise, or cytotoxic antibody transfusions. The reaction may be local or systemic. Local reactions usually involve urticaria and angioedema at the site of the antigen exposure. Although possibly severe, nonallergenic anaphylaxis reactions are rarely fatal. Systemic reactions occur within about 30 minutes after exposure and involve cardiovascular, respiratory, gastrointestinal, and integumentary organ systems. For the most part, the treatment of nonallergenic anaphylaxis reaction is identical to that of anaphylaxis (Johansson, Hourihane, Bousquet, et al., 2005).

#### Chart 53-3 • *Common Causes of Anaphylaxis*

**Foods**

Peanuts, tree nuts (eg, walnuts, pecans, cashews, almonds), shellfish (eg, shrimp, lobster, crab), fish, milk, eggs, soy, wheat

**Medications**

Antibiotics, especially penicillin and sulfa antibiotics, allopurinol, radiocontrast agents, anesthetic agents (lidocaine, procaine), vaccines, hormones (insulin, vasopressin, adrenocorticotropic hormone [ACTH]), aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs)

**Other Pharmaceutical/Biologic Agents**

Animal serums (tetanus antitoxin, snake venom antitoxin, rabies antitoxin), antigens used in skin testing

**Insect Stings**

Bees, wasps, hornets, yellow jackets, ants, including fire ants

**Latex**

Medical and nonmedical products containing latex

### Clinical Manifestations

Anaphylactic reactions produce a clinical syndrome that affects multiple organ systems. Reactions may be categorized as mild, moderate, or severe. The time from exposure to the antigen to onset of symptoms is a good indicator of the severity of the reaction: the faster the onset, the more severe the reaction. The severity of previous reactions does not determine the severity of subsequent reactions, which could be the same or more or less severe. The severity depends on the degree of allergy and the dose of allergen (Virella, 2007).

Mild systemic reactions consist of peripheral tingling and a sensation of warmth, possibly accompanied by a sensation of fullness in the mouth and throat. Nasal congestion, periorbital swelling, pruritus, sneezing, and tearing of

the eyes can also be expected. Onset of symptoms begins within the first 2 hours after exposure.

Moderate systemic reactions may include flushing, warmth, anxiety, and itching in addition to any of the milder symptoms. More serious reactions include bronchospasm and edema of the airways or larynx with dyspnea, cough, and wheezing. The onset of symptoms is the same as for a mild reaction.

Severe systemic reactions have an abrupt onset with the same signs and symptoms described previously. These symptoms progress rapidly to bronchospasm, laryngeal edema, severe dyspnea, cyanosis, and hypotension. Dysphagia (difficulty swallowing), abdominal cramping, vomiting, diarrhea, and seizures can also occur. Cardiac arrest and coma may follow.

## Prevention

Strict avoidance of potential allergens is an important preventive measure for the patient at risk for anaphylaxis. Patients at risk for anaphylaxis from insect stings should avoid areas populated by insects and should use appropriate clothing, insect repellent, and caution to avoid further stings.

If avoidance of exposure to allergens is impossible, the patient should be instructed to carry and administer epinephrine to prevent an anaphylactic reaction in the event of exposure to the allergen. People who are sensitive to insect bites and stings, those who have experienced food or medication reactions, and those who have experienced idiopathic or exercise-induced anaphylactic reactions should always carry an emergency kit that contains epinephrine. The EpiPen from Dey Pharmaceuticals (Napa, CA) is a commercially available first-aid device that delivers premeasured doses of 0.3 mg (EpiPen) or 0.15 mg (EpiPen Jr.) of epinephrine (Fig. 53-5). The autoinjection system requires no preparation, and the self-administration technique is not complicated. The patient must be given an opportunity to demonstrate the correct technique for use; an EpiPen training device can be used for teaching correct technique. Verbal and written information about the emergency kit, as well as strategies to avoid exposure to threatening allergens, must also be provided.

Screening for allergies before a medication is prescribed or first administered is an important preventive measure. A careful history of any sensitivity to suspected antigens must be obtained before administering any medication, particularly in parenteral form, because this route is associated with the most severe anaphylaxis. Nurses caring for patients in any setting (hospital, home, outpatient diagnostic testing sites, long-term care facilities) must assess patients' risks for anaphylactic reactions. Patients are asked about previous exposure to contrast agents used for diagnostic tests and any allergic reactions, as well as reactions to any medications, foods, insect stings, and latex. People who are predisposed to anaphylaxis should wear some form of identification, such as a MedicAlert bracelet, which names allergies to medications, food, and other substances.




**Figure 53-5** The EpiPen. Autoinjectors are commercially available first-aid devices that administer premeasured doses of epinephrine. An EpiPen training device is available for patients to practice correct self-injection technique. Courtesy of Dey, L. P., Napa, CA.

People who are allergic to insect venom may require venom immunotherapy, which is used as a control measure and not a cure. Immunotherapy administered after an insect sting is very effective in reducing the risk of anaphylaxis from future stings (Douglass & O'Hehir, 2006; Walker, 2007). Insulin-allergic patients with diabetes and those who are allergic to penicillin may require desensitization. Desensitization is based on controlled anaphylaxis, with a gradual release of mediators. Patients who undergo desensitization are cautioned that there should be no lapses in therapy, because this may lead to the reappearance of the allergic reaction when the use of the medication is resumed.

## Medical Management

Management depends on the severity of the reaction. Initially, respiratory and cardiovascular functions are evaluated. If the patient is in cardiac arrest, cardiopulmonary resuscitation is instituted. Oxygen is provided in high concentrations during cardiopulmonary resuscitation or if the patient is cyanotic, dyspneic, or wheezing. Epinephrine, in a 1:1000 dilution, is administered subcutaneously in the upper extremity or thigh and may be followed by a continuous IV infusion. Most adverse events associated with administration of epinephrine (ie, adrenaline) occur when the dose is excessive or it is given intravenously. Patients at risk for adverse effects include elderly patients and those with hypertension, arteriopathies, or known ischemic heart disease.

Antihistamines and corticosteroids may also be administered to prevent recurrences of the reaction (Goroll & Mulley, 2006) and to treat urticaria and angioedema. IV fluids (eg, normal saline solution), volume expanders, and vasopressor agents are administered to maintain blood pressure and normal hemodynamic status. In patients with episodes of bronchospasm or a history of bronchial asthma or chronic obstructive pulmonary disease, aminophylline and corticosteroids may also be administered to improve airway patency and function. If hypotension is unresponsive to vasopressors, glucagon may be administered intravenously for its acute inotropic and chronotropic effects.

Patients who have experienced anaphylactic reactions and received epinephrine should be transported to the local emergency department for observation and monitoring because of the risk for a "rebound" reaction 4 to 10 hours after the initial allergic reaction. Patients with severe reactions are monitored closely for 12 to 14 hours in a facility that can provide emergency care, if needed. Because of the potential for recurrence, patients with even mild reactions must be informed about this risk (Goroll & Mulley, 2006; Lieberman, 2006).

## Nursing Management

If a patient is experiencing an allergic response, the nurse's initial action is to assess the patient for signs and symptoms of anaphylaxis. The nurse assesses the airway, breathing pattern, and vital signs. The patient is observed for signs of increasing edema and respiratory distress. Prompt notification of the physician and preparation for initiation of emergency measures (intubation, administration of emergency medications, insertion of IV lines, fluid administration, oxygen

administration) are important to reduce the severity of the reaction and to restore cardiovascular function. The nurse documents the interventions used and the patient's vital signs and response to treatment.

The patient who has recovered from anaphylaxis needs an explanation of what occurred and instruction about avoiding future exposure to antigens and how to administer emergency medications to treat anaphylaxis. The patient must be instructed about antigens that should be avoided and about other strategies to prevent recurrence of anaphylaxis. All patients who have experienced an anaphylactic reaction should receive a prescription for preloaded syringes of epinephrine. The nurse instructs the patient and family in their use and has the patient and family demonstrate correct administration (Chart 53-4).

## Allergic Rhinitis

Allergic **rhinitis** (hay fever, seasonal allergic rhinitis) is the most common form of respiratory allergy presumed to be mediated by an immediate (type I hypersensitivity) immunologic reaction, and it is among the top 10 reasons for visits to primary care physicians (Ferguson, 2008; Quillen & Feller, 2006). It affects about 10% to 25% of the U.S. population (Nathan, 2008). The symptoms are similar to those of viral rhinitis (see Chapter 22) but are usually more persistent and demonstrate seasonal variation; rhinitis is considered to be the allergic form if the symptoms are caused by an allergen-specific IgE-mediated immunologic response. However, a sizable proportion of patients with rhinitis have mixed rhinitis, or coexisting allergic and nonallergic rhinitis (Nathan, 2008). The proportion of patients with the allergic form of rhinitis increases with age. It often occurs with other conditions, such as allergic conjunctivitis, sinusitis, and asthma. If symptoms are severe, allergic rhinitis may interfere with sleep, leisure, and school or work activities (Quillen & Feller, 2006). If left untreated, many complications may result, such as allergic asthma, chronic nasal obstruction, chronic otitis media with hearing loss, anosmia (absence of the sense of smell), and, in children, orofacial dental deformities. Early diagnosis and adequate treatment are essential to reduce complications and relieve symptoms.

Because allergic rhinitis is induced by airborne pollens or molds, it is characterized by the following seasonal occurrences:

- Early spring—tree pollen (oak, elm, poplar)
- Early summer—rose pollen (rose fever), grass pollen (Timothy, red-top)
- Early fall—weed pollen (ragweed)

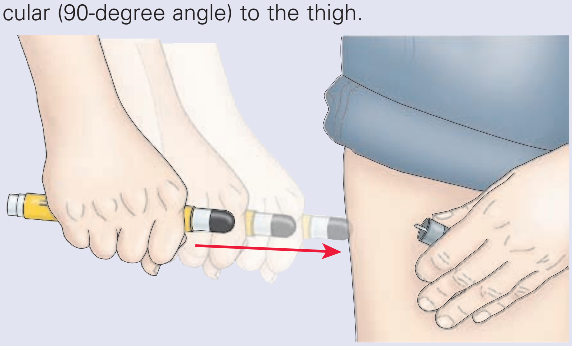
CHART 53-4 PATIENT EDUCATION

### *Self-Administration of Epinephrine*

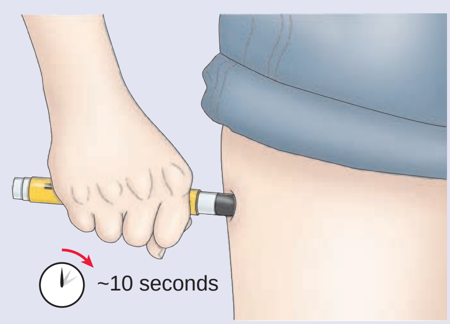
1. After removing the EpiPen autoinjector from its carrying tube, grasp the unit with the black tip (injecting end) pointing downward. Form fist around the unit with the black tip down and with your other hand, remove the gray safety release cap.



2. Hold black tip near outer thigh. Swing and **jab firmly** into outer thigh until a click is heard with the device perpendicular (90-degree angle) to the thigh.



3. Hold firmly against the thigh for approximately 10 seconds. Remove the unit from the thigh and massage injection area for 10 seconds. Call 911 and seek immediate medical attention. Carefully place the used EpiPen, needle-end first, into the device storage tube without bending the needle. Screw on the storage tube completely, and take with you to the hospital emergency room.



Each year attacks begin and end at about the same time. Airborne mold spores require warm, damp weather. Although there is no rigid seasonal pattern, these spores appear in early spring, are rampant during the summer, then taper off and disappear by the first frost in areas that experience dramatic seasonal temperature variation. In temperate areas that do not experience freezing temperatures, these allergens, especially mold, can persist throughout the year.

## Pathophysiology

Sensitization begins by ingestion or inhalation of an antigen. On re-exposure, the nasal mucosa reacts by the slowing of ciliary action, edema formation, and leukocyte (primarily eosinophil) infiltration. Histamine is the major mediator of allergic reactions in the nasal mucosa. Tissue edema results from vasodilation and increased capillary permeability.

## Clinical Manifestations

Typical signs and symptoms of allergic rhinitis include sneezing and nasal congestion; clear, watery nasal discharge; and nasal itching. Itching of the throat and soft palate is common. Drainage of nasal mucus into the pharynx results in multiple attempts to clear the throat and results in a dry cough or hoarseness. Headache, pain over the paranasal sinuses, and epistaxis can accompany allergic rhinitis. The symptoms of this chronic condition depend on environmental exposure and intrinsic host responsiveness. Allergic rhinitis can affect quality of life by also producing fatigue, loss of sleep, and poor concentration (Nathan, 2008).

## Assessment and Diagnostic Findings

Diagnosis of seasonal allergic rhinitis is based on history, physical examination, and diagnostic test results. Diagnostic tests include nasal smears, peripheral blood counts, total serum IgE, epicutaneous and intradermal testing, RAST, food elimination and challenge, and nasal provocation tests. Results indicative of allergy as the cause of rhinitis include increased IgE and eosinophil levels and positive reactions on allergen testing. False-positive and false-negative responses to these tests, particularly skin testing and provocation tests, may occur.

## Medical Management

The goal of therapy is to provide relief from symptoms. Therapy may include one or all of the following interventions: avoidance therapy, pharmacotherapy, and immunotherapy. Verbal instructions must be reinforced by written information. Knowledge of general concepts regarding assessment and therapy in allergic diseases is important so that the patient can learn to manage certain conditions as well as prevent severe reactions and illnesses.

### *Avoidance Therapy*

In avoidance therapy, every attempt is made to remove the allergens that act as precipitating factors. Simple measures and environmental controls are often effective in decreasing symptoms. Examples include use of air conditioners, air cleaners, humidifiers, and dehumidifiers; removal of dust-catching furnishings, carpets, and window coverings; removal of pets from the home or bedroom; use of pillow and mattress covers that are impermeable to dust mites; and a smoke-free environment (Nathan, 2008; Quillen & Feller, 2006). Because multiple allergens are often implicated, multiple measures to avoid exposure to allergens are often necessary (Nathan, 2008; Platts-Mills, Leung & Schatz, 2007). High-efficiency particulate air (HEPA) purifiers and vacuum cleaner filters may also be used to reduce allergens in the environment. Research has shown that multiple avoidance strategies tailored to a person's risk factors can reduce the severity of symptoms, the number of work or school days missed because of symptoms, and the number of unscheduled health care visits for treatment (Ferguson, 2008). In many cases, it is impossible to avoid exposure to all environmental allergens, so pharmacologic therapy or immunotherapy is needed.

### *Pharmacologic Therapy*

#### Antihistamines

Antihistamines, now classified as $H_1$ receptor antagonists (or $H_1$-blockers), are used in the management of mild allergic disorders. $H_1$ blockers bind selectively to $H_1$ receptors, preventing the actions of histamines at these sites. They do not prevent the release of histamine from mast cells or basophils. The $H_1$ antagonists have no effect on $H_2$ receptors, but they do have the ability to bind to nonhistaminic receptors. The ability of certain antihistamines to bind to and block muscarinic receptors underlies several of the prominent anticholinergic side effects of these medications.

Oral antihistamines, which are readily absorbed, are most effective when given at the first occurrence of symptoms, because they prevent the development of new symptoms. The effectiveness of these medications is limited to certain patients with hay fever, vasomotor rhinitis, **urticaria** (hives), and mild asthma. They are rarely effective in other conditions or in any severe conditions.

Antihistamines are the major class of medications prescribed for the symptomatic relief of allergic rhinitis. The major side effect is sedation, although $H_1$ antagonists are less sedating than earlier antihistamines (Arcangelo & Peterson, 2005; Karch, 2008). Additional side effects include nervousness, tremors, dizziness, dry mouth, palpitations, anorexia, nausea, and vomiting. Antihistamines are contraindicated during the third trimester of pregnancy; in nursing mothers and newborns; in children and elderly people; and in patients whose conditions may be aggravated by muscarinic blockade (eg, asthma, urinary retention, open-angle glaucoma, hypertension, prostatic hyperplasia).

Newer antihistamines are called second-generation or nonsedating $H_1$ receptor antagonists. Unlike first-generation $H_1$ receptor antagonists, they do not cross the blood–brain barrier and do not bind to cholinergic, serotoninergic, or alpha-adrenergic receptors (Karch, 2008). They bind to peripheral rather than central nervous system $H_1$ receptors, causing less sedation. Examples of these medications are loratadine (Claritin), cetirizine (Zyrtec), and fexofenadine (Allegra). These are summarized in Table 53-2.

Antihistamines may also be combined with decongestants to reduce the nasal congestion associated with allergies. Some of these combination products are available as over-the-counter (nonprescription) medications; examples are desloratadine/pseudoephedrine (Claritin-D) and

**Table 53-2 SELECTED $H_1$ ANTIHISTAMINES**

| $H_1$ Antihistamine | Contraindications | Major Side Effects | Nursing Implications and Patient Teaching |
|---|---|---|---|
| **First-Generation $H_1$ Antihistamines (Sedating)** | | | |
| Diphenhydramine (Benadryl) | Allergy to any antihistamines<br>Third trimester of pregnancy<br>Lactation<br>Use cautiously with narrow-angle glaucoma, asthma, stenosing peptic ulcer, BPH or bladder neck obstruction, pregnancy, elderly patients, hypertension | Drowsiness, confusion, dizziness, dry mouth, nausea, vomiting, photosensitivity, urinary retention | Administer with food if gastrointestinal upset occurs. Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until CNS response to medication is stabilized. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Encourage use of sunscreen and hat while outdoors. Assess for urinary retention; monitor urinary output. |
| Chlorpheniramine (Chlor-Trimeton) | Allergy to any antihistamines<br>Third trimester of pregnancy<br>Lactation<br>Use cautiously with narrow-angle glaucoma, asthma, stenosing peptic ulcer, BPH or bladder neck obstruction, pregnancy, elderly patients, hypertension | Drowsiness, sedation, and dizziness, although less than other sedating agents; confusion, dry mouth, nausea, vomiting, urinary retention, epigastric distress, thickening of bronchial secretions | Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until CNS response to medication is stabilized. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend use of humidifier. |
| Hydroxyzine (Atarax) | Allergy to hydroxyzine or cetirizine (Zyrtec), pregnancy, lactation, hypertension | Drowsiness, dry mouth, involuntary motor activity, including tremor and seizures | Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until CNS response to medication is stabilized. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Instruct patients to report tremors. |
| **Second-Generation $H_1$ Antihistamines (Nonsedating)** | | | |
| Cetirizine (Zyrtec) | Allergy to any antihistamines<br>Narrow-angle glaucoma<br>Asthma<br>Stenosing peptic ulcer<br>BPH or bladder neck obstruction<br>Lactation<br>Hypertension | Dry nasal mucosa, thickening of bronchial secretions | Can be taken without regard to meals. Instruct patients to use caution if driving or performing tasks that require alertness. Recommend use of humidifier. |
| Desloratadine (Clarinex) | Allergy to loratadine (Alavert, Claritin)<br>Lactation<br>Use cautiously with renal or hepatic impairment pregnancy, hypertension | Somnolence, nervousness, dizziness, fatigue, dry mouth | Can be taken without regard to meals. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend use of humidifier. |
| Loratadine (Alavert, Claritin) | Allergy to any antihistamines<br>Narrow-angle glaucoma<br>Asthma<br>Stenosing peptic ulcer<br>BPH or bladder neck obstruction, hypertension | Headache, nervousness, dizziness, depression, edema, increased appetite | Instruct patients to take on empty stomach (1 h before or 2 h after meals or food). Instruct patients to avoid alcohol and to use caution if driving or performing tasks that require alertness. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend use of humidifier. |
| Fexofenadine (Allegra) | Allergy to any antihistamines<br>Pregnancy<br>Lactation<br>Use with caution with hepatic or renal impairment, in elderly patients, and with hypertension | Fatigue, drowsiness, GI upset | Should not be administered within 15 min of ingestion of antacids. Instruct patients to use caution if driving or performing tasks that require alertness. Recommend use of humidifier. |

BPH = benign prostatic hyperplasia; CNS = central nervous system.

cetirizine/pseudoephedrine (Zyrtec-D). Decongestants can cause an increase in blood pressure; therefore, patients with a history of hypertension should be cautioned about long-term use of any medication containing decongestants.

### Adrenergic Agents

Adrenergic agents, vasoconstrictors of mucosal vessels, are used topically (nasal and ophthalmic formulations) in addition to the oral route. The topical route (drops and sprays) causes fewer side effects than oral administration; however, the use of drops and sprays should be limited to a few days to avoid rebound congestion. Adrenergic nasal decongestants are applied topically to the nasal mucosa for the relief of nasal congestion. They activate the alpha-adrenergic receptor sites on the smooth muscle of the nasal mucosal blood vessels, reducing local blood flow, fluid exudation, and mucosal edema. Topical ophthalmic drops are used for symptomatic relief of eye irritations caused by allergies. Potential side effects include hypertension, dysrhythmias, palpitations, central nervous system stimulation, irritability, tremor, and tachyphylaxis (acceleration of hemodynamic status).

### Mast Cell Stabilizers

Intranasal cromolyn sodium (NasalCrom) is a spray that acts by stabilizing the mast cell membrane, thus reducing the release of histamine and other mediators of the allergic response. In addition, it inhibits macrophages, eosinophils, monocytes, and platelets involved in the immune response

(Arcangelo & Peterson, 2005). Cromolyn interrupts the physiologic response to nasal antigens, and it is used prophylactically (before exposure to allergens) to prevent the onset of symptoms and to treat symptoms once they occur. It is also used therapeutically in chronic allergic rhinitis. This spray is as effective as antihistamines but is less effective than intranasal corticosteroids in the treatment of seasonal allergic rhinitis. The patient must be informed that the beneficial effects of the medication may take a week or so to manifest. The medication is of no benefit in the treatment of nonallergic rhinitis. Adverse effects (eg, sneezing, local stinging and burning sensations) are usually mild.

#### Corticosteroids

Intranasal corticosteroids are indicated in more severe cases of allergic and perennial rhinitis that cannot be controlled by more conventional medications such as decongestants, antihistamines, and intranasal cromolyn. Examples of these medications include beclomethasone (Beconase, Vancenase), budesonide (Rhinocort), dexamethasone (Decadron Phosphate Turbinaire), flunisolide (Nasalide), fluticasone (Cutivate, Flonase), and triamcinolone (Nasacort).

Because of their anti-inflammatory actions, corticosteroids are equally effective in preventing or suppressing the major symptoms of allergic rhinitis. These medications are administered by metered-spray devices. If the nasal passages are blocked, a topical decongestant may be used to clear the passages before the administration of the intranasal corticosteroid. Patients must be aware that full benefit may not be achieved for several days to 2 weeks. Adverse effects of intranasal corticosteroids are mild and include drying of the nasal mucosa and burning and itching sensations caused by the vehicle used to administer the medication. Systemic effects are more likely with dexamethasone. Recommended use of this medication is limited to 30 days. Beclomethasone, budesonide, flunisolide, fluticasone, and triamcinolone are deactivated rapidly after absorption, so they do not achieve significant blood levels. Because corticosteroids suppress host defenses, they must be used with caution in patients with tuberculosis or untreated bacterial infections of the lungs. Patients taking corticosteroids are at risk for infection and suppression of typical manifestations of inflammation, because host defenses are compromised. Inhaled corticosteroids do not affect the immune system to the same degree as systemic corticosteroids (ie, oral corticosteroids). Because corticosteroids are inhaled into the upper respiratory tract, tuberculosis or untreated bacterial infections of the lungs may become apparent and progress. Whenever possible, patients with tuberculosis or other bacterial infections of the lungs should avoid inhaled corticosteroids.

Oral and parenteral corticosteroids are used when conventional therapy has failed and symptoms are severe and of short duration. They can control symptoms of allergic reactions such as hay fever, medication-induced allergies, and allergic reactions to insect stings. Because the response to corticosteroids is delayed, these agents have little or no value in acute therapy for severe reactions such as anaphylaxis. Patients who receive corticosteroids must be cautioned not to stop taking the medication suddenly or without specific instructions from the physician. The patient is also instructed about side effects, which include fluid retention, weight gain, hypertension, gastric irritation, glucose intolerance, and adrenal suppression. Further discussion of corticosteroids is provided in Chapter 42.

#### Leukotriene Modifiers

As previously discussed, leukotrienes have many effects on the inflammatory cycle. Leukotriene modifiers, such as zileuton (Zyflo), zafirlukast (Accolate), and montelukast (Singulair), block the synthesis or action of leukotrienes and prevent the signs and symptoms associated with asthma (Table 53-3).

Leukotriene modifiers are for long-term use, and patients should be advised to take their medication daily. Patients take appropriate "rescue" medications for symptom exacerbation but continue to take the leukotriene modifier on a daily basis. The 2007 National Asthma Education and Prevention Program (NAEPP) suggests using a leukotriene modifier in conjunction with an inhaled corticosteroid for mild persistent asthma.

### *Immunotherapy*

Allergen desensitization (allergen immunotherapy, hyposensitization) is primarily used to treat IgE-mediated diseases by injections of allergen extracts. Immunotherapy, also referred to as allergy vaccine therapy, involves the administration of gradually increasing quantities of specific allergens to the patient until a dose is reached that is effective in reducing disease severity from natural exposure (Stokes, 2008). This type of therapy provides an adjunct to symptomatic pharmacologic therapy and can be used when avoidance of allergens is not possible. Specific immunotherapy has been used in the treatment of allergic disorders for about 100 years. Goals of immunotherapy include reducing the level of circulating IgE, increasing the level of blocking antibody IgG, and reducing mediator cell sensitivity. Immunotherapy has been most effective for ragweed pollen;

**Table 53-3 LEUKOTRIENE MODIFIERS**

| Leukotriene Modifier | Available Formulations | Frequency of Dosing |
|---|---|---|
| **Leukotriene-Receptor Antagonists (LTRAs)** | | |
| Zafirlukast (Accolate) | Tablets: 10 mg; 20 mg | Taken twice a day |
| Montelukast (Singulair) | Tablets: 10 mg<br>Chewable tablets: 4 mg; 5 mg<br>Granules: 4 mg/packet | Taken once a day in PM |
| **Leukotriene-Receptor Inhibitors (LTRIs)** | | |
| Zileuton (Zyflo CR) | Tables: 600 mg extended release | Taken twice a day within 1 h after morning and evening meals |

## Chart 53-5 • *Immunotherapy: Indications and Contraindications*

**Indications**

- Allergic rhinitis, conjunctivitis, or allergic asthma
- History of a systemic reaction to Hymenoptera and specific IgE antibodies to Hymenoptera venom
- Desire to avoid the long-term use, potential adverse effects, or costs of medications
- Lack of control of symptoms by avoidance measures or use of medications

**Contraindications**

- Use of beta-blocker or angiotensin-converting enzyme (ACE) inhibitor therapy, which may mask early signs of anaphylaxis
- Presence of significant pulmonary or cardiac disease or organ failure
- Inability of the patient to recognize or report signs and symptoms of a systemic reaction
- Nonadherence of the patient to other therapeutic regimens and nonlikelihood that the patient will adhere to the immunization schedule (often weekly for an indefinite period)
- Inability to monitor the patient for at least 30 minutes after administration of immunotherapy
- Absence of equipment or adequate personnel to respond to allergic reaction if one occurs

however, treatment for grass, tree pollen, cat dander, and house dust mite allergens has also been effective. Indications and contraindications for immunotherapy are presented in Chart 53-5.

Correlation of a positive skin test with a positive allergy history is an indication for immunotherapy if the allergen cannot be avoided. The benefit of immunotherapy has been fairly well established in instances of allergic rhinitis and bronchial asthma that are clearly due to sensitivity to one of the common pollens, molds, or household dust. Unlike antiallergy medication, allergen immunotherapy has the potential to alter the allergic disease course after 3 to 5 years of therapy. Because it may prevent progression or development of asthma or multiple or additional allergies, it is also considered to be a potential preventive measure (Stokes, 2008). The patient must understand what to expect and the importance of continuing therapy for several years before immunotherapy is accomplished. When skin tests are performed, the results are correlated with symptoms; treatment is based on the patient's needs rather than on the results of skin tests.

The most common method of treatment is the serial injection of one or more antigens that are selected in each particular case on the basis of skin testing. This method provides a simple and efficient technique for identifying IgE antibodies to specific antigens. Specific treatment consists of injecting extracts of the allergens that cause symptoms in a particular patient. Injections begin with very small amounts and are gradually increased, usually at weekly intervals, until a maximum tolerated dose is attained. Maintenance booster injections are administered at 2- to 4-week intervals, frequently for a period of several years, before maximum benefit is achieved, although some patients will note early improvement in their symptoms. Long-term benefit seems to be related to the cumulative dose of vaccine given over time (Stokes, 2008). Immunotherapy should not be initiated during pregnancy; for patients who have been receiving immunotherapy before pregnancy, the dosage should not be increased during pregnancy.

Although severe systemic reactions are rare, the risk of systemic and potentially fatal anaphylaxis exists. It tends to occur most frequently at the induction or "up-dosing" phase. Therefore, the patient must be monitored after administration of immunotherapy. Because of the risk of anaphylaxis, injections should not be administered by a lay person or by the patient. The patient must remain in the office or clinic for at least 30 minutes after the injection and is observed for possible systemic symptoms. If a large, local swelling develops at the injection site, the next dose should not be increased, because this may be a warning sign of a possible systemic reaction.

*NURSING ALERT*

**Because the injection of an allergen may induce systemic reactions, such injections are administered only in a setting (ie, physician's office, clinic) where epinephrine is immediately available.**

Therapeutic failure is evident when a patient does not experience a decrease of symptoms within 12 to 24 months, fails to develop increased tolerance to known allergens, and cannot decrease the use of medications to reduce symptoms. Potential causes of treatment failure include misdiagnosis of allergies, inadequate doses of allergen, newly developed allergies, and inadequate environmental controls.

## NURSING PROCESS

### The Patient With Allergic Rhinitis

#### Assessment

The examination and history of the patient reveal sneezing, often in paroxysms; thin and watery nasal discharge; itching eyes and nose; lacrimation; and occasionally headache. The health history includes a personal or family history of allergy. The allergy assessment identifies the nature of antigens, seasonal changes in symptoms, and medication history. The nurse also obtains subjective data about how the patient feels just before symptoms become obvious, such as the occurrence of pruritus, breathing problems, and tingling sensations. In addition to these symptoms, hoarseness, wheezing, hives, rash, erythema, and edema are noted. Any relationship between emotional problems or stress and the triggering of allergy symptoms is assessed.

#### Diagnosis

*Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective breathing pattern related to allergic reaction

- Deficient knowledge about allergy and the recommended modifications in lifestyle and self-care practices
- Ineffective individual coping with chronicity of condition and need for environmental modifications

#### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications may include the following:

- Anaphylaxis
- Impaired breathing
- Nonadherence to the therapeutic regimen

### Planning and Goals

The goals for the patient may include restoration of normal breathing pattern, increased knowledge about the causes and control of allergic symptoms, improved coping with alterations and modifications, and absence of complications.

### Nursing Interventions

#### *Improving Breathing Pattern*

The patient is instructed and assisted to modify the environment to reduce the severity of allergic symptoms or to prevent their occurrence. The patient is instructed to reduce exposure to people with upper respiratory tract infections. If an upper respiratory infection occurs, the patient is encouraged to take deep breaths and to cough frequently to ensure adequate gas exchange and prevent atelectasis. The patient is instructed to seek medical attention, because the presence of allergy symptoms along with an upper respiratory tract infection may compromise adequate lung function. Adherence to medication schedules and other treatment regimens is encouraged and reinforced.

#### *Promoting Understanding of Allergy and Allergy Control*

Instruction includes strategies to minimize exposure to allergens and explanation about desensitization procedures and correct use of medications. The nurse informs and reminds the patient of the importance of keeping appointments for desensitization procedures, because dosages are usually adjusted on a weekly basis, and missed appointments may interfere with the dosage adjustment.

Patients also need to understand that medications for allergy control should be used only when the allergy is apparent. This is usually on a seasonal basis. Continued use of medications when not required can cause an increased tolerance to the medication, with the result that the medication will not be effective when needed.

#### *Coping With a Chronic Disorder*

Although allergic reactions are infrequently life-threatening, they require constant vigilance to avoid allergens and modification of the lifestyle or environment to prevent recurrence of symptoms. Allergic symptoms are often present year-round and create discomfort and inconvenience for the patient. Although patients may not feel ill during allergy seasons, they often do not feel well, either. The need to be alert for possible allergens in the environment may be tiresome, placing a burden on the patient's ability to lead a normal life. Stress related to these difficulties may in turn increase the frequency or severity of symptoms.

To assist the patient in adjusting to these modifications, the nurse must have an appreciation of the difficulties encountered by the patient. The patient is encouraged to verbalize feelings and concerns in a supportive environment and to identify strategies to deal with them effectively.

#### *Monitoring and Managing Potential Complications*

**ANAPHYLAXIS AND IMPAIRED BREATHING.** Respiratory and cardiovascular functioning can be significantly altered during allergic reactions by the reaction itself or by the medications used to treat reactions. The respiratory status is evaluated by monitoring the respiratory rate and pattern and by assessing for breathing difficulties or abnormal lung sounds. The pulse rate and rhythm and blood pressure are monitored to assess cardiovascular status regularly or any time the patient reports symptoms such as itching or difficulty breathing. In the event of signs and symptoms suggestive of anaphylaxis, emergency medications and equipment must be available for immediate use.

**NONADHERENCE TO THE THERAPEUTIC REGIMEN.** Knowing about the treatment regimen does not ensure adherence. Having the patient identify potential barriers and explore acceptable solutions for effective management of the condition (eg, installing tile floors rather than carpet, not gardening in the spring) can increase adherence to the treatment regimen.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient is instructed about strategies to minimize exposure to allergens, the actions and adverse effects of medications, and the correct use of medications. The patient should know the name, dose, frequency, actions, and side effects of all medications taken.

Instruction about strategies to control allergic symptoms is based on the needs of the patient as determined by the results of tests, the severity of symptoms, and the motivation of the patient and family to deal with the condition. Suggestions for patients who are sensitive to dust and mold in the home are given in Chart 53-6. Additional nursing interventions for allergy management are presented in Chart 53-7.

If the patient is to undergo immunotherapy, the nurse reinforces the physician's explanation regarding the purpose and procedure. Instructions are given regarding the series of injections, which usually are administered initially every week and then at 2- to 4-week intervals. These instructions include remaining in the physician's office or the clinic for at least 30 minutes after the injection so that emergency treatment can be given if the patient has a reaction; avoiding rubbing or scratching the injection site; and continuing with the series for the period of time required. In addition, the patient and family are instructed about emergency treatment of severe allergic symptoms.

Because antihistamines may produce drowsiness, the patient is cautioned about this and other side effects of the particular medication. Operating machinery, driving a car, and performing activities that require intense concentration should be postponed. The patient is also informed about the dangers of drinking alcohol when taking these medications, because they tend to exaggerate the effects of alcohol.

**CHART 53-6** HOME CARE CHECKLIST
## *Allergy Management*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Verbalize how to maintain a dust-free environment by removing drapes, curtains, and venetian blinds and replacing them with pull shades; covering the mattress with a hypoallergenic cover that can be zipped; and removing rugs and replacing them with wood flooring or linoleum. | ✔ | ✔ |
| • Identify rationale for washing the floor and dusting and vacuuming daily. | ✔ | ✔ |
| • Identify rationale for replacing stuffed furniture with wood pieces that can easily be dusted. | ✔ | ✔ |
| • State rationale for wearing a mask whenever cleaning is being done. | ✔ | ✔ |
| • Identify rationale for avoiding use of tufted bedspreads, stuffed toys, and feather pillows and replacing them with washable cotton material. | ✔ | ✔ |
| • State rationale for avoiding the use of any clothing that causes itching. | ✔ | ✔ |
| • Verbalize ways to reduce dust in the house as a whole by using steam or hot water for heating rather than air and using air filters or air conditioning. | ✔ | ✔ |
| • Verbalize ways to reduce exposure to pollens or molds by identifying seasons of the year when pollen counts are high; wearing a mask at times of increased exposure (windy days and when grass is being cut); and avoiding contact with weeds, dry leaves, and freshly cut grass. | ✔ | ✔ |
| • State rationale for seeking air-conditioned areas at the height of the allergy season. | ✔ | ✔ |
| • State rationale for avoiding sprays and perfumes. | ✔ | ✔ |
| • State rationale for use of hypoallergenic cosmetics. | | |
| • State rationale for taking prescribed medications as ordered. | ✔ | ✔ |
| • Identify specific foods that may cause allergic symptoms. (Examples of foods that can cause allergic reactions are fish, nuts, eggs, and chocolate.) | ✔ | ✔ |
| • Develop a list of foods to avoid. | ✔ | ✔ |

## Chart 53-7 • *Selected Nursing Strategies for Allergy Management*

- Identify the patient's known allergens (eg, medications, foods, insects, environmental allergens).
- Describe the patient's typical allergic reaction and its severity.
- Document the patient's allergies (eg, medications, foods, insects, environmental allergens) in the patient's medical record.
- Post allergy alerts appropriately.
- Encourage the patient to wear a medical alert band and to carry information about allergies at all times.
- Monitor the patient closely after administration of new medications and exposure to new foods, contrast agents, latex, and other allergens.
- Investigate potential for allergic reactions with all new medications through consultation with the pharmacist.
- Instruct the patient to question all medications and new foods.
- Identify early manifestations of allergic reactions.
- Administer emergency treatment for allergic reactions.
- Monitor the patient's response and status for 12–14 hours after a severe allergic reaction.
- Instruct the patient and family about emergency home management of allergic reaction.
- Instruct the patient and family about avoidance measures to reduce risk of exposure to allergens.

The patient must be aware of the effects caused by overuse of the sympathomimetic agents in nose drops or sprays. A condition referred to as rhinitis medicamentosa may result (Fig. 53-6). After topical application of the medication, a rebound period occurs in which the nasal mucous membranes become more edematous and congested than they were before the medication was used. Such a reaction encourages the use of more medication, and a cyclic pattern results. The topical agent must be discontinued immediately and completely to correct this problem.

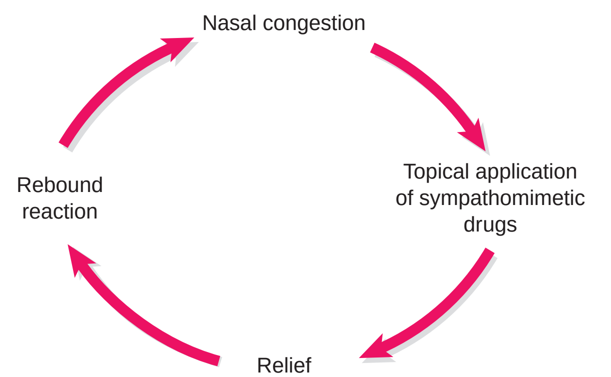



**Figure 53-6** Rhinitis medicamentosa. This cyclic pattern results from overuse of sympathomimetic nose drops or sprays.

**CONTINUING CARE.** Follow-up telephone calls to the patient are often reassuring to the patient and family and provide an opportunity for the nurse to answer any questions. The patient is reminded to keep follow-up appointments and is informed about the importance of continuing with treatment. The importance of participating in health promotion activities and health screening is also emphasized.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Exhibits normal breathing patterns
   a. Demonstrates lungs clear on auscultation
   b. Exhibits absence of adventitious breath sounds (crackles, rhonchi, wheezing)
   c. Has a normal respiratory rate and pattern
   d. Reports no complaints of respiratory distress (shortness of breath, difficulty on inspiration or expiration)
2. Demonstrates knowledge about allergy and strategies to control symptoms
   a. Identifies causative allergens, if known
   b. States methods of avoiding allergens and controlling indoor and outdoor precipitating factors
   c. Removes from the environment items that retain dust
   d. Wears a dampened mask if dust or mold may be a problem
   e. Avoids smoke-filled rooms and dust-filled or freshly sprayed areas
   f. Uses air conditioning for a major part of the day when allergens are high
   g. Takes antihistamines as prescribed; participates in hyposensitization program, if applicable
   h. Describes name, purpose, side effects, and method of administration of prescribed medications
   i. Identifies when to seek immediate medical attention for severe allergic responses
   j. Describes activities that are possible, including ways to participate in activities without activating the allergies
3. Experiences relief of discomfort while adapting to the inconveniences of an allergy
   a. Relates the emotional aspects of the allergic response
   b. Demonstrates use of measures to cope positively with allergy
4. Demonstrates absence of complications
   a. Exhibits vital signs within normal limits
   b. Reports no symptoms or episodes of anaphylaxis (urticaria, itching, peripheral tingling, fullness in the mouth and throat, flushing, difficulty swallowing, coughing, wheezing, or difficulty breathing)
   c. Demonstrates correct procedure to self-administer emergency medications to treat severe allergic reaction
   d. Correctly states medication names, dose and frequency of administration, and medication actions
   e. Correctly identifies side effects and untoward signs and symptoms to report to physician
   f. Discusses acceptable lifestyle changes and solutions for identified potential barriers to adherence to treatment and medication regimen

## Contact Dermatitis

Contact dermatitis, a type IV delayed hypersensitivity reaction, is an acute or chronic skin inflammation that results from direct skin contact with chemicals or allergens. There are four basic types: allergic, irritant, phototoxic, and photoallergic (Table 53-4). Eighty percent of cases are caused by excessive exposure to or additive effects of irritants (eg, soaps, detergents, organic solvents). Skin sensitivity may develop after brief or prolonged periods of exposure, and the clinical picture may appear hours or weeks after the sensitized skin has been exposed.

### Clinical Manifestations

Symptoms include itching, burning, erythema, skin lesions (vesicles), and edema, followed by weeping, crusting, and finally drying and peeling of the skin. In severe responses, hemorrhagic bullae may develop. Repeated reactions may be accompanied by thickening of the skin and pigmentary changes. Secondary invasion by bacteria may develop in skin that is abraded by rubbing or scratching. Usually, there are no systemic symptoms unless the eruption is widespread.

### Assessment and Diagnostic Findings

The location of the skin eruption and the history of exposure aid in determining the condition. However, in cases of obscure irritants or an unobservant patient, the diagnosis can be extremely difficult, often involving many trial-and-error procedures before the cause is determined. Patch tests on the skin with suspected offending agents may clarify the diagnosis. The patch test most commonly used is the Thin-layer Rapid Use Epicutaneous (TRUE) test.

## Atopic Dermatitis

**Atopic dermatitis** is a type I immediate hypersensitivity disorder characterized by inflammation and hyperreactivity of the skin. Other terms used to describe this skin disorder include atopic eczema, atopic dermatitis/eczema, and atopic dermatitis/eczema syndrome (AEDS). In a revised classification system developed to clarify terminology, AEDS includes both allergic and nonallergic disorders. The term *atopic dermatitis* is currently the most commonly used of these terms and is used in the following discussion.

Atopic dermatitis affects 15% to 20% of children and 1% to 3% of adults in developed countries (Bieber, 2008). Most patients have significant elevations of serum IgE and peripheral eosinophilia. Pruritus and hyperirritability of the skin are the most consistent features of atopic dermatitis and are related to large amounts of histamine in the skin. Excessive dryness of the skin with resultant itching is related to changes

**Table 53-4 TYPES, TESTING, AND TREATMENT OF CONTACT DERMATITIS**

| Type | Etiology | Clinical Presentation | Diagnostic Testing | Treatment |
|---|---|---|---|---|
| Allergic | Results from contact of skin and allergenic substance. Has a sensitization period of 10–14 days. | Vasodilation and perivascular infiltrates on the dermis<br>Intracellular edema<br>Usually seen on dorsal aspects of hand | Patch testing (contraindicated in acute, widespread dermatitis) | Avoidance of offending material<br>Burow's solution or cool water compress<br>Systemic corticosteroids (prednisone) for 7–10 days<br>Topical corticosteroids for mild cases<br>Oral antihistamines to relieve pruritus |
| Irritant | Results from contact with a substance that chemically or physically damages the skin on a nonimmunologic basis. Occurs after first exposure to irritant or repeated exposures to milder irritants over an extended time. | Dryness lasting days to months<br>Vesiculation, fissures, cracks<br>Hands and lower arms most common areas | Clinical picture<br>Appropriate negative patch tests | Identification and removal of source of irritation<br>Application of hydrophilic cream or petrolatum to soothe and protect<br>Topical corticosteroids and compresses for weeping lesions<br>Antibiotics for infection and oral antihistamines for pruritus |
| Phototoxic | Resembles the irritant type but requires sun and a chemical in combination to damage the epidermis. | Similar to irritant dermatitis | Photopatch test | Same as for allergic and irritant dermatitis |
| Photoallergic | Resembles allergic dermatitis but requires light exposure in addition to allergen contact to produce immunologic reactivity. | Similar to allergic dermatitis | Photopatch test | Same as for allergic and irritant dermatitis |

in lipid content, sebaceous gland activity, and sweating. In response to stroking of the skin, immediate redness appears on the skin. Pallor follows in 15 to 30 seconds and persists for 1 to 3 minutes. Lesions develop secondary to the trauma of scratching and appear in areas of increased sweating and hypervascularity. Atopic dermatitis is chronic, with remissions and exacerbations. This condition has a tendency to recur, with remission from adolescence to 20 years of age.

It is important to note that atopic dermatitis is often the first step in a process that leads to asthma and allergic rhinitis. It is the result of interactions between susceptibility genes, the environment, defective function of the skin barrier, and immunologic responses.

## Medical Management

Treatment of patients with atopic dermatitis must be individualized. Guidelines for treatment include decreasing itching and scratching by wearing cotton fabrics, washing with a mild detergent, humidifying dry heat in winter, maintaining room temperature at 20°C to 22.2°C (68°F to 72°F), using antihistamines such as diphenhydramine (Benadryl), and avoiding animals, dust, sprays, and perfumes. Keeping the skin moisturized with daily baths to hydrate the skin and the use of topical skin moisturizers is encouraged. Topical corticosteroids are used to prevent inflammation, and any infection is treated with antibiotics to eliminate *Staphylococcus aureus* when indicated. Use of immunosuppressive agents, such as cyclosporine (Neoral, Sandimmune), tacrolimus (Prograf, Protopic), and pimecrolimus (Elidel), may be effective in inhibiting T cells and mast cells involved in atopic dermatitis (Novak, 2007). Research to assess the effectiveness and the adverse side effects of medications used to treat atopic dermatitis is needed.

## Nursing Management

Patients who experience atopic dermatitis and their families require assistance and support from the nurse to cope with the disorder. The symptoms are often disturbing to the patient and disruptive to the family. The appearance of the skin may affect the patient's self-esteem and his or her willingness to interact with others. Instructions and counseling about strategies to incorporate preventive measures and treatments into the lifestyle of the family may be helpful.

The patient and family need to be aware of signs of secondary infection and of the need to seek treatment if infection occurs. The nurse also teaches the patient and family about the side effects of medications used in treatment.

# Dermatitis Medicamentosa (Drug Reactions)

Dermatitis medicamentosa, a type I hypersensitivity disorder, is the term applied to skin rashes associated with certain medications. Although people react differently to each medication, certain medications tend to induce eruptions of similar types. Rashes are among the most common adverse reactions to medications and occur in approximately 2% to 3% of hospitalized patients.

In general, drug reactions appear suddenly, have a particularly vivid color, manifest with characteristics that are more intense than the somewhat similar eruptions of infectious origin, and, with the exception of bromide and the iodide rashes, disappear rapidly after the medication is withdrawn. Rashes may be accompanied by systemic or generalized symptoms. On discovery of a medication allergy, patients are warned that they have a hypersensitivity to a

particular medication and are advised not to take it again. Patients should carry information identifying the hypersensitivity with them at all times.

Skin eruptions related to medication therapy suggest more serious hypersensitivities. Frequent assessment and prompt reporting of the appearance of any eruptions are important so that early treatment can be initiated. Some cutaneous drug reactions may be associated with a clinical complex that involves other organs. These are known as complex drug reactions. Patients who suspect that a new rash may be caused by a drug allergy (newly prescribed medications, especially antibiotics such as penicillin or sulfa medications) should stop taking the medication immediately and contact their prescribing clinician, who will determine whether the medication and the rash are related.

## Urticaria and Angioneurotic Edema

Urticaria (hives) is a type I hypersensitive allergic reaction of the skin characterized by the sudden appearance of pinkish, edematous elevations that vary in size and shape, itch, and cause local discomfort. They may involve any part of the body, including the mucous membranes (especially those of the mouth), the larynx (occasionally with serious respiratory complications), and the gastrointestinal tract.

Each hive remains for a few minutes to several hours before disappearing. For hours or days, clusters of these lesions may come, go, and return episodically. If this sequence continues for longer than 6 weeks, the condition is called chronic urticaria.

**Angioneurotic edema** involves the deeper layers of the skin, resulting in more diffuse swelling rather than the discrete lesions characteristic of hives. On occasion, this reaction covers the entire back. The skin over the reaction may appear normal but often has a reddish hue. The skin does not pit on pressure, as ordinary edema does. The regions most often involved are the lips, eyelids, cheeks, hands, feet, genitalia, and tongue; the mucous membranes of the larynx, the bronchi, and the gastrointestinal canal may also be affected, particularly in the hereditary type (see discussion in the following section). Swellings may appear suddenly, in a few seconds or minutes, or slowly, in 1 or 2 hours. In the latter case, their appearance is often preceded by itching or burning sensations. Seldom does more than a single swelling appear at one time, although one may develop while another is disappearing. Infrequently, swelling recurs in the same region. Individual lesions usually last 24 to 36 hours. On rare occasions, swelling may recur with remarkable regularity at intervals of 3 to 4 weeks.

Several frequently prescribed medications, such as angiotensin-converting enzyme (ACE) inhibitors and penicillin, may cause angioedema. The nurse needs to be aware of all medications the patient is taking and be alert to the potential of angioedema as a side effect.

## Hereditary Angioedema

Hereditary angioedema, although not an immunologic disorder in the usual sense, is included because of its resemblance to allergic angioedema and because of the potential seriousness of the condition. Symptoms are caused by edema of the skin, the respiratory tract, or the digestive tract. Attacks may be precipitated by trauma, or they may seem to occur spontaneously.

### Clinical Manifestations

When skin is involved, the swelling usually is diffuse, does not itch, and usually is not accompanied by urticaria. Gastrointestinal edema may cause abdominal pain severe enough to suggest the need for surgery. Typically, attacks last 1 to 4 days and are harmless; however, attacks can occasionally affect the subcutaneous and submucosal tissues in the region of the upper airway and can be associated with respiratory obstruction and asphyxiation. This disorder is inherited as an autosomal dominant trait. Approximately 85% of patients with this disorder have one nonproductive gene, and the remaining 15% have a gene mutation (Virella, 2007).

### Medical Management

Attacks usually subside within 3 to 4 days, but during this time the patient should be observed carefully for signs of laryngeal obstruction, which may necessitate tracheostomy as a life-saving measure. Epinephrine, antihistamines, and corticosteroids are usually used in treatment, but their success is limited.

## Food Allergy

IgE-mediated food allergy, a type I hypersensitivity reaction, occurs in 6% to 8% of children and about 2% of the adult population; it is thought to occur in people who have a genetic predisposition combined with exposure to allergens early in life through the gastrointestinal or respiratory tract or nasal mucosa (Bush, 2008). Researchers have also identified a second type of food allergy, a non-IgE–mediated food allergy syndrome in which T cells play a major role (Cappellano, 2008).

Almost any food can cause allergic symptoms. Any food can contain an allergen that results in anaphylaxis. The most common offenders are seafood (lobster, shrimp, crab, clams, fish), legumes (peanuts, peas, beans, licorice), seeds (sesame, cottonseed, caraway, mustard, flaxseed, sunflower seeds), tree nuts, berries, egg white, buckwheat, milk, and chocolate. Peanut and tree nut (eg, cashew, walnut) allergies are responsible for most severe food allergy reactions. In more than 70% of children with peanut allergy, symptoms develop at their first known exposure, suggesting unknown exposure through breast milk or another source (Burks, 2008; Bush, 2008). Pregnant and breast-feeding women who are aware of a family history of allergy (mother, father, or a sibling of the unborn infant with asthma, eczema, hay fever, or other allergy) should avoid peanuts and peanut-containing foods during pregnancy as a precaution (Burks, 2008; Cappellano, 2008).

One of the dangers of food allergens is that they may be hidden in other foods and not apparent to people who are susceptible to the allergen. For example, peanuts and peanut butter are often used in salad dressings and Asian, African, and Mexican cooking and may result in severe allergic reactions,

including anaphylaxis. Previous contamination of equipment with allergens (eg, peanuts) during preparation of another food product (eg, chocolate cake) is enough to produce anaphylaxis in people with severe allergy.

## Clinical Manifestations

The clinical symptoms are classic allergic symptoms (urticaria, dermatitis, wheezing, cough, laryngeal edema, angioedema) and gastrointestinal symptoms (itching; swelling of lips, tongue, and palate; abdominal pain; nausea; cramps; vomiting; and diarrhea).

## Assessment and Diagnostic Findings

A careful diagnostic workup is required in any patient with a suspected food hypersensitivity. Included are a detailed allergy history, a physical examination, and pertinent diagnostic tests. Skin testing is used to identify the source of symptoms and is useful in identifying specific foods as causative agents.

## Medical Management

Therapy for food hypersensitivity includes elimination of the food responsible for the hypersensitivity (Chart 53-8). Pharmacologic therapy is necessary for patients who cannot avoid exposure to offending foods and for patients with multiple food sensitivities not responsive to avoidance measures. Medication therapy involves the use of $H_1$ blockers, antihistamines, adrenergic agents, corticosteroids, and cromolyn sodium. Another essential aspect of management is teaching patients and family members how to recognize and manage the early stages of an acute anaphylactic reaction. Many food allergies disappear with time, particularly in children. About one third of proven allergies disappear in 1 to 2 years if the patient carefully avoids the offending food. However, peanut allergy has been reported to persist throughout adulthood in some people (Burks, 2008).

## Nursing Management

In addition to participating in management of the allergic reaction, the nurse focuses on preventing future exposure of the patient to the food allergen. If a severe allergic or anaphylactic reaction to food allergens has occurred, the nurse must instruct the patient and family about strategies to prevent its recurrence. The patient is instructed about the importance of carefully assessing foods prepared by others for obvious as well as hidden sources of food allergens and of avoiding locations and facilities where those allergens are likely to be present. This includes careful reading of food labels and monitoring the preparation of food by others to be sure that exposure to even minute amounts of allergenic foods is avoided. The patient and family must be knowledgeable about early signs and symptoms of allergic reactions and must be proficient in emergency administration of epinephrine if a reaction occurs. The nurse also advises the patient to wear a medical alert bracelet or to carry identification and emergency equipment at all times. Patients' food allergies should be noted on their medical records, because there may be risk of allergic reactions not only to food but also to some medications containing similar substances (Bush, 2008). Pregnant women and those who are breastfeeding are instructed to avoid eating peanuts or food containing peanuts to minimize the risk of peanut allergy in their children.

# Latex Allergy

Latex allergy, the allergic reaction to natural rubber proteins, has been implicated in rhinitis, conjunctivitis, contact dermatitis, urticaria, asthma, and anaphylaxis. Shortly after 1987, when hospitals and outpatient facilities mandated the use of powdered latex gloves to prevent transmission of infections, some health care workers began to experience numerous adverse reactions (Bernstein, 2006). From 1989 until the mid-1990s, the number of cases steadily increased. However, since that time, the prevalence has been steadily declining, possibly because of the use of nonpowdered latex and latex-free gloves (Rolland & O'Hehir, 2008).

Natural rubber latex is derived from the sap of the rubber tree (*Hevea brasiliensis*). The conversion of the liquid rubber latex into a finished product entails the addition of more than 200 chemicals. The proteins in the natural rubber latex (Hevea proteins) or the various chemicals that are used in the manufacturing process are thought to be the source of the allergic reactions. Not all objects composed of latex have the same ability to stimulate an allergic response. For example, the antigenicity of latex gloves can vary widely depending on the manufacturing method used.

**CHART 53-8** HOME CARE CHECKLIST
***Managing Food Allergies***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Verbalize understanding of the need to maintain an allergen-free diet. | ✔ | ✔ |
| • Demonstrate reading of food labels to identify hidden allergens in food. | ✔ | ✔ |
| • Identify ways to manage an allergen-free diet when eating away from home. | ✔ | ✔ |
| • State the need to wear a medical alert medallion or bracelet. | ✔ | ✔ |
| • List symptoms of food allergy. | ✔ | ✔ |
| • Demonstrate emergency administration of epinephrine. | ✔ | ✔ |
| • State the importance of replacing epinephrine when outdated. | ✔ | ✔ |
| • State the importance of prompt treatment of allergic reactions and health care follow-up. | ✔ | ✔ |

**Table 53-5 SELECTED PRODUCTS CONTAINING NATURAL RUBBER LATEX AND LATEX-FREE ALTERNATIVES**

| Products Containing Latex | Examples of Latex-Safe Alternatives* |
|---|---|
| **Hospital Environment** | |
| Ace bandage (brown) | Ace bandage, white all cotton |
| Adhesive bandages, Band-Aid dressing, Telfa | Cotton pads and plastic or silk tape, Active Strip (3M), Duoderm |
| Anesthesia equipment | Neoprene anesthesia kit (King) |
| Blood pressure cuff, tubing, and bladder | Clean Cuff, single-use nylon or vinyl blood pressure cuffs or wrap with stockinette or apply over clothing |
| Catheters | All-silicone or vinyl catheters |
| Catheter leg bag straps | Velcro straps |
| Crutch axillary pads and hand grips, tips | Cover with cloth, tape |
| ECG pads | Baxter, Red Dot 3M ECG pads |
| Elastic compression stockings | Kendall SCD stockings with stockinette |
| Gloves | Dermaprene, Neoprene, polymer, or vinyl gloves |
| IV catheters | Jelko, Deseret IV catheters |
| IV rubber injection ports | Cover Y-sites and ports; do not puncture. Use three-way stopcocks on plastic tubing |
| Levin tube | Salem sump tube |
| Medication vials | Remove rubber stopper |
| Penrose drains | Jackson-Pratt, Zimmer hemovac drains |
| Prepackaged enema kits | Theravac, Fleet Ready-to-use |
| Pulse oximeters | Nonin oximeters |
| Resuscitation bags | Laerdal, Puritan Bennett, *certain* Ambu |
| Stethoscope tubing | PVC tubing; cover with latex-free stockinette |
| Syringes—single use (Monoject, B & D) | Terumo syringes, Abbott PCA Abboject |
| Suction tubing | PVC (Davol, Laerdal) |
| Tapes | Dermicel, Micropore |
| Thermometer probes | Diatec probe covers |
| Tourniquets | X-Tourn straps (Avcor) |
| Theraband | New Thera-band Exercisers, plastic tubing |
| **Home Environment** | |
| Balloons | Mylar balloons |
| Diapers, incontinence pads | Huggies, Always, *some* Attends |
| Condoms, diaphragms | Polyurethane products, Durex/Avanti and Reality products (female condom) |
| Feminine hygiene pad | Kimberly-Clark products |
| Wheelchair cushions | ROHO cushions, Sof Care bed/chair cushions |

*Confirmation is essential to verify that all items are latex-free before using, especially if risk of latex allergy is present.

Populations at risk include health care workers, patients with atopic allergies or multiple surgeries, people working in factories that manufacture latex products, females, and patients with spina bifida. Because more food handlers, hairdressers, automobile mechanics, and police often wear latex gloves, they may also be at risk for latex allergy. It is estimated that 1% to 3% of the general population have an allergy to latex and that as many as 10% to 20% of health care workers are sensitized (Rolland & O'Hehir, 2008). Patients are at risk for anaphylactic reactions as a result of contact with latex during medical treatments, especially surgical procedures.

Food that has been handled by people wearing latex gloves may stimulate an allergic response. Cross-reactions have been reported in people who are allergic to certain food products, such as kiwis, bananas, pineapples, mangos, passion fruit, avocados, and chestnuts (Bernstein, 2006).

Routes of exposure to latex products can be cutaneous, percutaneous, mucosal, parenteral, or aerosol. Allergic reactions are more likely with parenteral or mucous membrane exposure but can also occur with cutaneous contact or inhalation (Rolland & O'Hehir, 2008). The most frequent source of exposure is cutaneous, which usually involves the wearing of natural latex gloves. The powder used to facilitate putting on latex gloves can become a carrier of latex proteins from the gloves; when the gloves are put on or removed, the particles become airborne and can be inhaled or settle on skin, mucous membranes, or clothing. Mucosal exposure can occur from the use of latex condoms, catheters, airways, and nipples. Parenteral exposure can occur from IV lines or hemodialysis equipment. In addition to latex-derived medical devices, many household items also contain latex. Examples of medical and household items containing latex and a list of alternative products are found in Table 53-5. It is estimated that more than 40,000 medical devices and nonmedical products contain latex. Even chemical additives used in the manufacture of nonlatex gloves and other items have been associated with allergic symptoms, although these items otherwise have a low potential to stimulate an allergic response (Bernstein, 2006).

## Clinical Manifestations

Several different types of reactions to latex are possible (Table 53-6). Irritant contact dermatitis, a nonimmunologic response, may be caused by mechanical skin irritation or an alkaline pH associated with latex gloves. Common symptoms of irritant dermatitis include erythema and pruritus. These symptoms can be eliminated by changing glove brands or by using powder-free gloves. Use of hand lotion before donning latex gloves can worsen the symptoms, because lotions may leach latex proteins from the gloves, increasing skin exposure and the risk of developing true allergic reactions (Bernstein, 2006).

Delayed hypersensitivity to latex, a type IV reaction mediated by T cells in the immune system, is localized to the area of exposure and is characterized by symptoms of

**Table 53-6 TYPES OF REACTIONS TO LATEX**

| Type of Reaction | Cause | Signs/Symptoms | Treatment |
|---|---|---|---|
| Irritant contact dermatitis | Damage to skin because of irritation and loss of epidermoid skin layer; not an allergic reaction. Can be caused by excessive use of soaps and cleansers, multiple handwashings, inadequate hand drying, mechanical irritation (eg, sweating, rubbing inside powdered gloves), exposure to chemicals added during the manufacturing of gloves, and alkaline pH of powdered gloves.<br>Reaction may occur with first exposure, is usually benign, and is not life-threatening. | Acute: redness, edema, burning, discomfort, itching<br>Chronic: dry, thickened, cracked skin | Referral for diagnostic testing<br>Avoidance of exposure to irritant<br>Thorough washing and drying of hands<br>Use of powder-free gloves with more frequent changes of gloves<br>Changing glove types<br>Use of water- or silicone-based moisturizing creams, lotions, or topical barrier agents<br>Avoidance of oil- or petroleum-based skin agents with latex products, because they cause breakdown of the latex product |
| Allergic contact dermatitis | Delayed hypersensitivity (type IV) reaction. Usually affects only area in contact with latex; reaction is usually to chemical additives used in the manufacturing process rather than to latex itself. Cause of reaction is T cell–mediated sensitization to additives of latex.<br>Reaction is not life-threatening and is far more common than a type I reaction.<br>Slow onset; occurs 18–24 h after exposure. Resolves within 3–4 days after exposure. More severe reactions may occur with subsequent exposures. | Pruritus, erythema, swelling, crusty thickened skin, blisters, other skin lesions | Referral for diagnosis (patch tests) and treatment<br>Thorough washing and drying of hands<br>Use of water- or silicone-based moisturizing creams, lotions, or topical barrier agents<br>Avoidance of oil- or petroleum-based products unless they are latex compatible<br>Avoidance of identified causative agent, because continued exposure to latex products in presence of breaks in skin may contribute to latex protein sensitization |
| Latex allergy | Type I IgE-mediated immediate hypersensitivity to plant proteins in natural rubber latex. In sensitized people, antilatex IgE antibody stimulates mast cell proliferation and basophil histamine release. Exposure can be through contact with the skin, mucous membranes, or internal tissues, or through inhalation of traces of powder from latex gloves.<br>Severe reactions usually occur shortly after parenteral or mucous membrane exposure. People with any type I reaction to latex are at high risk for anaphylaxis. Local swelling, redness, edema, itching, and systemic reactions, including anaphylaxis, occur within minutes after exposure. | Rhinitis, flushing, conjunctivitis, urticaria, laryngeal edema, bronchospasm, asthma, severe vasodilation angioedema, anaphylaxis, cardiovascular collapse, death | Immediate treatment of reaction with epinephrine, fluids, vasopressors, and corticosteroids, and airway and ventilator support, with close monitoring for recurrence for next 12–14 h<br>Prompt referral for diagnostic evaluation<br>Treatment and diagnostic evaluation in latex-free environment<br>Assessment of all patients for symptoms of latex allergy<br>Teaching of patients and family members about the disorder and about the importance of preventing future reactions by avoiding latex (eg, wearing medical alert bracelet, carrying EpiPen) |

contact dermatitis, including vesicular skin lesions, papules, pruritus, edema, erythema, and crusting and thickening of the skin. These symptoms usually appear on the back of the hands. This reaction is thought to be caused by chemicals that are used in the manufacturing of latex products. It is the most common allergic reaction to latex. Although not usually life-threatening, delayed hypersensitivity reactions often require major changes in the patient's home and work environment to avoid further exposure. People who are sensitized to latex are at increased risk for development of type I allergic reactions (Bernstein, 2006).

Immediate hypersensitivity, a type I allergic reaction, is mediated by the IgE mast cell system. Symptoms can include rhinitis, conjunctivitis, asthma, and anaphylaxis. The term *latex allergy* is usually used to describe the type I reaction. Clinical manifestations have a rapid onset and can include urticaria, wheezing, dyspnea, laryngeal edema, bronchospasm, tachycardia, angioedema, hypotension, and cardiac arrest.

Localized itching, erythema, or local urticaria within minutes after exposure to latex is often the initial symptom. Symptoms of subsequent reactions can include generalized urticaria, angioedema, rhinitis, conjunctivitis, asthma, and anaphylactic shock minutes after dermal or mucosal exposure to latex. An increasing number of people who are allergic to latex experience severe reactions characterized by generalized urticaria, bronchospasm, and hypotension.

## Assessment and Diagnostic Findings

The diagnosis of latex allergy is based on the history and diagnostic test results (Rolland & O'Hehir, 2008). Sensitization is detected by skin testing, RAST, ELISA or level of Hevea latex-specific IgE antibody in the serum. Testing for the chemicals found in the rubber production that makes latex is performed using the patch test. Skin patch testing is the preferred method for patients with contact allergies. The TRUE test and other skin tests should be performed only by clinicians who have expertise in their administration

and interpretation and who have the necessary equipment available to treat local or systemic allergic reactions to the reagent. Nasal challenge and dipstick tests may be useful in the future as screening tests for latex allergy.

## Medical Management

The best treatment available for latex allergy is the avoidance of latex-based products, but this is often difficult because of their widespread use. Patients who have experienced an anaphylactic reaction to latex should be instructed to wear medical identification. Antihistamines and an emergency kit containing epinephrine should be provided to these patients, along with instructions about emergency management of latex allergy symptoms. Patients should be counseled to notify all health care workers as well as local paramedic and ambulance companies about their allergy. Warning labels can be attached to car windows to alert police and paramedics about the driver's or passenger's latex allergy in case of a motor vehicle crash. People with latex allergy should be provided with a list of alternative products and referred to local support groups; they are also urged to carry their own supply of nonlatex gloves.

People with type I latex sensitivity may be unable to continue to work if a latex-free work environment is not possible. This may occur with surgeons, dentists, operating room personnel, or intensive care nurses. Occupational implications for employees with type IV latex sensitivity are usually easier to manage by changing to nonlatex gloves and avoiding direct contact with latex-based medical equipment. Although latex-specific immunotherapy has been attempted, this method of treatment remains experimental.

## Nursing Management

The nurse can assume a pivotal role in the management of latex allergies in both patients and staff. All patients should be asked about latex allergy, although special attention should be given to those at particularly high risk (eg, patients with spina bifida, patients who have undergone multiple surgical procedures). Every time an invasive procedure must be performed, the nurse should consider the possibility of latex allergies. Nurses working in operating rooms, intensive care units, short procedure units, and emergency departments need to pay particular attention to latex allergy. See Chapter 18 for a latex allergy screening form.

Although the type I reaction is the most significant of the reactions to latex, care must be taken in the presence of irritant contact dermatitis and delayed hypersensitivity reaction to avoid further exposure of the person to latex. Patients with latex allergy are advised to notify their health care providers and to wear a medical information bracelet. Patients must become knowledgeable about what products contain latex and what products are safe, nonlatex alternatives. They must also become knowledgeable about signs and symptoms of latex allergy and emergency treatment and self-injection of epinephrine in case of allergic reaction.

Nurses can be instrumental in establishing and participating in multidisciplinary committees to address latex allergy and to promote a latex-free environment. Latex allergy protocols and education of staff about latex allergy and precautions are important strategies to reduce this growing problem and to ensure assessment and prompt treatment of affected people.

## CRITICAL THINKING EXERCISES

**1** A 23-year-old college student has developed symptoms of severe seafood allergy. She is to receive instructions about self-administration of epinephrine if she experiences anaphylaxis. Develop a teaching plan for her and identify outcomes to measure the effectiveness of your teaching. Given her allergy to seafood, what other teaching or counseling is needed?

EBP **2** A 35-year-old woman has developed symptoms of asthma thought to be an allergic response to the two dogs and two cats her new roommate has brought with her into the apartment. Develop an evidence-based plan for strategies to reduce or eliminate the patient's allergen exposure. Describe the strength of the evidence and criteria used to assess its strength. What instructional strategies and outcome measures will you use to educate her about avoidance strategies and to assess the effectiveness of their use?

**3** An 18-year-old man is scheduled for removal of his wisdom teeth in the dentist's office. He reports that he has severe seasonal and bee sting allergies. He also experienced an episode of hives and itching during a dental procedure in the past. He reports that he has had to use emergency epinephrine on several occasions in the past because of severe allergic reactions caused by bee stings. What precautions are needed preprocedure, during the procedure, and postprocedure for this patient to prevent the potential occurrence of a severe allergic reaction? What interventions and nursing management would be indicated if he developed a severe allergic reaction?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Academy of Allergy, Asthma and Immunology, www.aaaai.org
American College of Allergy, Asthma and Immunology, www.acaai.org
Asthma and Allergy Foundation of America, www.aafa.org
Centers for Disease Control and Prevention, www.cdc.gov
Food Allergy and Anaphylaxis Network, www.foodallergy.org
National Institute of Allergy and Infectious Disease, www3.niaid.nih.gov



chapter 54

# Assessment and Management of Patients With Rheumatic Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Explain the pathophysiology of rheumatic diseases.
2. Describe the assessment and diagnostic findings seen in patients with a suspected diagnosis of rheumatic disease or disorder.
3. Discuss appropriate nursing interventions based on nursing diagnoses and collaborative problems that commonly occur with rheumatic disorders.
4. Describe the systemic effects of a connective tissue disease.
5. Devise a teaching plan for the patient with newly diagnosed rheumatic disease.
6. Identify modifications in interventions to accommodate changes in patients' functional ability that may occur with disease progression.

## GLOSSARY

**ankylosis:** fixation or immobility of a joint
**arthritis:** inflammation of a joint
**arthroplasty:** replacement of a joint
**osteoarthritis:** degenerative joint disease
**osteophyte:** a bony outgrowth or protuberance; bone spur
**pannus:** proliferation of newly formed synovial tissue infiltrated with inflammatory cells
**rheumatic diseases:** numerous disorders affecting skeletal muscles, bones, cartilage, ligaments, tendons, and joints
**rheumatoid arthritis:** autoimmune disease of unknown origin
**subchondral bone:** bony plate that supports the articular cartilage
**tophi:** accumulation of crystalline deposits in articular surfaces, bones, soft tissue, and cartilage

Rheumatic diseases include common disorders such as osteoarthritis (OA) and less common conditions such as systemic lupus erythematosus (SLE) and scleroderma. These conditions can be life-threatening, or they can be minor illnesses. The problems caused by the rheumatic diseases include not only the obvious limitations in mobility and activities of daily living but also the more subtle systemic effects that can lead to organ failure and death or result in problems such as pain, fatigue, altered self-image, and sleep disturbances. The rheumatic disease may be the patient's primary health problem or a secondary diagnosis. An understanding of rheumatic diseases and their effects on a patient's function and well-being is essential to developing an appropriate plan of nursing care.

## Rheumatic Diseases

Commonly called **arthritis** (inflammation of a joint) and thought of as one condition, the **rheumatic diseases** are more than 100 different types of disorders that primarily affect skeletal muscles, bones, cartilage, ligaments, tendons, and joints in males and females of all ages (Porth & Matfin, 2009). Some disorders are more likely to occur at a particular time of life or to affect one gender more than the other. The onset of these conditions may be acute or insidious, with a course possibly marked by periods of remission (a period when disease symptoms are reduced or absent) and exacerbation (a period when symptoms occur or increase). Treatment can be simple, aimed at localized relief, or it can be complex, directed toward relief of systemic effects. Permanent changes and disability may result from these disorders.

Nurses need to understand the classification of rheumatic diseases. One basic system is to classify disease as either monoarticular (affecting a single joint) or polyarticular (affecting multiple joints), and then to further classify it as either inflammatory or noninflammatory. Conditions that may secondarily affect the musculoskeletal structure are also included, illustrating the diversity of the rheumatic diseases.

### Pathophysiology

The joint is the area most commonly affected in rheumatic diseases. Despite the diversity of rheumatic diseases, from localized involvement of one joint to systemic, multisystem disorders, they all involve some degree of inflammation and degeneration, which may occur simultaneously. Inflammation is manifested in the joints as synovitis. In inflammatory rheumatic diseases, the primary process is inflammation caused by the immune response. Degeneration occurs as a secondary process, resulting from the effect of **pannus** (proliferation of newly formed synovial tissue infiltrated with inflammatory cells). Conversely, in degenerative rheumatic diseases, inflammation occurs as a secondary process. This synovitis is usually milder, is more likely to be seen in advanced disease, and represents a reactive process.

#### Inflammation

Inflammation is a series of related steps. In response to the triggering event, (eg, trauma, increased stress), the antigen stimulus activates monocytes and T lymphocytes (also called T cells). Next, the immunoglobulin antibodies form immune complexes with antigens. Phagocytosis of the immune complexes is initiated, generating an inflammatory reaction (joint effusion, pain, and edema) (Fig. 54-1). During the next step, the immune response deviates from normal. Phagocytosis produces chemicals such as leukotrienes and prostaglandins. Leukotrienes contribute to the inflam-

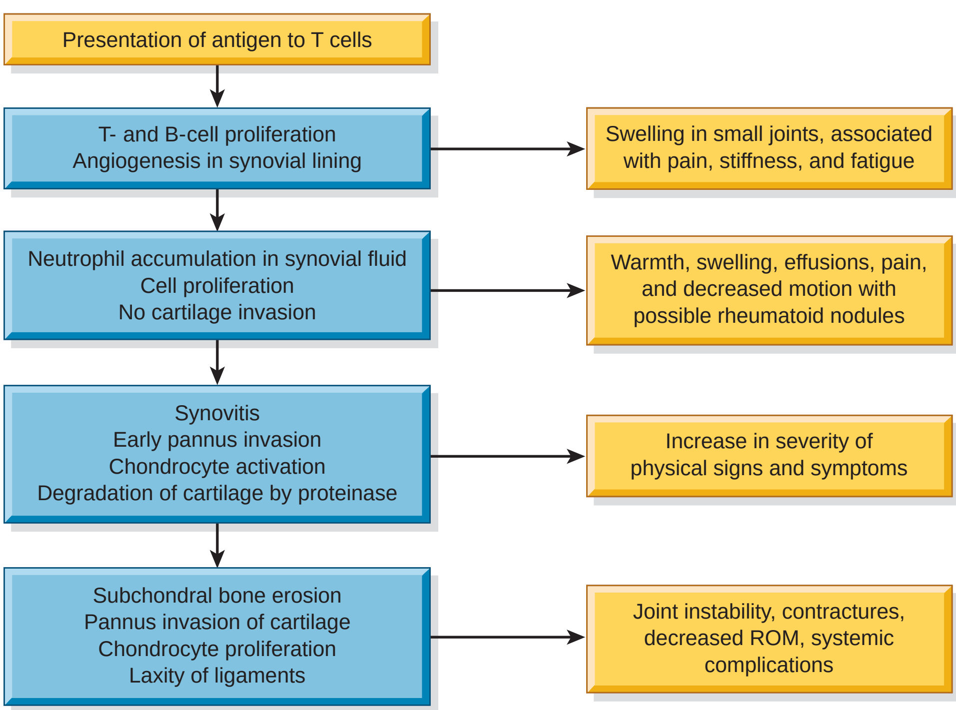



**Figure 54-1** Pathophysiology and associated physical signs of rheumatoid arthritis. ROM, range of motion.

matory process by attracting other white blood cells to the area. Prostaglandins act as modifiers to inflammation. In some cases, they increase inflammation; in other cases, they decrease it. Leukotrienes and prostaglandins produce enzymes such as collagenase that break down collagen, a vital part of a normal joint. The release of these enzymes in the joint causes edema, proliferation of synovial membrane and pannus formation, destruction of cartilage, and erosion of bone.

The immunologic inflammatory process begins when antigens are presented to T lymphocytes, leading to a proliferation of T and B cells. B cells are a source of antibody-forming cells, or plasma cells. In response to specific antigens, plasma cells produce and release antibodies. Antibodies combine with corresponding antigens to form pairs, or immune complexes. The immune complexes build up and are deposited in synovial tissue or other organs in the body, triggering the inflammatory reaction that can ultimately damage the involved tissue.

The systemic nature of the rheumatic diseases is reflected in the resultant widespread inflammatory process. Although focused in the joints, inflammation also involves other areas. The blood vessels (vasculitis and arteritis), lungs, heart, and kidneys may also be affected by the inflammation. In the joints, this inflammatory response is manifested as pannus extending throughout the joint space and, if persistent, eroding the articular cartilage, causing secondary degenerative changes to the joint.

### Degeneration

Although the cause of degeneration of the articular cartilage is poorly understood, the process is known to be metabolically active and therefore is more accurately called "degradation." One theory of degradation is that genetic or hormonal influences, mechanical factors, and prior joint damage cause cartilage failure. Degradation of cartilage ensues, and increased mechanical stress on bone ends causes stiffening of bone tissue. Another theory is that bone stiffening occurs and results in increased mechanical stress on cartilage, which in turn initiates the processes of degradation. (See Chapter 66 for more information on the structure and function of the articular system.)

## Clinical Manifestations

The most common symptom in the rheumatic diseases that causes a person to seek medical attention is pain. Other common symptoms include joint swelling, limited movement, stiffness, weakness, and fatigue.

## Assessment and Diagnostic Findings

Assessment begins with a general health history, which includes the onset of symptoms and how they evolved, family history, past health history, and any other contributing factors. Because many of the rheumatic diseases are chronic conditions, the health history should also include information about the patient's perception of the problem, previous treatments and their effectiveness, the patient's support systems, and the patient's current knowledge base and the source of that information. A complete health history is followed by a complete physical assessment (see Chapter 5).

Assessment for rheumatic diseases combines the physical examination with a functional assessment. Inspection of the patient's general appearance occurs during initial contact. Gait, posture, and general musculoskeletal size and structure are observed. Gross deformities and abnormalities in movement are noted. The symmetry, size, and contour of other connective tissues, such as the skin and adipose tissue, are also noted and recorded. Chart 54-1 outlines the important areas for consideration during the physical assessment. The functional assessment is a combination of history (what the patient reports that he or she can and cannot do) and examination (observation of activities: the patient demonstrates what he or she can and cannot do, such as dressing and getting in and out of a chair). Observation also includes the adaptations and adjustments the patient may have made (sometimes without awareness); for example, with shoulder or elbow involvement, the person may bend over to reach a fork, rather than raising the fork to the mouth.

The history and physical assessment data are supplemented by supportive or confirming diagnostic test findings. In some instances, tests are used to monitor the course of the disease. For example, the erythrocyte sedimentation rate (ESR) reflects inflammatory activity and, indirectly, the progression or remission of disease.

### Laboratory Studies

Some of the most common laboratory studies are listed with their corresponding normal ranges and primary indications in Table 54-1. Many of the tests require special laboratory techniques and may not be performed in every health care facility. The primary health care provider determines which tests are necessary based on symptoms, stage of disease, cost, and likely benefit.

### Other Diagnostic Studies

Imaging studies commonly used for patients with rheumatic diseases include x-ray studies, computed tomography (CT) scans and magnetic resonance imaging (MRI) scans, and arthrography. See Chapter 66 for further information about these and other diagnostic studies.

## Gerontologic Considerations

Although people of all ages, from infancy through childhood, adolescence, and adulthood, may be affected, rheumatic disease is commonly thought of by the patient, family, and society as a whole as an inevitable consequence of aging. Many older people expect and accept the immobility and self-care problems related to the rheumatic diseases and do not seek help, thinking that nothing can be done. Careful diagnosis and appropriate treatment can improve the quality of life for older people (Schmajuk, Schneeweiss, Katz, et al., 2007).

In elderly patients, other medical conditions may take precedence over the rheumatic disease, which commonly becomes a secondary diagnosis and concern. Identifying the effects of the rheumatic disease on the patient's lifestyle, independence, and other chronic or acute conditions is important.

The frequency, pattern of onset, clinical features, severity, and effects on function of the rheumatic disease in

## CHART 54-1 Assessing for Rheumatic Disorders

In addition to the head-to-toe assessment or systems review, the following are important areas of consideration to be noted when performing the complete physical assessment of a patient with a known or suspected rheumatic disorder.

| Manifestation | Significance |
|---|---|
| Skin (inquire and inspect) | |
| Rash, lesions | Associated with lupus erythematosus (LE), vasculitis, adverse effect of medication |
| Increased bruising | Associated with several rheumatic diseases and adverse effect of medication |
| Erythema | Sign of inflammation |
| Thinning | Adverse effect of medication |
| Warmth | Sign of inflammation |
| Photosensitivity | Associated with systemic lupus erythematosus (SLE), dermatomyositis, adverse effect of medication |
| Hair (inquire and inspect) | |
| Alopecia or thinning | Associated with rheumatic diseases or adverse effect of medication |
| Eye (inquire and inspect) | |
| Dryness, grittiness | Associated with Sjögren's syndrome (commonly occurring with rheumatoid arthritis [RA] and LE) |
| Decreased acuity or blindness | Associated with temporal arteritis, medication complications |
| Cataracts | Adverse effect of medication |
| Decreased peripheral vision | Adverse effect of medication |
| Conjunctivitis, uveitis | Associated with ankylosing spondylitis and Reiter's syndrome |
| Ear (inquire) | |
| Tinnitus | Adverse effect of medication |
| Decreased acuity | Adverse effect of medication |
| Mouth (inquire and inspect) | |
| Buccal, sublingual lesions | Associated with vasculitis, dermatomyositis, adverse effect of medication |
| Altered sense of taste | Adverse effect of medication |
| Dryness | Associated with Sjögren's syndrome |
| Dysphagia | Associated with myositis |
| Difficulty chewing | Associated with decreased range of motion of jaw |
| Chest (inspect and inquire) | |
| Pleuritic pain | Associated with RA and SLE |
| Decreased chest expansion | Associated with ankylosing spondylitis |
| Activity intolerance (dyspnea) | Associated with pulmonary hypertension in scleroderma |
| Cardiovascular system (inquire, inspect, palpate) | |
| Blanching of fingers on exposure to cold | Associated with Raynaud's phenomenon |
| Peripheral pulses | Deficit may indicate vascular involvement or edema associated with medication effect or rheumatic diseases, especially SLE or scleroderma |
| Abdomen (inquire and palpate) | |
| Altered bowel habits | Associated with scleroderma, spondylosis, ulcerative colitis, decreased physical mobility, medication effect |
| Nausea, vomiting, bloating, and pain | Adverse effect of medication |
| Weight change (measure) | Associated with RA (decreased), adverse effect of medication (increased or decreased) |
| Genitalia (inquire and inspect) | |
| Dryness, itching | Associated with Sjögren's syndrome |
| Abnormal menses | Adverse effect of medication |
| Altered sexual performance | Fear of pain (or of pain caused by partner) and limitation of motion may affect sexual mobility. |
| Hygiene | Poor hygiene may be related to limitations in activities of daily living. |
| Urethritis, dysuria | Associated with ankylosing spondylitis and Reiter's syndrome |
| Lesions | Associated with vasculitis |

**CHART 54-1** *Assessing for Rheumatic Disorders* (Continued)

| Manifestation | Significance |
|---|---|
| Neurologic (inquire and inspect) | |
| Paresthesias of extremities; abnormal reflex pattern | Nerve compressions associated with carpal tunnel syndrome, spinal stenosis, etc. |
| Headaches | Associated with temporal arteritis, adverse effect of medication |
| Musculoskeletal (inspect and palpate) | |
| Joint redness, warmth, swelling, tenderness, deformity—location of first joint involved, pattern of progression, symmetry, acute versus chronic nature | Signs of inflammation |
| Joint range of motion | Decreased range of motion may indicate severity or progression of disease. |
| Surrounding tissue findings | |
| Muscle atrophy, subcutaneous nodules, popliteal cyst | Extra-articular manifestations |
| Muscle strength (grip) | Muscle strength decreases with increased disease activity. |

elderly patients may be different in very old patients. One disease, OA, is the leading cause of disability and pain in the elderly (Porth & Matfin, 2009). OA may account for more total disability among elderly patients than many diseases (eg, stroke or cancer).

In some instances, the age of the patient and coexisting health problems make diagnosis difficult. A missed diagnosis is not unusual, because it is assumed that older people with joint problems have OA. In addition, it may be difficult to differentiate problems associated with aging from those caused by a rheumatic disease. For example, rheumatoid arthritis (RA), an autoimmune disorder that begins in the later years, has been shown to differ prognostically and therapeutically from RA that begins in childhood or early adulthood. In the older patient with early RA, the onset is more likely to be abrupt, but the clinical course does not appear to differ from that of RA with an insidious onset.

For the elderly person who has had a diffuse connective tissue disease, the risk of osteoporosis is increased. Pain, loss of mobility, diminished self-image, and increasing morbidity can result from progressive osteoporosis. Therefore, diagnosis and treatment of osteoporosis should not be overlooked in this population. Pharmacologic therapy including analgesic agents, exercise, postural assistance, modification of activities of daily living, and psychological support can be useful.

Other conditions (eg, soft tissue problems such as bursitis) usually are not problematic by themselves. However, when combined with other health problems and the normal physiologic processes of aging, these conditions may significantly affect the patient's quality of life. In fact, the effects of most forms of rheumatic disease may lead to considerable changes in the patient's lifestyle, possibly threatening his or her independence. Decreased vision and altered balance, often present in elderly people, may be problematic if rheumatic disease in the lower extremities affects locomotion. Also, the combination of decreased hearing and visual acuity, memory loss, and depression contributes to failure to follow the treatment regimen in elderly patients. Special techniques for promoting patient safety, self-management, and strategies such as memory aids for medications may be necessary.

Partly because of the more frequent contact of older adults with health care providers for a variety of health issues, overtreatment or inappropriate treatment is possible. Complaints of pain may be met with a prescription for an opioid analgesic agent rather than instructions for rest, use of an assistive device, and local comfort measures such as heat or cold. Acetaminophen may be appropriate and worth trying before other medications that pose a greater chance of side effects. Intra-articular corticosteroid injections, with their usually rapid relief of symptoms, may be requested by the patient who is unaware of the consequences of too-frequent use of this treatment. In addition, exercise programs may not be instituted or may be ineffective because the patient expects results to occur quickly or fails to appreciate the effectiveness of a program of exercise.

Pharmacologic treatment of rheumatic disease in older patients is more difficult than it is in younger patients. If therapeutic medications have an effect on the senses (hearing, cognition), this effect is intensified in the elderly. The cumulative effect of these medications is accentuated because of the physiologic changes of aging. For example, decreased renal function in the elderly alters the metabolism of certain medications, such as nonsteroidal anti-inflammatory drugs (NSAIDs). Older adults are more prone to side effects associated with the use of multiple-drug therapy for various disorders (Miller, 2009).

Elderly patients with rheumatic disease may unnecessarily accept or endure pain, loss of ambulation, and difficulty with activities of daily living. The need to view oneself as capable of managing life independently despite increasing age may take considerable energy. The body image and self-esteem of the elderly person with rheumatic disease, combined with underlying depression, may interfere with the use of assistive devices such as canes. Use of adaptive equipment such as long-handled reachers or tongs may be viewed as evidence of aging rather than as a means of increasing independence.

The elderly person usually has a lifelong pattern of dealing with the stresses of daily life. Depending on the success of that pattern, the elderly person can often maintain a

**Table 54-1 COMMON BLOOD STUDIES FOR RHEUMATIC DISEASES**

| Test | Normal Value | Significance |
|---|---|---|
| **Serum** | | |
| *Creatinine* | | |
| Metabolic waste excreted through the kidneys | 0.6–1.2 mg/dL (50–110 μmol/L) | Increase may indicate renal damage in SLE, scleroderma, and polyarteritis. |
| *Erythrocyte Sedimentation Rate (ESR)* | | |
| Measures the rate at which red blood cells settle out of unclotted blood in 1 h | Westergren = *Men,* 0–15 mm/h, *Women,* 0–25 mm/h<br>Wintrobe = *Men,* 0–9 mm/h, *Women* 0–15 mm/h | Increase is usually seen in inflammatory connective tissue diseases.<br>An increase indicates rising inflammation, resulting in clustering of RBCs, which makes them heavier than normal. The higher the ESR, the greater the inflammatory activity. |
| *Hematocrit* | | |
| Measures the size, capacity, and number of cells present in blood | *Men:* 42–52%<br>*Women:* 35–47% | Decrease can be seen in chronic inflammation (anemia of chronic disease); also, blood loss through bowel due to medication. |
| *Red Blood Cell Count* | | |
| Measures circulating erythrocytes | *Men:* Average 4.8 million/μL<br>*Women:* Average 4.3 million/μL | Decrease can be seen in RA, SLE. |
| *White Blood Cell Count* | | |
| Measures circulating leukocytes | 5000–10,000 cells/$mm^3$ | Decrease may be seen in SLE. |
| *VDRL (Venereal Disease Research Laboratory)* | | |
| Measures antibody to syphilis | Nonreactive | False-positive results are sometimes found with SLE. |
| *Uric Acid* | | |
| Measures level of uric acid in serum | 2.5–8 mg/dL (0.15–0.5 mmol/L) | Increase is seen with gout. |
| **Serum Immunology** | | |
| *Antinuclear Antibody (ANA)* | | |
| Measures antibodies that react with a variety of nuclear antigens<br>If antibodies are present, further testing determines the type of ANA circulating in the blood (anti-DNA, anti-RNP). | Negative<br>A few healthy adults have a positive ANA. | Positive test is associated with SLE, RA, scleroderma, Raynaud's disease, Sjögren's syndrome, necrotizing arteritis.<br>The higher the titer, the greater the inflammation.<br>The pattern of immunofluorescence (speckled, homogeneous, or nucleolar) helps determine the diagnosis. |
| *Anti-DNA, DNA Binding* | | |
| Titer measurement of antibody to double-stranded DNA | Negative | High titer is seen in SLE; increases in titer may indicate increase in disease activity. |
| *Complement Levels—C3, C4* | | |
| Complement is a protein substance that binds with antigen–antibody complexes for the purpose of lysis. When the number of complexes increases markedly, complement is used for lysis, thus depleting the amount available in the blood. | C3: 55–120 mg/dL (550–1200 mg/L)<br>C4: 11–40 mg/dL (110–400 mg/L) | Decrease may be seen in RA and SLE.<br>Decrease indicates autoimmune and inflammatory activity. |
| *C-Reactive Protein Test (CRP)* | | |
| Shows presence of abnormal glycoprotein due to inflammatory process | <1 mg/dL (<10 mg/L) | A positive reading indicates active inflammation.<br>Often is positive for RA and SLE |
| *Immunoglobulin Electrophoresis* | | |
| Measures the values of immunoglobulins | IgA 80–400 mg/dL (0.8–4.0 g/L)<br>IgG 600–1800 mg/dL (6.0–18.0 g/L)<br>IgM 55–250 mg/dL (0.55–2.5 g/L) | Increased levels are found in people who have autoimmune disorders. |
| *Rheumatoid Factor (RF)* | | |
| Determines the presence of abnormal antibodies seen in connective tissue disease | Negative | Positive titer >1:80<br>Present in 80% of those with RA<br>Positive RF may also suggest SLE, Sjögren's syndrome, or mixed connective tissue disease. The higher the titer (number at right of colon), the greater the inflammation. |
| **Tissue Typing** | | |
| *HLA-B27 Antigen* | | |
| Measures presence of HLA antigens, which are used for tissue recognition | Negative | Found in 80–90% of those with ankylosing spondylitis and Reiter's syndrome. |

DNA, deoxyribonucleic acid; HLA, human leukocyte antigen; RA, rheumatoid arthritis; RBCs, red blood cells; RNP, ribonucleoprotein; SLE, system lupus erythematosus.

positive attitude and self-esteem when faced with a rheumatic disease, especially if support is available. Previous stress management strategies are assessed. If these strategies have been effective, the patient is encouraged and supported in their use. If they were ineffective, the nurse assists the patient in identifying alternative strategies, encourages use of new strategies, and assesses their effectiveness.

## Medical Management

A treatment program involving an interdisciplinary team, including the patient, is the basis for managing the rheumatic diseases. The chronic nature of most of these diseases mandates that the patient understand the disease, have the information necessary to make good self-management decisions, and be presented with a therapeutic program that is compatible with his or her lifestyle. Table 54-2 outlines goals and strategies for care of the patient with rheumatic diseases.

### Pharmacologic Therapy

Medications are used with the rheumatic diseases to manage symptoms, to control inflammation, and, in some instances, to modify the disease. Useful medications include the salicylates, NSAIDs, and disease-modifying antirheumatic drugs (DMARDs). Table 54-3 reviews the medications commonly used.

Controlling the inflammation related to the disease process helps manage pain, but this is often a delayed response. Nonopioid medications are often used for pain management, especially early in the treatment program, until other measures can be instituted. Short-term use of low-dose antidepressant medications, such as amitriptyline (Elavil), may be prescribed to reestablish adequate sleep patterns and improve pain management (Karch, 2008).

### Nonpharmacologic Pain Management

Nonpharmacologic methods of pain management are important. Heat applications are also helpful in relieving pain, stiffness, and muscle spasm (Robinson, Brosseau, Casimiro, et al., 2006). Superficial heat may be applied in the form of warm tub baths or showers and warm moist compresses. Paraffin baths (dips), which offer concentrated heat, are helpful to patients with wrist and small-joint involvement. Maximum benefit is achieved within 20 minutes after application. More frequent use for shorter lengths of time is most beneficial. Therapeutic exercises can be carried out more comfortably and effectively after heat has been applied.

Devices such as braces, splints, and assistive devices for ambulation (eg, canes, crutches, walkers) ease pain by limiting movement or stress from putting weight on painful joints. Acutely inflamed joints can be rested by applying splints to limit motion. Splints also support the joint to relieve spasm. Canes and crutches can relieve stress from inflamed and painful weight-bearing joints while promoting safe ambulation. Cervical collars may be used to support the weight of the head and limit cervical motion. A metatarsal bar or special pads may be put into the patient's shoes if foot pain or deformity is present (Egan, Brosseau, Farmer, et al., 2006). A combination of methods may be required, because different methods often work better at different times.

**Table 54-2 MANAGEMENT GOALS AND STRATEGIES FOR RHEUMATIC DISEASES**

| Goals | Management Strategies |
|---|---|
| Suppress inflammation and the autoimmune response | Optimize pharmacologic therapy (anti-inflammatory and disease-modifying agents) |
| Control pain | Protect joints; ease pain with splints, thermal modalities, relaxation techniques |
| Maintain or improve joint mobility | Implement exercise programs for joint motion and muscle strengthening and overall health |
| Maintain or improve functional status | Make use of adaptive devices and techniques |
| Increase patient's knowledge of disease process | Provide and reinforce patient teaching |
| Promote self-management by patient compliance with the therapeutic regimen | Emphasize compatibility of therapeutic regimen and lifestyle |

### Exercise and Activity

The ongoing nature of most rheumatic diseases makes it important to maintain and, when possible, improve joint mobility and overall functional status. An individualized exercise program is crucial to movement. Table 54-4 summarizes the exercises appropriate for patients with rheumatic diseases. Appropriate programs of exercise have been shown to decrease pain and improve function (Miller, 2009). A mild analgesic agent may be suggested before exercise for a patient starting a program of exercise. Other strategies for decreasing pain include muscle relaxation techniques, imagery, self-hypnosis, and distraction, but acute or prolonged pain associated with exercise should be reported to a health care provider for evaluation. A weight reduction program may be recommended to relieve stress on painful joints.

The major challenge for the patient and the health care provider is the need to adjust all aspects of treatment according to the activity of the disease. Especially for the patient with an active diffuse connective tissue disease, such as RA or SLE, activity levels may vary from day to day and even within a single day.

### Sleep

It is important to help the patient obtain restful sleep so he or she can cope with pain, minimize physical fatigue, and deal with the changes related to having a chronic disease. In patients with acute disease, sleep time is frequently reduced and fragmented by prolonged awakenings. Stiffness, depression, and medications may also compromise the quality of sleep and increase daytime fatigue. A sleep-inducing routine, medication, and comfort measures may help improve the quality of sleep.

Teaching sleep hygiene strategies may be helpful in promoting restorative sleep. These strategies include establishing a set time to sleep and a regular wake-up time, creating a quiet sleep environment with a comfortable room temperature,

**Table 54-3 MEDICATIONS USED IN RHEUMATIC DISEASES**

| Medication | Action, Use, and Indication | Nursing Considerations |
|---|---|---|
| **Salicylates** | | |
| *Acetylated:* aspirin<br>*Nonacetylated:* choline salicylate (Arthropan, Trilisate), salsalate (Disalcid), sodium salicylate | *Action:* anti-inflammatory, analgesic, antipyretic<br>Acetylated salicylates are platelet aggregation inhibitors.<br>Anti-inflammatory doses will produce blood salicylate levels of 20–30 mg/dL. | Administer with meals to prevent gastric irritation.<br>Assess for tinnitus, gastric intolerance, GI bleeding, and purpura.<br>Monitor for possible confusion in the elderly. |
| **Nonsteroidal Anti-inflammatory Drugs (NSAIDs)** | | |
| diclofenac (Voltaren), diflunisal (Dolobid), etodolac (Lodine), flurbiprofen (Ansaid), ibuprofen (Motrin), indomethacin (Indocin), ketoprofen (Orudis, Oruvail), meclofenamate (Meclomen), meloxicam (Mobic), nabumetone (Relafen), naproxen (Naprosyn), oxaprozin (Daypro), piroxicam (Feldene), sulindac (Clinoril), tolmetin sodium (Tolectin) | *Action:* anti-inflammatory, analgesic, antipyretic, platelet aggregation inhibitor<br>Anti-inflammatory effect occurs 2–4 weeks after initiation.<br>All NSAIDs are useful for short-term treatment of acute gout attack.<br>NSAIDs are alternative to salicylates for first-line therapy in several rheumatic diseases. | Administer NSAIDs with food.<br>Monitor for GI, CNS, cardiovascular, renal, hematologic, and dermatologic adverse effects.<br>Avoid salicylates; use acetaminophen for additional analgesia.<br>Watch for possible confusion in older adults. |
| COX-2 enzyme blockers: celecoxib (Celebrex) | *Action:* Inhibit only cyclo-oxygenase-2 (COX-2) enzymes, which are produced during inflammation, and spare COX-1 enzymes, which can be protective to the stomach | Monitoring the same as for other NSAIDs<br>Increased risk of cardiovascular events, including myocardial infarction and stroke<br>Appropriate for the elderly and patients who are at high risk for gastric ulcers |
| **Disease-Modifying Antirheumatic Drugs (DMARDs)** | | |
| Antimalarials: hydroxychloroquine (Plaquenil), chloroquine (Aralen) | *Action:* Anti-inflammatory, inhibits lysosomal enzymes<br>Slow-acting, onset may take 2–4 mo<br>Useful in RA and SLE | Administer concurrently with NSAIDs.<br>Assess for visual changes, GI upset, skin rash, headaches, photosensitivity, bleaching of hair.<br>Emphasize need for ophthalmologic examinations (every 6–12 mo). |
| Gold-containing compounds: aurothioglucose (Solganal), gold sodium thiomalate (Myochrysine), auranofin (Ridaura) | *Action:* Inhibits T- and B-cell activity, suppresses synovitis during active stage of rheumatoid disease<br>Slow-acting, onset may take 3–6 mo<br>IM preparations are given weekly for about 6 mo, then every 2–4 weeks | Administer concurrently with NSAIDs.<br>Assess for stomatitis, diarrhea, dermatitis, proteinuria, hematuria, bone marrow suppression (decreased WBCs and/or platelets), CBC, and urinalysis with every other injection. |
| sulfasalazine (Azulfidine) | *Action:* Anti-inflammatory, reduces lymphocyte response, inhibits angiogenesis<br>Useful in RA, seronegative spondyloarthropathies | Administer concurrently with NSAIDs.<br>Do not use in patients with allergy to sulfa medications or salicylates.<br>Emphasize adequate fluid intake.<br>Assess for GI upset, skin rash, headache, liver abnormalities, anemia. |
| penicillamine (Cuprimine, Depen) | *Action:* Anti-inflammatory, inhibits T-cell function, impairs antigen presentation<br>Slow-acting, onset may take 2–3 mo<br>Useful in RA and systemic sclerosis | Administer concurrently with NSAIDs.<br>Assess for GI irritation, decreased taste, skin rash or itching, bone marrow suppression, proteinuria with CBC, and urinalysis every 2–4 weeks. |
| Immunosuppressives: methotrexate (Rheumatrex), azathioprine (Imuran), cyclophosphamide (Cytoxan) | *Action:* Immune suppression, affect DNA synthesis and other cellular effects<br>Have teratogenic potential; azathioprine and cyclophosphamide reserved for more aggressive or unresponsive disease<br>Methotrexate is “gold standard” for RA treatment; also useful in SLE. | Assess for bone marrow suppression, GI ulcerations, skin rashes, alopecia, bladder toxicity, increased infections.<br>Monitor CBC, liver enzymes, creatinine every 2–4 weeks.<br>Advise patient of contraceptive measures because of teratogenicity. |
| Cyclosporine (Neoral) | *Action:* Immune suppression by inhibiting T lymphocytes<br>Used for severe, progressive RA, unresponsive to other DMARDs<br>Used in combination with methotrexate | Assess slow dose titration upward until response noted or toxicity occurs.<br>Assess for toxic effects: bleeding gums, fluid retention, hair growth, tremors.<br>Monitor blood pressure and creatinine every 2 weeks until stable. |
| **Immunomodulators** | | |
| Pyrimidine synthesis inhibitor: leflunomide (Arava) | *Action:* Has antiproliferative and anti-inflammatory effects. Used in moderate to severe RA<br>May be used alone or in combination with other DMARDs (except methotrexate) | Long half-life; requires loading dose followed by daily administration. Assess for diarrhea, hair loss, skin rash, mouth sores. Monitor liver function tests. Contraindicated in pregnancy and breastfeeding Administered orally |

*Continued*

**Table 54-3 MEDICATIONS USED IN RHEUMATIC DISEASES (Continued)**

| Medication | Action, Use, and Indication | Nursing Considerations |
|---|---|---|
| TNF blocking agents: adalimumab (Humira), etanercept (Enbrel), infliximab (Remicade), golimumab (Simponi) | *Action:* Biologic response modifier that binds to TNF, a cytokine involved in inflammatory and immune responses. Used in moderate to severe RA unresponsive to methotrexate. Can be used alone or with methotrexate or other DMARDs. Humira is administered every 1–2 weeks, and Enbrel is administered twice a week. | Patient should be tested for tuberculosis before beginning this medication. Teach patient subcutaneous self-injection of adalimumab (Humira) or etanercept (Enbrel). Infliximab (Remicade) is administered by IV line over 2 h or more. Medication must be refrigerated. Monitor for injection site reactions. Educate patient about increased risk for infection and to withhold medication if fever occurs. |
| Interleukin-1 receptor antagonist: anakinra (Kineret) | *Action:* Human interleukin-1 (IL-1) receptor antagonist; blocks IL-1 receptors, decreasing inflammatory and immunologic responses. Used in moderate to severe RA unresponsive to methotrexate. Can be used alone or with methotrexate or DMARDs other than TNF blocking agents | Administered daily by subcutaneous injection. Teach patient subcutaneous self-injection to be administered daily. Medication must be refrigerated. Monitor for injection site reactions. Educate patient about increased risk of infection and to withhold medication if fever occurs. |
| **Corticosteroids:** | | |
| prednisone, prednisolone, hydrocortisone | *Action:* Anti-inflammatory Used for shortest duration and at lowest dose possible to minimize adverse effects<br>Useful for unremitting RA, SLE, polymyalgia rheumatica, myositis, arteritis<br>Fast-acting;onset in days<br>Intra-articular injections useful for joints unresponsive to NSAIDs | Assess for toxicity: cataracts, GI irritation, hyperglycemia, hypertension, fractures, avascular necrosis, hirsutism, psychosis.<br>Joints most amenable to injections include ankles, knees, hips, shoulders, and hands.<br>Repeated injections can cause joint damage. |
| **Topical Analgesics** | | |
| capsaicin (Zostrix) | *Action:* analgesic | Teach patient to apply sparingly, avoid areas of open skin, avoid contact with eyes and mucous membranes. Wash hands carefully after application.<br>Assess for local skin irritation. |

CBC, complete blood count; CNS, central nervous system; GI, gastrointestinal; RA, rheumatoid arthritis; TNF, tumor necrosis factor; SLE, systemic lupus erythematosus; WBCs, white blood cells.

avoiding factors that interfere with sleep (eg, use of alcohol and caffeine), using relaxation exercises, and getting out of bed and engaging in another activity (eg, reading) if unable to sleep (Bulechek, Butcher & Dochterman, 2008).

## Nursing Management

The plan of nursing care in Chart 54-2 details the nursing diagnoses, interventions, and expected outcomes for the patient with a rheumatic disorder.

**Table 54-4 EXERCISE TO PROMOTE MOBILITY**

| Type of Exercise | Purpose | Recommended Performance | Precautions |
|---|---|---|---|
| Range of motion | Maintain flexibility and joint motion | Active or active/self-assisted at least daily | Reduce number of repetitions when inflammation is present. |
| Isometric exercise | Improve muscle tone, static endurance, and strength; prepare for dynamic and weight-bearing exercises | Perform at 70% of maximal voluntary contraction daily. | Monitor blood pressure: isometric exercises may increase blood pressure and decrease blood flow to muscles. |
| Dynamic exercise | Maintain or increase dynamic strength and endurance; increase muscle power; enhance synovial blood flow; promote strength of bone and cartilage | Start with repetitions against gravity and add progressive resistance; perform 2–3 days per week. | May increase biomechanical stress on unstable or misaligned joints |
| Aerobic exercise | Improve cardiovascular fitness and endurance | Perform 3–5 days per week for 20–30 min of moderate-intensity exercise. | Progress slowly as activity tolerance and fitness improve. |
| Pool exercise | Water supports or resists movement; warm water may provide muscle relaxation. | Provides buoyant medium for performance of dynamic or aerobic exercise | Heated swimming pool; deep water to minimize joint compression; nonslip footwear for safety and comfort; receive appropriate instruction in a program designed for people with arthritis |

Adapted from Firestein, G. S., Panayi, G. S. & Willheim, F. A. (2006). *Rheumatoid arthritis*. Oxford, UK: Oxford University Press.

CHART 54-2

PLAN OF NURSING CARE

## Care of the Patient With a Rheumatic Disorder

**NURSING DIAGNOSIS:** Acute and chronic pain related to inflammation and increased disease activity, tissue damage, fatigue, or lowered tolerance level
**GOAL:** Improvement in comfort level; incorporation of pain management techniques into daily life

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Provide variety of comfort measures<br>a. Application of heat or cold<br>b. Massage, position changes, rest<br>c. Foam mattress, supportive pillow, splints<br>d. Relaxation techniques, diversional activities | 1. Pain may respond to nonpharmacologic interventions such as joint protection, exercise, relaxation, and thermal modalities. | • Identifies factors that exacerbate or influence pain response<br>• Identifies and uses pain management strategies<br>• Verbalizes decrease in pain<br>• Reports signs and symptoms of side effects in timely manner to prevent additional problems<br>• Verbalizes that pain is characteristic of rheumatic disease<br>• Establishes realistic pain relief goals<br>• Verbalizes that pain often leads to the use of nontraditional and unproven self-treatment methods<br>• Identifies changes in quality or intensity of pain |
| 2. Administer anti-inflammatory, analgesic, and slow-acting antirheumatic medications as prescribed. | 2. Pain of rheumatic disease responds to individual or combination medication regimens. | |
| 3. Individualize medication schedule to meet patient's need for pain management. | 3. Previous pain experiences and management strategies may be different from those needed for persistent pain. | |
| 4. Encourage verbalization of feelings about pain and chronicity of disease. | 4. Verbalization promotes coping. | |
| 5. Teach pathophysiology of pain and rheumatic disease, and assist patient to recognize that pain often leads to unproven treatment methods. | 5. Knowledge of rheumatic pain and appropriate treatment may help patient avoid unsafe, ineffective therapies. | |
| 6. Assist in identification of pain that leads to use of unproven methods of treatment. | 6. The impact of pain on an individual's life often leads to misconceptions about pain and pain management techniques. | |
| 7. Assess for subjective changes in pain. | 7. The individual's description of pain is a more reliable indicator than objective measurements such as change in vital signs, body movement, and facial expression. | |

**NURSING DIAGNOSIS:** Fatigue related to increased disease activity, pain, inadequate sleep/rest, deconditioning, inadequate nutrition, and emotional stress/depression
**GOAL:** Incorporates as part of daily activities strategies necessary to modify fatigue

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Provide instruction about fatigue. | 1. The patient's understanding of fatigue will affect his or her actions. | • Self-evaluates and monitors fatigue pattern<br>• Verbalizes the relationship of fatigue to disease activity<br>• Uses comfort measures as appropriate<br>• Practices effective sleep hygiene and routine<br>• Makes use of various assistive devices (splints, canes) and strategies (bed rest, relaxation techniques) to ease different kinds of fatigue<br>• Incorporates time management strategies in daily activities<br>• Uses appropriate measures to prevent physical and emotional fatigue<br>• Has an established plan to ensure well-paced, therapeutic activity schedule<br>• Adheres to therapeutic program<br>• Follows a planned conditioning program |
| a. Describe relationship of disease activity to fatigue. | a. The amount of fatigue is directly related to the activity of the disease. | |
| b. Describe comfort measures while providing them. | b. Relief of discomfort can relieve fatigue. | |
| c. Develop and encourage a sleep routine (warm bath and relaxation techniques that promote sleep). | c. Effective bedtime routine promotes restorative sleep. | |
| d. Explain importance of rest for relieving systematic, articular, and emotional stress. | d. Different kinds of rest are needed to relieve fatigue and are based on patient need and response. | |
| e. Explain how to use energy conservation techniques (pacing, delegating, setting priorities). | e. A variety of measures can be used to conserve energy. | |
| f. Identify physical and emotional factors that can cause fatigue. | f. Awareness of the various causes of fatigue provides the basis for measures to modify the fatigue. | |
| 2. Facilitate development of appropriate activity/rest schedule. | 2. Alternating rest and activity conserves energy while allowing most productivity. | |

*Continued*

CHART 54-2

**PLAN OF NURSING CARE**

## *Care of the Patient With a Rheumatic Disorder* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Encourage adherence to the treatment program. | 3. Overall control of disease activity can decrease the amount of fatigue. | • Consumes a nutritious diet consisting of appropriate food groups and recommended daily allowance of vitamins and minerals |
| 4. Refer to and encourage a conditioning program. | 4. Deconditioning resulting from lack of mobility, understanding, and disease activity contributes to fatigue. | |
| 5. Encourage adequate nutrition, including source of iron from food and supplements. | 5. A nutritious diet can help counteract fatigue. | |

**NURSING DIAGNOSIS:** Impaired physical mobility related to decreased range of motion, muscle weakness, pain on movement, limited endurance, lack of or improper use of ambulatory devices
**GOAL:** Attains and maintains optimal functional mobility

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage verbalization regarding limitations in mobility. | 1. Mobility is not necessarily related to deformity. Pain, stiffness, and fatigue may temporarily limit mobility. The degree of mobility is not synonymous with the degree of independence. Decreased mobility may influence a person's self-concept and lead to social isolation. | • Identifies factors that interfere with mobility<br>• Describes and uses measures to prevent loss of motion<br>• Identifies environmental (home, school, work, community) barriers to optimal mobility |
| 2. Assess need for occupational or physical therapy consultation:<br>a. Emphasize range of motion of affected joints.<br>b. Promote use of assistive ambulatory devices.<br>c. Explain use of safe footwear.<br>d. Use individual appropriate positioning/posture. | 2. Therapeutic exercises, proper footwear, and/or assistive equipment may improve mobility. Correct posture and positioning are necessary for maintaining optimal mobility. | • Uses appropriate techniques and/or assistive equipment to aid mobility<br>• Identifies community resources available to assist in managing decreased mobility |
| 3. Assist to identify environmental barriers. | 3. Furniture and architectural adaptations may enhance mobility. | |
| 4. Encourage independence in mobility and assist as needed.<br>a. Allow ample time for activity.<br>b. Provide rest period after activity.<br>c. Reinforce principles of joint protection and work simplification. | 4. Changes in mobility may lead to a decrease in personal safety. | |
| 5. Initiate referral to community health agency. | 5. The degree of mobility may be slow to improve or may not improve with intervention. | |

**NURSING DIAGNOSIS:** Self-care deficits related to contractures, fatigue, or loss of motion
**GOAL:** Achieves self-care independently or with the use of resources

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assist patient to identify self-care deficits and factors that interfere with ability to perform self-care activities. | 1. The ability to perform self-care activities is influenced by the disease activity and the accompanying pain, stiffness, fatigue, muscle weakness, loss of motion, and depression. | • Identifies factors that interfere with the ability to perform self-care activities<br>• Identifies alternative methods for meeting self-care needs |
| 2. Develop a plan based on the patient's perceptions and priorities on how to establish and achieve goals to meet self-care needs, incorporating joint protection, energy conservation, and work simplification concepts.<br>a. Provide appropriate assistive devices.<br>b. Reinforce correct and safe use of assistive devices. | 2. Assistive devices may enhance self-care abilities. Effective planning for changes must include the patient, who must accept and adopt the plan. | • Uses alternative methods for meeting self-care needs<br>• Identifies and uses other health care resources for meeting self-care needs |

*Continued on following page*

CHART 54-2

**PLAN OF NURSING CARE**

***Care of the Patient With a Rheumatic Disorder*** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| c. Allow patient to control timing of self-care activities.<br>d. Explore with the patient different ways to perform difficult tasks or ways to enlist the help of someone else.<br>3. Consult with community health care agencies when individuals have attained a maximum level of self-care yet still have some deficits, especially regarding safety. | 3. Individuals differ in ability and willingness to perform self-care activities. Changes in ability to care for self may lead to a decrease in personal safety. | |

**NURSING DIAGNOSIS:** Disturbed body image related to physical and psychological changes and dependency imposed by chronic illness
**GOAL:** Adapts to physical and psychological changes imposed by the rheumatic disease

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Help patient identify elements of control over disease symptoms and treatment.<br>2. Encourage patient's verbalization of feelings, perceptions, and fears.<br>a. Help to assess present situation and identify problems.<br>b. Assist to identify past coping mechanisms.<br>c. Assist to identify effective coping mechanisms. | 1. The individual's self-concept may be altered by the disease or its treatment.<br>2. The individual's coping strategies reflect the strength of his or her self-concept. | • Verbalizes an awareness that changes taking place in self-concept are normal responses to rheumatic disease and other chronic illnesses<br>• Identifies strategies to cope with altered self-concept |

**NURSING DIAGNOSIS:** Ineffective coping related to actual or perceived lifestyle or role changes
**GOAL:** Use of effective coping behaviors for dealing with actual or perceived limitations and role changes

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Identify areas of life affected by disease. Answer questions and dispel possible myths.<br>2. Develop plan for managing symptoms and enlisting support of family and friends to promote daily function. | 1. The effects of disease may be more or less manageable once identified and explored reasonably.<br>2. By taking action and involving others appropriately, patient develops or draws on coping skills and community support. | • Names functions and roles affected and not affected by disease process<br>• Describes therapeutic regimen and states actions to take to improve, change, or accept a particular situation, function, or role |

**COLLABORATIVE PROBLEMS:** Complications secondary to effects of medications
**GOAL:** Absence or resolution of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Perform periodic clinical assessment and laboratory evaluation.<br>2. Instruct in correct self- administration, potential side effects, and importance of monitoring.<br>3. Counsel regarding methods to reduce side effects and manage symptoms.<br>4. Administer medications in modified doses as prescribed if complications occur. | 1. Skillful assessment helps detect early symptoms of side effects of medications.<br>2. The patient needs accurate information about medications and potential side effects to avoid or manage them.<br>3. Appropriate identification and early intervention may minimize complications.<br>4. Modifications may help minimize side effects or other complications. | • Complies with monitoring procedures and experiences minimal side effects<br>• Takes medication as prescribed and lists potential side effects<br>• Identifies strategies to reduce or manage side effects<br>• Reports that side effects or complications have subsided |

## Diffuse Connective Tissue Diseases

Diffuse connective tissue disease refers to a group of systematic disorders that are chronic in nature and are characterized by diffuse inflammation and degeneration in the connective tissues. These disorders share similar clinical features and may affect some of the same organs. The characteristic clinical course is one of exacerbations and remissions. Although the diffuse connective tissue diseases have unknown causes, they are thought to be the result of immunologic abnormalities. They include **rheumatoid arthritis** (RA), SLE, scleroderma, polymyositis, and polymyalgia rheumatica.

### RHEUMATOID ARTHRITIS

RA is an autoimmune disease of unknown origin that affects 1% of the population worldwide, with a female-to-male ratio between 2:1 and 4:1 (Khanna, Arnold, Pencharz, et al., 2006).

#### Pathophysiology

In RA, the autoimmune reaction (Fig. 54-1) primarily occurs in the synovial tissue. Phagocytosis produces enzymes within the joint. The enzymes break down collagen, causing edema, proliferation of the synovial membrane, and ultimately pannus formation. Pannus destroys cartilage and erodes the bone. The consequence is loss of articular surfaces and joint motion. Muscle fibers undergo degenerative changes. Tendon and ligament elasticity and contractile power are lost.

#### Clinical Manifestations

Clinical manifestations of RA vary, usually reflecting the stage and severity of the disease. Joint pain, swelling, warmth, erythema, and lack of function are classic symptoms. Palpation of the joints reveals spongy or boggy tissue. Often fluid can be aspirated from the inflamed joint. Characteristically, the pattern of joint involvement begins in the small joints of the hands, wrists, and feet (Bickley, 2007). As the disease progresses, the knees, shoulders, hips, elbows, ankles, cervical spine, and temporomandibular joints are affected. The onset of symptoms is usually acute. Symptoms are usually bilateral and symmetric. In addition to joint pain and swelling, another classic sign of RA is joint stiffness in the morning.

In the early stages of disease, even before bony changes occur, limitation in function can occur when there is active inflammation in the joints. Joints that are hot, swollen, and painful are not easily moved. The patient tends to guard or protect these joints by immobilizing them. Immobilization for extended periods can lead to contractures, creating soft tissue deformity.

Deformities of the hands and feet are common in RA (see Chapter 66, Fig. 66-6). The deformity may be caused by misalignment resulting from swelling, progressive joint destruction, or the subluxation (partial dislocation) that occurs when one bone slips over another and eliminates the joint space.

RA is a systemic disease with multiple extra-articular features. Most common are fever, weight loss, fatigue, anemia, lymph node enlargement, and Raynaud's phenomenon (cold- and stress-induced vasospasm causing episodes of digital blanching or cyanosis). Rheumatoid nodules may be noted in patients with more advanced RA, and they develop at some time in the course of the disease in about 25% of patients. These nodules are usually nontender and movable in the subcutaneous tissue. They usually appear over bony prominences such as the elbow, are varied in size, and can disappear spontaneously. Nodules occur only in people who have rheumatoid factor. The nodules often are associated with rapidly progressive and destructive disease. Other extra-articular features include arteritis, neuropathy, scleritis, pericarditis, splenomegaly, and Sjögren's syndrome (dry eyes and dry mucous membranes).

#### Assessment and Diagnostic Findings

Several factors can contribute to a diagnosis of RA: rheumatoid nodules, joint inflammation detected on palpation, and laboratory findings. The history and physical examination address manifestations such as bilateral and symmetric stiffness, tenderness, swelling, and temperature changes in the joints. The patient is also assessed for extra-articular changes; these often include weight loss, sensory changes, lymph node enlargement, and fatigue. Rheumatoid factor is present in about three fourths of patients with RA, but its presence alone is not diagnostic of RA, and its absence does not rule out the diagnosis. The ESR is significantly elevated in RA. The red blood cell count and C4 complement component are decreased. C-reactive protein and antinuclear antibody (ANA) test results may also be positive (Karpoff & Labus, 2008) (Chart 54-3). Arthrocentesis shows synovial fluid that is cloudy, milky, or dark yellow and contains numerous inflammatory components, such as leukocytes and complement.

X-rays show bony erosions and narrowed joint spaces. X-rays of the hands and feet should be performed at baseline to help establish the diagnosis of RA and then every 3 years to monitor the progression of the disease (Khanna, et al., 2006).

#### Medical Management

##### *Early Rheumatoid Arthritis*

Patients with RA should receive aggressive and early treatment (Khanna, et al., 2006). Treatment includes education, a balance of rest and exercise, and referral to appropriate community agencies (such as the Arthritis Foundation) for support. Medical management begins with therapeutic doses of salicylates or NSAIDs. When used in full therapeutic dosages, these medications provide both anti-inflammatory and analgesic effects.

Several cyclo-oxygenase 2 (COX-2) enzyme blockers, another class of NSAIDs, have been approved for treatment of RA. Cyclo-oxygenase is an enzyme that is involved in the inflammatory process. COX-2 medications block the enzyme involved in inflammation (COX-2) while leaving intact the enzyme involved in protecting the stomach lining (COX-1). As a result, COX-2 enzyme blockers are less likely to cause gastric irritation and ulceration than other

CHART 54-3

## NURSING RESEARCH PROFILE
## *Managing Symptoms in Rheumatoid Arthritis*

Sousa, K. H., Ryu, E., Kwok, O., et al. (2007). Development of a model to measure symptom status in persons living with rheumatoid arthritis. *Nursing Research, 56*(6), 434–440.

### Purpose

Rheumatoid arthritis (RA) is a chronic, progressive, inflammatory disease of unknown etiology that causes disability as well as morbidity and mortality. RA has a constellation of symptoms (eg, blurred vision, pain, dizziness) that affect quality of life. The purpose of this study was to develop and validate a structured model to measure symptom status in patients with RA.

### Design

This study was a secondary analysis of symptom checklists available from 901 women enrolled in the Arthritis, Rheumatism, and Aging Medical Information System. The symptom checklists contained a list of 31 symptoms, and participants were asked to check off all symptoms they had experienced in the previous 6 months. Factor analysis was used to develop the model to measure symptoms.

### Findings

Results of the factor analysis supported a two-factor model for the measurement of symptom status. The factors were (1) RA pain symptoms and (2) general symptoms. The two factors were found to be significantly different from each other, and the RA pain symptoms factor had a stronger impact on functional health than general symptoms.

### Nursing Implications

The first aspect of effective symptom management for patients with RA is nursing assessment. This study provides a model and validated structure for such an assessment. For example, the symptoms that form the RA pain cluster could serve as a baseline assessment for nurses to identify goals and interventions to help improve the functional health and quality of life of patients with RA.

NSAIDs; however, they are associated with increased risk of cardiovascular disease and must be used with caution (Karch, 2008).

A window of opportunity for symptom control and improved disease management occurs within the first 2 years after disease onset. Therefore, it is recommended that treatment with the DMARDs (antimalarials, gold, penicillamine, or sulfasalazine) begin within 3 months of disease onset. If symptoms are aggressive (ie, early bony erosions as seen on x-rays), methotrexate may be considered. Methotrexate (Rheumatrex) is currently the standard treatment of RA because of its success in preventing both joint destruction and long-term disability (Schmajuk, et al., 2007).

An alternative treatment approach for RA has emerged in the area of biologic therapies. Biologic response modifiers are a group of agents that consist of molecules produced by cells of the immune system or by cells that participate in the inflammatory reactions. Research (Voulgari, Alamanos, Nikas, et al., 2005) using tumor necrosis factor-alpha (TNF-$\alpha$) inhibitors in combination with other medications has shown that patients demonstrate significant improvement. Examples of biologic response modifiers that are currently available are etanercept (Enbrel), infliximab (Remicade), adalimumab (Humira), golimumab (Simponi), and anakinra (Kineret). Etanercept, infliximab, adalimumab, and golimumab inhibit the function of TNF-$\alpha$, a key cytokine known to play a role in the disease process in RA (Porth & Matfin, 2009), whereas anakinra inhibits the function of interleukin-1, another cytokine that contributes to the destruction of the joint. Research in this area is ongoing.

Additional analgesia may be prescribed for periods of extreme pain. Opioid analgesic agents are avoided because of the potential for continuing need for pain relief. Nonpharmacologic pain management techniques (eg, relaxation techniques, heat and cold applications) are taught.

### *Moderate, Erosive Rheumatoid Arthritis*

For moderate, erosive RA, a formal program with occupational and physical therapy is prescribed to educate the patient about principles of joint protection, pacing activities, work simplification, range of motion, and muscle-strengthening exercises. The patient is encouraged to participate actively in the management program. The medication program is reevaluated periodically, and appropriate changes are made if indicated. Cyclosporine (Neoral), an immunosuppressant, may be added to enhance the disease-modifying effect of methotrexate.

### *Persistent, Erosive Rheumatoid Arthritis*

For persistent, erosive RA, reconstructive surgery and corticosteroids are often used. Reconstructive surgery is indicated when pain cannot be relieved by conservative measures and the threat of loss of independence is eminent. Surgical procedures include synovectomy (excision of the synovial membrane), tenorrhaphy (suturing of a tendon), arthrodesis (surgical fusion of the joint), and **arthroplasty** (surgical repair and replacement of the joint). Surgery is not performed during disease flares.

Systemic corticosteroids are used when the patient has unremitting inflammation and pain or needs a "bridging" medication while waiting for the slower DMARDs (eg, methotrexate) to begin taking effect. Low-dose corticosteroid therapy is prescribed for the shortest time necessary to minimize side effects (Khanna, et al., 2006). Single large joints that are severely inflamed and fail to respond promptly to the measures outlined previously may be treated by local injection of a corticosteroid.

### *Advanced, Unremitting Rheumatoid Arthritis*

For advanced, unremitting RA, immunosuppressive agents are prescribed because of their ability to affect the production

of antibodies at the cellular level. These include high-dose methotrexate (Rheumatrex), cyclophosphamide (Cytoxan), azathioprine (Imuran), and leflunomide (Arava). However, these medications are highly toxic and can produce bone marrow suppression, anemia, gastrointestinal disturbances, and rashes.

For most patients with RA, depression and sleep deprivation may require the short-term use of low-dose antidepressant medications, such as amitriptyline (Elavil), paroxetine (Paxil), or sertraline (Zoloft), to reestablish an adequate sleep pattern and to manage chronic pain.

The U.S. Food and Drug Administration (FDA) has approved a medical device for use in treating patients with more severe and long-standing RA who have had no response to or are intolerant of DMARDs. The device, a protein A immunoadsorption column (Prosorba), is used in 12 weekly 2-hour apheresis treatments to bind immunoglobulin G (IgG) (ie, circulating immune complex). In this unique population of patients, a significant improvement using the American College of Rheumatology criteria for improvement has been demonstrated (Eustice & Eustice, 2008).

#### Nutrition Therapy

Patients with RA frequently experience anorexia, weight loss, and anemia. A dietary history identifies usual eating habits and food preferences. Food selection should include the daily requirements from the basic food groups, with emphasis on foods high in vitamins, protein, and iron for tissue building and repair. For the patient who is extremely anorexic, small, frequent feedings with increased protein supplements may be prescribed. Supplemental vitamins and minerals may also be prescribed as needed (Klippel, Stone, Crofford, et al., 2008). Certain medications (ie, oral corticosteroids) used in RA treatment stimulate the appetite and, when combined with decreased activity, may lead to weight gain. Therefore, patients may need to be counseled about eating a healthy, calorie-restricted diet.

## Nursing Management

Nursing care of the patient with RA follows the basic plan of care presented earlier (see Chart 54-2). The most common issues for the patient with RA include pain, sleep disturbance, fatigue, altered mood, and limited mobility (Sousa, Ryu, Kwok, et al., 2007). The patient with newly diagnosed RA needs information about the disease to make daily self-management decisions and to cope with having a chronic disease.

### *Monitoring and Managing Potential Complications*

Medications used for treating RA may cause serious and adverse effects. These medication-induced complications may include bone marrow suppression, anemia, gastrointestinal disturbances, and rashes. The primary health care provider bases the prescribed medication regimen on clinical findings and past medical history, and then with the help of the nurse, monitors for side effects using periodic clinical assessments and laboratory testing. The nurse, who can be available for consultation between physician visits, works to help the patient recognize and deal with these side effects (see Table 54-3). The medication may need to be stopped or the dose reduced. If the patient experiences an increase in symptoms while the complication is being resolved or a new medication is being initiated, the nurse's counseling regarding symptom management may relieve potential anxiety and distress.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Patient teaching is an essential aspect of nursing care of the patient with RA to enable the patient to maintain as much independence as possible, to take medications accurately and safely, and to use adaptive devices correctly. Patient teaching focuses on the disorder itself, the possible changes related to the disorder, the therapeutic regimen prescribed to treat it, the potential side effects of medications, strategies to maintain independence and function, and patient safety in the home (Chart 54-4).

**CHART 54-4** HOME CARE CHECKLIST
***The Patient With Rheumatoid Arthritis***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Explain the nature of the disease and principles of disease management. | ✔ | ✔ |
| • Describe the medication regimen (name of medications, dosage, schedule of administration, precautions, potential side effects, and desired effects). | ✔ | ✔ |
| • Identify monitoring procedures and strategies that should be implemented. | ✔ | ✔ |
| • Identify sources of additional information, if necessary. | ✔ | ✔ |
| • Demonstrate accurate and safe self-administration of medications. | ✔ | ✔ |
| • Describe and demonstrate use of pain management techniques. | ✔ | ✔ |
| • Demonstrate use of joint protection techniques in activities of daily living (ADLs). | ✔ | ✔ |
| • Demonstrate ability to perform self-care activities independently or with assistive devices. | ✔ | |
| • Demonstrate a safe exercise program. | ✔ | |
| • Demonstrate a relaxation technique. | ✔ | |

The patient and family are encouraged to verbalize their concerns and ask questions. Because RA commonly affects young women, major concerns may be related to the effects of the disease on childbearing potential, caring for family, or work responsibilities. The patient with a chronic illness may seek a "cure" or have questions about alternative therapies. One alternative therapy, an expensive one, used by many patients with RA is elk antler velvet. The velvet from elk antlers is harvested, ground, and put into capsules. In one randomized clinical trial of 168 patients with early stages of RA, researchers found that elk velvet has no clinical efficacy in the symptom management of the disease (Allen, Oberle, Grace, et al., 2008).

Pain, fatigue, and depression can interfere with the patient's ability to learn and should be addressed before teaching is initiated. Various educational strategies may then be used, depending on the patient's previous knowledge base, interest level, degree of comfort, social or cultural influences, and readiness to learn. The nurse instructs the patient about basic disease management and necessary adaptations in lifestyle. Because suppression of inflammation and autoimmune responses requires the use of anti-inflammatory, disease-modifying antirheumatic, and immunosuppressive agents, the patient is taught about prescribed medications, including type, dosage, rationale, potential side effects, self-administration, and required monitoring procedures. If hospitalized, the patient is encouraged to practice new self-management skills with support from caregivers and significant others. The nurse then reinforces disease management skills during each patient contact. Barriers to compliance are assessed, and measures are taken to promote adherence to medications and the treatment program.

**Continuing Care**

Depending on the severity of the disorder and the patient's resources and supports, referral for home care may or may not be warranted. However, the patient who is elderly or frail, has RA that limits function significantly, and lives alone may need referral for home care.

The impact of RA on everyday life is not always evident when the patient is seen in the hospital or in an ambulatory care setting. The increased frequency with which nurses see patients in the home provides opportunities for recognizing problems and implementing interventions aimed at improving the quality of life of patients with RA.

During home visits, the nurse has the opportunity to assess the home environment and its adequacy for patient safety and management of the disorder. Adherence to the treatment program can be more easily monitored in the home setting, where physical and social barriers to adherence are more readily identified. For example, a patient who also has diabetes and requires insulin may be unable to fill the syringe accurately or unable to administer the insulin because of impaired joint mobility. Appropriate adaptive equipment needed for increased independence is often identified more readily when the nurse sees how the patient functions in the home. Any barriers to adherence are identified, and appropriate referrals are made.

For patients at risk for impaired skin integrity, the home care nurse can closely monitor skin status and also instruct, provide, or supervise the patient and family in preventive skin care measures. The nurse also assesses the patient's need for assistance in the home and supervises home health aides who may meet many of the needs of the patient with RA. Referrals to physical and occupational therapists may be made as problems are identified and limitations increase. A home care nurse may visit the home to make sure the patient can function as independently as possible despite mobility problems and can safely manage treatments, including pharmacotherapy. The patient and family should be informed about support services such as Meals on Wheels and local Arthritis Foundation chapters.

Because many of the medications used to suppress inflammation are injectable, the nurse may administer the medication to the patient or teach self-injection. These frequent contacts allow the nurse to reinforce other disease management techniques.

The nurse also assesses the patient's physical and psychological status, adequacy of symptom management, and adherence to the management plan. Patients should know which type of rheumatic disease they have, not just that they have "arthritis" or "arthritis of the knee." The importance of attending follow-up appointments is emphasized to the patient and family, and they should be reminded about the importance of participating in other health promotion activities and health screening. Patients with chronic disorders such as RA often focus on the chronic disease and neglect general health issues.

## SYSTEMIC LUPUS ERYTHEMATOSUS

The overall prevalence of SLE is estimated to be 1 per 2500 persons. It occurs 10 times more frequently in women than in men and approximately three times more frequently in African Americans than in Caucasians (Wandstrat, Carr-Johnson, Branch, et al., 2006).

### Pathophysiology

SLE is a result of disturbed immune regulation that causes an exaggerated production of autoantibodies. This immunoregulatory disturbance is brought about by some combination of genetic factors, hormonal factors (as evidenced by the usual onset during the childbearing years), and environmental factors (eg, sunlight, thermal burns). Certain medications, such as hydralazine (Apresoline), procainamide (Pronestyl), isoniazid (INH), chlorpromazine (Thorazine), and some antiseizure medications, have been implicated in chemical or drug-induced SLE.

Specifically, B cells and T cells both contribute to the immune response in SLE (Croker & Kimberly, 2005). B cells are instrumental in promoting the onset and flares of the disease (Tieng & Peeva, 2008).

### Clinical Manifestations

SLE is an autoimmune systemic disease that can affect any body system. Involvement of the musculoskeletal system, with arthralgias and arthritis (synovitis), is a common

presenting feature of SLE. Joint swelling, tenderness, and pain on movement are also common. Frequently, these are accompanied by morning stiffness. The onset of disease may be insidious or acute.

Several different types of skin manifestations may occur in patients with SLE, including subacute cutaneous lupus erythematosus, which involves papulosquamous or annular polycyclic lesions, and discoid lupus erythematosus, which is a chronic rash that has erythematous papules or plaques and scaling and can cause scarring and pigmentation changes. The most familiar skin manifestation (occurring in more than 50% of patients with SLE) is an acute cutaneous lesion consisting of a butterfly-shaped rash across the bridge of the nose and cheeks (Bickley, 2007) (Fig. 54-2). In some cases of discoid lupus erythematosus, only skin involvement occurs. In some patients with SLE, the initial skin involvement is the precursor to more systemic involvement. The lesions often worsen during exacerbations (flares) of the systemic disease and possibly are provoked by sunlight or artificial ultraviolet light. Oral ulcers, which may accompany skin lesions, may involve the buccal mucosa or the hard palate, occur in crops, and are often associated with exacerbations.

Pericarditis is the most common cardiac manifestation. Women who have SLE are also at risk for early atherosclerosis.

Serum creatinine levels and urinalysis are used in screening for renal involvement. Early detection allows for prompt treatment so that renal damage can be prevented. Renal involvement may lead to hypertension, which also requires careful monitoring and management (see Chapter 32).

Central nervous system involvement is widespread, encompassing the entire range of neurologic disease. The varied and frequent neuropsychiatric presentations of SLE are now widely recognized. These are generally demonstrated by subtle changes in behavior patterns or cognitive ability.



**Figure 54-2** The characteristic butterfly rash of systemic lupus erythematosus.

## Assessment and Diagnostic Findings

Diagnosis of SLE is based on a complete history, physical examination, and blood tests. Typically, assessment reveals classic symptoms, including fever, fatigue, weight loss, and possibly arthritis, pleurisy, and pericarditis. Interactions with the patient and family may provide further evidence of systemic involvement.

In addition to the general assessment performed for any patient with a rheumatic disease, assessment for known or suspected SLE has special features. The skin is inspected for erythematous rashes. Cutaneous erythematous plaques with an adherent scale may be observed on the scalp, face, or neck. Areas of hyperpigmentation or depigmentation may be noted, depending on the phase and type of the disease. The patient should be questioned about skin changes (because these may be transitory) and specifically about sensitivity to sunlight or artificial ultraviolet light. The scalp should be inspected for alopecia and the mouth and throat for ulcerations reflecting gastrointestinal involvement.

Cardiovascular assessment includes auscultation for pericardial friction rub, possibly associated with myocarditis and accompanying pleural effusions. The pleural effusions and infiltrations, which reflect respiratory insufficiency, are demonstrated by abnormal lung sounds. Papular, erythematous, and purpuric lesions developing on the fingertips, elbows, toes, and extensor surfaces of the forearms or lateral sides of the hand that may become necrotic suggest vascular involvement.

Joint swelling, tenderness, warmth, pain on movement, stiffness, and edema may be detected on physical examination. The joint involvement is often symmetric and similar to that found in RA.

The neurologic assessment is directed at identifying and describing any central nervous system changes. The patient and family members are asked about any behavioral changes, including manifestations of neurosis or psychosis. Signs of depression are noted, as are reports of seizures, chorea, or other central nervous system manifestations.

No single laboratory test confirms SLE; rather, blood testing reveals moderate to severe anemia, thrombocytopenia, leukocytosis, or leukopenia and positive ANAs (Wandstrat, et al., 2006). Other diagnostic immunologic tests support but do not confirm the diagnosis.

## Medical Management

Treatment of SLE includes management of acute and chronic disease. Although SLE can be life-threatening, advances in its treatment have led to improved survival and reduced morbidity. Acute disease requires interventions directed at controlling increased disease activity or exacerbations that can involve any organ system. Disease activity is a composite of clinical and laboratory features that reflect active inflammation secondary to SLE. Management of the

more chronic condition involves periodic monitoring and recognition of meaningful clinical changes requiring adjustments in therapy.

The goals of treatment include preventing progressive loss of organ function, reducing the likelihood of acute disease, minimizing disease-related disabilities, and preventing complications from therapy. Management of SLE involves regular monitoring to assess disease activity and therapeutic effectiveness.

### Pharmacologic Therapy

Medication therapy for SLE is based on the concept that local tissue inflammation is mediated by exaggerated or heightened immune responses, which can vary widely in intensity and require different therapies at different times. Corticosteroids are the single most important medication available for treatment. They are used topically for cutaneous manifestations, in low oral doses for minor disease activity, and in high doses for major disease activity. Intravenous (IV) administration of corticosteroids is an alternative to traditional high-dose oral use. Antimalarial medications are effective for managing cutaneous, musculoskeletal, and mild systemic features of SLE. The NSAIDs used for minor clinical manifestations are often used along with corticosteroids in an effort to minimize corticosteroid requirements.

Immunosuppressive agents (alkylating agents and purine analogues) are used because of their effect on immune function. These medications are generally reserved for patients who have serious forms of SLE that have not responded to conservative therapies. B-cell depleting therapies are the newest treatment for SLE. Monoclonal antibodies, rituximab (Rituxan), and epratuzumab (humanized anit-CD22 antibody) have shown good therapeutic results in clinical trials (Tieng & Peeva, 2008).

## Nursing Management

Nursing care of the patient with SLE is based on the fundamental plan presented earlier in the chapter (see Chart 54-2). The most common nursing diagnoses include fatigue, impaired skin integrity, body image disturbance, and lack of knowledge for self-management decisions. The disease or its treatment may produce dramatic changes in appearance and considerable distress for the patient. The changes and the unpredictable course of SLE necessitate expert assessment skills and nursing care with sensitivity to the psychological reactions of the patient. The patient may benefit from participation in support groups, which can provide disease information, daily management tips, and social support. Because sun and ultraviolet light exposure can increase disease activity or cause an exacerbation, patients should be taught to avoid exposure or to protect themselves with sunscreen and clothing.

Because of the increased risk of involvement of multiple organ systems, patients should understand the need for routine periodic screenings as well as health promotion activities. A dietary consultation may be indicated to ensure that the patient is knowledgeable about dietary recommendations, given the increased risk of cardiovascular disease, including hypertension and atherosclerosis. The nurse instructs the patient about the importance of continuing prescribed medications and addresses the changes and potential side effects that are likely to occur with their use. The patient is reminded of the importance of monitoring because of the increased risk of systemic involvement, including renal and cardiovascular effects.

# SCLERODERMA

Scleroderma ("hard skin") is a relatively rare disease that is poorly understood; the cause is unknown. The incidence of scleroderma (also known as systemic sclerosis) is 18 to 20 cases per million per year (Seibold, 2005). Like other diffuse connective tissue diseases, it has a variable course with remissions and exacerbations. Its prognosis is not as optimistic as that of SLE.

## Pathophysiology

Scleroderma commonly begins with skin involvement. Mononuclear cells cluster on the skin and stimulate lymphokines to stimulate procollagen. Insoluble collagen is formed and accumulates excessively in the tissues. Initially, the inflammatory response causes edema formation, with a resulting taut, smooth, and shiny skin appearance. The skin then undergoes fibrotic changes, leading to loss of elasticity and movement. Eventually, the tissue degenerates and becomes nonfunctional. This chain of events, from inflammation to degeneration, also occurs in blood vessels, major organs, and body systems (Klippel, et al., 2008).

## Clinical Manifestations

Scleroderma starts insidiously with Raynaud's phenomenon and swelling in the hands. The skin and the subcutaneous tissues become increasingly hard and rigid and cannot be pinched up from the underlying structures. Wrinkles and lines are obliterated. The skin is dry because sweat secretion over the involved region is suppressed. The extremities stiffen and lose mobility. The condition spreads slowly; for years, these changes may remain localized in the hands and the feet. The face appears masklike, immobile, and expressionless, and the mouth becomes rigid.

The changes within the body, although not visible directly, are vastly more important than the visible changes. The left ventricle of the heart is involved, resulting in heart failure. The esophagus hardens, interfering with swallowing. The lungs become scarred, impeding respiration. Digestive disturbances occur because of hardening (sclerosing) of the intestinal mucosa. Progressive renal failure may occur.

The patient may manifest a variety of symptoms referred to as the CREST syndrome. CREST stands for ***c***alcinosis (calcium deposits in the tissues), ***R***aynaud's phenomenon, ***e***sophageal hardening and dysfunction, ***s***clerodactyly (scleroderma of the digits), and ***t***elangiectasia (capillary dilation that forms a vascular lesion).

### Assessment and Diagnostic Findings

Assessment focuses on the sclerotic changes in the skin, contractures in the fingers, and color changes or lesions in the fingertips. Assessment of systemic involvement requires a systems review with special attention to gastrointestinal, pulmonary, renal, and cardiac symptoms. Limitations in mobility and self-care activities should be assessed, along with the impact the disease has had (or will have) on body image.

There is no one conclusive test to diagnose scleroderma. A skin biopsy is performed to identify cellular changes specific to scleroderma. Pulmonary studies show ventilation–perfusion abnormalities. Echocardiography identifies pericardial effusion (often present with cardiac involvement). Esophageal studies demonstrate decreased motility in most patients with scleroderma. Blood tests may detect ANAs, indicating a connective tissue disorder and possibly distinguishing the subgroup (diffuse or limited) of scleroderma. A positive ANA test result is common in patients with scleroderma.

### Medical Management

Treatment of scleroderma depends on the clinical manifestations. All patients require counseling, during which realistic individual goals may be determined. Support measures include strategies to decrease pain and limit disability. A moderate exercise program is encouraged to prevent joint contractures. Patients are advised to avoid extreme temperatures and to use lotion to minimize skin dryness.

#### *Pharmacologic Therapy*

No medication regimen has proved effective in modifying the disease process in scleroderma, but various medications are used to treat organ system involvement. Calcium channel blockers and other antihypertensive agents may provide improvement in symptoms of Raynaud's phenomenon. Anti-inflammatory medications can be used to control arthralgia, stiffness, and general musculoskeletal discomfort (Seibold, 2005).

### Nursing Management

The nursing care of the patient with scleroderma is based on the fundamental plan of nursing care presented earlier (see Chart 54-2). The most common nursing diagnoses of the patient with scleroderma are impaired skin integrity; self-care deficits; imbalanced nutrition, less than body requirements; and disturbed body image. The patient with advanced disease may also have impaired gas exchange, decreased cardiac output, impaired swallowing, and constipation.

Providing meticulous skin care and preventing the effects of Raynaud's phenomenon are major nursing challenges. Patient teaching must include the importance of avoiding cold and protecting the fingers with mittens in cold weather and when shopping in the frozen-food section of the grocery store. Warm socks and properly fitting shoes are helpful in preventing ulcers. Careful, frequent inspection for early ulcers is important. Smoking cessation is critical.

## POLYMYOSITIS

Polymyositis is a group of diseases that are termed idiopathic inflammatory myopathies (Klippel, et al., 2008). They are rare conditions, with an incidence estimated at 5 to 10 cases per million adults per year.

### Pathophysiology

Polymyositis is classified as autoimmune because autoantibodies are present. However, these antibodies do not cause damage to muscle cells, indicating only an indirect role in tissue damage. The pathogenesis is multifactorial, and a genetic predisposition is likely. Drug-induced disease is rare. Some evidence suggests a viral link.

### Clinical Manifestations

The onset ranges from sudden with rapid progression to very slow and insidious. Proximal muscle weakness is typically a first symptom. Muscle weakness is usually symmetric and diffuse. Dermatomyositis, a related condition, is most commonly identified by an erythematous smooth or scaly lesion found over the joint surface.

### Assessment and Diagnostic Findings

A complete history and physical examination help exclude other muscle-related disorders. As with other diffuse connective tissue disorders, no single test confirms polymyositis. An electromyogram is performed to rule out degenerative muscle disease. A muscle biopsy may reveal inflammatory infiltrate in the tissue. Serum studies indicate increased muscle enzyme activity.

### Medical Management

Management involves high-dose corticosteroid therapy initially, followed by a gradual dosage reduction over several months as muscle enzyme activity decreases. Patients who do not respond to corticosteroids require the addition of an immunosuppressive agent. Plasmapheresis, lymphapheresis, and total-body irradiation have been used if there is no response to corticosteroids and immunosuppressive medications. The antimalarial agent hydroxychloroquine (Plaquenil) may be effective for skin rashes. Physical therapy is initiated slowly, with range-of-motion exercises to maintain joint mobility, followed by gradual strengthening exercises (Klippel, et al., 2008).

### Nursing Management

Nursing care is based on the fundamental plan of nursing care presented earlier (see Chart 54-2). The most frequent nursing diagnoses for the patient with polymyositis are impaired physical mobility, fatigue, self-care deficit, and insufficient knowledge of self-management techniques.

Patients with polymyositis may have symptoms similar to those of other inflammatory diseases. However, proximal muscle weakness is characteristic, making activities such as combing the hair, reaching overhead, and using stairs difficult. Therefore, use of assistive devices may be recommended, and referral to occupational or physical therapy may be warranted.

## POLYMYALGIA RHEUMATICA

### Pathophysiology

The underlying mechanism involved with polymyalgia rheumatica is unknown. This disease occurs predominately in Caucasians and often in first-degree relatives. An association with the genetic marker HLA-DR4 suggests a familial predisposition. Immunoglobulin deposits in the walls of inflamed temporal arteries also suggest an autoimmune process.

Polymyalgia rheumatica and giant cell arteritis are found almost exclusively in people older than 50 years of age. Polymyalgia rheumatica has an annual incidence rate of 52 cases per 100,000 people older than 50 years. Giant cell arteritis varies by geographic location and has the highest incidence in Scandinavian countries (Klippel, et al., 2008).

### Clinical Manifestations

Polymyalgia rheumatica is characterized by severe proximal muscle discomfort with mild joint swelling. Severe aching in the neck, shoulder, and pelvic muscles is common. Stiffness is noticeable most often in the morning and after periods of inactivity. Systemic features include low-grade fever, weight loss, malaise, anorexia, and depression. Because polymyalgia rheumatica usually occurs in people 50 years of age and older, it may be confused with, or dismissed as, an inevitable consequence of aging.

Giant cell arteritis, sometimes associated with polymyalgia rheumatica, may cause headaches, changes in vision, and jaw claudication. These symptoms should be evaluated immediately because of the potential for a sudden and permanent loss of vision if the condition is left untreated. Polymyalgia rheumatica and giant cell arteritis typically have a self-limited course, lasting several months to several years (Klippel, et al., 2008).

### Assessment and Diagnostic Findings

Assessment focuses on musculoskeletal tenderness, weakness, and decreased function. Careful attention should be directed toward assessing the head (for changes in vision, headaches, and jaw claudication).

Often, diagnosis is difficult because of the lack of specificity of tests. A markedly high ESR is a screening test but is not definitive. Diagnosis is more likely to be made by eliminating other potential diagnoses, but this is highly dependent on the skills and experience of the diagnostician. The dramatic and immediate response to treatment with corticosteroids is considered by some to be diagnostic.

### Medical Management

The treatment for patients with polymyalgia rheumatica (without giant cell arteritis) is moderate doses of corticosteroids (Klippel, et al., 2008). NSAIDs are sometimes used for mild disease. The treatment for patients with giant cell arteritis is rapid initiation of and strict adherence to a regimen of corticosteroids. This is essential to avoid the complication of blindness. Aspirin is a useful adjunctive treatment that also helps reduce the risk of visual loss (Klippel, et al., 2008).

### Nursing Management

Nursing care of the patient with polymyalgia rheumatica is based on the fundamental plan of nursing care presented earlier (see Chart 54-2). The most common nursing diagnoses are pain and insufficient knowledge of the medication regimen.

A management concern is that the patient will take the prescribed medication, frequently corticosteroids, until symptoms improve and then discontinue the medication. The decision to discontinue the medication should be based on clinical and laboratory findings and the physician's prescription. Nursing implications are related to helping the patient prevent and monitor side effects of medications (eg, infections, diabetes mellitus, gastrointestinal problems, and depression) and adjust to those side effects that cannot be prevented (eg, increased appetite and altered body image).

*NURSING ALERT*

**The nurse must emphasize to the patient the need for continued adherence to the prescribed medication regimen to avoid complications of giant cell arteritis, such as blindness.**

The loss of bone mass with corticosteroid use increases the risk of osteoporosis in this already at-risk population. Interventions to promote bone health, such as adequate dietary calcium and vitamin D, measurement of bone mineral density, weight-bearing exercise, smoking cessation, and reduction of alcohol consumption if indicated, should be emphasized.

## *Degenerative Joint Disease (Osteoarthritis)*

**Osteoarthritis,** also known as degenerative joint disease or osteoarthrosis (even though inflammation may be present), is the most common and most frequently disabling of the joint disorders. OA is both overdiagnosed and trivialized; it is frequently overtreated or undertreated. The functional impact of OA on quality of life, especially for elderly patients, is often ignored.

OA has been classified as primary (idiopathic), with no prior event or disease related to the OA, and secondary, resulting from previous joint injury or inflammatory disease. The distinction between primary and secondary OA is not always clear.

Increasing age directly relates to the degenerative process in the joint, because the ability of the articular cartilage to resist microfracture with repetitive low loads diminishes with age. OA often begins in the third decade of life and peaks between the fifth and sixth decades. By 40 years of age, 90% of the population have degenerative joint changes in their weight-bearing joints, even though clinical symptoms are usually absent. Prevalence of OA is

between 50% and 80% in the elderly (Ganz, Chang, Roth, et al., 2006).

## Pathophysiology

OA may be thought of as the end result of many factors that, when combined, predispose the patient to the disease. OA affects the articular cartilage, **subchondral bone** (the bony plate that supports the articular cartilage), and synovium. A combination of cartilage degradation, bone stiffening, and reactive inflammation of the synovium occurs. Understanding of OA has been greatly expanded beyond what previously was thought of as simply "wear and tear" related to aging. The basic degenerative process in the joint exemplified in OA is presented in Figure 54-3.

Congenital and developmental disorders of the hip are well known for predisposing a person to OA of the hip. These include congenital subluxation–dislocation of the hip, acetabular dysplasia, Legg-Calvé-Perthes disease, and slipped capital femoral epiphysis.

Risk factors for OA include increased age, obesity, previous joint damage, repetitive use (occupational or recreational), anatomic deformity, and genetic susceptibility. Being overweight or obese also increases symptoms associated with the disease (Klippel, et al., 2008). Research has shown that a weight loss of 10% improves function by 28% in people with OA affecting the knee (Christensen, Astrup & Bliddal, 2005).

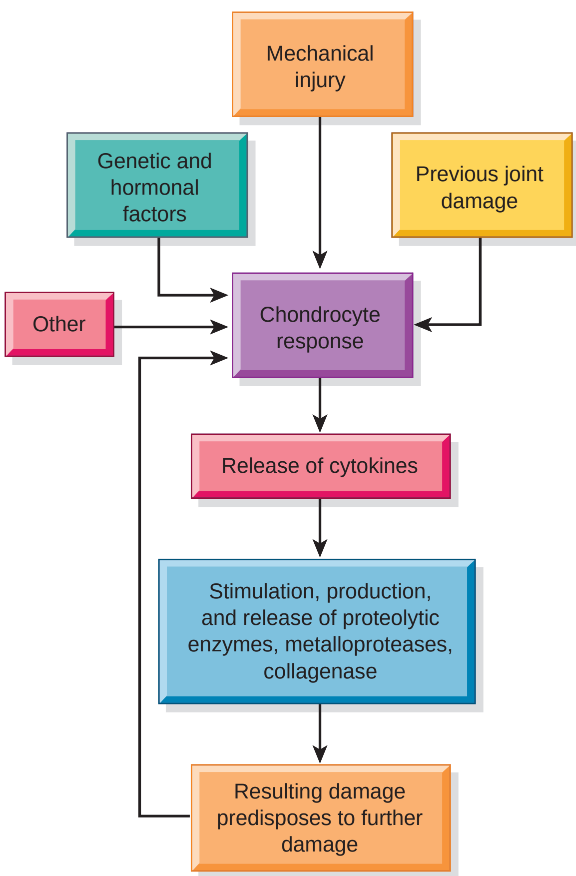



**Figure 54-3** Pathophysiology of osteoarthritis.

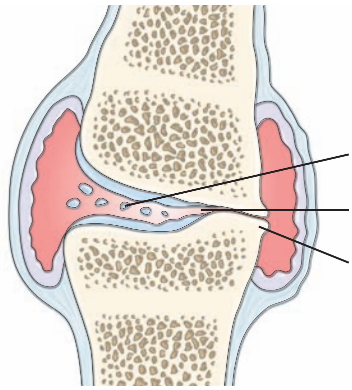



**Figure 54-4** Joint space narrowing and osteophytes (bone spurs) are characteristic of degenerative changes in joints.

## Clinical Manifestations

The primary clinical manifestations of OA are pain, stiffness, and functional impairment. The pain is caused by an inflamed synovium, stretching of the joint capsule or ligaments, irritation of nerve endings in the periosteum over **osteophytes** (bone spurs), trabecular microfracture, intraosseous hypertension, bursitis, tendinitis, and muscle spasm (Fig 54-4). Stiffness, which is most commonly experienced in the morning or after awakening, usually lasts less than 30 minutes and decreases with movement. Functional impairment results from pain on movement and limited motion caused by structural changes in the joints.

Although OA occurs most often in weight-bearing joints (hips, knees, cervical and lumbar spine), the proximal and distal finger joints are also often involved. Characteristic bony nodes may be present; on inspection and palpation, these are usually painless, unless inflammation is present.

## Assessment and Diagnostic Findings

Diagnosis of OA is complicated because only 30% of patients with changes seen on x-ray report symptoms. Physical assessment of the musculoskeletal system reveals tender and enlarged joints. Inflammation, when present, is not the destructive type seen in the connective tissue diseases such as RA. OA is characterized by a progressive loss of the joint cartilage, which appears on x-ray as a narrowing of the joint space. In addition, reactive changes occur at the joint margins and on the subchondral bone in the form of osteophytes as the cartilage attempts to regenerate. Neither the presence of osteophytes nor joint space narrowing alone is specific for OA; however, when combined, these are sensitive and specific findings. In early or mild OA, there is only a weak correlation between joint pain and synovitis. Blood tests are not useful in the diagnosis of OA.

## Medical Management

Although no treatment halts the degenerative process, certain preventive measures can slow the progress if undertaken early enough. These include weight reduction,

prevention of injuries, perinatal screening for congenital hip disease, and ergonomic modifications.

Conservative treatment measures include patient education, the use of heat, weight reduction, joint rest and avoidance of joint overuse, orthotic devices (eg, splints, braces) to support inflamed joints, isometric and postural exercises, and aerobic exercise. Other miscellaneous physical modalities, such as massage, yoga, pulsed electromagnetic fields, transcutaneous electrical nerve stimulation (TENS), and music therapy, have unproven value in the treatment of OA. Occupational and physical therapy can help the patient adopt self-management strategies.

Patients with arthritis often use complementary and alternative therapies, many of which are not traditionally taught in American medical schools and are not traditionally available in American hospitals. These may include herbal and dietary supplements, other special diets, acupuncture, acupressure, wearing copper bracelets or magnets, and participation in T'ai chi. Research is under way to determine the effectiveness of many of these treatments (Little, Parsons & Logan, 2006).

#### Pharmacologic Therapy

Pharmacologic management of OA is directed toward symptom management and pain control. Selection of medication is based on the patient's needs, the stage of disease, and the risk of side effects. Medications are used in conjunction with nonpharmacologic strategies. In most patients with OA, the initial analgesic therapy is acetaminophen. Some patients respond to the nonselective NSAIDs, and patients who are at increased risk for gastrointestinal complications, especially gastrointestinal bleeding, have been managed effectively with COX-2 enzyme blockers. However, COX-2 enzyme blockers must be used with caution because of the associated risk of cardiovascular disease. Other medications that may be considered are the opioids and intra-articular corticosteroids. Topical analgesic agents such as capsaicin (Capsin, Zostrix) and methylsalicylate are also used (Klippel, et al., 2008).

Other therapeutic approaches include glucosamine and chondroitin. Although it has been suggested that these substances modify cartilage structure, studies have not shown them to be effective (Towheed, Maxwell, Anastassiades, et al., 2006). Viscosupplementation, the injection of gel-like substances (hyaluronates), into a joint (intra-articular) is thought to supplement the viscous properties of synovial fluid. Five hyaluronates are currently approved by the FDA for joint injection in OA (Eustice & Eustice, 2006).

#### Surgical Management

In moderate to severe OA, when pain is severe or because of loss of function, surgical intervention may be used. The procedures most commonly used are osteotomy (to alter the distribution of weight within the joint) and arthroplasty. In arthroplasty, diseased joint components are replaced (see Chapter 67).

### Nursing Management

Nursing management of the patient with OA includes both pharmacologic and nonpharmacologic approaches. Nonpharmacologic interventions are used first and continued with pharmacologic agents. Pain management and optimal functional ability are major goals of nursing intervention. The patient's understanding of the disease process and symptom pattern is critical to a plan of care. Because patients with OA usually are older, they may have other health problems. Commonly they are overweight, and they may have a sedentary lifestyle. Weight loss and exercise are important approaches to pain and disability improvement (Christensen, et al., 2005; Klippel, et al., 2008). A referral for physical therapy or to an exercise program for people with similar problems can be very helpful. Canes or other assistive devices for ambulation should be considered. Exercises such as walking should be begun in moderation and increased gradually. Patients should plan their daily exercise for a time when the pain is least severe or plan to use an analgesic agent, if appropriate, before exercising. Adequate pain management is important for the success of an exercise program. Open discussion regarding the use of complementary and alternative therapies is important to maintain safe and effective practices for patients looking for a "cure."

## Spondyloarthropathies

The spondyloarthropathies are another category of systemic inflammatory disorders of the skeleton. The spondyloarthropathies include ankylosing spondylitis, reactive arthritis (Reiter's syndrome), and psoriatic arthritis. Spondyloarthritis is also associated with inflammatory bowel diseases such as regional enteritis (Crohn's disease) and ulcerative colitis.

These rheumatic diseases share several clinical features. The inflammation tends to occur peripherally at the sites of attachment—at tendons, joint capsules, and ligaments. Periosteal inflammation may be present. Many patients have arthritis of the sacroiliac joints. Onset tends to occur during young adulthood, with the disease affecting men more often than women. There is a strong tendency for these conditions to occur in families. Frequently, the HLA-B27 genetic marker is found.

### Types of Spondyloarthropathies

#### Ankylosing Spondylitis

Ankylosing spondylitis affects the cartilaginous joints of the spine and surrounding tissues. Occasionally, the large synovial joints, such as the hips, knees, or shoulders, may be involved. Ankylosing spondylitis is more prevalent in males than in females and is usually diagnosed in the second or third decade of life. The disease is more severe in males, and significant systemic involvement is likely. Back pain is the characteristic feature. As the disease progresses, ankylosis of the entire spine may occur, leading to respiratory compromise and complications.

#### *Reactive Arthritis (Reiter's Syndrome)*

The disease process involved in Reiter's syndrome is called reactive because the arthritis occurs after an infection. It mostly affects young adult males and is characterized primarily by urethritis, arthritis, and conjunctivitis. Dermatitis and ulcerations of the mouth and penis may also be present. Low back pain is common.

#### *Psoriatic Arthritis*

Psoriatic arthritis is characterized by synovitis, polyarthritis, and spondylitis. Both psoriasis and arthritis are common conditions, and one theory suggests that the overlap of the two conditions is a chance occurrence. However, epidemiologic data suggest that the prevalence of arthritis in patients with psoriasis is 15% to 25%, exceeding the rate in the general population. Similarly, the prevalence of psoriasis in persons with arthritis is 2.6% to 7.0%, compared with 0.1% to 2.8% in the general population, supporting the theory that these two processes occur together in a unique disease process (Klippel, et al., 2008).

### Medical Management

Medical management of spondyloarthropathies focuses on treating pain and maintaining mobility by suppressing inflammation. For the patient with ankylosing spondylitis, good body positioning and posture are essential, so that if **ankylosis** (fixation) does occur, the patient is in the most functional position. Maintaining range of motion with a regular exercise and muscle-strengthening program is especially important.

#### *Pharmacologic Management*

NSAIDs and corticosteroids often produce marked improvement in back, skin, and joint symptoms. Sulfasalazine (Azulfidine) and methotrexate (Rheumatrex) may help with peripheral joint disease. Methotrexate is also used to control psoriasis. More recently, anti-TNF therapy is under investigation for treatment of the spondyloarthropathies (Klippel, et al., 2008).

#### *Surgical Management*

Surgical management may include total joint replacement (see Chapter 67).

### Nursing Management

Major nursing interventions in the spondyloarthropathies are related to symptom management and maintenance of optimal functioning. Affected patients are primarily young men. Their major concerns are often related to prognosis and job modification, especially among those who perform physical work. Patients may also express concerns about leisure and recreational activities.

## *Metabolic and Endocrine Diseases Associated With Rheumatic Disorders*

Metabolic and endocrine diseases may be associated with rheumatic disorders. These include biochemical abnormalities (amyloidosis and scurvy), endocrine diseases (diabetes mellitus and acromegaly), immunodeficiency diseases (human immunodeficiency virus [HIV] infection, acquired immunodeficiency syndrome [AIDS]), and some inherited disorders (hypermobility syndromes). However, the most common conditions are the crystal-induced arthropathies, in which crystals such as monosodium urate (gout) or calcium pyrophosphate (calcium pyrophosphate dihydrate disease [CPPD] or pseudogout) are deposited within joints and other tissues.

## GOUT

Gout is a heterogeneous group of conditions related to a genetic defect of purine metabolism that results in hyperuricemia. Oversecretion of uric acid or a renal defect resulting in decreased excretion of uric acid, or a combination of both, occurs. The prevalence is reported to be about 2% and appears to be on the rise. The incidence of gout increases with age and body mass index, and the disorder occurs more commonly in males than in females (Singh, Hodges, Toscano, et al., 2007).

In primary hyperuricemia, elevated serum urate levels or manifestations of urate deposition appear to be consequences of faulty uric acid metabolism. Primary hyperuricemia may be caused by severe dieting or starvation, excessive intake of foods that are high in purines (shellfish, organ meats), or heredity. In secondary hyperuricemia, gout is a clinical feature secondary to any of a number of genetic or acquired processes, including conditions in which there is an increase in cell turnover (leukemia, multiple myeloma, some types of anemias, psoriasis) and an increase in cell breakdown. Altered renal tubular function, either as a major action or as an unintended side effect of certain pharmacologic agents (eg, diuretics such as thiazides and furosemide), low-dose salicylates, or ethanol, can contribute to uric acid underexcretion.

### Pathophysiology

Hyperuricemia (serum concentration greater than 7 mg/dL) can, but does not always, cause urate crystal deposition (Karpoff & Labus, 2008). However, as uric acid levels increase, the risk becomes greater. Attacks of gout appear to be related to sudden increases or decreases of serum uric acid levels. When the urate crystals precipitate within a joint, an inflammatory response occurs, and an attack of gout begins. With repeated attacks, accumulations of sodium urate crystals, called **tophi,** are deposited in peripheral areas of the body, such as the great toe, the hands, and the ear. Renal urate lithiasis (kidney stones), with chronic renal disease secondary to urate deposition, may develop.

The finding of urate crystals in the synovial fluid of asymptomatic joints suggests that factors other than crystals may be related to the inflammatory reaction. Recovered monosodium urate crystals are coated with immunoglobulins that are mainly IgG. IgG enhances crystal phagocytosis, thereby demonstrating immunologic activity (Klippel, et al., 2008).

### Clinical Manifestations

Manifestations of the gout syndrome include acute gouty arthritis (recurrent attacks of severe articular and periarticular inflammation), tophi (crystalline deposits

accumulating in articular tissue, osseous tissue, soft tissue, and cartilage), gouty nephropathy (renal impairment), and uric acid urinary calculi. Four stages of gout can be identified: asymptomatic hyperuricemia, acute gouty arthritis, intercritical gout, and chronic tophaceous gout. The subsequent development of gout is directly related to the duration and magnitude of the hyperuricemia. Therefore, the commitment to lifelong pharmacologic treatment of hyperuricemia is deferred until there is an initial attack of gout.

For hyperuricemic people who are going to develop gout, acute arthritis is the most common early clinical manifestation. The metatarsophalangeal joint of the big toe is the most commonly affected joint (90% of patients) (Porth & Matfin, 2009). The tarsal area, ankle, or knee may also be affected. Less commonly, the wrists, fingers, and elbows may be affected. Trauma, alcohol ingestion, dieting, medications, surgical stress, or illness may trigger the acute attack. The abrupt onset often occurs at night, awakening the patient with severe pain, redness, swelling, and warmth of the affected joint. Early attacks tend to subside spontaneously over 3 to 10 days even without treatment. The attack is followed by a symptom-free period (the intercritical stage) until the next attack, which may not come for months or years. However, with time, attacks tend to occur more frequently, to involve more joints, and to last longer.

Tophi are generally associated with more frequent and severe inflammatory episodes. Higher serum concentrations of uric acid are also associated with more extensive tophus formation. Tophi most commonly occur in the synovium, olecranon bursa, subchondral bone, infrapatellar and Achilles tendons, and subcutaneous tissue on the extensor surface of the forearms and overlying joints. They have also been found in the aortic walls, heart valves, nasal and ear cartilage, eyelids, cornea, and sclerae. Joint enlargement may cause a loss of joint motion. Uric acid deposits may cause renal stones and kidney damage.

## Medical Management

A definitive diagnosis of gouty arthritis is established by polarized light microscopy of the synovial fluid of the involved joint. Uric acid crystals are seen within the polymorphonuclear leukocytes in the fluid. Colchicine (oral or parenteral), an NSAID such as indomethacin, or a corticosteroid is prescribed to relieve an acute attack of gout. Management of hyperuricemia, tophi, joint destruction, and renal disorders is usually initiated after the acute inflammatory process has subsided. Uricosuric agents, such as probenecid (Benemid), correct hyperuricemia and dissolve deposited urate. When reduction of the serum urate level is indicated, uricosuric agents are the medications of choice. If the patient has, or is at risk for, renal insufficiency or renal calculi (kidney stones), allopurinol, a xanthine oxidase inhibitor, is recommended (Singh, et al., 2007). A new medication, febuxostat (Uloric), was approved by the FDA in 2009 for the treatment of gout that does not respond to usual treatment. Corticosteroids may also be used in patients who have no response to other therapy. If the patient experiences several acute episodes or there is evidence of tophi formation, prophylactic treatment is considered. Specific treatment is based on the serum uric acid level, 24-hour urinary uric acid excretion, and renal function (Table 54-5).

## Nursing Management

Historically, gouty arthritis was thought to be a condition of royalty and the very rich, with the disease attributed to "high living." This has not been shown to be entirely true. Although severe dietary restriction is not necessary, the nurse should encourage the patient to restrict consumption of foods high in purines, especially organ meats, and to limit alcohol intake. Maintenance of normal body weight should be encouraged. In an acute episode of gouty arthritis, pain management with prescribed medications is essential, along with avoidance of factors that increase pain and inflammation, such as trauma, stress, and alcohol. Between acute episodes, the patient feels well and may abandon preventive behaviors, which may result in an acute attack. Acute attacks are most effectively treated if therapy is begun early in the course.

# *Fibromyalgia*

Fibromyalgia is a chronic pain syndrome that involves chronic fatigue, generalized muscle aching, and stiffness. Two percent of the United States population is affected by this syndrome, with a prevalence rate of 4% in women and 0.5% in men (Klippel, et al., 2008). See Chapter 13.

**Table 54-5 MEDICATIONS USED TO TREAT GOUT**

| Medication | Actions and Use | Nursing Implications |
|---|---|---|
| colchicine | Lowers the deposition of uric acid and interferes with leukocyte infiltration, thus reducing inflammation; does not alter serum or urine levels of uric acid; used in acute and chronic management | *Acute management:* Administer when attack begins; dosage increased until pain is relieved or diarrhea develops<br>*Chronic management:* Causes GI upset in most patients |
| probenecid (Benemid) | Uricosuric agent; inhibits renal reabsorption of urates and increases the urinary excretion of uric acid; prevents tophi formation | Be alert for nausea and rash. |
| allopurinol (Zyloprim)<br>febuxostat (Uloric) | Xanthine oxidase inhibitors; interrupt the breakdown of purines before uric acid is formed; inhibits xanthinoxidase because it blocks uric acid formation | Monitor for side effects, including bone marrow depression, vomiting, and abdominal pain. |

### Medical Management

Treatment consists of attention to the specific symptoms reported by the patient. NSAIDs may be used to treat the diffuse muscle aching and stiffness. Tricyclic antidepressants are used to improve or restore normal sleep patterns. In addition, selective serotonin reuptake inhibitors and anticonvulsants have been effective in preliminary reports (Klippel, et al., 2008). Individualized programs of exercise are used to decrease muscle weakness and discomfort and to improve the general deconditioning that occurs in affected patients.

### Nursing Management

Typically, patients with fibromyalgia have endured their symptoms for a long period of time. They may feel as if their symptoms have not been taken seriously. Nurses need to pay special attention to supporting these patients and providing encouragement as they begin their program of therapy. Patient support groups may be helpful. Careful listening to patients' descriptions of their concerns and symptoms is essential to help them make the changes that are necessary to improve their quality of life (Schaefer, 2005).

## Arthritis Associated With Infectious Organisms

Arthritis, tenosynovitis, and bursitis can be associated with infectious organisms. Some inflammation of joints, tendons, and bursae is directly related to infection caused by bacterial, viral, fungal, or parasitic agents. Bacterial arthritis is the most rapidly destructive form of infectious arthritis. There are two major classes of bacterial arthritis: that caused by *Neisseria gonorrhoeae* and that caused by a nongonococcal bacterium. The most prevalent of the nongonococcal organisms include *Staphylococcus aureus* and the various streptococcal variants. Less common pathogens are related to syphilis, tuberculosis, leprosy, fungi (particularly coccidioidomycosis), mycoplasmas, and viral agents such as rubella, parvovirus, and hepatitis B.

### Clinical Manifestations

The characteristic symptom is acute onset of a warm, swollen joint. Culture of the bacterium from the synovial fluid confirms the diagnosis. The patient often immobilizes the joint and elevates the affected extremity because of pain and swelling. Fever may be high, or it may be absent. Signs of systemic infection may be absent in elderly patients, in those with diabetes, and in those with suppressed immune systems. Diagnosis and treatment may be delayed by patients with preexisting arthritic conditions if they attribute the symptoms to a flare-up of arthritis.

### Management

This condition is a medical emergency necessitating early diagnosis and appropriate treatment to eliminate the causative organism; otherwise, the joint may be destroyed relatively quickly. Treatment consists of parenteral antibiotics and drainage of the joint. The results of cultures are used to determine the appropriate antibiotic therapy. Immobilization of the joint and repeated joint aspirations may be necessary along with IV antibiotics. Nursing management focuses on providing pain relief, administering antibiotics, and assisting the patient with self-care activities. If the patient is sent home on IV antibiotic therapy, the nurse arranges for home care and instructs the patient and care providers in safe administration of the drug and changes that should be reported to a health care provider.

## Neoplasms and Neurovascular, Bone, and Extra-Articular Disorders

Primary neoplasms of joints, tendon sheaths, and bursae are rare. Most neoplasms are benign, arising from the synovium. These benign tumors include lipoma, hemangioma, fibroma, and tumorlike lesions such as ganglion, bursitis, and synovial cyst. Malignant tumors include primary tumors, such as synovial and bone sarcomas, and secondary involvement as manifestations of joint invasion by leukemia, lymphoma, myeloma, or metastasis. Neoplasms may manifest as back or neck pain.

Neurovascular disorders include the compression syndromes, such as those with peripheral entrapment (eg, carpal tunnel syndrome), radiculopathy, and spinal stenosis. Raynaud's phenomenon and erythromelalgia (throbbing and burning pain often affecting the hands and feet) are also included in this category.

Bone and cartilage disorders include osteoporosis, osteomalacia, hypertrophic osteoarthropathy, diffuse idiopathic skeletal hyperostosis, Paget's disease, osteonecrosis, avascular necrosis, costochondritis, osteolysis or chondrolysis, and biomechanical or anatomic abnormalities. Notably, these conditions involve resorption, destruction, infection, or remodeling of bone.

Extra-articular rheumatism is a descriptive term for a group of conditions that affect structures other than the joints. Included are general and regional pain syndromes, low back pain and intervertebral disk disorders, tendonitis and bursitis, and ganglion cysts.

## Miscellaneous Disorders

The last category in the classification of the rheumatic diseases is aptly labeled miscellaneous disorders because it contains a mix of disorders that are frequently associated with arthritis and other conditions. These include the direct consequences of trauma (including internal derangement and loose bodies of joints), pancreatic disease (related to avascular necrosis or osteonecrosis), sarcoidosis (a multisystem disorder particularly of the lymph nodes and lungs), and palindromic rheumatism (an uncommon variety of recurring and acute arthritis and periarthritis that in some may progress to RA but is characterized by symptom-free periods of days to months). Other conditions include villonodular synovitis, chronic active hepatitis, and drug-related rheumatic syndromes. The nursing

interventions related to these varied conditions are specific to the multisystemic problems experienced by the patient. However, the musculoskeletal components should not be neglected or overlooked. Further information about these rare disorders can be found in specialty references.

## CRITICAL THINKING EXERCISES

**1** Your patient with a rheumatic disorder has NSAIDs, corticosteroids, and a biologic response modifier prescribed. How do the actions, uses, and indications of these medications differ? What instructions and recommendations would you give to the patient to ensure their safe administration?

EBP **2** A 30-year-old woman with a recent diagnosis of RA states she is having joint pain, stiffness, and swelling, especially in her hands and wrists. What resources would you use to identify the current guidelines for treatment of patients with RA? What is the evidence base for these treatment practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

**3** A 79-year-old woman with a 10-year history of OA of the right knee complains of pain every day and difficulty walking. She is taking multiple medications and currently she uses a walker to ambulate but needs to stop and rest every so often because of the pain. Describe the pharmacologic treatment and nursing measures that are indicated for this patient. What teaching is important for the patient? How would you modify your teaching if the patient understands little English?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/ Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*

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## RESOURCES

American College of Rheumatology and Association of Rheumatology Health Professionals, www.rheumatology.org

American Fibromyalgia Syndrome Association, Inc., www.afsafund.org

Arthritis Foundation, www.arthritis.org

Centers for Disease Control & Prevention, www.cdc.gov

Lupus Foundation of America, Inc., www.lupus.org

National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, www.niams.nih.gov

Scleroderma Foundation, www.scleroderma.org

Sjögren's Syndrome Foundation, www.sjogrens.org

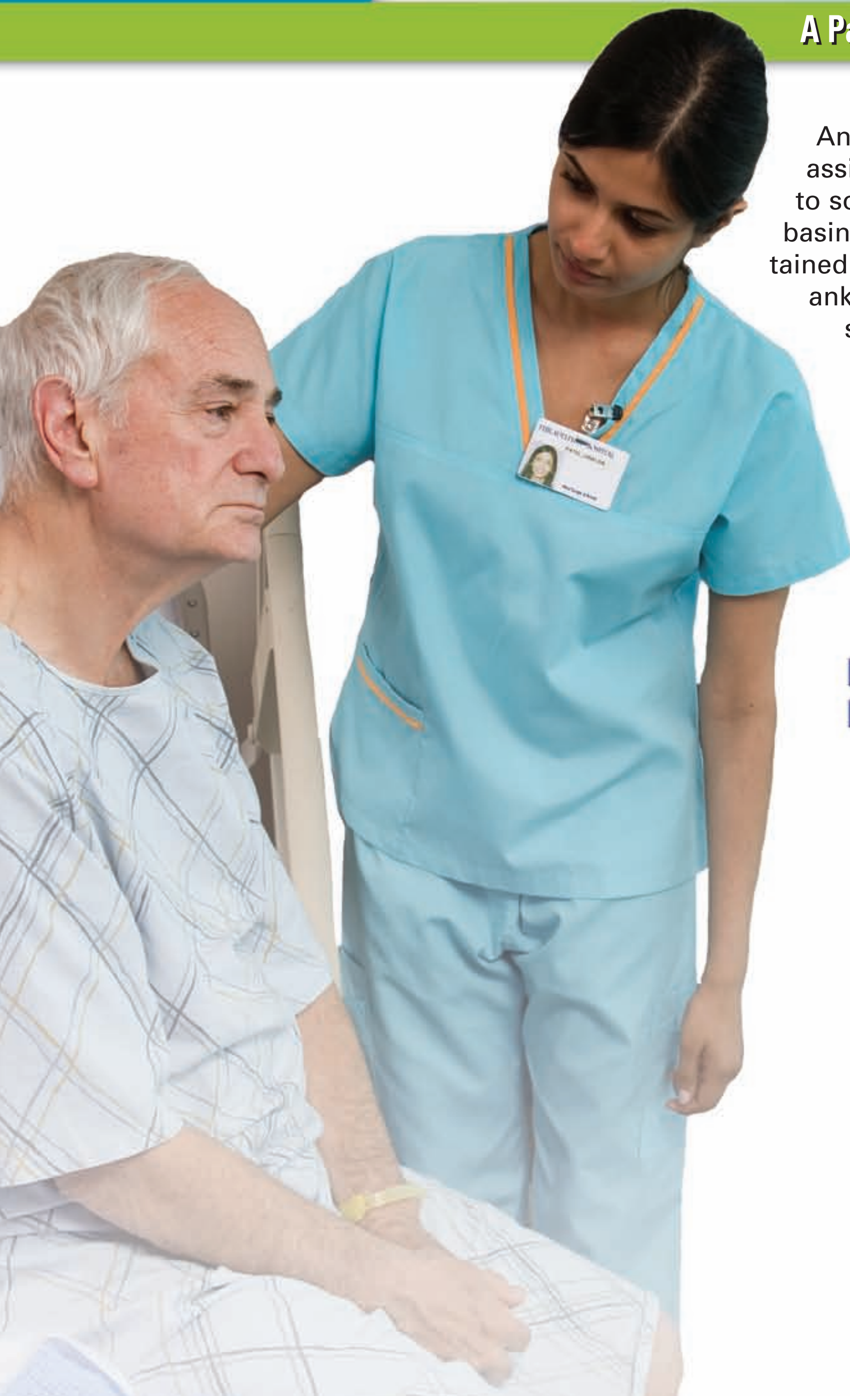
Spondylitis Association of America, www.spondylitis.org

unit 12

# Integumentary Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With a Thermal Injury



An 87-year-old man who lives with his wife at an assisted living residence. He filled a basin of water to soak his feet and immersed his left foot in the basin before checking the water temperature. He sustained a deep partial-thickness burn on his foot and ankle and has been admitted to the residence's skilled nursing unit. The nurse notes that the skin of his left foot is bright red and there are three 2- to 4-cm blisters on the dorsum. The burn is quite painful and he cannot bear weight on his foot. His wife states that she is concerned because he is not eating his meals.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **IMPAIRED SKIN INTEGRITY—**Altered epidermis and/or dermis | **SKIN CARE: TOPICAL TREATMENTS—**Application of topical substances or manipulation of devices to promote skin integrity and minimize skin breakdown | **WOUND HEALING: SECONDARY INTENTION—**Extent of regeneration of cells and tissues in an open wound |
| **ACUTE PAIN—**Unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage; sudden or slow onset of any intensity from mild to severe with an anticipated or predictable end and a duration of less than 6 months | **WOUND CARE—**Prevention of wound complications and promotion of wound healing | **PAIN CONTROL—**Personal actions to control pain |
| **RISK FOR INFECTION—**At increased risk for being invaded by pathogenic organisms | **PAIN MANAGEMENT—**Alleviation of pain or reduction in pain to a level of comfort that is acceptable to the patient | **INFECTION SEVERITY—**Severity of infection and associated symptoms |
| **RISK FOR IMBALANCED NUTRITION: LESS THAN BODY REQUIREMENTS—**At risk for intake of nutrients insufficient to meet metabolic needs | **INFECTION PROTECTION—**Prevention and early detection of infection in a patient at risk | **NUTRITIONAL STATUS—**Extent to which nutrients are available to meet metabolic needs |
| | **NUTRITION MANAGEMENT—**Assisting with or providing a balanced dietary intake of foods and fluids | |


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chapter 55

# Assessment of Integumentary Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the structures and functions of the skin.
2. Differentiate the composition and function of each skin layer: epidermis, dermis, and subcutaneous tissue.
3. Describe the normal aging process of the skin and skin changes common in elderly patients.
4. List appropriate questions that help elicit information during an assessment of the skin.
5. Describe the components of physical assessment that are most useful when examining the skin, hair, and nails.
6. Identify and describe primary and secondary skin lesions and their pattern and distribution.
7. Recognize common skin eruptions and manifestations associated with systemic disease.
8. Discuss common skin tests and procedures used in diagnosing skin and related disorders.

## GLOSSARY

**alopecia:** loss of hair from any cause
**dermatosis:** any abnormal skin condition
**erythema:** redness of the skin caused by congestion of the capillaries
**hirsutism:** the condition of having excessive hair growth
**hyperpigmentation:** increase in the melanin of the skin, resulting in an increase in pigmentation
**hypopigmentation:** decrease in the melanin of the skin, resulting in a loss of pigmentation
**keratin:** an insoluble, fibrous protein that forms the outer layer of skin
**Langerhans cells:** dendritic clear cells in the epidermis that carry surface receptors for immunoglobulin and complement and that are active participants in delayed hypersensitivity of the skin
**melanin:** the substance responsible for coloration of the skin
**melanocytes:** cells of the skin that produce melanin
**Merkel cells:** cells of the epidermis that play a role in transmission of sensory messages
**petechiae:** pinpoint red spots that appear on the skin as a result of blood leakage into the skin
**rete ridges:** undulations and furrows that appear at the dermis–epidermis junction and are responsible for cementing together the two layers
**sebaceous glands:** glands that exist within the epidermis and secrete sebum to keep the skin soft and pliable
**sebum:** fatty secretion of the sebaceous glands
**telangiectases:** red marks on the skin caused by distention of the superficial blood vessels
**vitiligo:** a localized or widespread condition characterized by destruction of the melanocytes in circumscribed areas of the skin, resulting in white patches
**Wood's light:** a blue light used for diagnosing skin conditions

Skin disorders are encountered frequently in nursing practice. Skin-related disorders account for up to 10% of all ambulatory patient visits in the United States. Because the skin mirrors the general condition of the patient, many systemic conditions may be accompanied by dermatologic manifestations.

The psychological stress of illness or various personal and family problems is commonly exhibited outwardly as dermatologic problems. Any hospitalized patient may suddenly develop itching and a rash from the treatment regimen. In certain systemic conditions, such as hepatitis and some cancers, dermatologic manifestations may be the first sign of the disorder and the primary reason that a patient seeks health care.

# Anatomic and Physiologic Overview

The largest organ system of the body, the skin, is essential for human life. It forms a barrier between the internal organs and the external environment and participates in many vital body functions. The skin is contiguous with the mucous membrane at the external openings of the digestive, respiratory, and urogenital systems.

## Anatomy of the Skin, Hair, Nails, and Glands of the Skin

### Skin

The skin is composed of three layers: epidermis, dermis, and subcutaneous tissue (Fig. 55-1). The epidermis is an outermost layer of stratified epithelial cells composed predominantly of keratinocytes. It ranges in thickness from about 0.1 mm on the eyelids to about 1 mm on the palms of the hands and soles of the feet. Four distinct layers compose the epidermis; from innermost to outermost they are the stratum germinativum, stratum granulosum, stratum lucidum, and stratum corneum. Each layer becomes more differentiated (ie, mature and with more specific functions) as it rises from the basal stratum germinativum layer to the outermost stratum corneum layer.

#### Epidermis

The epidermis, which is contiguous with the mucous membranes and the lining of the ear canals, consists of live, continuously dividing cells covered on the surface by dead cells that were originally deeper in the dermis but were pushed upward by the newly developing, more differentiated cells underneath. This external layer is almost completely replaced every 3 to 4 weeks. The dead cells contain large amounts of **keratin,** an insoluble, fibrous protein that forms the outer barrier of the skin and has the capacity to repel pathogens and prevent excessive fluid loss from the body. Keratin is the principal hardening ingredient of the hair and nails.

**Melanocytes** are the special cells of the epidermis that are primarily involved in producing the pigment **melanin,** which colors the skin and hair. Skin color darkens as melanin content increases. Most of the skin of dark-skinned people and the darker areas of the skin on light-skinned people (eg, the nipple) contain larger amounts of this pigment. Normal skin color depends on race and varies from pale, almost ivory, to deep brown, almost pure black. Systemic disease affects skin color as well. For example, the skin appears bluish when there is insufficient oxygenation of the blood, yellow-green in people with jaundice, or red or flushed when there is inflammation or fever.

Production of melanin is controlled by a hormone secreted from the hypothalamus of the brain called melanocyte-stimulating hormone. It is believed that melanin can absorb ultraviolet light in sunlight.

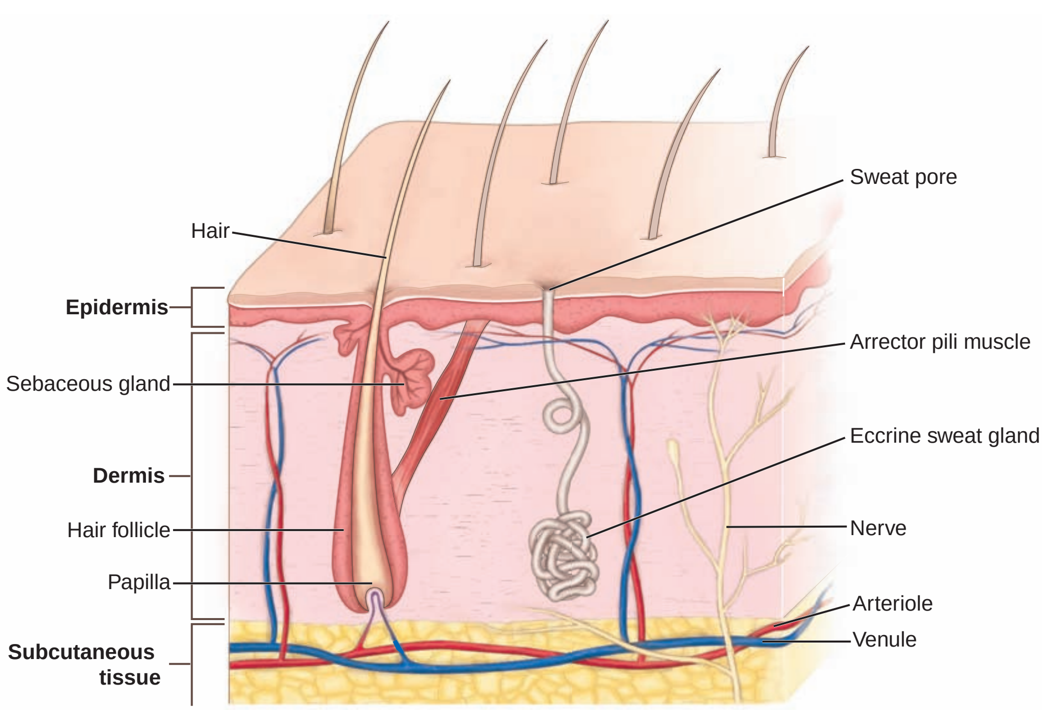



**Figure 55-1** Anatomic structures of the skin.

Two other types of cells are common to the epidermis: Merkel and Langerhans cells. **Merkel cells** are receptors that transmit stimuli to the axon through a chemical synapse. **Langerhans cells** are believed to play a significant role in cutaneous immune system reactions. These accessory cells of the afferent immune system process invading antigens and transport the antigens to the lymph system to activate the T lymphocytes.

The characteristics of the epidermis vary in different areas of the body. It is thickest over the palms of the hands and soles of the feet and contains increased amounts of keratin. The thickness of the epidermis can increase with use and can result in calluses forming on the hands or corns forming on the feet.

The junction of the epidermis and dermis is an area of many undulations and furrows called **rete ridges.** This junction anchors the epidermis to the dermis and permits the free exchange of essential nutrients between the two layers. This interlocking between the dermis and epidermis produces ripples on the surface of the skin. On the fingertips, these ripples are called fingerprints. They are a person's most individual physical characteristic, and they rarely change.

#### Dermis

The dermis makes up the largest portion of the skin, providing strength and structure. It is composed of two layers: papillary and reticular. The papillary dermis lies directly beneath the epidermis and is composed primarily of fibroblast cells capable of producing one form of collagen, a component of connective tissue. The reticular layer lies beneath the papillary layer and also produces collagen and elastic bundles. The dermis is also made up of blood and lymph vessels, nerves, sweat and sebaceous glands, and hair roots. The dermis is often referred to as the "true skin."

#### Subcutaneous Tissue

The subcutaneous tissue, or hypodermis, is the innermost layer of the skin. It is primarily adipose tissue, which provides a cushion between the skin layers, muscles, and bones. It promotes skin mobility, molds body contours, and insulates the body. Fat is deposited and distributed according to the person's gender and in part accounts for the difference in body shape between men and women. Overeating results in increased deposition of fat beneath the skin. The subcutaneous tissues and the amount of fat deposited are important factors in body temperature regulation.

### Hair

An outgrowth of the skin, hair is present over the entire body except for the palms and soles. The hair consists of a root formed in the dermis and a hair shaft that projects beyond the skin. It grows in a cavity called a hair follicle. Proliferation of cells in the bulb of the hair causes the hair to form (see Fig. 55-1).

Hair follicles undergo cycles of growth and rest. The rate of growth varies; beard growth is the most rapid, followed by hair on the scalp, axillae, thighs, and eyebrows. The growth or anagen phase may last up to 6 years for scalp hair, whereas the telogen or resting phase lasts approximately 4 months. During telogen, hair is shed from the body. The hair follicle recycles into the growing phase spontaneously, or it can be induced by plucking hairs. Growing and resting hairs can be found side by side on all parts of the body. About 90% of the 100,000 hair follicles on a normal scalp are in the growing phase at any one time, and 50 to 100 scalp hairs are shed each day.

There is a small bulge on the side of the hair follicle that houses the stem cells that migrate down to the follicle root and begin the cycle of reproducing the hair shaft. These bulges also contain the stem cells that migrate upward to reproduce skin. The location of these cells on the side of the hair shaft, rather than at the base, is a factor in hair loss. In conditions in which inflammation causes damage to the root of the hair, regrowth is possible. However, if inflammation causes damage to the side of the hair follicle, stem cells are destroyed and the hair does not grow.

In certain locations on the body, hair growth is controlled by sex hormones. The most obvious example is the growth of hair on the face (ie, beard and mustache), chest, and back, which is controlled by the male hormones known as androgens. Some women with higher levels of testosterone have hair in the areas generally thought of as masculine, such as the face, chest, and lower abdomen. This is often a normal genetic variation, but if it appears along with irregular menses and weight changes, it may indicate a hormonal imbalance.

Hair in different parts of the body serves different functions. The hairs of the eyes (ie, eyebrows and lashes), nose, and ears filter out dust, bugs, and airborne debris. The hair of the skin provides thermal insulation in mammals with hair or fur. This function is enhanced during cold or fright by piloerection (ie, hairs standing on end), caused by contraction of the tiny erector muscles attached to the hair follicle. The piloerector response that occurs in humans is probably vestigial (ie, rudimentary).

Hair color is supplied by various amounts of melanin within the hair shaft. Gray or white hair reflects the loss of pigment. Hair quantity and distribution can be affected by endocrine conditions. For example, Cushing's syndrome causes **hirsutism,** especially in women, and hypothyroidism (ie, underactive thyroid) causes changes in hair texture. **Alopecia** is the general loss of hair caused by various factors. Chemotherapy and radiation therapy cause hair thinning or weakening of the hair shaft. Several autoimmune disorders, including systemic lupus erythematosis and alopecia areata, cause hair loss in smaller defined areas. Folliculitis of the scalp will cause inflammation of the hair roots and scarring alopecia.

### Nails

On the dorsal surface of the fingers and toes, a hard, transparent plate of keratin, called the nail, overlies the skin. The nail grows from its root, which lies under a thin fold of skin called the cuticle. The nail protects the fingers and toes by preserving their highly developed sensory functions, such as for picking up small objects.

Nail growth is continuous throughout life, with an average growth of 0.1 mm daily. Growth is faster in fingernails than toenails and tends to slow with aging. Complete renewal of a fingernail takes about 170 days, whereas toenail renewal takes 12 to 18 months.

### Glands of the Skin

There are two types of skin glands: sebaceous glands and sweat glands (see Fig. 55-1). The **sebaceous glands** are associated with hair follicles. The ducts of the sebaceous glands empty **sebum** onto the space between the hair follicle and the hair shaft, thus lubricating the hair and rendering the skin soft and pliable.

Sweat glands are found in the skin over most of the body surface, but they are most heavily concentrated in the palms of the hands and soles of the feet. Only the glans penis, the margins of the lips, the external ear, and the nail bed are devoid of sweat glands. Sweat glands are subclassified into two categories: eccrine and apocrine.

The eccrine sweat glands are found in all areas of the skin. Their ducts open directly onto the skin surface. The thin, watery secretion called sweat is produced in the basal coiled portion of the eccrine gland and is released into its narrow duct. Sweat is composed predominantly of water and contains about half of the salt content of blood plasma. Sweat is released from eccrine glands in response to elevated ambient temperature and elevated body temperature. The rate of sweat secretion is under the control of the sympathetic nervous system. Excessive sweating of the palms and soles, axillae, forehead, and other areas may occur in response to pain and stress.

The apocrine sweat glands are larger than eccrine sweat glands and are located in the axillae, anal region, scrotum, and labia majora. Their ducts generally open onto hair follicles. The apocrine glands become active at puberty. In women, they enlarge and recede with each menstrual cycle. Apocrine glands produce a milky sweat that is sometimes broken down by bacteria to produce the characteristic underarm odor. Specialized apocrine glands called ceruminous glands are found in the external ear, where they produce cerumen (ie, wax).

## Functions of the Skin

### Protection

The skin covering most of the body is no more than 1 mm thick, but it provides very effective protection against invasion by bacteria and other foreign matter. The thickened skin of the palms and soles protects against the effects of the constant trauma that occurs in these areas.

The stratum corneum, the outer layer of the epidermis, provides the most effective barrier to epidermal water loss and penetration of environmental factors such as chemicals, microbes, and insect bites.

Various lipids are synthesized in the stratum corneum and are the basis for the barrier function of this layer. These are long-chain lipids that are better suited than phospholipids for water resistance. The presence of these lipids in the stratum corneum creates a relatively impermeable barrier for water loss and for the entry of toxins, microbes, and other substances that come in contact with the surface of the skin.

Some substances do penetrate the skin but meet resistance in trying to move through the channels between the cell layers of the stratum corneum. Microbes and fungi, which are part of the body's normal flora, cannot penetrate unless there is a break in the skin barrier.

The dermis–epidermis junction is the basal layer, which is composed of collagen. The basal layer serves four functions. It acts as a scaffold for tissue organization and a template for regeneration; it provides selective permeability for filtration of serum; it is a physical barrier between different types of cells; and it binds the epithelium to underlying cell layers.

### Sensation

The receptor endings of nerves in the skin allow the body to constantly monitor the conditions of the immediate environment. The primary functions of the receptors in the skin are to sense temperature, pain, light touch, and pressure (or heavy touch). Different nerve endings respond to each of the different stimuli. Although the nerve endings are distributed over the entire body, they are more concentrated in some areas than in others. For example, the fingertips are more densely innervated than the skin on the back.

### Fluid Balance

The stratum corneum, the outermost layer of the epidermis, has the capacity to absorb water, thereby preventing an excessive loss of water and electrolytes from the internal body and retaining moisture in the subcutaneous tissues. When skin is damaged, as occurs with a severe burn, large quantities of fluids and electrolytes may be lost rapidly, possibly leading to circulatory collapse, shock, and death.

The skin is not completely impermeable to water. Small amounts of water continuously evaporate from the skin surface. This evaporation, called insensible perspiration, amounts to approximately 600 mL daily in a normal adult. Insensible water loss varies with the body and ambient temperature. In a person with a fever, the loss can increase. During immersion in water, the skin can accumulate water up to three or four times its normal weight, such as the swelling of the skin that occurs after prolonged bathing.

### Temperature Regulation

The body continuously produces heat as a result of the metabolism of food, which produces energy. This heat is dissipated primarily through the skin. Three major physical processes are involved in loss of heat from the body to the environment. The first process, radiation, is the transfer of heat to another object of lower temperature situated at a distance. The second process, conduction, is the transfer of heat from the body to a cooler object in contact with it. The third process, convection, which consists of movement of warm air molecules away from the body, is the transfer of heat by conduction to the air surrounding the body.

Evaporation from the skin aids heat loss by conduction. Heat is conducted through the skin into water molecules on its surface, causing the water to evaporate. The water on the skin surface may be from insensible perspiration, sweat, or the environment.

Normally, all of these mechanisms for heat loss are used. However, when the ambient temperature is very high, radiation and convection are ineffective, and evaporation becomes the only means of heat loss.

Under normal conditions, metabolic heat production is balanced by heat loss, and the internal temperature of the

body is maintained constant at approximately 37°C (98.6°F). The rate of heat loss depends primarily on the surface temperature of the skin, which is a function of the skin blood flow. Under normal conditions, the total blood circulated through the skin is approximately 450 mL/min, or 10 to 20 times the amount of blood required to provide necessary metabolites and oxygen. Blood flow through these skin vessels is controlled primarily by the sympathetic nervous system. Increased blood flow to the skin results in more heat delivered to the skin and a greater rate of heat loss from the body. In contrast, decreased skin blood flow decreases the skin temperature and helps conserve heat for the body. When the temperature of the body begins to fall, as occurs on a cold day, the blood vessels of the skin constrict, thereby reducing heat loss from the body.

Sweating is another process by which the body can regulate the rate of heat loss. Sweating does not occur until the core body temperature exceeds 37°C, regardless of skin temperature. In extremely hot environments, the rate of sweat production may be as high as 1 L/h. Under some circumstances (eg, emotional stress), sweating may occur as a reflex and may be unrelated to the need to lose heat from the body.

### Vitamin Production

Skin exposed to ultraviolet light can convert substances necessary for synthesizing vitamin D (cholecalciferol). Vitamin D is essential for preventing osteoporosis and rickets, a condition that causes bone deformities and results from a deficiency of vitamin D, calcium, and phosphorus.

### Immune Response Function

Research has confirmed a definite action of Langerhans cells in facilitating the uptake of immunoglobulin E (IgE)-associated allergens. This action plays a pivotal role in the pathogenesis of atopic dermatitis and other allergic diseases such as asthma and allergic rhinitis. These findings support the concept of a systemic regulatory mechanism as a trigger for allergic diseases and suggest that this trigger can be aggravated by local inflammation of atopic eczema (Porth & Matfin, 2009).

## Gerontologic Considerations

The skin undergoes many physiologic changes associated with normal aging. A lifetime of excessive sun exposure, systemic diseases, and poor nutrition can increase the range of skin conditions and the rapidity with which they appear. In addition, certain medications (eg, antihistamines, antibiotics, diuretics) are photosensitizing and increase the damage that results from sun exposure. The outcome is an increasing vulnerability to injury and to certain diseases. Therefore, skin conditions are common among older people.

The major changes in the skin of older people include dryness, wrinkling, uneven pigmentation, and various proliferative lesions. Cellular changes associated with aging include a thinning at the junction of the dermis and epidermis. The result of this thinning is fewer anchoring sites between the two skin layers, which means that even minor injury or stress to the epidermis can cause it to shear away from the dermis. This phenomenon may account for the increased vulnerability of aged skin to trauma. With increasing age, the epidermis and dermis thin and flatten, causing wrinkles, sags, and overlapping skin folds (Fig. 55-2).



**Figure 55-2** Hands with and overlapping folds common to aging skin.

Loss of the subcutaneous tissue substances of elastin, collagen, and fat diminishes the protection and cushioning of underlying tissues and organs, decreases muscle tone, and results in the loss of the insulating properties of fat.

Cellular replacement slows as a result of aging. As the dermal layers thin, the skin becomes fragile and transparent. The blood supply to the skin also changes with age. Vessels, especially the capillary loops, decrease in number and size. These vascular changes contribute to the delayed wound healing commonly seen in the elderly patient. Sweat and sebaceous glands decrease in number and functional capacity, leading to dry and scaly skin. Reduced hormonal levels of androgens are thought to contribute to declining sebaceous gland function.

Hair growth gradually diminishes, especially over the lower legs and dorsum of the feet. Thinning is common in the scalp, axilla, and pubic areas. Other functions affected by normal aging include the barrier function of skin, sensory perception, and thermoregulation.

Photoaging, or damage from excessive sun exposure, has detrimental effects on the normal aging of skin. A lifetime of outdoor work or outdoor activities (eg, construction work, lifeguarding, sunbathing) without prudent use of sunscreens can lead to profound wrinkling; increased loss of elasticity; mottled, pigmented areas; cutaneous atrophy; and benign or malignant lesions.

Many skin lesions are part of normal aging. Recognizing these lesions enables the examiner to assist the patient to feel less anxious about changes in skin. Chart 55-1 summarizes some skin lesions that are expected to appear as the skin ages. These are normal and require no special attention unless the skin becomes infected or irritated.

# Assessment

When caring for patients with dermatologic disorders, the nurse obtains important information through the health history and direct observations. The nurse's skill in physical

CHART 55-1 **Benign Changes in Elderly Skin**

- Cherry angiomas (bright red "moles")
- Diminished hair, especially on scalp and pubic area
- Dyschromias (color variations)
  - Solar lentigo (liver spots)
  - Melasma (dark discoloration of the skin)
  - Lentigines (freckles)
- Neurodermatitis (itchy spots)
- Seborrheic keratoses (crusty brown "stuck-on" patches)
- Spider angiomas
- Telangiectasias (red marks on skin caused by stretching of the superficial blood vessels)
- Wrinkles
- Xerosis (dryness)
- Xanthelasma (yellowish waxy deposits on upper and lower eyelids)

assessment and an understanding of the anatomy and function of the skin can ensure that deviations from normal are recognized, reported, and documented.

## Health History

During the health history interview, the nurse asks about any family and personal history of skin allergies; allergic reactions to food, medications, and chemicals; previous skin conditions; and skin cancer. The names of cosmetics, soaps, shampoos, and other personal hygiene products are obtained if there have been any recent skin conditions noticed with the use of these products. If suspicious areas are noted, the patient is questioned about nonprescription or herbal preparations that are being used. The health history addresses the onset, signs and symptoms, location, and duration of any pain, itching, rash, or other discomfort experienced by the patient. Chart 55-2 lists selected questions useful in obtaining appropriate information and Chart 55-3 provides genetic factors influencing skin conditions.

CHART 55-2 **Assessing for Skin Disorders**

Patient history relevant to skin disorders may be obtained by asking the following questions:

- When did you first notice this skin problem? (Also investigate duration and intensity.)
- Has it occurred previously?
- Are there any other symptoms?
- What site was first affected?
- What did the rash or lesion look like when it first appeared?
- Where and how fast did it spread?
- Do you have any itching, burning, tingling, or crawling sensations?
- Is there any loss of sensation?
- Is the problem worse at a particular time or season?
- How do you think it started?
- Do you have a history of hay fever, asthma, hives, eczema, or allergies?
- Who in your family has skin problems or rashes?
- Did the eruptions appear after certain foods were eaten? Which foods?
- When the problem occurred, had you recently consumed alcohol?
- What relation do you think there may be between a specific event and the outbreak of the rash or lesion?
- What medications are you taking?
- What topical medication (ointment, cream, salve) have you put on the lesion (including over-the-counter medications)?
- What skin products or cosmetics do you use?
- What is your occupation?
- What in your immediate environment (plants, animals, chemicals, infections) might be precipitating this disorder? Is there anything new, or are there any changes in the environment?
- Does anything touching your skin cause a rash?
- How has this affected you (or your life)?
- Is there anything else you wish to talk about in regard to this disorder?

## Physical Assessment

Assessment of the skin involves the entire skin area, including the mucous membranes, scalp, hair, and nails. The skin is a reflection of a person's overall health, and alterations commonly correspond to disease in other organ systems. Inspection and palpation are techniques commonly used in examining the skin. The room must be well lighted and warm. A penlight may be used to highlight lesions. The patient completely disrobes and is adequately draped. Gloves are worn during skin examination if a rash or lesions are to be palpated. However, it is important to avoid making the patient feel as if he or she cannot be touched.

The general appearance of the skin is assessed by observing color, temperature, moisture or dryness, skin texture (rough or smooth), lesions, vascularity, mobility, and the condition of the hair and nails. Skin turgor, possible edema, and elasticity are assessed by palpation.

### Assessing Skin Color

The color gradations that occur in people with dark skin are largely determined by genetics; they may be described as light, medium, or dark. In people with dark skin, melanin is produced at a faster rate and in larger quantities than in people with light skin. Healthy dark skin has a reddish base or undertone. The buccal mucosa, tongue, lips, and nails normally are pink. The skin of exposed portions of the body, especially in sunny, warm climates, tends to be more pigmented than the rest of the body. Almost every process that occurs on the skin causes some color change. For example, **hypopigmentation** may be caused by a fungal infection, eczema, or **vitiligo; hyperpigmentation** can occur after sun injury or as a result of aging. Dark pigment responds with discoloration after injury or inflammation, and patients with dark skin more often experience postinflammatory hyperpigmentation than those with lighter skin. The hyperpigmentation eventually fades but may require months to a year to do so.

Changes in skin color in people with dark skin are more noticeable and may cause more concern because the discoloration is more readily visible. Because of the increased number of melanocytes in darker skin, pigment changes can become quite obvious and cause great psychological discomfort. Some variation in skin pigment levels is considered normal. Examples include the pigmented crease across

CHART 55-3

GENETICS IN NURSING PRACTICE

## *Integumentary Conditions*

Integumentary conditions influenced by genetic factors include the following:

- Albinism
- Eczema
- Hypohidrotic ectodermal dysplasia
- Incontinentia pigmenti
- Neurofibromatosis type 1
- Pseudoxanthoma elasticum
- Psoriasis

### Nursing Assessments

**Family History Assessment**

- Assess for other closely related family members with integumentary impairment or abnormalities.
- Inquire about the nature and type of skin lesions and age at onset (eg, skin involvement with incontinentia pigmenti occurs in the first few weeks of life with blistering of the skin, whereas lesions of neurofibromatosis type 1 may appear in early childhood through adulthood).
- Note gender of affected individuals (eg, mostly females with incontinentia pigmenti, mostly males with hypohidrotic ectodermal dysplasia).
- Inquire about the presence of other clinical features, such as unusual hair, teeth, or nails; thrombocytopenia; recurrent infections.

**Patient Assessment**

- Assess for related clinical features, such as sparse eyebrows and eyelashes, abnormally shaped teeth, alopecia, nail abnormalities (eg, hypohidrotic ectodermal dysplasia).
- Assess for related alterations in vision, such as nystagmus or strabismus; albinism; retinal abnormalities (eg, pseudoxanthoma elasticum); Lisch nodules and/or optic glioma (neurofibromatosis type 1).

### Management Issues Specific to Genetics

- Inquire whether DNA mutation or other genetics testing has been performed on affected family members.
- If indicated, refer for further genetics counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetics testing, and gene-based interventions.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed genetics-related integumentary conditions.
- Participate in management and coordination of care for patients with genetic conditions and for individuals predisposed to develop or pass on a genetic condition.

### Genetics Resources

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions; www.geneticalliance.org

**Gene Clinics**—a listing of common genetic disorders with clinical summaries and genetic counseling and testing information; www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders;www.rarediseases.org

**Online Mendelian Inheritance in Man (OMIM)**—a complete listing of inherited genetic conditions; www.ncbi.nlm.nih.gov/omim/stats/html

the bridge of the nose, pigmented streaks in the nails, and pigmented spots on the sclera of the eye.

Table 55-1 provides an overview of color changes in light-skinned and dark-skinned people.

#### Cyanosis

Cyanosis is the bluish discoloration that results from a lack of oxygen in the blood (Fig. 55-3). It appears with shock or with respiratory or circulatory compromise. In people with light skin, cyanosis manifests as a bluish hue to the lips, fingertips, and nail beds. Other indications of decreased tissue perfusion include cold, clammy skin; a rapid, thready pulse; and rapid, shallow respirations. The conjunctivae of the eyelids are examined for pallor and **petechiae.**

In a person with dark skin, the skin usually assumes a grayish cast. To detect cyanosis, the areas around the mouth and lips and over the cheekbones and earlobes should be observed.

#### Erythema

**Erythema** is redness of the skin caused by the congestion of capillaries. In light-skinned people, it is easily observable. To determine possible inflammation, the skin is palpated for increased warmth and for smoothness (ie, edema) or hardness (ie, intracellular infiltration). Because dark skin tends to assume a purple-gray cast when an inflammatory process is present, it may be difficult to detect erythema.

#### Jaundice

Jaundice, a yellowing of the skin, is directly related to elevations in serum bilirubin and is often first observed in the sclerae and mucous membranes (see Fig. 55-3).

### *Assessing Rash*

In instances of pruritus (ie, itching) the patient is asked to indicate which areas of the body are involved. The skin is then stretched gently to decrease the reddish tone and make the rash more visible. Pointing a penlight laterally across the skin may highlight the rash, making it easier to observe. The differences in skin texture are then assessed by running the tips of the fingers lightly over the skin. The borders of the rash may be palpable. The patient's mouth and ears are included in the examination (rubeola, or measles, causes a red cast to appear on the ears, and skin cancers are quite common on the crest of the ears). The patient's temperature is assessed, and the lymph nodes are palpated especially in the axilla, inguinal fold, and behind the knees (popliteal area).

### *Assessing Skin Lesions*

Skin lesions are the most prominent characteristics of dermatologic conditions. They vary in size, shape, and cause and are classified according to their appearance and origin.

**Table 55-1 COLOR CHANGES IN LIGHT AND DARK SKIN**

| Etiology | Light Skin | Dark Skin |
|---|---|---|
| **Pallor** | | |
| Anemia—decreased hematocrit<br>Shock—decreased perfusion, vasoconstriction | Generalized pallor | Brown skin appears yellow-brown, dull; black skin appears ashen gray, dull. (Observe areas with least pigmentation: conjunctivae, mucous membranes.) |
| Local arterial insufficiency | Marked localized pallor (lower extremities, especially when elevated) | Ashen gray, dull; cool to palpation |
| Albinism—total absence of pigment melanin | Whitish pink | Tan, cream, white |
| Vitiligo—a condition characterized by destruction of the melanocytes in circumscribed areas of the skin (may be localized or widespread) | Patchy, milky white spots, often symmetric bilaterally | Same |
| **Cyanosis** | | |
| Increased amount of unoxygenated hemoglobin: | Dusky blue | Dark but dull, lifeless; only severe cyanosis is apparent in skin. (Observe conjunctivae, oral mucosa, nail beds.) |
| Central—chronic heart and lung diseases cause arterial desaturation<br>Peripheral—exposure to cold, anxiety | Nail beds dusky | |
| **Erythema** | | |
| Hyperemia—increased blood flow through engorged arterial vessels, as in inflammation, fever, alcohol intake, blushing | Red, bright pink | Purplish tinge, but difficult to see. (Palpate for increased warmth with inflammation, taut skin, and hardening of deep tissues.) |
| Polycythemia—increased red blood cells, capillary stasis | Ruddy blue in face, oral mucosa, conjunctivae, hands and feet | Well concealed by pigment. (Observe for redness in lips.) |
| Carbon monoxide poisoning | Bright, cherry red in face and upper torso | Cherry red nail beds, lips, and oral mucosa |
| Venous stasis—decreased blood flow from area, engorged venules | Dusky rubor of dependent extremities (a prelude to necrosis with pressure ulcer) | Easily masked. (Use palpation to identify warmth or edema.) |
| **Jaundice** | | |
| Increased serum bilirubin concentration (>2−3 mg/100 mL) due to liver dysfunction or hemolysis, as after severe burns or some infections | Yellow first in sclerae, hard palate, and mucous membranes; then over skin | Check sclerae for yellow near limbus; do not mistake normal yellowish fatty deposits in the periphery under eyelids for jaundice. (Jaundice is best noted at junction of hard and soft palate, on palms.) |
| Carotenemia—increased level of serum carotene from ingestion of large amounts of carotene-rich foods | Yellow-orange tinge in forehead, palms and soles, and nasolabial folds, but no yellowing in sclerae or mucous membranes | Yellow-orange tinge in palms and soles |
| Uremia—renal failure causes retained urochrome pigments in the blood | Orange-green or gray overlying pallor of anemia; may also have ecchymoses and purpura | Easily masked. (Rely on laboratory and clinical findings.) |
| **Brown-Tan** | | |
| Addison's disease—cortisol deficiency stimulates increased melanin production | Bronzed appearance, an "external tan"; most apparent around nipples, perineum, genitalia, and pressure points (inner thighs, buttocks, elbows, axillae) | Easily masked. (Rely on laboratory and clinical findings.) |
| *Café-au-lait* spots—caused by increased melanin pigment in basal cell layer | Tan to light brown, irregularly shaped, oval patch with well-defined borders often not visible in the very dark skinned person | |



**Figure 55-3** Examples of skin color changes: the bluish tint of cyanosis (*left*) and the yellow hue of jaundice (*right*).

Skin lesions can be described as primary or secondary. Primary lesions are the initial lesions and are characteristic of the disease itself. Secondary lesions result from changes in primary lesions resulting from external causes, such as scratching, trauma, infections, or changes caused by wound healing. Depending on the stage of development, skin lesions are further categorized by type and appearance (Table 55-2).

A preliminary assessment of the eruption or lesion helps identify the type of **dermatosis** and indicates whether the lesion is primary or secondary. At the same time, the anatomic distribution of the eruption or lesion

**Table 55-2 PRIMARY AND SECONDARY SKIN LESIONS**

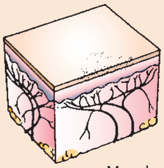
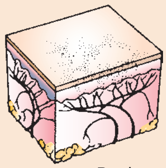
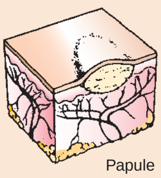
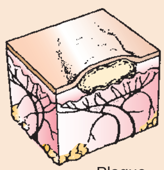
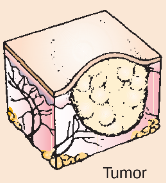
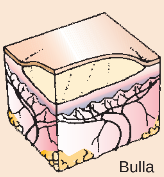
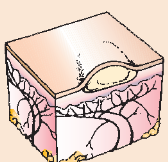
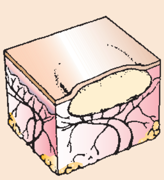
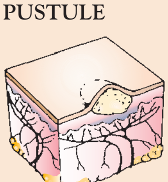
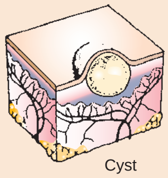
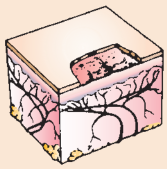
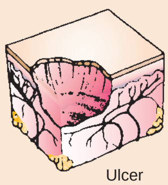
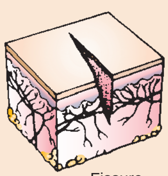
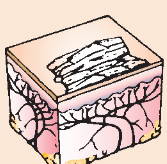
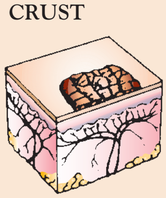
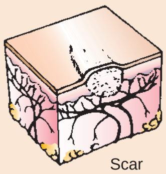
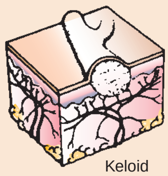
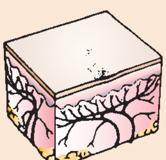
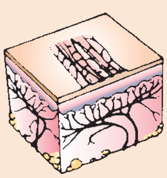
| Lesion | Description | Examples |
|---|---|---|
| **Primary Lesions** | | |
| MACULE, PATCH<br><br>Macule<br><br>Patch | Flat, nonpalpable skin color change (color may be brown, white, tan, purple, red)<br>• *Macule:* less than 1 cm, circumscribed border<br>• *Patch:* greater than 1 cm, may have irregular border | Freckles, flat moles, petechia, rubella, vitiligo, port wine stains, ecchymosis |
| PAPULE, PLAQUE<br><br>Papule<br><br>Plaque | Elevated, palpable, solid mass with a circumscribed border<br>Plaque may be coalesced papules with flat top<br>• *Papule:* less than 0.5 cm<br>• *Plaque:* greater than 0.5 cm | *Papules:* Elevated nevi, warts, lichen planus<br>*Plaques:* Psoriasis, actinic keratosis |
| NODULE, TUMOR<br><br>Tumor | Elevated, palpable, solid mass that extends deeper into the dermis than a papule<br>• *Nodule:* 0.5–2 cm; circumscribed<br>• *Tumor:* greater than 1–2 cm; tumors do not always have sharp borders | *Nodules:* Lipoma, squamous cell carcinoma, poorly absorbed injection, dermatofibroma<br>*Tumors:* Larger lipoma, carcinoma |
| VESICLE, BULLA<br><br>Bulla<br><br>Vesicle | Circumscribed, elevated, palpable mass containing serous fluid<br>• *Vesicle:* less than 0.5 cm<br>• *Bulla:* greater than 0.5 cm | *Vesicles:* Herpes simplex/zoster, chickenpox, poison ivy, second-degree burn (blister)<br>*Bulla:* Pemphigus, contact dermatitis, large burn blisters, poison ivy, bullous impetigo |
| WHEAL<br><br>Wheal | Elevated mass with transient borders; often irregular; size and color vary<br>Caused by movement of serous fluid into the dermis; does not contain free fluid in a cavity (as, for example, a vesicle does) | Urticaria (hives), insect bites |
| PUSTULE<br><br>Pustule | Pus-filled vesicle or bulla | Acne, impetigo, furuncles, carbuncles |

**Table 55-2 PRIMARY AND SECONDARY SKIN LESIONS (Continued)**

| Lesion | Description | Examples |
|---|---|---|
| **CYST**  Cyst | Encapsulated fluid-filled or semisolid mass in the subcutaneous tissue or dermis | Sebaceous cyst, epidermoid cysts |
| **Secondary Lesions** | | |
| **EROSION**  Erosion | Loss of superficial epidermis that does not extend to dermis; depressed, moist area | Ruptured vesicles, scratch marks |
| **ULCER**  Ulcer | Skin loss extending past epidermis; necrotic tissue loss; bleeding and scarring possible | Stasis ulcer of venous insufficiency, pressure ulcer |
| **FISSURE**  Fissure | Linear crack in the skin that may extend to dermis | Chapped lips or hands, athlete's foot |
| **SCALES**  Scales | Flakes secondary to desquamated, dead epithelium that may adhere to skin surface; color varies (silvery, white); texture varies (thick, fine) | Dandruff, psoriasis, dry skin, pityriasis rosea |
| **CRUST**  Crust | Dried residue of serum, blood, or pus on skin surface<br>Large, adherent crust is a scab | Residue left after vesicle rupture: impetigo, herpes, eczema |

*Continued on following page*

**Table 55-2 PRIMARY AND SECONDARY SKIN LESIONS (Continued)**

| Lesion | Description | Examples |
|---|---|---|
| SCAR (CICATRIX)<br><br>Scar | Skin mark left after healing of a wound or lesion; represents replacement by connective tissue of the injured tissue<br>• *Young scars:* red or purple<br>• *Mature scars:* white or glistening | Healed wound or surgical incision |
| KELOID<br><br>Keloid | Hypertrophied scar tissue secondary to excessive collagen formation during healing; elevated, irregular, red<br>Greater incidence among African Americans | Keloid of ear piercing or surgical incision |
| ATROPHY<br><br>Atrophy | Thin, dry, transparent appearance of epidermis; loss of surface markings; secondary to loss of collagen and elastin; underlying vessels may be visible | Aged skin, arterial insufficiency |
| LICHENIFICATION<br><br>Lichenification | Thickening and roughening of the skin or accentuated skin markings that may be secondary to repeated rubbing, irritation, scratching | Contact dermatitis |

should be observed because certain diseases affect certain sites of the body and are distributed in characteristic patterns and shapes (Figs. 55-4 and 55-5). To determine the extent of the regional distribution, the left and right sides of the body should be compared while the color and shape of the lesions are assessed. The degree of pigmentation of the patient's skin may affect the appearance of a lesion. Lesions may be black, purple, or gray on dark skin and tan or red in patients with light skin. A metric ruler is used to measure the size of the lesions so that any further extension can be compared with this baseline measurement. After observation, the lesions are palpated to determine their texture, shape, and border and to see if they are soft and filled with fluid or hard and fixed to the surrounding tissue.

Skin lesions are described clearly and in detail on the patient's health record, using precise terminology:

- Color of the lesion
- Any redness, heat, pain, or swelling
- Size and location of the involved area
- Pattern of eruption (eg, macular, papular, scaling, oozing, discrete, confluent)
- Distribution of the lesion (eg, bilateral, symmetric, linear, circular)

If acute open wounds or lesions are found on inspection of the skin, a comprehensive assessment should be made and documented. This assessment should address the following issues:

- Wound bed: Inspect for necrotic and granulation tissue, epithelium, exudate, color, and odor
- Wound edges and margins: Observe for undermining (ie, extension of the wound under the surface skin), and evaluate for condition
- Wound size: Measure in millimeters or centimeters, as appropriate, to determine diameter and depth of the wound and surrounding erythema
- Surrounding skin: Assess for color, suppleness and moisture, irritation, and scaling

### *Assessing Vascularity and Hydration*

After the color of the skin has been evaluated and lesions have been inspected, an assessment of vascular changes in the skin is performed. A description of vascular changes includes location, distribution, color, size, and the presence of

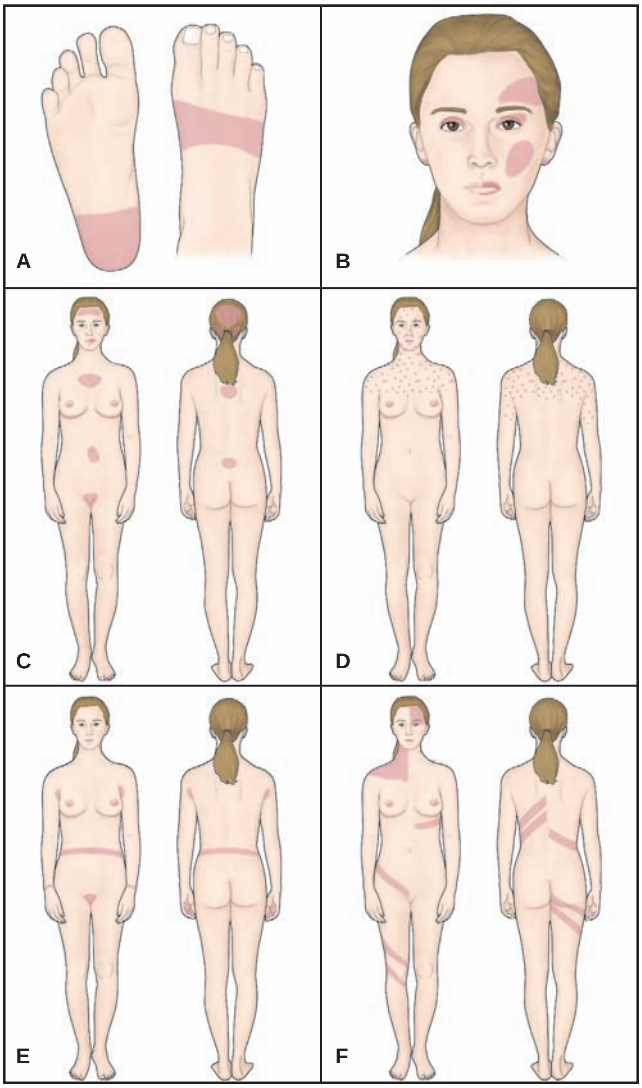


**Figure 55-4** Anatomic distribution of common skin disorders. **A,** Contact dermatitis (shoes). **B,** Contact dermatitis (cosmetics, perfumes, earrings). **C,** Seborrheic dermatitis. **D,** Acne. **E,** Scabies. **F,** Herpes zoster (shingles).

pulsations. Common vascular changes include petechiae, ecchymoses, **telangiectases** (venous stars), and angiomas, (Table 55-3).

Skin moisture, temperature, and texture are assessed primarily by palpation. The turgor (ie, elasticity) of the skin, which decreases in normal aging, may be a factor in assessing the hydration status of a patient.

## Assessing the Nails

A brief inspection of the nails includes observation of configuration, color, and consistency. Many alterations in the nail or nail bed reflect local or systemic abnormalities in progress or resulting from past events (Fig. 55-6). Transverse depressions known as Beau's lines in the nails may reflect retarded growth of the nail matrix because of severe illness or, more commonly, local trauma. Ridging, hypertrophy, and other changes may also be visible because of local trauma.

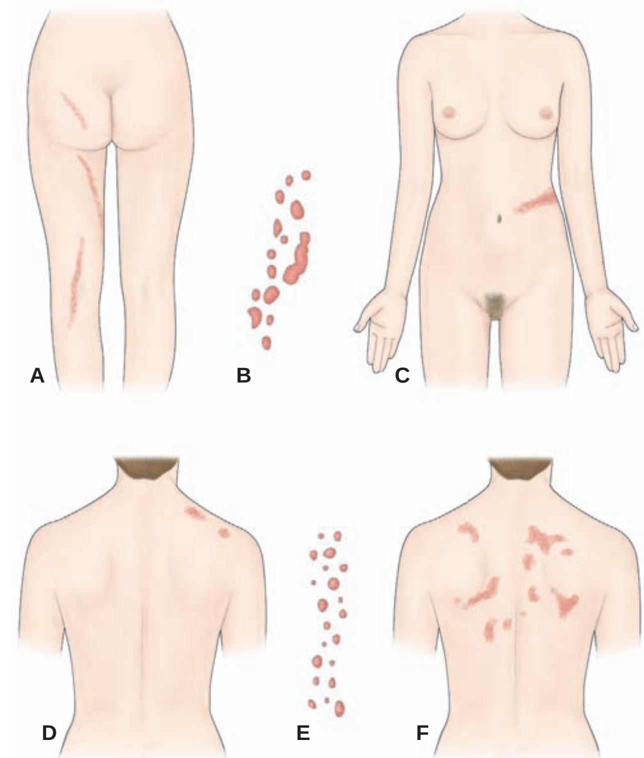


**Figure 55-5** Skin lesion configurations. **A,** Linear (in a line). **B,** Annular and arciform (circular or arcing). **C,** Zosteriform (linear along a nerve route). **D,** Grouped (clustered). **E,** Discrete (separate and distinct). **F,** Confluent (merged).

Paronychia, an inflammation of the skin around the nail, is usually accompanied by tenderness and erythema. Pitted surface of the nails is a definite indication of psoriasis. Spoon-shape nails can indicate a severe iron deficiency anemia. The angle between the normal nail and its base is 160 degrees. When palpated, the nail base is usually firm. Clubbing of the nails, which can occur from hypoxia, is manifested by a straightening of the normal angle (180 degrees or greater) and softening of the nail base. The softened area feels spongelike when palpated.

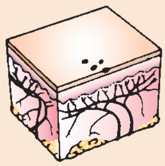
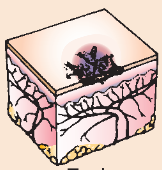
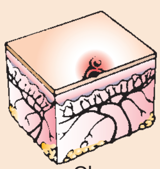
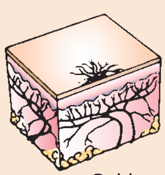
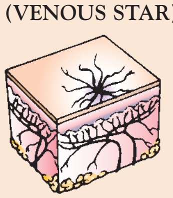
## Assessing the Hair

The hair assessment is carried out by inspection and palpation. Gloves are worn by the examiner, and the examination room should be well lighted. Separating the hair so that the condition of the skin underneath can be easily seen, the nurse assesses color, texture, and distribution. The wooden end of a cotton swab can be used to make small parts in the hair so that the scalp can be inspected. Any abnormal lesions, evidence of itching, inflammation, scaling, or signs of infestation (ie, lice or mites) are documented.

### Color and Texture

Natural hair color ranges from white to black. Hair begins to turn gray with age, initially during the third decade of life, when the loss of melanin begins to become apparent. However, it is not unusual for the hair of younger people to turn gray as a result of hereditary traits. The person with albinism (ie, partial or complete absence of pigmentation)

**Table 55-3 VASCULAR LESIONS**

| Lesion | Description |
|---|---|
| PETECHIA (*PL.* PETECHIAE)<br><br>Petechiae | Round red or purple macule<br>Small: 1–2 mm<br>Secondary to blood extravasation<br>Associated with bleeding tendencies or emboli to skin |
| ECCHYMOSIS (PL. ECCHYMOSES)<br><br>Ecchymoses | Round or irregular macular lesion<br>Larger than petechia<br>Color varies and changes: black, yellow, and green hues<br>Secondary to blood extravasation<br>Associated with trauma, bleeding tendencies |
| CHERRY ANGIOMA<br><br>Cherry angioma | Papular and round<br>Red or purple<br>Noted on trunk, extremities<br>May blanch with pressure<br>Normal age-related skin alteration<br>Usually not clinically significant |
| SPIDER ANGIOMA<br><br>Spider angioma | Red, arteriole lesion<br>Central body with radiating branches<br>Noted on face, neck, arms, trunk<br>Rare below the waist<br>May blanch with pressure<br>Associated with liver disease, pregnancy, vitamin B deficiency |
| TELANGIECTASIA (VENOUS STAR)<br><br>Telangiectasia | Shape varies: spider-like or linear<br>Color bluish or red<br>Does not blanch when pressure is applied<br>Noted on legs, anterior chest<br>Secondary to superficial dilation of venous vessels and capillaries<br>Associated with increased venous pressure states (varicosities) |

has a genetic predisposition to white hair from birth. The natural state of the hair can be altered by using hair dyes, bleaches, and curling or relaxing products. The types of products used are identified in the assessment.

The texture of scalp hair ranges from fine to coarse, silky to brittle, oily to dry, and shiny to dull, and hair can be straight, curly, or kinky. Dry, brittle hair may result from overuse of hair dyes, hair dryers, and curling irons or from endocrine disorders, such as thyroid dysfunction. Oily hair is usually caused by increased secretion from the sebaceous glands close to the scalp. If the patient reports a recent change in hair texture, the underlying reason is pursued; the alteration may arise simply from the overuse of commercial hair products or from changing to a new shampoo.

### Distribution

Body hair distribution varies with location. Hair over most of the body is fine, except in the axillae and pubic areas, where it is coarse. Pubic hair, which develops at puberty, forms a diamond shape extending up to the umbilicus in boys and men. Female pubic hair resembles an inverted triangle. If the pattern found is more characteristic of the opposite gender, it may indicate an endocrine disorder and further investigation is in order. Racial differences in hair are expected, such as straight hair in Asians and curly, coarser hair in people of African descent.

Men tend to have more body and facial hair than women. Alopecia can occur over the entire body or be confined to a specific area. Scalp hair loss may be localized to patchy areas or may range from generalized thinning to total baldness. When assessing scalp hair loss, it is important to investigate the underlying cause with the patient. Patchy hair loss may be from habitual hair pulling or twisting; excessive traction on the hair (eg, braiding too tightly); excessive use of dyes, straighteners, and oils; chemotherapeutic agents (eg, doxorubicin [Adriamycin], cyclophosphamide [Cytoxan]); bacterial or fungal infection; or moles or lesions on the scalp. Regrowth may be erratic, and distribution may never attain the previous thickness.

### Hair Loss

The most common cause of hair loss is male pattern baldness, which affects more than half of the male population and is believed to be related to heredity, aging, and androgen (male hormone) levels. Androgen is necessary for male pattern baldness to develop. The pattern of hair loss begins with receding of the hairline in the frontal-temporal area and progresses to gradual thinning and complete loss of hair over the top of the scalp and crown. Figure 55-7 illustrates the typical pattern of male hair loss. Though androgenic alopecia is considered a male disorder, millions of women also experience it. Women tend to retain some of the hair on the crown of the scalp and never go completely bald.

### Other Changes

Male pattern hair distribution may be seen in some women at the time of menopause, when the hormone estrogen is no longer produced by the ovaries. In women with hirsutism, excessive hair may grow on the face, chest, shoulders, and pubic area. If menopause is ruled out as the underlying cause, other hormonal changes related to pituitary or adrenal dysfunction must be investigated.

Because patients with skin conditions may be viewed negatively by others, these patients may become distraught and avoid interaction with people. Skin conditions can lead to disfigurement, isolation, job loss, and economic hardship.

Some conditions may lead to feelings of depression, frustration, self-consciousness, poor self-image, and rejection. Itching and skin irritation, features of many skin diseases, may be constant annoyances. These discomforts may result in loss of sleep, anxiety, and depression, all of which reinforce the general distress and fatigue that frequently accompany skin disorders.

For patients experiencing physical and psychological discomforts, the nurse needs to provide understanding,

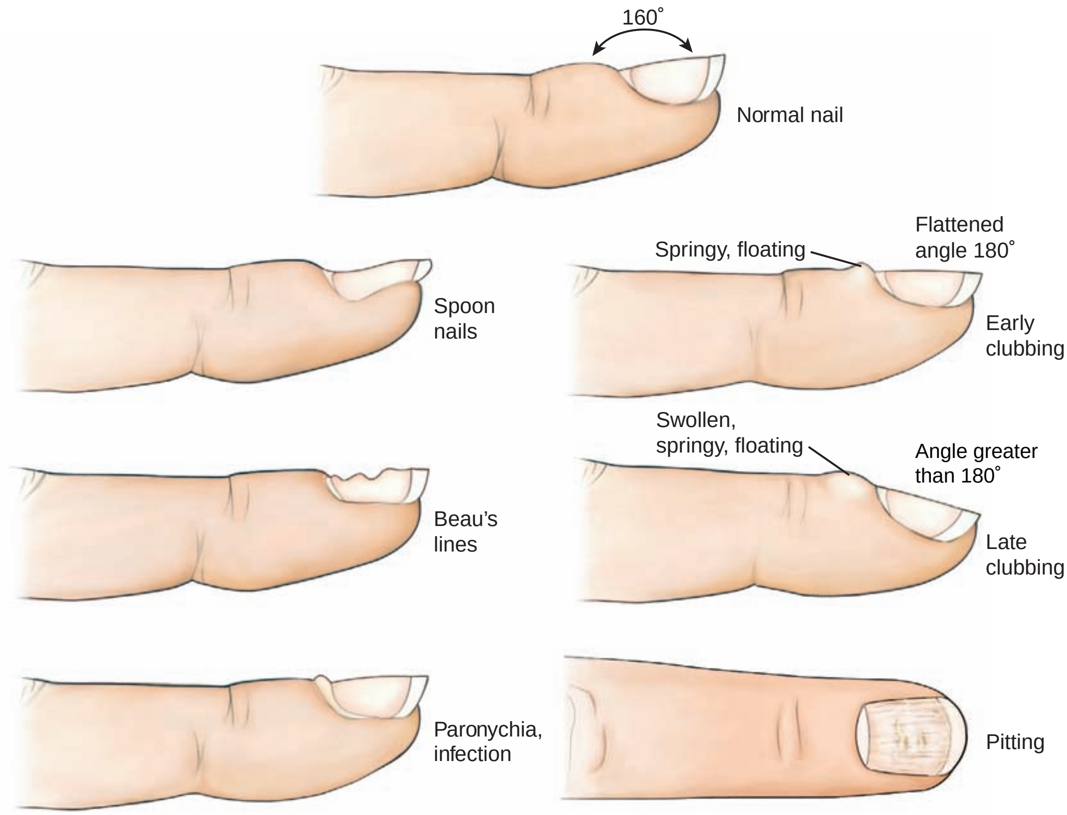



**Figure 55-6** Common nail disorders.

explanations of the problem, appropriate instructions related to treatment, nursing support, and encouragement. It is imperative to overcome any aversion that may be felt when caring for patients with unattractive skin disorders. The nurse should show no sign of hesitancy when approaching patients with skin disorders. Such hesitancy only reinforces the psychological trauma of the disorder.

## Skin Consequences of Selected Systemic Diseases

### *Diabetes Mellitus*

Because diabetes causes changes in circulation and cell nutrition, it can have a great impact on skin status. Some of the more common skin conditions encountered in diabetes are discussed in this section. Further information can be found in Chapter 41.

#### Diabetic Dermopathy

Diabetic dermopathy (shin spots) occurs in about 50% of peoples with diabetes. These lesions are found on the lower anterior legs, forearms, and thighs and over other bony prominences. They are caused by breakdown of the small vessels that supply the skin. Each spot starts as a dull red bump, smaller than a pencil eraser. It slowly spreads to about one inch (the size of a quarter), becomes increasingly scaly, and eventually leaves a brownish scar on the skin. The lesions are usually bilateral and occur in linear clusters.

#### Stasis Dermatitis

Stasis dermatitis is not unique to diabetes, but because of the blood vessel damage that results from diabetes, it is very common in patients with diabetes. Large vessels are damaged, compromising circulation to the lower arms and legs.

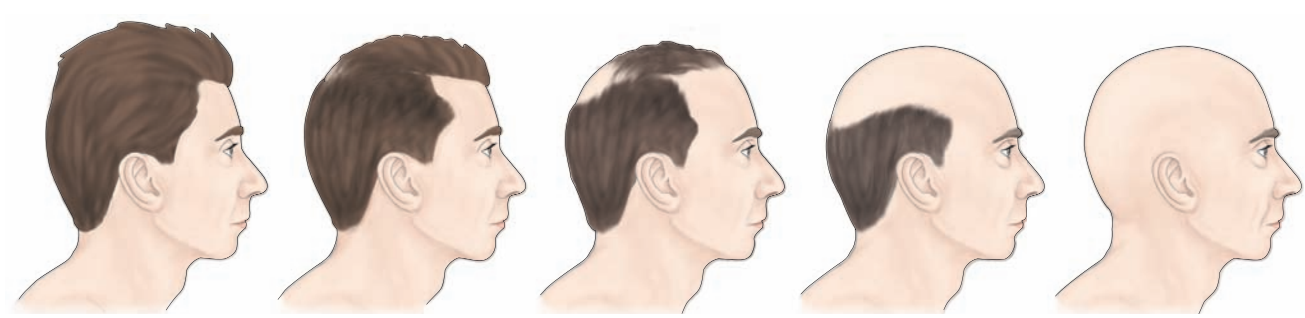


**Figure 55-7** The progression of male pattern baldness.

The skin suffers from lack of nutrients, becoming very dry and fragile. Minor injuries heal slowly, and ulcers form easily. The skin takes on a thick leathery texture and a yellowish, waxy hue.

#### Skin Infections

The skin of patients with diabetes is prone to bacterial and fungal infections. Bacterial infections appear as small pimples around hair follicles. The most frequently affected sites include the lower legs, lower abdomen, and buttocks. Sometimes these lesions enlarge to become furuncles or carbuncles. If the blood glucose level is not well controlled, these infections may be very slow to heal.

Fungal infections are quite common in areas that remain moist all the time (under breasts, upper thighs, in axilla). *Candida* (ie, yeast) infections appear beefy red and have small pustules around the border of the area, with the skin appearing moist and raw.

Dermatophyte infections are dry and only minimally red, with more scale. Common sites are the toenails and feet.

Nurses must be alert to the signs of these common infections. If necessary, they should bring them to the attention of the physician and help the patient or family learn basic skin maintenance techniques.

#### Leg and Foot Ulcers

Because of changes in peripheral nerves, patients with diabetes do not always sense minor injuries to the lower legs and feet. Infections begin and if left untreated may lead to ulcerations. Ulcerations are often not noticed and become quite large before being treated. Ulcerations unresponsive to treatment are a leading cause of diabetic foot and leg amputations.

### *Human Immunodeficiency Virus Disease*

Cutaneous signs may be the first manifestation of human immunodeficiency virus (HIV), appearing in more than 90% of HIV-infected people as immune function deteriorates. These skin signs correlate with low CD4 counts and may become very atypical in immunocompromised people. Some disorders such as Kaposi's sarcoma, oral hairy leukoplakia, facial molluscum contagiosum, and oral candidiasis may suggest that CD4 counts are less than 200 to 300 cell/μL. Being sensitive to these changes can alert the nurse so that early intervention can be initiated (Freytes, Arroyo-Novoa, Figueroa-Ramos, et al., 2007).

# *Diagnostic Evaluation*

As previously discussed, it is important to inspect the primary and secondary lesions and their configuration and distribution. Certain diagnostic procedures may also be used to help identify skin conditions.

## Skin Biopsy

Performed to obtain tissue for microscopic examination, a skin biopsy may be obtained by scalpel excision or by a skin punch instrument that removes a small core of tissue. Biopsies are performed on skin nodules, plaques, blisters, and other lesions to rule out malignancy and to establish an exact diagnosis.

## Immunofluorescence

Designed to identify the site of an immune reaction, immunofluorescence testing combines an antigen or antibody with a fluorochrome dye. Antibodies can be made fluorescent by attaching them to a dye. Direct immunofluorescence tests on skin are techniques to detect autoantibodies directed against portions of the skin. The indirect immunofluorescence test detects specific antibodies in the patient's serum.

## Patch Testing

Performed to identify substances to which the patient has developed an allergy, patch testing involves applying the suspected allergens to normal skin under occlusive patches. The development of redness, fine elevations, or itching is considered a weak positive reaction; fine blisters, papules, and severe itching indicate a moderately positive reaction; and blisters, pain, and ulceration indicate a strong positive reaction.

## Skin Scrapings

Tissue samples are scraped from suspected fungal lesions with a scalpel blade moistened with oil so that the scraped skin adheres to the blade. The scraped material is transferred to a glass slide, covered with a coverslip, and examined microscopically. The spores and hyphae of dermatophyte infections, as well as infestations such as scabies, can be visualized.

## Tzanck Smear

The Tzanck smear is a test used to examine cells from blistering skin conditions, such as herpes zoster, varicella, herpes simplex, and all forms of pemphigus. The secretions from a suspected lesion are applied to a glass slide, stained, and examined.

## Wood's Light Examination

**Wood's light** is a special lamp that produces long-wave ultraviolet rays, which result in a characteristic dark purple fluorescence. The color of the fluorescent light is best seen in a darkened room, where it is possible to differentiate epidermal from dermal lesions and hypopigmented and hyperpigmented lesions from normal skin. The patient is reassured that the light is not harmful to skin or eyes. Lesions that still contain melanin almost disappear under ultraviolet light, whereas lesions that are devoid of melanin increase in whiteness with ultraviolet light.

## Clinical Photographs

Photographs are taken to document the nature and extent of the skin condition and are used to determine progress or improvement resulting from treatment. They are sometimes used to track the status of moles to document if the characteristics of the mole are changing.

## CRITICAL THINKING EXERCISE

EBP You are volunteering at the skin cancer screening booth at a community health fair. A college student approaches you and asks about risk factors for skin cancer. He states that he lifeguards at a pool every summer and that he is on his school's golf team and plays golf year round. Identify the evidence to support the use of protection from the sun, including sunscreens, to prevent skin cancer. Discuss the strength of the evidence that supports the use of sunscreens. Identify the criteria used to evaluate the strength of the evidence for this practice.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com /Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

## REFERENCES AND SELECTED READINGS

**Asterisk indicates nursing research.*

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## RESOURCES

American Academy of Dermatology, www.aad.org

Dermatology Online Atlas, a cooperation between the Department of Clinical Social Medicine (University of Heidelberg) and the Department of Dermatology (University of Erlangen), www.dermis.net

New Zealand Dermatology Society, www.dermnetnz.org

Skin Cancer Foundation (lists approved sunscreens and other sun protection products), www.skincancer.org



chapter 56

# Management of Patients With Dermatologic Problems

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the general management of the patient with an abnormal skin condition.
2. Describe the health education needs of the patient with infections of the skin and parasitic skin diseases.
3. Describe the management and nursing care of the patient with psoriasis.
4. Use the nursing process as a framework for care of patients with blistering disorders.
5. Use the nursing process as a framework for care of patients with toxic epidermal necrolysis and Stevens-Johnson syndrome.
6. Describe the management and nursing care of the patient with skin cancer.
7. Use the nursing process as a framework for care of the patient with malignant melanoma.
8. Describe characteristics of the various types of Kaposi's sarcoma.
9. Compare the various types of dermatologic and plastic reconstructive procedures.
10. Describe the nursing care of patients undergoing dermatologic and plastic reconstructive procedures.

## GLOSSARY

**acantholysis:** separation of epidermal cells from each other due to damage or abnormality of the intracellular substance

**balneotherapy:** a bath with therapeutic additives

**carbuncle:** localized skin infection involving several hair follicles

**cheilitis:** inflammation of the lips (when dry, cracking, inflamed skin occurs at the corners of the mouth it is called angular cheilitis; when caused by sun exposure it is called solar cheilitis)

**comedones:** the primary lesions of acne, caused by sebum blockage in the hair follicle

**cytotoxic:** destructive of cells

**débridement:** removal of necrotic or dead tissue by mechanical, surgical, or autolytic means

**dermatitis:** any inflammation of the skin

**dermatosis:** any abnormal skin lesion

**epidermopoiesis:** development of epidermal cells

**fibrinolytic:** a substance that acts to break up fibrin, the fine filaments of blood clots

**furuncle:** localized skin infection of a single hair follicle

**hydrophilic:** a material that absorbs moisture

**hydrophobic:** a material that repels moisture

**hygroscopic:** a material that absorbs moisture from the air

**lichenification:** thickening of the horny layer of the skin

**liniments:** lotions with added oil for increased softening of the skin

**mitogenic:** a substance that stimulates mitosis or cell division and reproduction

**plasmapheresis:** removal of whole blood from the body, separation of its cellular elements by centrifugation, and reinfusion of them suspended in saline or some other plasma substitute, thereby depleting the body's own plasma without depleting its cells

**pyodermas:** bacterial skin infections

**striae:** bandlike streaks on the skin, distinguished by color, texture, depression, or elevation from the tissue in which they are found; usually purplish or white

**suspensions:** liquid preparations in which powder is suspended, requiring shaking before use

**tinea:** a superficial fungal infection on the skin or scalp

**xerosis:** overly dry skin

Nursing care for patients with dermatologic problems includes administering topical and systemic medications, managing wet dressings and other special dressings, and providing therapeutic baths. The four major objectives of therapy are to prevent additional damage, prevent secondary infection, reverse the inflammatory process, and relieve the symptoms.

## SKIN CARE FOR PATIENTS WITH SKIN CONDITIONS

Some skin problems are markedly aggravated by soap and water, and bathing routines are modified according to the condition. Denuded skin, whether the area of desquamation is large or small, is excessively prone to damage by chemicals and trauma. The friction of a towel, if applied with vigor, is sufficient to produce a brisk inflammatory response that causes any existing lesion to flare up and extend.

### Protecting the Skin

Basic skin care in bathing a patient with skin problems is as follows:

- A mild, lipid-free soap or soap substitute is used.
- The area is rinsed completely and blotted dry with a soft cloth.
- Deodorant soaps and laundry detergents are avoided.

Special care is necessary when changing dressings. Use of pledgets saturated with oil, sterile saline, or another prescribed solution helps loosen crusts, remove exudates, or free an adherent dry dressing.

### Preventing Secondary Infection

Skin lesions should be regarded as potentially infectious, and proper precautions should be observed until the diagnosis is established. Most lesions with purulent drainage contain infectious material. The nurse and physician must adhere to standard precautions and wear gloves when inspecting the skin or changing a dressing. Use of standard precautions and proper disposal of any contaminated dressing is carried out according to the Occupational Safety and Health Administration (OSHA) regulations.

### Reversing the Inflammatory Process

The type of skin lesion (eg, oozing, infected, or dry) usually determines the type of local medication or treatment that is prescribed. As a rule, if the skin is acutely inflamed (ie, hot, red, and swollen) and oozing, it is best to apply wet dressings and soothing lotions. For chronic conditions in which the skin surface is dry and scaly, water-soluble emulsions, creams, ointments, and pastes are used. The therapy is modified as the responses of the skin indicate. The patient and the nurse should note whether the medication or dressings seem to irritate the skin. The success or failure of therapy usually depends on adequate instruction and motivation of the patient and family, and the support of health care personnel promotes adherence to instructions.

## WOUND CARE FOR SKIN CONDITIONS

There are three types of wound dressings: passive, interactive, and active. *Passive* dressings have only a protective function and maintain a moist environment for natural healing. They include those that just cover the area (eg, DuoDERM, Tegaderm) and may remain in place for several days. *Interactive* dressings are capable of absorbing wound exudate while (1) maintaining a moist environment in the area of the wound and (2) allowing the surrounding skin to remain dry. They include hydrocolloids, alginates, and hydrogels. It is thought that interactive dressings are able to modify the physiology of the wound environment by modulating and stimulating cellular activity and by releasing growth factor (Fonder, Lazarus, Cowan, et al., 2008). *Active* dressings improve the healing process and decrease healing time. They include skin grafts and biologic skin substitutes. Both interactive and active dressings create a moist environment at the interface of the wound with the dressing.

Because so many wound care products are available, it is often difficult to select the most appropriate product for a specific wound. Selection of products should be made carefully because of their expense. Both clinical efficacy and health-related outcomes (eg, decreased pain, increased mobility) should be used to measure the success of a product for a wound. Even with the availability of a large variety of dressings, an appropriate selection can be made if certain principles are maintained. These principles are referred to as the five rules of wound care (Krasner, Rodeheaver & Sibbald, 2007):

- *Rule 1: Categorization.* The nurse learns about dressings by generic category and compares new products with those that already make up the category. The nurse becomes familiar with indications, contraindications, and side effects. The best dressing may be created by combining products in different categories to achieve several goals at the same time. These categories are discussed in subsequent sections.
- *Rule 2: Selection.* The nurse selects the safest and most effective, easy-to-use, and cost-effective dressing possible. In many cases, nurses carry out the physician's prescriptions for dressings, but they must be prepared to give the physician feedback about the dressing's effect on the wound, ease of use for the patient, and other considerations when applicable.
- *Rule 3: Change.* The nurse changes dressings based on patient, wound, and dressing assessments, not on standardized routines.

**NURSING ALERT**

**The natural wound-healing process should not be disrupted. Unless the wound is infected or has a heavy discharge, it is common to leave chronic wounds covered for 48 to 72 hours and acute wounds for 24 hours.**

- *Rule 4: Evolution.* As the wound progresses through the phases of wound healing, the dressing protocol

is altered to optimize wound healing. It is rare, especially in cases of chronic wounds, that the same dressing material is appropriate throughout the healing process. The nurse teaches the patient or family caregiver about wound care and ensures that the family has access to appropriate dressing choices.

- *Rule 5: Practice.* Practice with dressing material is required for the nurse to learn the performance parameters of the particular dressing. Refining the skills of applying appropriate dressings correctly and learning about new dressing products are essential nursing responsibilities. Dressing changes should not be delegated to unlicensed personnel; these techniques require the knowledge base and assessment skills of professional nurses.

## Autolytic Débridement

Autolytic **débridement** is a process that uses the body's own digestive enzymes to break down necrotic tissue. The wound is kept moist with occlusive dressings. Eschar and necrotic debris are softened, liquefied, and separated from the bed of the wound.

Several commercially available products contain the same enzymes that the body produces naturally. These are called enzymatic débriding agents; examples include Accu-Zyme, collagenase (Santyl), Granulex, and Zymase. Application of these products speeds the rate at which necrotic tissue is removed. This method, although slower than surgical débridement, is more discriminating for tissue removal and does not damage healthy tissue surrounding the wound. When enzymatic débridement is being used under an occlusive dressing, a foul odor is produced by the breakdown of cellular debris. This odor does not indicate that the wound is infected. The nurse should expect this reaction and help the patient and family understand the reason for the odor.

## Categories of Dressings

Table 56-1 is a guide to wound dressing functions and categories.

### Occlusive Dressings

Occlusive dressings may be commercially produced or made inexpensively from sterile or nonsterile gauze squares or wrap. Occlusive dressings cover topical medication that is applied to a skin lesion. The area is kept airtight by using plastic film (eg, plastic wrap). Plastic film is thin and readily adapts to all sizes, body shapes, and skin surfaces. Generally, plastic wrap should be used no more than 12 hours each day. Plastic surgical tape containing a corticosteroid in the adhesive layer can be cut to size and applied to individual lesions.

### Wet Dressings

Wet dressings (wet compresses applied to the skin) were traditionally used for acute, weeping, inflammatory lesions. They have become almost obsolete because of the many newer products available for wound care.

**Table 56-1 QUICK GUIDE TO FUNCTION AND ACTION OF WOUND DRESSINGS**

| Function | Action | Example |
|---|---|---|
| Absorption | Absorbs exudate | Alginates, composite dressings, foams, gauze, hydrocolloids, hydrogels |
| Cleansing | Removes purulent drainage, foreign debris, and devitalized tissue | Wound cleansers |
| Débridement | *Autolytic; covers* a wound and allows enzymes to self-digest sloughed skin | Absorption beads, pastes, powders; alginates; composite dressings; foams; hydrate gauze; hydrogels; hydrocolloids; transparent films; wound care systems |
| | *Chemical* or enzymatic; applied topically to break down devitalized tissue | Enzymatic débridement agents |
| | *Mechanical;* removes devitalized tissue with mechanical force | Wound cleansers, gauze (wet to dry), whirlpool |
| Diathermy | Produces electrical current to promote warmth and new tissue growth | |
| Hydration | Adds moisture to a wound | Gauze (saturated with saline) solution, hydrogels, wound care systems |
| Maintain moist environment | Manages moisture levels in a wound and maintains a moist environment | Composites, contact layers, foams, gauze (impregnated or saturated), hydrogels, hydrocolloids, transparent films, wound care systems |
| Manage high-output wounds | Manages excessive quantities of exudate | Pouching systems |
| Pack or fill dead space | Prevents premature wound closure or fills shallow areas and provides absorption | Absorbent beads, powders, pastes; alginates, composites, foams, gauze (impregnated and nonimpregnated) |
| Protect and cover wound | Provides protection from the external environment | Composites, compression bandages/wraps, foams, gauze dressings, hydrogels, hydrocolloids, transparent film dressings |
| Protect periwound skin | Prevents moisture and mechanical trauma from damaging delicate tissue around wound | Composites, foams, hydrocolloids, pouching systems, skin sealants, transparent film dressings |
| Provide therapeutic compression | Provides appropriate levels of support to the lower extremities in venous stasis disease | Compression bandages, wraps, graduated compression stockings |

### *Moisture-Retentive Dressings*

Commercially produced moisture-retentive dressings can perform the same functions as wet dressings but are more efficient at removing exudate because of their higher moisture-vapor transmission rate; some have reservoirs that can hold excessive exudate. A number of moisture-retentive dressings are already impregnated with saline solution, petrolatum, zinc-saline solution, hydrogel, or antimicrobial agents, thereby eliminating the need to coat the skin to avoid maceration. The main advantages of moisture-retentive dressings over wet dressings are improved fibrinolysis, accelerated epidermal resurfacing, reduced pain, fewer infections, less scar tissue, gentle autolytic débridement, and decreased frequency of dressing changes. Depending on the product used and the type of dermatologic conditions encountered, most moisture-retentive dressings may remain in place from 12 to 24 hours; some can remain in place as long as a week.

#### Hydrogels

Hydrogels are polymers with 90% to 95% water content. They are available in impregnated sheets or as gel in a tube. Their high moisture content makes them ideal for autolytic débridement of wounds. They are semitransparent, allowing for wound inspection without dressing removal. They are comfortable and soothing for the painful wound. They require a secondary dressing to keep them in place. Hydrogels are appropriate for superficial wounds with high serous output, such as abrasions, skin graft sites, and draining venous ulcers.

#### Hydrocolloids

Hydrocolloids are composed of a water-impermeable, polyurethane outer covering separated from the wound by a hydrocolloid material. They are adherent and nonpermeable to water vapor and oxygen. As water evaporates over the wound, it is absorbed into the dressing, which softens and discolors with the increased water content. The dressing can be removed without damage to the wound. As the dressing absorbs water, it produces a foul-smelling, yellowish covering over the wound. This is a normal chemical interaction between the dressing and wound exudate and should not be confused with purulent drainage from the wound. Unfortunately, most of the hydrocolloid dressings are opaque, preventing inspection of the wound without removal of the dressing.

Available in sheets and in gels, hydrocolloids are a good choice for exudative wounds and for acute wounds. Easy to use and comfortable, hydrocolloid dressings promote débridement and formation of granulation tissue. Most can be left in place for as long as 7 days and can be submerged in water for bathing or showering. A recent consensus statement of wound experts suggested that hydrocolloid dressings are better than saline gauze or paraffin gauze dressings for complete healing of chronic wounds (Vaneau, Chaby, Guillot, et al., 2007).

#### Foam Dressings

Foam dressings consist of microporous polyurethane with an absorptive **hydrophilic** (water-absorbing) surface that covers the wound and a **hydrophobic** (water-resistant) backing to block leakage of exudate. They are nonadherent and require a secondary dressing to keep them in place. Moisture is absorbed into the foam layer, decreasing maceration of surrounding tissue. A moist environment is maintained, and removal of the dressing does not damage the wound. The foams are opaque and must be removed for wound inspection. Foams are a good choice for exudative wounds. They are especially helpful over bony prominences because they provide contoured cushioning.

#### Calcium Alginates

Calcium alginates are derived from seaweed and consist of very absorbent calcium alginate fibers. They are hemostatic and bioabsorbable and can be used as sheets or mats of absorbent material. As the exudate is absorbed, the fibers turn into a viscous hydrogel. They are useful in areas where the tissue is more irritated or macerated. The alginate dressing forms a moist pocket over the wound while the surrounding skin stays dry. The dressing also reacts with wound fluid, which forms a foul-smelling coating. Alginates work well when packed into a deep cavity, wound, or sinus tract with heavy drainage (Krasner, et al., 2007). They are nonadherent and require a secondary dressing. A recent consensus statement of wound experts suggests that alginates are superior to other modern dressings for débriding necrotic wounds (Vaneau, et al., 2007).

## Advances in Wound Treatment

Increasing understanding of how skin heals has led to several advances in therapy. Growth factors are cytokines or proteins that have potent **mitogenic** activity (Vaneau, et al., 2007). Low levels of cytokines circulate in the blood continuously and control key factors involved in wound healing. Many investigators believe that a deficit of cytokines contributes to poor wound healing. Regranex gel, which contains becaplermin, a recombinant human platelet-derived growth factor, promotes chemotactic recruitment and proliferation of the cells involved in wound healing (Fonder, et al., 2008).

Bioengineered skin substitutes have emerged in the past 25 years as the most effective method for management of chronic wounds. Most of these skin substitutes are cultures of keratinocytes delivered on a petrolatum gauze. They work by maintaining wound moisture, providing a structure for regeneration of cells, and supplying beneficial cytokines. These substitutes include AlloDerm, Apligraf, Dermagraf, Epicel, and Laserskin.

Some oral medications are being investigated for their benefits in healing chronic venous ulcers of the lower legs. Pentoxifylline (Trental) increases peripheral blood flow by decreasing the viscosity of blood. It has some **fibrinolytic** action and decreases leukocyte adhesion to the wall of the blood vessels. Enteric-coated aspirin was thought to be of value, but a more recent study suggests that aspirin inhibits the tensile strength of skin and prolongs the healing time (Fonder, et al., 2008).

A recent study (Jones, Fennie & Lenihan, 2007) found several surprising results related to healing of chronic wounds:

- Mechanical débridement is contraindicated because it may increase the possibility of infection and because there may be inadvertent damage to healthy tissue.
- The use of a commercial cleansing agent rather than water, normal saline, or povidone-iodine is related to faster healing.

- Initial selection of the dressing type to be used is critical to success. Wounds heal faster when the type of dressing is not changed during treatment. If the type of dressing was changed four or five times, healing times were more likely to be prolonged.
- Documenting the presence of bacteria is critical. Bacteria slow healing time. However, antibiotics are often overused; thus, it is important to check for the presence of bacteria before initiating antibiotic therapy.

## Medical Management

### *Therapeutic Baths (Balneotherapy)*

Baths or soaks, known as **balneotherapy,** are useful when large areas of skin are affected. The baths remove crusts, scales, and previously applied topical medications and relieve the inflammation and pruritus (itching) that accompany acute dermatoses. Additional information about therapeutic baths is given in Chart 56-1.

### *Pharmacologic Therapy*

Because skin is easily accessible, topical medications are often used. High concentrations of some medications can be applied directly to the affected site with little systemic absorption and therefore with few systemic side effects. However, some medications are readily absorbed through the skin and can produce systemic effects. Because topical preparations may induce allergic contact **dermatitis** in sensitive patients, any untoward response should be reported immediately and the medication discontinued.

### Chart 56-1 • *Therapeutic Baths*

#### Types of Therapeutic Baths

| Bath Solution | Effects and Uses |
|---|---|
| Water | Same effect as wet dressings |
| Saline | Used for widely disseminated lesions |
| Colloidal (Aveeno, oatmeal) | Antipruritic, soothing |
| Sodium bicarbonate (baking soda) | Cooling |
| Starch | Soothing |
| Medicated tars | Psoriasis and chronic eczema |
| Bath oils | Antipruritic and emollient action; acute and subacute generalized eczematous eruptions |

#### Nursing Interventions

- Fill the tub half full.
- Keep the water at a comfortable temperature.
- Do not allow the water to cool excessively.
- Use a bath mat, because *medications added to the bath can cause the tub to be slippery*.
- Apply an emollient cream to damp skin after the bath if lubrication is desired.
- Because tars are volatile, the bath area should be well ventilated.
- Maintain a constant room temperature without drafts.
- Encourage the patient to wear light, loose clothing after the bath.

Medicated lotions, creams, ointments, and powders are frequently used to treat skin lesions. In general, moisture-retentive dressings, with or without medication, are used in the acute stage; lotions and creams are reserved for the subacute stage; and ointments are used when inflammation has become chronic and the skin is dry with scaling or **lichenification.**

With all types of topical medication, the patient is taught to apply the medication gently but thoroughly and, when necessary, to cover the medication with a dressing to protect clothing. Table 56-2 lists commonly used topical preparations.

#### Lotions

Lotions are frequently used to replenish lost skin oils or to relieve pruritus. They are usually applied directly to the skin, but a dressing soaked in the lotion can be placed on the affected area. Lotions must be applied every 3 or 4 hours for sustained therapeutic effect. If left in place for a longer period, they may crust and cake on the skin.

Lotions are of two types: suspensions and liniments. **Suspensions,** consist of a powder in water that requires shaking before application, and clear solutions, contain completely dissolved active ingredients. A suspension such as calamine lotion provides a rapid cooling and drying effect as it evaporates, leaving a thin, medicinal layer of powder on the affected skin. **Liniments** are lotions with oil added to prevent crusting. Because lotions are easy to use, therapeutic compliance is generally high.

#### Powders

Powders usually have a talc, zinc oxide, bentonite, or cornstarch base and are dusted on the skin with a shaker or with cotton sponges. Although their therapeutic action is brief, powders act as **hygroscopic** agents that absorb and retain moisture from the air and reduce friction between skin surfaces and clothing or bedding.

#### Creams

Creams may be suspensions of oil in water or emulsions of water in oil, with additional ingredients to prevent bacterial and fungal growth. Both may cause an allergic reaction such as contact dermatitis. Oil-in-water creams are easily applied and usually are the most cosmetically acceptable to the patient. Although they can be used on the face, they tend to have a drying effect. Water-in-oil emulsions are greasier and are preferred for drying and flaking dermatoses. Creams usually are rubbed into the skin by hand. They are used for their moisturizing and emollient effects.

#### Gels

Gels are semisolid emulsions that become liquid when applied to the skin or scalp. They are cosmetically acceptable to the patient because they are not visible after application, and they are greaseless and nonstaining. The newer water-based gels appear to penetrate the skin more effectively and cause less stinging on application. They are especially useful for acute dermatitis in which there is weeping exudate (eg, poison ivy).

#### Pastes

Pastes are mixtures of powders and ointments and are used in inflammatory blistering conditions. They adhere to the

**Table 56-2 COMMON TOPICAL PREPARATIONS AND MEDICATIONS**

| Preparation | Product Name |
|---|---|
| Bath preparations | |
| With tar | Balnetar, Doak Oil, Lavatar |
| With colloidal oatmeal | Aveeno Oilated Bath Powder |
| With oatmeal and mineral oil | Aveeno Bath Oil, Nutra Soothe |
| With mineral oil | Nutraderm Bath Oil, Lubath, Alpha-Keri Bath Oil |
| Moisturizer creams | Acid Mantle Cream, Curel Cream, Dermasil, Eucerin, Lubriderm, Noxzema Skin Cream |
| Moisturizer ointments | Aquaphor Ointment, Eutra Swiss Skin Cream, Vaseline Ointment |
| Topical anesthetics | lidocaine (Xylocaine) of various strengths in the form of spray, ointment, gel; EMLA cream (lidocaine 2.5% and prilocaine 2.5%) |
| Topical antibiotics | bacitracin, Polysporin (bacitracin and polymixin B), Bactroban ointment or cream (mupirocin 2%), erythromycin 2% (Emgel, Eryderm Solution), clindamycin phosphate 1% (Cleocin cream, gel, solution), gentamicin sulfate 1% (Garamycin cream or ointment), 1% silver sulfadiazine cream (Silvadene) |

skin and may be difficult to remove without using an oil (eg, olive oil, mineral oil). Pastes are applied with a wooden tongue depressor or gloved hand.

### Ointments

Ointments retard water loss and lubricate and protect the skin. They are the preferred vehicle for delivering medication to chronic or localized dry skin conditions, such as eczema or psoriasis. Ointments are applied with a wooden tongue depressor or gloved hand.

### Sprays and Aerosols

Spray and aerosol preparations may be used on any widespread dermatologic condition. They evaporate on contact and are used infrequently.

### Corticosteroids

Corticosteroids are widely used in treating dermatologic conditions to provide anti-inflammatory, antipruritic, and vasoconstrictive effects. The patient is taught to apply this medication according to strict guidelines, using it sparingly but rubbing it into the prescribed area thoroughly. Absorption of topical corticosteroids is enhanced when the skin is hydrated or the affected area is covered by an occlusive or moisture-retentive dressing. Inappropriate use of topical corticosteroids can result in local and systemic side effects, especially when the medication is absorbed through inflamed and excoriated skin, is used under occlusive dressings, or is used for long periods on sensitive areas. Local side effects may include skin atrophy and thinning, **striae** (bandlike streaks), and telangiectasia (small, red lesions caused by dilation of blood vessels). Thinning of the skin results from the ability of corticosteroids to inhibit skin collagen synthesis. The thinning process can be reversed by discontinuing the medication, but striae and telangiectasia are permanent. Systemic side effects may include hyperglycemia and symptoms of Cushing's syndrome. Caution is required when applying corticosteroids around the eyes for two reasons: (1) long-term use may cause glaucoma or cataracts, and (2) the anti-inflammatory effect of corticosteroids may mask existing viral or fungal infections.

Concentrated (fluorinated) corticosteroids are never applied on the face or intertriginous areas (ie, axilla and groin) because these areas have a thinner stratum corneum and absorb the medication much more quickly than areas such as the forearm or legs. Persistent use of concentrated topical corticosteroids in any location may produce acnelike dermatitis, known as steroid-induced acne, and hypertrichosis (excessive hair growth). Because some topical corticosteroid preparations are available without prescription, patients should be cautioned about prolonged and inappropriate use. Table 56-3 lists topical corticosteroid preparations according to potency.

### Intralesional Therapy

Intralesional therapy consists of injecting a sterile suspension of medication (usually a corticosteroid) into or just below a lesion. Although this treatment may have an anti-inflammatory effect, local atrophy may result if the medication is injected into subcutaneous fat. Skin lesions treated with intralesional therapy include psoriasis, keloids, and cystic acne. Occasionally, immunotherapeutic and antifungal agents are administered as intralesional therapy.

### Systemic Medications

Systemic medications are also prescribed for skin conditions. These include corticosteroids for short-term therapy for contact dermatitis or for long-term treatment of a chronic **dermatosis,** such as pemphigus vulgaris. Other frequently used systemic medications include antibiotics, antifungals, antihistamines, sedatives, tranquilizers, analgesics, and **cytotoxic** (destructive of cells) agents.

## Nursing Management

Management begins with a health history, direct observation, and a complete physical examination. (Chapter 55 provides a description of integumentary assessment.) Because of its visibility, a skin condition is usually difficult to ignore or conceal from others and may therefore cause the patient

**Table 56-3 POTENCY: TOPICAL CORTICOSTEROIDS**

| Potency | Topical Corticosteroid | Preparations |
|---|---|---|
| OTC | 0.5–1.0% hydrocortisone | cr, lot, oint |
| Lowest | dexamethasone 0.1% (Decaderm) | cr, oint, aerosol, gel |
| | alclometasone 0.05% (Aclovate) | cr, oint |
| | hydrocortisone 2.5% (Hytone) | cr, lot, oint |
| Low–medium | desonide 0.05% (DesOwen, Tridesilon) | cr, lot, oint |
| | fluocinolone acetonide 0.025% (Synalar) | cr, solution |
| | hydrocortisone valerate 0.2% (Westcort) | cr, solution |
| | betamethasone valerate 0.1% (Valisone) | cr, oint |
| | fluticasonepropionate 0.05% (Cutivate) | cr, oint |
| Medium–high | triamcinolone acetonide 0.1–0.5% (Aristocort) | cr, oint, lot |
| | fluocinonide 0.05% (Lidex) | cr, oint, gel |
| | desoximetasone 0.05–0.25% (Topicort) | cr, oint, gel |
| | fluocinolone 0.2% (Synalar) | cr, oint |
| | diflorasone diacetate 0.05% (Psorcon) | cr, oint |
| Very high | clobetasol propionate 0.05% (Temovate) | cr, oint, gel |
| | betamethasone dipropionate 0.05% (Diprolene) | cr, oint, gel |
| | halobetasole propionate 0.05% (Ultravate) | cr, oint |

cr, cream; lot, lotion; oint, ointment; OTC, over the counter.

emotional distress. The major goals for the patient may include maintenance of skin integrity, relief of discomfort, promotion of restful sleep, self-acceptance, knowledge about skin care, and avoidance of complications.

Nursing management for patients who must perform self-care for skin problems, such as applying medications and dressings, focuses mainly on teaching the patient how to wash the affected area and pat it dry, apply medication to the lesion while the skin is moist, cover the area with plastic (eg, Telfa pads, plastic wrap, vinyl gloves, plastic bag) if recommended, and cover it with an elastic bandage, dressing, or paper tape to seal the edges. Dressings that contain or cover a topical corticosteroid should be removed for 12 of every 24 hours to prevent skin thinning, striae, and telangiectasia.

Other forms of dressings, such as those used to cover topical medications, include soft cotton cloth and stretchable cotton dressings (eg, Surgitube, TubeGauz) that can be used for fingers, toes, hands, and feet. The hands can be covered with disposable polyethylene or vinyl gloves sealed at the wrists; the feet can be wrapped in plastic bags covered by cotton socks. Gloves and socks that are already impregnated with emollients, making application to the hands and feet more convenient, are also available. When large areas of the body must be covered, cotton cloth topped by an expandable stockinette can be used. Disposable diapers or cloths folded in diaper fashion are useful for dressing the groin and the perineal areas. Axillary dressings can be made of cotton cloth, or a commercially prepared dressing may be used and taped in place or held by dress shields. A turban or plastic shower cap is useful for holding dressings on the scalp. A face mask, made from gauze with holes cut out for the eyes, nose, and mouth, may be held in place with gauze ties looped through holes cut in the four corners of the mask.

# PRURITUS

## General Pruritus

Pruritus (itching) is one of the most common symptoms of patients with dermatologic disorders. Itch receptors are unmyelinated, penicillate (brushlike) nerve endings that are found exclusively in the skin, mucous membranes, and cornea. Although pruritus is usually caused by primary skin disease with resultant rash or lesions, it may occur without a rash or lesion. This is referred to as essential pruritus, which generally has a rapid onset, may be severe, and interferes with normal daily activities.

Pruritus may be the first indication of a systemic internal disease such as diabetes mellitus, blood disorders, or cancer (occult malignancy of the breast or colon; lymphoma). It may also accompany renal, hepatic, and thyroid diseases (Chart 56-2). Some common oral medications such as aspirin, antibiotics, hormones (ie, estrogens, testosterone, or oral contraceptives), and opioids (ie, morphine or cocaine) may cause pruritus directly or by increasing sensitivity to ultraviolet light. Certain soaps and chemicals, radiation therapy, prickly heat (miliaria), and contact with woolen garments are also associated with pruritus. Pruritus may also be

**Chart 56-2 • *Systemic Disorders Associated With Generalized Pruritus***

Chronic renal disease
Obstructive biliary disease (primary biliary cirrhosis, extrahepatic biliary obstruction, drug-induced cholestasis)
Endocrine disease (thyrotoxicosis, hypothyroidism, diabetes mellitus)
Psychiatric disorders (emotional stress, anxiety, neurosis, phobias)
Malignancies (polycythemia vera, Hodgkin's lymphoma, lymphoma, leukemia, multiple myeloma, mycosis fungoides, and cancers of the lung, breast, central nervous system, and gastrointestinal tract)
Neurologic disorders (multiple sclerosis, brain abscess, brain tumor)
Infestations (scabies, lice, other insects)
Pruritus of pregnancy (pruritic urticarial papules of pregnancy [PUPP], cholestasis of pregnancy, pemphigoid of pregnancy)
Folliculitis (bacterial, candidiasis, dermatophyte)
Skin conditions (seborrheic dermatitis, folliculitis, iron deficiency anemia, atopic dermatitis)

caused by psychological factors, such as excessive stress in family or work situations.

### Gerontologic Considerations

Pruritus occurs frequently in elderly people as a result of dry skin. Elderly people are also more likely to have a systemic illness that triggers pruritus, are at higher risk for occult malignancy, and are more likely to be taking multiple medications than younger people. All of these factors increase the incidence of pruritus in elderly people.

### Pathophysiology

Scratching the pruritic area causes the inflamed cells and nerve endings to release histamine, which produces more pruritus, generating a vicious itch–scratch cycle. If the patient responds to an itch by scratching, the integrity of the skin may be altered, and excoriation, redness, raised areas (ie, wheals), infection, or changes in pigmentation may result. Pruritus usually is more severe at night and is less frequently reported during waking hours, probably because the person is distracted by daily activities. At night, when there are fewer distractions, the slightest pruritus cannot be easily ignored. Severe itching can be debilitating.

### Medical Management

A thorough history and physical examination usually provide clues to the underlying cause of the pruritus, such as hay fever, allergy, recent administration of a new medication, or a change of cosmetics or soaps. After the cause has been identified, treatment of the condition should relieve the pruritus. Signs of infection and environmental clues, such as warm, dry air or irritating bed linens, should be identified. In general, washing with soap and hot water is avoided. Bath oils containing a surfactant that allows the oil to mix with bath water (eg, Lubath, Alpha-Keri) may be sufficient for cleaning. However, an elderly patient or a patient with unsteady balance should avoid adding oil because it increases the danger of slipping in the bathtub. A warm bath with a mild soap followed by application of a bland emollient to moist skin can control **xerosis** (dry skin). Applying a cold compress, ice cube, or cool agents that contain menthol and camphor (which constrict blood vessels) may also help relieve pruritus.

#### *Pharmacologic Therapy*

Topical corticosteroids may be beneficial as anti-inflammatory agents to decrease itching. Oral antihistamines are even more effective because they can overcome the effects of histamine release from damaged mast cells. An antihistamine, such as diphenhydramine (Benadryl) or hydroxyzine (Atarax), prescribed in a sedative dose at bedtime is often effective in producing a restful and comfortable sleep. Nonsedating antihistamine medications such as fexofenadine (Allegra) are more appropriate to relieve daytime pruritus. Tricyclic antidepressants, such as doxepin (Sinequan), may be prescribed for pruritus of neuropsychogenic origin. If pruritus continues, further investigation of a systemic problem is advised.

### Nursing Management

The nurse reinforces the reasons for the prescribed therapeutic regimen and counsels the patient on specific points of care. If baths have been prescribed, the patient is reminded to use tepid (not hot) water and to shake off the excess water and blot between intertriginous areas (body folds) with a towel. Rubbing vigorously with the towel is avoided because this overstimulates the skin and causes more itching. It also removes water from the stratum corneum. Immediately after bathing, the skin should be lubricated with an emollient to trap moisture.

The patient is instructed to avoid situations that cause vasodilation. Examples include exposure to an overly warm environment and ingestion of alcohol or hot foods and liquids. All can induce or intensify pruritus. Using a humidifier is helpful if environmental air is dry. Activities that result in perspiration should be limited because perspiration may irritate and promote pruritus. If the patient is troubled at night with itching that interferes with sleep, the nurse can advise wearing cotton clothing next to the skin rather than synthetic materials. The room should be kept cool and humidified. Vigorous scratching should be avoided and nails kept trimmed to prevent skin damage and infection. When the underlying cause of pruritus is unknown and further testing is required, the nurse explains each test and the expected outcome.

## *Perineal and Perianal Pruritus*

Pruritus of the genital and anal regions may be caused by small particles of fecal material lodged in the perianal crevices or attached to anal hairs. Alternatively, it may result from perianal skin damage caused by scratching, moisture, and decreased skin resistance as a result of corticosteroid or antibiotic therapy. Other possible causes of perianal itching include local irritants such as scabies and lice, local lesions such as hemorrhoids, fungal or yeast infections, and pinworm infestation. Conditions such as diabetes mellitus, anemia, hyperthyroidism, and pregnancy may also result in pruritus. Occasionally, no cause can be identified.

### Management

The patient is instructed to follow proper hygiene measures and to discontinue home and over-the-counter remedies. The perineal or anal area should be rinsed with lukewarm water and blotted dry with cotton balls. Premoistened tissues may be used after defecation. Cornstarch can be applied in the skinfold areas to absorb perspiration.

As part of health teaching, the nurse instructs the patient to avoid bathing in water that is too hot and to avoid using bubble baths, sodium bicarbonate, and detergent soaps, all of which aggravate dryness. To keep the perineal or perianal skin as dry as possible, patients should avoid wearing underwear made of synthetic fabrics. Local anesthetic agents should not be used because of possible allergic effects. The patient should also avoid vasodilating agents or stimulants (eg, alcohol, caffeine) and mechanical irritants such as rough or woolen clothing. A diet that includes adequate fiber may help maintain soft stools and prevent minor trauma to the anal mucosa.

## SECRETORY DISORDERS

The main secretory function of the skin is performed by the sweat glands, which help regulate body temperature. These glands excrete perspiration that evaporates, thereby cooling

the body. The sweat glands are located in various parts of the body and respond to different stimuli. Those on the trunk generally respond to thermal stimulation; those on the palms and soles respond to nervous stimulation; and those in the axillae and on the forehead respond to both kinds of stimulation. Normal perspiration has no odor. Body odor is produced by the increase in bacteria on the skin and the interaction of bacterial waste products with the chemicals of perspiration. As a rule, moist skin is warm, and dry skin is cool, but this is not always true. It is not unusual to observe warm, dry skin in a dehydrated patient and very hot, dry skin in some febrile states.

Normally, sweat can be controlled with the use of antiperspirants and deodorants. Most antiperspirants are aluminum salts that block the opening to the sweat duct. Pure deodorants inhibit bacterial growth and block the metabolism of sweat; they have no antiperspirant effect. Fragrance-free deodorants are available for those with sensitive skin.

## Hidradenitis Suppurativa

Hidradenitis suppurativa is a chronic suppurative folliculitis of the perianal, axillary, and genital areas or under the breasts. It develops after puberty and can produce abscesses or sinuses with scarring. The cause is unknown, but it appears to have a genetic basis.

### Pathophysiology

Abnormal blockage of the sweat glands causes recurring inflammation, nodules, and draining sinus tracts. Eventually, hypertrophic bands of scar tissue form in the area of the sweat glands.

### Clinical Manifestations

The condition occurs more frequently in the axilla but also appears in inguinal folds, on the mons pubis, and around the buttocks. The patient can be extremely uncomfortable with multiple suppurative lesions within a small area.

### Management

Management is often difficult. Hot compresses and oral antibiotics are used frequently. Isotretinoin (Accutane, Sotret) or acitretin (Soriatane) can be tried; careful monitoring for side effects is important. Incision and drainage of large suppurating areas with gauze packs inserted to facilitate drainage are often necessary. Rarely, the entire area is excised, removing the scar tissue and any infection. This surgery is drastic and performed only as a last resort.

## Seborrheic Dermatoses

Seborrhea is excessive production of sebum (secretion of sebaceous glands) in areas where sebaceous glands are normally found in large numbers, such as the face, scalp, eyebrows, eyelids, sides of the nose and upper lip, malar regions (cheeks), ears, axillae, under the breasts, groin, and gluteal crease of the buttocks. Seborrheic dermatitis is a chronic inflammatory disease of the skin with a predilection for areas that are well supplied with sebaceous glands or lie between skin folds, where the bacteria count is high.

### Clinical Manifestations

Two forms of seborrheic dermatoses can occur: an oily form and a dry form. Either form may start in childhood and continue throughout life. The oily form appears moist or greasy. There may be patches of sallow, greasy skin, with or without scaling, and slight erythema, predominantly on the forehead, nasolabial fold, beard area, scalp, and between adjacent skin surfaces in the regions of the axillae, groin, and breasts. Small pustules or papulopustules resembling acne may appear on the trunk. The dry form, consisting of flaky desquamation of the scalp with a profuse amount of fine, powdery scales, is commonly called dandruff. The mild forms of the disease are asymptomatic. When scaling occurs, it is often accompanied by pruritus, which may lead to scratching and secondary infections and excoriation.

Seborrheic dermatitis has a genetic predisposition. Hormones, nutritional status, infection, and emotional stress influence its course. The remissions and exacerbations of this condition should be explained to the patient. If a person has not previously been diagnosed with this condition and suddenly appears with a severe outbreak, a complete history and physical examination should be conducted.

### Medical Management

Because there is no known cure for seborrhea, the objectives of therapy are to control the disorder and allow the skin to repair itself. Seborrheic dermatitis of the body and face may respond to a topically applied corticosteroid cream, which allays the secondary inflammatory response. However, this medication should be used with caution near the eyelids because it can lead to glaucoma and cataracts. Patients with seborrheic dermatitis may develop a secondary candidal (yeast) infection in body creases or folds. To avoid this, patients should be advised to ensure maximum aeration of the skin and to clean areas where there are creases or folds in the skin carefully. Patients with persistent candidiasis should be evaluated for diabetes.

The mainstay of dandruff treatment is proper, frequent shampooing (at least three times weekly) with medicated shampoos. Two or three different types of shampoo should be used in rotation to prevent the seborrhea from becoming resistant to a particular shampoo. The shampoo is left on at least 5 to 10 minutes. As the condition of the scalp improves, the treatment can be less frequent. Antiseborrheic shampoos include those containing selenium sulfide suspension, zinc pyrithione, salicylic acid or sulfur compounds, and tar shampoo that contains sulfur or salicylic acid.

### Nursing Management

A person with seborrheic dermatitis is advised to avoid external irritants, excessive heat, and perspiration; rubbing and scratching prolong the disorder. To avoid secondary infection, the patient should air the skin and keep skin folds clean and dry.

Instructions for using medicated shampoos are reinforced for people with dandruff who require treatment. Frequent shampooing is contrary to some cultural practices; the nurse

should be sensitive to these differences when teaching the patient about home care.

The patient is cautioned that seborrheic dermatitis is a chronic condition that tends to reappear. The goal is to keep it under control. Patients need to be encouraged to adhere to the treatment program. Those who become discouraged and disheartened by the effect on body image should be treated with sensitivity and encouraged to express their feelings.

# Acne Vulgaris

Acne vulgaris is a common disorder affecting susceptible hair follicles, most commonly on the face, neck, and upper trunk. It is characterized by **comedones** (primary acne lesions), both closed and open, and by papules, pustules, nodules, and cysts.

Acne is the most commonly encountered skin condition in adolescents and young adults between 12 and 35 years. It accounts for at least 15% of all dermatology visits. Both males and females are affected equally, although onset is slightly earlier in females, because they reach puberty at a younger age than males. Acne becomes more marked during adolescence because the endocrine glands that influence the secretions of the sebaceous glands are functioning at peak activity. Acne appears to stem from an interplay of genetic, hormonal, and bacterial factors. In most cases, there is a family history of acne.

## Pathophysiology

During puberty, androgens stimulate the sebaceous glands, causing them to enlarge and secrete a natural oil, sebum, which rises to the top of the hair follicle and flows out onto the skin surface. In adolescents who develop acne, androgenic stimulation produces a heightened response in the sebaceous glands so that acne occurs when accumulated sebum plugs the pilosebaceous ducts.

## Clinical Manifestations

The primary lesions of acne are comedones. Closed comedones (whiteheads) form from impacted lipids or oils and keratin that plug the dilated follicle. Closed comedones may evolve into open comedones, in which the contents of the ducts are in open communication with the external environment. The color of open comedones (blackheads) results from an accumulation of lipid, bacterial, and epithelial debris. Some closed comedones may rupture, resulting in an inflammatory reaction caused by leakage of follicular contents (eg, sebum, keratin, bacteria) into the dermis. The resultant inflammation is seen clinically as erythematous papules, inflammatory pustules, and inflammatory cysts. Mild papules and cysts drain and heal without treatment. Deeper papules and cysts cause scarring of the skin. Acne is usually graded as mild, moderate, or severe based on the number and type of lesions.

## Assessment and Diagnostic Findings

The diagnosis of acne is based on the history and physical examination, evidence of lesions characteristic of acne, and age. Women may report a history of flare-ups a few days before menses. The presence of the typical comedones along with excessively oily skin is characteristic. Oiliness is more prominent in the midfacial area; other parts of the face may appear dry. When there are numerous lesions, some of which are open, the person may exude a distinct sebaceous odor. Biopsy of lesions is seldom necessary for a definitive diagnosis.

## Medical Management

The goals of management are to reduce bacterial colonies, decrease sebaceous gland activity, prevent the follicles from becoming plugged, reduce inflammation, combat secondary infection, minimize scarring, and eliminate factors that predispose the person to acne. The therapeutic regimen depends on the type of lesion (eg, comedones, papule, pustule, cyst). The duration of treatment depends on the extent and severity of the acne. In severe cases, treatment may extend over years.

There is no predictable cure for the disease, but combinations of therapies are available that can effectively control its activity. Table 56-4 summarizes the treatment modalities for acne vulgaris.

### Nutrition and Hygiene Therapy

Diet is not believed to play a major role in therapy. However, the elimination of a specific food or food product

**Table 56-4 TYPE OF TREATMENTS COMMONLY USED FOR ACNE VULGARIS**

| Type of Therapy | Prescribed Treatment Agent |
|---|---|
| Topical | benzoyl peroxide wash, gel |
| | benzoyl peroxide and erythromycin (Benzamycin gel) |
| | benzoyl peroxide and sulfur (Benzulfoid cream) |
| | resorcinol (as ingredient in other preparations) |
| | salicylic acid (as ingredient in other preparations) |
| | sulfur (as ingredient in other preparations) |
| | tretinoin (Retin A, Avita) |
| | other comedogenics (adapalene [Differen], azelaic acid [Azelex], tazorotene [Tazorac]) |
| | topical antibiotics |
| Systemic | oral antibiotics (erythromycin, tetracycline, clindamycin, doxycycline, minocin, penicillins) |
| | isotretinoin (Accutane) |
| | hormones: |
| | corticosteroids |
| | high dose for anti-nflammatory action |
| | low dose to suppress androgenic action |
| | intralesional for anti-inflammatory action |
| | antiandrogens |
| | oral contraceptives (women only) |
| Surgical | extraction of comedo contents |
| | drainage of pustules and cysts |
| | excision of sinus tracts and cysts |
| | intralesional corticosteroids for anti-inflammatory action |
| | cryotherapy |
| | dermabrasion for scars |
| | laser resurfacing of scars |

Treatments listed are common but do not include all available forms of therapy.

associated with a flare-up of acne, such as chocolate, cola, fried foods, or milk products, should be promoted. Maintenance of good nutrition equips the immune system for effective action against bacteria and infection.

For mild cases of acne, washing twice each day with a cleansing soap may be all that is required. Oil-free cosmetics and creams should be chosen. These products are usually designated as useful for acne-prone skin.

### Pharmacologic Therapy

#### Topical Therapy

Over-the-counter acne medications contain either salicylic acid or benzoyl peroxide, both of which are very effective at removing the sebaceous follicular plugs. However, the skin of some people is sensitive to these products, which can cause irritation or excessive dryness, especially when used with some prescribed topical medications. The patient should be instructed to discontinue use of the product if severe irritation occurs.

Benzoyl peroxide preparations are widely used because they produce a rapid and sustained reduction of inflammatory lesions. They depress sebum production and promote breakdown of comedo plugs and have an antibacterial effect. Initially, benzoyl peroxide causes redness and scaling, but the skin usually adjusts quickly to its use. Typically, the patient applies a gel of benzoyl peroxide once daily. In many instances, this is the only treatment needed. Benzoyl peroxide, benzoyl erythromycin (Benzamycin), and benzoyl sulfur (Sulfoxyl) are available over the counter and by prescription.

Vitamin A acid (tretinoin) applied topically is used to clear the keratin plugs from the pilosebaceous ducts. The patient should be informed that symptoms may worsen during early weeks of therapy because inflammation, erythema, and peeling may occur. The patient is cautioned against sun exposure while using this topical medication because it may cause an exaggerated sunburn. Package insert directions should be followed carefully. Improvement may take 8 to 12 weeks.

Topical antibiotic treatment for acne is common. Topical antibiotics suppress bacterial growth; reduce superficial free fatty acid levels; decrease comedones, papules, and pustules; and produce no systemic side effects.

#### Systemic Therapy

Oral antibiotics administered in small doses over a long period are very effective in treating moderate and severe acne, especially when the acne is inflammatory and results in pustules, abscesses, and scarring. Therapy may continue for months to years. The tetracycline family of antibiotics is contraindicated in children younger than 12 years and in pregnant women. Administration during pregnancy can affect the development of teeth, causing enamel hypoplasia and permanent discoloration of teeth in infants. Side effects of tetracyclines include photosensitivity, nausea, diarrhea, cutaneous infection in either gender, and vaginitis in women. In some women, broad-spectrum antibiotics may suppress normal vaginal bacteria and predispose the patient to candidiasis, a fungal infection.

Synthetic vitamin A compounds (ie, retinoids) are used with dramatic results in patients with nodular cystic acne unresponsive to conventional therapy. One compound is isotretinoin, which is used for active inflammatory papular pustular acne that has a tendency to scar. Isotretinoin reduces sebaceous gland size and inhibits sebum production. It also causes the epidermis to shed (epidermal desquamation), thereby unseating and expelling existing comedones.

The most common side effect, experienced by almost all patients, is **cheilitis** (inflammation of the lips). Dry and chafed skin and mucous membranes are frequent side effects. These changes are reversible with the withdrawal of the medication. Most important, isotretinoin, like other vitamin A metabolites, is teratogenic in humans, meaning that it can have an adverse effect on a fetus. Effective contraceptive measures for women of childbearing age are mandatory during treatment and for about 4 to 8 weeks thereafter. To avoid additive toxic effects, patients are cautioned not to take vitamin A supplements while taking isotretinoin.

Estrogen therapy (including progesterone–estrogen preparations) suppresses sebum production and reduces skin oiliness. It is usually reserved for young women when the acne begins somewhat later than usual and tends to flare up at certain times in the menstrual cycle. Estrogen-dominant oral contraceptive compounds may be administered on a prescribed cyclic regimen. Estrogen is not administered to male patients because of undesirable side effects such as enlargement of the breasts and decrease in body hair.

### Surgical Management

Treatment includes comedo extraction, injections of corticosteroids into the inflamed lesions, and incision and drainage of large, fluctuant (moving in palpable waves), nodular cystic lesions. Cryosurgery (freezing with liquid nitrogen) may be used for nodular and cystic forms of acne. Patients with deep scars may be treated with deep abrasive therapy (dermabrasion), in which the epidermis and some superficial dermis are removed down to the level of the scars.

Comedones may be removed with a comedo extractor. The site is first cleaned with alcohol. The opening of the extractor is then placed over the lesion, and direct pressure is applied to cause extrusion of the plug through the extractor. Removal of comedones leads to erythema, which may take several weeks to subside. Recurrence of comedones after extraction is common.

## Nursing Management

Nursing care of patients with acne consists largely of monitoring and managing potential complications of skin treatments. Major nursing activities include patient education, particularly in proper skin care techniques, and managing potential problems related to the skin disorder or therapy. Providing positive reassurance, listening attentively, and being sensitive to the feelings of the patient with acne are essential for the patient's psychological well-being and understanding of the disease and treatment plan.

### Preventing Scarring

Prevention of scarring is the ultimate goal of therapy. The chance of scarring increases with the severity of the grade of acne. Severe acne (25 to more than 50 comedones, papules,

or pustules) usually requires longer-term therapy with systemic antibiotics or isotretinoin. Patients should be warned that discontinuing these medications can lead to more flare-ups and increase the chance of deep scarring. Furthermore, manipulation of the comedones, papules, and pustules increases the potential for scarring.

When acne surgery is prescribed to extract deep-seated comedones or inflamed lesions or to incise and drain cystic lesions, the intervention itself may result in further scarring. Dermabrasion, which levels existing scar tissue, can also increase scar formation. Hyperpigmentation or hypopigmentation also may affect the tissue involved. The patient should be informed of these potential outcomes before choosing surgical intervention for acne.

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

In addition to instructions for taking prescribed medications, patients are instructed to wash the face and other affected areas with mild soap and water twice each day to remove surface oils and prevent obstruction of the oil glands. Mild abrasive soaps and drying agents are prescribed to eliminate the oily feeling that troubles many patients. At the same time, patients are cautioned to avoid excessive abrasion because it makes acne worse.

All forms of friction and trauma are avoided, including propping the hands against the face, rubbing the face, and wearing tight collars and helmets. Patients are instructed to avoid manipulation of pimples or blackheads. Squeezing merely worsens the problem, because a portion of the blackhead is pushed down into the skin, which may cause the follicle to rupture. Because cosmetics, shaving creams, and lotions can aggravate acne, these substances are best avoided unless the patient is advised otherwise.

# INFECTIOUS DERMATOSES

## *Bacterial Skin Infections*

Also called **pyodermas,** pus-forming bacterial infections of the skin may be primary or secondary. Primary skin infections originate in previously normal-appearing skin and are usually caused by a single organism. Secondary skin infections arise from a preexisting skin disorder or from disruption of the skin integrity from injury or surgery. In either case, several microorganisms may be implicated (eg, *Staphylococcus aureus*, group A streptococci). The most common primary bacterial skin infections are impetigo and folliculitis. Folliculitis may lead to furuncles or carbuncles.

### IMPETIGO

Impetigo is a superficial infection of the skin caused by staphylococci, streptococci, or multiple bacteria. Bullous impetigo, a more deep-seated infection of the skin caused by *S. aureus*, is characterized by the formation of bullae (large, fluid-filled blisters) from original vesicles. The bullae rupture, leaving raw, red areas.

The exposed areas of the body, face, hands, neck, and extremities are most frequently involved. Impetigo is contagious and may spread to other parts of the patient's skin or to other members of the family who touch the patient or use towels or combs that are soiled with the exudate of the lesions.

Impetigo is seen in people of all ages. It is particularly common in children living in poor hygienic conditions. It often follows pediculosis capitis (head lice), scabies (itch mites), herpes simplex, insect bites, poison ivy, or eczema. Chronic health problems, poor hygiene, and malnutrition may predispose an adult to impetigo. There is some indication that excessive use of antibacterial soaps may create resistant bacteria and contribute to the problem.

### Clinical Manifestations

The lesions of impetigo begin as small, red macules, which quickly become discrete, thin-walled vesicles that rupture and become covered with a loosely adherent honey-yellow crust (Fig. 56-1). These crusts are easily removed to reveal smooth, red, moist surfaces on which new crusts soon develop. If the scalp is involved, the hair is matted, which distinguishes the condition from ringworm.

### Medical Management

Systemic antibiotic therapy is the usual treatment. It reduces contagious spread, treats deep infection, and prevents acute glomerulonephritis (kidney infection), which may occur as a consequence of streptococcal skin diseases. In nonbullous impetigo, benzathine penicillin or oral penicillin may be prescribed. In bullous impetigo, a penicillinase-resistant penicillin (eg, cloxacillin [Cloxapen], dicloxacillin [Dycill]) may be used. In penicillin-allergic patients, erythromycin is an effective alternative.

Topical antibacterial therapy (eg, mupirocin [Bactroban]) may be prescribed when the disease is limited to a small area. The medication must be applied to the lesions several times daily for a week; this treatment regimen may be impossible for some patients or their caregivers to follow. Topical antibiotics generally are not as effective as systemic therapy in eradicating or preventing the spread of streptococci from the respiratory tract, thereby increasing the risk of developing glomerulonephritis.

When topical therapy is prescribed, lesions are soaked or washed with soap solution to remove the central site of bacterial growth, giving the topical antibiotic an opportunity to reach the infected site. After the crusts are removed, a topical antibiotic cream is applied. Gloves are worn when providing patient care. An antiseptic solution, such as povidone iodine (Betadine), may be used to clean the skin,

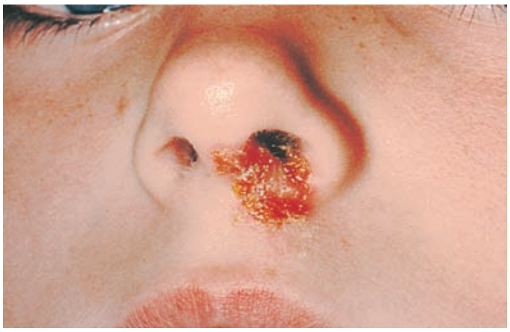


**Figure 56-1** Impetigo of the nostril.

reduce bacterial content in the infected area, and prevent spread.

## Nursing Management

The nurse instructs the patient and family members to bathe at least once daily with bactericidal soap. Cleanliness and good hygiene practices help prevent the spread of the lesions from one skin area to another and from one person to another. Each person should have a separate towel and washcloth. Because impetigo is a contagious disorder, infected people should avoid contact with other people until the lesions heal.

# FOLLICULITIS, FURUNCLES, AND CARBUNCLES

Folliculitis is an infection of bacterial or fungal origin that arises within the hair follicles. Lesions may be superficial or deep. Single or multiple papules or pustules appear close to the hair follicles. Folliculitis commonly affects the beard area of men who shave, as well as women's legs, if they shave. Other areas include the axillae, trunk, and buttocks. Follicular disorders are usually caused by staphylococci, although if the immune system is impaired, the causative organisms may be gram-negative bacilli.

Pseudofolliculitis barbae (shaving bumps) occur predominately on the faces of African American and other curly haired men as a result of shaving. The sharp ingrowing hairs have a curved root that grows at a more acute angle and pierces the skin, provoking an irritative reaction. The only entirely effective treatment is to avoid shaving. Other treatments include using special lotions or antibiotics or using a hand brush to dislodge the hairs mechanically. If the patient must remove facial hair, a depilatory cream or electric razor may be used.

A **furuncle** (boil) is an acute inflammation arising deep in one or more hair follicles and spreading into the surrounding dermis. This inflammation is a deep form of folliculitis. Furunculosis refers to multiple or recurrent lesions. Furuncles may occur anywhere on the body but are more prevalent in areas subjected to irritation, pressure, friction, and excessive perspiration, such as the back of the neck, the axillae, and the buttocks.

A furuncle may start as a small, red, raised, painful pimple. Frequently, the infection progresses and involves the skin and subcutaneous fatty tissue, causing tenderness, pain, and surrounding cellulitis. The area of redness and induration represents an effort of the body to keep the infection localized. The bacteria (usually staphylococci) produce necrosis of the invaded tissue. The characteristic pointing of a boil follows in a few days. When this occurs, the center becomes yellow or black, and the boil is said to have "come to a head."

A **carbuncle** is an abscess of the skin and subcutaneous tissue that represents an extension of a furuncle that has invaded several follicles and is large and deep seated. It is usually caused by a staphylococcal infection. Carbuncles appear most commonly in areas where the skin is thick and inelastic; the back of the neck and the buttocks are common sites. The extensive inflammation frequently prevents a complete walling off of the infection; purulent material may be absorbed, resulting in high fever, pain, leukocytosis, and even extension of the infection to the bloodstream.

Furuncles and carbuncles are more likely to occur in patients with underlying systemic diseases, such as diabetes or hematologic malignancies, and in those receiving immunosuppressive therapy for other diseases. Both are more prevalent in hot climates, especially on skin beneath occlusive clothing.

## Medical Management

In treating staphylococcal infections, it is important not to rupture or destroy the protective wall of induration that localizes the infection. The boil or pimple should never be squeezed. Systemic antibiotic therapy, selected by culture and sensitivity study, is generally indicated. Oral cloxacillin and dicloxacillin are first-line medications. Cephalosporins and erythromycin are also effective. To promote comfort, bed rest is advised for patients who have boils on the perineum or in the anal region, and a course of systemic antibiotic therapy is indicated to prevent the spread of the infection.

When the pus has localized and is fluctuant, a small incision with a scalpel can speed resolution by relieving the tension and ensuring direct evacuation of the pus and debris. The patient is instructed to keep the draining lesion covered with a dressing.

## Nursing Management

Intravenous (IV) fluids, fever reduction, and other supportive treatments are indicated for patients who are acutely ill from infection. Warm, moist compresses hasten resolution of the furuncle or carbuncle. The surrounding skin may be cleaned gently with antibacterial soap, and an antibacterial ointment may be applied. Soiled dressings are handled according to standard precautions. Nursing personnel should carefully follow standard precautions to avoid becoming carriers of staphylococci. Disposable gloves are worn when caring for these patients.

*NURSING ALERT*

**Nurses must take special precautions in caring for boils on the face because the skin area drains directly into the cranial venous sinuses. Sinus thrombosis with fatal pyemia can develop after manipulating a boil in this location. The infection can travel through the sinus tract and penetrate the brain cavity, causing a brain abscess.**

### *Promoting Home And Community-Based Care*

#### Teaching Patients Self-Care

To prevent and control staphylococcal skin infections such as boils and carbuncles, the staphylococcal pathogen must be eliminated from the skin and environment. Efforts must be made to increase the patient's resistance and provide a hygienic environment. If lesions are actively draining, the mattress and pillow should be covered with plastic material and wiped with disinfectant daily; the bed linens, towels, and clothing should be laundered after each use; and the

patient should use an antibacterial soap and shampoo for an indefinite period, often several months.

Recurrent infection is prevented with the use of long-term antibiotic therapy (longer than about 3 months). The patient must take the full dose for the time prescribed. The purulent exudate is a source of reinfection or transmission of infection to caregivers. If the patient has a history of recurrent infections, a carrier state may exist, which should be investigated and treated with an antibacterial cream such as mupirocin (Bactroban).

## Viral Skin Infections

### HERPES ZOSTER

Herpes zoster, also called shingles, is an infection caused by the varicella-zoster viruses (VZVs), members of a group of DNA viruses. The viruses that cause chickenpox (varicella) and herpes zoster are indistinguishable, hence the two-part name. The disease is characterized by a painful vesicular eruption along the area of distribution of the sensory nerves from one or more posterior ganglia. After a case of chickenpox runs its course, the VZV responsible for the outbreak lies dormant inside nerve cells near the brain and spinal cord. Later, when these latent viruses are reactivated because of declining cellular immunity, they travel by way of the peripheral nerves to the skin, where the viruses multiply and create a red rash of small, fluid-filled blisters.

It is thought that during the aging process, natural immunity to the varicella wanes, allowing the virus to reactivate and maintaining it in the population. Herpes zoster develops in about 10% of adults during their lifetimes, usually after 50 years of age; the disease develops in as many as 50% of people by 85 years of age. These episodes tend to be localized and have few sequelae. Compared with Caucasians, African Americans are affected by herpes zoster much less frequently; however, if they do develop the disease, they often have it at a younger age. There is an increased frequency of herpes zoster infections in patients with weakened immune systems, including those with human immunodeficiency virus (HIV) infection and in those with cancer. In these patients, the infection can become widespread and cause significant complications.

#### Clinical Manifestations

The eruption is usually accompanied or preceded by pain, which may radiate over the entire region supplied by the affected nerves. The pain may be burning, lancinating (tearing or sharply cutting), stabbing, or aching. Some patients have no pain, but itching and tenderness may occur over the area. Malaise and gastrointestinal disturbances may precede the eruption. The patches of grouped vesicles appear on the red and swollen skin. The early vesicles, which contain serum, later may become purulent, rupture, and form crusts. The inflammation is usually unilateral, involving the thoracic, cervical, or cranial nerves in a bandlike configuration. The blisters are usually confined to a narrow region of the face or trunk (Fig. 56-2). The clinical course varies from 1 to 3 weeks. If an ophthalmic nerve is involved, the patient may have eye pain. Inflammation and a rash on the trunk



**Figure 56-2** Herpes zoster (shingles).

may cause pain with the slightest touch. The healing time varies from 7 to 26 days.

The most common complication of herpes zoster is postherpetic neuralgia, which occurs in approximately 20% of cases, becoming more common in the elderly. Fifty percent of patients older than 60 years of age have persistent pain that lasts longer than 6 months (High, 2005).

#### Medical Management

Herpes zoster infection can be arrested if oral antiviral agents such as acyclovir (Zovirax), valacyclovir (Valtrex), or famciclovir (Famvir) are administered within 24 hours of the initial eruption. IV acyclovir, if started early, is effective in significantly reducing the pain and halting the progression of the disease. In older patients, the pain from herpes zoster may persist as postherpetic neuralgia for months after the skin lesions disappear.

The goals of herpes zoster management are to relieve the pain and to reduce or avoid complications, which include infection, scarring, and postherpetic neuralgia and eye complications. Pain is controlled with analgesics because adequate pain control during the acute phase helps prevent persistent pain patterns. Systemic corticosteroids may be prescribed for patients older than 50 years of age to reduce the incidence and duration of postherpetic neuralgia (persistent pain of the affected nerve after healing). Healing usually occurs more quickly in those who have been treated with corticosteroids. Triamcinolone (Aristocort, Kenacort, Kenalog) injected subcutaneously under painful areas is effective as an anti-inflammatory agent.

Ophthalmic herpes zoster occurs when an eye is involved. This is considered an ophthalmic emergency, and the patient should be referred to an ophthalmologist immediately to prevent the possible sequelae of keratitis, uveitis, ulceration, and blindness.

People who have been exposed to varicella by primary infection or by vaccination are not at risk for infection after exposure to patients with herpes zoster.

A vaccination for childhood varicella developed in the 1970s has been used successfully to decrease the incidence of childhood disease. A more potent formulation of the vaccine was developed to boost VZV cellular immunity in people older than 55 years of age. Studies have shown favorable results with very few side effects. One large study by the Veterans Administration showed a reduction in incidence of VZV infections by almost 50% in 60- to 69-year-old participants. This vaccination is now being recommended as part of prevention strategies in older adults (High, 2005).

### Nursing Management

The patient and family members are instructed about the importance of taking antiviral agents as prescribed and in keeping follow-up appointments with the health care provider. The nurse assesses the patient's discomfort and response to medication and collaborates with the physician to make necessary adjustments to the treatment regimen. The patient is taught how to apply wet dressings or medication to the lesions and to follow proper hand hygiene techniques to avoid spreading the virus.

Diversionary activities and relaxation techniques are encouraged to ensure restful sleep and to alleviate discomfort. A caregiver may be required to assist with dressings, particularly if the patient is elderly and unable to apply them. Food preparation for patients who cannot care for themselves or prepare nourishing meals must be arranged.

## HERPES SIMPLEX

Herpes simplex is a common skin infection. There are two types of the causative virus, which are identified by viral typing. Generally, herpes simplex type 1 occurs on the mouth and type 2 occurs in the genital area, but both viral types can be found in both locations. About 85% of adults worldwide are seropositive for herpes type 1. The prevalence of type 2 is lower; type 2 usually appears at the onset of sexual activity. Serologic testing shows that many more people are infected than have a history of clinical disease.

Herpes simplex is classified as a true primary infection, a nonprimary initial episode, or a recurrent episode. True primary infection is the initial exposure to the virus. A nonprimary initial episode is the initial episode of either type 1 or type 2 in a person previously infected with the other type. Recurrent episodes are subsequent episodes of the same viral type.

### Types of Herpes Simplex

#### *Orolabial Herpes*

Orolabial herpes, also called fever blisters or cold sores, consists of erythematous-based clusters of grouped vesicles on the lips. A prodrome of tingling or burning with pain may precede the appearance of the vesicles by up to 24 hours. Certain triggers, such as sunlight exposure or increased stress, may cause recurrent episodes. Fewer than 1% of people with primary orolabial herpes infections develop herpetic gingivostomatitis. This complication occurs more often in children and young adults than in people of other ages. The onset is often accompanied by high fever, regional lymphadenopathy, and generalized malaise. Another complication of orolabial herpes is the development of erythema multiforme, an acute inflammation of the skin and mucous membranes with characteristic lesions that have the appearance of targets (ie, concentric red rings with white bands between the red rings).

#### *Genital Herpes*

Genital herpes, or type 2 herpes simplex, manifests with a broad spectrum of clinical signs. Minor infections may produce no symptoms at all; severe primary infections with type 1 can cause systemic flulike illness. Lesions appear as grouped vesicles on an erythematous base initially involving the vagina, rectum, or penis. New lesions can continue to appear for 7 to 14 days. Lesions are symmetric and usually cause regional lymphadenopathy. Fever and flulike symptoms are common. Typical recurrences begin with a prodrome of burning, tingling, or itching about 24 hours before the vesicles appear. As the vesicles rupture, erosions and ulcerations begin to appear. Severe infections can cause extensive erosions of the vaginal or anal canal. For further information, see Chapter 47.

### Assessment and Diagnostic Findings

Herpes simplex infections are confirmed in several ways. Generally, the appearance of the skin eruption is strongly suggestive. Viral cultures and rapid assays are available, and the type of test used depends on lesion morphology. Acute vesicular lesions are more likely to react positively to the rapid assay, whereas older, crusted patches are better diagnosed with viral culture. In all cases, it is imperative to obtain enough viral cells for testing, and careful collection methods are therefore important. All crusts should be gently removed or vesicles gently unroofed. A sterile cotton swab premoistened in viral culture preservative is used to swab the base of the vesicle to obtain a specimen for analysis.

### Complications

Eczema herpeticum is a condition in which patients with eczema contract herpes that spreads throughout the eczematous areas. The same type of spread of herpes can occur in severe seborrhea, scabies, and other chronic skin conditions. Eczema herpeticum is managed with oral or IV acyclovir.

Herpetic whitlow is an infection of the pulp of a fingertip with herpes type 1 or 2. There is tenderness and erythema of the cuticle. Deep-seated vesicles appear within 24 hours.

In mothers who have primary infections during pregnancy, intrauterine neonatal infections can occur. Most cases of neonatal infection with herpes occur during delivery by contact of the infant with the mother's active ulcerations. Fetal anomalies include skin lesions, microcephaly, encephalitis, and intracerebral calcifications.

### Medical Management

In many patients, recurrent orolabial herpes represents more of a nuisance than a disease. Because sun exposure is a common trigger, people with recurrent orolabial herpes should use a sunscreen liberally on the lips and face. Topical treatment with drying agents may accelerate healing. In

more severe outbreaks or in patients with identified triggers, intermittent treatment with 200 mg acyclovir administered five times each day for 5 days is often started as soon as the earliest symptoms occur.

Treatment of genital herpes depends on the severity, the frequency, and the psychological impact of recurrences and on the infectious status of the sexual partner. For people who have mild or rare outbreaks, no treatment may be required. For those who have more severe outbreaks, but for whom outbreaks are still infrequent, intermittent treatment as described for oral lesions can be used. Use of intermittent oral medication has been shown to reduce the duration of herpes genital infections by only 24 to 36 hours. If a patient is using intermittent treatment for infrequent episodes, the medication should be initiated within the first 24 hours after the infection is identified.

Patients who have more than six recurrences per year may benefit from suppressive therapy. Use of acyclovir, valacyclovir, or famciclovir suppresses 85% of recurrences, and 20% of patients are free of recurrences during suppressive therapy. Suppressive therapy also reduces viral shedding by almost 95%, making the person less contagious. Treatment with suppressive doses of oral antiviral medications prevents recurrent erythema multiforme (acute eruption of macules, papules, and vesicles with a multiform appearance).

Management of genital herpes in pregnancy differs among clinicians. Routine prenatal cultures do not predict shedding at the time of delivery. The use of scalp electrodes during delivery should be avoided because they increase the risk of infection in the newborn. Because the risk of neonatal herpes is greater in women with their initial episode during pregnancy, suppression therapy should be started in affected women to reduce outbreaks during the third trimester. All women with active lesions at the time of delivery undergo cesarean section.

In immunocompromised patients, suppression therapy should be considered. In severe infections of hospitalized patients, IV acyclovir is prescribed.

## Fungal (Mycotic) Skin Infections

Fungi, tiny members of a subdivision of the plant kingdom that thrive on organic matter, cause various common skin infections. In some cases, they affect only the skin and its appendages (hair and nails). In other cases, internal organs are involved, and the diseases may be life-threatening. However, superficial infections rarely cause even temporary disability and respond readily to treatment. Secondary infection with bacteria, *Candida*, or both organisms may occur.

The most common fungal skin infection is **tinea,** which is also called ringworm because of its characteristic appearance of a ring or rounded tunnel under the skin. Tinea infections affect the head, body, groin, feet, and nails. Table 56-5 summarizes the tinea infections.

To obtain a specimen for diagnosis, the lesion is cleaned and a scalpel or glass slide is used to remove scales from the margin of the lesion. The scales are dropped onto a slide to which potassium hydroxide has been added. The diagnosis is made by examination of the infected scales microscopically for spores and hyphae or by isolating the organism in

**Table 56-5 TINEA (RINGWORM) INFECTIONS**

| Type and Location | Clinical Manifestations | Treatment |
|---|---|---|
| Tinea capitis (head)<br>Contagious fungal infection of the hair shaft | • Common in children<br>• Oval, scaling, erythematous patches<br>• Small papules or pustules on the scalp<br>• Brittle hair that breaks easily | • Griseofulvin for 6 weeks<br>• Shampoo hair two or three times with Nizoral or selenium sulfide shampoo |
| Tinea corporis (body) | • Begins with red macule, which spreads to a ring of papules or vesicles with central clearing<br>• Lesions found in clusters<br>• Many spread to the hair, scalp, or nails<br>• Very pruritic<br>• An infected pet may be the source | • Mild conditions: topical antifungal creams<br>• Severe conditions: griseofulvin or terbinafine |
| Tinea cruris (groin area; "jock itch") | • Begins with small, red scaling patches, which spread to form circular elevated plaques<br>• Very pruritic<br>• Clusters of pustules may be seen around borders | • Mild conditions: topical antifungal creams<br>• Severe conditions: griseofulvin or terbinafine |
| Tinea pedis (foot; "athlete's foot") | • Soles of one or both feet have scaling and mild redness with maceration in the toe webs<br>• More acute infections may have clusters of clear vesicles on dusky base | • Soak feet in vinegar and water solution<br>• Resistant infections: griseofulvin or terbinafine<br>• Terbinafine (Lamisil) daily for 3 months |
| Tinea ungum (toenails; affects about 50% of adults) | • Nails thicken, crumble easily, and lack luster<br>• Whole nail may be destroyed | • Itraconazole (Sporanox) in pulses of 1 week a month for 3 months in cases of terbinafine failure |

culture. Under Wood's light, a specimen of infected hair appears fluorescent; this may be helpful in diagnosing some cases of tinea capitis.

## Parasitic Skin Infestations

These conditions include infestations of the skin by lice (pediculosis) and the itch mite (scabies).

### PEDICULOSIS: LICE INFESTATION

Lice infestation affects people of all ages. Three varieties of lice infest humans: *Pediculus humanus capitis* (head louse), *Pediculus humanus corporis* (body louse), and *Phthirus pubis* (pubic louse or crab louse). Lice are called ectoparasites because they live on the outside of the host's body. They depend on the host for their nourishment, feeding on human blood approximately five times each day. They inject their digestive juices and excrement into the skin, which causes severe itching.

#### Types of Pediculosis

##### Pediculosis Capitis

Pediculosis capitis is an infestation of the scalp by the head louse. The female louse lays her eggs (nits) close to the scalp. The nits become firmly attached to the hair shafts with a tenacious substance. The young lice hatch in about 10 days and reach maturity in 2 weeks. Head lice may be transmitted directly by physical contact or indirectly by infested combs, brushes, wigs, hats, and bedding.

##### Pediculosis Corporis and Pubis

Pediculosis corporis is an infestation of the body by the body louse. This is a disease of unwashed people or those who live in close quarters and do not change their clothing (eg, survivors of natural disasters such as hurricanes, floods, and earthquakes who must live with others in temporary housing without access to running water and clean clothes). Pediculosis pubis is extremely common. The infestation is generally localized in the genital region and is transmitted chiefly by sexual contact.

#### Clinical Manifestations

Head lice are found most commonly along the back of the head and behind the ears. To the naked eye, the eggs look like silvery, glistening oval bodies. The bite of the insect causes intense pruritus, and the resultant scratching often leads to secondary bacterial infection, such as impetigo or furunculosis. The infestation is more common in children and people with long hair.

With body lice, the areas of the skin that come in closest contact with the underclothing (ie, neck, trunk, and thighs) are chiefly involved. The body louse lives primarily in the seams of underwear and clothing, to which it clings as it pierces the skin with its proboscis. Its bites cause characteristic minute hemorrhagic points. Widespread excoriation may appear as a result of intense pruritus and scratching, especially on the trunk and neck. Among the secondary lesions produced are parallel linear scratches and a slight degree of eczema. In long-standing cases, the skin may become thick, dry, and scaly, with dark pigmented areas.

Pruritus, particularly at night, is the most common symptom of pediculosis pubis. Reddish-brown dust (ie, excretions of the insects) may be found in the patient's underclothing. The pubic area should be examined with a magnifying glass for lice crawling down a hair shaft or nits cemented to the hair or at the junction with the skin. Infestation by pubic lice may coexist with sexually transmitted diseases such as gonorrhea, herpes, or syphilis. There may also be infestation of the hairs of the chest, axillae, beard, and eyelashes. Gray-blue macules may sometimes be seen on the trunk, thighs, and axillae as a result of either the reaction of the insects' saliva with bilirubin (converting it to biliverdin) or an excretion produced by the salivary glands of the louse.

#### Medical Management

Treatment of head lice involves washing the hair with a shampoo containing lindane (Kwell) or pyrethrin compounds with piperonyl butoxide (RID or R&C Shampoo). The patient is instructed to shampoo the scalp and hair according to the product directions. After the hair is rinsed thoroughly, it is combed with a fine-toothed comb dipped in vinegar to remove any remaining nits or nit shells freed from the hair shafts. They are extremely difficult to remove and may have to be picked off one by one.

All articles, clothing, towels, and bedding that may have lice or nits should be washed in hot water—at least 54°C (130°F)—or dry cleaned to prevent reinfestation. Upholstered furniture, rugs, and floors should be vacuumed frequently. Combs and brushes are also disinfected with the shampoo. All family members and close contacts are treated. Complications such as severe pruritus, pyoderma, and dermatitis are treated with antipruritics, systemic antibiotics, and topical corticosteroids.

The patient with body lice is instructed to bathe with soap and water, after which a prescription scabicide (lindane or 5% permethrin [Elimite]) is applied to affected areas of the skin and to hairy areas, according to the product directions. An alternative topical therapy is an over-the-counter strength of permethrin (1% Nix). If the eyelashes are involved, petrolatum may be thickly applied twice daily for 8 days, followed by mechanical removal of any remaining nits.

Complications, such as severe pruritus, pyoderma, and dermatitis, are treated with antipruritics, systemic antibiotics, and topical corticosteroids. Body lice can transmit epidemic rickettsial disease (eg, epidemic typhus, relapsing fever, and trench fever) to humans. The causative organism may be in the gastrointestinal tract of the insect and may be excreted on the skin surface of the infested person.

#### Nursing Management

The nurse informs the patient that head lice may infest anyone and are not a sign of uncleanliness. Because the condition spreads rapidly, treatment must be started immediately. School epidemics may be managed by having all of the students shampoo their hair on the same night. Students should be warned not to share combs, brushes, and hats. Each family member should be inspected for head lice daily for at least 2 weeks. The patient should be instructed that lindane may be toxic to the central nervous system when used more frequently or for longer periods of time than specified in the package insert.

Treatment is necessary for all family members and sexual contacts of patients with body and/or pubic lice. The nurse instructs them about personal hygiene and methods to prevent or control infestation. The patient and partner must also be scheduled for a diagnostic workup for coexisting sexually transmitted disease.

## SCABIES

Scabies is an infestation of the skin by the itch mite *Sarcoptes scabiei*. The disease may be found in people living in substandard hygienic conditions, but it can occur in anyone. Infestations may or may not be associated with sexual activity. The mites frequently involve the fingers, and hand contact may produce infection. In children, overnight stays with friends or the exchange of clothes may be a source of infection. Health care personnel who have prolonged hands-on physical contact with an infected patient may become infected.

### Clinical Manifestations

It takes approximately 4 weeks from the time of contact for the patient's symptoms to appear. The patient complains of severe itching caused by a delayed type of immunologic reaction to the mite or its fecal pellets. During examination, the patient is asked where the pruritus is most severe. A magnifying glass and a penlight are held at an oblique angle to the skin while a search is made for the small, raised burrows created by the mites. The burrows may be multiple, straight or wavy, brown or black, threadlike lesions, most commonly observed between the fingers and on the wrists. Other sites are the extensor surfaces of the elbows, the knees, the edges of the feet, the points of the elbows, around the nipples, in the axillary folds, under pendulous breasts, and in or near the groin or gluteal fold, penis, or scrotum. Red, pruritic eruptions usually appear between adjacent skin areas. However, the burrow is not always visible. Any patient with a rash may have scabies.

One classic sign of scabies is the increased itching that occurs during the overnight hours, perhaps because the increased warmth of the skin has a stimulating effect on the parasite. Hypersensitivity to the organism and its products of excretion also may contribute to the pruritus. If the infection has spread, other members of the family and close friends also complain of pruritus about 1 month later.

Secondary lesions are quite common and include vesicles, papules, excoriations, and crusts. Bacterial superinfection may result from constant excoriation of the burrows and papules.

### Gerontologic Considerations

Elderly patients living in long-term care facilities are susceptible to outbreaks of scabies because of close living quarters, poor hygiene due to limited physical ability, and the potential for incidental spread of the organisms by staff members. Although pruritus may be severe in the older patient, the vivid inflammatory reaction seen in younger people seldom occurs. Scabies may not be recognized in the elderly person; the pruritus may erroneously be attributed to the dry skin of old age or to anxiety.

Health care personnel in extended-care facilities should wear gloves when providing hands-on care for a patient suspected of having scabies until the diagnosis is confirmed and treatment completed. It is advisable to treat all residents, staff, and families of patients at the same time to prevent reinfection. Because geriatric patients may be more sensitive to side effects of the scabicides, they should be closely observed for reactions.

### Assessment and Diagnostic Findings

The diagnosis is confirmed by recovering *S. scabiei* or the mites' byproducts from the skin. A sample of superficial epidermis is scraped from the top of the burrows or papules with a small scalpel blade. The scrapings are placed on a microscope slide and examined through a microscope at low power to demonstrate evidence of the mite.

### Medical Management

The patient is instructed to take a warm, soapy bath or shower to remove the scaling debris from the crusts and then to dry thoroughly and allow the skin to cool. A prescription scabicide, such as lindane, crotamiton (Eurax), or 5% permethrin, is applied thinly to the entire skin from the neck down, sparing only the face and scalp (which are not affected in scabies). The medication is left on for 12 to 24 hours, after which the patient is instructed to wash thoroughly. One application may be curative, but it is advisable to repeat the treatment in 1 week.

*NURSING ALERT*

**The patient must understand medication instructions because application of a scabicide immediately after bathing and before the skin dries and cools increases percutaneous absorption of the scabicide and the potential for central nervous system abnormalities such as seizures.**

### Nursing Management

The patient should wear clean clothing and sleep between freshly laundered bed linens. All bedding and clothing should be washed in hot water and dried on the hot dryer cycle. If bed linens or clothing cannot be washed in hot water, dry cleaning is advised.

After treatment is completed, the patient should apply an ointment, such as a topical corticosteroid, to skin lesions because the scabicide may irritate the skin. The patient's hypersensitivity does not cease on destruction of the mites. Pruritus may continue for several weeks as a manifestation of hypersensitivity, particularly in atopic (allergic) people. This is not a sign that the treatment has failed. The patient is instructed (1) not to apply more scabicide, because it will cause more irritation and increased itching, and (2) not to take frequent hot showers, because they can dry the skin and produce pruritus. Oral antihistamines such as diphenhydramine or hydroxyzine can help control the pruritus.

All family members and close contacts should be treated simultaneously to eliminate the mites. Some scabicides are approved for use in infants and pregnant women. If scabies is sexually transmitted, the patient may require treatment for coexisting sexually transmitted disease. Scabies may also coexist with pediculosis.

## CONTACT DERMATITIS

Contact dermatitis is an inflammatory reaction of the skin to physical, chemical, or biologic agents. The epidermis is damaged by repeated physical and chemical irritations. Contact dermatitis may be of the primary irritant type, in which a nonallergic reaction results from exposure to an irritating substance, or it may be an allergic reaction resulting from exposure of sensitized people to contact allergens. Allergic dermatoses are discussed in Chapter 53. Common causes of irritant dermatitis are soaps, detergents, scouring compounds, and industrial chemicals. Predisposing factors include extremes of heat and cold, frequent contact with soap and water, and a preexisting skin disease (Chart 56-3).

### Clinical Manifestations

The eruptions begin when the causative agent contacts the skin. The first reactions include pruritus, burning, and erythema, followed closely by edema, papules, vesicles, and oozing or weeping. In the subacute phase, these vesicular changes are less marked, and they alternate with crusting, drying, fissuring, and peeling. If repeated reactions occur or if the patient continually scratches the skin, lichenification and pigmentation occur. Secondary bacterial invasion may follow.

### Medical Management

The objectives of management are to soothe and heal the involved skin and protect it from further damage. The distribution pattern of the reaction is identified to differentiate between allergic and irritant contact dermatitis. A detailed history is obtained. If possible, the offending irritant is removed. Local irritation should be avoided, and soap is not generally used until healing occurs.

Many preparations are advocated for relieving dermatitis. In general, a bland, unmedicated lotion is used for small patches of erythema. Cool, wet dressings also are applied over small areas of vesicular dermatitis. Finely cracked ice added to the water often enhances its antipruritic effect.

Wet dressings usually help clear the oozing eczematous lesions. A thin layer of cream or ointment containing a corticosteroid then may be used. Medicated baths at room temperature are prescribed for larger areas of dermatitis. For severe, widespread conditions, a short course of systemic corticosteroids may be prescribed.

**CHART 56-3** PATIENT EDUCATION

***Strategies for Avoiding Contact Dermatitis***

The following precautions may help prevent repeated cases of contact dermatitis. Follow these instructions for at least 4 months after your skin appears to be completely healed.

- Study the pattern and location of your dermatitis and think about which things have touched your skin and which things may have caused the problem.
- Try to avoid contact with these materials.
- Avoid heat, soap, and rubbing, all of which are external irritants.
- Choose bath soaps, laundry detergents, and cosmetics that do not contain fragrance.
- Avoid using a fabric softener dryer sheet (Bounce, Cling Free). Fabric softeners that are added to the washer may be used.
- Avoid topical medications, lotions, or ointments, except those specifically prescribed for your condition.
- Wash your skin thoroughly immediately after exposure to possible irritants.
- When wearing gloves (for example, for washing dishes or general cleaning), be sure they are cotton-lined. Do not wear them more than 15 or 20 minutes at a time.

## NONINFECTIOUS INFLAMMATORY DERMATOSES

### *Psoriasis*

Considered one of the most common skin diseases, psoriasis affects approximately 2% of the population, appearing more often in people of European ancestry. It is thought that this chronic disease stems from a hereditary defect that causes overproduction of keratin. Onset may occur at any age, but psoriasis is most common in people between 15 and 35 years of age. Psoriasis has a tendency to improve and then recur periodically throughout life (Porth & Matfin, 2009).

### Pathophysiology

Current evidence supports an immunologic basis for psoriasis (Porth & Matfin, 2009). Periods of emotional stress and anxiety aggravate the condition, and trauma, infections, and seasonal and hormonal changes also are trigger factors.

In this disease, the cells in the basal layer of the skin divide too quickly, and the newly formed cells move so rapidly to the skin surface that they become evident as profuse scales or plaques of epidermal tissue. As a result of the increased number of basal cells and rapid cell passage, the normal events of cell maturation and growth cannot occur, which prevent formation of the normal protective layers of the skin.

### Clinical Manifestations

Psoriasis may range in severity from a cosmetic source of annoyance to a physically disabling and disfiguring disorder. Lesions appear as red, raised patches of skin covered with silvery scales. The scaly patches are formed by the buildup of living and dead skin (Fig. 56-3). If the scales are scraped away, the dark-red base of the lesion is exposed, producing multiple bleeding points. The patches are not moist and may be pruritic. In approximately one fourth to one half of patients, the nails are also involved, with pitting, discoloration, crumbling beneath the free edges, and separation of the nail plate.

Bilateral symmetry is a feature of psoriasis. Particular sites of the body affected most by this condition include the scalp, the extensor surface of the elbows and knees, the lower part of the back, and the genitalia, as well as the nails.

### Complications

Asymmetric rheumatoid factor–negative arthritis of multiple joints occurs in about 5% of people with psoriasis, before or after the skin lesions appear. Psoriatic arthritis is discussed in more detail later in this chapter.

Erythrodermic psoriasis, an exfoliative psoriatic state, involves disease progression that involves the total body

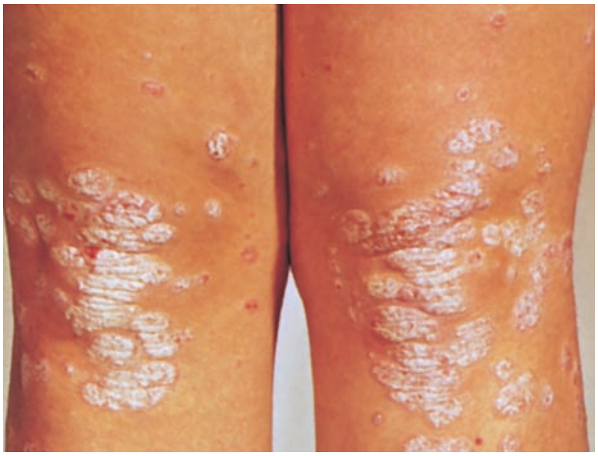


**Figure 56-3** Psoriasis. Courtesy of Roche Laboratories.

surface. The patient is acutely ill. Erythrodermic psoriasis often appears in people with chronic psoriasis after infections, after exposure to certain medications, or following withdrawal of systemic corticosteroids.

## Assessment and Diagnostic Findings

The presence of the classic plaque-type lesions generally confirms the diagnosis of psoriasis. If in doubt, the health care provider should assess for signs of nail and scalp involvement and for a positive family history. Biopsy of the skin is of little diagnostic value.

## Medical Management

The goals of management are to slow the rapid turnover of epidermis, to promote resolution of the psoriatic lesions, and to control the natural cycles of the disease. There is no known cure.

The therapeutic approach should be one that the patient understands; it should be cosmetically acceptable and minimally disruptive of lifestyle. Treatment involves the commitment of time and effort by the patient and possibly the family. Any precipitating or aggravating factors are addressed. An assessment is made of lifestyle because psoriasis is significantly affected by stress. Management of emotional factors should be addressed as part of the overall treatment of psoriasis. Disruption of self-image and depression have been reported in up to 50% of patients with severe psoriasis. The patient is informed that treatment of severe psoriasis can be time-consuming, expensive, and aesthetically unappealing at times. More than 50% of patients report difficulty complying with treatment plans, either for time reasons or lack of response to the treatment.

The most important principle of psoriasis treatment is gentle removal of scales. This can be accomplished with baths. Oils (eg, olive oil, mineral oil, Aveeno Oilated Oatmeal Bath) or coal tar preparations (eg, Balnetar) can be added to the bath water and a soft brush used to scrub the psoriatic plaques gently. After bathing, the application of emollient creams containing alpha-hydroxy acids (eg, Lac-Hydrin, Penederm) or salicylic acid continues to soften thick scales. The patient and family should be encouraged to establish a regular skin care routine that can be maintained even when the psoriasis is not in an acute stage.

### *Pharmacologic Therapy*

With the recent addition of biologic medications, three types of therapy are now commonly used: topical, systemic, and phototherapy (Table 56-6).

#### Topical Agents

Topically applied agents are used to slow the overactive epidermis. Topical corticosteroids may be applied for their

**Table 56-6 CURRENT PHARMACOLOGIC TREATMENT FOR PSORIASIS**

| Topical Agents | Use | Selected Agents |
|---|---|---|
| Biologicals | Moderate to severe lesions | Cyclosporine (Neoral), alefacept (Amevive), etanercept (Enbrel), infliximab (Remicade) |
| Topical corticosteroids | Mild to moderate lesions | Triamcinolone acetonide (Aristocort, Kenalog), bethamethasone valerate (Valisone, Diprosone) |
| | Moderate to severe lesions | Fluocinonide (Lidex) |
| | Severe lesions | Clobetasol (Temovate), betamethosone dipropionate (Diprolene), halobetasol (Ultravate) |
| | Lesions on face and groin | Alclometasome (Aclovate), desonide (DesOwen), hydrocortisone (Hytone 2.5%) |
| Topical nonsteroidals | Mild to severe | Retinoids such as tazarotene (Tazorac)<br>Vitamin $D_3$ derivative calcipotriene (Dovonex) |
| Coal tar products | Mild to moderate lesions | Coal tar and salicylic acid ointment (Aquatar, Estar gel, Fototar, Zetar); anthralin (AnthraDerm, Dritho-Cream); Neutrogena T-Derm, Psori Gel |
| Medicated shampoos | Scalp lesions | Neutrogena T-Gel, T-Sal, Zetar, Head & Shoulders, Desenex, Selsun Blue, Bakers P&S (emulsifying agent with phenol, saline solution, and mineral oil) |
| Intralesional therapy | Thick plaques and nails | Kenalog, Cordran-impregnated tape, Fluoroplex |
| Systemic therapy | Extensive lesions and nails | Methotrexate (Folex, Mexate); hydrourea (Hydrea); retinoic acid (Tegison) (not to be used in women of childbearing age) |
| | Psoriatic arthritis | Oral gold (auranofin), etrentinate, methotrexate |
| Photochemotherapy | Moderate to severe lesions | UVA or UVB light with or without topical medications<br>PUVA (combines UVA light with oral psoralens, or topical tripsoralen) |

anti-inflammatory effect. Choosing the correct strength of corticosteroid for the involved site and choosing the most effective vehicle base are important aspects of topical treatment. In general, high-potency topical corticosteroids should not be used on the face and intertriginous areas, and their use on other areas should be limited to a 4-week course of twice-daily applications. A 2-week break should be taken before repeating treatment with the high-potency corticosteroids. For long-term therapy, moderate-potency corticosteroids are used. On the face and intertriginous areas, only low-potency corticosteroids are appropriate for long-term use (see Table 56-3).

Occlusive dressings may be applied to increase the effectiveness of the corticosteroid. Large plastic bags may be used—one for the upper body with openings cut for the head and arms and one for the lower body with openings for the legs. Large rolls of tubular plastic can be used to cover the arms and legs. Another option is a vinyl jogging suit. The medication is applied, and the suit is put on over it. The hands can be wrapped in gloves, the feet in plastic bags, and the head in a shower cap. Occlusive dressings should not remain in place longer than 8 hours. The skin should be inspected carefully for the appearance of atrophy, hypopigmentation, striae, and telangiectasias, all side effects of corticosteroids.

*NURSING ALERT*

**When plastic substances are used, the nurse needs to check for flammability. Some thin plastic films burn slowly (if touched by a lighted cigarette), whereas others burst rapidly into flame. The patient should be cautioned not to smoke while wrapped in a plastic dressing.**

When psoriasis involves large areas of the body, topical corticosteroid treatment can be expensive and involve some systemic risk. The more potent corticosteroids, when applied to large areas of the body, have the potential to cause adrenal suppression through percutaneous absorption of the medication. In this event, other treatment modalities (eg, nonsteroidal topical medications, ultraviolet light) may be used instead or in combination to decrease the need for corticosteroids.

Two relatively new topical nonsteroidal treatments are calcipotriene (Dovonex) and tazarotene (Tazorac). Treatment with these agents tends to suppress **epidermopoiesis** (ie, development of epidermal cells) and cause sloughing of the rapidly growing epidermal cells. Calcipotriene 0.05% is a derivative of vitamin $D_2$. It works by decreasing the mitotic turnover of the psoriatic plaques. Its most common side effect is local irritation. The intertriginous areas and face should be avoided when using this medication. The patient should be monitored for symptoms of hypercalcemia. Calcipotriene is available as a cream for use on the body and a solution for the scalp. It is not recommended for use by elderly patients because of their more fragile skin or by pregnant or lactating women.

Tazarotene, a retinoid, causes sloughing of the scales covering psoriatic plaques. As with other retinoids, it causes increased sensitivity to sunlight by loss of the outermost layer of skin, so the patient should be cautioned to use an effective sunscreen and avoid other photosensitizers (eg, tetracycline, antihistamines). Tazarotene is listed as a Category X drug in pregnancy; reports indicate evidence of fetal risk, and the risk of use in pregnant women clearly outweighs any possible benefits. A negative result on a pregnancy test should be obtained before initiating this medication in women of childbearing age, and an effective contraceptive should be continued during treatment. Side effects include burning, erythema, or irritation at the site of application and worsening of psoriasis.

Intralesional injections of the corticosteroid triamcinolone acetonide (Aristocort, Kenalog-10, Trymex) can be administered directly into highly visible or isolated patches of psoriasis that are resistant to other forms of therapy. Care must be taken to ensure that the medication is not injected into normal skin.

### Systemic Agents

Although systemic corticosteroids may cause rapid improvement of psoriasis, the usual risks and the possibility of triggering a severe flare-up on withdrawal limit their use. Systemic cytotoxic preparations, such as methotrexate, have been used in treating extensive psoriasis that fails to respond to other forms of therapy.

***Biological Agents.*** The newest line of treatments for psoriasis includes a group called biologics because of their derivation from immunomodulators and bioengineered proteins (such as antibodies or recombinant cytokines) and their targeted action directly on the T cells. These agents act by inhibiting activation and migration, eliminating the T cells completely, slowing postsecretory cytokines or inducing immune deviation. Five biologics are approved by the U.S. Food and Drug Administration (FDA) for treatment of moderate to severe psoriasis with or without psoriatic arthritis. They are administered either intravenously or subcutaneously, and patients must have the ability and motivation to self-administer injections.

Because of suppressed immune status, live vaccines could trigger full-blown disease in susceptible patients. Discussion with an infectious disease specialist is recommended. Some biological agents are designated as pregnancy Category B; all are secreted in breast milk (Pirzada, Tomi & Gulliver, 2007).

Infliximab (Remicade) is a monoclonal antibody that binds to tumor necrosis factor-α (TNF-α) and can only be administered by IV infusion. Etanercept (Enbrel) is a fusion protein that binds to soluble TNF-α and blocks its interaction with cell surface receptors. Efalizumab (Raptiva) is a murine antibody that inhibits T-cell activation and adherence to keratinocytes. Alefacept (Amevive) is a fusion protein that inhibits T-cell proliferation. Adalimumab (Humira) is a recombinant human immunoglobulin G1 (IgG1) monoclonal antibody against TNF-α. These biological agents have significant side effects, making close monitoring essential.

***Oral Agents.*** Methotrexate appears to inhibit DNA synthesis in epidermal cells, thereby reducing the turnover time of the psoriatic epidermis. However, the medication can be toxic, especially to the liver, kidneys, and bone marrow. Laboratory studies must be monitored to ensure that

the hepatic, hematopoietic, and renal systems are functioning adequately. The patient should avoid drinking alcohol while taking methotrexate because alcohol ingestion increases the possibility of liver damage. The medication is teratogenic (produces physical defects in the fetus) and thus should not be administered to pregnant women.

Cyclosporine A, a cyclic peptide used to prevent rejection of transplanted organs, has shown some success in treatment of severe, therapy-resistant cases of psoriasis. However, its use is limited by side effects such as hypertension and nephrotoxicity.

Oral retinoids (ie, synthetic derivatives of vitamin A and its metabolite, vitamin A acid) modulate the growth and differentiation of epithelial tissue. Etretinate (Tegison, Tigason) is especially useful for severe pustular or erythrodermic psoriasis. Etretinate is a teratogen with a very long half-life; it cannot be used in women with childbearing potential.

#### Photochemotherapy

When psoriasis becomes widespread (defined as too many plaques to count or as involving more than 50% of the body surface), another treatment option involves combining a photosensitizing oral medication with exposure to ultraviolet-A light (PUVA). The patient takes a photosensitizing medication (usually 8-methoxypsoralen [8-mop, Houva-caps, meladinine, meloxine]) in a standard dose and is subsequently exposed to long-wave ultraviolet light as the medication plasma levels peak. It is thought that when psoralen-treated skin is exposed to UVA light, the psoralen binds with DNA and decreases cellular proliferation. PUVA has been associated with long-term risks of skin cancer, cataracts, and premature aging of the skin (Porth & Matfin, 2009).

The patient is usually treated two or three times each week until the psoriasis clears. An interim period of 48 hours between treatments is necessary to allow any burns resulting from PUVA therapy to become evident. After the psoriasis clears, the patient begins a maintenance program. Once little or no disease is active, less potent therapies are used to keep minor flare-ups under control.

Very often, phototherapy in the ultraviolet-B (UVB) spectrum is used as a single therapy modality. Research has shown that the most effective UVB range for therapeutic response is the range of 310 to 312 nm; therapy in this range precludes many of the negative side effects that can be experienced with broader range light. UVB is used alone or in combination with topical coal tar, emollients, and mild topical corticosteroids. Side effects are similar to those of PUVA therapy. A new therapy unit provides UVB in the narrow range of 311 to 312 nm, which decreases the harmful effects of UVB while providing more intense therapy. Response to treatment can be improved if narrow-band UVB is combined with the topical cream, calcipotriol (Dovonex). This cream induces synthesis of vitamin D in the skin and decreases the need for ultraviolet exposure (Lui & Mamelak, 2007).

If access to a light treatment unit is not feasible, the patient can expose himself or herself to sunlight. The risks of all light treatments are similar and include acute sunburn; exacerbation of photosensitive disorders such as lupus and rosacea; as well as other skin changes such as increased wrinkles, thickening, and an increased risk for skin cancer.

Excimer lasers have come into use in treating psoriasis. These lasers function at 308 nm. Studies show that medium-size psoriatic plaques clear in four to six treatments and remain clear for up to 9 months. A laser can be more effective on the scalp or on other hard-to-treat areas because it can be aimed very specifically on the plaque (Taibjee, 2005).

## Nursing Management

### *Assessment*

The nursing assessment focuses on the appearance of the normal skin, the appearance of the skin lesions, and how the patient is coping with the psoriatic skin condition. It is important to examine the areas especially prone to psoriasis: elbows, knees, scalp, gluteal cleft, and all nails (for small pits).

Psoriasis may cause despair and frustration for the patient; observers may stare, comment, ask embarrassing questions, or even avoid the person. The disease can eventually exhaust the patient's resources, interfere with his or her job, and negatively affect many aspects of life. Teenagers are especially vulnerable to the psychological effects of this disorder.

The nurse assesses the impact of the disease on the patient and the coping strategies used for conducting normal activities and interactions with family and friends. Many patients need reassurance that the condition is not infectious, is not a reflection of poor personal hygiene, and is not skin cancer. The nurse can create an environment in which the patient feels comfortable discussing important quality-of-life issues related to his or her psychosocial and physical response to this chronic illness.

### *Nursing Interventions*

#### Promoting Understanding

The nurse explains with sensitivity that although there is no cure for psoriasis and lifetime management is necessary, the condition can usually be controlled. The pathophysiology of psoriasis is reviewed, as are the factors that provoke it—irritation or injury to the skin (eg, cut, abrasion, sunburn), current illness (eg, pharyngeal streptococcal infection), and emotional stress. It is emphasized that repeated trauma to the skin and an unfavorable environment (eg, cold) or a specific medication (eg, lithium, beta-blockers, indomethacin [Indocin]) may exacerbate psoriasis. The patient is cautioned about taking any nonprescription medications because some may aggravate mild psoriasis.

Reviewing and explaining the treatment regimen are essential to ensure compliance. For example, if the patient has a mild condition confined to localized areas, such as the elbows or knees, application of an emollient to maintain softness and minimize scaling may be all that is required. Most patients need a comprehensive plan of care that ranges from using topical medications and shampoos to more complex and lengthy treatment with systemic medications and photochemotherapy, such as PUVA therapy. Patient education materials that include a description of the therapy and specific guidelines are helpful but cannot replace face-to-face discussions of the treatment plan.

### Increasing Skin Integrity

To avoid injuring the skin, the patient is advised not to pick at or scratch the affected areas. Measures to prevent dry skin are encouraged because dry skin worsens psoriasis. Too-frequent washing produces more soreness and scaling. Water should be warm, not hot, and the skin should be dried by patting with a towel rather than by rubbing. Emollients have a moisturizing effect, providing an occlusive film on the skin surface so that normal water loss through the skin is halted and allowing the trapped water to hydrate the stratum corneum. A bath oil or emollient cleansing agent can comfort sore and scaling skin. Softening the skin can prevent fissures.

### Improving Self-Concept and Body Image

A therapeutic relationship between health care professionals and the patient with psoriasis includes education and support. Introducing the patient to successful coping strategies used by others with psoriasis and making suggestions for reducing or coping with stressful situations at home, school, and work can facilitate a more positive outlook and acceptance of the chronicity of the disease.

### Monitoring and Managing Potential Complications

The diagnosis of psoriasis, especially when it is accompanied by the complication of arthritis, is usually difficult to make. Psoriatic arthritis involving the sacroiliac and distal joints of the fingers may be overlooked, especially if the patient has the typical psoriatic lesions. However, patients who complain of mild joint discomfort and some pitting of the fingernails may not be diagnosed with psoriasis until the more obvious cutaneous lesions appear. The patient requires education about the care and treatment of the involved joints and the need for compliance with therapy. However, when the psoriasis is extensive and a family history of inflammatory arthritis is elicited, the chance that the patient will develop psoriatic arthritis increases substantially. It is recommended that a rheumatologist be consulted to assist in the diagnosis and treatment of the arthropathy.

### Promoting Home and Community-Based Care

***Teaching Patients Self-Care.*** Printed patient education materials may be provided to reinforce face-to-face discussions about treatment guidelines and other considerations. Patients using topical corticosteroid preparations repeatedly on the face and around the eyes should be aware that cataract development is possible. Strict guidelines for applying these medications should be emphasized because overuse can result in skin atrophy, striae, and medication resistance.

PUVA, which is reserved for moderate to severe psoriasis, produces photosensitization. If exposure to the sun is unavoidable, the skin must be protected with sunscreen and clothing. Gray-tinted or green-tinted wraparound sunglasses should be worn to protect the eyes during and after treatment, and ophthalmologic examinations should be performed on a regular basis. Contraceptives should be used by sexually active women of reproductive age because the teratogenic effect of PUVA has not been determined.

If indicated, referral may be made to a mental health professional who can help to ease emotional strain and give support. Belonging to a support group may also help patients recognize that they are not alone in experiencing life adjustments in response to a visible, chronic disease. The National Psoriasis Foundation publishes periodic bulletins and reports about new and relevant developments in this condition.

Chart 56-4 is a Home Care Checklist for the patient with psoriasis.

## Exfoliative Dermatitis

Exfoliative dermatitis is a serious condition characterized by progressive inflammation in which generalized erythema and scaling occur. It may be associated with chills, fever, prostration, severe toxicity, and a pruritic scaling of the skin. There is a profound loss of stratum corneum (ie, outermost layer of the skin), which causes capillary leakage, hypoproteinemia, and negative nitrogen balance. Because of widespread dilation of cutaneous vessels, large amounts of body heat are lost, and exfoliative dermatitis has a marked effect on the entire body.

Exfoliative dermatitis has a variety of causes. It is considered to be a secondary or reactive process to an underlying skin or systemic disease. It may appear as a part of the lymphoma group of diseases and may precede the clinical manifestations of lymphoma. Preexisting skin disorders

**CHART 56-4 HOME CARE CHECKLIST**
***The Patient With Psoriasis***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the etiology of psoriasis. | ✔ | ✔ |
| • Describe optimal skin maintenance practices to maintain moisture of skin and prevent infection. | ✔ | ✔ |
| • Demonstrate correct application of prescribed topical medications. | ✔ | ✔ |
| • Describe common side effects of oral medication, if prescribed. | ✔ | ✔ |
| • Demonstrate appropriate therapeutic bath technique, if prescribed. | ✔ | ✔ |
| • Verbalize optimism about condition. | ✔ | |
| • Identify a support person with whom to discuss feelings and concerns. | ✔ | |

that have been implicated include psoriasis, atopic dermatitis, and contact dermatitis. It also appears as a severe reaction to many medications, including penicillin and phenylbutazone (Butazolidin). The cause is unknown in approximately 25% of cases (James, Berger & Elston, 2005).

### Clinical Manifestations

This condition starts acutely as a patchy or generalized erythematous eruption accompanied by fever, malaise, and occasionally gastrointestinal symptoms. The skin color changes from pink to dark red. After a week, the characteristic exfoliation (ie, scaling) begins, usually in the form of thin flakes that leave the underlying skin smooth and red, with new scales forming as the older ones come off. Hair loss may accompany this disorder. Relapses are common. The systemic effects include high-output heart failure, other gastrointestinal disturbances, breast enlargement, elevated levels of uric acid in the blood (ie, hyperuricemia), and temperature disturbances.

### Medical Management

The objectives of management are to maintain fluid and electrolyte balance and to prevent infection. The treatment is individualized and supportive and should be initiated as soon as the condition is diagnosed.

The patient may be hospitalized and placed on bed rest. All medications that may be implicated are discontinued. A comfortable room temperature should be maintained because the patient does not have normal thermoregulatory control as a result of temperature fluctuations caused by vasodilation and evaporative water loss. Fluid and electrolyte balance must be maintained because there is considerable water and protein loss from the skin surface. Administration of plasma volume expanders may be indicated.

### Nursing Management

Continual nursing assessment is carried out to detect infection. The disrupted, erythematous, moist skin is susceptible to infection and becomes colonized with pathogenic organisms, which produce more inflammation. Antibiotics, which are prescribed if infection is present, are selected on the basis of culture and sensitivity.

*NURSING ALERT*

**The nurse observes the patient for signs and symptoms of heart failure because hyperemia and increased cutaneous blood flow can produce high-output cardiac failure.**

Hypothermia may occur because increased blood flow in the skin, coupled with increased water loss through the skin, leads to heat loss by radiation, conduction, and evaporation. Changes in vital signs are closely monitored and reported.

Topical therapy is used to provide symptomatic relief. Soothing baths, compresses, and lubrication with emollients are used to treat the extensive dermatitis. The patient is likely to be extremely irritable because of the severe pruritus. Oral or parenteral corticosteroids may be prescribed when the disease is not controlled by more conservative therapy. When a specific cause is known, more specific therapy may be used. The patient is advised to avoid all irritants in the future, particularly medications that are known to cause the disease.

## BLISTERING DISEASES

Blisters of the skin have many origins, including bacterial, fungal, or viral infections; allergic contact reactions; burns; metabolic disorders; and immunologically mediated reactions. Some of these have been discussed previously (eg, herpes simplex and zoster infections, contact dermatitis). Immunologically mediated diseases are autoimmune reactions and represent a defect of IgM, IgE, IgG, and complement, C3. Some of these conditions are life-threatening; others become chronic.

The diagnosis is always made by histologic examination of a biopsy specimen, usually by a dermatopathologist. A specimen from the blister and surrounding skin demonstrates **acantholysis** (separation of epidermal cells from each other because of damage to or an abnormality of the intracellular substance). Circulating antibodies may be detected by immunofluorescent studies of the patient's serum.

### *Pemphigus*

Pemphigus is a group of serious diseases of the skin characterized by the appearance of bullae (blisters) of various sizes on apparently normal skin (Fig. 56-4) and mucous membranes. Pemphigus is an autoimmune disease involving IgG. It is thought that the pemphigus antibody is directed against a specific cell-surface antigen in epidermal cells. A blister forms from the antigen–antibody reaction. The level of serum antibody is predictive of disease severity. Genetic factors may also have a role in its development, with the highest incidence in people of Jewish or Mediterranean descent. This disorder usually occurs in men and women in middle and late adulthood. The condition may be associated with penicillins and captopril (Capoten) and with myasthenia gravis.



**Figure 56-4** Vesicles on the chin (in pemphigus). From Hall, J. C. (2006). *Sauer's manual of skin diseases.* Philadelphia: Lippincott Williams & Wilkins.

## Clinical Manifestations

Most patients present with oral lesions appearing as irregularly shaped erosions that are painful, bleed easily, and heal slowly. The skin bullae enlarge, rupture, and leave large, painful eroded areas that are accompanied by crusting and oozing. A characteristic odor emanates from the bullae and the exuding serum. There is blistering or sloughing of uninvolved skin when minimal pressure is applied (Nikolsky's sign). The eroded skin heals slowly, and large areas of the body eventually are involved. Bacterial superinfection is common.

## Complications

The most common complications arise when the disease process is widespread. Before the advent of corticosteroid and immunosuppressive therapy, patients were very susceptible to secondary bacterial infection. Skin bacteria have relatively easy access to the bullae as they ooze, rupture, and leave denuded areas exposed to the environment. Fluid and electrolyte imbalance results from fluid and protein loss as the bullae rupture. Hypoalbuminemia is common when the disease process includes extensive areas of the body skin surface and mucous membranes.

## Management

The goals of therapy are to bring the disease under control as rapidly as possible, to prevent loss of serum and the development of secondary infection, and to promote re-epithelization (ie, renewal of epithelial tissue).

Corticosteroids are administered in high doses to control the disease and keep the skin free of blisters. The high dosage level is maintained until remission is apparent. In some cases, corticosteroid therapy must be maintained for life. High-dose corticosteroid therapy has serious toxic effects (see Chapter 42).

Immunosuppressive agents (eg, azathioprine [Azasan], cyclophosphamide [Cytoxan], gold [Aurasol]) may be prescribed to help control the disease and reduce the corticosteroid dose. **Plasmapheresis** temporarily decreases the serum antibody level and has been used with variable success, although it is generally reserved for life-threatening cases.

# *Bullous Pemphigoid*

Bullous pemphigoid is an acquired disease of flaccid blisters appearing on normal or erythematous skin. It appears more often on the flexor surfaces of the arms, legs, axilla, and groin. Oral lesions, if present, are usually transient and minimal. When the blisters break, the skin has shallow erosions that heal fairly quickly. Pruritus can be intense, even before the appearance of the blisters. Bullous pemphigoid is common in the elderly, with a peak incidence at about 60 years of age. There is no gender or racial predilection, and the disease can be found throughout the world.

## Management

Medical treatment includes topical corticosteroids for localized eruptions and systemic corticosteroids for widespread involvement. Systemic corticosteroids (eg, prednisone [Deltasone]) may be continued for months, in alternate-day doses. The patient needs to understand the implications of long-term corticosteroid therapy (see Chapter 42).

# *Dermatitis Herpetiformis*

Dermatitis herpetiformis is an intensely pruritic, chronic disease that manifests with small, tense blisters that are distributed symmetrically over the elbows, knees, buttocks, and nape of the neck. It most commonly occurs between 20 and 40 years of age but can appear at any age. Most patients with dermatitis herpetiformis have a subclinical defect in gluten metabolism.

## Management

Most patients respond to Dapsone and to a gluten-free diet. All patients should be screened for glucose-6-phosphate dehydrogenase (G6PD) deficiency because dapsone can induce severe hemolysis in those with this deficiency. Patients benefit from dietary counseling because the dietary restrictions are lifelong, and a gluten-free diet is often difficult to follow. They need emotional support as they deal with the process of learning new habits and accepting major changes in their lives.

# NURSING PROCESS

## Care of the Patient With Blistering Diseases

### Assessment

Patients with blistering disorders may experience significant disability. There is constant itching and possible pain in the denuded areas of skin. There may be drainage from the denuded areas, which may be malodorous. Effective assessment and nursing management become a challenge.

Disease activity is monitored clinically by examining the skin for the appearance of new blisters. Areas where healing has occurred may show signs of hyperpigmentation. Particular attention is given to assessing for signs and symptoms of infection.

### Diagnosis

#### *Nursing Diagnoses*

Based on nursing assessment data, the patient's major nursing diagnoses may include the following:

- Acute pain of skin and oral cavity related to blistering and erosions
- Impaired skin integrity related to ruptured bullae and denuded areas of the skin
- Anxiety and ineffective coping related to the appearance of the skin and no hope of a cure
- Deficient knowledge about medications and side effects

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications include the following:

- Infection and sepsis related to loss of protective barrier of skin and mucous membranes
- Fluid volume deficit and electrolyte imbalance related to loss of tissue fluids

## Planning and Goals

The major goals for the patient may include relief of discomfort from lesions, skin healing, reduced anxiety and improved coping capacity, and absence of complications.

## Nursing Interventions

### *Relieving Oral Discomfort*

The patient's entire oral cavity may be affected with erosions and denuded surfaces. Necrotic tissue may develop over these areas, adding to the patient's discomfort and interfering with eating. Weight loss and hypoproteinemia may result. Meticulous oral hygiene is important to keep the oral mucosa clean and allow the epithelium to regenerate. Frequent rinsing of the mouth with a solution of salt and baking soda is prescribed to rid the mouth of debris and to soothe ulcerated areas. Commercial mouthwashes are avoided. The lips are kept moist with lanolin, petrolatum, or lip balm. Cool mist therapy helps humidify environmental air.

### *Enhancing Skin Integrity and Relieving Discomfort*

Cool, wet dressings or baths are protective and soothing. The patient with painful and extensive lesions should be premedicated with analgesics before skin care is initiated. Patients with large areas of blistering have a characteristic odor that decreases when secondary infection is controlled. After the patient's skin is bathed, it is dried carefully and dusted liberally with nonirritating powder (eg, cornstarch), which enables the patient to move about freely in bed. Fairly large amounts are necessary to keep the patient's skin from adhering to the sheets. Tape should never be used because it may produce more blisters. Hypothermia is common, and measures to keep the patient warm and comfortable are priority nursing activities. The nursing management of patients with bullous skin conditions is similar to that for patients with extensive burns (see Chapter 57).

### *Reducing Anxiety*

Attention to the psychological needs of the patient requires listening to the patient, being available, providing expert nursing care, and educating the patient and the family. The patient is encouraged to express anxieties, discomfort, and feelings of hopelessness. Arranging for a family member or a close friend to spend more time with the patient can be supportive. When patients receive information about the disease and its treatment, uncertainty and anxiety often decrease, and the patient's capacity to act on his or her own behalf is enhanced. Psychological counseling may assist the patient in dealing with fears, anxiety, and depression.

### *Monitoring and Managing Potential Complications*

**INFECTION AND SEPSIS.** The patient is susceptible to infection because the barrier function of the skin is compromised. Bullae are also susceptible to infection, and sepsis may follow. The skin is cleaned to remove debris and dead skin and to prevent infection.

Secondary infection may be accompanied by an unpleasant odor from skin or oral lesions. *C. albicans* of the mouth (ie, thrush) commonly affects patients receiving high-dose corticosteroid therapy. The oral cavity is inspected daily, and any changes are reported. Oral lesions are slow to heal.

Infection is the leading cause of death in patients with blistering diseases. Particular attention is given to assessment for signs and symptoms of local and systemic infection. Seemingly trivial complaints or minimal changes are investigated because corticosteroids can mask or alter typical signs and symptoms of infection. The patient's vital signs are monitored, and temperature fluctuations are documented. The patient is observed for chills, and all secretions and excretions are monitored for changes suggesting infection. Results of culture and sensitivity tests are monitored. Antimicrobial agents are administered as prescribed, and response to treatment is assessed. Health care personnel must perform effective hand hygiene and wear gloves.

In hospitalized patients, environmental contamination is reduced as much as possible. Protective isolation measures and standard precautions are warranted.

**FLUID AND ELECTROLYTE IMBALANCE.** Extensive denudation of the skin leads to fluid and electrolyte imbalance because of significant loss of fluids and sodium chloride from the skin. This sodium chloride loss is responsible for many of the systemic symptoms associated with the disease and is treated by IV administration of saline solution.

A large amount of protein and blood is also lost from the denuded skin areas. Blood component therapy may be prescribed to maintain the blood volume, hemoglobin level, and plasma protein concentration. Serum albumin, protein, hemoglobin, and hematocrit values are monitored.

The patient is encouraged to maintain adequate oral fluid intake. Cool, nonirritating fluids are encouraged to maintain hydration. Small, frequent meals or snacks of high-protein, high-calorie foods (eg, oral nutritional supplements, eggnog, milk shakes) help maintain nutritional status. Parenteral nutrition is considered if the patient cannot eat an adequate diet.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports relief from pain of oral lesions
   a. Identifies therapies that reduce pain
   b. Uses mouthwashes and anesthetic or antiseptic aerosol mouth spray
   c. Drinks chilled fluids at 2-hour intervals
2. Achieves skin healing
   a. States purpose of therapeutic regimen
   b. Cooperates with soaks and bath regimen
   c. Reminds caregivers to use liberal amounts of nonirritating powder on bed linens
3. Reports that anxiety and ability to cope with the condition have improved
   a. Verbalizes concerns about condition, self, and relationships with others

   b. Participates in self-care
4. Experiences no complications
   a. Has cultures from bullae, skin, and orifices that are negative for pathogenic organisms
   b. Has no purulent drainage
   c. Shows signs that skin is clearing
   d. Has normal body temperature
   e. Keeps intake record to ensure adequate fluid intake and normal fluid and electrolyte balance
   f. Verbalizes the rationale for IV infusion therapy
   g. Has urine output within normal limits
   h. Has serum chemistry and hemoglobin and hematocrit values within normal limits

## *Toxic Epidermal Necrolysis and Stevens-Johnson Syndrome*

Toxic epidermal necrolysis (TEN) and Stevens-Johnson syndrome (SJS) are potentially fatal skin disorders and the most severe forms of erythema multiforme. These diseases are mucocutaneous reactions that constitute a spectrum of reactions, with TEN being the most severe. The mortality rate from TEN is 30% to 35%. TEN and SJS are triggered by a reaction to medications. Antibiotics, especially sulfonamides, antiseizure agents, nonsteroidal anti-inflammatory drugs (NSAIDs), and sulfonamides are the most frequent medications implicated (Porth & Maffin, 2009).

TEN and SJS occur in all ages and both genders. The incidence is increased in older people because of their use of many medications. People who are immunosuppressed, including those with HIV infection and acquired immunodeficiency syndrome (AIDS), have a high risk of TEN and SJS. Although the incidence of these diseases in the general population is about two to three cases per 1 million people in the United States, the risk associated with sulfonamides in HIV-positive people may approach 1 case per 1000 (Porth & Maffin, 2009). Most patients with TEN have an abnormal metabolism of the medication; the mechanism leading to TEN seems to be a cell-mediated cytotoxic reaction.

### Clinical Manifestations

TEN and SJS are characterized initially by conjunctival burning or itching, cutaneous tenderness, fever, cough, sore throat, headache, extreme malaise, and myalgias (ie, aches and pains). These signs are followed by a rapid onset of erythema involving much of the skin surface and mucous membranes, including the oral mucosa, conjunctiva, and genitalia. In severe cases of mucosal involvement, there may be danger of damage to the larynx, bronchi, and esophagus from ulcerations. Large, flaccid bullae develop in some areas; in other areas, large sheets of epidermis are shed, exposing the underlying dermis. Fingernails, toenails, eyebrows, and eyelashes may be shed along with the surrounding epidermis. The skin is excruciatingly tender, and the loss of skin leaves a weeping surface similar to that of a total-body, partial-thickness burn; hence, the condition is also referred to as "scalded skin syndrome."

### Complications

Sepsis and keratoconjunctivitis are complications of TEN and SJS. Unrecognized and untreated sepsis can be life-threatening. Keratoconjunctivitis can impair vision and result in conjunctival retraction, scarring, and corneal lesions.

### Assessment and Diagnostic Findings

Histologic studies of frozen skin cells from a fresh lesion and cytodiagnosis of collections of cellular material from a freshly denuded area are conducted. A history of use of medications known to precipitate TEN or SJS may confirm medication reaction as the underlying cause.

Immunofluorescent studies may be performed to detect atypical epidermal autoantibodies. A genetic predisposition to erythema multiforme has been suggested but has not been confirmed in all cases.

### Medical Management

The goals of treatment include control of fluid and electrolyte balance, prevention of sepsis, and prevention of ophthalmic complications. Supportive care is the mainstay of treatment.

All nonessential medications are discontinued immediately. If possible, the patient is treated in a regional burn center because aggressive treatment similar to that for severe burns is required. Skin loss may approach 100% of the total body surface area. Surgical débridement or hydrotherapy in a Hubbard tank (large steel tub) may be performed to remove involved skin.

Tissue samples from the nasopharynx, eyes, ears, blood, urine, skin, and unruptured blisters are obtained for culture to identify pathogenic organisms. IV fluids are prescribed to maintain fluid and electrolyte balance, especially in the patient who has severe mucosal involvement and who cannot easily take oral nourishment. Because an indwelling IV catheter may be a site of infection, fluid replacement is carried out by nasogastric tube and then orally as soon as possible.

Initial treatment with systemic corticosteroids is controversial. Some experts argue for early high-dose corticosteroid treatment. However, in most cases, the risk of infection, fluid and electrolyte imbalance, delayed healing, and difficulty in initiating oral corticosteroids early in the course of the disease outweigh its benefits. In patients with TEN thought to be due to a medication reaction, corticosteroids may be administered; however, the patient should be closely monitored for adverse effects.

Administration of IV immunoglobulin (IVIG) may provide rapid improvement and skin healing. This response is dramatically better than that obtained with immunosuppressives, and IVIG may become the treatment of choice (Mittmann, Chan, Knowles, et al., 2007).

Protecting the skin with topical agents is crucial. Various topical antibacterial and anesthetic agents are used to prevent wound sepsis and to assist with pain management. Systemic antibiotic therapy is used with extreme caution. Temporary biologic dressings (eg, pigskin, amniotic membrane) or plastic semipermeable dressings (eg, Vigilon) may be used to reduce pain, decrease evaporation, and

prevent secondary infection until the epithelium regenerates. Meticulous oropharyngeal and eye care is essential when there is involvement of the mucous membranes and the eyes.

## NURSING PROCESS

## Care of the Patient With Toxic Epidermal Necrolysis or Stevens-Johnson Syndrome

### Assessment

A careful inspection of the skin is made, including its appearance and the extent of involvement. The normal skin is closely observed to determine if new areas of blisters are developing. Drainage from blisters is monitored for amount, color, and odor. The oral cavity is inspected daily for blistering and erosive lesions; the patient is assessed daily for itching, burning, and dryness of the eyes. The patient's ability to swallow and drink fluids, as well as speak normally, is determined.

The patient's vital signs are monitored, and special attention is given to the presence and character of fever and the respiratory rate, depth, rhythm, and cough. The characteristics and amount of respiratory secretions are observed. Assessment for high fever, tachycardia, and extreme weakness and fatigue is essential because these factors indicate the process of epidermal necrosis, increased metabolic needs, and possible gastrointestinal and respiratory mucosal sloughing. Urine volume, specific gravity, and color are monitored. The insertion sites of IV lines are inspected for signs of local infection. Body weight is recorded daily.

The patient is asked to describe fatigue and pain levels. An attempt is made to evaluate the patient's level of anxiety. The patient's basic coping mechanisms are assessed, and effective coping strategies are identified.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Impaired tissue integrity (ie, oral, eye, and skin) related to epidermal shedding
- Deficient fluid volume and electrolyte losses related to loss of fluids from denuded skin
- Risk for imbalanced body temperature (ie, hypothermia) related to heat loss secondary to skin loss
- Acute pain related to denuded skin, oral lesions, and possible infection
- Anxiety related to the physical appearance of the skin and prognosis

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications include the following:

- Sepsis
- Conjunctival retraction, scars, and corneal lesions

### Planning and Goals

The major goals for the patient may include skin and oral tissue healing, fluid balance, prevention of heat loss, relief of pain, reduced anxiety, and absence of complications.

### Nursing Interventions

#### *Maintaining Skin and Mucous Membrane Integrity*

The local care of the skin is an important area of nursing management. The skin denudes easily, especially when the patient is lifted and turned. The nursing staff must take special care to avoid friction involving the skin when moving the patient in bed. The skin should be checked after each position change to ensure that no new denuded areas have appeared. The nurse applies the prescribed topical agents to reduce the bacterial population of the wound surface. Warm compresses, if prescribed, should be applied gently to denuded areas. The topical antibacterial agent may be used in conjunction with hydrotherapy in a tank, bathtub, or shower. The nurse monitors the patient's condition during the treatment and encourages the patient to exercise the extremities during hydrotherapy.

The painful oral lesions make oral hygiene difficult. Careful oral hygiene is performed to keep the oral mucosa clean. Prescribed mouthwashes, anesthetics, or coating agents are used frequently to rid the mouth of debris, soothe ulcerative areas, and control foul mouth odor. The oral cavity is inspected several times each day, and any changes are documented and reported. Petrolatum or a prescribed ointment is applied to the lips.

#### *Attaining Fluid Balance*

The vital signs, urine output, and sensorium are observed for indications of hypovolemia. Mental changes from fluid and electrolyte imbalance, sensory overload, or sensory deprivation may occur. Laboratory test results are evaluated, and abnormal results are reported. The patient is weighed daily (with a bed scale if necessary).

Oral lesions may result in dysphagia, making tube feeding or parenteral nutrition necessary until oral ingestion can be tolerated. A daily calorie count and accurate recording of all intake and output are essential.

#### *Preventing Hypothermia*

The patient with TEN is prone to chilling. Dehydration may be made worse by exposing the denuded skin to a continuous current of warm air. The patient is usually sensitive to changes in room temperature. Measures similar to those implemented for a burn patient, such as cotton blankets, ceiling-mounted heat lamps, and heat shields, are useful in maintaining body temperature. To minimize shivering and heat loss, the nurse should work rapidly and efficiently when large wounds are exposed for wound care. The patient's temperature is monitored frequently.

#### *Relieving Pain*

The nurse assesses the patient's pain, its characteristics, factors that influence the pain, and the patient's behavioral responses. Prescribed analgesics are administered on a regular schedule, and the nurse documents pain relief and any side effects. Analgesics are administered before painful

treatments are performed. Providing thorough explanations and speaking calmly to the patient during treatments can allay the anxiety that may intensify pain. Offering emotional support and reassurance and implementing measures that promote rest and sleep are basic in achieving pain control. As the pain diminishes and the patient has more physical and emotional energy, self-management techniques for pain relief, such as progressive muscle relaxation and imagery, may be taught.

#### *Reducing Anxiety*

Because the lifestyle of the patient with TEN has been abruptly changed to one of complete dependence, an assessment of his or her emotional state may reveal anxiety, depression, and fear of dying. The patient can be reassured that these reactions are normal. The patient also needs nursing support, honest communication, and hope that the situation can improve. The patient is encouraged to express his or her feelings. Listening to the patient's concerns and being readily available with skillful and compassionate care are important anxiety-relieving interventions. Emotional support by a psychiatric nurse, spiritual advisor, psychologist, or psychiatrist may be helpful to promote coping during the long recovery period.

#### *Monitoring and Managing Potential Complications*

**SEPSIS.** The major cause of death from TEN is infection, and the most common sites of infection are the skin and mucosal surfaces, lungs, and blood. The organisms most often involved are *S. aureus*, *Pseudomonas*, *Klebsiella*, *Escherichia coli*, *Serratia*, and *Candida*. Monitoring vital signs closely and noticing changes in respiratory, renal, and gastrointestinal function may quickly detect the beginning of an infection. Strict asepsis is always maintained during routine skin care measures. Hand hygiene and wearing sterile gloves when carrying out procedures are essential. When the condition involves a large portion of the body, the patient should be in a private room to prevent possible cross-infection from other patients. Visitors should wear protective garments and wash their hands before and after coming into contact with the patient. People with any infections or infectious disease should not visit the patient until they are no longer a danger to the patient. The nurse is critical in identifying early signs and symptoms of infection and notifying the physician. Antibiotics are not generally begun until there is indication for their use.

**CONJUNCTIVAL RETRACTION, SCARS, AND CORNEAL LESIONS.** The eyes are inspected daily for signs of pruritus, burning, and dryness, which may indicate progression to keratoconjunctivitis, the principal eye complication. Applying a cool, damp cloth over the eyes may relieve burning sensations. The eyes are kept clean and observed for signs of discharge or discomfort, and the progression of symptoms is documented and reported. Administering an eye lubricant, when prescribed, may alleviate dryness and prevent corneal abrasion. Using eye patches or reminding the patient to blink periodically may also counteract dryness. The patient is instructed to avoid rubbing the eyes or putting any medication into the eyes that has not been prescribed or approved by the physician.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients with TEN or SJS with involvement of large areas of the skin require care that is similar to that of patients with thermal burns. As the patient completes the acute inpatient stage of illness, the focus is directed toward rehabilitation and outpatient care or care in a rehabilitation center. Throughout this care, the patient and family members are involved in the care and are instructed in the procedures, such as wound care and dressing changes, that will need to be continued at home. The patient and family members are assisted in acquiring dressing supplies that will be needed at home.

The patient and family members are also provided with instructions about pain management, nutrition, measures to increase mobility, and prevention of complications, including prevention of infection. They are taught the signs and symptoms of complications and instructed when to notify the health care provider. When appropriate, instructions are provided in writing to the patient and family so they can refer to these instructions when necessary at later times.

**CONTINUING CARE.** Interdisciplinary follow-up care is imperative to ensure that the patient's progress continues. Some patients will require care in a rehabilitation center before returning home. Others will require outpatient physical and occupational therapy for an extended period. When the patient returns home, the home care nurse coordinates the care provided by the various members of the health care team (eg, physician, physical therapist, occupational therapist, dietician). The nurse also monitors the patient's progress, provides ongoing assessment to identify complications, and monitors the patient's adherence to the plan of care. The patient's adaptation to the home care environment and the patient's and family's needs for support and assistance are also assessed. Referrals to community agencies are made as appropriate.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Achieves increasing skin and oral tissue healing
   a. Demonstrates areas of healing skin
   b. Swallows fluids and speaks clearly
2. Attains fluid balance
   a. Demonstrates laboratory values within normal ranges
   b. Maintains urine volume and specific gravity within acceptable range
   c. Shows stable vital signs
   d. Increases intake of oral fluids without discomfort
   e. Maintains weight or gains weight, if appropriate
3. Attains thermoregulation
   a. Registers body temperature within normal range
   b. Reports no chills
4. Achieves pain relief
   a. Uses analgesics as prescribed
   b. Uses self-management techniques for relief of pain
5. Appears less anxious
   a. Discusses concerns freely
   b. Sleeps for progressively longer periods

6. Absence of complications, such as sepsis and impaired vision
   a. Has body temperature within normal range
   b. Laboratory values within normal ranges
   c. Has no abnormal discharges or signs of infection
   d. Continues to see objects at baseline acuity level
   e. Shows no signs of keratoconjunctivitis

## ULCERATIONS

Superficial loss of surface tissue as a result of death of cells is called an ulceration. A simple ulcer, such as the kind found in a small, superficial, partial-thickness burn, tends to heal by granulation if kept clean and protected from injury. If exposed to the air, the serum that escapes dries and forms a scab, under which the epithelial cells grow and cover the surface completely. Certain diseases cause characteristic ulcers (eg, tuberculous ulcers, syphilitic ulcers).

Ulcers related to problems with arterial circulation are seen in patients with peripheral vascular disease, arteriosclerosis, Raynaud's disease, and frostbite. In these patients, treatment of the ulcers is concurrent with treatment of the arterial disease (see Chapter 31). Nursing management includes the use of the dressings discussed at the beginning of this chapter. If nursing interventions are instituted early in the progression of an ulcer, the condition can often be effectively improved. Surgical amputation of an affected limb is a last resort.

Pressure ulcers involve breakdown of the skin due to prolonged pressure, friction and shear forces, and insufficient blood supply, usually at bony prominences. Information about these ulcers is presented in Chapter 11.

## SKIN TUMORS

### *Benign Skin Tumors*

#### Cysts

Cysts of the skin are epithelium-lined cavities that contain fluid or solid material. Epidermal cysts (epidermoid cysts) occur frequently and may be described as slow-growing, firm, elevated tumors found most frequently on the face, neck, upper chest, and back. Removal of the cysts provides a cure.

Pilar cysts (trichilemmal cysts), formerly called sebaceous cysts, are most frequently found on the scalp. They originate from the middle portion of the hair follicle and from the cells of the outer hair root sheath. Treatment is surgical removal.

#### Seborrheic and Actinic Keratoses

Seborrheic keratoses are benign, wartlike lesions of various sizes and colors, ranging from light tan to black. They are usually located on the face, shoulders, chest, and back and are the most common skin tumors seen in middle-age and elderly people. They may be cosmetically unacceptable to the patient. A black keratosis may be erroneously diagnosed as malignant melanoma. Treatment is removal of the tumor tissue by excision, electrodesiccation (destruction of the skin lesions by monopolar high-frequency electric current) and curettage, or application of carbon dioxide or liquid nitrogen. However, there is no harm in allowing these growths to remain because there is no medical significance to their presence.

Actinic keratoses are premalignant skin lesions that develop in chronically sun-exposed areas of the body. They appear as rough, scaly patches with underlying erythema. A small percentage of these lesions gradually transform into cutaneous squamous cell carcinoma; they are usually removed by cryotherapy or shave excision.

#### Verrucae: Warts

Warts are common, benign skin tumors caused by infection with the human papillomavirus, which belongs to the DNA virus group. People of all ages may be affected, but the warts occur most frequently between the ages of 12 and 16 years. There are many types of warts.

As a rule, warts are asymptomatic, except when they occur on weight-bearing areas, such as the soles of the feet. They may be treated with locally applied laser therapy, liquid nitrogen, salicylic acid plasters, or electrodesiccation.

Warts occurring on the genitalia and perianal areas are known as condylomata acuminata. They may be transmitted sexually and are treated with liquid nitrogen, cryosurgery, electrosurgery, topically applied trichloroacetic acid, and curettage. Condylomata that affect the uterine cervix predispose the patient to cervical cancer (see Chapter 47).

#### Angiomas

Angiomas are benign vascular tumors that involve the skin and the subcutaneous tissues. They are present at birth and may occur as flat, violet-red patches (port-wine angiomas) or as raised, bright-red, nodular lesions (strawberry angiomas). The latter tend to involute spontaneously within the first few years of life, but port-wine angiomas usually persist indefinitely. Most patients use masking cosmetics (ie, Covermark or Dermablend) to camouflage the lesions. The argon laser is being used on various angiomas with some success. Treatment of strawberry angiomas is more successful if undertaken as soon after birth as possible.

#### Pigmented Nevi: Moles

Moles are common skin tumors of various sizes and shades, ranging from yellowish brown to black. They may be flat, macular lesions or elevated papules or nodules that occasionally contain hair. Most pigmented nevi are harmless lesions. However, in rare cases, malignant changes occur, and a melanoma develops at the site of the nevus. Some authorities believe that all congenital moles should be removed because they may have a higher incidence of malignant change. However, depending on the quantity and location, this may be impractical. Nevi that show a change in color or size, become symptomatic (eg, itch), or develop irregular borders should be removed to determine if malignant changes have occurred. Moles that occur in unusual places should be examined carefully for any irregularity and for notching of the border and variation in color. Early melanomas may display some redness and irritation and

areas of bluish pigmentation where the pigment-containing cells have spread deeper into the skin. Late melanomas have areas of paler color, where pigment cells have stopped producing melanin. Nevi larger than 1 cm should be examined carefully. Excised nevi should be examined histologically.

### Keloids

Keloids are benign overgrowths of fibrous tissue at the site of a scar or trauma. They appear to be more common among dark-skinned people. Keloids are asymptomatic but may cause disfigurement and cosmetic concern. The treatment, which is not always satisfactory, consists of surgical excision, intralesional corticosteroid therapy, and radiation.

### Dermatofibroma

A dermatofibroma is a common, benign tumor of connective tissue that occurs predominantly on the extremities. It is a firm, dome-shaped papule or nodule that may be skin-colored or pinkish brown. Excisional biopsy is the recommended method of treatment.

### Neurofibromatosis: Von Recklinghausen's Disease

Neurofibromatosis is a hereditary condition manifested by pigmented patches (*café-au-lait* macules), axillary freckling, and cutaneous neurofibromas that vary in size. Developmental changes may occur in the nervous system, muscles, and bone. Malignant degeneration of the neurofibromas occurs in some patients.

## Malignant Skin Tumors

Skin cancer is the most common cancer in the United States. If the incidence continues at the present rate, an estimated one of eight fair-skinned Americans will eventually develop skin cancer, especially basal cell carcinoma (Chart 56-5). Because the skin is easily inspected, skin cancer is readily seen and detected and is the most successfully treated type of cancer (Neville, Welch & Leffell, 2007).

Exposure to the sun is the leading cause of skin cancer; incidence is related to the total amount of exposure to the sun. Sun damage is cumulative, and harmful effects may be severe by 20 years of age. The increase in skin cancer probably reflects changing lifestyles and the emphasis on sunbathing and related activities in light of changes in the environment, such as holes in the earth's ozone layer. Protective measures should be used throughout life, and nurses should inform patients about risk factors associated with skin cancer.

## BASAL CELL AND SQUAMOUS CELL CARCINOMA

The most common types of skin cancer are basal cell carcinoma (BCC) and squamous cell (epidermoid) carcinoma (SCC). The third most common type, malignant melanoma, is discussed separately. Skin cancer is diagnosed by biopsy and histologic evaluation.

**CHART 56-5** ***Risk Factors for Skin Cancer***

Changes in the ozone layer from the effects of worldwide industrial air pollutants, such as chlorofluorocarbons, have prompted concern that the incidence of skin cancers, especially malignant melanoma, will increase. The ozone layer, a stratospheric blanket of bluish, explosive gas formed by the sun's ultraviolet radiation, varies in depth with the seasons and is thickest at the North and South Poles and thinnest at the equator. Scientists believe that it helps protect the earth from the effects of solar ultraviolet radiation. Proponents of this theory predict an increase in skin cancers as a consequence of changes in the ozone layer. Other skin cancer risk factors follow:

- Fair-skinned, fair-haired, blue-eyed people, particularly those of Celtic origin, with insufficient skin pigmentation to protect underlying tissues
- People who sustain sunburn and who do not tan
- Chronic sun exposure (certain occupations, such as farming, construction work)
- Exposure to chemical pollutants (industrial workers in arsenic, nitrates, coal, tar and pitch, oils and paraffins)
- Sun-damaged skin (elderly people)
- History of x-ray therapy for acne or benign lesions
- Scars from severe burns
- Chronic skin irritations
- Immunosuppression
- Genetic factors

### Clinical Manifestations

BCC is the most common type of skin cancer. It generally appears on sun-exposed areas of the body and is more prevalent in regions where the population is subjected to intense and extensive exposure to the sun. The incidence is proportional to the age of the patient (average: 60 years) and the total amount of sun exposure, and it is inversely proportional to the amount of melanin in the skin.

BCC usually begins as a small, waxy nodule with rolled, translucent, pearly borders; telangiectatic vessels may be present. As it grows, it undergoes central ulceration and sometimes crusting (Fig. 56-5). The tumors appear most

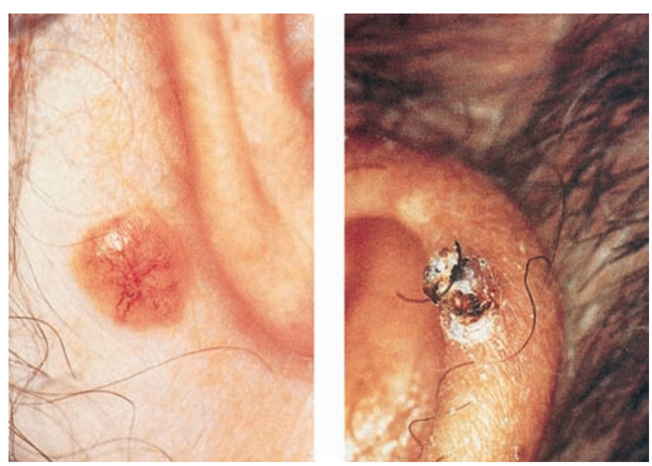


**Figure 56-5** Basal cell carcinoma (*left*) and squamous cell carcinoma (*right*). Reprinted by permission from *New England Journal of Medicine, 326,* 169–170, 1992.

frequently on the face. BCC is characterized by invasion and erosion of contiguous (adjoining) tissues. It rarely metastasizes, but recurrence is common. However, a neglected lesion can result in the loss of a nose, an ear, or a lip. Other variants of BCC may appear as shiny, flat, gray or yellowish plaques.

SCC is a malignant proliferation arising from the epidermis. Although it usually appears on sun-damaged skin, it may arise from normal skin or from preexisting skin lesions. It is of greater concern than BCC because it is a truly invasive carcinoma, metastasizing by the blood or lymphatic system.

Metastases account for 75% of deaths from SCC. The lesions may be primary, arising on the skin and mucous membranes, or they may develop from a precancerous condition, such as actinic keratosis (lesions occurring in sun-exposed areas), leukoplakia (premalignant lesion of the mucous membrane), or scarred or ulcerated lesions. SCC appears as a rough, thickened, scaly tumor that may be asymptomatic or may involve bleeding (see Fig. 56-5). The border of an SCC lesion may be wider, more infiltrated, and more inflammatory than that of a BCC lesion. Secondary infection can occur. Exposed areas, especially of the upper extremities and of the face, lower lip, ears, nose, and forehead, are common sites.

The incidence of BCC and SCC is increased in all immunocompromised people, including those infected with HIV. Clinically, the tumors have the same appearance as in non–HIV-infected people; however, in HIV-positive people, the tumors may grow more rapidly and recur more frequently. These tumors are managed the same as those for the general population. Frequent follow-up (every 4 to 6 months) is recommended to monitor for recurrence.

## Prognosis

The prognosis for BCC is usually good because tumors remain localized. Although some require wide excision with resultant disfigurement, the risk of death from BCC is low. The prognosis for SCC depends on the incidence of metastases, which is related to the histologic type and the level or depth of invasion. Usually, SCC arising in sun-damaged areas is less invasive and rarely causes death, whereas SCC that arises without a history of sun or arsenic exposure or scar formation appears to have a greater chance of spread. Regional lymph nodes should be evaluated for metastases.

## Medical Management

The goal of treatment is to eradicate the tumor. The treatment method depends on the tumor location; the cell type, location, and depth; the cosmetic desires of the patient; the history of previous treatment; whether the tumor is invasive; and whether metastatic nodes are present. The management of BCC and SCC includes surgical excision, Mohs' micrographic surgery, electrosurgery, cryosurgery, and radiation therapy.

### *Surgical Management*

The primary goal is to remove the tumor entirely. The best way to maintain cosmetic appearance is to place the incision properly along natural skin tension lines and natural anatomic body lines. In this way, scars are less noticeable. The size of the incision depends on the tumor size and location but usually involves a length-to-width ratio of 3:1.

The adequacy of the surgical excision is verified by microscopic evaluation of sections of the specimen. When the tumor is large, reconstructive surgery with use of a skin flap or skin grafting may be required. The incision is closed in layers to enhance cosmetic effect. A pressure dressing applied over the wound provides support. Infection after a simple excision is uncommon if proper surgical asepsis is maintained.

#### Mohs' Micrographic Surgery

This technique is the most accurate surgical technique and best conserves normal tissue. The procedure removes the tumor layer by layer. The first layer excised includes all evident tumor and a small margin of normal-appearing tissue. The specimen is frozen and analyzed by section to determine if all the tumor has been removed. If not, additional layers of tissue are shaved and examined until all tissue margins are tumor free. In this manner, only the tumor and a safe, normal-tissue margin are removed. Mohs' surgery is the recommended tissue-sparing procedure, with extremely high cure rates for BCC and SCC. It is the treatment of choice and the most effective for tumors around the eyes, nose, upper lip, and auricular and periauricular areas (Bowen, White & Gerwels, 2005).

#### Electrosurgery

Electrosurgery is the destruction or removal of tissue by electrical energy. The current is converted to heat, which then passes to the tissue from a cold electrode. Electrosurgery may be preceded by curettage (excising the skin tumor by scraping its surface with a curette). Electrodesiccation is then implemented to achieve hemostasis and to destroy any viable malignant cells at the base of the wound or along its edges. Electrodesiccation is useful for lesions smaller than 1 to 2 cm (0.4 to 0.8 in) in diameter.

This method takes advantage of the fact that the tumor is softer than surrounding skin and therefore can be outlined by a curette, which "feels" the extent of the tumor. The tumor is removed and the base cauterized. The process is repeated twice. Usually, healing occurs within 1 month.

#### Cryosurgery

Cryosurgery destroys the tumor by deep freezing the tissue. A thermocouple needle apparatus is inserted into the skin, and liquid nitrogen is directed to the center of the tumor until the tumor base is –40°C to –60°C (–40°F to –76°F). Liquid nitrogen has the lowest boiling point of all cryogens, is inexpensive, and is easy to obtain. The tumor tissue is frozen, allowed to thaw, and then refrozen. The site thaws naturally and then becomes gelatinous and heals spontaneously. Swelling and edema follow the freezing. The appearance of the lesion varies. Normal healing, which may take 4 to 6 weeks, occurs faster in areas with a good blood supply.

### *Radiation Therapy*

Radiation therapy is frequently performed for cancer of the eyelid, the tip of the nose, and areas in or near vital structures (eg, facial nerve). It is reserved for older patients, because x-ray changes may be seen after 5 to 10 years, and

malignant changes in scars may be induced by irradiation 15 to 30 years later.

The patient should be informed that the skin may become red and blistered. A bland skin ointment prescribed by the physician may be applied to relieve discomfort. The patient should also be cautioned to avoid exposure to the sun.

## Nursing Management

Because many skin cancers are removed by excision, patients are usually treated in outpatient surgical units. The role of the nurse is to teach the patient about prevention of skin cancer and about self-care after treatment (Chart 56-6).

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The wound is usually covered with a dressing to protect the site from physical trauma, external irritants, and contaminants. The patient is advised when to report for a dressing change or is given written and verbal information on how to change dressings, including the type of dressing to purchase, how to remove dressings and apply fresh ones, and the importance of hand hygiene before and after the procedure.

The patient is advised to watch for excessive bleeding and tight dressings that compromise circulation. If the lesion is in the perioral area, the patient is instructed to drink liquids through a straw and limit talking and facial movement. Dental work should be avoided until the area is completely healed.

After the sutures are removed, an emollient cream may be used to help reduce dryness. Applying a sunscreen over the wound is advised to prevent postoperative hyperpigmentation if the patient spends time outdoors.

Follow-up examinations should be at regular intervals, usually every 3 months for a year, and should include palpation of the adjacent lymph nodes. The patient should also be instructed to seek treatment for any moles that are subject to repeated friction and irritation and to watch for indications of potential malignancy in moles as described previously. The importance of lifelong follow-up evaluations is emphasized.

#### Teaching About Prevention

Studies show that regular daily use of a sunscreen with a sun protection factor (SPF) of at least 15 can reduce the recurrence of skin cancer by as much as 40%. The sunscreen should be applied to head, neck, arms, and hands every morning at least 30 minutes before leaving the house and reapplied every 4 hours if the skin perspires. Intermittent application of sunscreen only when exposure is anticipated has been shown to be less effective than daily use. Research has shown that daily use of sunscreen on the hands and face reduces the total incidence of solar keratoses (Barclay, 2007), which are precursors of SCC, but has no effect on the overall incidence of BCC. These data are inconsistent, but one theory is that people have a false sense of security when wearing sunscreen and tend to stay out in the sun for longer periods. This longer exposure is believed to contribute to the increasing incidence of melanoma. Although the evidence is insufficient, nurses should discuss the issues with patients who are at high risk of skin cancer.

## MALIGNANT MELANOMA

A malignant melanoma is a cancerous neoplasm in which atypical melanocytes are present in the epidermis and the dermis (and sometimes the subcutaneous cells). It is the most lethal of all the skin cancers and is responsible for about 3% of all cancer deaths (Porth & Maffin, 2009).

Malignant melanoma can occur in one of several forms: superficial spreading melanoma, lentigo-maligna melanoma, nodular melanoma, and acral-lentiginous melanoma. These types have specific clinical and histologic features as well as different biologic behaviors. Most melanomas arise from

CHART 56-6 HEALTH PROMOTION
***Preventing Skin Cancer***

- Teach patients that sunscreens are rated in strength from 4 (weakest) to 50 (strongest). The solar protection factor, or SPF, indicates how much longer a person can stay in the sun before the skin begins to redden. For example, if the person can normally stay in the sun for 10 minutes before reddening begins, an SPF of 4 will protect the person from reddening for about 40 minutes.
- Remind patients that up to 50% of ultraviolet rays can penetrate loosely woven clothing.
- Remind patients that ultraviolet light can penetrate cloud cover, and a sunburn can still occur.
- Teach children to avoid all but modest sun exposure and to use a sunscreen regularly for lifelong protection.
- Advise patients to:
  - Avoid tanning if their skin burns easily, never tans, or tans poorly.
  - Avoid unnecessary exposure to the sun, especially during the time of day when ultraviolet radiation (sunlight) is most intense (10 AM to 3 PM).
  - Avoid sunburns.
  - Apply a sunscreen daily to block harmful sun rays.
  - Use a sunscreen with an SPF of 15 or higher that protects against both ultraviolet-A (UVA) and ultraviolet-B (UVB) light.
  - Reapply water-resistant sunscreens after swimming, if heavily sweating, and every 2 to 3 hours during prolonged periods of sun exposure.
  - Avoid applying oils before or during sun exposure (oils do not protect against sunlight or sun damage).
  - Use a lip balm that contains a sunscreen with an SPF of 15 or higher.
  - Wear protective clothing, such as a broad-brimmed hat and long sleeves.
  - Avoid using sun lamps for indoor tanning, and avoid commercial tanning booths.

cutaneous epidermal melanocytes, but some appear in preexisting nevi (ie, moles) in the skin or develop in the uveal tract of the eye. Melanomas occasionally appear simultaneously with cancer of other organs.

The worldwide incidence of cutaneous melanoma continues to rise faster than any other malignancy in the Caucasian population. Despite better understanding of prevention and several new treatment options, mortality rates continue to climb. The highest incidence of the disease occurs in men, probably because of increased recreational sun exposure and decreasing ozone levels. In 2007, approximately 108,000 people in the United States were diagnosed with melanoma, and about 8,000 of these will die of the disease. Any short-term decrease in mortality will be related to improved detection and treatment. The impact of primary preventive measures will not be noticeable for several decades (American Melanoma Foundation, 2007).

## Risk Factors

The cause of malignant melanoma is unknown, but ultraviolet rays are strongly suspected, based on indirect evidence such as the increased incidence of melanoma in countries near the equator and in people younger than 30 years of age who have used a tanning bed more than 10 times per year. One in 100 Caucasians develops melanoma each year. As many as 10% of patients with melanoma are members of melanoma-prone families who have multiple changing moles (dysplastic nevi) that are susceptible to malignant transformation. Patients with dysplastic nevus syndrome have been found to have unusual moles, larger and more numerous moles, lesions with irregular outlines, and pigmentation located all over the skin. Microscopic examination of dysplastic moles shows disordered, faulty growth (Sekulic, Haluska, Miller, et al., 2008). Chart 56-7 lists risk factors for malignant melanoma.

Research has identified a gene that resides on chromosome 9p, the absence of which increases the likelihood that potentially mutagenic DNA damage will escape repair before cell division. The absence of this gene can be identified in melanoma-prone families (Price, Herlyn, Dent, et al., 2005).

Patients who have the melanoma gene, those who have a larger number of pigmented lesions (more than 100), and those with a strong family history of melanoma can benefit from total body digital photography. This procedure is increasingly being offered at research facilities and large teaching facilities as a way to document lesion status. It is intended to decrease the number of unnecessary skin biopsies; it targets only lesions that show change over time, usually 3 to 6 months. Although the use of this photographic method has not reduced the number of skin biopsies in the short term, most practitioners who specialize in the treatment of pigmented lesions believe that the diagnostic value of this procedure will be realized in the next several decades. Some patients with high risk of melanoma would also benefit from "mole mapping" to track changes in individual lesions (Risser, Pressley, Veledar, et al., 2007).

## Clinical Manifestations

### Superficial Spreading Melanoma

Superficial spreading melanoma occurs anywhere on the body and is the most common form of melanoma. It usually affects middle-age people and occurs most frequently on the trunk and lower extremities. The lesion tends to be circular, with irregular outer portions. The margins of the lesion may be flat or elevated and palpable (Fig. 56-6). This type of melanoma may appear in a combination of colors, with hues of tan, brown, and black mixed with gray, blue-black, or white. Sometimes a dull pink rose color can be seen in a small area within the lesion.

### Lentigo-Maligna Melanoma

Lentigo-maligna melanoma is a slowly evolving, pigmented lesion that occurs on exposed skin areas, especially the dorsum of the hand, the head, and the neck in elderly people. Often, the lesion is present for many years before it is examined by a physician. It first appears as a tan, flat lesion, but in time it undergoes changes in size and color.

### Nodular Melanomas

Nodular melanoma is a spherical, blueberry-like nodule with a relatively smooth surface and a relatively uniform, blue-black color (see Fig. 56-6). It may be dome shaped with a smooth surface. It may have other shadings of red, gray, or purple. Sometimes, nodular melanomas appear as irregularly shaped plaques. The patient may describe this as a blood blister that fails to resolve. A nodular melanoma directly invades the adjacent dermis (ie, vertical growth) and therefore has a poorer prognosis.

**CHART 56-7 Risk Factors for Malignant Melanoma**

- Fair-skinned or freckled, blue-eyed, light-haired people of Celtic or Scandinavian origin
- People who burn and do not tan or who have a significant history of severe sunburn
- Environmental exposure to intense sunlight (older Americans retiring to the southwestern United States appear to have a higher incidence)
- History of melanoma (personal or family)
- Skin with giant congenital nevi




**Figure 56-6** Two forms of malignant melanoma: superficial spreading (*left*) and nodular (*right*). *From* Bickley, L. S. (2009). *Bates' guide to physical examination* (10th ed.). Philadelphia: Lippincott Williams & Wilkins.

### *Acral-Lentiginous Melanoma*

Acral-lentiginous melanoma occurs in areas not excessively exposed to sunlight and where hair follicles are absent. It is found on the palms of the hands, on the soles, in the nail beds, and in the mucous membranes in dark-skinned people. These melanomas appear as irregular, pigmented macules that develop nodules. They may become invasive early.

## Assessment and Diagnostic Findings

Biopsy results confirm the diagnosis of melanoma. An excisional biopsy specimen provides information on the type, level of invasion, and thickness of the lesion. An excisional biopsy specimen that includes a 1-cm margin of normal tissue and a portion of underlying subcutaneous fatty tissue is sufficient for staging a melanoma in situ or an early, noninvasive melanoma. Incisional biopsy should be performed when the suspicious lesion is too large to be removed safely without extensive scarring. Biopsy specimens obtained by shaving, curettage, or needle aspiration are not considered reliable histologic proof of disease.

A thorough history and physical examination should include a meticulous skin examination and palpation of regional lymph nodes that drain the lesional area. Because melanoma occurs in families, a positive family history of melanoma is investigated so that first-degree relatives, who may be at high risk for melanoma, can be evaluated for atypical lesions. After the diagnosis of melanoma has been confirmed, a chest x-ray, complete blood cell count, liver function tests, and radionuclide or computed tomography scans are usually performed to stage the extent of disease.

## Prognosis

The prognosis for long-term (5-year) survival is considered poor when the lesion is more than 1.5 mm thick or there is regional lymph node involvement. A person with a thin lesion and no lymph node involvement has a 3% chance of developing metastases and a 95% chance of surviving 5 years. If regional lymph nodes are involved, there is a 20% to 50% chance of surviving 5 years. Patients with melanoma on the hand, foot, or scalp have a better prognosis; those with lesions on the torso have an increased chance of metastases to the bone, liver, lungs, spleen, and central nervous system. Men and elderly patients also have poor prognoses (Jade, Kashani-Sabet, Messina, et al., 2005).

## Medical Management

Treatment depends on the level of invasion and the depth of the lesion. Surgical excision is the treatment of choice for small, superficial lesions. Deeper lesions require wide local excision, after which skin grafting may be necessary. Regional lymph node dissection is commonly performed to rule out metastasis, although new surgical approaches call for only sentinel node biopsy. This technique is used to sample the nodes nearest the tumor and to spare the patient the long-term sequelae of extensive removal of lymph nodes if the sample nodes are negative.

Despite many years of investigation, no dependable systemic treatment for melanoma has been identified. Recently, greater understanding of the stem cells of melanoma indicates that effective therapies will have to be individualized for each patient. Clinical observations suggest that very few single-agent therapies provide significant clinical benefits because of the complex molecular nature of melanoma and the need to further define individual cell variations (Sekulic, et al., 2008).

Current treatments for metastatic melanoma, rarely, if ever, produce a satisfactory outcome. Further surgical intervention may be performed to debulk the tumor or to remove part of the organ involved (eg, lung, liver, or colon). However, the rationale for more extensive surgery is for relief of symptoms, not for cure. Chemotherapy for metastatic melanoma may be used; however, only a few agents (eg, dacarbazine [DTIC-Dome], nitrosoureas, cisplatin [Platinol]) have been effective in controlling the disease. When the melanoma is located in an extremity, regional perfusion may be used; the chemotherapeutic agent is perfused directly into the area that contains the melanoma. This approach delivers a high concentration of cytotoxic agents while avoiding systemic, toxic side effects. The limb is perfused for 1 hour with high concentrations of the medication at temperatures of 39°C to 40°C (102.2°F to 104°F) with a perfusion pump. Inducing hyperthermia enhances the effect of the chemotherapy so that a smaller total dose can be used. The goal of regional perfusion is control of the metastasis, especially if it is used in combination with surgical excision of the primary lesion and with regional lymph node dissection.

Investigators are exploring the potential for the use of lipid-lowering medications to prevent melanoma. A 2008 review concluded that there was a reduction in the incidence of melanoma in patients taking statins and fibrates, but the results were not highly significant. More research is needed before conclusions can be drawn (Dellavalle, Drake, Graber, et al., 2005). Several other studies continue to explore the potential for vaccine therapy, but none has yet identified an effective agent (Russo, Maccalli, Pilla, et al., 2008).

# NURSING PROCESS

## Care of the Patient With Malignant Melanoma

### Assessment

Assessment of the patient with malignant melanoma is based on the patient's history and symptoms. The patient is asked specifically about pruritus, tenderness, and pain, which are not features of a benign nevus. The patient is also questioned about changes in preexisting moles or the development of new, pigmented lesions. People at risk are assessed carefully.

A magnifying lens and good lighting are needed for inspecting the skin for irregularity and changes in the mole. Signs that suggest malignant changes are referred to as the ABCDs of moles (Chart 56-8).

**CHART 56-8 Assessing the ABCDs of Moles**

**A for Asymmetry**

- The lesion does not appear balanced on both sides. If an imaginary line were drawn down the middle, the two halves would not look alike.
- The lesion has an irregular surface with uneven elevations (irregular topography) either palpable or visible. A change in the surface may be noted from smooth to scaly.
- Some nodular melanomas have a smooth surface.

**B for Irregular Border**

- Angular indentations or multiple notches appear in the border.
- The border is fuzzy or indistinct, as if rubbed with an eraser.

**C for Variegated Color**

- Normal moles are usually a uniform light to medium brown. Darker coloration indicates that the melanocytes have penetrated to a deeper layer of the dermis.
- Colors that may indicate malignancy if found together within a single lesion are shades of red, white, and blue; shades of blue are ominous.
- White areas within a pigmented lesion are suspicious.
- Some malignant melanomas, however, are not variegated but are uniformly colored (bluish-black, bluish-gray, bluish-red).

**D for Diameter**

- A diameter exceeding 6 mm (about the size of a pencil eraser) is considered more suspicious, although this finding without other signs is not significant. Many benign skin growths are larger than 6 mm, whereas some early melanomas may be smaller.

Common sites of melanomas are the skin of the back, the legs (especially in women), between the toes, and on the feet, face, scalp, fingernails, and backs of hands. In dark-skinned people, melanomas are most likely to occur in less pigmented sites: palms, soles, subungual areas, and mucous membranes. Satellite lesions (ie, those situated near the mole) are inspected.

## Diagnosis

### *Nursing Diagnoses*

Based on the nursing assessment data, the patient's major nursing diagnoses may include the following:

- Acute pain related to surgical excision and grafting
- Anxiety and depression related to possible life-threatening consequences of melanoma and disfigurement
- Deficient knowledge about early signs of melanoma

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications include the following:

- Metastasis
- Infection of the surgical site

## Planning and Goals

The major goals for the patient may include relief of pain and discomfort, reduced anxiety and depression, increased knowledge of early signs of melanoma, and absence of complications.

## Nursing Interventions

### *Relieving Pain and Discomfort*

Surgical removal of melanoma in different locations presents different challenges, taking into consideration the removal of the primary melanoma, the intervening lymphatic vessels, and the lymph nodes to which metastases may spread. Nursing management of the patient having surgery in these regions is discussed in the appropriate chapters.

Nursing interventions after surgery for a malignant melanoma center on promoting comfort, because wide excision surgery may be necessary. A split-thickness or full-thickness skin graft may be necessary when large defects are created by surgical removal of a melanoma. Anticipating the need for and administration of appropriate analgesic medications is important.

### *Reducing Anxiety and Depression*

Psychological support is essential when disfiguring surgery is performed. Support includes allowing the patient to express feelings about the seriousness of the cutaneous neoplasm, understanding the patient's anxiety and depression, and conveying understanding of these feelings. During the diagnostic workup and staging of the depth, type, and extent of the tumor, the nurse answers questions, clarifies information, and helps clarify misconceptions. Learning that he or she has a melanoma can cause the patient considerable fear and anguish. Pointing out the patient's resources, past effective coping mechanisms, and social support systems helps the patient cope with the diagnosis and need for treatment and continuing follow-up. Family members should be included in all discussions to enable them to clarify information, ask questions that the patient might be reluctant to ask, and provide emotional support to the patient.

### *Monitoring and Managing Potential Complications*

Metastasis of malignant melanoma is closely related to prognosis: the deeper and thicker (more than 4 mm) the melanoma, the greater is the likelihood of metastasis. If the melanoma is growing radially (ie, horizontally) and is characterized by peripheral growth with minimal or no dermal invasion, the prognosis is favorable. When the melanoma invades the dermal layer, the prognosis is poor. Lesions with ulceration have a poor prognosis. Melanomas of the trunk appear to have a poorer prognosis than those of other sites, perhaps because the network of lymphatics in the trunk permits metastasis to regional lymph nodes.

The role of the nurse in caring for the patient with metastatic disease is to provide holistic care. The nurse must be knowledgeable about the most effective current therapies and must deliver supportive care, provide and clarify information about the therapy and the rationale for

its use, identify potential side effects of therapy and ways to manage them, and instruct the patient and family about the expected outcomes of treatment. The nurse monitors and documents symptoms that may indicate metastasis: lung (eg, difficulty breathing, shortness of breath, increasing cough), bone (eg, pain, decreased mobility and function, pathologic fractures), and liver (eg, change in liver enzyme levels, pain, jaundice). Nursing care is based on the patient's symptoms and emotional needs.

Although the chance of a cure for malignant melanoma that has metastasized is poor, the nurse encourages hope while maintaining a realistic perspective about the disease and ultimate outcome. Furthermore, the nurse provides time for the patient to express fears and concerns regarding future activities and relationships, offers information about support groups and contact people, and arranges palliative and hospice care if appropriate (see Chapter 17).

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The best hope of decreasing the incidence of skin cancer lies in educating patients about the early signs. Patients at risk are taught to examine their skin and scalp monthly in a systematic manner and to seek prompt medical attention if changes are detected (Chart 56-9). The nurse also points out that a key factor in the development of melanoma is exposure to sunlight. Because melanoma is thought to be genetically linked, the family as well as the patient should be taught sun-avoiding measures and the importance of annual assessment by a health care provider.

## Evaluation

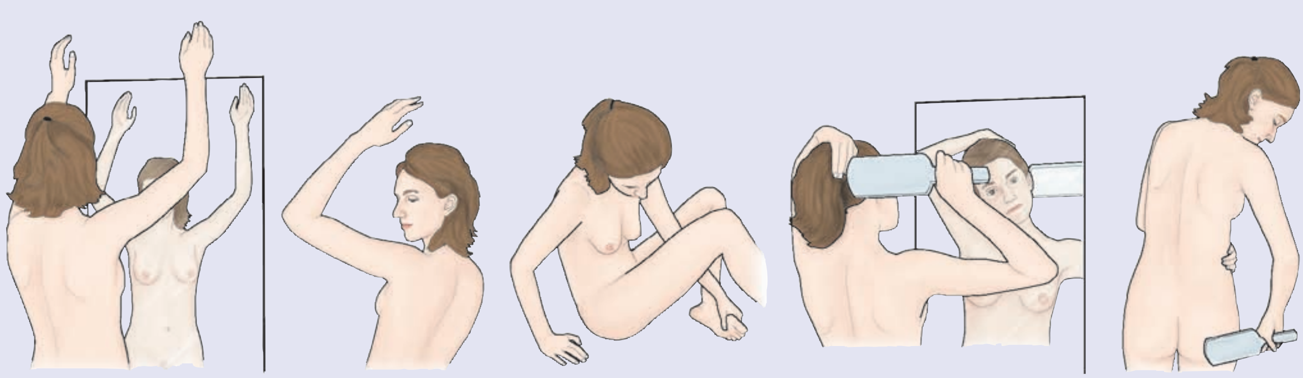
### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Experiences relief of pain and discomfort
   a. States pain is diminishing
   b. Exhibits healing of surgical scar without heat, redness, or swelling
2. Is less anxious
   a. Expresses fears and fantasies
   b. Asks questions about medical condition
   c. Requests facts about melanoma
   d. Identifies support and comfort provided by family member or significant other
3. Demonstrates understanding of the means for detecting and preventing melanoma
   a. Demonstrates how to conduct self-examination of skin on a monthly basis
   b. Verbalizes the following danger signals of melanoma: change in size, color, shape, or outline of mole, mole surface, or skin around mole
   c. Identifies measures to protect self from exposure to sunlight
4. Experiences absence of complications
   a. Recognizes abnormal signs and symptoms that should be reported to physician
   b. Complies with recommended follow-up procedures and prevention strategies

**CHART 56-9** PATIENT EDUCATION
### *Periodic Self-Examination*

Prevention of melanoma/skin cancer is the best weapon against these diseases, but if a melanoma should develop, it is almost always curable if caught in the early stages. Practice periodic self-examination to aid in early recognition of any new or developing lesion. The following is one way of self-examination that will ensure that no area of the body is neglected. To perform your self-examination, you will need a full-length mirror, a hand mirror, and a brightly lit room.



1. Examine the body front and back in the mirror, then the right and left sides, with the arms raised.
2. Bend the elbows, looking carefully at the forearms, back of the upper arms, and palms
3. Next, look at the back of the legs and feet, the spaces between the toes, and the soles of the feet.
4. Examine the back of the neck and the scalp with a hand-held mirror. Part the hair to lift.
5. Finally, check the back and buttocks with a hand mirror.

## Metastatic Skin Tumors

The skin is an important, although not a common, site of metastatic cancer. All types of cancer may metastasize to the skin, but carcinoma of the breast is the primary source of cutaneous metastases in women. Other sources include cancer of the large intestine, ovaries, and lungs. In men, the most common primary sites are the lungs, large intestine, oral cavity, kidneys, or stomach. Skin metastases from melanomas are found in both genders. The clinical appearance of metastatic skin lesions is not distinctive, except perhaps in some cases of breast cancer in which diffuse, brawny hardening of the skin of the involved breast is seen. In most instances, metastatic lesions occur as multiple cutaneous or subcutaneous nodules of various sizes that may be skin colored or different shades of red.

## Kaposi's Sarcoma

Kaposi's sarcoma (KS) is a malignancy of endothelial cells that line the small blood vessels. KS is manifested clinically by lesions of the skin, oral cavity, gastrointestinal tract, and lungs. The skin lesions consist of reddish-purple to dark-blue macules, plaques, or nodules. KS is subdivided into three categories:

- *Classic KS* occurs predominantly in men of Mediterranean or Jewish ancestry between 40 and 70 years of age. Most patients have nodules or plaques on the lower extremities that rarely metastasize beyond this area. Classic KS is chronic, relatively benign, and rarely fatal.
- *Endemic (African) KS* affects people predominantly in the eastern half of Africa near the equator. Men are affected more often than women, and children can be affected as well. The disease may resemble classic KS or it may infiltrate and progress to lymphadenopathic forms.
- *Immunosuppression-associated KS* occurs in transplant recipients and people with AIDS. This form of KS is characterized by local skin lesions and disseminated visceral and mucocutaneous diseases. The greater the degree of immunosuppression, the higher the incidence of KS. Immunosuppression-related KS that results from AIDS is an aggressive tumor that involves multiple body organs. Its presentation resembles that of KS associated with immunosuppressive therapy. Most patients are between 20 and 40 years of age. More information on AIDS-related KS can be found in Chapter 52.

# DERMATOLOGIC AND PLASTIC RECONSTRUCTIVE PROCEDURES

The word *plastic* comes from a Greek word meaning *to form*. Plastic or reconstructive procedures are performed to reconstruct or alter congenital or acquired defects to restore or improve the body's form and function. Often the terms "plastic" and "reconstructive" are used interchangeably. This type of surgery includes closure of wounds, removal of skin tumors, repair of soft tissue injuries or burns, correction of deformities, and repair of cosmetic defects. Plastic surgery can be used to repair many parts of the body and numerous structures, such as bone, cartilage, fat, fascia, mucous membrane, muscle, nerve, and cutaneous structures. Bone inlays and transplants for deformities and nonunion can be performed, muscle can be transferred, nerves can be reconstructed and spliced, and cartilage can be replaced. As important as any of these measures is the reconstruction of the cutaneous tissues around the neck and the face; this is usually referred to as aesthetic or cosmetic surgery.

Cosmetic procedures are generally considered to be ones that correct defects that are not life-threatening or caused by disease. An example would be removal of a benign mole or sebaceous cyst from the face. Most health insurance plans do not cover procedures deemed to be cosmetic, and these procedures can be expensive. Procedures that are performed to correct a surgical defect, such as removal of a skin cancer or correction of a significant congenital defect such as a cleft lip, are generally covered by insurance, but this should be confirmed before surgery is scheduled.

## Wound Coverage: Grafts and Flaps

Various surgical techniques, including skin grafts and flaps, are used to cover skin wounds.

### Skin Grafts

Skin grafting is a technique in which a section of skin is detached from its own blood supply and transferred as free tissue to a distant (recipient) site. Skin grafting can be used to repair almost any type of wound and is the most common form of reconstructive surgery.

Skin grafts are commonly used to repair surgical defects such as those that result from excision of skin tumors, to cover areas denuded of skin (eg, burns), and to cover wounds in which insufficient skin is available to permit wound closure. They are also used when primary closure of the wound increases the risk of complications or when primary wound closure would interfere with function.

Skin grafts may be classified as autografts, allografts, or xenografts. An autograft is tissue obtained from the patient's own skin. An allograft is tissue obtained from a donor of the same species. These grafts are also called allogeneic or homograft. A xenograft or heterograft is tissue obtained from another species. A common xenograft for human skin is the pig.

Grafts are also referred to by their thickness. A skin graft may be a split-thickness (ie, thin, intermediate, or thick) or a full-thickness graft, depending on the amount of dermis included in the specimen. A split-thickness graft can be cut at various thicknesses and is commonly used to cover large wounds or defects for which a full-thickness graft or flap is impractical (Fig. 56-7). A full-thickness graft consists of epidermis and the entire dermis without the underlying fat. It is used to cover wounds that are too large to be closed directly.

#### Site Selection

The site where the intact skin is harvested is called the donor site. Selection of the donor site is made to match the

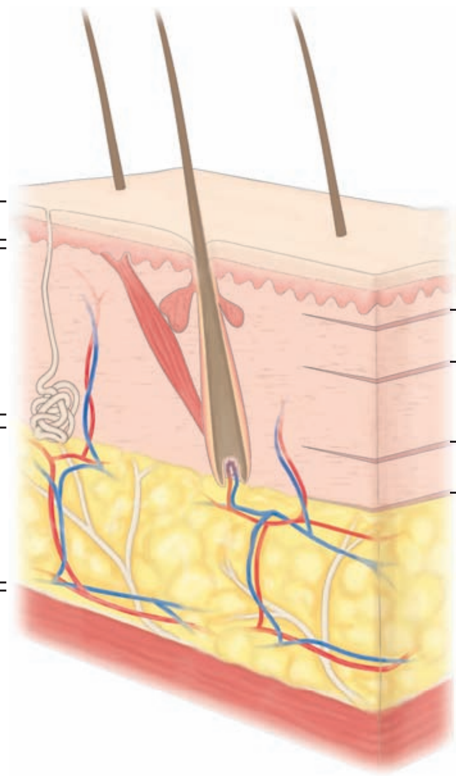



**Figure 56-7** Layers of skin appropriate for split-thickness and full-thickness graft.

color and texture of skin at the surgical site and to leave as little scarring as possible.

### Graft Application

The skin graft is taken from the donor or host site and applied to the desired site, called the recipient site or graft bed.

For a graft to survive and be effective, certain conditions must be met:

- The recipient site must have an adequate blood supply so that normal physiologic function can resume.
- The graft must be in close contact with its bed to avoid accumulation of blood or fluid between the graft and the recipient site.
- The graft must be fixed firmly (immobilized) so that it remains in place on the recipient site.
- The area must be free of infection.

The graft, when applied to the recipient site, may be sutured in place; alternatively, it may be slit and spread apart to cover a greater area. The process of revascularization (establishing the blood supply) and reattachment of a skin graft to a recipient bed is referred to as a "take." After a skin graft is put in place, it may be left exposed (in areas that are impossible to immobilize) or covered with a light dressing or a pressure dressing, depending on the area of the body.

### Nursing Interventions

The nurse must ensure that both the surgical and the donor sites receive proper postoperative care. The surgical site is covered by the harvested skin, and the donor site heals by re-epithelization of the raw, exposed dermis. Both sites are protected by dressings as they heal. Prevention of infection is essential as with all surgical sites. Both sites can be kept soft and pliable with cream (eg, lanolin). Both the donor site and the grafted area must be protected from exposure to extremes in temperature, external trauma, and sunlight because these areas are sensitive, especially to thermal injuries.

## Flaps

Another form of wound coverage is provided by flaps. A flap is a segment of tissue that remains attached at one end (ie, a base or pedicle) while the other end is moved to a recipient area. Its survival depends on functioning arterial and venous blood supplies and lymphatic drainage in its pedicle or base. A flap differs from a graft in that a portion of the tissue is attached to its original site and retains its blood supply. An exception is the free flap, which is described below.

Flaps may consist of skin, mucosa, muscle, adipose tissue, omentum, and bone. They are used for wound coverage and provide bulk, especially when bone, tendon, blood vessels, or nerve tissue is exposed. Flaps are used to repair defects caused by congenital deformity, trauma, or tumor ablation (removal, usually by excision) in an adjacent part of the body.

Flaps offer an aesthetic solution because a flap retains the color and texture of the donor area, is more likely to survive than a graft, and can be used to cover nerves, tendons, and blood vessels. However, several surgical procedures are usually required to advance a flap. The major complication is necrosis of the pedicle or base as a result of failure of the blood supply.

#### Free Flaps

A striking advance in reconstructive surgery is the use of free flaps or free-tissue transfer achieved by microvascular techniques. A free flap is completely severed from the body and transferred to another site. A free flap receives early vascular supply from microvascular anastomosis with vessels at the recipient site. The procedure usually is completed in one step, eliminating the need for a series of surgical procedures to move the flap. Microvascular surgery allows surgeons to use a variety of donor sites for tissue reconstruction.

## Cosmetic Procedures

### Chemical Face Peeling

Chemical face peeling involves application of a chemical mixture to the face for superficial destruction of the epidermis and the upper layers of the dermis to treat fine wrinkles, keratoses, and pigment problems. It is especially useful for wrinkles at the upper and lower lip, forehead, and periorbital areas. The type of chemical used depends on the planned depth of the peel. The conscious patient feels a burning sensation that continues for 12 to 24 hours. Frequent small doses of analgesics and tranquilizers are prescribed to keep the patient comfortable. The most common complications include discoloration of the skin, infection of the burned area, persistent sensory changes or itching, and occasionally permanent scarring of the skin.

### Dermabrasion

Dermabrasion is a form of skin abrasion used to treat acne scarring, aging, and sun-damaged skin. A special instrument (ie, motor-driven wire brush, diamond-impregnated disk, or serrated wheel) is used. The epidermis and some superficial dermis are removed by a sanding-like action, and enough of the dermis is preserved to allow re-epithelization of the treated areas. Results are best in the face because it is rich in intradermal epithelial elements.

The primary reason for undergoing dermabrasion is to improve appearance.

### Facial Reconstructive Surgery

Reconstructive procedures on the face are individualized to the patient's needs and desired outcomes. They are performed to repair deformities or restore normal function. They may vary from closure of small defects to complicated procedures involving implantation of prosthetic devices to conceal a large defect or reconstruct a lost part of the face (eg, nose, ear, jaw). Each surgical procedure is customized and involves a variety of incisions, flaps, and grafts. Multiple surgical procedures may be required.

The process of facial reconstruction is often slow and tedious. Because a person's facial appearance affects self-esteem so greatly, this type of reconstruction is often a very emotional experience for the patient.

### Face Lift

Rhytidectomy (face lift) is a surgical procedure that removes soft tissue folds and minimizes cutaneous wrinkles on the face. It is performed to create a more youthful appearance. Psychological preparation requires that the patient recognize the limitations of surgery and the fact that miraculous rejuvenation will not occur. The patient is informed that the face may appear bruised and swollen after the dressings are removed and that several weeks may pass before the edema subsides.

## LASER TREATMENT OF CUTANEOUS LESIONS

Lasers are devices that amplify or generate highly specialized light energy. They can mobilize immense heat and power when focused at close range and are valuable tools in surgical procedures. The argon laser, carbon dioxide ($CO_2$) laser, and tunable pulse-dye laser are used in dermatologic surgery. Each type of laser emits its own wavelength within the color spectrum.

### Argon Laser

The argon laser is useful in treating vascular lesions: port-wine stains, telangiectases, vascular tumors, and pigmented lesions. The argon beam can penetrate approximately 1 mm of skin and reach the pigmented layer, causing protein coagulation in this area. An immediate effect is that tiny blood vessels under the skin coagulate, causing the area to turn a much lighter color. A crust forms within a few days.

### Carbon Dioxide Laser

The $CO_2$ laser is a precise surgical instrument that vaporizes and excises tissue with minimal damage. Because the beam can seal blood and lymphatic vessels, it creates a dry surgical field that makes many procedures easier and quicker. Therefore, it is safe to use on patients with bleeding disorders or those receiving anticoagulant therapy. It is useful for removing epidermal nevi, tattoos, certain warts, skin cancer, ingrown toenails, and keloids. Incisions made with the laser beam heal and scar much like those made by a scalpel.

### Pulse-Dye Laser

The tunable pulse-dye laser is especially useful in treating cutaneous vascular lesions such as port-wine stains and telangiectasia. The procedure is generally painless. For procedures requiring anesthesia, lidocaine without epinephrine is sufficient because local vasoconstriction (which epinephrine induces) is unnecessary.

### Nursing Management

The majority of dermatologic and reconstructive procedures are performed in the physician's office or in an outpatient surgical department; therefore, most care takes place in the home. Most procedures, except very extensive reconstruction, are performed under local anesthesia or moderate sedation, therefore requiring a very short recovery time. Unless there are complications, the patient does not need hospitalization. It is important for the nurse to prepare both the patient and family for what to expect during the postoperative recovery time. Table 56-7 lists a few of the nursing considerations that must be reviewed in educating the patient and family.

**Table 56–7 NURSING CONSIDERATIONS IN COSMETIC PROCEDURES**

| Nursing Consideration | Interventions and Patient Education |
|---|---|
| Maintaining airway and pulmonary function | Cosmetic surgeries involving the face and neck can cause considerable swelling; bandages can restrict breathing or eating. Check dressings frequently and ensure that no constriction occurs as swelling develops. |
| Relieving pain and achieving comfort | Procedures that involve a large surface area will cause considerable pain. Cool compresses or ice packs will relieve the burning of dermabrasion or chemical peels. Oral analgesics should be administered regularly to control pain. |
| Maintaining adequate nutrition | When the face is involved, the patient may be unable to fully open the mouth, and chewing may be painful. Provide soft or liquid diet that is high in protein to assist with healing. |
| Enhancing communication | Depending on the type of cosmetic procedure, a nonverbal method of communication might be necessary until pain and swelling have subsided. |
| Improving self-concept | Recovery time from cosmetic procedures is slow. Expected results will take weeks to become apparent. Persons of color will experience increased pigmentation long after the initial wounds have healed. Helping patients to understand postoperative expectations will allow them to feel more comfortable with the healing process. |
| Promoting family coping | Most cosmetic procedures are performed in an outpatient facility; therefore, family members are integral to postoperative care. They should understand what to expect as the patient emerges from the procedure room: the type of dressings that will be in place, the skin care plan that is prescribed, and how to cope with the patient's pain. |
| Monitoring and managing potential complications | Infection is the most common complication, but excessive pain, nerve damage, and emotional distress about appearance are also common. If opioids are used, there may be gastrointestinal upset, mental status changes, or allergic reaction to the medication. Alert the caregiver to signs of these complications and how and when to report changes in status. |

## CRITICAL THINKING EXERCISES

EBP **1** You are caring for a middle-age woman who has diabetes and peripheral vascular disease. She has now developed a venous stasis ulcer on her lower leg just above the ankle. Her physician has prescribed a moisture-retentive dressing that is impregnated with hydrogel. The dressing is to be changed every 3 days, and the patient asks you why the dressing is not changed every day. How would you explain to the patient the purpose of the dressing? Identify the evidence that supports the use of moisture-retentive dressings for venous ulcers. Discuss the strength of the evidence regarding their effectiveness in the promotion of wound healing. What other teaching would you provide to this patient about care of her skin?

**2** A 35-year-old woman, who has two small children at home and is in the middle of a divorce, is admitted to your nursing unit for treatment of an acute flare of psoriasis. Her skin is covered with bright red, dry scaling plaques, involving 60% of her body surface. Additionally, she has distortions of her fingers and pitted nail plates, and she reports bilateral ankle pain on awakening each day. She has been admitted for twice-daily bath treatments and to initiate an injectable biologic for management of her condition. What should be included in the admission nursing assessment? What should be included in the teaching plan? List some of the possible psychosocial issues that that may arise as you care for this patient.

**3** A 50-year-old professional golfer is having a routine physical examination. He states that his mother had malignant melanoma and that he is concerned about several lesions on his arms and neck. He asks about the risk factors for melanoma and about total body digital photography that a colleague had recently had. How would you explain the purpose of this photographic method? Identify the evidence and the strength of the evidence that supports the diagnostic value of this procedure. What teaching would you provide to this patient about prevention of melanoma and self-examination of the skin?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

Dermatology online atlas, a cooperation between the Department of Clinical Social Medicine (University of Heidelberg) and the Department of Dermatology (University of Erlangen), www.dermis.net

Foundation for Ichthyosis and Related Skin Types, www.scalyskin.org

Lupus Foundation, www.lupus.org

National Alopecia Areata Foundation (NAAF), www.naaf.org

National Eczema Association for Science and Education, www.nationaleczema.org

National Organization for Albinism and Hypopigmentation, www.albinism.org

National Pressure Ulcer Advisory Panel, www.npuap.org

National Psoriasis Foundation (USA), www.psoriasis.org

National Rosacea Society, www.rosacea.org

National Vitiligo Foundation, www.nvfi.org

New Zealand Dermatology Society, www.dermnetnz.org

Skin Cancer Foundation, www.skincancer.org



chapter 57

# Management of Patients With Burn Injury

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Discuss the incidence of burn injury in the United States today.
2. Describe the factors that affect the severity of burn injury.
3. Describe the local and systemic effects of a major burn injury.
4. Compare and contrast the potential fluid and electrolyte alterations of the emergent/resuscitative and acute phases of burn management.
5. Describe the goals of burn care and the nurse's role in wound assessment, wound cleansing, topical antibacterial therapy, wound dressing, débridement, excision, and skin grafting.
6. Describe the nurse's role in pain management, restoration of function, psychological support of the patient and family, nutritional support, pulmonary care, and patient and family education.
7. Describe patient care and the recovery process for burn patients

## GLOSSARY

**AlloDerm:** processed dermis from human cadaver skin; can be used as dermal layer for skin grafts

**autograft:** a graft derived from one part of a patient's body and used on another part of that same patient's body

**Biobrane:** synthetic dressing composed of a nylon, Silastic membrane combined with a collagen derivative

**carboxyhemoglobin:** a compound of carbon monoxide and hemoglobin, formed in the blood with exposure to carbon monoxide

**collagen:** a protein present in skin, tendon, bone, cartilage, and connective tissue

**contracture:** shrinkage of burn scar through collagen maturation

**cultured epithelial autograft (CEA):** autologous epidermal cells that proliferate in culture and then are regrafted onto the patient

**débridement:** removal of foreign material and devitalized tissue until surrounding healthy tissue is exposed

**donor site:** the area from which skin is taken to provide a skin graft for another part of the body

**eschar:** devitalized tissue resulting from a burn

**escharotomy:** a linear excision made through eschar to release constriction of underlying tissue

**excision:** surgical removal of tissue

**fasciotomy:** an incision made through the fascia to release constriction of underlying muscle

**heterograft:** graft (ie, pigskin) obtained from an animal of a species other than that of the recipient; also called a xenograft

**homograft:** a graft transferred from one human (living or cadaveric) to another human; also called allograft

**hydrotherapy:** cleansing of wounds through use of bath, shower, shower cart table, or immersion

**hypertrophic scar:** excessive scar formation that rises above the level of the skin

**Integra:** synthetic dermal substitute

**rule of nines:** method for calculating body surface area burned by dividing the body into multiples of nine

The nurse who cares for a patient with a burn injury requires a high level of knowledge about the physiologic changes that occur after a burn, as well as astute assessment skills to detect subtle changes in the patient's condition. The patient's health history affects burn care. This makes each burn patient very unique and provides a variety of challenges to the patient's plan of care. In addition, the nurse provides sensitive, compassionate care to patients who are critically ill and initiates rehabilitation early in the course of care. The nurse must also be able to communicate effectively with patients who have burn injuries, family members in crisis, and members of the entire interdisciplinary burn management team. Care of the patient with a burn requires knowledge and skill throughout the care continuum from injury to recovery. This ensures quality care, improved patient outcomes, and optimal quality of life.

# Overview of Burn Injury

## Incidence

A burn injury can affect people of all age groups, in all socioeconomic groups. An estimated 500,000 people are treated for minor burn injury annually (Pitts, Niska, Xu, et al., 2008). The number of patients who are hospitalized each year with burn injuries is more than 40,000. This includes approximately 25,000 people who require hospitalization in specialized burn centers across the country. As emergency transportation and awareness of burn specialized hospitals has increased, the number of patients referred to these centers has risen. The remaining 5,000 hospitals see an average of three burns per year. Of those people admitted to burn centers, 47% of their injuries occurred at home, 27% on the road, 8% are occupational, 5% are recreational, and the remaining 13% from other sources. Forty percent of these injuries were flame related, 30% scald injuries, 4% electrical, 3% chemical, with the remaining unspecified (Miller, Bessey, Lentz, et al., 2008).

Males have greater then twice the chance of burn injury than women, and the most frequent age group for contact burns is between 20 to 40 years of age (Miller, et al., 2008). The National Fire Protection Association reports 4,000 fire and burn deaths each year. Of these, 3,500 deaths occur from residential fires and the remaining 500 from other sources such as motor vehicle crashes, scalds, or electrical and chemical sources. The overall mortality rate, for all ages and for total body surface area (TBSA) burned is 4.9% (Miller, et al., 2008).

### Gerontologic Considerations

Reduced mobility, coordination, strength, and sensation and changes in vision place elderly people at higher risk for burn injury. Difficulties cooking and bathing and other activities of daily living are associated with flame and scald injury in this age group. These changes also place older people at risk for severe burn because they have difficulty in extinguishing the fire and removing themselves from the burn source (Sheridan, 2007a).

Morbidity and mortality rates associated with burns are greater in elderly patients than in younger patients when comparing injuries with similar severity. In 2007 patients over the age of 60 who had a 60% TBSA or greater had an overall mortality rate of 96% (Sheridan, 2007a). Predisposing factors and the health history in the older adult influence the complexity of care for the patient. Pulmonary function is limited in the older adult, therefore, airway exchange, lung elasticity, and ventilation can be affected. This can be further affected by a history of smoking. Decreased cardiac function and coronary artery disease increase the risk of complications in elderly patients with burn injuries. Malnutrition and presence of diabetes mellitus or other endocrine disorders present nutritional challenges and require close monitoring. Varying degrees of orientation may present themselves on admission or through the course of care, making assessment of pain and anxiety a challenge for the burn team. The skin of the elderly is thinner and less elastic, which affects the depth of injury and its ability to heal (Sheridan, 2007a).

An important goal of nurses in community and home settings is to provide education on the prevention of burn injury, especially among the elderly (Chart 57-1). Nurses

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**CHART 57-1 — HEALTH PROMOTION**

**Burn Prevention**

- Advise that matches and lighters be kept out of the reach of children.
- Emphasize the importance of never leaving children unattended around fire or in bathroom/bathtub.
- Advise the installation and maintenance of smoke detectors on every level of the home, changing batteries annually on birthday.
- Recommend the development and practice of a home exit fire drill with all members of the household.
- Advise setting the water heater temperature no higher than 120°F.
- Caution against smoking in bed, while using home oxygen, or against falling asleep while smoking.
- Caution against throwing flammable liquids onto an already burning fire.
- Caution against using flammable liquids to start fires.
- Caution against removing the radiator cap from a hot car engine.
- Recommend avoidance of overhead electrical wires and underground wires when working outside.
- Advise that hot irons and curling irons be kept out of the reach of children.
- Caution against running electric cords under carpets or rugs.
- Recommend storage of flammable liquids well away from a fire source, such as a pilot light.
- Advocate caution when cooking, being aware of loose clothing hanging over the stove top.
- Recommend having a working fire extinguisher in the home and knowing how to use it.

need to assess an elderly patient's ability to safely perform activities of daily living, assist elderly patients and families to modify their environment to ensure safety, and make referrals as needed.

## Outlook for Survival and Recovery

The National Center for Injury Prevention and Control of the Centers for Disease Control and Prevention (CDC) identifies fire or burn injury as the fifth most common cause of death from unintentional injury in the United States and the third leading cause of death in the home from injury (CDC, 2008).

Great strides in research have helped to increase the survival rate of patients with burn injuries. Mortality has fallen to levels never thought possible. Long-term outcomes can now be explored because patients with very large burns are surviving their injuries. Research in areas such as fluid resuscitation, emergency burn treatment, inhalation injury and management, nutritional needs and changes in wound care practice with early excision, skin grafting, and use of skin substitutes have contributed greatly to the decrease in burn deaths. Continued research and advances in the areas of critical care, rehabilitation, psychosocial, and scar management are essential for continued progress in burn care.

## Severity

The severity of each burn injury is determined by multiple factors that when assessed help the burn team estimate the likelihood that a patient will survive and plan for the care for each patient. These factors include age of the patient; depth of the burn; amount of surface area of the body that is burned; the presence of inhalation injury; presence of other injuries; location of the injury in special care areas such as the face, the perineum, hands, or feet; and the presence of a past medical history.

### *Age*

Young children and the elderly continue to have increased morbidity and mortality when compared to other age groups with similar injuries and present a challenge for burn care. This is an important factor when determining the severity of injury and possible outcome for the patient.

### *Burn Depth*

Burns are classified according to the depth of tissue destruction as superficial partial-thickness injuries, deep partial-thickness injuries, or full-thickness injuries (Table 57-1). These three categories are similar to, but not the same as, first-, second-, and third-degree burn classifications. Although the term fourth-degree burn is not used universally, it occurs with prolonged flame contact or high-voltage injury that destroys all layers of the skin and damages tendons and muscles.

In a superficial partial-thickness burn, the epidermis is destroyed or injured and a portion of the dermis may be injured. A deep partial-thickness burn involves destruction of the epidermis and upper layers of the dermis and injury to deeper portions of the dermis. Capillary refill follows tissue blanching. Hair follicles remain intact. A full-thickness burn involves total destruction of epidermis and dermis and, in some cases, destruction of underlying tissue, muscle, and bone. Wound color ranges widely from pale white to red, brown, or charred black. The burned area is painless and lacks sensation because nerve fibers are destroyed. The wound appears leathery; hair follicles and sweat glands are destroyed (Fig. 57-1). The severity of this burn is often deceiving to patients because they have no pain in the injury area. These wounds require skin grafting for healing.

Burn depth determines whether epithelialization will occur. Determining burn depth can be difficult even for the experienced burn care provider. The following factors are

**Table 57-1 CHARACTERISTICS OF BURNS ACCORDING TO DEPTH**

| Depth of Burn and Causes | Skin Involvement | Symptoms | Wound Appearance | Recuperative Course |
|---|---|---|---|---|
| **Superficial Partial-Thickness (Similar to First Degree)** | | | | |
| Sunburn<br>Low-intensity flash | Epidermis; possibly a portion of dermis | Tingling<br>Hyperesthesia (supersensitivity)<br>Pain that is soothed by cooling | Reddened; blanches with pressure; dry<br>Minimal or no edema<br>Possible blisters | Complete recovery within a week; no scarring<br>Peeling |
| **Deep Partial-Thickness (Similar to Second Degree)** | | | | |
| Scalds<br>Flash flame<br>Contact | Epidermis, upper dermis, portion of deeper dermis | Pain<br>Hyperesthesia<br>Sensitive to cold air | Blistered, mottled red base; broken epidermis; weeping surface<br>Edema | Recovery in 2 to 4 weeks<br>Some scarring and depigmentation contractures<br>Infection may convert it to full thickness |
| **Full-Thickness (Similar to Third Degree)** | | | | |
| Flame<br>Prolonged exposure to hot liquids<br>Electric current<br>Chemical<br>Contact | Epidermis, entire dermis, and sometimes subcutaneous tissue; may involve connective tissue, muscle, and bone | Pain free<br>Shock<br>Hematuria (blood in the urine) and possibly hemolysis (blood cell destruction)<br>Possible entrance and exit wounds (electrical burn) | Dry; pale white, leathery, or charred<br>Broken skin with fat exposed<br>Edema | Eschar sloughs<br>Grafting necessary<br>Scarring and loss of contour and function; contractures<br>Loss of digits or extremity possible |



**Figure 57-1** Full-thickness injury to chest and upper extremity. Epidermis, varying levels of the dermis and subcutaneous tissue is injured. Used with permission. Lehigh Valley Health Network, Allentown, PA.

considered in determining the depth of a burn: how the injury occurred, causative agent (such as flame or scalding liquid), temperature of the burning agent, duration of contact with the agent, and thickness of the skin.

### *Extent of Body Surface Area Injured*

Various methods are used to estimate the TBSA affected by burns; among them are the rule of nines, the Lund and Browder method, and the palmer method. These methods assist the burn team in making decisions about treatment and transfer of the patient to a burn center.

#### Rule of Nines

A common method, the **rule of nines** (Fig. 57-2), is a quick way to estimate the extent of burns in adults. The system divides the body into multiples of nine. The sum total of these parts equals the total body surface area and is an important measurement in the severity of injury (Shukla & Sheridan, 2008).

#### Lund and Browder Method

A more precise method of estimating the extent of a burn is the Lund and Browder method, which recognizes the percentage of surface area of various anatomic parts, especially the head and legs, as it relates to the age of the patient. By dividing the body into very small areas and providing an estimate of the proportion of TBSA accounted for by each body part, one can obtain a reliable estimate of TBSA burned. The initial evaluation is made on arrival of the patient at the hospital and is revised within the first 72 hours because demarcation of the wound and its depth presents itself more clearly by this time.

#### Palmer Method

In patients with scattered burns, or for a quick prehospital assessment, the palmer method may be used to estimate the extent of the burns. The size of the patient's palm, not including the surface area of the digits, is approximately 1% of the TBSA. The patient's palm without the fingers is equivalent to 0.5% TBSA and serves as a general measurement for all age groups (Shukla & Sheridan, 2008).

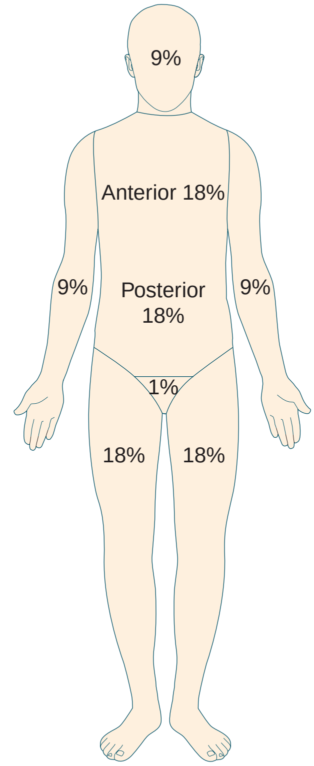



**Figure 57-2** The rule of nines: Estimated percentage of total body surface area (TBSA) in the adult is arrived at by sectioning the body surface into areas with a numerical value related to nine. (Note: The anterior and posterior head total 9% of TBSA.)

## Pathophysiology

Burn injury is a result of heat transfer from one site to another. Tissue destruction results from coagulation, protein denaturation, or ionization of cellular contents (Fig. 57-3). The skin and the mucosa of the upper airways are sites of tissue destruction. Deep tissues, including the viscera, can be damaged by electrical burns (Chart 57-2) or by prolonged contact with a heat source. Disruption of the skin can lead to increased fluid loss, infection, hypothermia, scarring, compromised immunity, and changes in function, appearance, and body image.

The depth of the injury depends on the temperature of the burning agent and the duration of contact with the agent. For example, in the case of scald burns in adults, 1 second of contact with hot tap water at 68.9°C (156°F) may result in a burn that destroys both the epidermis and the dermis, causing a full-thickness (third-degree) injury. Fifteen seconds of exposure to hot water at 56.1°C (133°F) results in a similar full-thickness injury. Temperatures less than 44°C (111°F) can be tolerated for long periods without injury.

Burns that do not exceed 20% TBSA produce a primarily local response. Burns that exceed 20% TBSA may produce both a local and a systemic response and are considered major burn injuries. The systemic response is caused by

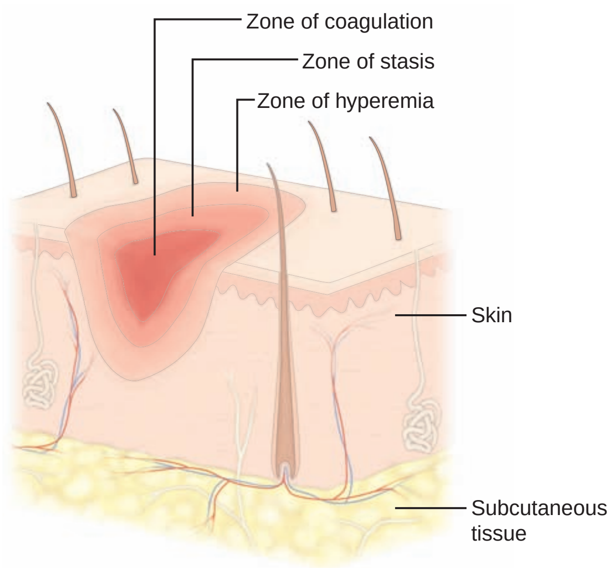



**Figure 57-3** Zones of burn injury. Each burned area has three zones of injury. The inner zone (known as the area of coagulation, where cellular death occurs) sustains the most damage. The middle area, or zone of stasis, has a compromised blood supply, inflammation, and tissue injury. The outer zone—the zone of hyperemia—sustains the least damage.

the release of cytokines and other mediators into the systemic circulation. The release of local mediators and changes in blood flow, tissue edema, and infection can cause progression of the burn injury.

Pathophysiologic changes resulting from major burns during the initial burn-shock period include tissue hypoperfusion and organ hypofunction secondary to decreased cardiac output, followed by hyperdynamic and hypermetabolic phases. The incidence, magnitude, and duration of pathophysiologic changes in burns are proportional to the extent of burn injury, with a maximal response seen in burns covering 60% or more TBSA.

The initial systemic event after a major burn injury is hemodynamic instability, which results from loss of capillary integrity and a subsequent shift of fluid, sodium, and protein from the intravascular space into the interstitial spaces. Hemodynamic instability involves cardiovascular, fluid and electrolyte, blood volume, pulmonary, and other mechanisms.

### *Cardiovascular Alterations*

Hypovolemia is the immediate consequence of fluid loss and results in decreased perfusion and oxygen delivery. Cardiac output decreases before any significant change in blood volume is evident. As fluid loss continues and vascular

## Chart 57-2 • *Electrical Burns*

Electrical injury accounts for a small percentage of burn unit admissions each year, yet it is one of the most destructive types of burn injuries that can be sustained. The devastating effects of an electrical injury can cause lifelong neurovascular problems. Low-voltage injury (ie, less than 500 V exposure) generally does not cause significant damage or medical problems. Midrange exposure (ie, 200–1000 V) can cause local destruction to the tissue. High-voltage exposure (ie, greater than 1000 V) can cause loss of consciousness, fractures, compartment syndrome, arrhythmias, and is often associated with falls (Shukla & Sheridan, 2008).

Tissue and bone destruction often results in amputations and possible loss of life as the result of cardiac and respiratory abnormalities. A true electrical injury results when a current of electricity travels through the body and exits to the ground, causing internal damage to tissue and organs. Such an injury results in an entrance wound, which is the patient's point of contact with the source. The exit wound has a blow-out appearance, causing extensive damage to the surrounding tissue and structures. The amount of damage depends on the strength of the current and the length of the duration of contact with the source. An arc injury is the result of the electricity's traveling on the outside of the body or arcing around it. There is usually also a thermal injury due to clothing catching on fire. The surface injury from an electrical source is usually small compared with the damage under the surface of the skin. Electricity travels through areas of least resistance, nerves and blood vessels, to the most resistant, bone. The most severe damage occurs beneath the skin surface and is difficult to determine without surgical intervention (Shukla & Sheridan, 2008).

Once the patient is out of the path of the electricity, emergency care can safely be provided. The ABCs of emergency care are always followed. An electrical current immediately contracts muscles as it travels through the body, and cardiac dysrhythmias and spinal injuries often result from the muscular contraction. Cardiac dysrhythmias can occur in both low-voltage and high-voltage injury and therefore require electrocardiogram evaluation and monitoring. Those patients with loss of consciousness, dysrhythmias, or ST changes on ECG must be admitted and cardiac monitoring should occur (Arnoldo, Klein & Gibran, 2006). Until it is known that the patient has no fractures, it is imperative that a neck collar remain in place and that the patient is log-rolled to eliminate the chance of further spinal cord injury. With high-voltage electrical injuries, cervical spine immobilization is a priority until cervical spine injury is ruled out.

Prompt administration of intravenous (IV) fluids and monitoring of urine output are critical components of care. Patients with electrical burns are prone to acute renal failure because of the release of myoglobin resulting from the destruction of muscle and tissue. Myoglobin can constrict renal arteries and block urine flow through the kidneys. Patients can have gross hematuria on admission to the hospital. Administration of large amounts of IV fluids helps maintain the flow of urine. It is difficult to assess the amount of fluid a patient will require because the electrical injury creates such extensive internal damage. The nurse should expect 75 to 100 mL/h of urine output for a patient who is receiving fluid resuscitation. Creatine kinase (CK) is released by damaged muscle cells and it is measured during the early phases of care to assist in determining the degree of muscle injury.

In patients with electrical injuries, neurovascular checks of affected extremities are very important. Assessment of color, temperature, and sensation in the extremity as well as the monitoring of palpable or Doppler pulses should be done to assess adequate blood flow to the extremity. If indicated by clinical assessment, the measurement of compartment syndrome to determine deep tissue injury can be performed. Compartment pressures greater than 30 mm Hg can indicate poor tissue perfusion and the need for surgical decompression (Arnoldo, et al., 2006).

volume decreases, cardiac output continues to decrease and the blood pressure drops. This is the onset of burn shock. In response, the sympathetic nervous system releases catecholamines, resulting in an increase in peripheral resistance (vasoconstriction) and an increase in pulse rate. Peripheral vasoconstriction further decreases cardiac output.

Prompt fluid resuscitation maintains the blood pressure in the low to normal range and improves cardiac output. Despite adequate fluid resuscitation, cardiac filling pressures (central venous pressure, pulmonary artery pressure, and pulmonary artery wedge pressure) remain low during the burn-shock period. If inadequate fluid resuscitation occurs, distributive shock occurs (see Chapter 15).

Generally the greatest volume of fluid leak occurs in the first 24 to 36 hours after the burn, peaking by 6 to 8 hours. As the capillaries begin to regain their integrity, burn shock resolves and fluid returns to the vascular compartment. As fluid is reabsorbed from the interstitial tissue into the vascular compartment, blood volume increases. If renal and cardiac function is adequate, urinary output increases. Diuresis continues for several days to 2 weeks.

At the time of burn injury, some red blood cells may be destroyed and others damaged, resulting in anemia. Despite this, the hematocrit may be elevated due to plasma loss. Blood losses sustained during surgical procedures, wound care, and diagnostic studies and ongoing hemolysis further contribute to anemia. Blood transfusions are required periodically to maintain adequate hemoglobin levels for oxygen delivery. Abnormalities in coagulation, including a decrease in platelets (thrombocytopenia) and prolonged clotting and prothrombin times, also occur with burn injury.

### Fluid and Electrolyte Alterations

Edema forms rapidly after a burn injury. A superficial burn will cause edema to form within 4 hours after injury, while a deeper burn will continue to form over a longer period of time up to 18 hours postinjury. This is caused by increased perfusion to the injured area and is reflective of the amount of vascular and lymphatic damage to the tissue. There is loss of capillary integrity, and fluid is localized to the burn itself, resulting in blister formation and edema only in the area of injury. Patients with more severe burns develop massive systemic edema (Greenhalgh, 2007). Reabsorption begins at about 4 hours and is complete by 4 days postburn injury. However, the reabsorption is dependent on the depth of injury to the tissue. Partial-thickness injury resolves more quickly due to a more functioning lymphatic system and increased perfusion when compared to the full-thickness injury (Greenhalgh, 2007). Edema in burn wounds can be reduced by avoiding excessive fluid administration during the early postburn period. Excessive fluid administration increases edema formation in both burned and nonburned tissue.

As the taut, burned tissue becomes unyielding to the edema underneath its surface, it begins to act like a tourniquet, especially if the burn is circumferential. As edema increases, pressure on small blood vessels and nerves in the distal extremities causes an obstruction of blood flow and consequent ischemia. This complication is similar to a compartment syndrome. The physician may need to perform an **escharotomy,** a surgical incision into the **eschar** (devitalized tissue resulting from a burn) to relieve the constricting effect of the burned tissue (Demling, 2005a).

Circulating blood volume decreases dramatically during burn shock. In addition, evaporative fluid loss through the burn wound may reach 3 to 5 L or more over a 24-hour period until the burn surfaces are covered.

During burn shock, serum sodium levels vary in response to fluid resuscitation. Usually, hyponatremia (sodium depletion) is present. Hyponatremia is also common during the first week of the acute phase, as water shifts from the interstitial space to the vascular space.

Immediately after burn injury, hyperkalemia (excessive potassium) results from massive cell destruction. Hypokalemia (potassium depletion) may occur later with fluid shifts and inadequate potassium replacement.

### Pulmonary Alterations

Approximately 10% to 20% of patients admitted to burn centers have an inhalation injury. The presence of this injury increases the hospital length of stay, is a determinant of the severity of injury, and increases mortality and morbidity (Palmieri, 2007). An inhalation injury occurs when a person is trapped inside a burning structure or involved in an explosion that leads to the inhalation of superheated air and noxious gas (McCall & Cahill, 2005).

Deterioration in severely burned patients can occur without obvious evidence of a smoke inhalation injury. Bronchoconstriction (caused by release of histamine, serotonin, and thromboxane, a powerful vasoconstrictor) and chest constriction secondary to circumferential full-thickness chest burns cause this deterioration. Even without pulmonary injury, hypoxia (oxygen starvation) may be present. Early in the postburn period, catecholamine release in response to the stress of the burn injury alters peripheral blood flow, thereby reducing oxygen delivery to the periphery. Later, hypermetabolism and continued catecholamine release lead to increased tissue oxygen consumption, which can lead to hypoxia. To ensure that adequate oxygen is available to the tissues, supplemental oxygen may be needed.

Pulmonary injuries are categorized as upper airway injury or inhalation injury below the glottis. Upper airway injury results from inhalation of direct heat greater then 150°C (302°F) to the epithelium. This damage results in severe upper airway edema, which can cause obstruction of the upper airway, including the pharynx and larynx, in the early hours postburn (Palmieri, 2007). Because of the cooling effect of rapid vaporization in the pulmonary tract, direct heat injury does not normally occur below the level of the bronchus. Upper airway injury is treated by early nasotracheal or endotracheal intubation.

Inhalation injury below the glottis results from inhaling the products of incomplete combustion or noxious gases. Inhalation of noxious gases is often the source of death at the scene of a fire. These products include carbon monoxide, cyanide, ammonia, aldehydes, acrolein, sulfur dioxide, and isocyanates (Barillo, 2009; Kealey, 2009; Palmieri, 2007). Tissue hypoxia is the result of carbon monoxide inhalation. It combines with hemoglobin to form **carboxyhemoglobin.** The affinity of hemoglobin for carbon monoxide is 250 times greater than that for oxygen. This injury results

directly from chemical irritation of the pulmonary tissues at the alveolar level. Inhalation injuries below the glottis cause loss of ciliary action, hypersecretion, severe mucosal edema, and possibly bronchospasm. The pulmonary surfactant is reduced, resulting in atelectasis (collapse of alveoli). Expectoration of carbon particles in the sputum is the cardinal sign of this injury.

Treatment usually consists of early intubation and mechanical ventilation with 100% oxygen, which reduces the half-life of carboxyhemoglobin from 4 hours to 45 minutes (Kealey, 2009; Pham & Gibran, 2007). However, some patients require only oxygen therapy, depending on the extent of pulmonary injury and edema.

Restrictive pulmonary excursion may occur with full-thickness burns encircling the neck and thorax. Chest excursion may be greatly restricted, resulting in decreased tidal volume. In such situations, escharotomy is necessary.

Pulmonary abnormalities are not always immediately apparent. More than half of all patients with burn injuries with pulmonary involvement do not initially demonstrate pulmonary signs and symptoms. Any patient with possible inhalation injury must be observed for at least 24 hours for respiratory complications. Airway obstruction may occur very rapidly or develop in hours, even while fluid resuscitation is under way. Decreased lung compliance, decreased arterial oxygen levels, and respiratory acidosis may occur gradually over the first 5 days after a burn.

Indicators of possible upper airway injury include (1) injury occurring in an enclosed space; (2) burns of the face or neck; (3) singed nasal hair; (4) hoarseness, high-pitched voice change, dry cough, stridor; (5) sooty or bloody sputum; (6) labored breathing or tachypnea (rapid breathing) and other signs of reduced oxygen levels (hypoxemia); and (7) erythema and blistering of the oral or pharyngeal mucosa.

Diagnosis of lower airway inhalation injury includes monitoring of arterial blood gases and carboxyhemoglobin levels and direct observation of the airway by fiberoptic bronchoscopy to confirm the clinical diagnosis. Findings on bronchoscopy include airway edema, inflammation, necrosis, and soot in the airway (Edelman, White, Tyburski, et al., 2006). Less frequently, xenon scan and computed tomography scans can be used to aid diagnosis but are of questionable value (Pham & Gibran, 2007).

Pulmonary complications secondary to inhalation injuries include sloughing of the airway, increased secretions and inflammation, atelectasis, airway obstruction and ulceration, pulmonary edema, and tissue hypoxia. As a result, respiratory failure and acute respiratory distress syndrome (ARDS) and pneumonia can develop (Edelman, et al., 2006). Respiratory failure and ARDS are discussed in Chapter 23.

### Renal Alterations

Renal function may be altered as a result of decreased blood volume. Destruction of red blood cells at the injury site results in free hemoglobin in the urine. If muscle damage occurs (eg, from electrical burns), myoglobin is released from the muscle cells and excreted by the kidneys. Adequate fluid volume replacement restores renal blood flow, increasing the glomerular filtration rate and urine volume. If there is inadequate blood flow through the kidneys, the hemoglobin and myoglobin occlude the renal tubules, resulting in acute tubular necrosis and renal failure (see Chapter 44).

### Immunologic Alterations

The immunologic defenses of the body are greatly altered by a burn injury. Patients with burn injury are at high risk for infection and sepsis. The skin is the largest barrier to infection, and when it is compromised, the patient is continually exposed to the environment. The loss of skin integrity is compounded by the release of abnormal inflammatory factors, altered levels of immunoglobulins and serum complement, impaired neutrophil function, and a reduction in lymphocytes (lymphocytopenia). These alterations result in immunosuppression and increase the risk for sepsis. As a result, the major cause of death in the burn patient who survives after 24 hours is multiple organ dysfunction syndrome (MODS) (Greenhalgh, 2007). Most burn centers are specifically designed to provide an infection-controlled environment to protect the patient and minimize exposure to potentially harmful organisms.

### Thermoregulatory Alterations

Loss of skin also results in an inability to regulate body temperature. Patients with burn injuries may therefore exhibit low body temperatures in the early hours after injury. Then, as hypermetabolism resets core temperature, the patient becomes hypothermic for much of the postburn period, even in the absence of infection. Most burn centers have heat panels at the bedside and additional heating sources to help maintain the patient's body temperature.

### Gastrointestinal Alterations

Two potential gastrointestinal (GI) complications may occur: paralytic ileus (absence of intestinal peristalsis) and Curling's ulcer. Decreased peristalsis and bowel sounds are manifestations of paralytic ileus resulting from burn trauma. Gastric distention and nausea may lead to vomiting unless gastric decompression is initiated. Gastric bleeding secondary to massive physiologic stress may be signaled by occult blood in the stool, regurgitation of "coffee ground" material from the stomach, or bloody vomitus. These signs suggest gastric or duodenal erosion (Curling's ulcer).

Other alterations affect the GI tract after burn injury: the mucosal barrier becomes permeable, the permeability allows for overgrowth of GI bacteria, and the bacteria translocate to other organs, causing infection. Patients are unable to defend against their own bacteria due to immunosuppression. In addition, alcohol ingestion, which is common in the burn population, affects GI integrity and immune response, further increasing the risk of infection and possible bleeding complications (Gosain & Gamelli, 2005a).

Patients with large TBSA burns are also at risk for abdominal compartment syndrome (ACS). During resuscitation, fluid shifts into the abdominal cavity, causing increased abdominal distention, decreased urine output, hypotension, and respiratory insufficiency. The development of ACS is related to the volume of fluids administered. Factors such as the presence of inhalation injury, deep thermal injury, glucosuria, delayed or inadequate

resuscitation, and hemoglobinuria may necessitate additional fluids that may not be calculated by formulas. Bladder pressure is measured to determine the need for invasive intervention to treat increasing abdominal pressure. Bladder pressures greater than 25 mm Hg over time indicate increasing abdominal pressure. Although the prevention of this complication is not always possible, cautious and continuous measurement of fluids administered and urine output is essential (Hershberger, Hunt, Arnoldo, et al., 2007).

## Management of Burn Injury

Burn care is typically categorized into three phases of care: emergent/resuscitative phase, acute/intermediate phase, and rehabilitation phase. Although priorities exist for each of the phases, the phases overlap, assessment, and management of specific problems and complications are not limited to these phases but take place throughout burn care. The three phases and the priorities for care are summarized in Table 57-2.

### EMERGENT/RESUSCITATIVE PHASE

#### On-the-Scene Care

Preventing injury to the rescuer is the first priority of on-the-scene care. If needed, fire and emergency medical services should be requested at the first opportunity. Usually, rescue workers cover the wound, establish an airway, supply oxygen, and insert at least one large-bore intravenous (IV) line. Chart 57-3 describes the procedures and care required at the burn scene.

The burned person's appearance can be frightening at first. Although the local effects of a burn are the most evident, the systemic effects pose greater threats to life. A primary survey of the patient is carried out to assess the *a*irway (A), gas exchange or *b*reathing (B), and circulatory status (C) as well as the need for cervical spine immobilization and cardiac monitoring for patients with high-voltage electrical injuries. The circulatory system must be assessed quickly. Apical pulse and blood pressure are monitored frequently. Tachycardia (abnormally rapid heart rate) and slight hypotension are expected soon after the burn. In the patient with extensive burns, neurologic status is assessed quickly. Often the patient is awake and alert initially, and vital information can be obtained at that time.

*NURSING ALERT*

**Breathing must be assessed and a patent airway established immediately during the initial minutes of emergency care. Immediate therapy is directed toward establishing an airway and administering humidified 100% oxygen. If such a high concentration of oxygen is not available under emergency conditions, oxygen by mask or nasal cannula is given initially. If qualified personnel and equipment are available and the victim has severe respiratory distress or airway edema, the rescuers can insert an endotracheal tube and initiate manual ventilation.**

*NURSING ALERT*

**No food or fluid is given by mouth, and the patient is placed in a position that will prevent aspiration of vomitus, because nausea and vomiting typically occur due to paralytic ileus resulting from the stress of injury.**

The secondary survey focuses on the completion of the total body system assessment, including the mechanism of injury, inhalation injury, and presence of corneal injury. A secondary head-to-toe survey of the patient is carried out to identify other potentially life-threatening injuries (Shukla & Sheridan, 2008).

#### Medical Management

The patient is transported to the nearest emergency department (ED). The hospital and physician are alerted that the patient is en route so that life-saving measures can be initiated immediately by a trained team and plans for referral to a burn center can be made.

Initial priorities in the ED remain airway, breathing, and circulation. For mild pulmonary injury, 100% humidified

**Table 57-2 PHASES OF BURN CARE**

| Phase | Duration | Priorities |
|---|---|---|
| Emergent/resuscitative | From onset of injury to completion of fluid resuscitation | • First aid<br>• Prevention of shock<br>• Prevention of respiratory distress<br>• Detection and treatment of concomitant injuries<br>• Wound assessment and initial care |
| Acute/intermediate | From beginning of diuresis to near completion of wound closure | • Wound care and closure<br>• Prevention or treatment of complications, including infection<br>• Nutritional support |
| Rehabilitation | From major wound closure to return to individual's optimal level of physical and psychosocial adjustment | • Prevention of scars and contractures<br>• Physical, occupational, and vocational rehabilitation<br>• Functional and cosmetic reconstruction<br>• Psychosocial counseling |

## Chart 57-3 • *Emergency Procedures at the Burn Scene*

- **Extinguish the flames.** When clothes catch fire, the flames can be extinguished if the person falls to the floor or ground and rolls ("stop, drop, and roll"); anything available to smother the flames, such as a blanket, rug, or coat, may be used. Standing still forces the person to breathe flames and smoke, and running fans the flames. If the burn source is electrical, the electrical source must be disconnected safely.
- **Cool the burn.** After the flames are extinguished, the burned area and adherent clothing are soaked with *cool* water, briefly, to cool the wound and halt the burning process. Once a burn has been sustained, the application of cool water is the best first-aid measure. However, *never* apply ice directly to the burn, *never* wrap the person in ice, and *never* use cold soaks or dressings for longer than several minutes; such procedures may worsen the tissue damage and lead to hypothermia in people with large burns.
- **Remove restrictive objects.** If possible, remove clothing immediately. Adherent clothing may be left in place once cooled. Other clothing and all jewelry, including all piercings, should be removed to allow for assessment and to prevent constriction secondary to rapidly developing edema.
- **Cover the wound.** The burn should be covered as quickly as possible to minimize bacterial contamination, to maintain body temperature, and decrease pain by preventing air from coming in contact with the injured surface. Sterile dressings are best, but any clean, dry cloth can be used as an emergency dressing. Ointments and salves should *not* be used. Other than the dressing, no medication or material should be applied to the burn wound.
- **Irrigate chemical burns.** Chemical burns resulting from contact with a corrosive material are irrigated immediately. Most chemical laboratories have a high-pressure shower for such emergencies. If such an injury occurs at home, brush off the chemical agent, remove clothes immediately, and rinse all areas of the body that have come in contact with the chemical. Rinsing can occur in the shower or any other source of continuous running water. If a chemical gets in or near the eyes, the eyes should be flushed with cool, clean water immediately. Outcomes for the patient with chemical burns are significantly improved by rapid, sustained flushing of the injury at the scene.

oxygen is administered and the patient is encouraged to cough so that secretions can be removed by suctioning. For more severe situations, it is necessary to remove secretions by bronchial suctioning and to administer bronchodilators and mucolytic agents. If edema of the airway develops, endotracheal intubation may be necessary. Continuous positive airway pressure and mechanical ventilation may also be required to achieve adequate oxygenation.

After adequate respiratory function and circulatory status have been established, the patient is assessed for cervical spinal injuries or head injury if he or she was involved in an explosion, a fall, a jump, or an electrical injury. Once the patient's condition is stable, attention is directed to the burn wound itself. All clothing and jewelry are removed. For chemical burns, flushing of the exposed areas is continued. The patient is checked for contact lenses. These are removed immediately if chemicals have contacted the eyes or if facial burns have occurred.

It is important to validate an account of the burn scenario provided by the patient, witnesses at the scene, and paramedics. Information needs to include the time of the burn injury, the source of the burn, the place where the burn occurred, how long the patient was in the burning structure, how the burn was treated at the scene, and any history of falling or jumping at the scene. A history of preexisting diseases, allergies, medications, and the use of drugs, alcohol, and tobacco is obtained at this point to aid in planning the patient's care. A large-bore (16- or 18-gauge) IV catheter should be inserted in a nonburned area (if not inserted earlier). Most patients will have a central venous catheter inserted so that large amounts of IV fluids can be administered quickly and central venous pressures can be monitored.

If the burn exceeds 20% to 25% TBSA, a nasogastric tube is inserted and connected to low intermittent suction. Often, patients with large burns become nauseated as a result of the GI effects of the burn injury, such as paralytic ileus, and the effects of medication, such as opioids. All patients who are intubated should have a nasogastric tube inserted to decompress the stomach and prevent vomiting.

The physician evaluates the patient's general condition, assesses the burn, determines the priorities of care, and directs the individualized plan of treatment, which is divided into systemic management and local care of the burned area. Nonsterile gloves, caps, masks and cover gowns are worn by personnel while assessing the exposed burned areas. Clean technique is maintained while assessing and treating the burn wounds.

Assessment of both the TBSA burned and the depth of the burn are completed after soot and debris have been gently cleansed from the burn wound. Careful attention is paid to keeping the patient warm during wound assessment and cleansing. Assessment is repeated frequently throughout burn wound care. Photographs may be taken of the burn areas initially and periodically throughout treatment; in this way, the initial injury and burn wound can be documented. Such documentation is invaluable for insurance and legal claims.

Clean sheets are placed under and over the patient to protect the burn wound from contamination, maintain body temperature, and reduce pain caused by air currents passing over exposed nerve endings. An indwelling urinary catheter is inserted to permit more accurate monitoring of urine output and renal function for patients with moderate to severe burns. Baseline height, weight, arterial blood gases, hematocrit, electrolyte values, blood alcohol level, drug panel, urinalysis, and chest x-rays are obtained. If the patient is elderly or has an electrical burn, a baseline electrocardiogram (ECG) is obtained. Because burns are contaminated wounds, tetanus prophylaxis is administered if

the patient's immunization status is not current or is unknown.

**NURSING ALERT**

**If necessary, a blood pressure cuff can be placed around a patient's burned extremity. The cuff must be of the correct size with accommodations made for bulky dressings.**

Although the major focus of care during the emergent phase is physical stabilization, the nurse must also attend to the patient's and family's psychological needs. Burn injury is a crisis, one that causes varying emotional responses. The patient's and family's coping abilities and available supports are assessed. Circumstances surrounding the burn injury should be considered when providing care. Individualized psychosocial support must be given to the patient and family. Because the patient is usually anxious and in pain, nurses should provide reassurance and support, explanations of procedures, and adequate pain relief. Because poor tissue perfusion accompanies burn injuries, only IV analgesia (usually morphine) is administered, titrated for the individual patient. If the patient wishes to see a spiritual advisor or counselor, one is notified.

### Transfer to a Burn Center

Patients with the following types of injuries are referred to a burn center for evaluation and care: burns with partial-thickness injury greater than 10% or full-thickness burns in any age group; a burn in an area of the body that requires special attention, such as the face, hands, feet, genitalia, perineum, and over joints; and chemical, electrical, or inhalation burns. Patients with preexisting medical problems or who may have additional trauma that could complicate care should be referred. Children with burns are transferred if they cannot be managed by the available pediatric team. Lastly, any burn injury that carries special social, emotional, or rehabilitative need should be referred to a burn center where these needs are addressed more readily (Guidelines for the Operation of Burn Centers, 2007).

If the patient is to be transported to a burn center, the following measures, listed in order of importance, are instituted before transfer:

- A patent airway is ensured.
- Adequate peripheral circulation is established in any burned extremity.
- A secure IV catheter is inserted with lactated Ringer's solution infusing at the rate required to maintain a urine output of at least 30 mL per hour.
- An indwelling urinary catheter is inserted.
- Adequate pain relief is attained.
- Wounds are covered with a clean, dry sheet, and the patient is kept comfortably warm.

All assessments and treatments are documented, and this information is provided to the burn center personnel. The transferring facility must relay accurate vital signs, temperature, and intake and output totals to burn center personnel so that adequate fluid resuscitation measures will continue.

### Management of Fluid Loss and Shock

Next to managing respiratory difficulties, the most urgent need is preventing irreversible shock by replacing lost fluids and electrolytes. As stated previously, survival of the patient with burn injury depends on adequate fluid resuscitation. Table 57-3 describes the fluid changes that occur in the emergent/resuscitative phase of care. Baseline weight and laboratory test results are obtained, and these parameters must be monitored closely in the immediate postburn (resuscitation) period. Both underresuscitation and overresuscitation are associated with poor outcome, and the optimal formula has not been identified; however, regardless of rate and composition of the fluids and colloids administered, diligent monitoring through the first 72 hours is critical to ensure optimal management (Pham, Cancio & Gilbran, 2008).

#### Fluid Replacement Therapy

The total volume and rate of IV fluid replacement are gauged by the patient's response and guided by the resuscitation formula. The adequacy of fluid resuscitation is determined by monitoring urine output totals, an index of renal

**Table 57-3 FLUID AND ELECTROLYTE CHANGES IN THE EMERGENT/RESUSCITATIVE PHASE**

Fluid accumulation phase (shock phase)
Plasma → interstitial fluid (edema at burn site)

| Observation | Explanation |
|---|---|
| Generalized dehydration | Plasma leaks through damaged capillaries |
| Reduction of blood volume | Secondary to plasma loss, fall of blood pressure, and diminished cardiac output |
| Decreased urinary output | Secondary to:<br>Fluid loss<br>Decreased renal blood flow<br>Sodium and water retention caused by increased adrenocortical activity<br>Hemolysis of red blood cells, causing hemoglobinuria and myonecrosis or myoglobinuria |
| Potassium ($K^+$) excess | Massive cellular trauma causes release of $K^+$ into extracellular fluid (ordinarily, most $K^+$ is intracellular) |
| Sodium ($Na^+$) deficit | Large amount of $Na^+$ is lost in trapped edema fluid and exudate and by shift into cells as $K^+$ is released from cells (ordinarily most $Na^+$ is extracellular) |
| Metabolic acidosis (base-bicarbonate deficit) | Loss of bicarbonate ions accompanies sodium loss |
| Hemoconcentration (elevated hematocrit) | Liquid blood component is lost into extravascular space |

perfusion. Urine output totals of 0.5 to 1.0 mL/kg/h for adults have been used as resuscitation goals (Pham, et al., 2008).

> *NURSING ALERT*
>
> **Clinical parameters are far more important in resuscitation than any formula. Indeed, the patient's individual response is the key to assessing the adequacy of fluid resuscitation.**

Additional gauges of fluid requirements and response to fluid resuscitation include hematocrit and hemoglobin and serum sodium levels. Within the first 24 hours after injury, if the hematocrit and the hemoglobin levels decrease or if the urinary output exceeds 50 mL/h, the rate of IV fluid administration may be decreased. One goal is to maintain serum sodium levels in the normal range during fluid replacement.

Appropriate resuscitation endpoints for patients with burn injuries remain unresolved, although some studies have examined hemodynamic and oxygen transport as resuscitation endpoints. Successful resuscitation is associated with increased delivery of oxygen and consumption of oxygen with declining serum lactate levels (Demling, 2005a). Factors associated with increased fluid requirements include delayed resuscitation, full-thickness injury, and presence of inhalation injuries. A State-of-the-Science in Burn Care conference was held in 2006 to identify the focus of research in the next decade. Overresuscitation was identified as a high-priority topic along with a need to identify endpoints for resuscitation (Pham, et al., 2008).

#### Fluid Requirements

The projected fluid requirements for the first 24 hours are calculated by the clinician based on the extent of the burn injury. Some combination of fluid categories may be used, including colloids (whole blood, plasma, and plasma expanders) and crystalloids/electrolytes (physiologic sodium chloride or lactated Ringer's solution). Adequate fluid resuscitation results in slightly decreased blood volume levels during the first 24 postburn hours and restoration of plasma levels to normal by the end of 48 hours. Formulas have been developed for estimating fluid loss based on the estimated percentage of burned TBSA and the weight of the patient. TBSA greater than 20% to 25% is associated with increased capillary permeability and intravascular fluid shifts that are most profound in the first 24 hours postburn (Pham, et al., 2008).

Oral and enteral resuscitation can be successful in adults with less than 20% TBSA burned (Atiyeh, Gunn & Hayek, 2005). Intravenous resuscitation is recommended when burn TBSA is greater then 20% (Pham, et al., 2008).

Although there is no consensus on the formulas for resuscitation, currently the most popular formula provides for the volume of an isotonic solution to be administered during the first 24 hours in a range of 2 to 4 mL/kg per percentage of TBSA burned. As with the other formulas, half of the calculated total should be given over the first 8 postburn hours, and the other half should be given over the next 16 hours. The hourly rate and volume of the infusion are modified based on the patient's response (Pham, et al., 2008). Clinicians should take note that the resuscitation formulas serve only as guidelines, and the patient's response to fluid therapy is the best parameter to use (Atiyeh, et al., 2005).

With large burns, there is a failure of the sodium–potassium pump (a physiologic mechanism involved in fluid–electrolyte balance) at the cellular level. Therefore, patients with very large burns may need proportionately more milliliters of fluid per percentage of burn than those with smaller burns. Also, patients with electrical injury, inhalation injury, or delayed fluid resuscitation and those who were burned while intoxicated may need additional fluids.

The following example illustrates the use of the consensus formula in a 70-kg (154-lb) patient with a 50% TBSA burn:

1. Formula: 2 to 4 mL/kg/% TBSA
2. 2 mL × 70 kg × 50 TBSA = 7000 mL/24 h
3. Plan to administer: first 8 hours = 3500 mL, or 437 mL/h; next 16 hours = 3500 mL, or 219 mL/h

Most fluid replacement formulas use isotonic electrolyte solutions. Regardless of which standard replacement formula is used, the patient receives approximately the same fluid volume and sodium replacement during the first 48 hours.

Another fluid replacement method requires hypertonic electrolyte solutions. The goal is to deliver smaller amounts of fluid and maintain the same urine output. Hypertonic resuscitation increases the osmolarity of the blood and encourages a shift of fluid into the intravascular space from the interstitial space. Careful monitoring of serum sodium level is required to prevent hypernatremia and acute renal failure (Pham, et al., 2008).

The use of colloids during resuscitation has been the subject of much controversy. Administration of large volumes of crystalloid during resuscitation decreases the protein content in the blood. Proteins help to prevent the movement of fluid and decrease edema. The purpose of adding colloid to the formula is to decrease the amount of fluid needed and also prevent massive edema formation. In contrast, some clinicians believe that after 24 hours the integrity of the capillaries begins to be restored and the use of colloids during that time would not be advantageous. These theories require further study (Pham, et al., 2008).

> *NURSING ALERT*
>
> **Formulas are only a guide. The patient's response, evidenced by heart rate, blood pressure, and urine output, is the primary determinant of actual fluid therapy and must be assessed at least hourly. Patient outcomes are improved by optimal fluid resuscitation.**

## Nursing Management

Nursing assessment in the emergent phase of burn injury focuses on the major priorities for any trauma patient; the burn wound is a secondary consideration. Aseptic management of the burn wounds and invasive lines continues.

The nurse monitors vital signs frequently. Respiratory status is monitored closely, and apical, carotid, and femoral pulses are evaluated particularly in areas of circumferential burn injury to an extremity. Cardiac monitoring is indicated initially or if the patient has a history of cardiac disease, electrical injury, or respiratory conditions.

If all extremities are burned, determining blood pressure may be difficult. A sterile dressing applied under the blood pressure cuff protects the wound from contamination. Because increasing edema makes blood pressure difficult to auscultate, a Doppler (ultrasound) device or a noninvasive electronic blood pressure device may be helpful. In patients with severe burns, an arterial catheter is used for blood pressure measurement and for collecting blood specimens. Peripheral pulses of burned extremities are checked hourly; the Doppler device is useful for this. Elevation of burned upper extremities above the level of the heart is crucial to decrease edema. Elevation of the lower extremities on pillows and of the upper extremities on pillows or by suspension using IV poles may be helpful.

Large-bore IV catheters and an indwelling urinary catheter are inserted, if not already in place, and the nurse's assessment includes monitoring of fluid intake and output. Urine output, an indicator of renal perfusion, is monitored carefully and measured hourly. The amount of urine first obtained when the urinary catheter was inserted is recorded. This may assist in determining the extent of preburn renal function and fluid status.

Burgundy-colored urine suggests the presence of hemochromogen and myoglobin resulting from muscle damage. This is associated with deep burns caused by electrical injury or prolonged contact with flames. Glycosuria, a common finding in the early postburn hours, results from the release of stored glucose from the liver in response to stress.

Although not responsible for prescribing the fluids the nurse should be able to calculate the patient's expected fluid requirements. Infusion pumps are used to deliver a complex regimen of IV fluids prescribed. Administering and monitoring IV therapy are major nursing responsibilities. Strict monitoring of fluid intake and output is essential during the resuscitative phase along with reporting laboratory values and reporting patient responses to the physician.

Body temperature, body weight, preburn weight, and history of allergies, tetanus immunization, past medical and surgical disorders, current illnesses, and a list of current medications are essential to help guide medication needs for the patient. A head-to-toe assessment is performed, focusing on signs and symptoms of concomitant illness, associated injury, or developing complications. If the patient has facial burns, his or her eyes should be examined for injury to the corneas. An ophthalmologist is consulted for complete assessment via fluorescent staining.

Assessing the extent of the burn wound continues and is facilitated with anatomic diagrams (described previously). In addition, the nurse works with the physician to assess the depth of the wound and areas of full-thickness and partial-thickness injury. Assessment of the circumstances surrounding the injury is important. Obtaining a history of the burn injury can help in planning the care for the patient. Assessment should include the time of injury, mechanism of burn, whether the burn occurred in a closed space, the possibility of inhalation of noxious chemicals, and any related trauma. The neurologic assessment focuses on the patient's level of consciousness, psychological status, pain and anxiety levels, and behavior.

The patient's and family's understanding of the injury and treatment is assessed as well. A family meeting upon admission is helpful to explain the detail of the patient's injuries and the course of treatment. Ethical dilemmas, such as those discussed in Chart 57-4, may also occur during hospitalization.

Nursing care of the patient during the emergent/resuscitative phase of burn injury is detailed in the plan of nursing care in Chart 57-5.

### Gerontologic Considerations

Comorbid conditions coupled with the burn injury contribute to the high mortality rates of patients 65 years and older. Demling (2005b) reported that more than 60% of elderly patients with burn injuries admitted to the hospital had moderate to severe protein–energy malnutrition, which contributed to an increase in infection compared with well-nourished elderly burn patients. Decreased function of the cardiovascular, renal, and pulmonary systems increases the need for close observation of elderly patients with even relatively minor burns during the emergent and acute phases. Acute renal failure is much more common in elderly patients than in those younger than 40 years of age. The margin of difference between hypovolemia and fluid overload is very small. Suppressed immunologic response, a high incidence of malnutrition, and an inability to withstand metabolic stressors (eg, a cold environment) further compromise the elderly person's ability to heal. As a result of these issues in elderly patients who sustain burn injury, close monitoring and prompt treatment of complications are mandatory.

## ACUTE/INTERMEDIATE PHASE

The acute/intermediate phase of burn care follows the emergent/resuscitative phase and begins 48 to 72 hours after the burn injury. During this phase, attention is directed toward continued assessment and maintenance of respiratory and circulatory status, fluid and electrolyte balance, and GI function. Infection prevention, burn wound care (ie, wound cleaning, topical antibacterial therapy, wound dressing, dressing changes, wound débridement, and wound grafting), pain management, and nutritional support are priorities at this stage and are discussed in detail in the following sections.

### Medical Management

Airway obstruction caused by upper airway edema can take as long as 48 hours to develop. Changes detected by x-ray and arterial blood gas analysis may occur as the effects of resuscitative fluid and the chemical reactions of smoke ingredients with lung tissues become apparent. Pulmonary complications are not unusual in burn injury. Those with ventilator-associated pneumonia (VAP) have a 40% mortality rate, increasing to 60% to 77% for VAP with an inhalation injury. Bronchial washing or bronchioalveolar lavage can assist in the diagnosis and treatment of pneumonia (Wahl, Ahrns, Brandt, et al., 2005). Ideally, the best practice

CHART 57-4

## Ethics and Related Issues

### How Much Is Enough and What Is Comfort Care?

**Situation**

A 71-year-old woman was flown to the nearest burn center. She lives alone and was cooking on top of a gas stove. She reached over the burner and caught her robe on fire. The flame consumed most of her upper body. She sustained a full-thickness burn to 42% of her body (face, neck, both arms, and chest). In addition, she turned to remove herself from the room quickly, slipped, and fell, fracturing two ribs and spraining her right ankle. Due to the nature of the fire she was enclosed in a burning area so she also sustained an upper airway inhalation injury. She was awake and alert at the scene and indicated a past medical history of diabetes, hypertension, and renal disease. She was in little pain at the time due to the depth of the burn injury; however, she was asking the team questions related to the survivability of her injury, "Am I going to die?"

Upon admission she was intubated to treat her upper airway edema and suspected inhalation injury. Family arrived and the burn surgeon explained the extent of injury. A decision was made to proceed with care and assess her progress postresuscitation. They were prepared for a future decision regarding withdrawal of care if survival becomes futile.

**Dilemma**

Initial resuscitation has occurred and approximately 4 days postburn the patient begins to show signs of renal failure. She has had one surgical procedure for débridement and grafting to her chest, and although grafts are intact, they do not look healthy. She is showing increased signs of discomfort and pain due to the operative procedure and the addition of another wound (the new donor site). The family decides in a team meeting that they do not want to initiate hemodialysis and therefore place the patient on comfort measures. Approximately 3 days later she remains on comfort care and has increased signs of restlessness and pain. The nurse caring for the patient requests an order from the physician for an increase in pain medication from 5 mg morphine to 10 mg IV. Within 2 hours after administration the patient expired without discomfort. Six months later the facility is contacted by an attorney and informed that the family is taking legal action against the nurse and physician for performing euthanasia on their mother.

**Discussion**

The burn team is faced with these types of ethical dilemmas on a regular basis. Whenever possible the team should attempt to elicit the patient's wishes as early as possible, including any advanced directives. This should be considered again prior to intubation unless it is an emergency situation. The problem in this case is that due to absence of pain it is often difficult for a patient to understand the severity of his or her burn injury. The patient begins to experience increased pain as care progresses and increased medication is expected. Once the patient is unable to make decisions for herself, family members assume this responsibility. Clear and documented discussions with the family are essential for communication. Decision makers should always make decisions based on what the patient would want them to do, not their individual concerns. They often have difficulty making comfort care decisions; not all family members always agree. If death does not occur rapidly after a decision, they have feelings of remorse and guilt.

**Discussion Questions**

1. As a member of the team when the patient arrived at your facility, what would you have done differently?
2. Do you believe this was a survivable injury?
3. Given the failing renal status of the patient, do you believe additional medication should have been administered?
4. Do you believe there is reason for the family to seek legal action for their mother's death?

is to remove the endotracheal tube as soon as possible so that a route for pathogens is not accessible to the lungs. The arterial blood gas values and other parameters determine the need for intubation and mechanical ventilation.

As capillaries regain integrity, 48 or more hours after the burn, fluid moves from the interstitial to the intravascular compartment and diuresis begins (Table 57-4). If cardiac or renal function is inadequate, for example in an elderly patient or in a patient with preexisting cardiac disease, fluid overload occurs and symptoms of congestive heart failure may result (see Chapter 30).

Cautious administration of fluids and electrolytes continues during this phase of burn care because of the shifts in fluid from the interstitial to the intravascular compartment, losses of fluid from large burn wounds, and the patient's physiologic responses to the burn injury. Blood components are administered as needed to treat blood loss and anemia.

Fever is common in patients after burn shock resolves. A resetting of the core body temperature in severely burned patients results in a body temperature a few degrees higher than normal for several weeks after the burn. Bacteremia and septicemia also cause fever in many patients. Acetaminophen (Tylenol) and hypothermia blankets and ancillary heating devices may be required to maintain body temperature in a range of 37.2°C to 38.3°C (99°F to 101°F) so as to reduce metabolic stress and tissue oxygen demand.

**Table 57-4 FLUID AND ELECTROLYTE CHANGES IN THE ACUTE PHASE**

Fluid remobilization phase (state of diuresis)
Interstitial fluid → plasma

| Observation | Explanation |
|---|---|
| Hemodilution (decreased hematocrit) | Blood cell concentration is diluted as fluid enters the intravascular compartment; loss of red blood cells destroyed at burn site. |
| Increased urinary output | Fluid shift into intravascular compartment increases renal blood flow and causes increased urine formation. |
| Sodium ($Na^+$) deficit | With diuresis, sodium is lost with water; existing serum sodium is diluted by water influx. |
| Potassium ($K^+$) deficit (occurs occasionally in this phase) | Beginning on the fourth or fifth postburn day, $K^+$ shifts from extracellular fluid into cells. |
| Metabolic acidosis | Loss of sodium depletes fixed base; relative carbon dioxide content increases. |

CHART 57-5

## PLAN OF NURSING CARE
### *Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury*

**NURSING DIAGNOSIS:** Impaired gas exchange related to carbon monoxide poisoning, smoke inhalation, and upper airway obstruction
**GOAL:** Maintenance of adequate tissue oxygenation

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Provide humidified oxygen. | 1. Humidified oxygen provides moisture to injured tissues; supplemental oxygen increases alveolar oxygenation. | • Absence of dyspnea<br>• Respiratory rate between 12 and 20 breaths/min<br>• Lungs clear on auscultation<br>• Arterial oxygen saturation greater than 96% by pulse oximetry<br>• Arterial blood gas levels within normal limits |
| 2. Assess breath sounds, and respiratory rate, rhythm, depth, and symmetry. Monitor patient for signs of hypoxia. | 2. These factors provide baseline data for further assessment and evidence of increasing respiratory compromise. | |
| 3. Observe for the following:<br>a. Erythema or blistering of lips or buccal mucosa<br>b. Singed nostrils<br>c. Burns of face, neck, or chest<br>d. Increasing hoarseness<br>e. Soot in sputum or tracheal tissue in respiratory secretions | 3. These signs indicate possible inhalation injury and risk of respiratory dysfunction. | |
| 4. Monitor arterial blood gas values, pulse oximetry readings, and carboxyhemoglobin levels. | 4. Increasing $PaCO_2$ and decreasing $PaO_2$ and $O_2$ saturation may indicate need for mechanical ventilation. | |
| 5. Report labored respirations, decreased depth of respirations, or signs of hypoxia to physician immediately. | 5. Immediate intervention is indicated for respiratory difficulty. | |
| 6. Prepare to assist with intubation and escharotomies. | 6. Intubation allows mechanical ventilation. Escharotomy enables chest excursion in circumferential chest burns. | |
| 7. Monitor mechanically ventilated patient closely. | 7. Monitoring allows early detection of decreasing respiratory status or complications of mechanical ventilation. | |

**NURSING DIAGNOSIS:** Ineffective airway clearance related to edema and effects of smoke inhalation
**GOAL:** Maintain patent airway and adequate airway clearance

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Maintain patent airway through proper patient positioning, removal of secretions, and artificial airway if needed. | 1. A patent airway is crucial to respiration. | • Patent airway<br>• Respiratory secretions are minimal, colorless, and thin<br>• Respiratory rate, pattern, and breath sounds normal |
| 2. Provide humidified oxygen. | 2. Humidity liquefies secretions and facilitates expectoration. | |
| 3. Encourage patient to turn, cough, and deep breathe. Encourage patient to use incentive spirometry. Suction as needed. | 3. These activities promote mobilization and removal of secretions. | |

**NURSING DIAGNOSIS:** Fluid volume deficit related to increased capillary permeability and evaporative losses from the burn wound
**GOAL:** Restoration of optimal fluid and electrolyte balance and perfusion of vital organs

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| 1. Observe vital signs (including central venous pressure or pulmonary artery pressure, if indicated) and urine output, and be alert for signs of hypovolemia or fluid overload. | 1. Hypovolemia is a major risk immediately after the burn injury. Overresuscitation might cause fluid overload. | • Serum electrolytes within normal limits<br>• Urine output between 0.5 and 1.0 mL/kg/h<br>• Blood pressure higher than 90/60 mm Hg<br>• Heart rate less than 120 beats/min<br>• Exhibits clear sensorium<br>• Voids clear yellow urine with specific gravity within normal limits |
| 2. Monitor urine output at least hourly and weigh patient daily. | 2. Output and weight provide information about renal perfusion, adequacy of fluid replacement, and fluid requirement and fluid status. | |

*Continued on following page*

CHART 57-5

PLAN OF NURSING CARE

## Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Maintain IV lines and regulate fluids at appropriate rates, as prescribed. | 3. Adequate fluids are necessary to maintain fluid and electrolyte balance and perfusion of vital organs. | |
| 4. Observe for symptoms of deficiency or excess of serum sodium, potassium, calcium, phosphorus, and bicarbonate. | 4. Rapid shifts in fluid and electrolyte status are possible in the postburn period. | |
| 5. Elevate head of patient's bed and elevate burned extremities. | 5. Elevation promotes venous return. | |
| 6. Notify physician immediately of decreased urine output, blood pressure, central venous, pulmonary artery, or pulmonary artery wedge pressures, or increased pulse rate. | 6. Because of the rapid fluid shifts in burn shock, fluid deficit must be detected early so that distributive shock does not occur. | |

**NURSING DIAGNOSIS:** Hypothermia related to loss of skin microcirculation and open wounds
**GOAL:** Maintenance of adequate body temperature

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Provide a warm environment through use of heat shield, space blanket, heat lights, or blankets. | 1. A stable environment minimizes evaporative heat loss. | • Body temperature remains 36.1°C to 38.3°C (97°F to 101°F)<br>• Absence of chills or shivering |
| 2. Work quickly when wounds must be exposed. | 2. Minimal exposure minimizes heat loss from wound. | |
| 3. Assess core body temperature frequently. | 3. Frequent temperature assessments help detect developing hypothermia. | |

**NURSING DIAGNOSIS:** Pain related to tissue and nerve injury and emotional impact of injury
**GOAL:** Control of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Use pain intensity scale to assess pain level (ie, 1 to 10). Differentiate restlessness due to pain from restlessness due to hypoxia. | 1. Pain level provides baseline for evaluating effectiveness of pain relief measures. Hypoxia can cause similar signs and must be ruled out before analgesic medication is administered. | • States pain level is decreased<br>• Absence of nonverbal cues of pain |
| 2. Administer intravenous opioid analgesics as prescribed. Observe for respiratory depression in the patient who is not mechanically ventilated. Assess response to analgesic. | 2. Intravenous administration is necessary because of altered tissue perfusion from burn injury. | |
| 3. Provide emotional support and reassurance. | 3. Emotional support is essential to reduce fear and anxiety resulting from burn injury. Fear and anxiety increase the perception of pain. | |

**NURSING DIAGNOSIS:** Anxiety related to fear and the emotional impact of burn injury
**GOAL:** Minimization of patient's and family's anxiety

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's and family's understanding of burn injury, coping skills, and family dynamics. | 1. Previous successful coping strategies can be fostered for use in the present crisis. Assessment allows planning of individualized interventions. | • Patient and family verbalize understanding of emergent burn care<br>• Able to answer simple questions |
| 2. Individualize responses to the patient's and family's coping level. | 2. Reactions to burn injury are extremely variable. Interventions must be appropriate to the patient's and family's present level of coping. | |

*Continued*

CHART 57-5

PLAN OF NURSING CARE

## Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Explain all procedures to the patient and the family in clear, simple terms. | 3. Increased understanding alleviates fear of the unknown. High levels of anxiety may interfere with understanding of complex explanations. | |
| 4. Maintain adequate pain relief. | 4. Pain increases anxiety. | |
| 5. Consider administering prescribed antianxiety medications if the patient remains extremely anxious despite nonpharmacologic interventions. | 5. Anxiety levels during the emergent phase may exceed the patient's coping abilities. Medication decreases physiologic and psychological anxiety responses. | |

**COLLABORATIVE PROBLEMS:** Acute respiratory failure, distributive shock, acute renal failure, compartment syndrome, paralytic ileus, Curling's ulcer
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Acute Respiratory Failure** | | |
| 1. Assess for increasing dyspnea, stridor, changes in respiratory patterns. | 1. Such signs reflect deteriorating respiratory status. | • Arterial blood gas values within acceptable limits: $PaO_2$ greater than 80 mm Hg, $PaCO_2$ less than 50 mm Hg<br>• Breathes spontaneously with adequate tidal volume<br>• Chest x-ray findings normal<br>• Absence of cerebral signs of hypoxia |
| 2. Monitor pulse oximetry, arterial blood gas values for decreasing $PaO_2$ and oxygen saturation, and increasing $PaCO_2$. | 2. Such signs reflect decreased oxygenation status. | |
| 3. Monitor chest x-ray results. | 3. X-ray may disclose pulmonary injury. | |
| 4. Assess for restlessness, confusion, difficulty attending to questions, or decreasing level of consciousness. | 4. Such manifestations may indicate cerebral hypoxia. | |
| 5. Report deteriorating respiratory status immediately to physician. | 5. Acute respiratory failure is life-threatening, and immediate intervention is required. | |
| 6. Prepare to assist with intubation or escharotomies as indicated. | 6. Intubation allows mechanical ventilation. Escharotomies allow improved chest excursion with respirations. | |
| **Distributive Shock** | | |
| 1. Assess for decreasing urine output and blood pressure as well as increasing pulse rate. (If hemodynamic monitoring is used, assess for decreasing pulmonary artery and pulmonary artery wedge pressures and cardiac output.) | 1. Such signs and symptoms may indicate distributive shock and inadequate intravascular volume. | • Urine output between 0.5 and 1.0 mL/kg/h<br>• Blood pressure within patient's normal range (usually greater than 90/60 mm Hg)<br>• Heart rate within patient's normal range (usually less than110/min)<br>• Pressures and cardiac output remain within normal limits |
| 2. Assess for progressive edema as fluid shifts occur. | 2. As fluid shifts into the interstitial spaces in burn shock, edema occurs and may compromise tissue perfusion. | |
| 3. Adjust fluid resuscitation in collaboration with the physician in response to physiologic findings. | 3. Optimal fluid resuscitation prevents distributive shock and improves patient outcomes. | |
| **Acute Renal Failure** | | |
| 1. Monitor urine output and blood urea nitrogen (BUN) and serum creatinine levels. | 1. These values reflect renal function. | • Adequate urine output<br>• BUN and serum creatinine values remain normal |
| 2. Report decreased urine output or increased BUN and creatinine values to physician. | 2. These laboratory values indicate possible renal failure. | |
| 3. Assess urine for hemoglobin or myoglobin. | 3. Hemoglobin or myoglobin in the urine points to an increased risk of renal failure. | |

*Continued on following page*

CHART 57-5 PLAN OF NURSING CARE

**Care of the Patient During the Emergent/Resuscitative Phase of Burn Injury** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 4. Administer increased fluids as prescribed. | 4. Fluids help to flush hemoglobin and myoglobin from renal tubules, decreasing the potential for renal failure. | |
| **Compartment Syndrome** | | |
| 1. Assess peripheral pulses hourly with Doppler ultrasound device. | 1. Assessment with Doppler device substitutes for auscultation and indicates characteristics of arterial blood flow. | • Absence of paresthesias or symptoms of ischemia of nerves and muscles<br>• Peripheral pulses detectable by Doppler |
| 2. Assess warmth, capillary refill, sensation, and movement of extremity hourly. Compare affected with unaffected extremity. | 2. These assessments indicate characteristics of peripheral perfusion. | |
| 3. Remove blood pressure cuff after each reading. | 3. Cuff may act as a tourniquet as extremities swell. | |
| 4. Elevate burned extremities. | 4. Elevation reduces edema formation. | |
| 5. Report loss of pulse or sensation or presence of pain to physician immediately. | 5. These signs and symptoms may indicate inadequate tissue perfusion. | |
| 6. Prepare to assist with escharotomies. | 6. Escharotomies relieve the constriction caused by swelling under circumferential burns and improve tissue perfusion. | |
| **Paralytic Ileus** | | |
| 1. Maintain nasogastric tube on low intermittent suction until bowel sounds resume. | 1. This measure relieves gastric and abdominal distention, also prevents vomiting. | • Absence of abdominal distention<br>• Normal bowel sounds within 48 hours |
| 2. Auscultate for bowel sounds, abdominal distention. | 2. As bowel sounds resume, feeding may be slowly initiated. Abdominal distention reflects inadequate decompression. | |
| **Curling's Ulcer** | | |
| 1. Assess gastric aspirate for pH and blood. | 1. Acidic pH indicates need for antacids or histamine blockers. Blood indicates possible gastric bleeding. | • Absence of abdominal distention<br>• Normal bowel sounds within 48 hours<br>• Gastric aspirate and stools do not contain blood |
| 2. Assess stools for occult blood. | 2. Blood in stools may indicate gastric or duodenal ulcer. | |
| 3. Administer histamine blockers and antacids as prescribed. | 3. Such medications reduce gastric acidity and risk of ulceration. | |

Central venous, peripheral arterial, or pulmonary artery thermodilution catheters may be required for monitoring venous and arterial pressures, pulmonary artery pressures, pulmonary capillary wedge pressures, or cardiac output. It is not uncommon for patients with major burns to have multiple invasive line sites due to the amount and frequency of fluid and medication that need to be administered. Whenever possible, burned areas of the body are avoided as sites for insertion of invasive lines.

### *Infection Prevention*

Infection progressing to sepsis is the major cause of death in patients who have survived the first few days after a major burn. Burn patients are at risk for infection for a few reasons. The loss of skin removes their ability to protect themselves from the environment. The longer length of stay in the hospital predisposes them to hospital-associated infections. The number and frequency of invasive procedures, both in the patient room and in the operating room, increase the risk of infection. Lastly, immunosuppression that accompanies extensive burn injury places patients at high risk. The nursing goal is to provide protection and safety in the patients' environment to ultimately prevent or control infection in the burn population (Hodle, Richter & Thompson, 2006).

The burn wound is an excellent medium for bacterial growth and proliferation. The burn eschar is nonviable tissue and has no blood supply; therefore, neither leukocytes or antibodies nor systemic antibiotics can reach the area. More than 1 billion bacteria per gram of tissue may

be present and subsequently spread to the bloodstream or release their toxins, which reach distant sites. *Pseudomonas* is the major challenge in 44% of burn centers. Other common organisms are methicillin-resistant *Staphylococcus aureus* (MRSA) and *Acinetobacter*. Important but somewhat less common are *Staphylococcus* and vancomycin-resistant enterococci (VRE) (Hodle, et al., 2006). *Staphylococcus* and *Enterococci* are responsible for more than 50% of nosocomial bloodstream infections in patients with burn injuries. Other bacteria that are important in burn care include *Proteus, Escherichia coli,* and *Klebsiella*. Bloodstream infections are confirmed if two positive blood cultures are obtained or if one positive culture is obtained in the presence of clinical signs of sepsis (Greenhalgh, 2007). Fungi such as *Candida albicans* also grow easily in burn wounds.

Infection impedes burn wound healing by promoting excessive inflammation and damaging tissue. When the burn wound is healing through spontaneous reepithelialization or is being prepared for skin grafting, it must be protected from sepsis. Characteristics of burn wound sepsis are $10^5$ bacteria per gram of tissue, inflammation or destruction of unburned skin, and invasive infection with or without signs of sepsis (Greenhalgh, 2007).

A primary source of bacterial infection is the patient's intestinal tract, the source of most microbes. The intestinal mucosa normally serves as a barrier to keep the internal environment free from a variety of pathogens. After a severe burn injury, the intestinal mucosa becomes markedly permeable (Gosain & Gamelli, 2005b), allowing microbial flora and endotoxins to pass freely into the systemic circulation and causing infection. Early enteral feeding is one strategy to help avoid increased intestinal permeability and prevent early endotoxin translocation (De-Souza & Greene, 2005).

A major secondary source of pathogenic microbes is the environment. Compliance with infection-control policies has been identified as the single greatest challenge along with the abundance of resistant organisms (Hodle, et al., 2006). Burn centers are designed with specific measures to reduce the risk of infection: private rooms and bathrooms; increased airflow within patient rooms to create a more positive airflow; low humidification to prevent bacterial growth; limited use of cloth (eg, patient privacy curtains, window treatments); accessibility of proper protective equipment such as caps, masks, gowns and gloves; convenient and available hand washing/hand hygiene areas; and room design with antidust and dirt collection areas.

Use of cap, gown, mask, and gloves is essential while caring for the patient with open burn wounds. Aseptic technique is used when caring directly for burn wounds. Gowns and gloves are worn by all caregivers and visitors; hand hygiene is used before and after leaving the patient room. Special instruction is given to all visitors with the goal of preventing the spread of infection because of the immunosuppression experienced by patients with burns.

Bacteria are found on all skin surfaces; by itself, their presence does not determine burn infection. Constant monitoring and observation of the wound (eg, changes in the wound, presence of purulent drainage, pain, and increasing depth of burn wound) are needed to detect wound infection. Tissue specimens may be obtained for culture to monitor colonization (Greenhalgh, 2007). Antibiotics are seldom prescribed prophylactically because of the risk of promoting resistant strains of bacteria. Systemic antibiotics are administered when there is documented burn wound sepsis or other positive cultures such as urine, sputum, or blood. Sensitivity of the organisms to the prescribed antibiotics should be determined before administration. Careful attention is paid to antibiotic use in the burn unit because inappropriate use of antibiotics significantly affects the microbial flora present in the burn unit and increases the risk of drug resistance.

### *Wound Cleaning*

Various measures are used to clean the burn wound, such as **hydrotherapy.** If the patient is ambulatory, the wounds can be cleansed in a shower. The wounds of nonambulatory patients can be cleansed using shower carts—mobile stretchers made with removable sides, drainage holes, and positioning capabilities. Retractable shower hoses suspended from walls and ceilings provide the nurse with easy access to a water source for washing the wounds. Unstable patients may have their wounds washed at the bedside. Total immersion hydrotherapy is rarely performed. Because of the high risk for infection and sepsis, the use of plastic liners, water filters, and thorough decontamination of hydrotherapy equipment and wound care areas is required to prevent cross-contamination. The temperature of the water is maintained at 37.8°C (100°F), and the temperature of the room should be maintained between 26.6°C and 29.4°C (80°F to 85°F). The duration of wound cleansing and dressing change is determined by the patient's ability to tolerate the treatment and to maintain a satisfactory body temperature.

During the bath, the patient is encouraged to be as active as possible. Hydrotherapy provides an excellent opportunity for exercising the extremities and cleaning the entire body. When the patient is removed, any residue adhering to the body is washed away with a clear water spray or shower. Unburned areas, including the hair, must be washed regularly as well. At the time of wound cleaning, all skin is inspected for any hints of redness, breakdown, or local infection. Hair in and around the burn area, except the eyebrows, should be clipped short or shaved. Intact blisters should be left alone and débrided only if they rupture or break.

Conscientious management of the burn wound is essential. When nonviable loose skin is removed, aseptic conditions must be established. Wound cleansing is usually performed daily in wound areas that are not undergoing surgical intervention. Mechanical débridement can be performed to remove loose nonviable tissue. However, surgical removal as soon as possible is preferred.

After the burn wounds are cleaned, they are gently patted dry, and the prescribed method of wound care is performed. Whatever the method is used, the goal is to protect the wound from overwhelming proliferation of pathogenic organisms and invasion of deeper tissues until either spontaneous healing or skin grafting can be achieved.

Patient comfort and ability to participate in the prescribed treatment are also important considerations. During the treatment, the patient is assessed for signs of chilling, fatigue, changes in hemodynamic status, and pain unrelieved by analgesic medications or relaxation techniques.

### *Topical Antibacterial Therapy*

Variations in topical wound care for nonsurgical burn wounds exist among burn centers across the country and choices are made based on the individualized needs of each patient. There is general agreement that some form of antimicrobial therapy applied to the burn wound is an acceptable method of local care in extensive burn injury. Silver sulfadiazine is considered the gold standard for protecting wounds from infection (Caruso, Foster, Blome-Eberwein, et al., 2006). Topical antibacterial therapy becomes more important in the deep dermal and full-thickness injury because they are more prone to infection. Silver has been introduced into a variety of topical treatments because of its broad spectrum effectiveness against *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Pham & Gibran, 2007). The goal of topical therapy is to provide a dressing that

- Is effective against gram-positive and gram-negative organisms and fungi,
- Penetrates the eschar but is not systemically toxic,
- Does not lose effectiveness or allow another infection to develop,
- Is cost-effective, available, and acceptable to the patient,
- Is easy to apply and remove, and decreases the frequency of dressing changes, decreases pain, and minimizes nursing time.

Table 57-5 describes three commonly used topical agents, silver sulfadiazine (Silvadene), silver nitrate, and mafenide acetate (Sulfamylon), two of which contain silver. Many other topical agents are available, including povidone–iodine ointment 10% (Betadine), gentamicin sulfate, nitrofurazone (Furacin), Dakin's solution, acetic acid, and antifungal agents (miconazole, clotrimazole, and mupirocin [Bactroban]). Bacitracin or a triple antibiotic agent may be used for facial burns or on skin grafts initially.

No single topical medication is universally effective, and use of different agents at different times in the postburn period may be necessary. Prudent use and alternation of antimicrobial agents result in less-resistant strains of bacteria, greater effectiveness of the agents, and a decreased risk of sepsis.

**Table 57-5 OVERVIEW OF SELECTED TOPICAL ANTIBACTERIAL AGENTS USED FOR BURN WOUNDS**

| Agent | Indication/Comment | Application | Nursing Implications |
|---|---|---|---|
| Silver sulfadiazine 1% (Silvadene) water-soluble cream | • Most bactericidal agent<br>• Minimal penetration of eschar | Apply 1⁄16-inch layer of cream with a sterile glove 1–3 times daily. | • Watch for leukopenia 2–3 days after initiation of therapy. (Leukopenia usually resolves within 2–3 days.)<br>• Anticipate formation of pseudo-eschar (proteinaceous gel), which is removed easily after 72 hours. |
| Mafenide acetate 5% to 10% (Sulfamylon) hydrophilic-based cream | • Effective against gram-negative and gram-positive organisms<br>• Diffuses rapidly through eschar<br>• In 10% strength, it is the agent of choice for electrical burns because of its ability to penetrate thick eschar | Apply thin layer with sterile glove twice a day and leave open as prescribed; if the wound is dressed, change the dressing every 6 hours as prescribed. | • Monitor arterial blood gas levels and discontinue as prescribed, if acidosis occurs. Mafenide acetate is a strong carbonic anhydrase inhibitor that may reduce renal buffering and cause metabolic acidosis.<br>• Premedicate the patient with an analgesic before applying mafenide acetate because this agent causes severe burning pain for up to 20 minutes after application. |
| Silver nitrate 0.5% aqueous solution | • Bacteriostatic and fungicidal<br>• Does not penetrate eschar | Apply solution to gauze dressing and place over wound. Keep the dressing wet but covered with dry gauze and dry blankets to decrease vaporization.<br>Remoisten every 2 hours, and redress wound twice a day. | • Monitor serum sodium ($Na^+$) and potassium ($K^+$) levels and replace as prescribed. Silver nitrate solution is hypotonic and acts as wick for sodium and potassium.<br>• Protect bed linen and clothing from contact with silver nitrate, which stains everything it touches black. |
| Acticoat | • Effective against gram-negative and gram-positive organisms and some yeasts and molds<br>• Delivers a uniform, antimicrobial concentration of silver to the burn wound | Moisten with sterile water only (never use normal saline). Apply directly to wound. Cover with absorbent secondary dressing. Remoisten every 3–4 hours with sterile water. | • Do not use oil-based products or topical antimicrobials with Acticoat burn dressing. Keep Acticoat moist, not saturated. May produce a "pseudo-eschar" from silver after application.<br>• Can be left in place for 3–5 days. Also available in Acticoat 7, which can be left in place for up to 7 days without the need to change the dressing. |

### Wound Dressing

After wound cleaning, the burned areas are patted dry and the prescribed topical agent is applied; the wound is then covered with several layers of dressings. A light dressing is used over joint areas to allow for motion (unless the particular area has a graft and motion is contraindicated). A light dressing is also applied over areas for which a splint has been designed to conform to the body contour for proper positioning. Circumferential dressings should be applied distally to proximally. If the hand or foot is burned, the fingers and toes should be wrapped individually to promote adequate healing.

Burns to the face may be left open to air once they have been cleaned and the topical agent has been applied. Careful attention must be given to ensure that the topical agent does not interfere with the eyes or mouth. A light dressing can be applied to the face to absorb excess exudates that might run into the eyes, causing irritation.

Occlusive dressings may be used over areas with new skin grafts to protect the graft and promote an optimal condition for its adherence to the recipient site. An occlusive dressing is a thin gauze that is impregnated with a topical antimicrobial agent or is applied after application of a topical antimicrobial agent. Ideally, these dressings remain in place for 3 to 5 days, at which time they are removed for examination of the graft. When occlusive dressings are applied, precautions are taken to prevent two body surfaces from touching, such as fingers or toes, ear and scalp, the areas under the breasts, any point of flexion, or between the genital folds. Functional body alignment positions are maintained by using splints or by regular repositioning of the patient.

**NURSING ALERT**

**Dressings impede circulation if they are too tightly wrapped. The peripheral pulses must be checked frequently and burned extremities elevated on two pillows. Extremities are always wrapped from distal to proximal to the heart. If the patient's pulse is diminished, this is a critical situation and must be addressed immediately.**

Dressings that adhere to the wound can be removed more comfortably and without damaging healing tissue by moistening the wound with tap water. The remaining dressings are carefully and gently removed. The patient may participate in removing the dressings, providing some degree of control over this painful procedure. The wounds are then cleaned and débrided to remove any remaining topical agent, exudate, and dead skin. Sterile scissors and forceps may be used to trim loose eschar and encourage separation of devitalized skin. During this procedure, the wound and surrounding skin are carefully inspected. The color, odor, size, exudate, signs of reepithelialization, and other characteristics of the wound and the eschar and any changes from the previous dressing change are noted.

### Wound Débridement

The goals of, **débridement,** the removal of devitalized tissue, are:

- Removal of tissue contaminated by bacteria and foreign bodies, thereby protecting the patient from invasion of bacteria
- Removal of devitalized tissue or burn eschar in preparation for grafting and wound healing

There are three types of débridement—natural, mechanical, and surgical.

#### Natural Débridement

With natural débridement, the dead tissue separates from the underlying viable tissue spontaneously. Bacteria that are present at the interface of the burned tissue and the viable tissue underneath gradually liquefy the fibrils of **collagen** that hold the eschar in place for the first or second postburn weeks. Proteolytic and other natural enzymes cause this phenomenon. However, use of antibacterial topical agents tends to slow this natural process of eschar separation and slows the healing process.

#### Mechanical Débridement

Mechanical débridement involves the use of surgical scissors, scalpels, and forceps to separate and remove the eschar. This technique can be performed by skilled physicians, nurses, or physical therapists and is usually done with daily dressing changes. If bleeding occurs, hemostatic agents or pressure can be used to stop the bleeding from small vessels. Wet-to-dry dressings are not advocated in burn care because of the chance of removing viable cells along with necrotic tissue. Dressing changes alone aid the removal of wound debris.

#### Chemical Débridement

Topical enzymatic débridement agents are available to promote débridement of the burn wounds. Because such agents usually do not have antimicrobial properties, they should be used together with topical antibacterial therapy to protect the patient from bacterial invasion. Heavy metals such as silver deactivate the débriding agent; therefore, caution is necessary to ensure that the débriding agent does not interfere with the topical antimicrobial agent. Separate dressings are used to prevent this from occurring.

#### Surgical Débridement

Early surgical excision to remove devitalized tissue along with early burn wound closure is now recognized as one of the most important factors contributing to survival in a patient with a major burn injury. Aggressive surgical wound closure has reduced the incidence of burn wound sepsis, thus improving survival rates (Burke, 2005). Early excision is carried out before the natural separation of eschar is allowed to occur.

Surgical débridement is an operative procedure involving either primary **excision** (surgical removal of tissue) of the full thickness of the skin down to the fascia (tangential excision) or shaving of the burned skin layers gradually down to freely bleeding, viable tissue. Surgical excision is initiated early in burn wound management. This may be performed within the first few days after the burn or as soon as the patient is hemodynamically stable and edema has decreased. Ideally, the wound is then covered immediately with a skin graft, if needed, and an occlusive dressing. If the wound bed is not ready for a skin graft at the time of excision, a temporary biologic dressing may be used until a skin graft can be applied during subsequent surgery.

The use of surgical excision carries with it risks and complications, especially with large burns. The procedure creates a high risk of extensive blood loss (as much as 100 to 125 mL of blood per percentage of body surface excised) and lengthy operating and anesthesia times. However, when conducted in a timely and efficient manner, surgical excision results in shorter hospital stays and possibly a decreased risk of complications from invasive burn wound sepsis.

### Gerontologic Considerations

Eschar separation in full-thickness burns is typically delayed in elderly patients, and older patients are frequently poor risks for surgical excision. For these reasons, prolonged hospitalization, immobilization, and associated problems are common. If the elderly patient can tolerate surgery, early excision with skin grafting is the treatment of choice because it decreases the mortality rate in this population. If the patient is not a surgical candidate, chemical débridement is often chosen to enhance the removal of eschar over time. Prevention of complications of prolonged hospitalization, immobility, and surgery is essential in the care of the elderly burn patient.

## Wound Grafting

The patient with deep partial-thickness or full-thickness burns may be a candidate for skin grafting. If so, temporary coverage of the burn wound is necessary until coverage with a graft of the patient's own skin (**autograft**) is possible. The purposes of wound coverage are to decrease the risk of infection; prevent further loss of protein, fluid, and electrolytes through the wound; and minimize heat loss through evaporation. Several methods of wound coverage are available; some are temporary until grafting with permanent coverage is possible. Wound coverage may consist of biologic, biosynthetic, synthetic, and autologous methods or a combination of these approaches.

The main areas for skin grafting include the face (for cosmetic and psychological reasons); functional areas, such as the hands and feet; and areas that involve joints. Grafting permits earlier functional ability and reduces wound **contractures.** When burns are very extensive, the order in which areas are grafted is chosen based on the ability to achieve wound closure as soon as possible, and, therefore, the chest and abdomen or back may be grafted first to reduce the burn surface.

Granulation tissue fills the space created by the wound, creates a barrier to bacteria, and serves as a bed for epithelial cell growth. Richly vascular granulation tissue is pink, firm, shiny, and free of exudate and debris. It should have a bacterial count of less than 100,000/g of tissue to optimize graft success. If the wound is not ready for skin grafting, the burn wound is excised and allowed to granulate. Once the wound is excised, a wound covering is applied to keep the wound bed moist and promote the granulation process.

### Biologic Dressings (Homografts and Heterografts)

Biologic dressings have several uses. In extensive burns, they provide temporary wound coverage and protect the granulation tissue until autografting is possible. Biologic dressings are commonly used in patients with large areas of burn and little remaining normal skin for donor sites. They can be used as a test graft in preparation for the patient's own skin graft to determine if the bed will accept the graft. Once the biologic dressing appears to be "taking," or adhering to the granulating surface with minimal underlying exudation, the patient is ready for an autologous skin graft.

Biologic dressings also provide temporary immediate coverage for clean, superficial burns and decrease the wound's evaporative water and protein loss. They decrease pain by protecting nerve endings and are an effective barrier against water loss and entry of bacteria. When applied to superficial partial-thickness wounds, they seem to speed healing. Biologic materials can be left open or covered. They stay in place for varying lengths of time but are removed in instances of infection or rejection. Another advantage for the patient is that these dressings often require fewer dressing changes, therefore, decreasing pain. They can also be used in the outpatient environment.

Biologic dressings consist of **homografts** (or allografts) and **heterografts** (or xenografts). Homografts are skin obtained from living or recently deceased humans. Heterografts consist of skin taken from animals (usually pigs). Most biologic dressings are used as temporary coverings of burn wounds and are eventually rejected because of the body's immune reaction to them as foreign.

Homografts tend to be the most expensive biologic dressings. They are available from skin banks in fresh and cryopreserved (frozen) forms. Homografts are thought to provide the best infection control of all the biologic or biosynthetic dressings available. Revascularization occurs within 48 hours, and the graft may be left in place for several weeks.

Pigskin is available from commercial suppliers. It is available fresh, frozen, or lyophilized (freeze dried) for longer shelf life. Pigskin is used for temporary covering of clean wounds such as superficial partial-thickness wounds and donor sites. Although pigskin does not vascularize, it does adhere to clean superficial wounds and provides excellent pain control while the underlying wound epithelializes (Atiyeh, et al., 2005).

### Biosynthetic and Synthetic Dressings

Problems with availability, sterility, and cost have prompted the search for biosynthetic and synthetic skin substitutes, which may eventually replace biologic dressings as temporary wound coverings. A widely used synthetic dressing is **Biobrane,** which is composed of a nylon, silastic membrane combined with a collagen derivative. The material is semitransparent and sterile. It has an indefinite shelf life and is less costly than homograft or pigskin. Like biologic dressings, Biobrane protects the wound from fluid loss and bacterial invasion (Fig. 57-4).

Biobrane adheres to the wound fibrin, which binds to the nylon–collagen material. Within 5 days, cells migrate into the nylon mesh. In general, adherence to the wound surface correlates directly with low bacterial counts. When the Biobrane dressing adheres to the wound, the wound remains stable. Biobrane can remain in place until spontaneous epithelialization and wound healing occur. It can be laid on top of a wide-meshed autograft to protect the wound until the autograft epithelium grows out to close the interstices. As the Biobrane gradually separates, it is trimmed, leaving a healed wound.

Another temporary wound covering is BCG Matrix. This dressing combines beta-glucan, a complex carbohydrate, with collagen in a meshed reinforced wound dressing. Beta-glucan is known to stimulate macrophages, which are vital in the inflammatory process of healing. BCG Matrix is



**Figure 57-4** Biobrane dressing for partial-thickness burn wound. Biobrane dressing applied to a clean wound bed on the hand. Used with permission. Lehigh Valley Health Network, Allentown, PA.

a temporary wound covering intended for use with partial-thickness burns and donor sites. It is applied immediately after cleaning and débridement. If the burn wound surface remains free of infection, BCG Matrix can be left in place until healing is complete (Atiyeh, et al., 2005).

Several other synthetic dressings are available for burn wound care. Op-Site, a thin, transparent, polyurethane elastic film, can be used to cover clean partial-thickness wounds and donor sites. This dressing is occlusive and waterproof but permeable to water vapor and air; this permeability not only provides protection from microbial contamination but also allows for the exchange of gases, which occurs much more quickly in a moist environment. Other synthetic dressings used for burn wounds include Tegaderm, N-Terface, and DuoDerm.

### Skin Substitutes

In an attempt to develop the ideal burn wound covering product, skin substitutes have been created that surgically replace the epidermis and the dermis. It is believed that skin substitutes enhance the healing process of an open wound when autologous skin is unavailable or limited for use. These products are often the choice when donor sites are inadequate or unavailable.

A **cultured epithelial autograft (CEA)** provides permanent coverage of large wounds when harvesting of skin for autografting is not an option. This involves a biopsy of the patient's skin in an unburned area. Keratinocytes are isolated, and epithelial cells are cultured in a laboratory. The original epithelial cell reproduces multiple plated sheets of CEA to cover an already surgically excised wound. These cells are then attached to the burn wound surface, and extreme care is taken until they have adhered to the wound surface. Varying degrees of success have been reported and results are encouraging. However, the disadvantages of the CEA are that the grafts are thin and fragile and can shear easily. Patients have longer hospital stays and higher hospital costs and require more surgical procedures than those treated by traditional methods. In addition, patients require more reconstructive procedures in the first 1 to 2 years after injury. Therefore, CEA use is very limited and is reserved for burn patients whose donor sites are limited (Pham & Gibran, 2007).

Two dermal substitutes are **Integra** Artificial Skin and **AlloDerm**. Artificial skin (Integra) is the newest type of dermal substitute (Fig. 57-5). A dermal analogue, Integra is

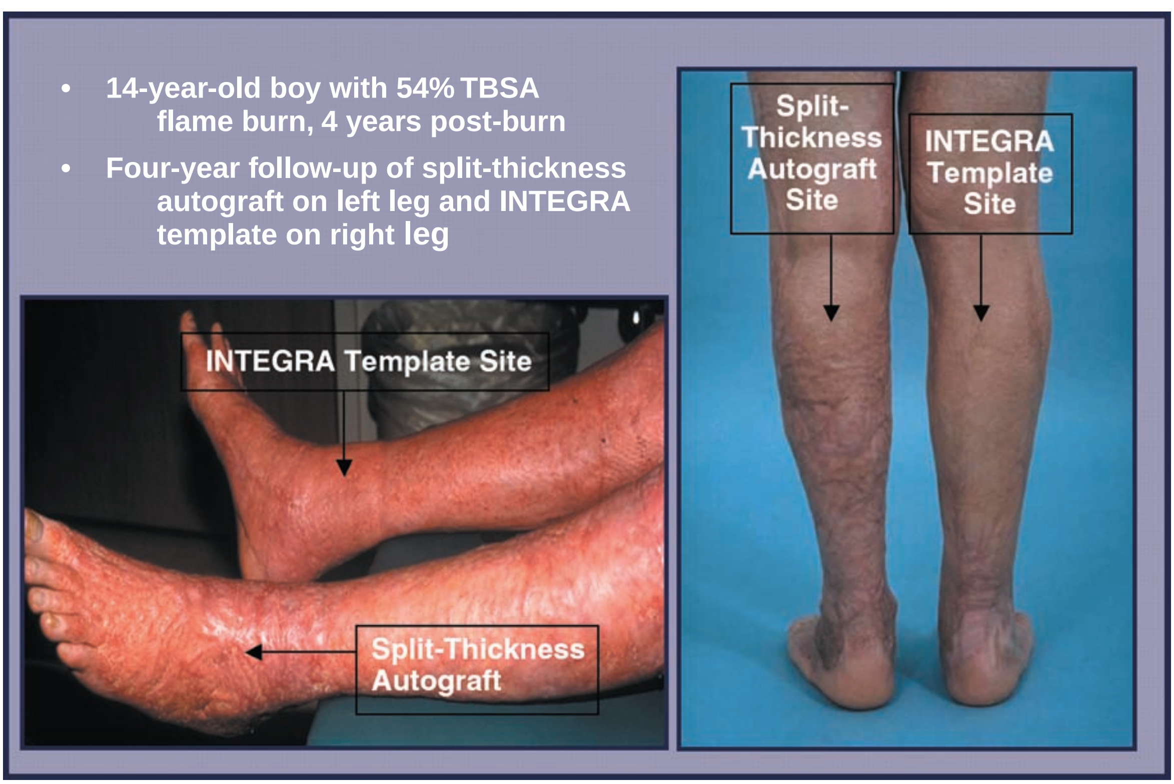



**Figure 57-5** Comparison of Integra template site (*right leg*) to split-thickness autograft site (*left leg*). Used with permission from Glenn Warden, MD.

composed of two main layers. The epidermal layer, consisting of silicone, acts as a bacterial barrier and prevents water loss from the dermis. The dermal layer is composed of animal collagen. It interfaces with the open wound surface and allows migration of fibroblasts and capillaries into the material. This "neodermis" becomes a permanent structure. The artificial dermis is biodegraded and reabsorbed. The outer silicone membrane is removed 2 weeks after application and is replaced with the patient's own skin in the form of a thin epidermal skin graft. When a thinner autologous donor graft is used, donor site healing is quicker. Long-term effects of Integra include minimal contracture formation. The graft site is very pliable, almost eliminating the need for repeated cosmetic surgery. Most important, Integra has resulted in less hypertrophic scarring, thus reducing the need for compression devices once the burn wound has healed. Because Integra allows for earlier excision and coverage of the burn wound, metabolic demands of the patient are reduced. Integra allows for the increased survivability of patients with large burn injuries and improves the functional and cosmetic qualities of the healed burns. The combination of Integra with cultured skin substitutes has demonstrated promise in burn management (Pham & Gibran, 2007).

Another promising dermal substitute is AlloDerm. It is processed dermis from human cadaver skin, which can be used as the dermal layer for skin grafts. When a **donor site** (the area from which skin is taken to provide a skin graft for another part of the body) is harvested for an autologous skin graft, both the epidermal and the dermal layers of skin are removed from the donor site. AlloDerm provides a permanent dermal layer replacement. Its use allows the burn surgeon to harvest a thinner skin graft, consisting of the epidermal layer only. The patient's epidermal layer is placed directly over the dermal base (AlloDerm). The new graft is then treated according to the burn unit's protocol. Use of AlloDerm has also resulted in less scarring and contractures with healed grafts; donor sites heal more quickly than conventional donor sites because only the epidermal layer has been harvested. This is important when donor sites are limited because of extensive burns (Boyce, Greenhalgh, Palmieri, et al., 2006; Pham & Gibran, 2007).

### Autografts

Autografts remain the preferred material for definitive burn wound closure after excision. Autografts are the ideal means of covering burn wounds because the grafts are the patient's own skin and therefore are not rejected by the patient's immune system. They can be split-thickness (Fig. 57-6), full-thickness, pedicle flaps, or epithelial grafts. Full-thickness autografts and pedicle flaps are commonly used for reconstructive surgery, which may take place months or years after the initial injury.

Split-thickness autografts can be applied in sheets or they can be expanded by meshing so that they cover 1.5 to 9 times more than a given donor site area. Skin meshers enable the surgeon to cut tiny slits into a sheet of donor skin, making it possible to cover large areas with smaller amounts of donor skin. These expanded grafts adhere to the recipient site more easily than sheet grafts and prevent the accumulation of blood, serum, air, or purulent material under the graft. However, any kind of graft other than a sheet graft contributes to scar formation as it heals. Use of expanded grafts may be necessary in large wounds but should be viewed as a compromise in terms of cosmesis.



**Figure 57-6** Healed split-thickness skin graft to the chest and upper extremity. Used with permission. Lehigh Valley Health Network, Allentown, PA.

If blood, serum, air, fat, or necrotic tissue lies between the recipient site and the graft, there may be partial or total loss of the graft. Infection or mishandling of the graft and trauma during dressing changes account for most other instances of graft loss. Use of split-thickness grafts allows the remaining donor site to retain sweat glands and hair follicles and minimizes donor site healing time.

***Care of the Graft Site.*** Protection is the key goal of caring for skin grafts postoperatively. Occlusive dressings are commonly used initially after grafting to immobilize the graft. Occupational therapists may be helpful in constructing splints to immobilize newly grafted areas to prevent dislodging of the graft. Homografts, heterografts, or synthetic dressings may also be used to protect grafts.

The first dressing change is usually performed 2 to 5 days after surgery, or earlier in the case of clinical signs of infection, purulent drainage, or a foul odor. Infection, bleeding beneath the graft, and shearing force are the most common reasons for graft loss in the early postoperative period.

The patient is positioned and turned carefully to avoid disturbing the graft or putting pressure on the graft site. If an extremity has been grafted, it is elevated to minimize edema. The patient begins exercising the grafted area 5 to 7 days after grafting.

***Care of the Donor Site.*** Donor sites are clean new wounds that are usually very painful. Caregivers need to recognize this additional source of pain and possible site of infection. Since the donor site is a clean wound created in a surgical environment, it should heal easily unless other complications exist. A moist gauze dressing is applied at the time of surgery to maintain pressure and to stop any oozing. After the donor skin is excised, a thrombostatic agent such as thrombin or epinephrine may be applied directly to the site. The donor site may be covered in several ways, from single-

layer gauze impregnated with petrolatum, scarlet red, or bismuth to new biosynthetic dressings such as Biobrane or BCG Matrix. Acticoat can also be used as a dressing on donor sites. With all types of covering, donor sites must remain clean, dry, and free from pressure. Because a donor site is a partial-thickness wound, it is very painful and will heal spontaneously within 7 to 14 days with proper care.

### Pain Management

The ability to quantify pain may be difficult in any patient; however, the patient who has experienced a burn has many additional challenges. A burn injury is considered one of the most painful types of trauma that a patient can endure. The nature of the injury requires multiple procedures, débridement, surgery and treatments. All of these experiences vary in length and intensity, therefore creating variations in sensation. Additional pain occurs with each skin graft because a new painful donor site is created. In addition, moving, changing position, and receiving occupational and physical therapy cause addition discomfort. This is a constantly changing source of pain throughout the entire healing process, and to the patient it appears to be never ending. Therefore, the pain management plan for any patient needs to be flexible, evaluated regularly using standardized scales, and individualized to meet the patient's needs (Faucher & Furukawa, 2006, Connor-Ballard, 2009a, 2009b).

The American Burn Association's guidelines for pain management are: there must be an organized approach to pain management that addresses background, procedural, and breakthrough pain; the goal should be for patients to be comfortable and alert; and pain needs to be differentiated from anxiety (Faucher & Furukawa, 2006).

Background pain is a continuous level of discomfort even when the patient is inactive or not undergoing any procedures. The goal of treatment is to provide a long-acting analgesic that will provide even coverage for this long-term discomfort. It is helpful to use escalating doses when initiating the medication to reach the level of pain control that is acceptable to the patient. The use of patient-controlled analgesia (PCA) gives control to the patient and achieves this goal. Breakthrough pain is described as acute, intense, and episodic pain. It is generally related to an activity or movement of the affected area. Short-acting agents are used to achieve pain control in addition to the baseline treatment the patient receives for background pain. Procedural pain is discomfort that occurs with procedures such as daily wound treatments, invasive line insertions, physical and occupational therapy. The goal is to plan proper sedation that will place the patient in a state of comfort throughout the procedure. Depending on the agent, an anesthesia provider can be helpful in achievement of pain relief (Faucher & Furukawa, 2006).

Most severe burns are a combination of partial-thickness and full-thickness burns and the depth influences the amount of pain the patient experiences. Superficial and deep partial-thickness burns are very painful because the nerve endings are exposed, resulting in excruciating pain with exposure to temperature, pressure, and movement. In a full-thickness burn the nerve endings are destroyed, and upon admission there is numbness and decreased sensation to the area. Thus, severe injuries are often underestimated by the patient because the pain at that time is minimal. Educating patients and their families about burn pain and its relationship to the depth of injury as well as the pain management plan is an important priority for the nurse.

The pharmacologic treatment for the management of burn pain includes the use of opioids, nonsteroidal anti-inflammatory drugs (NASIDs), anxiolytics, and anesthetic agents. These and other pain management strategies are discussed in Chapter 13. Treatment of anxiety with benzodiazepines is used along with opioids to achieve both a pain-free and anxiety-free experience. The use of anesthetics in a nonoperative setting (ie, moderate sedation) requires administration by qualified personnel. Recent advances include the use of agents with rapid onset and short duration, which have been very effective in pain control during a planned procedure (Faucher & Furukawa, 2006).

Nonpharmacologic pain control can be achieved by using relaxation techniques, distraction, guided imagery, hypnosis, therapeutic touch, humor, music therapy, and more recently virtual reality techniques (see Chapter 13). These techniques can be used either alone or in conjunction with medications to achieve an acceptable level of comfort for the burn patient (Hansen, Gauld, Wathen, et al., 2008).

### Nutritional Support

Burn injuries produce profound metabolic abnormalities fueled by the exaggerated stress response to the injury. The body's response has been classified as hyperdynamic, hypermetabolic, and hypercatabolic. Hypermetabolism can affect morbidity and mortality by increasing the risk for infection and slowing the healing rate. Patients' metabolic demands vary with the extent of the burn injury and age (Demling, 2005b). Hypermetabolism is evident immediately after a burn injury. The degree of the response depends on the size of the burn and the patient's age, body composition, size, and genetic response to insult (Jeschke, Chinkes, Finnerty, et al., 2008). Persistent hypermetabolism may last up to 1 year after burn injury.

Major metabolic abnormalities after a burn injury include increased catabolic hormones (cortisol and catechols); decreased anabolic hormones (human growth factor and testosterone); a marked increase in the metabolic rate; a sustained increase in body temperature; a marked increase in glucose demands; rapid skeletal muscle breakdown with amino acids serving as the energy source; lack of ketosis, indicating that fat is not a major source of calories; and catabolism that does not respond to nutrient intake (Pereira, Murphy & Herndon, 2005). Therefore, it is essential to control the stress response by increasing the anabolic process through adequate nutrition and increased muscle activity, decreasing heat loss from wounds, and maintaining a warm environment. Controlling secondary stressors, such as pain and anxiety, also helps control the stress response.

The most important nutritional intervention is to provide energy and nutrients for prevention of infection and promotion of wound healing (Wolfe, 2007). Healing of the burn wound consumes large quantities of energy. Patients with burns greater than 40% TBSA have resting metabolic rates twice that of normal (Pereira, et al., 2005). Effective nutrition management depends on how well the energy

expenditure due to the burn injury can be estimated and matched with appropriate amounts of micronutrients, carbohydrates, lipids, and protein. The nutritional support required is based on the patient's preburn status and the TBSA burned.

Several formulas exist for estimating the daily metabolic expenditure and caloric requirements of patients with burn injuries. The most commonly used formulas are the Harris-Benedict equation, which determines basal energy requirements based on activity and burn size, Ireton-Jones formula, and the Modified Schoefield (Masters & Wood, 2008). Protein requirements may range from 2.0 to 3.0 g of protein per kilogram of body weight every 24 hours, which is 15% to 25% of the caloric intake. Although variation exists, most burn centers use a low fat and high carbohydrate enteral feeding, approximately 55% to 85% carbohydrate and 3% to 20% fat. Carbohydrates are included to meet caloric requirements and to spare protein, which is essential for wound healing. The patient may also receive added vitamins and minerals in excess of the normal requirements (Masters & Wood, 2008).

Feeding usually begins immediately or at least within 24 to 72 hours postburn injury. Nutrition can be administered either by the enteral or parenteral route, or a combination of both. The goal is to reach the patient's nutritional needs, which are usually in proportion to the burn size. These feedings are continued until the patient can adequately consume the recommended daily requirements by mouth (Wolfe, 2007). When the oral route is used, high-protein, high-calorie meals and supplements are given. Dietary consultations are useful in helping patients meet their nutritional needs. Daily calorie counts aid in assessing the adequacy of nutritional intake.

Patients lose a great deal of weight during recovery from severe burns. Reserve fat deposits are catabolized, fluids are lost, and caloric intake may be limited. Because a burn injury decreases the patient's resistance to infection and disease, the nutritional status must be improved and maintained even though the patient has a poor appetite and is weak. One goal of nutrition management is to decrease or stop the catabolic process and promote protein anabolism.

In addition, research is focused on aggressive alteration of the hyperglycemic response and administration of insulin therapy to promote wound healing. Other treatment modalities include early excision and skin grafting of the burn wound, aggressive prevention or treatment of infections, and adequate exercise with physical therapy to lessen muscle wasting and increase strength. Additional pharmacologic modalities used to alter the hypermetabolic state of burn injury include the use of oxandrolone (Oxandrin), an anabolic steroid; an adrenergic antagonist (propranolol [Indural]); and the anabolic protein, recombinant human growth hormone (Pereira, et al., 2005).

Indications for parenteral nutrition include weight loss greater than 10% of normal body weight, inadequate intake of enteral nutrition due to clinical status, prolonged wound exposure, and malnutrition or debilitated condition before injury. The risk of infection at the site of the central venous catheter required for parenteral nutrition must be considered.

## Nursing Management

Continued assessment of the patient during the early weeks after the burn injury focuses on hemodynamic alterations, wound healing, pain and psychosocial responses, and early detection of complications. Assessment of respiratory and fluid status remains the highest priority for detection of potential complications.

The nurse assesses vital signs frequently. Continued assessment of peripheral pulses is essential for the first few postburn days while edema continues to increase, potentially damaging peripheral nerves and restricting blood flow. Close observation of the hourly fluid intake and urinary output as well as blood pressure and cardiac rhythm is essential during this phase and changes should be reported to the burn surgeon promptly.

The patient with an inhalation injury will require regular monitoring of level of consciousness, pulmonary function, and ability to ventilate. When inadequate ventilation and airway edema require the patient to be intubated and placed on a ventilator, frequent suctioning and assessment of the airway are priorities.

### *Restoring Normal Fluid Balance*

To reduce the risk of fluid overload and consequent heart failure and pulmonary edema, the nurse closely monitors IV and oral fluid intake, using IV infusion pumps to minimize the risk of rapid fluid infusion. To monitor changes in fluid status, careful intake and output and daily weights are obtained. Changes, including those of blood pressure and pulse rate, are reported to the physician (invasive hemodynamic monitoring is avoided because of the high risk of infection).

### *Preventing Infection*

A major part of the nurse's role during the acute phase of burn care is detection and prevention of infection. The nurse is responsible for providing a clean and safe environment and for closely scrutinizing the burn wound to detect early signs of infection. Culture results and white blood cell counts are monitored.

Aseptic technique is used for wound care procedures. Sterile technique is used for any invasive procedures, such as insertion of IV lines and urinary catheters or tracheal suctioning. Meticulous hand hygiene before and after each patient contact is also an essential component of preventing infection, even though gloves are worn to provide care.

The nurse protects the patient from sources of contamination, including other patients, staff members, visitors, and equipment. Invasive lines and tubing must be routinely changed according to recommendations of the CDC. Tube feeding reservoirs, ventilator circuits, and drainage containers are replaced regularly. Fresh flowers, plants, and fresh fruit baskets are not permitted in the patient's room because of the risk of microorganism growth. Visitors are screened to avoid exposure of the immunocompromised patient to pathogens.

Patients can inadvertently promote migration of microorganisms from one burned area to another by touching their wounds or dressings. Bed linens also can spread infection through either colonization with wound microorgan-

isms or fecal contamination. Regular bathing of unburned areas and changing of linens can help prevent infection.

### Maintaining Adequate Nutrition

Oral fluids should be initiated slowly after bowel sounds resume. The patient's tolerance is recorded. If vomiting and distention do not occur, fluids may be increased gradually and the patient may be advanced to a normal diet or to tube feedings.

The nurse collaborates with the dietitian or nutrition support team to plan a protein- and calorie-rich diet that is acceptable to the patient. Family members may be encouraged to bring nutritious and favorite foods to the hospital. High-calorie nutritional supplements such as Ensure and Resource may be provided. Caloric intake must be documented. Vitamin and mineral supplements may be prescribed.

If caloric goals cannot be met by oral feeding, a feeding tube is inserted and used for continuous or bolus feedings of specific formulas. The volume of residual gastric secretions should be checked to ensure absorption.

The patient should be weighed each day and the results graphed. The patient can use this information to set goals for nutritional intake and to monitor weight loss and gain. Ideally, the patient will lose no more than 5% of preburn weight if aggressive nutritional management is implemented.

### Promoting Skin Integrity

Wound care is usually the single most time-consuming element of burn care after the emergent phase. The physician prescribes the desired topical antibacterial agents and specific biologic, biosynthetic, or synthetic wound coverings and plans for surgical excision and grafting. The nurse needs to make astute assessments of wound status, use creative approaches to wound dressing, and support the patient during the emotionally distressing and very painful experience of wound care.

Assessment of the burn wound requires an experienced eye, hand, and sense of smell. Important wound assessment features include size, color, odor, eschar, exudate, epithelial buds (small pearl-like clusters of cells on the wound surface), bleeding, granulation tissue, the status of graft take, healing of the donor site, and the condition of the surrounding skin. Any significant changes in the wound are reported to the physician because they usually indicate burn infection and require immediate intervention.

A diagram, updated daily by the nurse responsible for the patient's care, helps inform all those concerned about the latest wound care procedures in use for the patient.

The nurse also assists the patient and family by providing instruction, support, and encouragement to take an active part in dressing changes and wound care when appropriate. Discharge planning needs for wound care are anticipated early in the course of burn management, and the strengths of the patient and family are assessed and used in preparing for the patient's eventual discharge and home care.

### Relieving Pain and Discomfort

Pain measures are continued during the acute phase of burn recovery. Analgesic agents and anxiolytic medications are administered as prescribed. Frequent assessment of pain and discomfort is essential. To increase its effectiveness, analgesic medication is provided before the pain becomes severe. Nursing interventions such as teaching the patient relaxation techniques, giving the patient some control over wound care and analgesia, and providing frequent reassurance are helpful. Guided imagery and distraction (eg, video programs or video games) can be used to alter the patient's perceptions of and responses to pain. Other pain-relieving approaches include hypnosis, music therapy, and virtual reality.

The nurse assesses the patient's sleep patterns daily. Lack of sleep and rest interferes with healing, comfort, and restoration of energy. If necessary, sedatives are prescribed on a regular basis in addition to analgesics and anxiolytics.

The nurse works quickly to complete treatments and dressing changes to reduce pain and discomfort. The patient is encouraged to take analgesic medications before painful procedures. The patient's response to the medication and other interventions is assessed and documented.

Healing burn wounds are typically described by patients as itchy and tight. Oral antipruritic agents, a cool environment, frequent lubrication of the skin with water or a silica-based lotion, exercise and splinting to prevent skin contracture, and diversional activities all help promote comfort in this phase.

### Promoting Physical Mobility

An early priority is to prevent complications of immobility. Deep breathing, turning, and proper positioning are essential nursing practices that prevent atelectasis and pneumonia, control edema, and prevent pressure ulcers and contractures. These interventions are modified to meet the patient's needs. Low-air-loss and rotation beds may be useful, and early sitting and ambulation are encouraged. If the lower extremities are burned, elastic pressure bandages should be applied before the patient is placed in an upright position. These bandages promote venous return and minimize edema formation. Prevention of deep vein thrombosis (DVT) is an important factor in care. Patients with burn injuries are at high risk because of their hypercoagulability, loss of vascular integrity, immobility, multiple invasive lines and need for other operative procedures. In fact, there is a 1% to 23% incidence of DVT in burn patients documented. There is cautious use of heparin due to the bleeding potential; however, most burn centers use prophylactic therapy including sequential graduated compression devices in the high-risk groups (Faucher & Conlon, 2007).

The burn wound is in a dynamic state for at least 1 year after wound closure. During this time, aggressive efforts must be made to prevent contracture and hypertrophic scarring. Both passive and active range-of-motion exercises are initiated from the day of admission and are continued after grafting, within prescribed limitations. Splints or functional devices may be applied to the extremities for contracture control. The nurse monitors the splinted areas for signs of vascular insufficiency, nerve compression, and skin breakdown. Occupational and physical therapists are consulted to develop a patient-specific plan of care throughout hospitalization and recovery.

### Strengthening Coping Strategies

In the acute phase of burn care, the patient is facing the reality of the burn injury and is grieving over obvious losses. Depression, anger, regression, and manipulative behavior

are common responses of patients who have burn injuries. Withdrawal from participation in required treatments and regression must be viewed with an understanding that such behavior may help the patient cope with an enormously stressful event. Although most patients recover emotionally from a burn injury, some have more difficult psychological reactions to the injury and its outcomes (Kildal, Willebrand, Andersson, et al., 2004). There is evidence that psychological distress and depression are common in people who have experienced burns; however, more studies are needed in this area (Fauerbach, Pruzinsky & Saxe, 2007).

Difficulty coping along with other psychological stressors often limits the patient's physical and psychological recovery (Fauerbach, Lezotte, Hills, et al., 2005). Patients who experience a burn injury tend to have high rates of involvement in risky behaviors (eg, alcohol and substance abuse, depression) before the injury (Appleby, 2005). Intrusive thoughts of the burn event and reliving it over and over may also occur and can indicate posttraumatic stress disorder (PTSD).

Much of the patient's energy goes into maintaining vital physical functions and wound healing in the early postburn weeks, leaving little emotional energy for coping in a more effective manner. The nurse can assist the patient to develop effective coping strategies by setting specific expectations for behavior, promoting truthful communication to build trust, helping the patient practice appropriate strategies, and giving positive reinforcement when appropriate.

The patient frequently vents feelings of anger. At times the anger may be directed inward because of a sense of guilt, perhaps for causing the fire or even for surviving when loved ones perished. The anger may be directed outward toward those who escaped unharmed or toward those who are now providing care. One way to help the patient handle these emotions is to enlist someone to whom the patient can vent feelings without fear of retaliation. A nurse, social worker, psychiatric liaison nurse, or spiritual advisor or counselor who is not involved in direct care activities may fill this role successfully.

Patients with burn injuries are very dependent on health care team members during the long period of treatment and recovery. However, even when physically unable to contribute much to self-care, they should be included in decisions regarding care and encouraged to assert their individuality in terms of preferences and recognition of their unique identities. As the patient improves in mobility and strength, the nurse works with the patient to set realistic expectations for self-care, including self-feeding, assistance with wound care procedures, exercise, and planning for the future. Many patients respond positively to the use of contractual agreements and other strategies that recognize their independence and their specific role as part of the health care team moving toward the goal of self-care. Consultation with psychiatric/mental health care providers may be helpful to assist the patient in developing effective coping strategies.

### *Supporting Patient and Family Processes*

Family functioning is disrupted with burn injury. One of the nurse's responsibilities is to support the patient and family and to address their spoken and unspoken concerns. Family members need to be instructed about ways that they can support the patient as adaptation to burn trauma occurs. The family also needs support from the health care team. The burn injury has tremendous psychological, economic, and practical impact on the patient and family. Referrals for social services or psychological counseling should be made as appropriate. This support continues into the rehabilitation phase. Some burn centers offer a peer support program that involves a burn survivor visiting the patient while hospitalized to provide support. Many survivors enjoy the opportunity to help others through this experience.

Patients who experience major burns are commonly sent to burn centers far from home. Because burn injuries are sudden and unexpected, family roles are disrupted. Therefore, both the patient and the family need thorough information about the patient's burn care and expected course of treatment. Patient and family education begins at the initiation of burn management. Barriers to learning are assessed and considered in teaching. The preferred learning styles of both the patient and family are assessed. This information is used to tailor teaching activities. The nurse assesses the ability of the patient and family to grasp and cope with the information. Verbal information is supplemented with videos, models, or printed materials if available. Patient and family education is a priority in the acute and rehabilitation phases.

Nurses must remain sensitive to the possibility of changing family dynamics. It is not unusual for the provider in the family to be the one who is injured. Roles begin to change, which adds more stress to the family. In addition, families are often relocated due to loss of property from the fire. Social services play an integral part in providing support at this time.

### *Monitoring and Managing Potential Complications*

#### Heart Failure and Pulmonary Edema

The patient is assessed for fluid overload, which may occur as fluid is mobilized from the interstitial compartment back into the intravascular compartment. If the cardiac and renal systems cannot compensate for the excess vascular volume, heart failure and pulmonary edema may result. The patient is assessed for signs of heart failure, including decreased cardiac output, oliguria, jugular vein distention, edema, and the onset of an $S_3$ or $S_4$ heart sound. If invasive hemodynamic monitoring is used, increasing central venous, pulmonary artery, and wedge pressures indicate increased fluid volume.

Crackles in the lungs and increased difficulty with respiration may indicate a fluid buildup in the lungs, which is reported promptly to the physician. In the meantime, the patient is positioned comfortably, with the head of the bed raised (if not contraindicated because of other treatments or injuries) to promote lung expansion and gas exchange. Management of this complication includes providing supplemental oxygen, administering IV diuretic agents, carefully assessing the patient's response, and providing vasoactive medications, if indicated.

#### Sepsis

The signs of early systemic sepsis are subtle and require a high index of suspicion and very close monitoring of changes in the patient's status. Early signs of sepsis may include increased temperature, increased pulse rate,

widened pulse pressure, and flushed dry skin in unburned areas. As with many observations of the patient with a burn injury, one needs to look for patterns or trends in the data. (See Chapter 15 for a more detailed discussion of septic shock.)

Wound and blood cultures are performed as prescribed, and results are reported to the physician immediately. The nurse also observes for and reports early signs of sepsis and promptly intervenes, administering prescribed IV fluids and antibiotics to prevent septic shock, a complication with a high mortality rate. Antibiotics must be administered as scheduled to maintain proper blood concentrations. Serum antibiotic levels are monitored for evidence of maximal effectiveness, and the patient is monitored for toxic side effects.

#### Acute Respiratory Failure and Acute Respiratory Distress Syndrome

The patient's respiratory status is monitored closely for increased difficulty in breathing, change in respiratory pattern, or onset of adventitious (abnormal) sounds. Typically, at this stage, signs and symptoms of injury to the respiratory tract become apparent. Respiratory failure may follow. As described previously, signs of hypoxia (decreased oxygen to the tissues), decreased breath sounds, wheezing, tachypnea, stridor, and sputum tinged with soot (or in some cases containing sloughed tracheal tissue) are among the many possible findings. Patients receiving mechanical ventilation must be assessed for a decrease in tidal volume and lung compliance. The key sign of the onset of ARDS is hypoxemia while receiving 100% oxygen, with decreased lung compliance and significant shunting. The physician should be notified immediately of deteriorating respiratory status.

Medical management of the patient with acute respiratory failure requires intubation and mechanical ventilation (if not already in use). If ARDS has developed, higher oxygen levels, positive end-expiratory pressure, and pressure support are used with mechanical ventilation to promote gas exchange across the alveolar–capillary membrane (see Chapter 25).

***Visceral Damage.*** The nurse must be alert to signs of necrosis of visceral organs due to electrical injury. Tissues affected are usually located between the entrance and exit wounds of the electrical burn. All patients with electrical burns should undergo cardiac monitoring, with dysrhythmias being reported to the physician. Careful attention must also be paid to signs or reports of pain related to deep muscle ischemia. To minimize the severity of complications, visceral ischemia must be detected as early as possible. In the operating room, the burn surgeon may perform **fasciotomies** to relieve the swelling and ischemia in the muscles and fascia and to promote oxygenation of the injured tissues. Because of the deep incisions involved with fasciotomies, the patient must be monitored carefully for signs of excessive blood loss and hypovolemia.

### *Gerontologic Considerations*

In elderly patients, a careful history of preburn medications and preexisting illnesses is essential. Nursing assessment of the elderly patient with burns should include particular attention to pulmonary function, response to fluid resuscitation, and signs of mental confusion or disorientation. Fever may be absent in the presence of complications such as sepsis. Therefore, surveillance for other signs of infection becomes even more important. Nursing care of the elderly patient with burn injuries promotes early mobilization, aggressive pulmonary care, and attention to preventing complications.

## REHABILITATION PHASE

Rehabilitation begins immediately after the burn has occurred and often extends for years after injury. The emphasis on early rehabilitation cannot be overestimated. In this final phase of care, the focus becomes rehabilitation, reconstruction, and reintegration of the burn survivor (Sheridan, 2007b). In addition, the burn team focuses on late complications (Table 57-6).

Burn rehabilitation is time-consuming and challenging and is very specific to the severity and location of injury as well as the patient's needs and goals. These goals vary based on phase of care and need to be addressed frequently to ensure constant progress. During hospitalization the goals include maintaining range of motion (ROM), preventing contractures through splinting techniques, decreasing edema, and the preventing skin breakdown through proper positioning. As the acute phase comes to a close, patients become more aware of their injuries and the challenges they face. The goals are functional and aimed at activities of daily living such as ambulation and participation in self-care as well as scar management and returning to work or school (Chart 57-6). Occupational and physical therapists are essential to optimizing patient goals and outcomes (Sheridan, 2007b).

### Psychological Support

A patient's outlook, motivation, and support system are important to his or her overall well-being and ability to progress through the rehabilitation phase. There are three basic phases of psychological recovery from a burn injury. During the critical phase, patients often are confused from medication they are taking, but they have an underlying sense of fear, anxiety, and pain. In the acute phase, patients recognize that survival is expected. They have periods of depression due to their awareness of the functional and body image challenges ahead and can recognize all they have lost. Thirty percent of burn patients develop some form of PTSD. The symptoms and psychological responses to traumatic events including PTSD are discussed further in Chapter 7.

The final stage of psychological recovery occurs within 1 to 2 years following discharge. This is an emotional time as the patient and family begin to live with new physical limitations and challenges in relationships. The role of various team members and the support from peer burn survivors during this time cannot be understated (Sheridan, 2007b).

Psychological treatment plans should include a full assessment of these issues and a targeted plan with the appropriate resources to promote the patient's social and vocational reintegration and improved quality of life (Wallis, Renneberg, Ripper, et al., 2006). Burn injuries can have a major impact

**Table 57-6 COMPLICATIONS IN REHABILITATION PHASE OF BURN CARE**

| Complications | Contributing Factors | Interventions |
|---|---|---|
| Neuropathies, peripheral neuropathies, mononeuropathies, multimononeuropathies, nerve entrapment | Electrical injury, large deep burns, improper positioning, edema, scar tissue | Assess peripheral pulses and sensation (neurovascular checks).<br>Prevent edema and pressure by elevation, positioning, and prevention of constricting dressings.<br>Assess splints for proper fit and application.<br>Consult occupational therapy (OT) and physical therapy (PT) for positioning. |
| Heterotopic ossification (abnormal formation of bone in response to soft tissue trauma) | Prolonged immobility | Perform gentle range-of-motion exercises. |
| Hypertrophic scarring | Partial-thickness and full-thickness burns | Keep skin pliable and soft.<br>Apply pressure garments as prescribed.<br>Massage. |
| Contractures | Partial-thickness and full-thickness burns | Maintain position of joints in alignment.<br>Perform gentle range of motion exercises.<br>Consult OT and PT for exercises and positioning recommendations. |
| Wound breakdown | Shearing, pressure, inadequate nutrition | Teach patient about importance of good nutrition.<br>Protect wound from pressure and shearing forces. |
| Gait deviations | Pain, burn wound, donor site, scarring of joints, electrical injury of the brain | Provide adequate pain management.<br>Consult OT and PT.<br>Promote ambulation and mobility training. |
| Complex regional pain syndrome (previous reflex sympathetic dystrophy [RSD]) | Trauma and burns | Provide adequate pain management.<br>Consult OT and PT for exercises.<br>Promote gentle motion of affected extremities. |
| Joint instability | Burn wound, burn scar and contractures | Maintain joint through appropriate application of splints.<br>Monitor joint pinning if indicated.<br>Consult OT and PT. |

on quality of life. Changes in physical activity as well as social and psychological adjustments, such as returning to school and employment status, may be challenging. It is important throughout this process to assess and address the family needs. When one member of a family sustains a major burn injury, the entire family is affected. Separation, feelings of helplessness, loss, and psychological dysfunction may be experienced in varying degrees. Family and friends need support, education, and guidance in assisting the patient to return to their optimal health (Ceranoglu & Stern, 2006).

## CHART 57-6 NURSING RESEARCH PROFILE
### *Life After Burn Injury*

Moi, A. L. & Gjengedal, E. (2008). Life after burn injury: Striving for regained freedom. *Qualitative Health Research, 18*(12), 1621–1630.

#### Purpose

Second only to the patient's survival, the priority of burn care today is optimal quality of life of survivors. The purpose of this study was to identify and describe the meaning of the experience of life after major burn injury.

#### Design

This qualitative study used a phenomenological perspective to describe and explore the meaning that 14 people who survived severe burn injury attributed to the experience. They were recruited from an outpatient clinic at a burn center in Norway. The researchers intentionally recruited participants of both genders (men = 11, women = 4), across a wide age range (19 to 74, with mean age of 46 years), who had experienced different types of burns (flames = 9, electrical injury = 3, scalding = 2), and received different treatments of their burns. In-depth unstructured interviews were conducted 10 to 35 months after the burn injury; the interviews were audiotaped, transcribed, and analyzed using Giorgi's phenomenological method.

#### Findings

The major finding was the effort on the part of participants to regain freedom that included reduced or absent bodily or social restrictions and a meaningful life that was the same as or better than before the injury occurred. The experiences described as supporting this goal included (1) facing the extreme and trying to restore order and minimize damage, (2) having a disrupted life history with the loss of memory that occurred during the immediate postburn period, (3) accepting the unchangeable, and (4) changing what could be changed. Some participants indicated that experiencing and surviving their injury gave them a new view of life and made their lives richer.

#### Nursing Implications

The experience of surviving a severe burn injury is life-altering. The researchers suggest that patients should be given the opportunity to tell their stories and to express their views. Positive feelings and growth on the part of patients should be recognized by burn-care staff, particularly during the later phases of burn care. Patients should be encouraged to share their experiences and views. The researchers also suggest that patients and families be provided with information about what to expect as they move through the phases of burn care.

## Abnormal Wound Healing

Partial-thickness wounds involving the epidermis and superficial dermis tend to heal without scarring. However, deep partial-thickness and full-thickness wounds involving the dermis and subcutaneous tissue heal with varying degrees of scarring due to abnormal healing (Arnt, Dover & Alam, 2006).

Normal scarring occurs in a superficial tissue injury and begins forming within 7 to 10 days postinjury and progresses over the next 6 to 12 months. Abnormal scarring occurs after a longer period of wound healing and forms either hypertrophic or keloid scars.

### Hypertrophic and Keloid Scars

**Hypertrophic scars** form within the boundaries of the initial wound and push outward on the perimeter of the wound. They are common in areas over joints and in the younger population. These scars may be hypopigmented or hyperpigmented (Arnt, et al., 2006).

The scar becomes red (because of its hypervascular nature), raised, and hard. A keloid is an irregularly formed scar that extends beyond the margins of the original wound. They are large, nodular, and ropelike, often causing itching and tenderness. They are more common in dark pigmented skin, uncommon in children and the elderly, and have familial tendencies. Scars occur in all forms and arise in different areas, making some more undesirable than others. Therefore, prevention and treatment is individualized to the patient's needs (Arnt, et al., 2006).

### Prevention and Treatment of Scars

Treatment modalities that are theoretically based on wound healing and scar formation are used to prevent scar contractures and excess hypertrophic tissue. Compression is introduced early in burn wound treatment. Elastic bandage wraps are used initially to help promote adequate circulation, but they can also be used as the first form of compression followed by elasticized tubular bandage until the patient can be measured for a customized garment (Fig. 57-7). Tools of therapy include pressure, use of topical silicone, scar massage, and steroid injections (Sheridan, 2007b). Application of elastic pressure garments loosens collagen bundles and encourages parallel orientation of the collagen to the skin surface. As pressure continues over time, there is a restructuring of the collagen and a decrease in vascularity and cellularity. Although this therapy is somewhat controversial, pressure has shown to be beneficial in controlling scar formation over time. Garments are worn continuously (ie, 23 hours a day). Many areas of the body are difficult to compress due to the contours or location of the injury. Silicone sheets are helpful for these small troublesome areas and are placed beneath the garment to enhance scar compression. Gentle superficial scar massage can be performed with a moisturizer several times a day. This is helpful in smaller areas and is convenient for the patient. The use of steroid injections into the scar may be helpful in areas of scar development, but they are difficult and painful. Pruritus is a common discomfort in the healed burn wound and can last up to 6 months after healing has occurred. It is treated with moisturizers, massage, oral and topical antihistamines, and topical compresses or baths. This is a troublesome part of recovery and requires further research (Sheridan, 2007b).



**Figure 57-7** Pressure garments. Application of pressure garments helps prevent hypertrophic burn scarring. Used with permission of Jobst Institute, Inc., Toledo, OH.

Burn reconstruction is a treatment option after all scars have matured and is discussed within the first few years after injury. This decision requires individualized planning, realistic expectations, and patience. The procedures utilized by the surgeon include contracture release and skin grafting, use of tissue expansion, and skin flaps to cover or reconstruct the defect area (Sheridan, 2007b).

## NURSING PROCESS

### Care of the Patient During the Rehabilitation Phase

#### Assessment

The nurse obtains information about the patient's education level, occupation, leisure activities, cultural background, religion, and family interactions early. The patient's self-concept, mental status, emotional response to the injury and hospitalization, level of intellectual functioning, previous hospitalizations, response to pain and pain relief measures, and sleep pattern are also essential components of a comprehensive assessment. Information about the patient's general self-concept, self-esteem, and coping strategies in the past are valuable in addressing emotional needs.

Ongoing physical assessments related to rehabilitation goals include range of motion of affected joints, functional abilities in activities of daily living, early signs of skin breakdown from splints or positioning devices, evidence of neuropathies (neurologic damage), activity tolerance, and quality or condition of healing skin. The patient's participation in care and ability to demonstrate self-care in such areas as ambulation, eating, wound cleaning, and applying pressure wraps are documented on a regular basis. In addition to these assessment parameters, specific complications and treatments require additional specific assessments; for

example, the patient undergoing primary excision requires postoperative assessment.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, priority nursing diagnoses in the long-term rehabilitation phase of burn care may include the following:

- Activity intolerance related to pain on exercise, limited joint mobility, muscle wasting, and limited endurance
- Disturbed body image related to altered physical appearance and self-concept
- Deficient knowledge about postdischarge home care and recovery needs

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop in the rehabilitation phase include:

- Contractures
- Inadequate psychological adaptation to burn injury

## Planning and Goals

The major goals for the patient include increased participation in activities of daily living; increased understanding of the injury, treatment, and planned follow-up care; adaptation and adjustment to alterations in body image, self-concept, and lifestyle; and absence of complications.

## Nursing Interventions

### *Promoting Activity Tolerance*

Nursing interventions that must be carried out according to a strict regimen and the pain that accompanies movement take their toll on the patient. The patient may become confused and disoriented and lack the energy or motivation to participate optimally in care. The nurse must schedule care in such a way that the patient has periods of uninterrupted sleep. A good time for planned patient rest is after the stress of dressing changes and exercise, while pain interventions and sedatives are still effective. This plan must be communicated to family members and other care providers.

The patient may have insomnia related to frequent nightmares about the burn injury or to other fears and anxieties about the outcome of the injury. The nurse listens to and reassures the patient and administers hypnotic agents, as prescribed, to promote sleep.

Reducing metabolic stress by relieving pain, preventing chilling or fever, and promoting the physical integrity of all body systems help the patient conserve energy for therapeutic activities and wound healing.

The nurse incorporates physical therapy exercises in the patient's care to prevent muscle atrophy and to maintain the mobility required for daily activities. The patient's activity tolerance, strength, and endurance gradually increase if activity occurs over increasingly longer periods. Fatigue, fever, and pain tolerance are monitored and used to determine the amount of activity to be encouraged on a daily basis. Activities such as family visits and recreational or play therapy (eg, video games, radio, television) can provide diversion, improve the patient's outlook, and increase tolerance for physical activity. In elderly patients and those with chronic illnesses and disabilities, rehabilitation must take into account preexisting functional abilities and limitations.

### *Improving Body Image and Self-Concept*

Patients who have survived burn injuries frequently suffer profound losses. These include not only a loss of body image due to disfigurement but also losses of personal property, homes, loved ones, and ability to work. They lack the benefit of anticipatory grief often seen in a patient who is approaching surgery or dealing with the terminal illness of a loved one.

As care progresses, the patient who is recovering from burns becomes aware of daily improvement and begins to exhibit basic concerns: Will I be disfigured or be disabled? How long will I be in the hospital? What about my job and family? Will I ever be independent again? How can I pay for my care? Was my burn the result of my carelessness?

As the patient expresses such concerns, the nurse must take time to listen and to provide realistic support. The nurse can refer the patient to a support group, such as those usually available at regional burn centers or through organizations such as the Phoenix Society (see Resources at the end of the chapter). Through participation in such groups, the patient will meet others with similar experiences and learn coping strategies to help him or her deal with losses. Interaction with other burn survivors allows the patient to see that adaptation to the burn injury is possible. If a support group is not available, visits from other survivors of burn injuries can be helpful to the patient coping with such a traumatic injury.

A major responsibility of the nurse is to constantly assess the patient's psychosocial reactions. Questions to consider include the following: What are the patient's fears and concerns? Does the patient fear loss of control of care, independence, or sanity itself? Is the patient afraid of rejection by family and loved ones? Does he or she fear being unable to cope with pain or physical appearance? Does the patient have concerns about sexuality, including sexual function? Being aware of these anxieties and understanding the basis of the patient's fears enable the nurse to provide support and to cooperate with other members of the health care team in developing a plan to help the patient deal with these feelings. Journaling can be helpful for patients to express themselves and track their progress with psychological healing.

When caring for a patient with a burn injury, the nurse needs to be aware that there are prejudices and misunderstandings in society about those who are viewed as different. Opportunities and accommodations available to others are often denied those who are disfigured. These include social participation, employment, prestige, various roles, and status. The health care team must actively promote a healthy body image and self-concept in patients with burn injuries so that they can accept or challenge others' perceptions of those who are disfigured or disabled. Survivors themselves must show others who they are, how they function, and how they want to be treated.

The nurse can help patients practice their responses to people who may stare or inquire about their injury once

they are discharged from the hospital. The nurse can help patients build self-esteem by recognizing their uniqueness—for example, with small gestures such as providing a birthday cake, combing the patient's hair before visiting hours, giving information about the availability of a cosmetician to enhance appearance, and teaching the patient ways to direct attention away from a disfigured body to the self within. Consultants such as psychologists, social workers, vocational counselors, and teachers are valuable participants in assisting burn patients to regain their self-esteem.

#### *Monitoring and Managing Potential Complications*

**CONTRACTURES.** With early and aggressive physical and occupational therapy, contractures are rarely a long-term complication. However, surgical intervention is indicated if a full range of motion in the burn patient is not achieved. (See Chapter 11 for a discussion of prevention of contractures.)

**IMPAIRED PSYCHOLOGICAL ADAPTATION TO THE BURN INJURY.** Some patients, particularly those with limited coping skills or psychological function or a history of psychiatric problems before the burn injury, may not achieve adequate psychological adaptation to the burn injury. Psychological counseling or psychiatric referral may be made to assess the patient's emotional status, to help the patient develop coping skills, and to intervene if major psychological issues or ineffective coping is identified.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** As the inpatient phase of recovery becomes shorter, the focus of rehabilitative interventions is directed toward outpatient care, home care, or care in a rehabilitation center. Throughout the phases of burn care, efforts are made to prepare the patient and family for the care that will continue at home. They are instructed about the measures and procedures that they will need to perform. For example, patients commonly have small areas of clean, open wounds that are healing slowly. They are instructed to wash these areas daily with mild soap and water and to apply the prescribed topical agent or dressing.

In addition to instructions about wound care, patients and families require careful written and verbal instructions about pain management, nutrition, and prevention of complications. Information about specific exercises and use of pressure garments and splints is reviewed with both the patient and the family, and written instructions are provided for their use at home. The patient and family are taught to recognize abnormal signs and report them to the physician. The patient and family are assisted in planning for the patient's continued care by identifying and acquiring supplies and equipment that are needed at home (Chart 57-7).

**CONTINUING CARE.** Follow-up care after discharge by the multidisciplinary team is necessary. Patients who receive care in a burn center usually return to the burn clinic or center periodically for evaluation by the burn team, modification of home care instructions, and planning for reconstructive surgery. Other patients receive ongoing care from the burn surgeon who cared for them during the acute phase of their management. Still other patients require the services of a rehabilitation center and may be transferred to such a center for aggressive rehabilitation before going home. Many patients require outpatient physical or occupational therapy, often several times weekly. It is often the nurse who is responsible for coordinating all aspects of care and ensuring that the patient's needs are met. Such coordination is an important aspect of assisting the patient to achieve independence.

Patients who return home after a severe burn injury, those who cannot manage their own burn care, and those with inadequate support systems need referral for home care. During visits to the patient at home, the home care nurse assesses the patient's physical and psychological status as well as the adequacy of the home setting for safe and adequate care. The nurse monitors the patient's progress and adherence to the plan of care and notes any problems that interfere with the patient's ability to carry out the care. During the visit, the nurse assists the patient and family with wound care and exercises. Patients with severe or persistent depression or difficulty adjusting to changes in their social or occupational roles are identified and referred to the burn team for possible referral to a psychologist, psychiatrist, or vocational counselor.

The burn team or home care nurse identifies community resources that may be helpful for the patient and family. Several burn patient support groups and other organizations throughout the United States offer services for burn survivors. They provide contact with caring people (often people who have themselves recovered from burn injuries) who can visit the patient in the hospital or home or telephone the patient and family periodically to provide support and counseling about skin care, cosmetics, and problems related to psychosocial adjustment. Such organizations, and many regional burn centers, sponsor group meetings and social functions at which outpatients are welcome. Some also provide reentry programs or burn retreats and are active in burn prevention activities.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Demonstrates activity tolerance required for desired daily activities
   a. Obtains adequate sleep daily
   b. Reports absence of nightmares or sleep disturbances
   c. Shows gradually increasing tolerance and endurance in physical activities
   d. Can concentrate during conversations
   e. Has energy available to sustain desired daily activities
2. Adapts to altered body image
   a. Verbalizes accurate description of alterations in body image and accepts physical appearance
   b. Demonstrates interest in resources that may improve body appearance and function
   c. Uses cosmetics, wigs, and prostheses as desired to achieve acceptable appearance
   d. Socializes with significant others, peers, and usual social group

CHART 57-7

## HOME CARE CHECKLIST
### *The Patient With a Burn Injury*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| **Mental Health** | | |
| Identify strategies to promote own mental health; for example: | | |
| • Remember that changes in lifestyle take time. | ✔ | ✔ |
| • Resume previous interests and activities gradually. | ✔ | |
| • Take one day at a time to regain physical and mental strength. | ✔ | |
| • Be aware of own feelings and fears and discuss them with selected others. | ✔ | ✔ |
| • Expect concerns, frustrations, and depression about changes in appearance. | ✔ | ✔ |
| • Be honest with self, family, and friends about needs, hopes, and fears. | ✔ | ✔ |
| • Realize that emotional adjustment to the burn injury will occur with time. | ✔ | ✔ |
| **Burn Skin Precautions and Wound Care** | | |
| Identify the following skin precautions and wound care: | | |
| • Wear sun block with the highest SPF possible to protect burned skin from the sun. | ✔ | |
| • Avoid further trauma to burned skin; leave unbroken blisters that may form. | ✔ | ✔ |
| • Lubricate healed burned skin with mild lotion (as prescribed); avoid scratching. | ✔ | |
| • Wear wide-brimmed hats if face has been burned to protect the area from the sun. | ✔ | |
| • Use only mild soap and lotion (ie, products without perfume) on burned areas. | ✔ | ✔ |
| **Exercise** | | |
| Describe the following guidelines for exercise: | | |
| • Do as much for self as possible. | ✔ | |
| • Adhere to the exercise regimen given by the therapist. | ✔ | |
| • Participate in exercise every day, several times a day, even when "not feeling like it." | ✔ | |
| **Nutrition** | | |
| Identify the following guidelines for nutrition: | | |
| • Eat a diet high in calories and protein. | ✔ | |
| • Drink adequate volume of fluids to prevent constipation associated with use of analgesic medications. | ✔ | |
| **Pain Management** | | |
| Describe the following steps for managing pain: | | |
| • Avoid situations that require alertness (analgesic agents may produce drowsiness). | ✔ | |
| • Take analgesic medication as prescribed (30 minutes before painful procedures such as dressing changes). | ✔ | |
| • Use relaxation and distraction to relieve pain and discomfort. | ✔ | |
| **Thermoregulation** | | |
| Identify strategies to compensate for inability to regulate body temperature: | | |
| • Dress to accommodate cold and hot weather or environment. | ✔ | |
| • Avoid extremes of temperature. | ✔ | |

CHART 57-7 HOME CARE CHECKLIST
**The Patient With a Burn Injury** (Continued)

| | PATIENT | CAREGIVER |
|---|---|---|
| **Clothing Considerations** | | |
| State the following strategies in selection of clothing to wear: | | |
| • Avoid tight clothing over burned areas. | ✔ | |
| • Select white cotton, loose-fitting clothing so that dyes in colored clothes do not irritate healing skin. | ✔ | |
| • Wear clothing and gloves to protect healing skin from unnecessary bruises, bumps, and scratches. | ✔ | |
| **Management of Burn Scar** | | |
| Describe the following strategies to manage burn scar: | | |
| • Massage and stretch skin to maintain/increase its elasticity. | ✔ | ✔ |
| • Use lotion for massage as recommended by therapist. | ✔ | ✔ |
| • Wear compression garments 23 hours a day. | ✔ | |
| **Resumption of Sexual Relations** | | |
| Identify the following guidelines regarding resumption of sexual relationships: | | |
| • Realize that resumption of sexual relationships is the rule rather than the exception. | ✔ | ✔ |
| • Expect sensitivity of and around the genital area for several months if these areas were burned. | ✔ | |
| • Resume sexual activity slowly; endurance will increase with time. | ✔ | |

Adapted with permission from Orlando Regional Medical Center Burn Unit's Personal Guide to Burn Care.

   e. Seeks and achieves return to role in family, school, and community as a contributing member
3. Demonstrates knowledge of required self-care and follow-up care
   a. Describes surgical procedures and treatments accurately
   b. Verbalizes detailed plan for follow-up care
   c. Demonstrates ability to perform wound care and prescribed exercises
   d. Returns for follow-up appointments as scheduled
   e. Identifies resource people and agencies to contact for specific problems
4. Exhibits no complications
   a. Demonstrates full range of motion
   b. Shows no signs of withdrawal or depression
   c. Displays no psychotic behaviors

## Outpatient Burn Care

Increasing numbers of patients receive treatment of burns in outpatient settings in an effort to coordinate specific burn care needs and to decrease healthcare costs and length of hospitalization. The increased availability of outpatient surgery and access to expert burn care in outpatient settings make this option possible for the treatment of minor burn care as well as a destination for the discharged burn patient.

The goals for treatment in an outpatient setting may include burn wound management, pain management, scar and reconstructive care, and rehabilitation. However, a number of factors must be considered in determining if outpatient care is appropriate for the patient: age, past medical history, the extent and depth of the burn, location of the burn wounds, the availability of family support systems and community resources, the patient's compliance and the distance from home, and availability of transportation from home to the outpatient setting.

The frequency of follow-up visits is individualized and based on these factors. The initial outpatient visit for a discharged burn patient is usually scheduled within 2 or 3 days after hospital discharge and then biweekly until there is evidence of a successful outcome. After healing has occurred, appointments are monthly and eventually every 4 to 6 weeks for continued assessment of pain, physical limitations, and scar maturation. Patient and family education is very important and should include verbal and written instructions as well as return demonstration of the burn or scar care required. These include the wound treatment, pain management, treatment for itching, provision of adequate nutrition, and promotion of exercise and rest. Instruction is also provided about the signs and symptoms of infection that should be reported to the burn team. The importance of notifying the outpatient setting about early complications and of keeping follow-up appointments is emphasized to the patient and family. Physical therapy and occupational therapy are often provided in the outpatient

burn setting. The rehabilitation goals are to increase range of motion and to strengthen and build the patient's endurance. This is accomplished with a specific plan of care and includes routine visits for up to 2 years following the injury. Adaptation to lifestyle changes and emotional status should be assessed during the outpatient visits and proper referrals made for counseling services. These assessments are difficult to recognize due to the infrequent nature of the visits, and, therefore, it is helpful to incorporate family response and interactions into the assessment. The health care team must also be alert to issues of substance abuse, safety concerns, suicidal thoughts, depression, and PTSD.

## CRITICAL THINKING EXERCISES

**1** A 35-year-old woman was scalded in the bathtub, where she sustained 40% full-thickness burns to her lower legs, right arm, and back. It is not known how long the woman was in the tub. She apparently had a seizure while showering and fell onto the hot water faucet. On admission to the emergency department, the woman's temperature is 35.5°C (94°F) and her weight is 111 lb (50 kg). She has diabetes as well as a history of uncontrolled seizure activity. What are the priorities in her medical and nursing care during the emergent phase of burn care? What assessment parameters would you monitor closely?

**2** An 82-year-old man who is wheelchair dependent and has a history of chronic obstructive pulmonary disease was smoking while using oxygen at home. He sustained superficial partial-thickness burns to his face, including his nose, lips, and chin. This is his second admission for the same type of injury in less than 1 year. His pulse oximetry is 91% and his vital signs are stable. Before he is intubated in the emergency room, he asks for a cigarette and states he wants to go home. What are this patient's immediate care needs? What referrals for inpatient services should be arranged before his discharge? What important factors need to be addressed as part of his discharge plan?

**3** A 19-year-old, 233 lb (105 kg) man sustained partial-thickness and full-thickness burn injuries to his face, neck, and both hands and forearms circumferentially that occurred while he was working on his car while smoking a cigarette. Using the rule of nines, estimate the percentage of TBSA burned and estimate his fluid resuscitation needs. What immediate concerns would you have for his airway? How would you handle the care of the circumferential injury of his forearms?

EBP **4** A 52-year-old man suffered an electrical burn when he touched a high-voltage wire inside a closet while on the job. There was an explosion and he was thrown backward. The current entered his right hand and exited his left knee, leaving a large deficit in his knee. He also sustained a 45% TBSA flame burn when his clothing ignited. When asked to rate the intensity of his pain, he reports a "10" on a 10-point pain scale. What immediate concerns would you have related to his cardiopulmonary and neurological status? What strategies would you use to relieve his pain? What is the evidence that supports the pain relief strategies that you identified and the strength of that evidence?

**5** A 28-year-old woman involved in a house fire is brought to the emergency department by her boyfriend. There is no information from the scene. She is complaining of severe pain in her neck and back. She sustained a full-thickness burn of her lower extremities and her lower back. She is asking about the status of her two children who perished in the fire. What would you be concerned about related to her complaints that requires action from the burn team? What are the psychological and emotional issues that need to be addressed? Who might you consult to assist in the psychological management of this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

Alisa Ann Ruch Burn Foundation, www.aarbf.org
American Burn Association, www.ameriburn.org
American Red Cross, www.redcross.org
Burn Children Recovery Foundation, www.burnchildrenrecovery.org
Burn Foundation, www.burnfoundation.org/
Burn Institute, www.burninstitute.org
Burn Prevention, www.burnprevention.org
Chemical Educational Foundation, www.chemed.org
Firefighters Pacific Burn Institute, www.ffburn.org
Integra Life Sciences Corporation, www.integra-ls.com
International Association of Fire Fighters Burn Foundation, www.iaff.org
International Medical Education Foundation. www.burnsurgery.org
International Society for Burn Injuries, www.worldburn.org
National Burn Center Reporting System Report Form, U.S. Consumer Product Safety Commission, www.cpsc.gov/burnctr.html
National Fire Protection Association Fire, www.nfpa.org
Phoenix Society for Burn Survivors, Inc., www.phoenix-society.org
United States Fire Administration, www.usfa.dh.gov

unit 13

# Sensorineural Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Impaired Vision and Decreased Attention to One Side of the Body



**Mr. Martin** is a 60-year-old man who has had several strokes. Ophthalmologic testing reveals that he has homonymous hemianopsia of the left visual field and visual spatial neglect; as a result, he has limited vision in the left visual fields of both eyes. He has difficulty in many areas, such as bumping into objects and ignoring the left side of his body.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **DISTURBED SENSORY PERCEPTION: VISUAL—**Change in the amount or patterning of incoming stimuli accompanied by a diminished, exaggerated, distorted, or impaired response to such stimuli | **COMMUNICATION ENHANCEMENT: VISUAL DEFICIT—**Assistance in accepting and learning alternative methods for living with diminished vision | **VISION COMPENSATION BEHAVIOR—**Personal actions to compensate for visual impairment |
| **UNILATERAL NEGLECT—**Lack of awareness and attention to one side of the body | **UNILATERAL NEGLECT MANAGEMENT—**Protecting and safely reintegrating the affected part of the body while helping the patient adapt to disturbed perceptual abilities | **SAFE HOME ENVIRONMENT—**Physical arrangements to minimize environmental factors that might cause physical harm or injury in the home |
| **RISK FOR INJURY—**At risk for injury as a result of environmental conditions interacting with the individual's adaptive and defensive resources | **POSITIONING—**Deliberative placement of the patient or a body part to promote physiological and/or psychological well-being | **PHYSICAL INJURY SEVERITY—**Severity of injuries from trauma |


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chapter 58

# Assessment and Management of Patients With Eye and Vision Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify significant eye structures and describe their functions.
2. Identify diagnostic tests for assessment of vision and evaluation of visual disabilities.
3. Discuss clinical features, diagnostic assessment and examinations, medical or surgical management, and nursing management of ocular disorders.
4. Describe therapeutic effects of ophthalmic medications.
5. Define low vision and blindness and differentiate between functional and visual impairment.
6. List and describe assessment and management strategies for low vision.
7. Demonstrate orientation and mobility techniques for patients with low vision in a hospital setting.
8. Demonstrate instillation of eye drops and ointment.
9. Discuss general discharge instructions for patients after ocular surgery.
10. Discuss strategies for patient safety in ophthalmology.

## GLOSSARY

**accommodation:** process by which the eye adjusts for near distance (eg, reading) by changing the curvature of the lens to focus a clear image on the retina
**anterior chamber:** space in the eye bordered anteriorly by the cornea and posteriorly by the iris and pupil
**aphakia:** absence of the natural lens
**aqueous humor:** watery fluid that fills the anterior and posterior chambers of the eye
**astigmatism:** refractive error in which light rays are spread over a diffuse area rather than sharply focused on the retina, a condition caused by differences in the curvature of the cornea and lens
**binocular vision:** normal ability of both eyes to focus on one object and fuse the two images into one
**blindness:** inability to see, usually defined as corrected visual acuity of 20/400 or less, or a visual field of no more than 20 degrees in the better eye
**bullous keratopathy:** corneal edema with painful blisters in the epithelium due to excessive corneal hydration
**chemosis:** edema of the conjunctiva
**cones:** retinal photoreceptor cells essential for visual acuity and color discrimination

## GLOSSARY *(Continued)*

**diplopia:** seeing one object as two; double vision
**emmetropia:** absence of refractive error
**enucleation:** complete removal of the eyeball and part of the optic nerve
**evisceration:** removal of the intraocular contents through a corneal or scleral incision; the optic nerve, sclera, extraocular muscles, and sometimes, the cornea are left intact
**exenteration:** surgical removal of the entire contents of the orbit, including the eyeball and lids
**hyperemia:** "red eye" resulting from dilation of the vasculature of the conjunctiva
**hyperopia:** farsightedness; a refractive error in which the focus of light rays from a distant object is behind the retina
**hyphema:** blood in the anterior chamber
**hypopyon:** collection of inflammatory cells that has the appearance of a pale layer in the inferior anterior chamber of the eye
**injection:** congestion of blood vessels
**keratoconus:** cone-shaped deformity of the cornea
**limbus:** junction of the cornea and sclera
**miotics:** medications that cause pupillary constriction
**mydriatics:** medications that cause pupillary dilation
**myopia:** nearsightedness; a refractive error in which the focus of light rays from a distant object is anterior to the retina
**neovascularization:** growth of abnormal new blood vessels
**nystagmus:** involuntary oscillation of the eyeball
**papilledema:** swelling of the optic disc due to increased intracranial pressure
**photophobia:** ocular pain on exposure to light
**posterior chamber:** space between the iris and vitreous
**proptosis:** downward displacement of the eyeball resulting from an inflammatory condition of the orbit or a mass within the orbital cavity
**ptosis:** drooping eyelid
**refraction:** determination of the refractive errors of the eye and correction by lenses
**rods:** retinal photoreceptor cells essential for bright and dim light
**scotomas:** blind or partially blind areas in the visual field
**strabismus:** a condition in which there is deviation from perfect ocular alignment
**sympathetic ophthalmia:** an inflammatory condition created in the fellow eye by the affected eye (without useful vision); the condition may become chronic and result in blindness (of the fellow eye)
**trachoma:** a bilateral chronic follicular conjunctivitis of childhood that leads to blindness during adulthood, if left untreated
**vitreous humor:** gelatinous material (transparent and colorless) that fills the eyeball behind the lens

***Note:*** Common abbreviations related to vision and eye health are OD (oculus dexter, right eye), OS (oculus sinister, left eye), and OU (oculus uterque, both eyes).

The ability to see the world clearly can easily be taken for granted. The eye is a sensitive, highly specialized sense organ subject to various disorders, many of which lead to impaired vision. Impaired vision may affect a person's independence in self-care, work and lifestyle choices, sense of self-esteem, safety, ability to interact with society and the environment, and overall quality of life. Many of the leading causes of visual impairment are associated with aging (eg, cataracts, glaucoma, macular degeneration). Careful fitting with corrective lenses could help more than 80% of the 14 million Americans who are visually impaired (Bressler, Quigley & Schein, 2008). Two thirds of the population with impaired vision is older than 65 years of age. Younger people are also at risk for eye disorders, particularly traumatic injuries. The rapidly changing technological advances of ophthalmic surgery affect all age groups. These include refractive procedures as well as implantation of intraocular lenses and telescopic devices.

Although most people with eye disorders are treated in an ambulatory care setting, many patients receiving health care have an eye disorder as a comorbid condition. In addition to understanding the prevention, treatment, and consequences of eye disorders, nurses in all settings assess visual acuity in patients at risk (eg, those who are elderly, those with diabetes or acquired immunodeficiency syndrome [AIDS]), refer patients to eye care specialists as appropriate, implement measures to prevent further visual loss, and help patients adapt to impaired vision.

# ASSESSMENT OF THE EYE

## *Anatomic and Physiologic Overview*

Unlike most organs of the body, the eye is available for external examination, and its anatomy is more easily assessed than many other body parts (Fig. 58-1). The eyeball, or globe, sits in a protective bony structure known as the orbit.

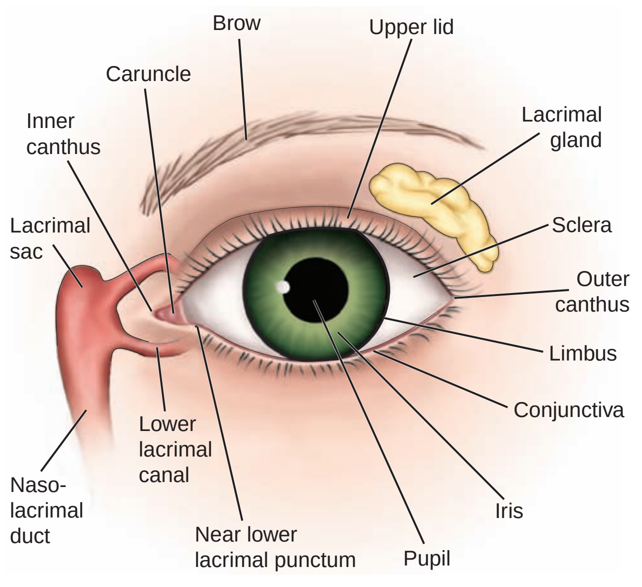



**Figure 58-1** External structures of the eye and position of the lacrimal structures.

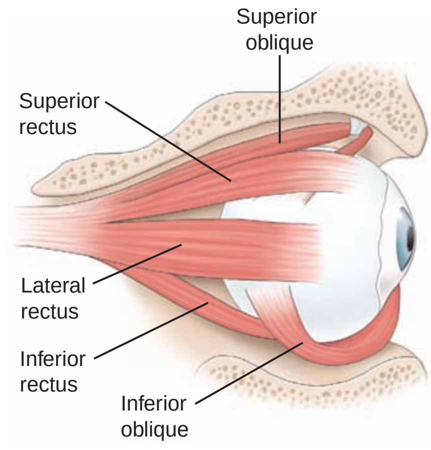



**Figure 58-2** The extraocular muscles responsible for eye movement. The medial rectus muscle (not shown) is responsible for opposing the movement of the lateral rectus muscle.

Lined with muscle and connective and adipose tissues, the orbit is about 4-cm high, wide, and deep, and it is shaped roughly like a four-sided pyramid, surrounded on three sides by the sinuses: ethmoid (medially), frontal (superiorly), and maxillary (inferiorly). The optic nerve and the ophthalmic artery enter the orbit at its apex through the optic foramen. The eyeball is moved through all fields of gaze by the extraocular muscles. The four rectus muscles and two oblique muscles (Fig. 58-2) are innervated by cranial nerves (CN) III, IV, and VI. Normally, the movements of the two eyes are coordinated, and the brain perceives a single image.

The eyelids, composed of thin elastic skin that covers striated and smooth muscles, protect the anterior portion of the eye. The eyelids contain multiple glands, including sebaceous, sweat, and accessory lacrimal glands, and they are lined with conjunctival material. The upper lid normally covers the uppermost portion of the iris and is innervated by the oculomotor nerve (CN III). The lid margins contain meibomian glands, the inferior and superior puncta, and the eyelashes. The triangular spaces formed by the junction of the eyelids are known as the inner or medial canthus and the outer or lateral canthus. With every blink of the eyes, the lids wash the cornea and conjunctiva with tears.

Tears are vital to eye health. They are formed by the lacrimal gland and the accessory lacrimal glands. A healthy tear is composed of three layers: lipoid, aqueous, and mucoid. If there is a defect in the composition of any of these layers, the integrity of the cornea may be compromised. Tears are secreted in response to reflex or emotional stimuli.

The conjunctiva, a mucous membrane, provides a barrier to the external environment and nourishes the eye. The goblet cells of the conjunctiva secrete lubricating mucus. The bulbar conjunctiva covers the sclera, whereas the palpebral conjunctiva lines the inner surface of the upper and lower eyelids. The junction of the two portions is known as the fornix.

The sclera, commonly known as the white of the eye, is a dense, fibrous structure that makes up the posterior five sixths of the eye (Fig. 58-3). The sclera helps maintain the shape of the eyeball and protects the intraocular contents from trauma. The sclera may have a slightly bluish tinge in young children, a dull white color in adults, and a slightly

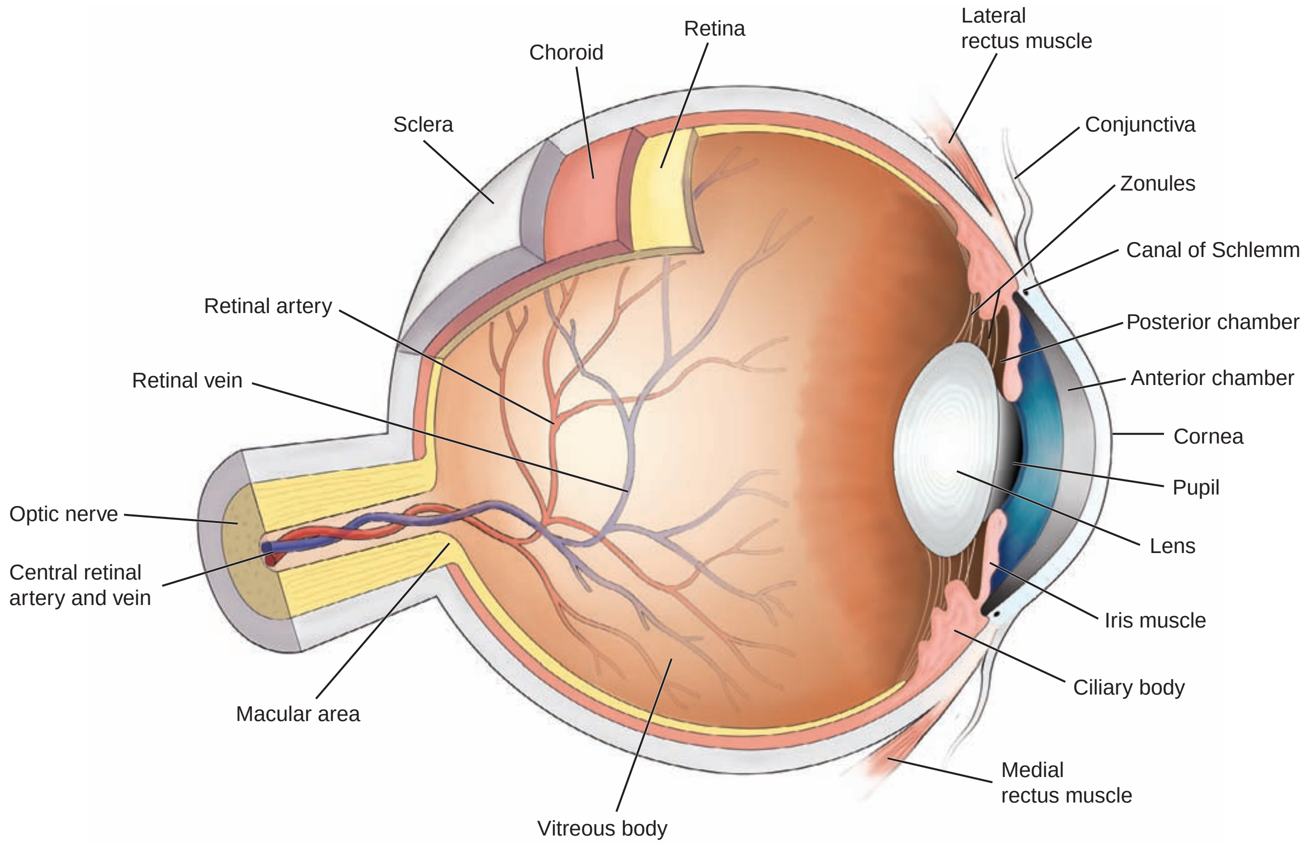



**Figure 58-3** Three-dimensional cross-section of the eye.

yellowish color in the elderly. Externally, it is overlaid with conjunctiva, which is a thin, transparent, mucous membrane that contains fine blood vessels. The conjunctiva meets the cornea at the **limbus** on the outermost edge of the iris.

The cornea (Fig. 58-4), a transparent, avascular, domelike structure, forms the most anterior portion of the eyeball and is the main refracting surface of the eye. It is composed of five layers: epithelium, Bowman's membrane, stroma, Descemet's membrane, and endothelium. The epithelial cells are capable of rapid replication and are completely replaced every 7 days.

Behind the cornea lies the **anterior chamber,** filled with a continually replenished supply of clear aqueous humor, which nourishes the cornea. The **aqueous humor** is produced by the ciliary body, and its production is related to the intraocular pressure (IOP). Normal IOP is 10 to 21 mm Hg.

The uvea consists of the iris, the ciliary body, and the choroid. The iris, or colored part of the eye, is a highly vascularized, pigmented collection of fibers surrounding the pupil. The pupil is a space that dilates and constricts in response to light. Normal pupils are round and constrict symmetrically when a bright light shines on them. About 20% of the population have pupils that are slightly unequal in size but that respond equally to light. Dilation and constriction are controlled by the sphincter and dilator pupillae muscles. The dilator muscles are controlled by the sympathetic nervous system, whereas the sphincter muscles are controlled by the parasympathetic nervous system.

Directly behind the pupil and iris lies the lens, a colorless and almost completely transparent, biconvex structure held in position by zonular fibers. It is avascular and has no nerve or pain fibers. The lens enables focusing for near vision and refocusing for distance vision. The ability to focus and refocus is called **accommodation.** The lens is suspended behind the iris by the zonules and is connected to the ciliary body. The ciliary body controls accommodation through the zonular fibers and the ciliary muscles. The aqueous humor is anterior to the lens; posterior to the lens is the vitreous humor. All cells formed throughout life are retained by the lens, which makes the cell structure of the lens susceptible to the degenerative effects of aging. The lens continues to grow throughout life, laying down fibers in concentric rings. This gradual thickening becomes evident in the fifth decade of life and eventually results in an increasingly dense core or nucleus, which can limit accommodative powers.

The **posterior chamber** is a small space between the vitreous and the iris. Aqueous fluid is manufactured in the posterior chamber by the ciliary body. This aqueous fluid flows from the posterior chamber into the anterior chamber, from which it drains through the trabecular meshwork into the canal of Schlemm.

The choroid lies between the retina and the sclera. It is avascular tissue, supplying blood to the portion of the sensory retina closest to it.

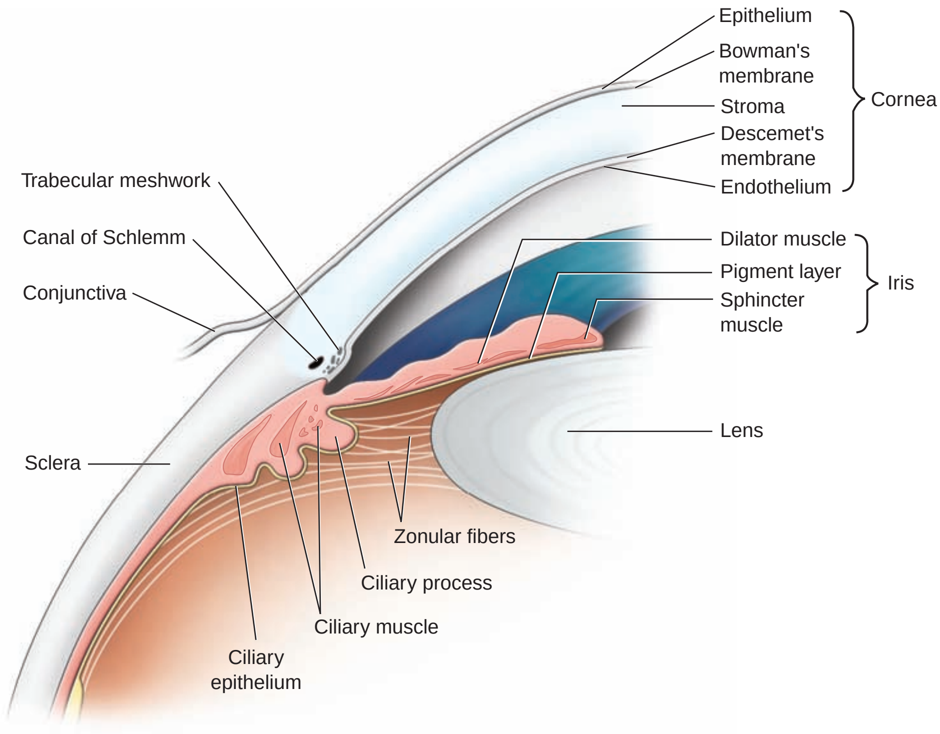



**Figure 58-4** Internal structures of the eye. From American Society of Ophthalmic Registered Nurses. (2008). *Core curriculum for ophthalmic nursing* (3rd ed.) Dubuque, IA: Kendall/Hunt Publishing.

The ocular fundus is the largest chamber of the eye and contains the **vitreous humor,** a clear, gelatinous substance, composed mostly of water and encapsulated by a hyaloid membrane. The vitreous humor occupies about two thirds of the eye's volume and helps maintain the shape of the eye. As the body ages, the gel-like characteristics are gradually lost, and various cells and fibers cast shadows that the patient perceives as "floaters." The vitreous is in continuous contact with the retina and is attached to the retina by scattered collagenous filaments. The vitreous shrinks and shifts with age.

The innermost surface of the fundus is the retina. The retina is composed of 10 microscopic layers and has the consistency of wet tissue paper. It is neural tissue, an extension of the optic nerve. Viewed through the pupil, the landmarks of the retina are the optic disc, the retinal vessels, and the macula. The point of entrance of the optic nerve into the retina is the optic disc. The optic disc is pink; it is oval or circular and has sharp margins. In the disc, a physiologic depression or cup is present centrally, with the retinal blood vessels emerging from it. The retinal tissues arise from the optic disc and line the inner surface of the vitreous chamber. The retinal vessels also enter the eye through the optic disc, branching out through the retina and forming superior and inferior branches. The macula is the area of the retina responsible for central vision. The rest of the retina is responsible for peripheral vision. In the center of the macula is the most sensitive area, the fovea, which is avascular and surrounded by the superior and inferior vascular arcades. Two important layers of the retina are the retinal pigment epithelium (RPE) and the sensory retina. A single layer of cells constitutes the RPE, and these cells have numerous functions, including the absorption of light. The sensory retina contains the photoreceptor cells: **rods** and **cones.** The rods are mainly responsible for night vision or vision in low light, whereas the cones provide the best vision for bright light, color vision, and fine detail. Cones are distributed throughout the retina, with their greatest concentration in the fovea. Rods are absent in the fovea.

Visual acuity depends on a healthy, functioning eyeball and an intact visual pathway (Fig. 58-5). This pathway is made up of the retina, optic nerve, optic chiasm, optic tracks, lateral geniculate bodies, and optic radiations, and the visual cortex area of the brain. The pathway is an extension of the central nervous system.

The optic nerve is also known as the second cranial nerve (CN II). Its purpose is to transmit impulses from the retina to the occipital lobe of the brain. The optic nerve head, or optic disc, is the physiologic blind spot in each eye. The optic nerve leaves the eye and then meets the optic nerve from the other eye at the optic chiasm. The chiasm is the anatomic point at which the nasal fibers from the nasal retina of each eye cross to the opposite side of the brain. The nerve fibers from the temporal retina of each eye remain uncrossed. Fibers from the right half of each eye, which would be the left visual field, carry impulses to the right occipital lobe. Fibers from the left half of each eye, or the right visual field, carry impulses to the left occipital lobe. Beyond the chiasm, these fibers are known as the optic tract. The optic tract continues on to the lateral geniculate body. The lateral geniculate body leads to the optic radiations and then to the cortex of the occipital lobe of the brain.

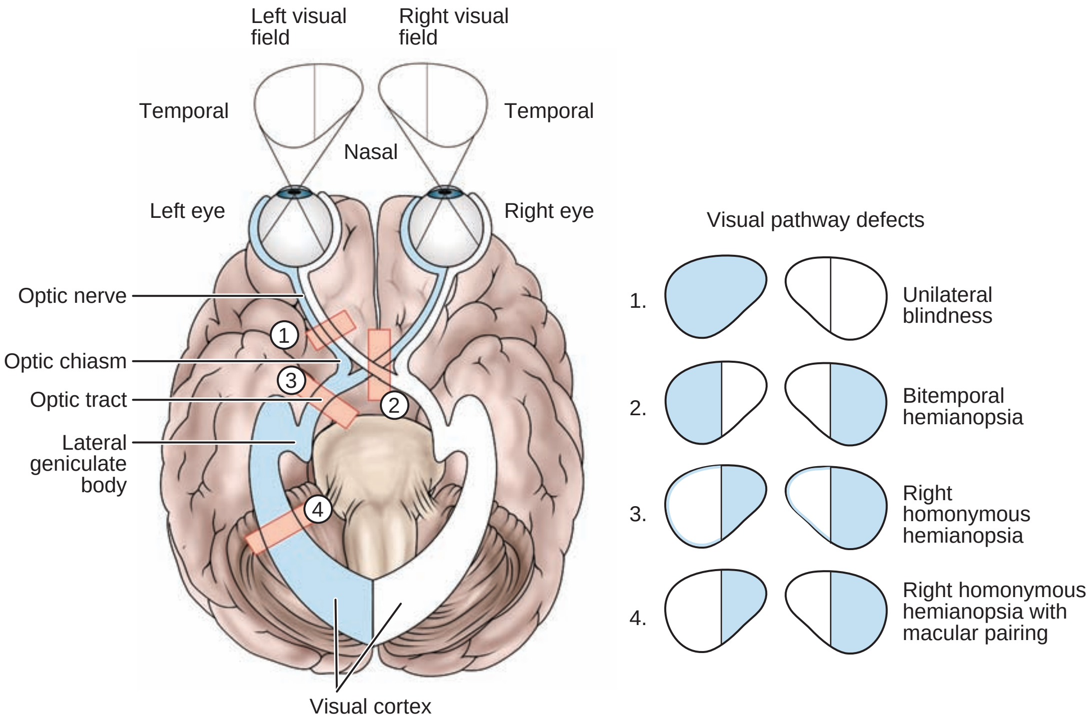



**Figure 58-5** The visual pathway. From Fuller, J. & Schaller-Ayers, J. (2000). *Health assessment: A nursing approach* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins.

# Assessment

## Ocular History

The nurse, through careful questioning, elicits the necessary information that can assist in diagnosis of an ophthalmic condition. Pertinent questions to ask during the interview are presented in Chart 58-1. Genetics plays a role in many eye and vision problems; for more information, see Chart 58-2.

## Visual Acuity

Following the health history, the patient's visual acuity is assessed. This is an essential part of the eye examination and a measure against which all therapeutic outcomes are based.

The Snellen chart, which is composed of a series of progressively smaller rows of letters, is used to test distance vision. The fraction 20/20 is considered the standard of normal vision. Most people can see the letters on the line designated as 20/20 from a distance of 20 feet. A person whose vision is 20/200 can see an object from 20 feet away that a person with 20/20 vision can see from 200 feet away. The patient is positioned at the prescribed distance, usually 20 feet, from the chart and is asked to read the smallest line that he or she can see. The patient should wear distance correction (eyeglasses or contact lenses) if required, and each eye should be tested separately. If the patient cannot read the 20/20 line, he or she is given a pinhole occluder and asked to read again using the eye in question. A makeshift occluder may be created by making a pinhole in an index card and asking the patient to look through the pinhole. Squinting produces the same effect. Patients should be encouraged to read more letters and to guess, if necessary. Often, patients avoid guessing and prefer not to try at all rather than to make a mistake. The patient should be encouraged to read every letter possible.

### CHART 58-1 Taking an Ocular History

- What does the patient perceive to be the problem?
- Is visual acuity diminished?
- Does the patient experience blurred, double, or distorted vision?
- Is there pain; is it sharp or dull; is it worse when blinking?
- Is the discomfort an itching sensation or more of a foreign body sensation?
- Are both eyes affected?
- Is there a history of discharge? If so, inquire about color, consistency, odor.
- Describe the onset of the problem (sudden, gradual). Is it worsening?
- What is the duration of the problem?
- Is this a recurrence of a previous condition?
- How has the patient self-treated?
- What makes the symptoms improve or worsen?
- Has the condition affected performance of activities of daily living (ADLs)?
- Are there any systemic diseases? What medications are used in their treatment?
- What concurrent ophthalmic conditions does the patient have?
- Is there a history of ophthalmic surgery?
- Have other family members had the same symptoms or condition?

CHART 58-2

GENETICS IN NURSING PRACTICE

## Eye and Vision Disorders

Several eye and vision disorders are associated with genetic abnormalities. Some examples are:

- Albinism
- Aniridia
- Color blindness
- Glaucoma
- Homocystinuria
- Isolated familial congenital cataracts
- Leber hereditary optic neuropathy
- Leber congenital amaurosis
- Marfan syndrome
- Retinitis pigmentosa

### Nursing Assessments

**Family History Assessment**

- Assess history of family members with glaucoma, cataracts, night blindness (retinitis pigmentosa), color blindness, or other vision impairment.
- Inquire about the age of onset of symptoms (the onset of Leber congenital amaurosis is in childhood, while the onset of Leber hereditary optic neuropathy is in young adulthood).
- Inquire about family members with other disorders that may include visual impairment, such as cutaneous, metabolic, or connective tissue disorders and hearing loss.

**Patient Assessment**

- Assess for other systemic and/or clinical features such as cutaneous or skeletal conditions, or hearing loss.

### Management Issues Specific to Genetics

- Inquire whether DNA gene mutation or other genetics testing has been performed on any affected family members.
- If indicated, refer for further genetics counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetics testing, and gene-based interventions.
- Offer appropriate genetics information and resources.
- Assess patient's understanding of genetics information.
- Provide support to families with newly diagnosed genetic-related sensorineural disorders.
- Participate in management and coordination of care of patients with genetic conditions and individuals pre-disposed to develop or pass on a genetic condition

### Genetics Resources

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Clinics**—a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling and testing information, www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.ncbi.nlm.nih.gov/omim/stats/html

Visual acuity is then recorded. If the patient reads all five letters from the 20/20 line with the right eye (OD) and three of the five letters on the 20/15 line with the left eye (OS), the examiner writes OD 20/20, OS 20/15-2.

If the patient cannot read the largest letter on the chart (the 20/200 line), the patient should be moved toward the chart or the chart moved toward the patient until the patient can identify the largest letter on the chart. If the patient can recognize only the letter E on the top line at a distance of 10 feet, the visual acuity would be recorded as 10'/200. If the patient cannot see the letter E at any distance, the examiner should determine if the patient can count fingers (CF). The examiner holds up a random number of fingers and asks the patient to count the number he or she sees. If the patient correctly identifies the number of fingers at 3 feet, the examiner would record CF/3'.

If the patient cannot count fingers, the examiner raises one hand up and down or moves it side to side and asks in which direction the hand is moving. This level of vision is known as hand motion (HM). A patient who can perceive only light is described as having light perception (LP). The vision of a patient who cannot perceive light is described as no light perception (NLP).

## External Eye Examination

After the visual acuity has been recorded, an external eye examination is performed. The position of the eyelids is noted. Commonly, the upper 2 mm of the iris are covered by the upper lid. The patient is examined for **ptosis** (drooping eyelid) and for lid retraction (too much of the eye exposed). Sometimes, the upper or lower lid turns out, affecting closure. The lid margins and lashes should have no edema, erythema, or lesions. The examiner looks for scaling or crusting, and the sclera is inspected. A normal sclera is opaque and white. Lesions on the conjunctiva, discharge, and tearing or blinking are noted.

The room should be darkened so that the pupils can be examined. The pupillary response is checked with a penlight to determine if the pupils are equally reactive and regular. A normal pupil is black. An irregular pupil may result from trauma, previous surgery, or a disease process.

The patient's eyes are observed in primary or direct gaze, and any head tilt is noted. A tilt may indicate cranial nerve palsy. The patient is asked to stare at a target; each eye is covered and uncovered quickly while the examiner looks for any shift in gaze. The examiner observes for **nystagmus** (ie, oscillating movement of the eyeball). The extraocular movements of the eyes are tested by having the patient follow the examiner's finger, pencil, or a hand light through the six cardinal directions of gaze (ie, up, down, right, left, and both diagonals). This is especially important when screening patients for ocular trauma or for neurologic disorders.

## Diagnostic Evaluation

### Direct Ophthalmoscopy

A direct ophthalmoscope is a hand-held instrument with various plus and minus lenses. The lenses can be rotated into place, enabling the examiner to bring the cornea, lens, and retina into focus sequentially. The examiner holds the ophthalmoscope in the right hand and uses the right eye to examine the patient's right eye. The examiner switches to the left hand and left eye when examining the patient's left eye. During this examination, the room should be darkened, and the patient's eye should be on the same level as the examiner's eye. The patient and the examiner should be comfortable, and both should breathe normally. The patient is given a target to gaze at and is encouraged to keep both eyes open and steady.

When the fundus is examined, the vasculature comes into focus first. The veins are larger in diameter than the arteries. The examiner focuses on a large vessel and then follows it toward the midline of the body, which leads to the optic nerve. The central depression in the disc is known as the cup. The normal cup is about one-third the size of the diameter of the disc. The size of the physiologic optic cup should be estimated and the disc margins described as sharp or blurred. A silvery or coppery appearance, which indicates arteriolosclerosis, should be noted. The periphery of the retina is examined by having the patient shift his or her gaze. The last area of the fundus to be examined is the macula, because this area is the most sensitive to light. The retina of a young person often has a glistening effect, sometimes referred to as a cellophane reflex.

The healthy fundus should be free of any lesions. The examiner looks for intraretinal hemorrhages, which may appear as red smudges, and, if the patient has hypertension, they may be somewhat flame shaped. Lipid may be present in the retina of patients with hypercholesterolemia or diabetes. This lipid has a yellowish appearance. Soft exudates that have a fuzzy, white appearance (cotton-wool spots) should be noted. The examiner looks for microaneurysms, which look like little red dots, and nevi. Drusen (small, hyaline, globular deposits), commonly found in macular degeneration, appear as yellowish areas with indistinct edges. Small drusen have a more distinct edge. The examiner should sketch the fundus and document any abnormalities.

### Indirect Ophthalmoscopy

The indirect ophthalmoscope is an instrument commonly used by the ophthalmologist to see larger areas of the retina, although in an unmagnified state. It produces a bright and intense light. The light source is affixed with a pair of binocular lenses mounted on the examiner's head. The ophthalmoscope is used with a hand-held, 20-diopter lens.

### Slit-Lamp Examination

The slit lamp is a binocular microscope mounted on a table. This instrument enables the user to examine the eye with magnification of 10 to 40 times the real image. The illumination can be varied from a broad to a narrow beam of light for different parts of the eye. For example, by varying the width and intensity of the light, the anterior chamber can be examined for signs of inflammation. Cataracts may be evaluated by changing the angle of the light. When a hand-held contact lens, such as a three-mirror lens, is used with the slit lamp, the angle of the anterior chamber may be examined, as may the ocular fundus.

### Color Vision Testing

The ability to differentiate colors has a dramatic effect on the activities of daily living (ADLs). For example, the inability to differentiate between red and green can compromise traffic safety. Some careers (eg, commercial artist, [color] photographer, airline pilot, electrician) may be closed to people with significant color deficiencies. The photoreceptor cells responsible for color vision are the cones, and the greatest area of color sensitivity is in the macula, the area of densest cone concentration.

A screening test, such as the polychromatic plates discussed in the next paragraph, can be used to establish whether a person's color vision is within normal range. Color vision deficits can be inherited. For example, red–green color deficiencies are inherited in an X-linked manner, affecting approximately 8% of men and 0.4% of women. Acquired color vision losses may be caused by medications (eg, digitalis) or pathology (eg, cataracts). A simple test, such as asking a patient if the red top on a bottle of eye drops appears redder to one eye than the other, can be an effective tool. A difference in the perception of the intensity of the color red between the two eyes can be a symptom of a neurologic problem and may provide information about the location of the lesion.

Because alteration in color vision sometimes indicates conditions of the optic nerve, color vision testing is often performed in a neuro-ophthalmologic workup. The most common color vision test is performed using Ishihara polychromatic plates. These plates are bound together in a booklet. On each plate of this booklet are dots of primary colors that are integrated into a background of secondary colors. The dots are arranged in simple patterns, such as numbers or geometric shapes. Patients with diminished color vision may be unable to identify the hidden shapes. Patients with central vision conditions (eg, macular degeneration) have more difficulty identifying colors than those with peripheral vision conditions (eg, glaucoma) because central vision identifies color.

### Amsler Grid

The Amsler grid is a test often used for patients with macular problems, such as macular degeneration. It consists of a geometric grid of identical squares with a central fixation point. The grid should be viewed by the patient wearing normal reading glasses. Each eye is tested separately. The patient is instructed to stare at the central fixation spot on the grid and report any distortion in the squares of the grid itself. For patients with macular problems, some of the squares may look faded, or the lines may be wavy. Patients with age-related macular degeneration are commonly given these Amsler grids to take home. The patient is encouraged to check them frequently, as often as daily, to detect any early signs of distortion that may indicate the development of a neovascular choroidal membrane, an advanced stage of

macular degeneration characterized by the growth of abnormal choroidal vessels.

### Ultrasonography

Lesions in the globe or the orbit may not be directly visible and are evaluated by ultrasonography. Ultrasonography is a valuable diagnostic technique, especially when the view of the retina is obscured by opaque media such as cataract or hemorrhage. Ultrasonography can be used to identify orbital tumors, retinal detachment, vitreous hemorrhage, and changes in tissue composition with minimal discomfort for the patient.

### Optical Coherence Tomography

Optical coherence tomography is a technology that involves low-coherence interferometry. Light is used to evaluate retinal and macular diseases as well as anterior segment conditions. This method is noninvasive and involves no physical contact with the eye.

### Color Fundus Photography

Fundus photography is used to detect and document retinal lesions. The patient's pupils are widely dilated before the procedure. The resulting fundus photographs can be viewed stereoscopically so that elevations such as macular edema can be identified. Visual acuity is diminished for about 30 minutes as a result of retinal "bleaching" by the intense flashing lights.

### Fluorescein Angiography

Fluorescein angiography evaluates clinically significant macular edema, documents macular capillary nonperfusion, and identifies retinal and choroidal **neovascularization** (growth of abnormal new blood vessels) in age-related macular degeneration. It is an invasive procedure in which fluorescein dye is injected, usually into an antecubital vein. Within 10 to 15 seconds, this dye can be seen coursing through the retinal vessels. Over a 10-minute period, serial black-and-white photographs are taken of the retinal vasculature. The dye may impart a gold tone to the skin of some patients, and urine may turn deep yellow or orange. This discoloration usually disappears in 24 hours.

### Indocyanine Green Angiography

Indocyanine green angiography is used to evaluate abnormalities in the choroidal vasculature, conditions often seen in macular degeneration. Indocyanine green dye is injected intravenously, and multiple images are captured using digital videoangiography over a period of 30 seconds to 20 minutes. The dye is generally well tolerated, but some patients experience nausea and vomiting. Allergic reactions are rare; however, indocyanine green angiography is contraindicated in patients with a history of iodide reactions.

### Tonometry

Tonometry measures IOP by determining the pressure necessary to indent or flatten (applanate) a small anterior area of the globe of the eye. Pressure is measured in millimeters of mercury (mm Hg). High readings indicate high pressure; low readings indicate low pressure. The procedure is noninvasive and usually painless. A topical anesthetic eye drop is instilled in the lower conjunctival sac, and the tonometer is then used to measure the IOP.

### Perimetry Testing

Perimetry testing evaluates the field of vision. A visual field is the area or extent of physical space visible to an eye in a given position. Its average extent is 65 degrees upward, 75 degrees downward, 60 degrees inward, and 95 degrees outward when the eye is in the primary gaze (ie, looking directly forward). Visual field testing (ie, perimetry) helps identify which parts of the patient's central and peripheral visual fields have useful vision. It is most helpful in detecting central **scotomas** (blind areas in the visual field) in macular degeneration and the peripheral field defects in glaucoma and retinitis pigmentosa.

# IMPAIRED VISION

## *Refractive Errors*

In refractive errors, vision is impaired because a shortened or elongated eyeball prevents light rays from focusing sharply on the retina. Blurred vision from refractive error can be corrected with eyeglasses or contact lenses. The appropriate eyeglass or contact lens is determined by **refraction.** Ophthalmic refraction consists of placing various types of lenses in front of the patient's eyes to determine which lens best improves the patient's vision.

The depth of the eyeball is important in determining refractive error (Fig. 58-6). Patients for whom the visual image focuses precisely on the macula and who do not need

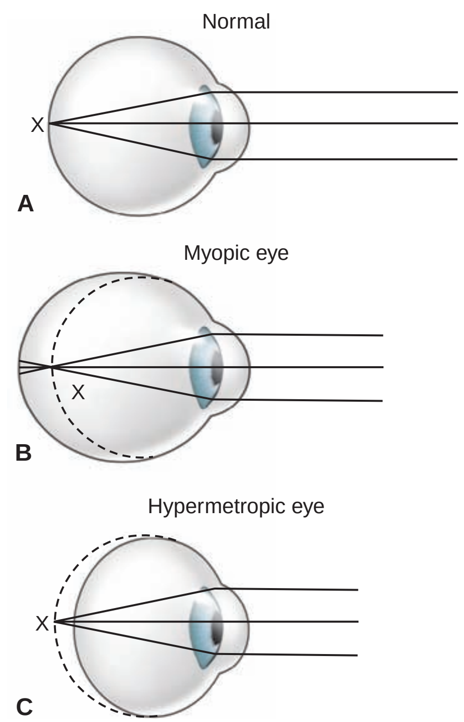



**Figure 58-6** Eyeball shape determines visual acuity in refractive errors. **A,** Normal eye. **B,** Myopic eye. **C,** Hypermetropic eye.

eyeglasses or contact lenses are said to have **emmetropia** (normal vision). Some people have deeper eyeballs; thus, the distant visual image focuses in front of, or short of, the retina. They have **myopia,** are said to be nearsighted, and have blurred distance vision. Other people have shallower eyeballs; thus, the visual image focuses beyond the retina. They have **hyperopia,** are said to be farsighted, and have excellent distance vision but blurry near vision.

Another important cause of refractive error is **astigmatism,** an irregularity in the curve of the cornea. Because astigmatism causes a distortion of the visual image, acuity of distance and near vision can be decreased. Hard contact lenses, which by means of their tear film correct astigmatic errors, or soft toric contact lenses with a cylinder correction may be used in place of eyeglasses for patients with astigmatism.

Ophthalmology has entered the era of customized vision correction in its desire to achieve "super-normal vision." Wavefront technology to measure unique refractive imperfections of the cornea or higher aberrations (ie, myopia, hyperopia, astigmatism) is currently used to customize laser-assisted in situ keratomileusis (LASIK) procedures. To customize the corneal flaps during LASIK, a newer procedure uses a femtosecond (ultrashort-pulse) laser (Slade, 2007).

## Low Vision and Blindness

*Low vision* is a general term describing visual impairment that requires patients to use devices and strategies in addition to corrective lenses to perform visual tasks. Low vision is defined as a best corrected visual acuity (BCVA) of 20/70 to 20/200.

**Blindness** is defined as a BCVA that can range from 20/400 to no light perception. The clinical definition of absolute blindness is the absence of light perception. Legal blindness is a condition of impaired vision in which a person has a BCVA that does not exceed 20/200 in the better eye or whose widest visual field diameter is 20 degrees or less. This definition neither equates with functional ability nor classifies the degrees of visual impairment. Legal blindness ranges from an inability to perceive light to having some vision remaining. A person who meets the criteria for legal blindness may be eligible for government financial assistance.

Impaired vision is often accompanied by difficulty in performing functional activities. People with visual acuity of 20/80 to 20/100 with a visual field restriction of 60 degrees to greater than 20 degrees can read at a nearly normal level with optical aids. Their visual orientation is near normal but requires increased scanning of the environment (ie, systematic use of head and eye movements). In a visual acuity range of 20/200 to 20/400 with a 20-degree to greater than 10-degree visual field restriction, the person can read slowly with optical aids. His or her visual orientation is slow, with constant scanning of the environment. People in this category may have the ability to negotiate their environment without auxiliary aids. This ability is termed "travel vision." People with HM vision or no vision may benefit from the use of mobility devices (eg, cane, guide dog) and should be encouraged to learn Braille and to use computer aids.

The most common causes of blindness and visual impairment among adults 40 years of age or older are diabetic retinopathy, macular degeneration, glaucoma, and cataracts (Prevent Blindness America, 2008). Macular degeneration is more prevalent among Caucasians, whereas glaucoma is more prevalent among African Americans. Age-related changes in the eye are summarized in Table 58-1.

### Assessment and Diagnostic Testing

The assessment of low vision includes a thorough history and the examination of distance and near visual acuity, visual field, contrast sensitivity, glare, color perception, and refraction. Specially designed, low-vision visual acuity charts are used to evaluate patients.

**Table 58-1 AGE-RELATED CHANGES IN THE EYE**

| The External Eye | Structural Change | Functional Change | History & Physical Findings |
|---|---|---|---|
| Eyelids and lacrimal structures | Loss of skin elasticity and orbital fat, decreased muscle tone; wrinkles develop | Lid margins turn in, causing lashes to irritate cornea and conjunctiva (entropian); or lid margins may turn out, resulting in increased corneal exposure (ectropian). | Reports of burning, foreign body sensation, increased tearing (epiphoria); injection, inflammation, and ulceration may occur |
| Refractive changes; presbyopia | Loss of accommodative power in the lens with age | Reading materials must be held at increasing distance in order to focus. | Patient reports, "Arms are too short!"; need for increased light; reading glasses or bifocals needed |
| Cataract | Opacities in the normally crystalline lens | Interference with the focus of a sharp image on the retina | Patients report increased glare, decreased vision, changes in color values (blue and yellow especially affected) |
| Posterior vitreous detachment | Liquefaction and shrinkage of vitreous body | May lead to retinal tears and detachment | Reports light flashes, cobwebs, floaters |
| Age-related macular degeneration (AMD) | Drusen (yellowish aging spots in the retina) appear and coalesce in the macula. Abnormal choroidal blood vessels may lead to formation of fibrotic disciform scars in the macula. | Central vision is affected; onset is more gradual in dry AMD, more rapid in wet AMD; distortion and loss of central vision may occur. | Reading vision is affected; words may be missing letters, faded areas appear on the page, straight lines may appear wavy; drusen, pigmentary changes in retina; abnormal submacular choroidal vessels |

**Table 58-2 ACTIVITIES AFFECTED BY VISUAL IMPAIRMENT AND SUGGESTIONS FOR LOW-VISION AIDS**

| Activity | Optical Aids | Nonoptical Aids |
|---|---|---|
| Shopping | Hand magnifier | Lighting, color cues |
| Fixing a snack | Bifocals | Color cues; consistent food storage plan |
| Eating out | Hand magnifier | Flashlight, portable lamp |
| Identifying money | Bifocals, hand magnifier | Arrange paper money in wallet compartments |
| Reading print | High-power spectacle, bifocals, hand magnifier, stand magnifier, closed-circuit television | Lighting, high-contrast print, large print, reading slit |
| Writing | Hand magnifier, | Lighting, bold-tip pen, black ink |
| Using a telephone | Hand magnifier | Large print dial or touch tone buttons, hand-printed directory |
| Crossing streets | Lightweight hand held monoscopes/telescopes | Cane, ask directions |
| Finding taxis and bus signs | Lightweight hand held monoscopes/telescopes | Ask for assistance |
| Reading medication labels | Hand magnifier | Color codes, large print |
| Reading stove dials | Hand magnifier | Color codes, raised dots |
| Adjusting the thermostat | Hand magnifier | Enlarged print model |
| Using a computer | Spectacles | High-contrast color, large-print program |
| Reading signs | Spectacles | Move closer |
| Watching sporting event | Lightweight hand held monoscopes/telescopes | Sit in front rows |

Adapted from Riordan-Eva, P. & Whitcher, J. P. (2008). *Vaughn and Asbury's general ophthalmology*. New York: McGraw-Hill.

### *Patient Interview*

During history taking, the cause and duration of the patient's visual impairment are identified. Patients with retinitis pigmentosa, for example, have a genetic abnormality. Patients with diabetic macular edema typically have fluctuating visual acuity. Patients with macular degeneration have central acuity problems, which cause difficulty in performing activities that require finer vision, such as reading. People with peripheral field defects have more difficulties with mobility. The patient's customary ADLs, medication regimen, habits (eg, smoking), acceptance of the physical limitations brought about by the visual impairment, and realistic expectations of low-vision aids are identified and included in the plan of care, including provision of guidelines for safety and referrals to social services.

### *Contrast-Sensitivity Testing and Glare Testing*

Contrast-sensitivity testing measures visual acuity in different degrees of contrast. The initial test may take the form of simply turning on the lights while testing the distance acuity. If the patient can read better with the lights on, the patient can benefit from magnification. Glare testing enables the examiner to obtain a more realistic evaluation of the patient's ability to function in his or her environment. Glare can reduce a person's ability to see, especially in patients with cataracts. Devices that test glare, such as the Brightness Acuity Tester, produce three degrees of bright light to create a dazzle effect while the patient is viewing a target, such as Snellen letters on the wall. The lights have been calibrated to imitate certain objects that create glare, such as a car's headlights at night.

## Medical Management

Managing low vision involves magnification and image enhancement through the use of low-vision aids and strategies and referrals to social services and community agencies serving those with visual impairment. The goals are to optimize the patient's remaining vision, whether central or peripheral, and assist the patient to perform customary activities. Low-vision aids include optical and nonoptical devices (Table 58-2) The optical devices include convex lens aids, such as magnifiers and spectacles; telescopic devices; antireflective lenses that diminish glare; and electronic reading systems, such as closed-circuit television and computers with large print. Continuing advances in computer software provide very useful products for patients with low vision. Scanners and the appropriate software enable the user to scan printed material and have it read by computer voice or enlarge the print for reading. Magnifiers can be hand-held or attached to a stand with or without illumination. Telescopic devices can be spectacle telescopes or clip-on or hand-held loupes.

A telephone system has been developed that allows access to the Internet and e-mail using voice commands (Chart 58-3). A mobile telephone-based communication support system allows people with poor eyesight to communicate by mobile phone. The system consists of a low-power mobile phone (personal handyphone system; PHS) and a large screen. When the person telephones, a registered support personnel picture is displayed on the screen and the PHS telephone dials that person automatically (Ogawa, Yonezawa, Maki, et al., 2007).

Referrals to community agencies may be necessary for patients with low vision who live alone and cannot self-administer their medications. Community agencies, such as the Lighthouse National Center for Vision and Aging, offer services to patients with low vision that include training in independent living skills and the provision of occupational and recreational activities and a wide variety of assistive devices for vision enhancement and orientation and mobility.

Ophthalmologists have worked for years toward visual restoration for people who are blind. Retinal implants for those whose optic nerves are functional as well as cortical implants for those whose optic nerves are diseased are being developed but are still experimental (Zaqloul & Boahen, 2006). The rapid changes in technology and miniaturization of computer chips may enable dramatic advances in synthetic vision in the future.

### Chart 58-3 • *Web Access for the Visually Impaired*

People with impaired vision need not be left behind in the computer age. Various technologies are available. A list of general equipment needs follows:

- Computer: software specifically developed for people with visual impairment.
- Internet service provider (eg, AOL, Netscape, Earthlink, Comcast)
- Screen-reader program: converts text on the computer screen to synthesized speech (eg, JAWS for Windows, Windows Eyes, Slimware Window Bridge, ProTalk 32, Hal Screen Reader, WinVision, WYNN, outSPOKEN for Windows)
- Browser program to navigate the World Wide Web (eg, Microsoft Internet Explorer, IBM Home Page Reader)

The following Web sites provide extensive information about low vision resources for people with vision loss, vision impairment, and blindness:

- www.lowvision.org
- www.magnifiers.org

Researchers are developing graphic tactile displays that provide information for people with visual impairment using the sense of touch. Efficient, low-cost tactile displays are not yet available. At this time, most of these devices are research prototypes (Vidal-Verdu & Hafez, 2007).

## Nursing Management

Coping with blindness involves three types of adaptation: emotional, physical, and social. The emotional adjustment to blindness or severe visual impairment determines the success of the physical and social adjustments of the patient. Successful emotional adjustment means acceptance of blindness or severe visual impairment.

### *Promoting Coping Efforts*

Effective coping may not occur until the patient recognizes the permanence of the low vision or blindness. Clinging to false hopes of regaining vision hampers effective adaptation to blindness. A patient who is newly visually impaired and his or her family members (especially those who live with the patient) undergo the various steps of grieving: denial and shock, anger and protest, restitution, loss resolution, and acceptance. The ability to accept the changes that must come with visual loss and willingness to adapt to those changes influence the successful rehabilitation of the patient who is blind. Additional aspects to consider are value changes, independence–dependence conflicts, coping with stigma, and learning to function in social settings without visual cues and landmarks.

### *Promoting Spatial Orientation and Mobility*

A person who is blind or severely visually impaired requires strategies for adapting to the environment. ADLs, such as walking to a chair from a bed, require spatial concepts. The person needs to know where he or she is in relation to the rest of the room, to understand the changes that may occur, and to know how to approach the desired location safely. This requires a collaborative effort between the patient and the responsible adult who serves as the sighted guide.

A patient whose visual impairment results from a chronic progressive eye disorder, such as glaucoma, has better cognitive mapping skills than the patient who loses vision suddenly. Patients with progressive eye disorders develop the use of spatial and topographic concepts early and gradually; hence, remembering a room layout is easier for them. Patients who lose vision suddenly have more difficulty in adjusting, and emotional and behavioral issues of coping with loss of vision may hinder their learning. These patients require intensive emotional support. The nurse must assess the degree of physical assistance the person with vision loss requires and communicate this to other health care personnel.

In the hospital, the bedside table and the call button must always be within reach. The parts of the call button are explained, and the patient is taught to touch and press the buttons or dials until the activity is mastered. The patient must be familiarized with the location of the telephone, water pitcher, and other objects on the bedside table. The food tray's composition is likened to the face of a clock; for example, the main plate may be described as being at 12 o'clock or the coffee cup at 3 o'clock. All articles and furniture must remain in the same positions throughout the patient's hospitalization. The nurse should introduce himself or herself on entering a patient's room and alert the patient to his or her departure. Such behaviors are always polite and help in the care of a patient with vision loss.

The nurse should be aware of the importance of techniques in providing physical assistance, encouraging independence, and ensuring safety. Specific guidelines for interacting with the patient with vision loss are presented in Chart 58-4. The readiness of the patient and his or her family to learn must be assessed before initiating orientation and mobility training.

### *Promoting Home and Community-Based Care*

The nurse, social worker, family, and others collaborate to assess the patient's home condition and support system. If available, a low-vision specialist or occupational therapist should be consulted, particularly for patients for whom identifying and administering medications pose problems. The level of visual acuity and patient preference help determine appropriate interventions. Some private and nonprofit services are identified in the Resources section at the end of this chapter.

Other interventions that are appropriate for some people with low vision or blindness include Braille and service animals. Recent rapid advances in technology have led to the erroneous conclusion by some that Braille is an outmoded communication tool. There has been an ever-increasing reliance on print magnification technology as well as computer-assisted speech output. However, although the use of Braille may be less important for adults who have already learned language and grammar skills, educators and low-vision specialists have continued to advocate that children who are legally blind be given the opportunity to learn Braille.

Guide dogs, also known as seeing-eye dogs or service dogs, are dogs that are specially bred, raised, and rigorously trained to assist people who are blind. The guide dog is a constant companion to the person who is blind (also

## Chart 58-4 • *Guidelines for Interacting With People Who Are Blind Or Have Low Vision*

- Remember that the only difference between you and people who are blind or have low vision is that they are not able to see through their eyes what you are able to see through yours.
- Do not be uncomfortable when in the company of a person who is blind or has low vision. Talk with the person as you would talk with any other individual, honestly and without pity; do not be concerned about using words like "see" and "look." There is no need to raise your voice unless the person asks you to do so.
- Identify yourself as you approach the person and before you make physical contact. Tell the person your name and your role. If another person approaches, introduce him or her. When you leave the room, be sure to tell the person that you are leaving and if anyone else remains in the room.
- It is often appropriate to touch the person's hand or arm lightly to indicate that you are about to speak.
- When talking, face the person and speak directly to him or her using a normal tone of voice.
- Be specific when communicating direction. Mention a specific distance or use clock cues when possible (eg, walk left about 2 yards; walk about 20 feet to the right; the telephone is at 2 o'clock). Avoid using phrases such as "over there."
- When you offer to assist someone, allow the person to hold on to your arm just above the elbow and to walk a half-step behind you.
- When offering the person a seat, place the person's hand on the back or the arm of the seat.
- When you are about to go up or down a flight of stairs, tell the person and place his or her hand on the banister.
- Make sure that the environment is free of obstacles; close doors and cabinets so they are not in the path.
- Offer to read written information, such as a menu.
- If you serve food to the person, use clock cues to specify where everything is on the plate.
- When the person who is blind or who has low vision is a patient in a health care facility:
  - Make sure all objects the person will need are close at hand.
  - Identify the location of objects that the person may need (eg, "The call light is near your right hand"; "The telephone is on the table on the left side of your bed.")
  - Remove obstacles that may be in the person's pathway and could cause a fall.
  - Place all assistive devices the person uses close at hand; let the person feel the devices so that he or she knows their location.
- Do not distract the service animal unless the owner has given permission.
- Ask the person, "How can I help you?" At some times the person needs help, but at other times help may not be needed.

This material is adapted from and based in part on *Achieving Physical and Communication Accessibility,* a publication of the National Center for Access Unlimited; *Community Access Facts,* an Adaptive Environments Center publication; and *The Ten Commandments of Interacting with People with Mental Health Disabilities,* a publication of The Ability Center of Greater Toledo.

referred to as the animal's handler) and is allowed on airplanes and in restaurants, stores, hotels, and other public places. With the assistance of the guide dog, the person who is blind can be extremely mobile and accomplish normal activities both within and outside of the home and workplace. A dog in harness is a working dog, not a pet. The dog should not be distracted from his job by well-intentioned strangers who want to pet, feed, or play with the animal. The dog's handler should always be consulted before approaching the working guide dog. Most health care facilities have a service animal policy that outlines the responsibilities of the handler with regard to the care of the animal.

## Glaucoma

The term *glaucoma* is used to refer to a group of ocular conditions characterized by optic nerve damage. In the past, glaucoma was seen more as a condition of elevated IOP than of optic neuropathy. Increasingly, that is no longer the case. There is no doubt that increased IOP damages the optic nerve and nerve fiber layer, but the degree of harm is highly variable (McKinnon, Goldberg, Peeples, et al., 2008). The optic nerve damage is related to the IOP caused by congestion of aqueous humor in the eye. A range of IOPs are considered "normal," but these may be associated with vision loss in some patients.

Glaucoma is the second leading cause of blindness in adults in the United States. It is estimated that at least 2.2 million Americans have glaucoma and that 3 to 6 million more are at risk for the disease (Bressler, et al., 2008). Glaucoma is more prevalent in people older than 40 years of age, and it is the third most common age-related eye disease in the United States. It also occurs more frequently in African Americans than Caucasians (Chart 58-5). There is no cure for glaucoma, but the disease can be controlled (Sharts-Hopko & Glynn-Milley, 2009).

### Physiology

Aqueous humor flows between the iris and the lens, nourishing the cornea and lens. Most (90%) of the fluid then flows out of the anterior chamber, draining through the spongy trabecular meshwork into the canal of Schlemm and

### CHART 58-5 *Risk Factors for Glaucoma*

- Family history of glaucoma
- Thin cornea
- African American race
- Older age
- Diabetes mellitus
- Cardiovascular disease
- Migraine syndromes
- Nearsightedness (myopia)
- Eye trauma
- Prolonged use of topical or systemic corticosteroids

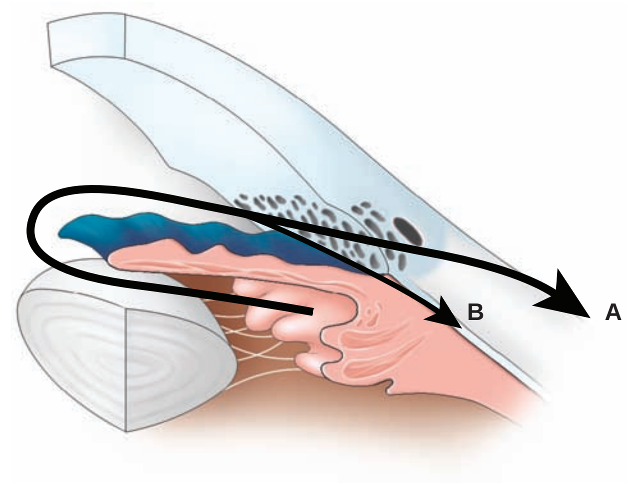



**Figure 58-7** Normal outflow of aqueous humor. **A,** Trabecular meshwork. **B,** Uveoscleral route. From Kanski, J. J. (2007). *Clinical ophthalmology.* Oxford: Butterworth-Heinemann.

the episcleral veins (Fig. 58-7). About 10% of the aqueous fluid exits through the ciliary body into the suprachoroidal space and then drains into the venous circulation of the ciliary body, choroid, and sclera. Unimpeded outflow of aqueous fluid depends on an intact drainage system and an open angle (about 45 degrees) between the iris and the cornea. A narrower angle places the iris closer to the trabecular meshwork, diminishing the angle. The amount of aqueous humor produced tends to decrease with age, in systemic diseases such as diabetes, and in ocular inflammatory conditions.

IOP is determined by the rate of aqueous production, the resistance encountered by the aqueous humor as it flows out of the passages, and the venous pressure of the episcleral veins that drain into the anterior ciliary vein. When aqueous fluid production and drainage are in balance, the IOP is between 10 and 21 mm Hg. When aqueous fluid is inhibited from flowing out, pressure builds up within the eye. Fluctuations in IOP occur with time of day, exertion, diet, and medications. IOP tends to increase with blinking, tight lid squeezing, and upward gazing. Systemic conditions such as diabetes and intraocular conditions such as uveitis and retinal detachment have been associated with elevated IOP. Glaucoma may not be recognized in people with thin corneas because measurement of the IOP may be falsely low as a result of this thinness (Bressler, et al., 2008).

## Pathophysiology

There are two accepted theories regarding how increased IOP damages the optic nerve in glaucoma. The direct mechanical theory suggests that high IOP damages the retinal layer as it passes through the optic nerve head. The indirect ischemic theory suggests that high IOP compresses the microcirculation in the optic nerve head, resulting in cell injury and death. Some glaucomas appear as exclusively mechanical, and some are exclusively ischemic types. Typically, most cases are a combination of both. Regardless of the cause of damage, glaucomatous changes typically evolve through clearly discernible stages (Chart 58-6).

### Chart 58-6 • *Stages of Glaucoma*

1. **Initiating events.** Precipitating factors include illness, emotional stress, congenital narrow angles, long-term use of corticosteroids, and use of mydriatics (ie, medications causing pupillary dilation). These events may lead to the second stage.
2. **Structural alterations in the aqueous outflow system.** Tissue and cellular changes caused by factors that affect aqueous humor dynamics lead to structural alterations and may lead to the third stage.
3. **Functional alterations.** Conditions such as increased intraocular pressure or impaired blood flow create functional changes that may lead to the fourth stage.
4. **Optic nerve damage.** Atrophy of the optic nerve is characterized by loss of nerve fibers and blood supply. This fourth stage inevitably progresses to the fifth stage.
5. **Visual loss.** Progressive loss of vision is characterized by visual field defects.

## Classification of Glaucoma

There are several types of glaucoma. Although glaucoma classification is changing as knowledge increases, current clinical forms of glaucoma are identified as open-angle glaucoma, angle-closure glaucoma (also called pupillary block), congenital glaucoma, and glaucoma associated with other conditions, such as developmental anomalies or corticosteroid use. Glaucoma can be primary or secondary, depending on whether associated factors contribute to the rise in IOP. The two common clinical forms of glaucoma encountered in adults are primary open-angle glaucoma (POAG) and angle-closure glaucoma, which are differentiated by the mechanisms that cause impaired aqueous outflow. Table 58-3 summarizes the characteristics of the different types of open-angle and angle-closure glaucoma.

## Clinical Manifestations

Glaucoma is often called the "silent thief of sight" because most patients are unaware that they have the disease until they have experienced visual changes and vision loss. The patient may not seek health care until he or she experiences blurred vision or "halos" around lights, difficulty focusing, difficulty adjusting eyes in low lighting, loss of peripheral vision, aching or discomfort around the eyes, and headache.

## Assessment and Diagnostic Findings

The purpose of a glaucoma workup is to establish the diagnostic category, assess the optic nerve damage, and formulate a treatment plan. The patient's ocular and medical history must be detailed to investigate the history of predisposing factors. Four major types of examinations are used in glaucoma evaluation, diagnosis, and management: tonometry to measure the IOP, ophthalmoscopy to inspect the optic nerve, gonioscopy to examine the filtration angle of the anterior chamber, and perimetry to assess the visual fields.

The changes in the optic nerve related to glaucoma are pallor and cupping of the optic nerve disc. The pallor of the optic nerve is caused by a lack of blood supply that results from cellular destruction. Cupping is characterized by exaggerated bending of the blood vessels as they cross the optic

**Table 58-3 GLAUCOMA TYPES, CLINICAL MANIFESTATION, AND TREATMENT**

| Types of Glaucoma | Clinical Manifestations | Treatment |
|---|---|---|
| **Open-Angle Glaucoma** | | |
| Usually bilateral, but one eye may be more severely affected than the other. In all three types of open-angle glaucoma, the anterior chamber angle is open and appears normal. | | |
| Primary open-angle glaucoma (POAG) | Optic nerve damage, visual field defects, IOP >21 mm Hg. May have fluctuating IOPs. Usually no symptoms but possible ocular pain, headache, and halos. | Decrease IOP 20% to 50%. Additional topical and oral agents added as necessary. If medical treatment is unsuccessful, laser trabeculoplasty (LT) can decrease intraocular pressure by 20%. Glaucoma filtering surgery if continued optic nerve damage despite medication therapy and LT. |
| Normal tension glaucoma | IOP ≤21 mm Hg. Optic nerve damage, visual field defects. | Treatment similar to POAG, however, the best management for normal tension glaucoma management is yet to be established. Goal is to lower the IOP by at least 30%. |
| Ocular hypertension | Elevated IOP. Possible ocular pain or headache. | Decrease IOP by at least 20%. |
| **Angle-Closure (Pupillary Block) Glaucoma** | | |
| Obstruction in aqueous humor outflow due to the complete or partial closure of the angle from the forward shift of the peripheral iris to the trabecula. The obstruction results in an increased IOP. | | |
| Acute angle-closure glaucoma (AACG) | Rapidly progressive visual impairment, periocular pain, conjunctival hyperemia, and congestion. Pain may be associated with nausea, vomiting, bradycardia, and profuse sweating. Reduced central visual acuity, severely elevated IOP, corneal edema. Pupil is vertically oval, fixed in a semidilated position, and unreactive to light and accommodation. | Ocular emergency; administration of hyperosmotics, azetazolamide, and topical ocular hypotensive agents, such as pilocarpine and beta-blockers (betaxolol). Possible laser incision in the iris (iridotomy) to release blocked aqueous and reduce IOP. Other eye is also treated with pilocarpine eye drops and/or surgical management to avoid a similar spontaneous attack. |
| Subacute angle-closure glaucoma | Transient blurring of vision, halos around lights; temporal headaches and/or ocular pain; pupil may be semidilated. | Prophylactic peripheral laser iridotomy. Can lead to acute or chronic angle-closure glaucoma if untreated. |
| Chronic angle-closure glaucoma | Progression of glaucomatous cupping and significant visual field loss; IOP may be normal or elevated; ocular pain and headache. | Management similar to that for POAG: includes laser iridotomy and medications. |

IOP, intraocular pressure.

disc, resulting in an enlarged optic cup that appears more basinlike compared with a normal cup. The progression of cupping in glaucoma is caused by the gradual loss of retinal nerve fibers accompanied by the loss of blood supply, resulting in increased pallor of the optic disc.

As the optic nerve damage increases, visual perception in the area is lost. The localized areas of visual loss (ie, scotomas) represent loss of retinal sensitivity and nerve fiber damage and are measured and mapped by perimetry. The results are mapped on a graph. In patients with glaucoma, the graph has a distinct pattern that is different from other ocular diseases and is useful in establishing the diagnosis. Figure 58-8 shows the progression of visual field defects caused by glaucoma.

## Medical Management

The aim of all glaucoma treatment is prevention of optic nerve damage. Lifelong therapy is almost always necessary because glaucoma cannot be cured. Treatment focuses on pharmacologic therapy, laser procedures, surgery, or a combination of these approaches, all of which have potential complications and side effects. The object is to achieve the greatest benefit at the least risk, cost, and inconvenience to the patient. Although treatment cannot reverse optic nerve damage, further damage can be controlled. The goal is to maintain an IOP within a range unlikely to cause further damage.

The initial target for IOP among patients with elevated IOP and those with low-tension glaucoma with progressive visual field loss is typically set at 30% lower than the current pressure. The patient is monitored for changes in the appearance of the optic nerve. If there is evidence of progressive damage, the target IOP is again lowered until the optic nerve shows stability.

### *Pharmacologic Therapy*

Medical management of glaucoma relies on systemic and topical ocular medications that lower IOP. Periodic follow-up examinations are essential to monitor IOP, the appearance of the optic nerve, the visual fields, and side effects of medications. Therapy takes into account the patient's health and stage of glaucoma. Comfort, affordability, convenience, lifestyle, and personality are factors to consider in the patient's adherence to the medical regimen.

The patient is usually started on the lowest dose of topical medication and then advanced to increased concentrations until the desired IOP level is reached and maintained. Because of their efficacy, minimal dosing (can be used once each day), and low cost, beta-blockers are the preferred initial topical medications. One eye is treated first, with the other eye used as a control in determining the efficacy of the medication; once efficacy has been established, treatment of

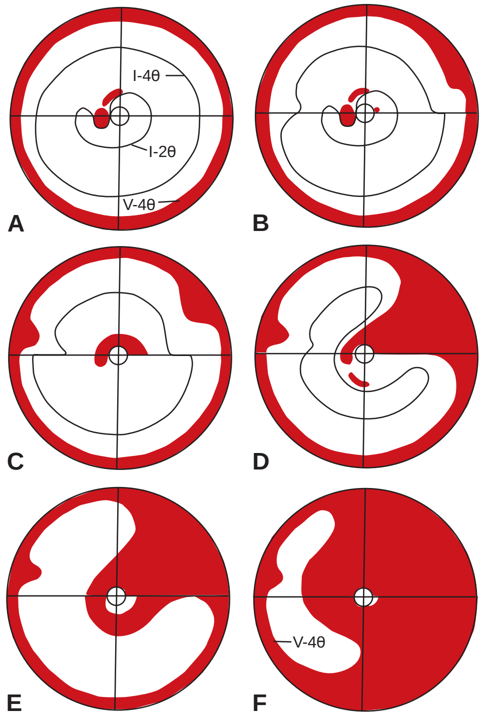



**Figure 58-8** Progression of glaucomatous visual field defects. A central scotoma at 10 to 20 degrees of fixation near the blind spot is the initial significant finding **(A, B)**. As the glaucoma progresses, the scotomas enlarge and deepen, resulting in peripheral vision loss. **C,** Defect within 5 degrees of fixation point nasally. **D,** Peripheral involvement enlarges. **E,** Ringlike scotoma. **F,** Eventually, vision is lost. The resulting "island of vision" becomes the characteristic visual field appearance of glaucoma and correlates with the "tunnel vision," in which peripheral vision is lost. From Kanski, J. J. (2007). *Clinical ophthalmology.* Oxford: Butterworth-Heinemann.

the other eye is started. If the IOP is elevated in both eyes, both are treated. When results are not satisfactory, a new medication is substituted. The main markers of the efficacy of the medication in glaucoma control are lowering of the IOP to the target pressure, appearance of the optic nerve head, and the visual field.

Several types of ocular medications are used to treat glaucoma (Table 58-4), including **miotics** (medications that cause pupillary constriction), adrenergic agonists (ie, sympathomimetic agents), beta-blockers, alpha$_2$-agonists (ie, adrenergic agents), carbonic anhydrase inhibitors, and prostaglandins. Cholinergics (ie, miotics) increase the outflow of the aqueous humor by affecting ciliary muscle contraction and pupil constriction, allowing flow through a larger opening between the iris and the trabecular meshwork. Adrenergic agonists increase aqueous outflow but primarily decrease aqueous production with an action similar to beta-blockers and carbonic anhydrase inhibitors. Prostaglandin analogues reduce IOP by increasing aqueous humor outflow. They can be used once daily and do not affect pupil size.

### *Surgical Management*

In *laser trabeculoplasty* for glaucoma, laser burns are applied to the inner surface of the trabecular meshwork to open the intratrabecular spaces and widen the canal of Schlemm, thereby promoting outflow of aqueous humor and decreasing IOP. The procedure is indicated when IOP is inadequately controlled by medications, and it is contraindicated when the trabecular meshwork cannot be fully visualized because of narrow angles. A serious complication of this procedure is a transient increase in IOP (usually 2 hours after surgery) that may become persistent. IOP assessment in the immediate postoperative period is essential.

In *laser iridotomy* for pupillary block glaucoma, an opening is made in the iris to eliminate the pupillary block. Laser iridotomy is contraindicated in patients with corneal edema, which interferes with laser targeting and strength. Potential complications are burns to the cornea, lens, or retina; transient elevated IOP; closure of the iridotomy; uveitis; and blurring. Pilocarpine (Pilocar) is usually prescribed to prevent closure of the iridotomy.

*Filtering procedures* for chronic glaucoma are used to create an opening or fistula in the trabecular meshwork to drain aqueous humor from the anterior chamber to the subconjunctival space into a bleb (fluid collection on the outside of the eye), thereby bypassing the usual drainage structures. This allows the aqueous humor to flow and exit by different routes (ie, absorption by the conjunctival vessels or mixing with tears). *Trabeculectomy* is the standard filtering technique used to remove part of the trabecular meshwork. Complications include hemorrhage, an extremely low (hypotony) or extremely elevated IOP, uveitis, cataracts, bleb failure, bleb leak, and endophthalmitis. Unlike other surgical procedures, the goal of the filtering procedure is to achieve incomplete healing of the surgical wound. The outflow of aqueous humor in a newly created drainage fistula is circumvented by the granulation of fibrovascular tissue or scar tissue formation on the surgical site. Scarring is inhibited by using antifibrosis agents such as the antimetabolites fluorouracil (Efudex) and mitomycin (Mutamycin). Like all antineoplastic agents, they require special handling procedures before, during, and after the procedure. Fluorouracil can be administered intraoperatively and by subconjunctival injection during follow-up; mitomycin is much more potent and is administered only intraoperatively.

*Drainage implants* or *shunts* are open tubes implanted in the anterior chamber to shunt aqueous humor to the episcleral plate in the conjunctival space. These implants are used when failure has occurred with one or more trabeculectomies in which antifibrotic agents were used. A fibrous capsule develops around the episcleral plate and filters the aqueous humor, thereby regulating the outflow and controlling IOP.

*Trabectome* surgery is reserved for patients in whom pharmacologic treatment and/or laser trabeculoplasty do not control the IOP sufficiently (Filippopoulos & Rhee, 2008). This minimally invasive procedure is specifically designed to improve fluid drainage from the eye to balance IOP. By restoring the eye's natural fluid balance, trabectome surgery stabilizes the optic nerve and minimizes further visual field damage. The surgery is performed through a small incision and does not require creation of a permanent hole in the eye wall or an external filtering bleb or an implant.

**Table 58-4 MEDICATIONS USED IN THE MANAGEMENT OF GLAUCOMA**

| Medication | Action | Side Effects | Nursing Implications |
|---|---|---|---|
| Cholinergics (miotics) (pilocarpine, carbachol) | Increases aqueous fluid outflow by contracting the ciliary muscle and causing miosis (constriction of the pupil) and opening of trabecular meshwork | Periorbital pain, blurry vision, difficulty seeing in the dark | Caution patients about diminished vision in dimly lit areas. |
| Adrenergic agonists (dipivefrin, epinephrine) | Reduces production of aqueous humor and increases outflow | Eye redness and burning; can have systemic effects, including palpitations, elevated blood pressure, tremor, headaches, and anxiety | Teach patients punctal occlusion to limit systemic effects (described in Chart 58-13). |
| Beta-blockers (betaxolol, timolol) | Decreases aqueous humor production | Can have systemic effects, including bradycardia, exacerbation of pulmonary disease, and hypotension | Contraindicated in patients with asthma, chronic obstructive pulmonary disease, second- or third-degree heart block, bradycardia, or cardiac failure; teach patients punctal occlusion to limit systemic effects. |
| Alpha-adrenergic agonists (apraclonidine, brimonidine) | Decreases aqueous humor production | Eye redness, dry mouth and nasal passages | Teach patients punctal occlusion to limit systemic effects. |
| Carbonic anhydrase inhibitors (acetazolamide, methazolamide, dorzolamide) | Decreases aqueous humor production | Oral medications (acetazolamide and methazolamide) associated with serious side effects, including anaphylactic reactions, electrolyte loss, depression, lethargy, gastrointestinal upset, impotence, and weight loss; side effects of topical form (dorzolamide) include topical allergy | Do not administer to patients with sulfa allergies; monitor electrolyte levels. |
| Prostaglandin analogs (latanoprost, bimatoprost) | Increases uveoscleral outflow | Darkening of the iris, conjunctival redness, possible rash | Instruct patients to report any side effects. |

## Nursing Management

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The medical and surgical management of glaucoma slows the progression of glaucoma but does not cure it. The lifelong therapeutic regimen mandates patient education. The nature of the disease and the importance of strict adherence to the medication regimen must be included in a teaching plan to help ensure compliance. A thorough discussion of the medication program, particularly the interactions of glaucoma-control medications with other medications, is essential. For example, the diuretic effect of acetazolamide (Diamox) has an additive effect on the diuretic effects of other antihypertensive medications and can result in hypokalemia. The effects of glaucoma-control medications on vision must also be explained. Miotics and sympathomimetics result in altered focus; therefore, patients need to be cautious in navigating their surroundings. Information about instilling ocular medication and preventing systemic absorption with punctal occlusion is given in the section of this chapter on ophthalmic medications.

Nurses in all settings encounter patients with glaucoma. Even patients with long-standing disease and those with glaucoma as a secondary diagnosis should be assessed for knowledge level and compliance with the therapeutic regimen. Chart 58-7 contains points to review with patients with glaucoma.

**CHART 58-7 PATIENT EDUCATION**

***Managing Glaucoma***

- Know your intraocular pressure (IOP) measurement and the desired range.
- Be informed about the extent of your vision loss and optic nerve damage.
- Keep a record of your eye pressure measurements and visual field test results to monitor your own progress.
- Review all your medications (including over-the-counter and herbal medications) with your ophthalmologist, and mention any side effects each time you visit.
- Ask about potential side effects and drug interactions of your eye medications.
- Ask whether generic or less costly forms of your eye medications are available.
- Review the dosing schedule with your ophthalmologist and inform him or her if you have trouble following the schedule.
- Participate in the decision-making process. Let your doctor know what dosing schedule works for you and other preferences regarding your eye care.
- Have the nurse observe you instilling eye medication to determine whether you are administering it properly.
- Be aware that glaucoma medications can cause adverse effects if used inappropriately. Eye drops are to be administered as prescribed, not when eyes feel irritated.
- Ask your ophthalmologist to send a report to your doctor after each appointment.
- Keep all follow-up appointments.

### Continuing Care

For the patient with severe glaucoma and impaired function, referral to services that assist the patient in performing ADLs may be needed. The loss of peripheral vision impairs mobility the most. These patients need to be referred for low vision and rehabilitation services. Patients who meet the criteria for legal blindness should be offered referrals to agencies that can assist them in obtaining federal assistance.

Reassurance and emotional support are important aspects of care. A lifelong disease involving possible loss of sight has psychological, physical, social, and vocational ramifications. The family must be integrated into the plan of care, and because the disease has a familial tendency, family members should be encouraged to undergo examinations at least once every 2 years to detect glaucoma early.

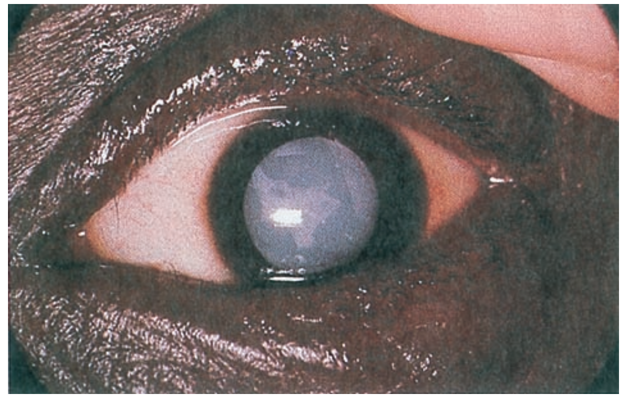


**Figure 58-9** A cataract is a cloudy or opaque lens. On visual inspection, the lens appears gray or milky. From Rubin, E., Gorstein, F., Rubin, R., et al. (2005). *Pathology* (4th ed.). Philadelphia: Lippincott Williams & Wilkins.

# Cataracts

A cataract is a lens opacity or cloudiness (Fig. 58-9). Cataracts rank behind only arthritis and heart disease as a leading cause of disability in older adults. Cataracts affect nearly 20.5 million Americans who are 40 years of age or older, or about one in six people in this age range. By 80 years of age, more than half of all Americans have cataracts. According to the World Health Organization, cataract is the leading cause of blindness in the world (Prevent Blindness America, 2008).

## Pathophysiology

Cataracts can develop in one or both eyes at any age as a result of a variety of causes (Chart 58-8). Cigarette smoking, long-term use of corticosteroids, especially at high doses, sunlight and ionizing radiation, diabetes, obesity, and eye injuries can increase the risk of cataracts. Recent studies have linked cataract risk to lower income and educational level, smoking for 35 or more pack-years, and high triglyceride levels in men (Klein, Klein, Lee, et al., 2003). The three most common types of senile (age-related) cataracts are defined by their location in the lens: nuclear, cortical, and posterior subcapsular. The extent of visual impairment depends on their size, density, and location in the lens. More than one type can be present in one eye.

A nuclear cataract is caused by central opacity in the lens and has a substantial genetic component. It is associated with myopia (ie, nearsightedness), which worsens when the cataract progresses. If dense, the cataract severely blurs vision. Periodic changes in prescription eyeglasses help manage this condition.

**CHART 58-8** *Risk Factors for Cataract Formation*

**Aging**

- Loss of lens transparency
- Clumping or aggregation of lens protein (which leads to light scattering)
- Accumulation of a yellow-brown pigment due to the breakdown of lens protein
- Decreased oxygen uptake
- Increase in sodium and calcium
- Decrease in levels of vitamin C, protein, and glutathione (an antioxidant)

**Associated Ocular Conditions**

- Retinitis pigmentosa
- Myopia
- Retinal detachment and retinal surgery
- Infection (eg, herpes zoster, uveitis)

**Toxic Factors**

- Corticosteroids, especially at high doses and in long-term use
- Alkaline chemical eye burns, poisoning
- Cigarette smoking
- Calcium, copper, iron, gold, silver, and mercury, which tend to deposit in the pupillary area of the lens

**Nutritional Factors**

- Reduced levels of antioxidants
- Poor nutrition
- Obesity

**Physical Factors**

- Dehydration associated with chronic diarrhea, use of purgatives in anorexia nervosa, and use of hyperbaric oxygenation
- Blunt trauma, perforation of the lens with a sharp object or foreign body, electric shock
- Ultraviolet radiation in sunlight and x-ray

**Systemic Diseases and Syndromes**

- Diabetes mellitus
- Down syndrome
- Disorders related to lipid metabolism
- Renal disorders
- Musculoskeletal disorders

A cortical cataract involves the anterior, posterior, or equatorial cortex of the lens. A cataract in the equator or periphery of the cortex does not interfere with the passage of light through the center of the lens and has little effect on vision. Cortical cataracts progress at a highly variable rate. Vision is worse in very bright light. People with the highest levels of sunlight exposure have twice the risk of developing cortical cataracts as those with low-level sunlight exposure.

Posterior subcapsular cataracts occur in front of the posterior capsule. This type typically develops in younger people and, in some cases, is associated with prolonged corticosteroid use, diabetes, or ocular trauma. Near vision is diminished, and the eye is increasingly sensitive to glare from bright light (eg, sunlight, headlights). Caucasians are more likely to develop nuclear and posterior subcapsular cataracts, whereas cortical cataracts are more prevalent among African Americans.

## Clinical Manifestations

Painless, blurry vision is characteristic of cataracts. The person perceives that surroundings are dimmer, as if his or her glasses need cleaning. Light scattering is common, and the person experiences reduced contrast sensitivity, sensitivity to glare, and reduced visual acuity. Other effects include myopic shift (return of ability to do close work [eg, reading fine print] without eyeglasses), astigmatism, monocular **diplopia** (double vision), color shift (the aging lens become progressively more absorbent at the blue end of the spectrum), brunescens (color values shift to yellow-brown), and reduced light transmission.

## Assessment and Diagnostic Findings

Decreased visual acuity is directly proportionate to cataract density. The Snellen visual acuity test, ophthalmoscopy, and slit-lamp biomicroscopic examination are used to establish the degree of cataract formation. The degree of lens opacity does not always correlate with the patient's functional status. Some patients can perform normal activities despite clinically significant cataracts. Others with less lens opacification have a disproportionate decrease in visual acuity; hence, visual acuity is an imperfect measure of visual impairment.

## Medical Management

No nonsurgical (medications, eyedrops, eyeglasses) treatment cures cataracts or prevents age-related cataracts. Results from the Age-Related Eye Disease Study Research Group (2001b), a randomized, placebo-controlled trial, found no benefit from antioxidant supplements, vitamins C and E, beta-carotene, and selenium. Results of studies that have attempted to determine the possible benefit of a once-a-day multivitamin supplement to prevent or delay the onset of cataracts have been mixed. (Clinical Trial of Nutritional Supplements and Age-Related Cataract Study Group, 2008). In the early stages of cataract development, glasses, contact lenses, strong bifocals, or magnifying lenses may improve vision.

### *Surgical Management*

In general, if reduced vision from cataract does not interfere with normal activities, surgery may not be needed. In deciding when cataract surgery is to be performed, the patient's functional and visual status should be a primary consideration. Surgery is performed on an outpatient basis and usually takes less than 1 hour, with the patient being discharged in 30 minutes or less afterward. Although complications from cataract surgery are uncommon, they can have significant effects on vision (Table 58-5). Restoration of visual function through a safe and minimally invasive procedure is the surgical goal, which is achieved with advances in topical anesthesia, smaller wound incision (ie, clear cornea incision), and lens design (ie, foldable and more accurate intraocular lens measurements).

Injection-free topical and intraocular anesthesia, such as 1% lidocaine gel applied to the surface of the eye, eliminates the hazards of regional (retrobulbar and peribulbar) anesthesia, such as ocular perforation, retrobulbar hemorrhage, optic injuries, diplopia, and ptosis, and is ideal for patients receiving anticoagulants. Furthermore, patients can communicate and cooperate during surgery. Intravenous (IV) moderate sedation may be used to minimize anxiety and discomfort.

When both eyes have cataracts, one eye is treated first, with at least several weeks, preferably months, separating the two procedures. Because cataract surgery is performed to improve visual functioning, the delay for the other eye gives time for the patient and the surgeon to evaluate whether the results from the first surgery are adequate to preclude the need for a second operation. The delay also provides time for the first eye to recover; if there are any complications, the surgeon may decide to perform the second procedure differently.

#### Phacoemulsification

In this method of extracapsular cataract surgery, a portion of the anterior capsule is removed, allowing extraction of the lens nucleus and cortex while the posterior capsule and zonular support are left intact. An ultrasonic device is used to liquefy the nucleus and cortex, which are then suctioned out through a tube. An intact zonular–capsular diaphragm provides the needed safe anchor for the posterior chamber intraocular lens (IOL). After the pupil has been dilated and the surgeon has made a small incision on the upper edge of the cornea, a viscoelastic substance (clear gel) is injected into the space between the cornea and the lens. This prevents the space from collapsing and facilitates insertion of the IOL. Because the incision is smaller than the manual extracapsular cataract extraction, the wound heals more rapidly, and there is early stabilization of refractive error and less astigmatism. New phaco needles that are used to cut and aspirate the cataract permit safe and efficient removal of nearly all cataracts through a clear cornea incision (Hoffman, Fine & Packer, 2005). With increasing frequency, self-sealing (sutureless) clear corneal incisions in the temporal part of the cornea are performed with phacoemulsification, minimizing postoperative astigmatism and thus decreasing bleeding and subconjunctival hemorrhage while speeding recovery of visual acuity.

#### Lens Replacement

After removal of the crystalline lens, the patient is referred to as *aphakic* (ie, without lens). The lens, which focuses light on the retina, must be replaced for the patient to see clearly. There are three lens replacement options: aphakic eyeglasses, contact lenses, and IOL implants.

Aphakic glasses, although effective, are rarely used. Objects are magnified by 25%, making them appear closer than

**Table 58-5 POTENTIAL COMPLICATIONS OF CATARACT SURGERY**

| Complication | Effects | Management and Outcome |
|---|---|---|
| **Immediate Preoperative** | | |
| Retrobulbar hemorrhage: can result from retrobulbar infiltration of anesthetic agents if the short ciliary artery is located by the injectia | Increased IOP, proptosis, lid tightness, and subconjunctival hemorrhage with or without edema | Emergent lateral canthotomy (slitting of the canthus) is performed to stop central retinal perfusion when the IOP is dangerously elevated. If this procedure fails to reduce IOP, a puncture of the anterior chamber with removal of fluid is considered. The patient must be closely monitored for at least a few hours. Postponement of cataract surgery for 2 to 4 weeks is advised. Complications such as iris prolapse, vitreous loss, and choroidal hemorrhage could result in a catastrophic visual outcome. |
| **Intraoperative Complications** | | |
| Rupture of the posterior capsule | May result in loss of vitreous | Anterior vitrectomy is required if vitreous loss occurs. |
| Suprachoroidal (expulsive) hemorrhage: profuse bleeding into the suprachoroidal space | Extrusion of intraocular contents from the eye or opposition of retinal surfaces | Closure of the incision and administration of a hyperosmotic agent to reduce IOP or corticosteroids to reduce intraocular inflammation. Vitrectomy is performed 1 to 2 weeks later. Visual prognosis is poor; some useful vision may be salvaged on rare occasions. |
| **Early Postoperative Complications** | | |
| Acute bacterial endophthalmitis: devastating complication that occurs in about 1 in 1000 cases; the most common causative organisms are *Staphylococcus epidermidis*, *S. aureus*, *Pseudomonas* and *Proteus* species | Characterized by marked visual loss, pain, lid edema, hypopyon, corneal haze, and chemosis | Managed by aggressive antibiotic therapy. Broad-spectrum antibiotics are administered while awaiting culture and sensitivity results. Once results are obtained, the appropriate antibiotics are administered via intravitreal injection. Corticosteroid therapy is also administered. |
| Toxic anterior segment syndrome: noninfectious inflammation that is a complication of anterior chamber surgery; caused by a toxic agent such as an agent used to sterilize surgical instruments | Corneal edema occurs less than 24 hours after surgery; symptoms include reduced visual acuity and pain | If there is no growth of microorganisms, the treatment is topical steroids alone. |
| **Late Postoperative Complications** | | |
| Suture-related problems | Toxic reactions or mechanical injury from broken or loose sutures | Suture removal relieves the symptoms. Topical corticosteroids are used when the incision is not healed and sutures cannot be removed. |
| Malposition of the IOL | Results in astigmatism, sensitivity to glare, or appearance of halos | Miotics are used for mild cases, whereas IOL removal and replacement is necessary for severe cases. |
| Chronic endophthalmitis | Persistent, low-grade inflammation and granuloma | Corticosteroids and antibiotics are administered systemically. If the condition persists, removal of the IOL and capsular bag, vitrectomy, and intravitreal injection of antibiotics are required. |
| Opacification of the posterior capsule (most common late complication of extracapsular cataract extraction) | Visual acuity is diminished | YAG laser is used to create a hole in the posterior capsule. Blurred vision is cleared immediately. |

IOL, intraocular lens; IOP, intraocular pressure.

they actually are. This magnification creates distortion. Peripheral vision is also limited, and **binocular vision** (ie, ability of both eyes to focus on one object and fuse the two images into one) is impossible if the other eye is phakic (normal).

Contact lenses provide patients with almost normal vision, but because contact lenses need to be removed occasionally, the patient also needs a pair of aphakic glasses. Contact lenses are not advised for patients who have difficulty inserting, removing, and cleaning them. Frequent handling and improper disinfection increase the risk of infection.

Insertion of IOLs during cataract surgery is the usual approach to lens replacement. After cataract extraction, or phacoemulsification, the surgeon implants an IOL. Cataract extraction and posterior chamber IOLs are associated with a relatively low incidence of complications (eg, hyphema, macular edema, secondary glaucoma, damage to the corneal endothelium). IOL implantation is contraindicated in patients with recurrent uveitis, proliferative diabetic retinopathy, neovascular glaucoma, or rubeosis iridis.

The most common IOL is the single-focus lens or monofocal IOL. Eyeglasses are still needed for distant or close vision, because the single-focus lens, unlike the natural lens of the eye, cannot alter its shape to bring objects at different distances into focus. Multifocal IOLs reduce the need for eyeglasses (near, intermediate, or far vision). Accommodative IOLs mimic the accommodative response of the youthful, phakic eye and are also known as presbyopia-correcting IOLs (Fong, 2007). A combined surgical approach using customized IOLs and refractive surgery for a customized vision correction is now proving beneficial for elderly patients (Fine, Hoffman & Packer, 2007).

#### *Toxic Anterior Segment Syndrome*

Toxic anterior segment syndrome (TASS), which is also known as toxic endothelial cell destruction or sterile endophthalmitis, is a noninfectious anterior segment inflammation caused by a toxic agent within days of an uncomplicated and uneventful cataract surgery. In recent years, TASS has emerged as a complication of increasing frequency. Investigations have shown that it may be caused by toxins from improperly rinsed surgical instruments soaked in enzymatic detergents, residue from instruments sterilized with plasma gas, abnormalities in the pH or ionic composition of irrigation solutions, ophthalmic viscoelastic devices, intraocular medications, or even the finish of the IOL (Mamalis, Edelhauser, Dawson, et al., 2006). Specific intraoperative causes have been identified such as endotoxin contamination of balanced salt solution and antibiotic ointment penetrating the anterior chamber (Holland, Morck & Lee, 2007). Decontamination and cleaning of ophthalmic instruments should follow recommended procedures, in particular use of enzymatic solutions and rinsing with copious amounts of deionized or distilled water.

TASS is characterized by corneal edema that occurs less than 24 hours after surgery, compared with classic endophthalmitis, which appears 48 to 72 hours after surgery and is bacterial in nature. Like classic endophthalmitis, the symptoms include reduction in visual acuity and pain. In the absence of micro-organism growth, improvement has occurred with topical steroid treatment alone.

### Nursing Management

The patient with cataracts should receive the usual preoperative care for ambulatory surgical patients undergoing eye surgery. The standard battery of preoperative tests (eg, complete blood count, electrocardiogram, urinalysis) that were once required in all cases are prescribed only if they are indicated by the patient's medical history.

#### *Providing Preoperative Care*

It has been common practice to withhold any anticoagulant therapy (eg, aspirin, warfarin [Coumadin]) to reduce the risk of retrobulbar hemorrhage (after retrobulbar injection) for 5 to 7 days before surgery. However, a recent study showed that the risk of adverse events for patients who continued anticoagulant therapy before cataract surgery was very low (0.1% to 0.8%). The researchers speculated that regular users of aspirin or warfarin are already at higher risk for transient ischemic attacks or angina and suggest that patients may not need to discontinue these medications prior to surgery (Katz, Feldman, Bass, et al., 2003).

Dilating drops are administered every 10 minutes for four doses at least 1 hour before surgery. Additional dilating drops may be administered in the operating room (immediately before surgery). Antibiotic, corticosteroid, and anti-inflammatory drops may be administered prophylactically to prevent postoperative infection and inflammation.

#### *Providing Postoperative Care*

Before discharge, the patient receives verbal and written instructions about how to protect the eye, administer medications, recognize signs of complications, and obtain emergency care. Activities to be avoided are identified in Chart 58-9. The nurse also explains that there should be minimal discomfort after surgery and instructs the patient to take a mild analgesic agent, such as acetaminophen, as needed. Antibiotic, anti-inflammatory, and corticosteroid eye drops or ointments are prescribed postoperatively. A clinical pathway for the care of patients undergoing ambulatory cataract surgery is presented in Appendix B at the end of this textbook.

#### *Promoting Home and Community-Based Care*

**Teaching Patients Self-Care**

To prevent accidental rubbing or poking of the eye, the patient wears a protective eye patch for 24 hours after surgery, followed by eyeglasses worn during the day and a metal shield worn at night for 1 to 4 weeks. The nurse instructs the patient and family in applying and caring for the eye shield. Sunglasses should be worn while outdoors during the day because the eye is sensitive to light.

Slight morning discharge, some redness, and a scratchy feeling may be expected for a few days. A clean, damp washcloth may be used to remove slight morning eye discharge. Because cataract surgery increases the risk of retinal detachment, the patient must know to notify the surgeon if new floaters (dots) in vision, flashing lights, decrease in vision, pain, or increase in redness occurs.

**Continuing Care**

The eye patch is removed after the first follow-up appointment. The patient may experience blurring of vision for several days to weeks. Sutures, if used, are left in the eye but alter the curvature of the cornea, resulting in temporary blurring and some astigmatism. Vision gradually improves as the eye heals. Patients with IOL implants have functional vision on the first day after surgery. Vision is stabilized when the eye is completely healed, usually within 6 to 12 weeks, when final corrective prescription is completed. Visual correction may still be needed for any remaining refractive errors. Patients who choose multifocal IOLs should be aware that there may be increased night glare and contrast sensitivity.

## CORNEAL DISORDERS

## *Corneal Dystrophies*

Corneal dystrophies are inherited as autosomal dominant traits and manifest when the person is about 20 years of age. They are characterized by deposits in the corneal layers. Decreased vision is caused by the irregular corneal surface and

CHART 58-9

HOME CARE CHECKLIST
*Intraocular Lens Implant*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Wear glasses or metal eye shield at all times following surgery as instructed by the physician. | ✔ | |
| • Always wash hands before touching or cleaning the postoperative eye. | ✔ | ✔ |
| • Clean postoperative eye with a clean tissue; wipe the closed eye with a single gesture from the inner canthus outward. | ✔ | ✔ |
| • Bathe or shower; shampoo hair cautiously or seek assistance. | ✔ | |
| • Avoid lying on the side of the affected eye the night after surgery. | ✔ | |
| • Keep activity light (eg, walking, reading, watching television). Resume the following activities only as directed by the physician: driving, sexual activity, unusually strenuous activity. | ✔ | |
| • Avoid lifting, pushing, or pulling objects heavier than 15 lb. | ✔ | |
| • Avoid bending or stooping for an extended period. | ✔ | |
| • Be careful when climbing or descending stairs. | ✔ | |
| • Know when to contact the physician.* | ✔ | ✔ |

*Contact the physician immediately if any of the following problems occur before the next physician's appointment: (1) vision changes; (2) continuous flashing lights appear to the affected eye; (3) redness, swelling, or pain increase in the eye; (4) the amount or type of eye drainage changes; (5) the eye is injured in any way; (6) significant pain is not relieved by acetaminophen.

corneal deposits. Corneal endothelial decompensation leads to corneal edema and blurring of vision. Persistent edema leads to **bullous keratopathy** (formation of blisters that cause pain and discomfort on rupturing). This condition is usually associated with primary open-angle glaucoma.

A bandage contact lens is used to flatten the bullae, protect the exposed corneal nerve endings, and relieve discomfort. Symptomatic treatments, such as hypertonic drops or ointment (5% sodium chloride), may reduce epithelial edema; lowering the IOP also reduces stromal edema.

## Keratoconus

**Keratoconus** is a condition characterized by a conical protuberance of the cornea with progressive thinning on protrusion and irregular astigmatism. This hereditary condition has a higher incidence among women. Onset occurs at puberty; the condition may progress for more than 20 years and is bilateral. Corneal scarring occurs in severe cases. Blurred vision is a prominent symptom. Rigid, gas-permeable contact lenses correct irregular astigmatism and improve vision. Advances in contact lens design have reduced the need for surgery. Penetrating keratoplasty is indicated when contact lens correction is no longer effective.

## Corneal Surgeries

Among the surgical procedures used to treat diseased corneal tissue are phototherapeutic keratectomy, penetrating keratoplasty and corneal endothelial transplantation, and Descemet's stripping endothelial keratoplasty.

### Phototherapeutic Keratectomy

Phototherapeutic keratectomy (PTK) is a laser procedure that is used to treat diseased corneal tissue by removing or reducing corneal opacities and smoothing the anterior corneal surface to improve functional vision. PTK is a safer, more effective (when indicated) alternative than penetrating or lamellar keratoplasty. PTK is contraindicated in patients with active herpetic keratitis because the ultraviolet rays may reactivate latent virus. Common side effects are induced hyperopia and stromal haze. Complications are delayed reepithelization (particularly in patients with diabetes) and bacterial keratitis. Postoperative management consists of oral analgesics for eye pain. Reepithelization is promoted with a pressure patch or therapeutic soft contact lens. Antibiotic and corticosteroid ointments and nonsteroidal anti-inflammatory agents (NSAIDs) are prescribed postoperatively. Follow-up examinations are required for up to 2 years.

### Penetrating Keratoplasty

Penetrating keratoplasty (PKP; corneal transplantation or corneal grafting) involves replacing abnormal host tissue with healthy donor (cadaver) corneal tissue. Common indications are keratoconus, corneal dystrophy, corneal scarring from herpes simplex keratitis, and chemical burns.

Several factors affect the success of the graft: the condition of the ocular structures (eg, lids, conjunctiva), quality of the tears, adequacy of blinking, and viability of the donor endothelium. Tissue that is typically not used for grafting (Chart 58-10) includes tissue that may be the source of disease transmission from donor to recipient; corneas with functionally compromised endothelium; and corneas from donors who have undergone LASIK, because the cornea is no longer intact. Conditions such as glaucoma, retinal

### Chart 58-10 • *Contraindications to the Use of Donor Tissue for Corneal Transplantation: Donor Characteristics*

**Systemic Disorders**

- Death from unknown cause
- Creutzfeldt-Jacob disease
- AIDS or high risk for HIV infection
- Hepatitis
- Eye infection, systemic infection

**Intrinsic Eye Disease**

- Retinoblastoma
- Ocular inflammation
- Malignant tumors of anterior segment
- Disorders of the conjunctiva or corneal surface involving the optical zone of the cornea

**Other**

- History of eye trauma
- Corneal scars
- Previous surgical procedure
- Corneal graft
- LASIK eye surgery

disease, and **strabismus** (deviation in ocular alignment) can negatively affect the outcome.

In PKP, the surgeon determines the graft size before the procedure, and the appropriate size is marked on the surface of the cornea. The surgeon prepares the donor cornea and the recipient bed, removes the diseased cornea, places the donor cornea on the recipient bed, and sutures it in place. Sutures remain in place for 12 to 18 months and are then removed. Potential complications include early graft failure due to poor quality of donor tissue, surgical trauma, acute infection, and persistently increased IOP and late graft failure due to rejection.

Postoperatively, the patient receives **mydriatics** (medications causing pupillary dilation) for 2 weeks and topical corticosteroids for 12 months (daily doses for 6 months and tapered doses thereafter). These mydriatics and corticosteroid drops should be preservative free to prevent a reactive inflammation. Patients typically describe a sensation of postoperative eye discomfort rather than acute pain.

### Descemet's Stripping Endothelial Keratoplasty

For the past 50 years, PKP has been the standard of care for patients with corneal endothelial failure but with poor refractive results. Recently, a technique known as Descemet's stripping endothelial keratoplasty (DSEK) has been developed. Layers of the cornea are dissected and selectively replaced by donor cornea tissue. DSEK offers several advantages such as less postoperative astigmatism, faster visual recovery, and stronger wound integrity. Theoretically, the risk of rejection is less because less of the patient's tissue is replaced.

### Nursing Management

For corneal surgeries, the nurse reinforces the surgeon's recommendations and instructions regarding visual rehabilitation and visual improvement. A technically successful graft may initially produce disappointing results because the procedure has produced a new optical surface. Only after several months do patients start seeing the natural and true colors of their environment. Correction of a resultant refractive error with eyeglasses or contact lenses determines the final visual outcome. The nurse assesses the patient's support system and his or her ability to comply with long-term follow-up, which includes frequent clinic visits for several months for tapering of topical corticosteroid therapy, selective suture removal, and ongoing evaluation of the graft site and visual acuity. The nurse also initiates appropriate referrals to community services when indicated.

Because graft failure is an ophthalmic emergency that can occur at any time, the primary goal of nursing care is to teach the patient to identify signs and symptoms of graft failure. The early symptoms are blurred vision, discomfort, tearing, or redness of the eye. Decreased vision results after graft destruction. The patient must contact the ophthalmologist as soon as symptoms occur. Treatment of graft rejection involves prompt administration of hourly topical corticosteroids and periocular corticosteroid injections. Systemic immunosuppressive agents may be necessary for severe, resistant cases.

In DSEK, the nurse keeps the patient in a supine position postoperatively for 1 hour and instructs the patient to remain supine until the first postoperative day (Pramanik, Goins & Sutphin, 2007). Patients are maintained on low-dose topical corticosteroids indefinitely (Price & Price, 2007).

## Refractive Surgeries

Refractive surgeries are cosmetic, elective procedures performed to recontour corneal tissue and correct refractive errors so that eyeglasses or contact lenses are no longer needed. Both photorefractive keratectomy (PRK) and LASIK use an excimer laser (193-nm wavelength argon fluoride laser), which can evaporate corneal tissue very cleanly with almost no damage to the epithelial cells. Newer excimer lasers have a smaller spot size, a robust tracking system for eye movements, and wavefront custom ablation technology. These advances have minimized or eliminated aberrations induced by conventional laser vision correction as well as preexisting aberrations; they have improved treatment accuracy and therefore have provided for better vision, including the reduction of postoperative night vision problems.

Laser vision correction alters the major optical function of the eye and thereby carries certain surgical risks. The patient must fully understand the benefits, potential risks and complications, common side effects, and limitations of the procedure. Refractive surgery does not alter the normal aging process of the eye. If the reason for the procedure is to meet vision requirements for the patient's occupation, the results must satisfy both the patient and the employer. Precise visual outcome cannot be guaranteed. Typically, patients must be at least 18 years of age.

The corneal structure must be normal and the refractive error must be stable. The patient is required to discontinue using contact lenses for a period before the procedure (2 to 3 weeks for soft lenses and 4 weeks for hard lenses). Patients with conditions that are likely to adversely affect corneal wound healing (eg, corticosteroid use, immunosuppression, elevated IOP) are not good candidates for the procedure.

Any superficial eye disease must be diagnosed and fully treated before a refractive procedure.

Patient satisfaction is the ultimate goal; therefore, patient education and counseling about potential risks, complications, and postoperative follow-up are critical. Minimal postoperative care includes topical corticosteroid or NSAID and antibiotic drops.

## Laser Vision Correction Photorefractive Keratectomy

PRK is used to treat myopia and hyperopia with or without astigmatism. The excimer laser is applied directly to the cornea according to carefully calculated measurements. For myopia, the relative curvature is decreased; for hyperopia, the relative curvature is increased. A bandage contact lens is placed over the cornea to promote epithelial healing and reduce pain, which is similar to that of a severe corneal abrasion. The major limitations of this procedure are postoperative pain, corneal haze, and prolonged recovery of vision.

## Laser-Assisted In Situ Keratomileusis

An improvement over PRK, particularly for correcting high (severe) myopia, LASIK involves flattening the anterior curvature of the cornea by removing a stromal lamella or layer. The surgeon creates a corneal flap with a microkeratome, which is an automatic corneal shaper similar to a carpenter's plane. The surgeon retracts a flap of corneal tissue less than one-third the thickness of a human hair to access the corneal stroma and then uses the excimer laser on the stromal bed to reshape the cornea according to calculated measurements (Fig. 58-10). LASIK causes less postoperative discomfort, has fewer side effects, and is safer than PRK. The patient has no corneal haze and requires less postoperative care. However, with LASIK, the cornea has been invaded at a deeper level, and any complications are more significant than those that can occur with PRK. With the increasing success and popularity of LASIK, PRK is now reserved for patients who are unsuitable for LASIK, such as people with very thin corneas.

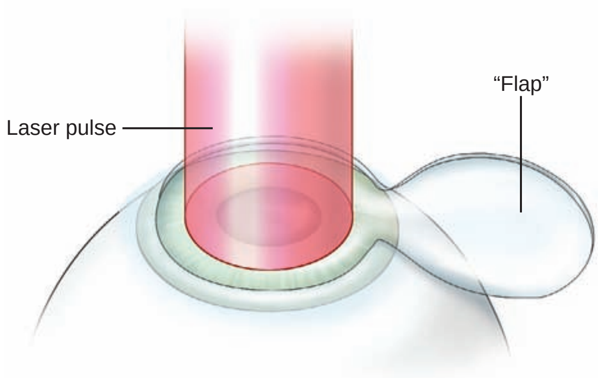



**Figure 58-10** LASIK combines delicate surgical procedures and laser treatment. A flap is surgically created and lifted to one side. A laser is then applied to the cornea to reshape it. With permission from The Wilmer Laser Vision Center, Lutherville, MD.

### *Perioperative Complications*

#### Surgically Induced Abnormalities

Corneal surface irregularities can occur after LASIK treatment. These include central islands (central areas of stiffness or elevation), decentered ablations resulting from misalignment of the laser treatment or from involuntary eye movement during laser treatment, and forms of irregular astigmatism. Symptoms of central islands and decentered ablations include monocular diplopia or ghost images, halos, glare, and decreased visual acuity.

#### Diffuse Lamellar Keratitis

As LASIK is performed more frequently, the vision-threatening complication known as diffuse lamellar keratitis (DLK) is reported more often. DLK is a peculiar, noninfectious, inflammatory reaction in the lamellar interface after LASIK. DLK seems to be strongly associated with a decrease of contrast sensitivity up to 6 months postoperatively (Han, Wee, Lee, et al., 2007). Depending on the severity of the condition, treatment methods range from administering corticosteroid drops to intervening surgically.

## Phakic Intraocular Lenses

Because the results of refractive surgery on high (severe) myopia, hyperopia, and astigmatism are less predictable, there has been increasing interest in the use of phakic IOL implantation in patients who retain their natural lens. These phakic IOLs may be used in either the anterior or posterior chamber. The implantation of such devices is reversible because the natural lens is left in place and the normal architecture of the cornea is preserved. This procedure may provide more predictable refractive results than procedures that alter the corneal curvature. Potential complications include cataract, iritis or uveitis, endothelial cell loss, and increased IOP.

Although phakic IOL implantation provides a more predictable alternative to corneal refractive surgery, more controlled, longitudinal multicenter trials are needed to evaluate its long-term safety. The design of phakic IOLs continues to improve.

## Conductive Keratoplasty

A recent innovation in refractive surgery for the correction of low to mild hyperopia uses the principles of thermal keratoplasty by applying radiofrequency current to the peripheral cornea using a thin, hand-held probe. It does not involve the removal of cornea tissue. Clinical trials have shown that postprocedure visual acuity, predictability, and stability are as good as, if not better than, with other refractive procedures (Du, Fan & Asbell, 2007).

# RETINAL DISORDERS

Although the retina is composed of multiple microscopic layers, the two innermost layers, the sensory retina and the retinal pigment epithelium (RPE), are the most relevant to common retinal disorders. Just as the film in a camera captures an image, so does the retina, the neural tissue of the eye. The rods and cones, the photoreceptor cells, are found

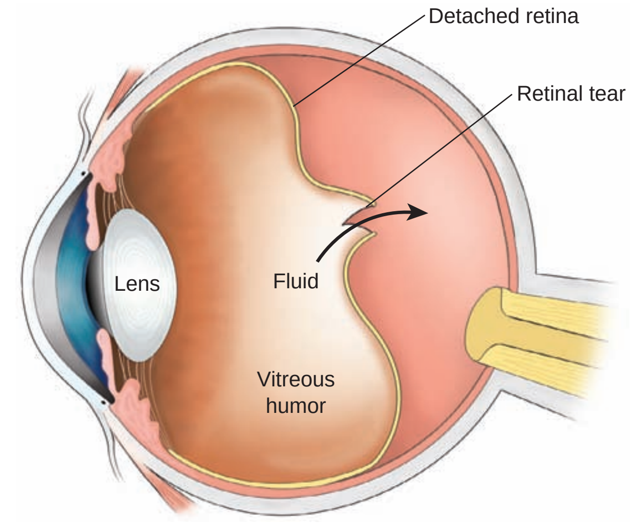



**Figure 58-11** Retinal detachment.

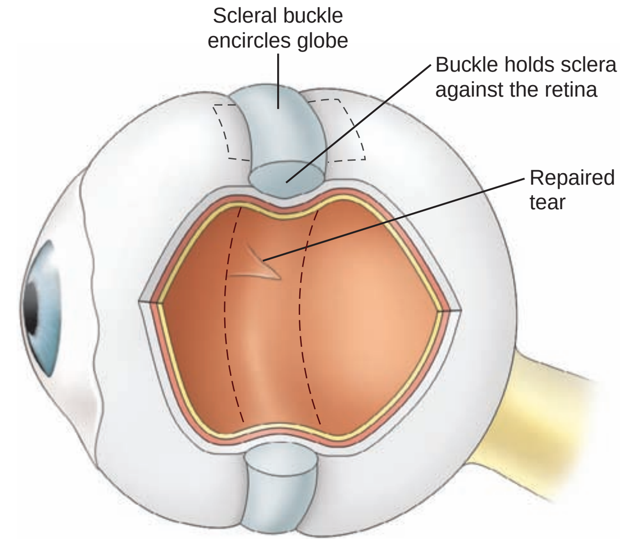



**Figure 58-12** Scleral buckle.

in the sensory layer of the retina. Beneath the sensory layer lies the RPE, the pigmented layer. When the rods and cones are stimulated by light, an electrical impulse is generated, and the image is transmitted to the brain.

## Retinal Detachment

Retinal detachment refers to the separation of the RPE from the sensory layer. The four types of retinal detachment are rhegmatogenous, traction, a combination of rhegmatogenous and traction, and exudative. *Rhegmatogenous detachment* is the most common form. In this condition, a hole or tear develops in the sensory retina, allowing some of the liquid vitreous to seep through the sensory retina and detach it from the RPE (Fig. 58-11). People at risk for this type of detachment include those with high myopia or **aphakia** after cataract surgery. Trauma may also play a role in rhegmatogenous retinal detachment. Between 5% and 10% of all rhegmatogenous retinal detachments are associated with proliferative retinopathy, a retinopathy associated with diabetic neovascularization (see Chapter 41).

Tension, or a pulling force, is responsible for *traction retinal detachment*. An ophthalmologist must ascertain all of the areas of retinal break and identify and release the scars or bands of fibrous material providing traction on the retina. Generally, patients with this condition have developed fibrous scar tissue from conditions such as diabetic retinopathy, vitreous hemorrhage, or the retinopathy of prematurity. The hemorrhages and fibrous proliferation associated with these conditions exert a pulling force on the delicate retina.

Patients can have both rhegmatogenous and traction retinal detachment. *Exudative retinal detachments* are the result of the production of a serous fluid under the retina from the choroid. Conditions such as uveitis and macular degeneration may cause the production of this serous fluid.

### Clinical Manifestations

Patients may report the sensation of a shade or curtain coming across the vision of one eye, cobwebs, bright flashing lights, or the sudden onset of a great number of floaters. Patients do not complain of pain.

### Assessment and Diagnostic Findings

After visual acuity is determined, the patient must have a dilated fundus examination using an indirect ophthalmoscope as well as slit-lamp biomicroscopy. Stereo fundus photography and fluorescein angiography are commonly used during the evaluation.

Increasingly, optical coherence tomography and ultrasound are used for the complete retinal assessment, especially if the view is obscured by a dense cataract or vitreal hemorrhage. All retinal breaks, all fibrous bands that may be causing traction on the retina, and all degenerative changes must be identified.

### Surgical Management

In rhegmatogenous detachment, an attempt is made to surgically reattach the sensory retina to the RPE. In traction detachment, the source of traction must be removed and the sensory retina reattached. New surgical techniques as well as advances in instrumentation have led to an increased rate of success of surgical reattachment and better visual outcomes. The most commonly used surgical interventions are the scleral buckle, the pars plana vitrectomy, and pneumatic retinopexy. A recently developed procedure is the 25-gauge transconjunctival sutureless vitrectomy.

#### *Scleral Buckle*

The retinal surgeon compresses the sclera (often with a scleral buckle or a silicone band; Fig. 58-12) to indent the scleral wall from the outside of the eye and bring the two retinal layers in contact with each other. This type of surgery has a high success rate in the hands of experienced retinal surgeons. It causes less damage to the lens of the eye in

phakic patients, and there is a low risk of endophthalmitis. However, there is an increased incidence of diplopia and other complications, such as induced myopia and increased postoperative pain.

### Pars Plana Vitrectomy

A vitrectomy is an intraocular procedure in which 1- to 4-mm incisions are made at the pars plana. One incision allows the introduction of a light source, and another incision serves as the portal for the vitrectomy instrument. The surgeon dissects preretinal membranes under direct visualization while the retina is stabilized by an intraoperative vitreous substitute.

This surgical technique was originally introduced as a treatment for eyes with conditions that were previously inoperable (eg, vitreous hemorrhage, proliferative diabetic retinopathy). Technologic improvements, including the use of operating microscopes, microinstrumentation, and instruments that combine vitreous cutting, aspiration, and illumination capabilities in one device, have advanced vitreoretinal surgery. The techniques of vitreoretinal surgery can be used in various procedures, including the removal of foreign bodies, vitreous opacities such as blood, and dislocated lenses. Traction on the retina may be relieved through vitrectomy and may be combined with scleral buckling to repair retinal breaks. Treatment of macular holes includes vitrectomy, laser photocoagulation, air-fluid-gas exchanges, and the use of growth factor.

### Pneumatic Retinopexy

This technique is used for the repair of a rhegmatogenous retinal detachment. It is the least invasive of the three procedures described. A gas bubble, silicone oil, or perfluorocarbon and liquids may be injected into the vitreous cavity to help push the sensory retina up against the RPE Argon laser photocoagulation or cryotherapy is also used to "spot-weld" small holes.

### Transconjunctival Sutureless Vitrectomy

The 25-gauge transconjunctival sutureless vitrectomy is a significant advancement in vitreoretinal surgery. Replacement of the larger 20-gauge approach with the less invasive 25-gauge technique allows for self-sealing transconjunctival pars plana sclerotomies. As a result, postoperative inflammation is decreased, thus promoting rapid wound healing and patient recovery. The 25-gauge microcannula maintains the alignment between the entry site of the conjunctiva and the sclera (Chen, 2007) (Fig. 58-13).

Complications such as hypotony and endophthalmitis may be related to the unsutured sclerotomy. However, clinical experience has shown that this sutureless system is both safe and effective with decreased surgical times, reduced postoperative inflammation, and more rapid recovery (Chen, 2007).

## Nursing Management

For the most part, nursing interventions consist of educating the patient and providing supportive care. For pneumatic retinopexy, postoperative positioning of the patient is critical because the injected bubble must float into a position overlying the area of detachment, providing consistent

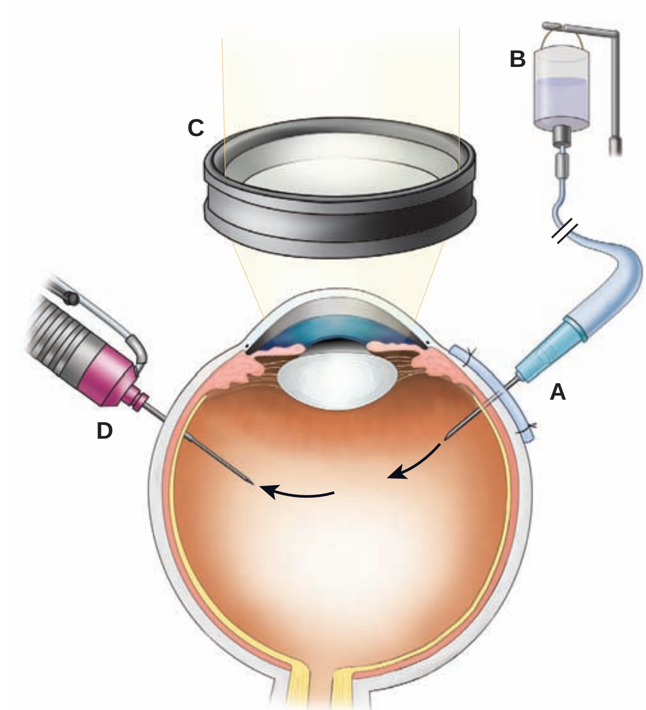



**Figure 58-13** 25-gauge transconjunctival pars plana sutureless vitrectomy with simultaneous suction and infusion. **A,** Infusion of fluid through a 25-gauge needle secured by passing through a block of plastic sutured to the eye. **B,** Balanced salt solution is fed into the eye by gravity. **C,** Illumination and observation are provided with the indirect ophthalmoscope. **D,** The vitreous is aspirated into the port of the sharp-tipped vitreous cutter.

pressure to reattach the sensory retina. The patient must maintain a prone position that would allow the gas bubble to act as a tamponade for the retinal break (Ross & Lavina, 2008). Patients and family members should be made aware of these special needs beforehand so that the patient can be made as comfortable as possible.

### Teaching About Complications

In many cases, vitreoretinal procedures are performed on an outpatient basis, and the patient is seen the next day for a follow-up examination and closely monitored thereafter as required. Postoperative complications may include increased IOP, endophthalmitis, development of other retinal detachments, development of cataracts, and loss of turgor of the eye. Patients must be taught the signs and symptoms of complications, particularly of increasing IOP and postoperative infection. Patients should be provided with telephone numbers of members of the ophthalmic team and encouraged to call immediately if discomfort escalates.

## Retinal Vascular Disorders

Loss of vision can occur from occlusion of a retinal artery or vein. Such occlusions may result from atherosclerosis, cardiac valvular disease, venous stasis, hypertension, or increased blood viscosity. Associated risk factors include diabetes mellitus, glaucoma, and aging.

## Central Retinal Vein Occlusion

Blood supply to and from the ocular fundus is provided by the central retinal artery and vein. Central retinal vein occlusions (CRVOs) are relatively common and found most often in people older than 50 years of age. Patients who have suffered a CRVO report decreased visual acuity, which may range from mild blurring to vision that is severely limited.

Direct ophthalmoscopy of the retina shows optic disc swelling, venous dilation and tortuousness, retinal hemorrhages, cotton-wool spots, and a "blood and thunder" (extremely bloody) appearance of the retina. The better the initial visual acuity, the better the general prognosis.

Fluorescein angiography may show extensive areas of capillary closure. The patient should be monitored carefully over the ensuing several months for signs of neovascularization and neovascular glaucoma. Laser panretinal photocoagulation may be necessary to treat the abnormal neovascularization. Neovascularization of the iris may cause neovascular glaucoma, which may be difficult to control. Macular edema, macular nonperfusion, and vitreous hemorrhage from the neovascularization are among the potential complications of CRVO. In addition, CRVO is a significant cause of vision loss (Mohamed, McIntosh, Seang, et al., 2007).

## Branch Retinal Vein Occlusion

Some patients with branch retinal vein occlusion (BRVO) are symptom free, whereas others complain of a sudden loss of vision if the macular area is involved. A more gradual loss of vision may occur if macular edema associated with BRVO develops. Studies have shown that a gridlike pattern of laser burns reduces macular edema and improves visual acuity by two or more lines on the Snellen chart (Esrick, Subramanian, Heier, et al., 2005).

On examination, the ocular fundus appears similar to that found in CRVO; however, only those portions of the retina affected by the obstructive veins have what is known as a "blood and thunder" appearance. The occlusions generally occur at the arteriovenous crossings. The diagnostic evaluation and follow-up assessments are the same as for CRVO. Potential complications are similar. Associated conditions include glaucoma, systemic hypertension, diabetes mellitus, hyperlipidemia, and hyperviscosity syndrome.

## Central Retinal Artery Occlusion

Patients with central retinal artery occlusion, a relatively rare disorder that accounts for approximately 1 in 10,000 ophthalmologic visits, present with a sudden loss of vision. Visual acuity is reduced to being able to count the examiner's fingers, or the field of vision is tremendously restricted. A relative afferent pupillary defect is present. Examination of the ocular fundus reveals a pale retina with a cherry-red spot at the fovea. The retinal arteries are thin, and emboli are occasionally seen in the central retinal artery or its branches. Central retinal artery occlusion is a true ocular emergency. Various treatments are used: ocular massage, anterior chamber paracentesis, IV administration of hyperosmotic agents such as acetazolamide (Diamox), and high concentrations of oxygen. An aggressive stepwise approach may be beneficial, depending on the underlying cause of the occlusion and the amount of time from onset of occlusion to treatment. Most visual loss associated with central retinal artery occlusion is severe and permanent.

# Age-Related Macular Degeneration

Age-related macular degeneration (AMD) is the most common cause of visual loss in people older than 60 years of age in developed countries (Seddon & Chen, 2004). In the United States alone, the number of cases is expected to reach almost 3 million by the year 2020 (Bressler, et al., 2008). AMD is characterized by tiny, yellowish spots called drusen (Fig. 58-14) beneath the retina. Most people older than 60 years of age have at least a few small drusen. These drusen are small clusters of debris or waste material that lie deep within the RPE. When these drusen are located in the macular area, they can affect vision. Patients with AMD have a wide range of visual loss, but most do not experience total blindness. Central vision is generally the most affected, with most patients retaining peripheral vision (Fig. 58-15). There are two types of AMD, commonly known as the dry type and wet type.

Between 85% and 90% of people with AMD have the dry (nonneovascular, nonexudative) type of the condition, in which the outer layers of the retina slowly break down (Fig. 58-16). With this breakdown comes the appearance of drusen. When the drusen occur outside of the macular area, patients generally have no symptoms. When the drusen occur within the macula, however, there is a gradual blurring of vision that patients may notice when they try to read.

The second type of AMD, the wet (neovascular, exudative) type, may have an abrupt onset. Patients report that straight lines appear crooked and distorted or that letters in words appear broken. This effect results from proliferation of abnormal blood vessels growing under the retina, within the choroid layer of the eye, a condition known as choroidal neovascularization. The affected vessels can leak fluid and blood, elevating the retina. Some patients can be treated with the argon laser to stop the leakage from these vessels. However, this treatment is not ideal because vision may be affected by the laser treatment and abnormal vessels often grow back after treatment.

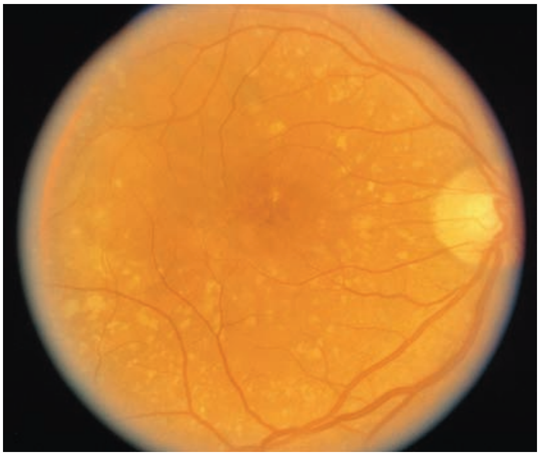


**Figure 58-14** Retina showing drusen and age-related macular degeneration (AMD).

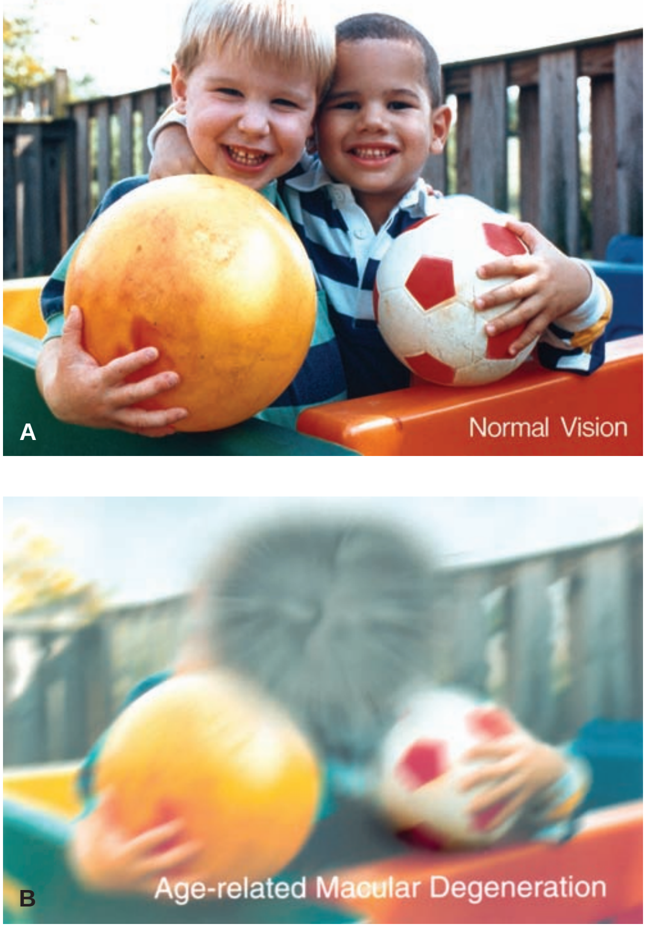



**Figure 58-15** Visual loss associated with macular degeneration. **(A)** Normal vision. **(B)** Visual changes resulting from age-related macular degeneration. Photos courtesy of the National Eye Institute/National Institutes of Health.

## Medical Management

There is no known cure for the dry (nonexudative, nonneovascular) type of AMD. The Age-Related Eye Disease Study (2001a), a multicenter clinical trial, has provided promising information about the prevention and treatment of AMD. The study was designed to determine whether large doses of macronutrients are effective in preventing or slowing the course of the disease. The study revealed that use of antioxidants (vitamin C, vitamin E, and beta-carotene) and minerals (zinc oxide) in megadoses can slow the progression of AMD and vision loss for people at high risk for developing advanced AMD. Research continues; the National Eye Institute (NEI) is sponsoring an ongoing clinical trial, Age-Related Eye Disease Study II (AREDS II), to study the effect of lutein and zeaxanthin (carotenoids) or fish oils in protecting the macula and preventing the progression of AMD (NEI, 2008).

### *Antiangiogenic Therapy*

An important component of treatment of neovascular (wet, exudative) AMD targets development and progression of angiogenesis (abnormal blood vessel formation). Studies continue toward identification of agents that can be used to inhibit angiogenesis. This has implications for ocular neovascularization (Andreoli & Miller, 2007).

Vasoproliferation in exudative AMD is believed to be caused by an underlying angiogenic stimulus known as vascular endothelial growth factor (VEGF). Research has resulted in the development of agents that inhibit the development of VEGF and therefore angiogenesis. Pegaptanib sodium (Macugen), a VEGF antagonist, is designed to inhibit the ability of VEGF to bind to cellular receptors. This agent is no longer widely used because visual acuity has improved in only a limited number of patients as a result of this treatment (Jager, Mieler & Miller, 2008). Ranibizumab (Lucentis) is designed to bind and inactivate all isoforms of VEGF. Approved in 2006, it is administered by intravitreal injection once a month. Studies have shown that, on average, patients may gain one to two lines of vision on the Snellen chart after a year of treatment (Bressler, et al., 2008). This is a dramatic positive step; in the early days of photocoagulation therapy, the best that could be achieved was a slowing of visual loss that was accompanied by a treatment-related scotoma.

The monoclonal antibody bevacizumab (Avastin) has been found to be helpful in the treatment of neovascular AMD. Originally developed for the treatment of colon cancer, it has been used "off-label" by many ophthalmologists for AMD, with results that rival those of the more expensive ranibizumab.

## Nursing Management

Amsler grids are given to patients to use in their homes to monitor for a sudden onset or distortion of vision. These may provide the earliest sign that macular degeneration is getting worse. Patients should be encouraged to look at these grids, one eye at a time, several times each week with glasses on. If there is a change in the grid (eg, if the lines or squares appear distorted or faded), the patient should notify the ophthalmologist immediately and should arrange to be seen promptly.

# ORBITAL AND OCULAR TRAUMA

Whether affecting the eye or the orbit, trauma to the eye and surrounding structures may have devastating consequences for vision. It is preferable to prevent injury rather than treat it. Chart 58-11 details safety measures to prevent orbital and ocular trauma.

## *Orbital Trauma*

Injury to the orbit is usually associated with a head injury; hence, the patient's general medical condition must first be stabilized before conducting an ocular examination. Only then is the globe assessed for soft tissue injury. During inspection, the face is meticulously assessed for underlying fractures, which should always be suspected in cases of blunt trauma. To establish the extent of ocular injury, visual acuity is assessed as soon as possible, even if it is only a rough

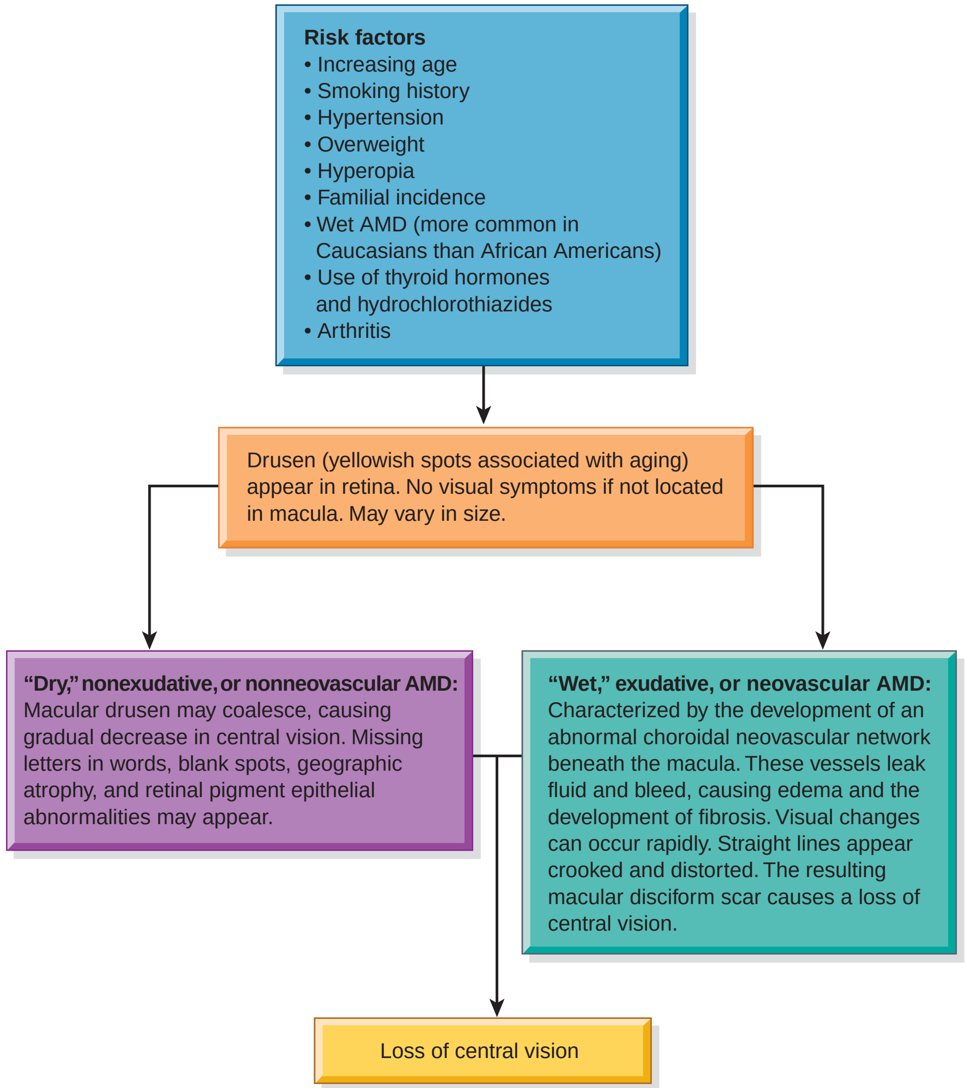



**Figure 58-16** Progression of age-related macular degeneration (AMD): pathways to vision loss.

estimate. Soft tissue orbital injuries often result in damage to the optic nerve. Major ocular injuries indicated by a soft globe, prolapsing tissue, ruptured globe, and hemorrhage require immediate surgical attention.

## Soft Tissue Injury and Hemorrhage

The signs and symptoms of soft tissue injury from blunt or penetrating trauma include tenderness, ecchymosis, lid swelling, **proptosis** (ie, downward displacement of the eyeball), and hemorrhage. Closed injuries lead to contusions with subconjunctival hemorrhage, commonly known as a *black eye*. Blood accumulates in the tissues of the conjunctiva. Hemorrhage may be caused by a soft tissue injury to the eyelid or by an underlying fracture.

Management of soft tissue hemorrhage that does not threaten vision is usually conservative and consists of thorough inspection, cleansing, and repair of wounds. Cold compresses are used in the early phase, followed by warm compresses. Hematomas that appear as swollen, fluctuating areas may be surgically drained or aspirated; if they are causing significant orbital pressure, they may be surgically evacuated.

Penetrating injuries or a severe blow to the head can result in severe optic nerve damage. Visual loss can be sudden or delayed and progressive. Immediate loss of vision after an ocular injury is usually irreversible. Delayed visual loss has a better prognosis. Corticosteroid therapy is indicated to reduce optic nerve swelling. Surgery, such as optic nerve decompression, may be performed.

## Orbital Fractures

Orbital fractures are detected by facial x-rays. Depending on the orbital structures involved, orbital fractures can be classified as blowout, zygomatic or tripod, maxillary, midfacial, orbital apex, and orbital roof fractures. Blowout fractures result from compression of soft tissue and the sudden increase in orbital pressure when the force is transmitted to the orbital floor, the area of least resistance.

The inferior rectus and inferior oblique muscles, with their fat and fascial attachments, or the nerve that courses

CHART 58-11 PATIENT EDUCATION

### Advice for Patients About Preventing Eye Injuries

**In and Around the House**

- Make sure that all spray nozzles are directed away from themselves before pressing down on the handle.
- Read instructions carefully before using cleaning fluids, detergents, ammonia, or harsh chemicals, and to wash hands thoroughly after use.
- Use grease shields on frying pans to decrease spattering.
- Wear special goggles to shield their eyes from fumes and splashes when using powerful chemicals.
- Use opaque goggles to avoid burns from sunlamps.

**In the Workshop**

- Protect their eyes from flying fragments, fumes, dust particles, sparks, and splashed chemicals by wearing safety glasses.
- Read instructions thoroughly before using tools and chemicals, and follow precautions for their use.

**Around Children**

- Pay attention to age and maturity level of a child when selecting toys and games, and to avoid projectile toys, such as darts and pellet guns.
- Supervise children when they are playing with toys or games that can be dangerous.
- Teach children the correct way to handle potentially dangerous items, such as scissors and pencils.

**In the Garden**

- Avoid letting anyone stand at the side of or in front of a moving lawn mower.
- Pick up rocks and stones before going over them with the lawn mower (stones can be hurled out of the rotary blades and rebound off curbs or walls, causing severe injury to the eye).
- Direct pesticide spray can nozzles away from the face.
- Avoid low-hanging branches.

**Around the Car**

- Put out all smoking materials and matches before opening the hood of the car.
- Use a flashlight, not a match or lighter, to look at the battery at night.
- Wear goggles when grinding metal or striking metal against metal while performing auto body repair.
- Take standard safety precautions when using jumper cables (wear goggles; make sure the cars are not touching one another; make sure the jumper cable clamps never touch each other; never lean over the battery when attaching cables; and never attach a cable to the negative terminal of a dead battery).

**In Sports**

- Wear protective safety glasses, especially for sports such as racquetball, squash, tennis, baseball, and basketball.
- Wear protective caps, helmets, or face protectors when appropriate, especially for sports such as ice hockey.

**Around Fireworks**

- Wear eye glasses or safety goggles.
- Avoid explosive fireworks.
- Never allow children to ignite fireworks.
- Avoid standing near others when lighting fireworks.
- Douse duds in water instead of attempting to relight them.

along the inferior oblique muscle may become entrapped, and the globe may be displaced inward (ie, enophthalmos). Computed tomography (CT) can identify the muscle and its auxiliary structures that are entrapped. These fractures are usually caused by blunt small objects, such as a fist, knee, elbow, or tennis or golf ball.

Orbital roof fractures are dangerous because of potential complications to the brain. Surgical management of these fractures requires a neurosurgeon and an ophthalmologist. The most common indications for surgical intervention are displacement of bone fragments disfiguring the normal facial contours, interference with normal binocular vision caused by extraocular muscle entrapment, interference with mastication in zygomatic fracture, and obstruction of the nasolacrimal duct. Surgery is usually nonemergent, and a period of 10 to 14 days gives the ophthalmologist time to assess ocular function, especially the extraocular muscles and the nasolacrimal duct. Emergency surgical repair is usually not performed unless the globe is displaced into the maxillary sinus. Surgical repair is primarily directed at freeing the entrapped ocular structures and restoring the integrity of the orbital floor.

### Foreign Bodies

Foreign bodies that enter the orbit are usually tolerated, except for copper, iron, and vegetable materials such as those from plants or trees, which may cause purulent infection. X-rays and CT scans are used to identify the foreign body. A careful history is important, especially if the foreign body has been in the orbit for a period of time and the incident forgotten. It is important to identify metallic foreign bodies because they prohibit the use of magnetic resonance imaging (MRI) as a diagnostic tool.

After the extent of the orbital damage is assessed, the decision to use conservative treatment or surgical removal is made. In general, orbital foreign bodies are removed if they are superficial and anterior in location; have sharp edges that may affect adjacent orbital structures; or are composed of copper, iron, or vegetable material. Surgical intervention is directed at preventing further ocular injury and maintaining the integrity of the affected areas. Cultures are usually obtained, and the patient is placed on prophylactic IV antibiotics that are later changed to oral antibiotics.

## Ocular Trauma

Ocular trauma is the leading cause of blindness among children and young adults, especially male trauma victims. The most common circumstances of ocular trauma are occupational injuries (eg, construction industry), sports (eg, baseball, basketball, racquet sports, boxing), weapons (eg, air guns, BB guns), assault, motor vehicle

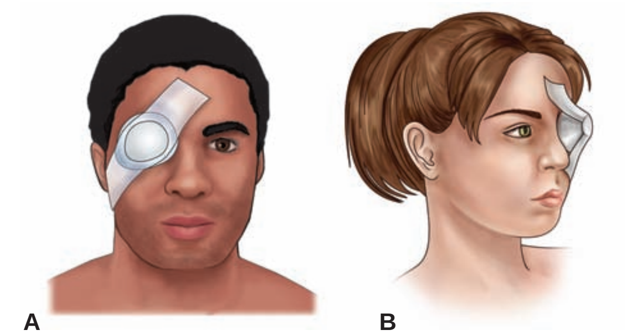



**Figure 58-17** Two kinds of eye patches. **A,** Aluminum shield. **B,** Stiff paper cup shield (innovative substitute when aluminum shield is unavailable).

crashes (eg, broken windshields), and explosions (eg, blast fragments).

There are two types of ocular trauma in which the first response is critical: chemical burn and foreign object in the eye. With a chemical burn, the eye should be immediately irrigated with tap water or normal saline. With a foreign body, no attempt should be made to remove the foreign object. The object should be protected from jarring or movement to prevent further ocular damage. No pressure or patch should be applied to the affected eye. All traumatic eye injuries should be protected using a metal shield if available or a stiff paper cup until medical treatment can be obtained (Fig. 58-17).

## Assessment and Diagnostic Findings

A thorough history is obtained, particularly assessing the patient's ocular history, such as preinjury vision in the affected eye or past ocular surgery. Details related to the injury that help in the diagnosis and assessment of need for further tests include the nature of the ocular injury (ie, blunt or penetrating trauma); the type of activity that caused the injury to determine the nature of the force striking the eye; and whether onset of vision loss was sudden, slow, or progressive. For chemical eye burns, the chemical agent must be identified and tested for pH if the agent is available. The corneal surface is examined for foreign bodies, wounds, and abrasions, after which the other external structures of the eye are examined. Pupillary size, shape, and light reaction of the pupil of the affected eye are compared with the other eye. Ocular motility (ability of the eyes to move synchronously up, down, right, and left) is also assessed.

## Medical Management

### Splash Injuries

Splash injuries are irrigated with normal saline solution before further evaluation occurs. In cases of a ruptured globe, cycloplegic agents (agents that paralyze the ciliary muscle) or topical antibiotics must be deferred because of potential toxicity to exposed intraocular tissues. Further manipulation of the eye must be avoided until the patient is under general anesthesia. Parenteral, broad-spectrum antibiotics are initiated. Tetanus antitoxin is administered, if indicated, as well as analgesics. (Tetanus prophylaxis is recommended for full-thickness ocular and skin wounds.) Any topical ophthalmic medication (eg, anesthetic, dyes) must be sterile.

### Foreign Bodies and Corneal Abrasions

After removal of a foreign body from the surface of the eye, an antibiotic ointment is applied and the eye is patched. The eye is examined daily for evidence of infection until the wound is completely healed.

Contact lens wear is a common cause of corneal abrasion. The patient experiences severe pain and **photophobia** (ocular pain on exposure to light). Corneal epithelial defects are treated with antibiotic ointment and a pressure patch to immobilize the eyelids. Topical anesthetic eye drops must not be given to the patient to take home for repeated use after corneal injury because their effects mask further damage, delay healing, and can lead to permanent corneal scarring. Corticosteroids are avoided while the epithelial defect exists.

### Penetrating Injuries and Contusions of the Eyeball

Sharp penetrating injury or blunt contusion force can rupture the eyeball. When the globe, cornea, and sclera rupture, rapid decompression or herniation of the orbital contents into adjacent sinuses can occur. In general, blunt traumatic injuries (with an increased incidence of retinal detachment, intraocular tissue avulsion, and herniation) have a worse prognosis than penetrating injuries. Most penetrating injuries result in marked loss of vision with the following signs: hemorrhagic **chemosis** (edema of the conjunctiva), conjunctival laceration, shallow anterior chamber with or without an eccentrically placed pupil, **hyphema** (hemorrhage within the chamber), or vitreous hemorrhage.

Hyphema is caused by contusion forces that tear the vessels of the iris and damage the anterior chamber angle. Preventing rebleeding and prolonged increased IOP are the goals of treatment for hyphema. In severe cases, the patient is hospitalized with moderate activity restriction. An eye shield is applied. Topical corticosteroids are prescribed to reduce inflammation. An antifibrinolytic agent, aminocaproic acid (Amicar), stabilizes clot formation at the site of hemorrhage. Aspirin is contraindicated.

A ruptured globe and severe injuries with intraocular hemorrhage require surgical intervention. Vitrectomy is performed for traumatic retinal detachments. Primary **enucleation** (complete removal of the eyeball and part of the optic nerve) is considered only if the globe is irreparable and has no light perception. It is a general rule that enucleation is performed within 2 weeks of the initial injury (in an eye that has no useful vision after sustaining penetrating injury) to prevent the risk of **sympathetic ophthalmia** (an inflammation created in the uninjured eye by the affected eye that can result in blindness of the uninjured eye).

### Intraocular Foreign Bodies

A patient who complains of blurred vision and discomfort should be questioned carefully about recent injuries and exposures. Patients may be injured in a number of different situations and experience an intraocular foreign body (IOFB). Precipitating circumstances can include working in construction; striking metal against metal; being involved in a

motor vehicle crash with facial injury; a gunshot wound; grinding-wheel work; and an explosion.

IOFB is diagnosed and localized by slit-lamp biomicroscopy and indirect ophthalmoscopy, as well as CT or ultrasonography. MRI is contraindicated because most foreign bodies are metallic and magnetic. It is important to determine the composition, size, and location of the IOFB and affected eye structures. Every effort should be made to identify the type of IOFB and whether it is magnetic. Iron, steel, copper, and vegetable matter cause intense inflammatory reactions. The incidence of endophthalmitis is also high. If the cornea is perforated, tetanus prophylaxis and IV antibiotics are administered. The extraction route (ie, surgical incision) of the foreign body depends on its location and composition and associated ocular injuries. Specially designed IOFB forceps and magnets are used to grasp and remove the foreign body. Any damaged area of the retina is treated to prevent retinal detachment.

#### Ocular Burns

Alkali, acid, and other chemically active organic substances, such as Mace and tear gas, cause chemical burns. Alkali burns (eg, lye, ammonia) result in the most severe injury because they penetrate the ocular tissues rapidly and continue to cause damage long after the initial injury is sustained. They also cause an immediate rise in IOP. Acids (eg, bleach, car batteries, refrigerant) generally cause less damage because the precipitated necrotic tissue proteins form a barrier to further penetration and damage. Chemical burns may appear as superficial punctate keratopathy (ie, spotty damage to the cornea), subconjunctival hemorrhage, or complete marbleizing of the cornea.

In treating chemical burns, every minute counts. Immediate tap-water irrigation should be started on site before transport of the patient to an emergency department. Only a brief history and examination are performed. Critical information, if available, is the name of the substance that went into the eye (the actual container is best). Material Safety Data Sheets (MSDS) should be accessed for reference. The corneal surfaces and conjunctival fornices are immediately and copiously irrigated with normal saline or any neutral solution. A local anesthetic is instilled, and a lid speculum is applied to overcome blepharospasm (ie, spasms of the eyelid muscles that result in closure of the lids). Particulate matter must be removed from the fornices using moistened, cotton-tipped applicators and minimal pressure on the globe. Irrigation continues until the conjunctival pH normalizes (between 7.3 and 7.6). The pH of the corneal surface is checked by placing a pH paper strip in the fornix. Antibiotics are instilled, and the eye is patched.

The goal of intermediate treatment is to prevent tissue ulceration and promote reepithelization. Intense lubrication using nonpreserved (ie, without preservatives to avoid allergic reactions) artificial tears is essential. Reepithelization is promoted with patching or therapeutic soft lenses, both of which act to keep the eye quiet by preventing blinking, thus retarding replication of corneal cells. The patient is usually monitored daily for several days. Prognosis depends on the type of injury and adequacy of the irrigation immediately after exposure. Long-term treatment consists of two phases: restoration of the ocular surface through grafting procedures and surgical restoration of corneal integrity and optical clarity.

Thermal injury is caused by exposure to a hot object (eg, curling iron, tobacco, ash), whereas photochemical injury results from ultraviolet irradiation or infrared exposure (eg, exposure to the reflections from snow, sun gazing, viewing an eclipse of the sun without an adequate filter). These injuries can cause corneal epithelial defect, corneal opacity, conjunctival chemosis and **injection** (congestion of blood vessels), and burns of the eyelids and periocular region. Antibiotics and a pressure patch for 24 hours constitute the treatment of mild injuries. Scarring of the eyelids may require oculoplastic surgery, whereas corneal scarring may require corneal surgery.

# INFECTIOUS AND INFLAMMATORY CONDITIONS

Inflammation and infections of eye structures are common. Eye infection is a leading cause of blindness worldwide. Table 58-6 summarizes selected common infections and their treatment.

## Dry Eye Syndrome

Dry eye syndrome, or keratoconjunctivitis sicca, is a deficiency in the production of any of the aqueous, mucin, or lipid tear film components; lid surface abnormalities; or epithelial abnormalities related to systemic diseases or conditions (eg, thyroid disorders, Parkinson's disease), menopause, infection, injury, or complications of medications (eg, antihistamines, oral contraceptives, phenothiazines).

### Clinical Manifestations

The most common complaint in dry eye syndrome is a scratchy or foreign body sensation. Other symptoms include itching, excessive mucus secretion, inability to produce tears, a burning sensation, redness, pain, and difficulty moving the lids.

### Assessment and Diagnostic Findings

Slit-lamp examination shows an absent or interrupted tear meniscus at the lower lid margin, and the conjunctiva is thickened, edematous, and hyperemic and has lost its luster. A tear meniscus is the crescent-shaped edge of the tear film in the lower lid margin. Chronic dry eyes may result in chronic conjunctival and corneal irritation that can lead to corneal erosion, scarring, ulceration, thinning, or perforation that can seriously threaten vision. Secondary bacterial infection can occur.

### Management

Management of dry eye syndrome requires the complete cooperation of the patient with a regimen that needs to be followed at home for a long period; otherwise, complete relief of symptoms is unlikely. Instillation of artificial tears during the day and an ointment at night is the usual regimen to

**Table 58-6 COMMON INFECTIONS AND INFLAMMATORY DISORDERS OF EYE STRUCTURES**

| Disorder | Description | Management |
|---|---|---|
| **Hordeolum (stye)** | Acute suppurative infection of the glands of the eyelids caused by *Staphylococcus aureus*. The lid is red and edematous with a small collection of pus in the form of an abscess. There is considerable discomfort. | Warm compresses are applied directly to the affected lid area three to four times a day for 10–15 minutes. If the condition is not improved after 48 hours, incision and drainage may be indicated. Application of topical antibiotics may be prescribed thereafter. |
| **Chalazion** | Sterile inflammatory process involving chronic granulomatous inflammation of the meibomian glands; can appear as a single granuloma or multiple granulomas in the upper or lower eyelids. | Warm compresses applied three to four times a day for 10–15 minutes may resolve the inflammation in the early stages. Most often, however, surgical excision is indicated. Corticosteroid injection to the chalazion lesion may be used for smaller lesions. |
| **Blepharitis** | Chronic bilateral inflammation of the eyelid margins. There are two types: staphylococcal and seborrheic. Staphylococcal blepharitis is usually ulcerative and is more serious due to the involvement of the base of hair follicles. Permanent scarring can result. | The seborrheic type is chronic and is usually resistant to treatment, but the milder cases may respond to lid hygiene. Staphylococcal blepharitis requires topical antibiotic treatment. Instructions on lid hygiene (to keep the lid margins clean and free of exudates) are given to the patient. |
| **Bacterial keratitis** | Infection of the cornea by *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Pseudomonas aeruginosa*. | Fortified (high-concentration) antibiotic eyedrops are administered every 30 minutes around the clock for the first few days, then every 1–2 hours. Systemic antibiotics may be administered. Cycloplegics are administered to reduce pain caused by ciliary spasm. Corticosteroid therapy and subconjunctival injections of antibiotics are controversial. |
| **Herpes simplex keratitis** | Leading cause of corneal blindness in the United States. Symptoms are severe pain, tearing, and photophobia. The dendritic ulcer has a branching, linear pattern with feathery edges and terminal bulbs at its ends. Herpes simplex keratitis can lead to recurrent stromal keratitis and persist to 12 months with residual corneal scarring. | Many lesions heal without treatment and residual effects. The treatment goal is to minimize the damaging effect of the inflammatory response and eliminate viral replication within the cornea. Penetrating keratoplasty is indicated for corneal scarring and must be performed when the herpetic disease has been inactive for many months. |

hydrate and lubricate the eye and preserve a moist ocular surface. Cyclosporine ophthalmic emulsion (Restasis) is an effective agent that increases tear production and is used once daily. Anti-inflammatory medications are also used, and moisture chambers (eg, moisture chamber spectacles, swim goggles) may provide additional relief.

Patients may become hypersensitive to chemical preservatives such as benzalkonium chloride and thimerosal. For these patients, preservative-free ophthalmic solutions are used. Management of the dry eye syndrome also includes the concurrent treatment of infections, such as chronic blepharitis and acne rosacea, and treating the underlying systemic disease, such as Sjögren syndrome (an autoimmune disease).

In advanced cases of dry eye syndrome, surgical treatment that includes punctal occlusion, grafting procedures, and lateral tarsorrhaphy (uniting the edges of the lids) are options. Punctal plugs are made of silicone material for the temporary or permanent occlusion of the puncta. This helps preserve the natural tears and prolongs the effects of artificial tears. Short-term occlusion is performed by inserting punctal or silicone rods in all four puncta. If tearing is induced by the occlusion, the upper plugs are removed, and the remaining lower plugs are removed in another week. Permanent occlusion is performed only in severe cases in adults who do not develop tearing after partial occlusion and who have results on a repeated Schirmer's test of 2 mm or less (filter paper is used to measure tear production).

## Conjunctivitis

Conjunctivitis (inflammation of the conjunctiva) is the most common ocular disease worldwide. It is characterized by a pink appearance (hence the common term *pink eye*) because of subconjunctival blood vessel congestion.

### Clinical Manifestations

General symptoms include foreign body sensation, scratching or burning sensation, itching, and photophobia. Conjunctivitis may be unilateral or bilateral, but the infection usually starts in one eye and then spreads to the other eye by hand contact.

### Assessment and Diagnostic Findings

The four main clinical features important to evaluate are the type of discharge (watery, mucoid, purulent, or mucopurulent), type of conjunctival reaction (follicular or papillary), presence of pseudomembranes or true membranes, and presence or absence of lymphadenopathy (enlargement of the preauricular and submandibular lymph nodes where the eyelids drain). Pseudomembranes consist of coagulated exudate that adheres to the surface of the inflamed conjunctiva. True membranes form when the exudate adheres to the superficial layer of the conjunctiva, and removal results in bleeding. Follicles are multiple, slightly elevated lesions encircled by tiny blood vessels; they look like grains of rice. Papillae are hyperplastic conjunctival epithelium in

numerous projections that are usually seen as a fine mosaic pattern under slit-lamp examination. Diagnosis is based on the distinctive characteristics of ocular signs, acute or chronic presentation, and identification of any precipitating events. Positive results of swab smear preparations and cultures confirm the diagnosis.

## Types of Conjunctivitis

Conjunctivitis is classified according to its cause. The major causes are microbial infection, allergy, and irritating toxic stimuli. A wide spectrum of organisms can cause conjunctivitis, including bacteria (eg, *Chlamydia*), viruses, fungus, and parasites. Conjunctivitis can also result from an existing ocular infection or can be a manifestation of a systemic disease.

### *Microbial Conjunctivitis*

#### Bacterial Conjunctivitis

Bacterial conjunctivitis can be acute or chronic. The acute type can develop into a chronic condition. Signs and symptoms can vary from mild to severe. Chronic bacterial conjunctivitis is usually seen in patients with lacrimal duct obstruction, chronic dacryocystitis, and chronic blepharitis. The most common causative microorganisms are *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Staphylococcus aureus*.

Bacterial conjunctivitis manifests with an acute onset of redness, burning, and discharge. There is papillary formation, conjunctival irritation, and injection in the fornices. The exudates are variable but are usually present on waking in the morning. The eyes may be difficult to open because of adhesions caused by the exudate. Purulent discharge occurs in severe acute bacterial infections, whereas mucopurulent discharge appears in mild cases. In gonococcal conjunctivitis, the symptoms are more acute. The exudate is profuse and purulent, and there is lymphadenopathy. Pseudomembranes may be present.

Chlamydial conjunctivitis includes **trachoma** (a bilateral chronic follicular conjunctivitis of childhood that leads to blindness during adulthood if left untreated) and inclusion conjunctivitis. Trachoma is an ancient disease and is the leading cause of preventable blindness in the world. It is prevalent in areas with hot, dry, and dusty climates and in areas with poor living conditions. It is spread by direct contact or fomites, and the vectors can be insects such as flies and gnats. The onset of trachoma in children is usually insidious, but it can be acute or subacute in adults. The initial symptoms include red inflamed eyes, tearing, photophobia, ocular pain, purulent exudates, preauricular lymphadenopathy, and lid edema. Initial ocular signs include follicular and papillary formations. At the middle stage of the disease, there is an acute inflammation with papillary hypertrophy and follicular necrosis, after which trichiasis (turning inward of hair follicles) and entropion begin to develop. The lashes that are turned in rub against the cornea and, after prolonged irritation, cause corneal erosion and ulceration. The late stage of the disease is characterized by scarred conjunctiva, subepithelial keratitis, abnormal vascularization of the cornea (pannus), and residual scars from the follicles that look like depressions in the conjunctiva (Herbert's pits). Severe corneal ulceration can lead to perforation and blindness.

Inclusion conjunctivitis affects sexually active people who have genital chlamydial infection. Transmission is by oral–genital sex or hand-to-eye transmission. Indirect transmission can occur in inadequately chlorinated swimming pools. The eye lesions usually appear a week after exposure and may be associated with a nonspecific urethritis or cervicitis. The discharge is mucopurulent, follicles are present, and there is lymphadenopathy.

#### Viral Conjunctivitis

Viral conjunctivitis can be acute and chronic. The discharge is watery, and follicles are prominent. Severe cases include pseudomembranes. The common causative organisms are adenovirus and herpes simplex virus. Conjunctivitis caused by adenovirus is highly contagious. The condition is usually preceded by symptoms of upper respiratory infection. Corneal involvement causes extreme photophobia. Symptoms include extreme tearing, redness, and foreign body sensation that can involve one or both eyes. There is lid edema, ptosis, and conjunctival **hyperemia** (dilation of the conjunctival blood vessels) (Fig. 58-18). These signs and symptoms vary from mild to severe and may last for 2 weeks. Viral conjunctivitis, although self-limited, tends to last longer than bacterial conjunctivitis.

Epidemic keratoconjunctivitis (EKC) is a highly contagious viral conjunctivitis that is easily transmitted from one person to another among household members, schoolchildren, and health care workers. The outbreak of epidemics is seasonal, especially during the summer when people use swimming pools. EKC is most often accompanied by preauricular lymphadenopathy and occasionally periorbital pain. There are marked follicular and papillary formations. This type of conjunctivitis can lead to keratopathy.

### *Allergic Conjunctivitis*

Immunologic or allergic conjunctivitis is a hypersensitivity reaction that occurs as part of allergic rhinitis (hay fever), or it can be an independent allergic reaction. The patient usually has a history of an allergy to pollens and other environmental allergens. There is extreme pruritus, epiphora (ie, excessive secretion of tears), injection, and usually severe

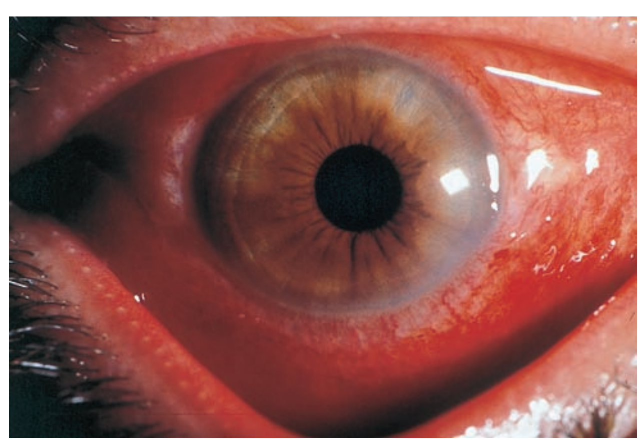


**Figure 58-18** Conjunctival hyperemia in viral conjunctivitis.

CHART 58-12 PATIENT EDUCATION

**Instructions for Patients With Viral Conjunctivitis**

Viral conjunctivitis is a highly contagious eye infection. It can easily spread from one person to another. The symptoms can be alarming, but they are not serious. The following information will help you understand this eye condition and how to take care of yourself and/or your family member at home.

- Your eyes will look red and will have watery discharge, and your lids will be swollen for about a week.
- You will experience eye pain, a sandy sensation in your eye, and sensitivity to light.
- Symptoms will resolve after about 1 week.
- You may use light cold compresses over your eyes for about 10 minutes four to five times a day to soothe the pain.
- You may use artificial tears for the sandy sensation in your eye and mild pain medications such as acetaminophen (Tylenol).
- You need to stay at home. Children must not play outside. You may return to work or school after 7 days when the redness and discharge have cleared. You may obtain a doctor's note to return to work or school.
- Do not share towels, linens, makeup, or toys.
- Wash your hands thoroughly with soap and water frequently, including and before and after you apply artificial tears or cold compresses.
- Use a new tissue every time you wipe the discharge from your eye. You may dampen the tissue with clean water to clean the outside of the eye.
- You may wash your face and take a shower as you normally do.
- Discard all of your makeup articles. You must not apply makeup until the infection has resolved.
- Wear dark glasses if bright lights bother you.
- If the discharge from your eye turns yellowish and puslike or you experience changes in your vision, you need to return to the health care provider for an examination.

photophobia. The stringlike mucoid discharge is usually associated with rubbing the eyes because of severe pruritus. Vernal conjunctivitis is also known as seasonal conjunctivitis because it appears mostly during warm weather. There may be large formations of papillae that have a cobblestone appearance. It is more common in children and young adults. Most affected people have a history of asthma or eczema.

#### Toxic Conjunctivitis

Chemical conjunctivitis can be the result of medications; chlorine from swimming pools; exposure to toxic fumes among industrial workers; or exposure to other irritants such as smoke, hair sprays, acids, and alkalis.

## Management

The management of conjunctivitis depends on the type. Most types of mild and viral conjunctivitis are self-limiting, benign conditions that may not require treatment and laboratory procedures. For more severe cases, topical antibiotics, eye drops, or ointments are prescribed. Patients with gonococcal conjunctivitis require urgent antibiotic therapy. If left untreated, this ocular disease can lead to corneal perforation and blindness. The systemic complications can include meningitis and generalized septicemia.

#### Bacterial Conjunctivitis

Acute bacterial conjunctivitis is almost always self-limiting, lasting 2 weeks if left untreated. If treated with antibiotics, it may last a few days, except for gonococcal and staphylococcal conjunctivitis.

For trachoma, usually broad-spectrum antibiotics are administered topically and systemically. Surgical management includes the correction of trichiasis (eyelashes growing inward toward the conjunctiva and cornea) to prevent conjunctival scarring.

Adult inclusion conjunctivitis requires 1 week of antibiotics. Prevention of reinfection is important, and affected people and their sexual partners must seek treatment for sexually transmitted disease, if indicated.

#### Viral Conjunctivitis

Viral conjunctivitis is not responsive to any treatment. Cold compresses may alleviate some symptoms. It is extremely important to remember that viral conjunctivitis, especially epidemic keratoconjunctivitis, is highly contagious. Patients must be made aware of the contagious nature of the disease, and adequate instructions must be given (Chart 58-12). These instructions should include an emphasis on hand hygiene and avoiding sharing of hand towels, face cloths, and eye drops. Tissues should be directly discarded into a covered trash can.

Proper steps must be taken to avoid nosocomial infections. Frequent hand hygiene and procedures for environmental cleaning and disinfection of equipment used for eye examination must be strictly followed at all times. To prevent spread during outbreaks of conjunctivitis caused by adenovirus, health care facilities must set aside specified areas for treating patients with or suspected of having conjunctivitis caused by adenovirus to prevent spread. All forms of tonometry must be avoided unless medically indicated. All multidose ophthalmic medications must be discarded at the end of each day or when contaminated. Infected employees and others must not be allowed to work or attend school until symptoms have resolved, which can take 3 to 7 days.

#### Allergic Conjunctivitis

Patients with allergic conjunctivitis, especially recurrent vernal or seasonal conjunctivitis, are usually given corticosteroids in ophthalmic preparations. Depending on the severity of the disease, they may be given oral preparations. Use of vasoconstrictors, such as topical epinephrine solution, cold compresses, ice packs, and cool ventilation usually provide comfort by decreasing swelling.

#### Toxic Conjunctivitis

For conjunctivitis caused by chemical irritants, the eye must be irrigated immediately and profusely with saline or sterile water.

## Uveitis

Inflammation of the uveal tract (uveitis) can affect the iris, the ciliary body, or the choroid. There are two types of uveitis: nongranulomatous and granulomatous.

The more common type of uveitis is the nongranulomatous type, which manifests as an acute condition with pain, photophobia, and a pattern of conjunctival injection, especially around the cornea. The pupil is small or irregular, and vision is blurred. There may be small, fine precipitates on the posterior corneal surface and cells in the aqueous humor (ie, cell and flare). If the uveitis is severe, a **hypopyon** (accumulation of pus in the anterior chamber) may develop. The condition may be unilateral or bilateral and may be recurrent. Repeated attacks of nongranulomatous anterior uveitis can cause anterior synechiae (peripheral iris adheres to the cornea and impedes outflow of aqueous humor). Posterior synechiae (adherence of the iris and lens) block aqueous outflow from the posterior chamber. Secondary glaucoma can result from either anterior or posterior synechiae. Cataracts may also occur as a sequela to uveitis.

Granulomatous uveitis can have a more insidious onset and can involve any portion of the uveal tract. It tends to be chronic. Symptoms such as photophobia and pain may be minimal. Vision is markedly and adversely affected. Conjunctival injection is diffuse, and there may be vitreous clouding. In a severe posterior uveitis, such as chorioretinitis, there may be retinal and choroidal hemorrhages.

### Management

Because photophobia is a common symptom, patients should wear dark glasses outdoors. Ciliary spasm and synechia are best avoided through mydriasis; cyclopentolate (Cyclogyl) and atropine are commonly used. Local corticosteroid drops, such as Pred Forte 1% and Flarex 0.1%, instilled four to six times a day are also used to decrease inflammation. In very severe cases, systemic corticosteroids, as well as intravitreal corticosteroids, may be used. Daclizumab (Zenapax), a monoclonal antibody, is designed to prevent a specific chemical interaction needed by immune cells, such as lymphocytes, to produce inflammation. The National Eye Institute of the National Institutes of Health has conducted a preliminary clinical trial to examine the safety and effectiveness of treating uveitis with daclizumab with positive results. Larger-scale trials are planned (Yeh, Wroblewski, Buggage, et al., 2008).

If the uveitis is recurrent, a careful history should be initiated to discover any underlying causes. This evaluation should include a complete history, physical examination, and diagnostic tests, including a complete blood cell count, erythrocyte sedimentation rate, antinuclear antibodies, and Venereal Disease Research Laboratory (VDRL) and Lyme disease titers. Underlying causes include autoimmune disorders such as ankylosing spondylitis and sarcoidosis as well as toxoplasmosis, herpes zoster virus, ocular candidiasis, histoplasmosis, herpes simplex virus, tuberculosis, and syphilis.

## Orbital Cellulitis

Orbital cellulitis is inflammation of the tissues surrounding the eye and may result from bacterial, fungal, or viral inflammatory conditions of contiguous structures, such as the face, oropharynx, dental structures, or intracranial structures. It can also result from foreign bodies and from a preexisting ocular infection, such as dacryocystitis and panophthalmitis, or from generalized septicemia. Infection of the sinuses is the most frequent cause. Infection originating in the sinuses can spread easily to the orbit through the thin bony walls and foramina or by means of the interconnecting venous system of the orbit and sinuses. The most common causative organisms are staphylococci and streptococci in adults and *H. influenzae* in children. The symptoms include pain, lid swelling, conjunctival edema, proptosis, and decreased ocular motility. With such edema, optic nerve compression can occur and IOP may increase.

The severe intraorbital tension caused by abscess formation and the impairment of optic nerve function in orbital cellulitis can result in permanent visual loss. Because of the orbit's proximity to the brain, orbital cellulitis can lead to life-threatening complications, such as intracranial abscess and cavernous sinus thrombosis.

### Management

Immediate administration of high-dose, broad-spectrum, systemic antibiotics is indicated. Cultures and Gram-stained smears are obtained. Monitoring changes in visual acuity, degree of proptosis, central nervous system function (eg, nausea, vomiting, fever, cognitive changes), displacement of the globe, extraocular movements, pupillary signs, and the fundus is extremely important. Consultation with an otolaryngologist is necessary, especially when rhinosinusitis is suspected. In the event of abscess formation or progressive loss of vision, surgical drainage of the abscess or sinus is performed. Sinusotomy and antibiotic irrigation are also performed.

# ORBITAL AND OCULAR TUMORS

## Benign Tumors of the Orbit

Benign tumors can develop from infancy and grow rapidly or slowly and present in later life. Some benign tumors are superficial and are easily identifiable by external presentation, palpation, and x-rays, but some are deep and may require a CT scan for a more thorough and precise diagnosis. There can be a significant proptosis, and visual function may be jeopardized. Benign tumors are masses characterized by the lack of infiltration in the surrounding tissues. Examples are cystic dermoid cysts and mucocele, hemangiomas, lymphangiomas, lacrimal tumors, and neurofibromas.

To prevent recurrence, benign masses are excised completely when possible. Sometimes, excision is difficult because of the involvement of some portions of the orbital bones, such as deep dermoid cysts, in which dissection of the bone is required. Subtotal resection may be indicated in deep benign tumors that intertwine with other orbital structures,

such as optic nerve meningiomas. Complete removal of the tumor may endanger visual function.

## Benign Tumors of the Eyelids

Benign tumors include a wide variety of neoplasms and increase in frequency with age. Nevi may be unpigmented at birth and may enlarge and darken in adolescence or may never acquire any pigment at all. Hemangiomas are vascular capillary tumors that may be bright, superficial, strawberry-red lesions (ie, strawberry nevus) or bluish and purplish deeper lesions. Milia are small, white, slightly elevated cysts of the eyelid that may occur in multiples. Xanthelasma are yellowish, lipoid deposits on both lids near the inner angle of the eye that commonly appear as a result of the aging of the skin or a lipid disorder. Molluscum contagiosum lesions are flat, symmetric growths along the lid margin caused by a virus that can result in conjunctivitis and keratitis if debris gets into the conjunctival sac.

Treatment of benign congenital lid lesions is rarely indicated, except when visual function is affected. Corticosteroid injection to the hemangioma lesion is usually effective, but surgical excision may be performed. Benign lid lesions usually present aesthetic problems rather than visual function problems. Surgical excision, or electrocautery, is primarily performed for cosmetic reasons, except for cases of molluscum contagiosum, for which surgical intervention is performed to prevent an infectious process that may ensue.

## Benign Tumors of the Conjunctiva

Conjunctival nevus, a congenital, benign neoplasm, is a flat, slightly elevated, brown spot that becomes pigmented during late childhood or adolescence. This should be differentiated from the pigmented lesion melanosis acquired at middle age, which tends to wax and wane and become malignant melanoma. Keratin- and sebum-containing dermoid cysts are congenital and can be found in the conjunctiva. Dermolipoma is a congenital tumor that manifests as a smooth, rounded growth in the conjunctiva near the lateral canthus. Papillomas are usually soft with irregular surfaces and appear on the lid margins. Treatment consists of surgical excision.

## Malignant Tumors of the Orbit

Rhabdomyosarcoma is the most common malignant primary orbital tumor in childhood, but it can also develop in elderly people. The symptoms of rhabdomyosarcoma include sudden painless proptosis of one eye followed by lid swelling, conjunctival chemosis, and impairment of ocular motility. Imaging of these tumors establishes the size, configuration, location, and stage of the disease; delineates the degree of bone destruction; and is useful in estimating the field for radiation therapy, if needed. The most common site of metastasis is the lung.

Management of these primary malignant orbital tumors involves three major therapeutic modalities: surgery, radiation therapy, and adjuvant chemotherapy. The degree of orbital destruction is important in planning the surgical approach. Resection often involves removal of the eyeball. The psychological needs of the patient and family are paramount in planning the management approach.

## Malignant Tumors of the Eyelid

Basal cell carcinoma is the most common malignant tumor of the eyelid. Squamous cell carcinoma occurs less frequently but is considered the second most common malignant tumor. Malignant melanoma is rare. Malignant eyelid tumors occur more frequently among people with a fair complexion who have a history of chronic exposure to the sun.

Basal cell carcinoma appears as a painless nodule that may ulcerate. The lesion is invasive, spreads to the surrounding tissues, and grows slowly but does not metastasize. It usually appears on the lower lid margin near the inner canthus with a pearly white margin. Squamous cell carcinoma of the eyelids may resemble basal cell carcinoma initially because it also grows slowly and painlessly. It tends to ulcerate and invade the surrounding tissues, but it can metastasize to the regional lymph nodes. Malignant melanoma may not be pigmented and can arise from nevi. It spreads to the surrounding tissues and metastasizes to other organs.

Complete excision of these carcinomas is followed by reconstruction with skin grafting if the surgical excision is extensive. The ocular postoperative site and the graft donor site are monitored for bleeding. Donor graft sites may include the buccal mucosa, the thigh, or the abdomen. The patient is referred to an oncologist for evaluation of the need for radiation therapy and monitoring for metastasis. Early diagnosis and surgical management are the basis of a good prognosis. These conditions have life-threatening consequences, and surgical excisions may result in facial disfigurement. Emotional support is an extremely important aspect of nursing management.

## Malignant Tumors of the Conjunctiva

Conjunctival carcinoma most often grows in the exposed areas of the conjunctiva. The typical lesions are usually gelatinous and whitish due to keratin formation. They grow gradually, and deep invasion and metastasis are rare. Malignant melanoma is rare but may arise from a preexisting nevus or acquired melanosis during middle age. Squamous cell carcinoma is also rare but invasive.

The management is surgical incision. Some benign tumors and most malignant tumors recur. To avoid recurrences, patients usually undergo radiation therapy and cryotherapy after the excision of malignant tumors. Cosmetic disfigurement may result from extensive excision when deep invasion by the malignant tumor is involved.

## Malignant Tumors of the Globe

Retinoblastoma, a malignant tumor of the retina, occurs in childhood and is hereditary, found in 1 of 15,000 live births. It is hereditary in 30% to 40% of cases. All bilateral

cases are hereditary. The retinoblastoma gene is found on chromosome 13, region q14. If this gene is inhibited, the growth in retinal cells is unchecked and the retinoblastoma results. Signs and symptoms include an initial leukocoria or "white" pupil with a peculiar light reflection and possible strabismus as well. Less frequent signs are uveitis, glaucoma, hyphema, nystagmus, and periorbital cellulitis. Treatment for this life-threatening tumor is enucleation, if the tumor is large and unilateral. If the eye is removed before cancer spreads to the optic nerve, the cure rate is greater than 90%.

Ocular melanoma, another cancer, primarily occurs in adults. This rare, malignant choroidal tumor is often discovered on a retinal examination. In its early stages, it could be mistaken for a nevus. Many ophthalmologists may practice for decades and never encounter this lesion. For this reason, any patient who is suspected of having ocular melanoma should be immediately referred to an ocular oncologist with experience in this disease.

Although many patients do not have symptoms in the early stages, some patients complain of blurred vision or a change in eye color. A number of such tumors have been found in people with blindness who have painful eyes. In addition to a complete physical examination to discover any evidence of metastasis (to the liver, lung, and breast), retinal fundus photography, fluorescein angiography, and ultrasonography are performed. The diagnosis is confirmed at biopsy after enucleation.

Tumors are classified according to boundary lines (apical height and basal diameter) as small, medium, or large. Small tumors are generally monitored, whereas medium and large tumors require treatment. Treatment consists of radiation, enucleation, or both. Radiation therapy may be achieved by external beam performed in repeated episodes over several days or through the implantation of a small plaque that contains radioactive iodine (I-125) pellets over the tumor.

## SURGICAL PROCEDURES AND ENUCLEATION

### Orbital Surgeries

Orbital surgeries may be performed to repair fractures, remove a foreign body, or remove benign or malignant growths. Surgical procedures involving the orbit and lids affect facial appearance (cosmesis). The goals are to recover and preserve visual function and to maintain the anatomic relationship of the ocular structures to achieve cosmesis. During the repair of orbital fractures, the orbital bones are realigned to follow the anatomic positions of facial structures.

Orbital surgical procedures involve working around delicate structures of the eye, such as the optic nerve, retinal blood vessels, and ocular muscles. Complications of orbital surgical procedures may include blindness as a result of damage to the optic nerve and its blood supply. Sudden pain and loss of vision may indicate intraorbital hemorrhage or compression of the optic nerve. Ptosis and diplopia may result from trauma to the extraocular muscles during the surgical procedure, but these conditions typically resolve after a few weeks.

Prophylaxis with IV antibiotics is the usual postoperative regimen after orbital surgery, especially with repair of orbital fractures and intraorbital foreign body removal. IV corticosteroids are used if there is a concern about optic nerve swelling. Topical ocular antibiotics are typically instilled, and antibiotic ointments are applied externally to the skin suture sites.

For the first 24 to 48 hours postoperatively, ice compresses are applied over the periocular area to decrease periorbital swelling, facial swelling, and hematoma. The head of the patient's bed should be elevated to a comfortable position (30 to 45 degrees).

Discharge teaching should include medication instructions for oral antibiotics, instillation of ophthalmic medications, and application of ocular compresses.

### Enucleation

Enucleation is the removal of the entire eye and part of the optic nerve. It may be performed for the following conditions:

- Severe injury resulting in prolapse of uveal tissue or loss of light projection (the ability to identify the direction of the light source) or perception
- An irritated, blind, painful, deformed, or disfigured eye, usually caused by glaucoma, retinal detachment, or chronic inflammation
- An eye without useful vision that is producing or has produced sympathetic ophthalmia in the other eye
- Intraocular tumors that are untreatable by other means

The procedure for enucleation involves the separation and cutting of each of the ocular muscles, dissection of the Tenon's capsule (fibrous membrane covering the sclera), and cutting of the optic nerve from the eyeball. The insertion of an orbital implant typically follows, and the conjunctiva is closed. A large pressure dressing is applied over the area.

**Evisceration** involves the surgical removal of the intraocular contents through an incision or opening in the cornea or sclera. Evisceration may be performed to treat severe ocular trauma with ruptured globe, severe ocular inflammation, or severe ocular infection. The optic nerve, sclera, extraocular muscles, and sometimes the cornea are left intact. The main advantage of evisceration over enucleation is that the final cosmetic result and motility after fitting the ocular prosthesis are enhanced. This procedure would be more acceptable to a patient whose body image is severely threatened. The main disadvantage is the high risk of sympathetic ophthalmia.

**Exenteration** is the removal of the eyelids, the eye, and various amounts of orbital contents. It is indicated in malignancies in the orbit that are life-threatening or when more conservative modalities of treatment have failed or are inappropriate. An example is squamous cell carcinoma of the paranasal sinuses, skin, and conjunctiva with deep orbital involvement. In its most extensive form, exenteration may include the removal of all orbital tissues and resection of the orbital bones.

## Ocular Prostheses

Orbital implants and conformers (ocular prostheses usually made of silicone rubber) maintain the shape of the eye after enucleation or evisceration to prevent a contracted, sunken appearance. The temporary conformer is placed over the conjunctival closure after the implantation of an orbital implant. A conformer is placed after the enucleation or evisceration procedure to protect the suture line, maintain the fornices, prevent contracture of the socket in preparation for the ocular prosthesis, and promote the integrity of the eyelids.

All ocular prosthetics have limitations in their motility. There are two designs of eye prostheses. The anophthalmic ocular prostheses are used in the absence of the globe. Scleral shells look just like the anophthalmic prosthesis (Fig. 58-19) but are thinner and fit over a globe with intact corneal sensation. An eye prosthesis usually lasts about 6 years, depending on the quality of fit, comfort, and cosmetic appearance. When the anophthalmic socket is completely healed, conformers are replaced with prosthetic eyes.

An ocularist is a specially trained and skilled professional who makes prosthetic eyes. After the ophthalmologist is satisfied that the anophthalmic socket is completely healed and is ready for prosthetic fitting, the patient is referred to an ocularist. The healing period is usually 6 to 8 weeks. It is advisable for the patient to have a consultation with the ocularist before the fitting. Obtaining accurate information and verbalizing concerns can lessen anxiety about wearing an ocular prosthesis.

## Medical Management

Removal of an eye has physical, social, and psychological ramifications for any person. The significance of loss of the eye and vision must be addressed in the plan of care. The patient's preparation should include information about the surgical procedure and placement of orbital implants and conformers and the availability of ocular prosthetics to enhance cosmetic appearance. In some cases, patients may choose to see an ocularist before the surgery to discuss ocular prosthetics.

## Nursing Management

### Teaching About Postsurgical and Prosthetic Care

Patients who undergo eye removal need to know that they will usually have a large ocular pressure dressing, which is typically removed after a week, and that an ophthalmic topical antibiotic ointment is applied in the socket three times daily.

After the removal of an eye, there is a loss of depth perception. Patients must be advised to take extra caution in their ambulation and movement to avoid miscalculations that may result in injury. It may take some time to adjust to monocular vision.

The patient must be advised that conformers may accidentally fall out of the socket. If this happens, the conformer must be washed, wiped dry, and placed back in the socket.

When surgical eye removal is unexpected, such as in severe ocular trauma, leaving no time for the patient and family to prepare for the loss, the nurse's role in providing emotional support is crucial.

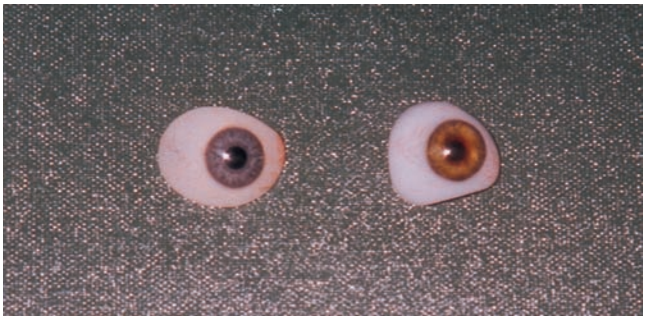


**Figure 58-19** Eye prostheses. (*Left*) Anophthalmic ocular prosthesis. (*Right*) Scleral shell.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

Patients need to be taught how to insert, remove, and care for the prosthetic eye. Proper hand hygiene must be observed before inserting and removing an ocular prosthesis. A suction cup may be used if there are problems with manual dexterity. Precautions, such as draping a towel over the sink and closing the sink drain, must be taken to avoid loss of the prosthesis. When instructing patients or family members, a return demonstration is important to assess the level of understanding and ability to perform the procedure.

Before insertion, the inner punctal or outer lateral aspects and the superior and inferior aspects of the prosthesis must be identified by locating the identifying marks, such as a reddish color in the inner punctal area. For people with low vision, other forms of identifying markers, such as dots or notches, are used. The upper lid is raised high enough to create a space; then the patient learns to slide the prosthesis up, underneath, and behind the upper eyelid. Meanwhile, the patient pulls the lower eyelid down to help put the prosthesis in place and to have its inferior edge fall back gradually to the lower eyelid. The lower eyelid is checked for correct positioning.

To remove the prosthesis, the patient cups one hand on the cheek to catch the prosthesis, places the forefinger of the free hand against the midportion of the lower eyelid, and gazes upward. Gazing upward brings the inferior edge of the prosthesis nearer the inferior eyelid margin. With the finger pushing inward, downward, and laterally against the lower eyelid, the prosthesis slides out into the cupped hand.

#### Continuing Care

An eye prosthesis can be worn and left in place for several months. Hygiene and comfort are usually maintained with daily irrigation of the prosthesis in place with normal saline solution, hard contact lens solution, or artificial tears. In the case of dry eye symptoms, the use of ophthalmic ointment lubricants or oil-based drops, such as vitamin E and mineral oil, can be helpful. Removing crusting and mucous discharge that accumulate overnight is performed with the prosthesis in place. Malpositions may occur when wiping or

rubbing the prosthesis in the socket. The prosthesis can be repositioned with the use of clean fingers. Proper wiping of the prosthesis should be a gentle temporal-to-nasal motion to avoid malpositions.

The prosthesis needs to be removed and cleaned when it becomes uncomfortable and when there is increased mucous discharge. The socket should also be rendered free of mucus and inspected for any signs of infection. Any unusual discomfort, irritation, or redness of the globe or eyelids may indicate excessive wear, debris under the shell, or lack of proper hygiene. Any infection or irritation that does not resolve needs medical attention.

# OCULAR CONSEQUENCES OF SYSTEMIC DISEASE

## Diabetic Retinopathy

Of all of the medical disorders that the nurse encounters, diabetes mellitus is one of the most common. One of the most serious complications of diabetes is retinopathy. In the United States today, diabetes is the leading cause of new cases of blindness in people between 20 and 74 years of age (Prevent Blindness America, 2008). Before the discovery of insulin in the 1920s, diabetic retinopathy was relatively rare because most people with diabetes did not survive for more than 1 or 2 years. However, with the many advancements in the treatment of diabetes, more and more patients are able to survive and enjoy relatively normal lifespans, but they are also confronted with the complications of long-term diabetes. With the rate of obesity in the United States rising, type 2 diabetes has become epidemic, and the incidence of diabetic retinopathy may be expected to increase. Chapter 41 provides a detailed discussion of diabetic retinopathy.

## Cytomegalovirus Retinitis

Many ophthalmic complications have been associated with AIDS. Cytomegalovirus (CMV) is the most common cause of retinal inflammation in patients with AIDS. Early symptoms of CMV retinitis vary from patient to patient. Some patients complain of floaters or a decrease in peripheral vision. Some have a paracentral or central scotoma, whereas others have fluctuations in vision from macular edema. The retina often becomes thin and atrophic and susceptible to retinal tears and breaks.

CMV retinitis generally takes one of three forms: hemorrhagic, brushfire, or granular. In the hemorrhagic type, large areas of white, necrotic retina may be associated with retinal hemorrhage. In the brushfire type, a yellow-white margin begins at the edge of burned-out atrophic retina. This retinitis expands and, if untreated, involves the entire retina. In the granular type, white granular lesions in the periphery of the retina gradually expand. The white, feathery infiltration of the retina destroys sensory retina and leads to necrosis, optic atrophy, and retinal detachment.

### Medical Management

#### Pharmacologic Therapy

Pharmacologic agents available for treatment of CMV retinitis include ganciclovir (Cytovene), foscarnet (Foscavir), and cidofovir (Vistide).

Ganciclovir is administered intravenously, orally, or intravitreously in the acute stage of CMV retinitis. The intravitreous form is available as a 4-mm intraocular implant or insert containing the medication embedded in a polymer-based system that slowly releases the medication. The insert is surgically placed in the posterior segment of the eye, and the medication diffuses locally to the site of the infection over a period of 5 to 8 months before the insert must be replaced. When administered systemically, ganciclovir is a very potent medication; it can cause neutropenia, thrombocytopenia, anemia, and elevated serum creatinine levels. The surgically implanted sustained-release insert enables higher concentrations of ganciclovir to reach the CMV retinitis, but there are risks and complications associated with the inserts, including endophthalmitis, retinal detachment, and hypotony.

Foscarnet inhibits viral DNA replication. It may be the medication of choice when ganciclovir is ineffective. It may be administered by IV or intravitreal injections. The combination of foscarnet and ganciclovir has been more effective than either medication alone. Nephrotoxicity may occur with systemic foscarnet, and renal function must be monitored carefully.

Cidofovir impedes CMV replication and is administered by IV. Cidofovir has been shown to delay the progression of CMV retinitis significantly. Nephrotoxicity, proteinuria, and increased serum creatinine levels are significant side effects.

In the late 1990s, the routine management of patients with AIDS, including those with CMV retinitis, changed with the introduction of highly active antiretroviral therapy (HAART). HAART is a combination of two or three medications of different categories. For example, a nucleoside analogue such as zidovudine (Retrovir) administered in combination with one or more protease inhibitors such as ritonavir (Norvir) has led to a suppression of human immunodeficiency virus (HIV) replication for sustained periods. The immune system can then recover to a functional level. Several patients who had been treated for CMV retinitis have been able to discontinue treatment for CMV retinitis as their immune systems rebounded. However, some patients develop immune recovery uveitis, characterized by intraocular inflammation, cystoid macular edema, and the formation of epiretinal membranes. Immune recovery uveitis is managed by corticosteroids or by injection of corticosteroids into the sub-Tenon's area of the eye.

## Hypertension-Related Eye Changes

Hypertension can shorten the lifespan by as many as 20 years and affects the eye as well as the heart, brain, and kidneys. Long-standing hypertension goes hand in hand

with atherosclerosis, and the associated retinal changes are evidenced by the development of retinal arteriolar changes, such as tortuousness, narrowing, and a change in light reflex. Funduscopic examination reveals a copper or silver coloration of the arterioles and venous compression (arteriovenous nicking) at the arteriolar and venous crossings. Intraretinal hemorrhages from hypertension appear flame-shaped because they occur in the nerve fiber layer of the retina.

Hypertension can also occur as an acute consequence of conditions such as pheochromocytoma, acute renal failure, and pregnancy-induced hypertension. The retinopathy associated with these crisis states is extensive, and the manifestations include cotton-wool spots, retinal hemorrhages, retinal edema, and retinal exudates, often clustered around the macula.

The choroid is also affected by the profound and abrupt rise in blood pressure and resulting vasoconstriction, and ischemia may result in serous retinal detachments and infarction of the RPE. Ischemic optic neuropathy and **papilledema** (swelling of the optic disc due to increased IOP) may also result. Blood pressure in these more severe stages should be lowered in a controlled gradual fashion to avoid ischemia of the optic nerve and brain secondary to a too-rapid fall in blood pressure. For further information about hypertension, see Chapter 32.

## CONCEPTS IN OCULAR MEDICATION ADMINISTRATION

The main objective of ocular medication delivery is to maximize the amount of medication that reaches the ocular site of action in sufficient concentration to produce a beneficial therapeutic effect. This is determined by the dynamics of ocular pharmacokinetics: absorption, distribution, metabolism, and excretion.

Topical administration of ocular medications results in only a 1% to 7% absorption rate by the ocular tissues. Ocular absorption involves the entry of a medication into the aqueous humor through the different routes of ocular medication administration. The rate and extent of aqueous humor absorption are determined by the characteristics of the medication and the anatomy and physiology of the eye. Natural barriers of absorption that diminish the efficacy of ocular medications include the following:

- *Limited size of the conjunctival sac.* The conjunctival sac can hold only 50 μL, and any excess is wasted. The volume of one eye drop from commercial topical ocular solutions typically ranges from 20 to 35 μL.
- *Corneal membrane barriers.* The epithelial, stromal, and endothelial layers are barriers to absorption.
- *Blood–ocular barriers.* Blood–ocular barriers prevent high ocular tissue concentration of most ophthalmic medications because they separate the bloodstream from the ocular tissues and keep foreign substances from entering the eye, thereby limiting a medication's efficacy.
- *Tearing, blinking, and drainage.* Increased tear production and drainage due to ocular irritation or an ocular condition may dilute or wash out an instilled eye drop; blinking expels an instilled eye drop from the conjunctival sac.

Distribution of an ocular medication into the various ocular tissues varies by tissue type; the various tissues (eg, conjunctiva, cornea, lens, iris, ciliary body, choroids) absorb medications to varying degrees. Medications penetrate the corneal epithelium by diffusion by passing through the cells (intracellular) or by passing between the cells (intercellular). Water-soluble (hydrophilic) medications diffuse through the intracellular route, and fat-soluble (lipophilic) medications diffuse through the intercellular route. Topical administration usually does not reach the retina in significant concentrations. Because the space between the ciliary process and the lens is small, medication diffusion in the vitreous is slow. When high concentrations of medication in the vitreous are required, intraocular injection is often chosen to bypass the natural ocular anatomic and physiologic barriers.

Aqueous solutions are most commonly used for the eye. They are the least expensive medications and interfere least with vision. However, corneal contact time is brief because tears dilute the medication. Ophthalmic ointments have extended retention time in the conjunctival sac and provide a higher concentration than eye drops. The major disadvantage of ointments is the blurred vision that results after application. In general, eyelids and eyelid margins are best treated with ointments. The conjunctiva, limbus, cornea, and anterior chamber are treated most effectively with instilled solutions or suspensions. Subconjunctival injection may be necessary for better absorption in the anterior chamber. If high medication concentrations are required in the posterior chamber, intravitreal injections or systemically absorbed medications are considered. Contact lenses and collagen shields soaked in antibiotics are alternative delivery methods for treating corneal infections.

Of all these delivery methods, the topical route of administration—instilled eye drops and applied ointments—remains the most common. Topical instillation, which is the least invasive method, permits self-administration of medication and produces fewer side effects.

Preservatives are commonly used in ocular medications. Benzalkonium chloride, for example, prevents the growth of organisms and enhances the corneal permeability of most medications; however, some patients are allergic to this preservative. This may be suspected even if the patient had never before experienced an allergic reaction to systemic use of the medication in question. Eye drops without preservatives can be prepared by pharmacists.

### Commonly Used Ocular Medications

Common ocular medications include topical anesthetic, mydriatic, and cycloplegic agents that reduce IOP; anti-infective medications; corticosteroids; NSAIDs; antiallergy medications; eye irrigants; and lubricants.

#### *Topical Anesthetics*

One or two drops of proparacaine hydrochloride (Ophthaine 0.5%) and tetracaine hydrochloride (Pontocaine 0.5%) are

instilled before diagnostic procedures such as tonometry and gonioscopy and in minor ocular procedures such as removal of sutures or conjunctival or corneal scrapings. Topical anesthetics are also used for severe eye pain to allow the patient to open his or her eyes for examination or treatment (eg, eye irrigation for chemical burns). Anesthesia occurs within 20 seconds to 1 minute and lasts 10 to 20 minutes. The nurse must instruct the patient not to rub his or her eyes while anesthetized because this may result in corneal damage.

Most patients are not allowed to take topical anesthetics home because of the risk of overuse. Patients with corneal abrasions and erosions experience severe pain and are often tempted to overuse topical anesthetic eye drops. Overuse of these drops results in softening of the cornea. Prolonged use of anesthetic drops can delay wound healing and can lead to permanent corneal opacification and scarring, resulting in visual loss.

### Mydriatics and Cycloplegics

Mydriasis, or pupil dilation, is the main objective of the administration of mydriatic and cycloplegic agents (Table 58-7). These two types of medications function differently and are used in combination to achieve the maximal dilation that is needed during surgery and fundus examinations to give the ophthalmologist a better view of the internal eye structures. Mydriatics potentiate alpha-adrenergic sympathetic effects that result in the relaxation of the ciliary muscle. This causes the pupil to dilate. However, this sympathetic action alone is not enough to sustain mydriasis because of its short duration of action. The strong light used during an eye examination also stimulates miosis (ie, pupillary contraction). Cycloplegic medications are administered to paralyze the iris sphincter.

The patient is instructed about the temporary effects of mydriasis on vision, such as glare and the inability to focus properly. The patient may have difficulty reading. The effects of the various mydriatics and cycloplegics can last 3 hours to several days. The patient is advised to wear sunglasses (most eye clinics provide protective sunglasses). The ability to drive is dependent on the person's age, vision, and comfort level. Some patients can drive safely with the use of sunglasses, whereas others may need to be driven home.

Mydriatic and cycloplegic agents affect the central nervous system. Their effects are most prominent in children and elderly patients; these patients must be assessed closely for symptoms, such as increased blood pressure, tachycardia, dizziness, ataxia, confusion, disorientation, incoherent speech, and hallucination. These medications are contraindicated in patients with narrow angles or shallow anterior chambers and in patients taking monoamine oxidase inhibitors or tricyclic antidepressants.

### Medications Used to Treat Glaucoma

Therapeutic medications for glaucoma are used to lower IOP by decreasing aqueous production or increasing aqueous outflow. Because glaucoma calls for lifetime therapy, the patient must be instructed regarding both the ocular and systemic side effects of the medications.

Most antiglaucoma medications affect the accommodation of the lens and limit light entry through a constricted pupil. Visual acuity and the ability to focus may be affected. Some drops (eg, prostaglandin analogues) may cause iris color change as well as eyelash hypertrichosis (excessive growth of hair). Factors to consider in selecting glaucoma medications are efficacy, systemic and ocular side effects, convenience, and cost.

**Table 58-7 MYDRIATICS AND CYCLOPLEGICS**

| Medication | Available Preparation/ Concentration | Indication/Dosage | Peak | | Recovery Time | |
|---|---|---|---|---|---|---|
| | | | Mydriasis | Cycloplegia | Mydriasis | Cycloplegia |
| phenylephrine (Neo-Synephrine) | Solutions (2.5%, 10%) | Administered with cycloplegics in pupillary dilation for ophthalmoscopy and surgical procedures every 5–10 min × 3 or until the pupils are fully dilated | 10–60 min | — | 3–6 h | — |
| atropine (Atropine Ophthalmic) | Ointment (0.5%–2%) Solutions (0.5%–3%) | In glaucoma, uveitis, or after surgery, 2× to 4× daily | 30–40 min | 60–180 min | 7–10 d | 6–12 d |
| scopolamine (Isopto Hyoscine Ophthalmic) | Solution (0.25%) | Same as atropine | 20–30 min | 30–60 min | 3–7 d | 3–7 d |
| homatropine (Homatropine HBR) | Solution (5%–2.5%) | Same as atropine and scopolamine | 40–60 min | 30–60 min | 1–3 d | 1–3 d |
| cyclopentolate (AK-Pentolate) | Solution (0.5%–2%) | Administered with mydriatics every 5–10 min × 3 or until the pupils are fully dilated for ophthalmoscopy and surgical procedures | 30–60 min | 25–75 min | 1 d | 6–24 h |
| tropicamide (Mydriacyl) | Solution (0.25%–1%) | | 20–40 min | 20–35 min | 6 h | <6 h |

Data on peak and recovery time from *Ophthalmic drug facts by facts and comparisons* (2008), pp. 45 and 49.

### Anti-Infective Medications

Anti-infective medications include antibiotic, antifungal, and antiviral agents. Most are available as drops, ointments, or subconjunctival or intravitreal injections. Antibiotics include penicillin, cephalosporins, aminoglycosides, and fluoroquinolones. The main antifungal agent is amphotericin B. Side effects of amphotericin are serious and include severe pain, conjunctival necrosis, iritis, and retinal toxicity. Antiviral medications include acyclovir (Zovirax) and ganciclovir. They are used to treat ocular infections associated with herpesvirus and CMV. Patients receiving ocular anti-infective agents are subject to the same side effects and adverse reactions as those receiving oral or parenteral medications.

### Corticosteroids and Nonsteroidal Anti-Inflammatory Drugs

The topical preparations of corticosteroids are commonly used in inflammatory conditions of the eyelids, conjunctiva, cornea, anterior chamber, lens, and uvea. In posterior segment diseases that involve the posterior sclera, retina, and optic nerve, the topical agents are less effective, and parenteral and oral routes are preferred. Because these topical eye drop preparations are suspensions, the patient is instructed to shake the bottle several times to promote mixture of the medication and maximize its therapeutic effect. The most common ocular side effects of long-term topical corticosteroid administration are glaucoma, cataracts, susceptibility to infection, impaired wound healing, mydriasis, and ptosis. High IOP may develop, which is reversible after corticosteroid use is discontinued. To avoid the side effects of corticosteroids, NSAIDs are used as an alternative in controlling inflammatory eye conditions and postoperatively to reduce inflammation. NSAID therapy in combination with topical and oral preparations is an important adjunct therapy in managing uveitis.

### Antiallergy Medications

Ocular hypersensitivity reactions, such as allergic conjunctivitis, are extremely common. These conditions result primarily from responses to environmental allergens. Most allergens are airborne or carried to the eye by the hand or by other means, although allergic reactions may also be drug induced. Corticosteroids are commonly used as anti-inflammatory and immunosuppressive agents to control ocular hypersensitivity reactions.

### Ocular Irrigants and Lubricants

Most irrigating solutions are used to cleanse the external lids to maintain lid hygiene, to irrigate the external corneal surface to regain normal pH (eg, in chemical burns), to irrigate the corneal surface to eliminate debris, or to inflate the globe intraoperatively. These solutions have various compositions that include sodium, potassium, magnesium, calcium, bicarbonate, glucose, and glutathione (ie, substance found in the aqueous humor). Sterile irrigating solutions, such as Dacriose, for lid hygiene are available. Irrigating solutions are safe to use with an intact corneal surface; however, the corneal surface should not be irrigated in cases of threatened corneal perforation. For patients with severe corneal ulcer, specific orders must be obtained regarding whether it is safe to irrigate the corneal surface or just to cleanse the external lids. Although it is good practice to promote hygiene, prevention of complications must be the primary concern. Normal saline solutions are commonly used to irrigate the corneal surface when chemical burns occur.

Lubricants, such as artificial tears, help alleviate corneal irritation, such as dry eye syndrome. Artificial tears are topical preparations of methyl or hydroxypropyl cellulose that are prepared as eye drop solutions, ointments, or ocular inserts (inserted at the lower conjunctival cul-de-sac once each day). The eye drops can be instilled as often as every hour, depending on the severity of symptoms.

## Nursing Management

The objectives in administering ocular medications are to ensure proper administration to maximize the therapeutic effects and to ensure the safety of the patient by monitoring for systemic and local side effects. Absorption of eye drops by the nasolacrimal duct is undesirable because of the potential systemic side effects of ocular medications. To diminish systemic absorption and minimize the side effects, it is important to occlude the puncta (Chart 58-13). This is especially important for patients who are most vulnerable to medication overdose, including elderly people, children, infants, women who are lactating or are pregnant, and patients with cardiac, pulmonary, hepatic, or renal disease. A 1-minute interval between instillation of different types of ocular drops is recommended.

Before the administration of ocular medications, the nurse warns the patient that blurred vision, stinging, and a burning sensation are symptoms that ordinarily occur after instillation and are temporary. Risk for interactions of the ocular medication with other ocular and systemic medications must be emphasized; therefore, a careful patient interview regarding the medications being taken must be obtained.

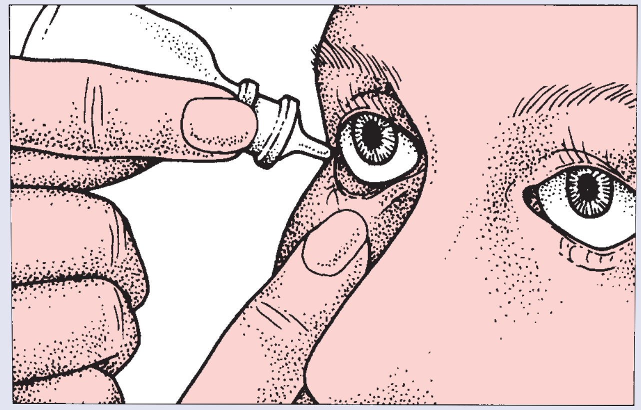
Emphasis must be placed on hand hygiene techniques before and after medication instillation. The tip of the eye drop bottle or the ointment tube must never touch any part of the eye. The medication must be recapped immediately after each use. If a patient who instills his or her own medications cannot feel the eye drops when they are instilled, the eye medication may be refrigerated, because a cold drop is easier to detect. A 5-minute interval between successive administrations allows adequate drug retention and absorption. The patient or the caregiver at home should be asked to demonstrate actual eye drop or ointment instillation and punctal occlusion.

# ISSUES IN OPHTHALMOLOGY

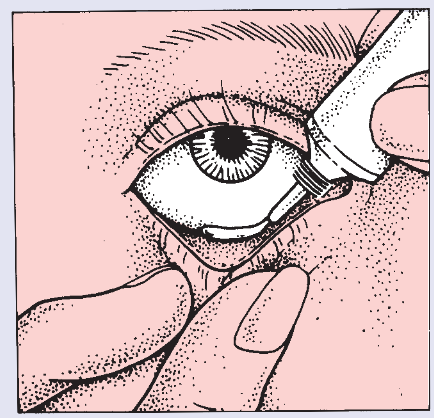
The well-being of the patient physically, emotionally, financially, socially, and spiritually can be at risk when vision is threatened. Patients with a deteriorating eye condition often worry about the impact that visual loss will have on their lives. As they experience visual

CHART 58-13 PATIENT EDUCATION
*Instilling Eye Medications*

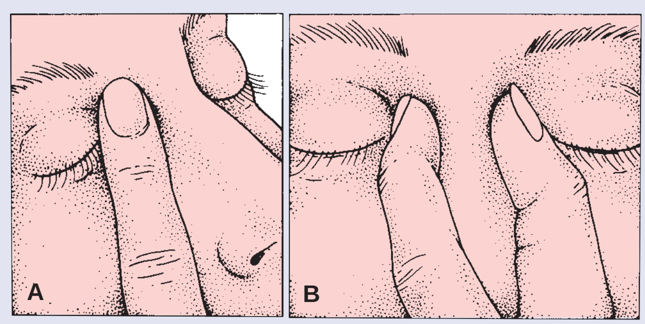
- Shake suspensions or "milky" solutions to obtain the desired medication level.
- Wash hands thoroughly before and after the procedure.
- Ensure adequate lighting.
- Read the label of the eye medication to make sure it is the correct medication.
- Assume a comfortable position.
- Do not touch the tip of the medication container to any part of the eye or face.
- Hold the lower lid down; do not press on the eyeball. Apply gentle pressure to the cheek bone to anchor the finger holding the lid.



- Instill eye drops before applying ointments.
- Apply a ½-inch ribbon of ointment to the lower conjunctival sac.



- Keep the eyelids closed, and apply gentle pressure on the inner canthus (punctal occlusion) near the bridge of the nose for 1 or 2 minutes immediately after instilling eyedrops.
- Using a clean tissue, gently pat skin to absorb excess eyedrops that run onto the cheeks.
- Wait 5 to 10 minutes before instilling another eye medication.




distortions, scotomas, or gradual visual loss, what was a vague worry can become a consuming preoccupation. The patient may equate a decrease in visual acuity with a loss of independence. The loss of a driver's license may force a patient to relocate or give up or change careers.

## Vision Loss

Major goals should include the preservation of vision and the prevention of further visual loss in patients who have already experienced some degree of loss. Aging itself is a risk factor for many conditions such as cataracts, glaucoma, and AMD, which may lead to visual loss. Therefore, people older than 50 years of age should have regular examinations by an eye care specialist to help detect problems at their earliest stages, when there may be more treatment options. Those with diabetes or other systemic conditions should also be proactive in obtaining regular ophthalmic care.

For patients with visual impairment, effective communication is essential to promote rehabilitation. The nurse together with the patient should establish goals. The nurse listens to the patient, tries to determine his or her level of health care need, and makes suggestions and recommendations.

## Patient Safety

With the advent of the 2000 report from the Institute of Medicine on medical errors and the subsequent report of the Institute's Committee on Identifying and Preventing Medication Errors (Aspden, Wolcott, Bootman, et al., 2007), the nurse must be aware of patient safety practices unique to ophthalmology and must be an active participant in the development of a culture of safety. High-volume, efficient, fast-paced procedures characterize ophthalmic practice. This means that patient identification is critical. Active identification (asking the patient his or her name) and a second identifier (birth date, history, hospital number) must be verified before any procedure. As with other organs involving laterality, the correct eye must be verified before medication administration and surgery. Verification of the correct eye before surgery with the involvement of the patient or caregiver (for pediatric patients and adults with cognitive impairment) must be done before initiating any procedure or transferring the patient to another unit. Marking of the operative eye by the surgeon and a final verification of the correct eye by the surgeon, anesthesiologist, and nurse immediately before incision must be performed in all cases.

Cataract surgery with an IOL implant is one of the most frequently performed surgeries. Each facility must have a policy for multiple checks and verification of the IOL type, power, and diopter, as well as the operative eye. The surgeon, scrub nurse or technician, and circulating nurse should each verify the correct IOL measurements, the correct patient, and the patient's chart.

# CRITICAL THINKING EXERCISES

**1** An ophthalmic surgeon calls a meeting with the operating room (OR) nurse manager and you, the charge nurse of the OR where he performs surgeries. Five of 15 postoperative cataract patients in the past week have complained of blurred vision and eye pain 1 to 5 days postoperatively. The operative eye showed corneal edema and inflammation of the anterior chamber. The patients were placed on topical nonsteroidal anti-inflammatory agents and were showing some improvement. Is there a need to be alarmed? Identify the steps you plan to take to investigate what is causing the postoperative problems. What initial measures are you planning?

**2** You are working in a medical unit of a community hospital. An 86-year-old woman, a cardiac patient who has previously been diagnosed with dry age-related macular degeneration, is worried about some changes in her vision that she has noticed. When checking her vision with her glasses on, you are relieved to find that her vision for distance seems satisfactory. However, the patient complains that when she reads the menu, some of the letters on some lines seem to be missing. In addition, she seems to have some visual distortion; she cannot tell the letter *D* from the letter *O*. The patient has a follow-up appointment scheduled with her ophthalmologist in 4 months. Should she be seen sooner? What additional tests do you think will be necessary? What could be the etiology of her complaints? How can you make this patient's environment safer?

EBP **3** You are working the evening shift in the operating room and an environmental services' employee runs to you stating that he accidently splashed his eyes with a cleaning solution. He is holding the bottle that has no label but still has some solution left in it. He has a lot of eye pain, and his vision is extremely blurred. What should you do immediately? What is the evidence base that supports the treatment of chemical burns to the eyes? What is the strength of this evidence? What critical information do you need to provide to the emergency physician? What environmental safety measures do you need to put in place?



The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Academy of Ophthalmology www.aao.org
American Council of the Blind, www.acb.org
American Society of Ophthalmic Registered Nurses, http://webeye.ophth.uiowa.edu/ASORN
Association for Macular Diseases, Inc., www.macular.org
Foundation Fighting Blindness, www.blindness.org
Glaucoma Research Foundation, www.glaucoma.org
Lighthouse National Center for Vision and Aging, www.lighthouse.org
Macular Degeneration Foundation, www.eyesight.org
National Association for Visually Handicapped, www.navh.org
National Eye Institute Information Office, www.nei.nih.gov
Prevent Blindness America, www.preventblindness.org
Research to Prevent Blindness, www.rpbusa.org
VISION Community Services, www.mablind.org
Vision World Wide, Inc., www.visionww.org



chapter 59

# Assessment and Management of Patients With Hearing and Balance Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe methods used to assess hearing and to diagnose hearing and balance disorders.
2. List the manifestations that may be exhibited by a person with a hearing disorder.
3. Identify ways to communicate effectively with a person with a hearing disorder.
4. Differentiate problems of the external ear from those of the middle ear and inner ear.
5. Compare the various types of surgical procedures used for managing middle ear disorders and appropriate nursing care.
6. Describe the teaching topics that need to be addressed for patients undergoing middle ear and mastoid surgery.
7. Describe the different types of inner ear disorders, including the clinical manifestations, diagnosis, and management.

## GLOSSARY

**acute otitis media:** inflammation in the middle ear lasting less than 6 weeks
**cholesteatoma:** tumor of the middle ear or mastoid, or both, that can destroy structures of the temporal bone
**chronic otitis media:** repeated episodes of acute otitis media causing irreversible tissue damage and persistent tympanic membrane perforation
**conductive hearing loss:** loss of hearing in which efficient sound transmission to the inner ear is interrupted by some obstruction or disease process
**deafness:** partial or complete loss of the ability to hear
**dizziness:** altered sensation of orientation in space
**endolymphatic hydrops:** dilation of the endolymphatic space of the inner ear; the pathologic correlate of Ménière's disease
**exostoses:** small, hard, bony protrusions in the lower posterior bony portion of the ear canal
**labyrinthitis:** inflammation of the labyrinth of the inner ear
**Ménière's disease:** condition of the inner ear characterized by a triad of symptoms: episodic vertigo, tinnitus, and fluctuating sensorineural hearing loss
**middle ear effusion:** fluid in the middle ear without evidence of infection
**myringotomy (ie, tympanotomy):** incision in the tympanic membrane
**nystagmus:** involuntary rhythmic eye movement
**ossiculoplasty:** surgical reconstruction of the middle ear bones to restore hearing
**otalgia:** sensation of fullness or pain in the ear
**otitis externa (ie, external otitis):** inflammation of the external auditory canal
**otorrhea:** drainage from the ear
**otosclerosis:** a condition characterized by abnormal spongy bone formation around the stapes
**presbycusis:** progressive hearing loss associated with aging
**rhinorrhea:** drainage from the nose
**sensorineural hearing loss:** loss of hearing related to damage of the end organ for hearing or cranial nerve VIII, or both
**tinnitus:** subjective perception of sound with internal origin; unwanted noises in the head or ear
**tympanoplasty:** surgical repair of the tympanic membrane
**vertigo:** illusion of movement in which the individual or the surroundings are sensed as moving

The ear is a sensory organ with dual functions—hearing and balance. The sense of hearing is essential for normal development and maintenance of speech as well as the ability to communicate with others. Balance, or equilibrium, is essential for maintaining body movement, position, and coordination.

The delicate structure and function of the ear make early detection and accurate diagnosis of disorders necessary for preservation of normal hearing and balance. The diagnosis and treatment of these disorders requires skilled health care professionals such as otolaryngologists, internists, and nurses. Nurses can become certified in the specialty of otolaryngology.

This chapter addresses the assessment and management of hearing and balance disorders common to adults. The pediatric otolaryngology literature provides information about otologic disorders that pertain to children.

# ASSESSMENT OF THE EAR

## *Anatomic and Physiologic Overview*

The cranium encloses and protects the brain and surrounding structures, providing attachment for various muscles that control head and jaw movements. Eight bones form the cranium: the occipital bone, the frontal bone, two parietal bones, two temporal bones, the sphenoid bone, and the ethmoid bone. Some of these bones contain sinuses, which are cavities lined with mucous membranes and connected to the nasal cavity. The ears are located on either side of the cranium at approximately eye level.

### Anatomy of the External Ear

The external ear includes the auricle (pinna) and the external auditory canal (Fig. 59-1). The external ear is separated from the middle ear by a disklike structure called the tympanic membrane (eardrum).

#### *Auricle*

The auricle, attached to the side of the head by skin, is composed mainly of cartilage, except for the fat and subcutaneous tissue in the earlobe. The auricle collects the sound waves and directs vibrations into the external auditory canal.

#### *External Auditory Canal*

The external auditory canal is approximately 2.5 cm long. The lateral third is an elastic cartilaginous and dense fibrous framework to which thin skin is attached. The medial two thirds is bone lined with thin skin. The external auditory canal ends at the tympanic membrane.

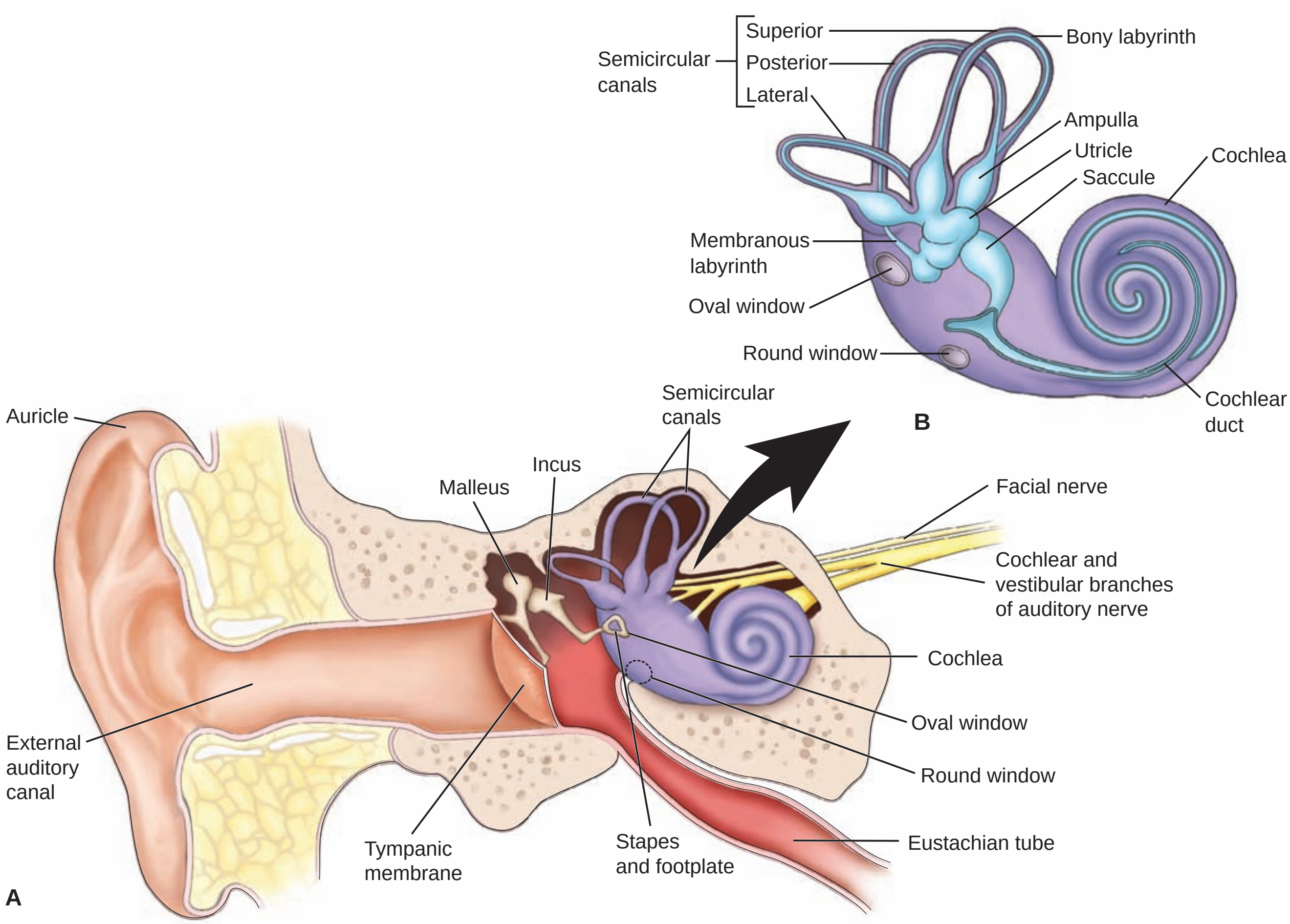



**Figure 59-1** **A,** Anatomy of the ear. **B,** The inner ear.

The skin of the canal contains hair, sebaceous glands, and ceruminous glands, which secrete a brown, waxlike substance called cerumen (ear wax). The ear's self-cleaning mechanism moves old skin cells and cerumen to the outer part of the ear.

Just anterior to the external auditory canal is the temporomandibular joint. The head of the mandible can be felt by placing a fingertip in the external auditory canal while the patient opens and closes the mouth.

## Anatomy of the Middle Ear

The middle ear, an air-filled cavity, includes the tympanic membrane laterally and the otic capsule medially. The middle ear cleft lies between the two. The middle ear is connected to the nasopharynx by the eustachian tube and is continuous with air-filled cells in the adjacent mastoid portion of the temporal bone.

The eustachian tube, which is approximately 1 mm wide and 35 mm long, connects the middle ear to the nasopharynx. Normally, the eustachian tube is closed, but it opens by action of the tensor veli palatini muscle when the person performs a Valsalva maneuver, yawns, or swallows. It drains normal and abnormal secretions of the middle ear and equalizes pressure in the middle ear with that of the atmosphere.

### Tympanic Membrane

The tympanic membrane (eardrum), about 1 cm in diameter and very thin, is normally pearly gray and translucent. It consists of three layers of tissue: an outer layer, continuous with the skin of the ear canal; a fibrous middle layer; and an inner mucosal layer, continuous with the lining of the middle ear cavity. Approximately 80% of the tympanic membrane is composed of all three layers and is called the pars tensa. The remaining 20% lacks the middle layer and is called the pars flaccida. The absence of this fibrous middle layer makes the pars flaccida more vulnerable to pathologic disorders than the pars tensa. Distinguishing landmarks include the annulus, the fibrous border that attaches the eardrum to the temporal bone; the short process of the malleus; the long process of the malleus; the umbo of the malleus, which attaches to the tympanic membrane in the center; the pars flaccida; and the pars tensa (Fig. 59-2).

The tympanic membrane protects the middle ear and conducts sound vibrations from the external canal to the ossicles. The sound pressure is magnified 22 times as a result of transmission from a larger area to a smaller one.

### Ossicles

The middle ear contains the three smallest bones (the ossicles) of the body: the malleus, the incus, and the stapes. The ossicles, which are held in place by joints, muscles, and ligaments, assist in the transmission of sound. Two small fenestrae (oval and round windows), located in the medial wall of the middle ear, separate the middle ear from the inner ear. The footplate of the stapes sits in the oval window, secured by a fibrous annulus (ring-shaped structure). The footplate transmits sound to the inner ear. The round window, covered by a thin membrane, provides an exit for sound vibrations (see Fig. 59-1).

## Anatomy of the Inner Ear

The inner ear is housed deep within the temporal bone. The organs for hearing (cochlea) and balance (semicircular canals), as well as cranial nerves VII (facial nerve) and VIII (vestibulocochlear nerve), are all part of this complex anatomy (see Fig. 59-1). The cochlea and semicircular canals are housed in the bony labyrinth. The bony labyrinth surrounds and protects the membranous labyrinth, which is bathed in a fluid called perilymph.

### Membranous Labyrinth

The membranous labyrinth is composed of the utricle, the saccule, the cochlear duct, the semicircular canals, and the organ of Corti, all of which are surrounded by a fluid called

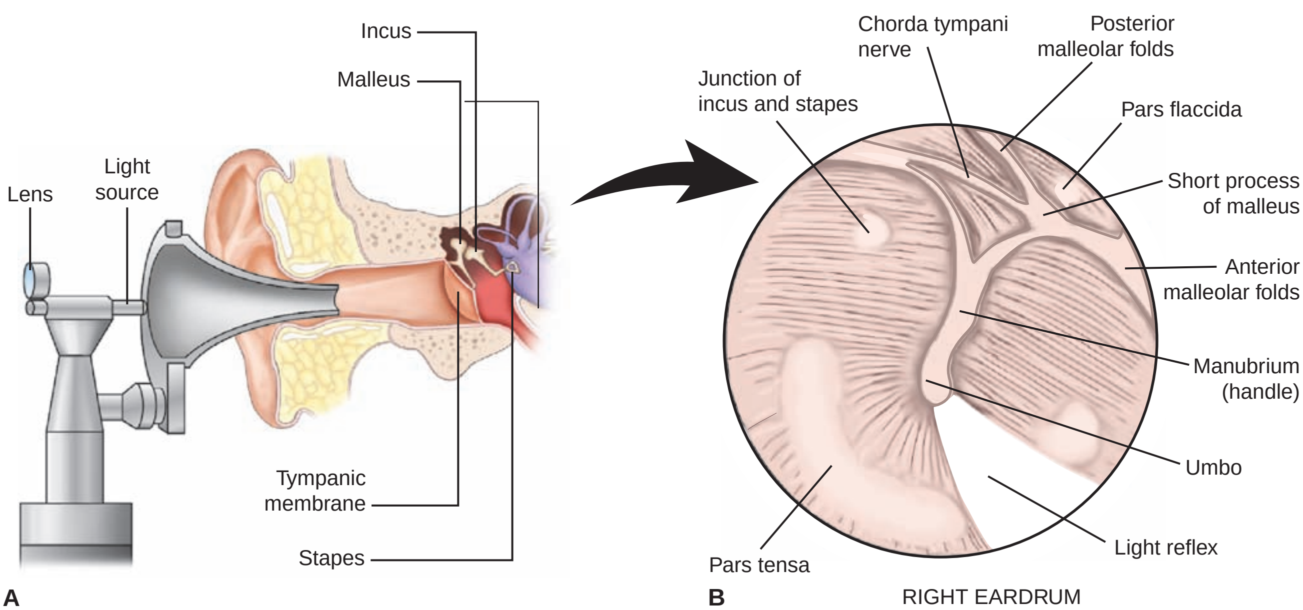



**Figure 59-2** Technique for using the otoscope **(A)** to see the tympanic membrane **(B)**.

endolymph. The three semicircular canals—posterior, superior, and lateral, which lie at 90-degree angles to one another—contain sensory receptor organs, arranged to detect rotational movement. These receptor end organs are stimulated by changes in the rate or direction of a person's movement. The utricle and saccule are involved with linear movements.

### *Organ of Corti*

The organ of Corti is housed in the cochlea, a snail-shaped, bony tube about 3.5 cm long with two and a half spiral turns. Membranes separate the cochlear duct (scala media) from the scala vestibuli and the scala tympani from the basilar membrane. The organ of Corti is located on the basilar membrane that stretches from the base to the apex of the cochlea. As sound vibrations enter the perilymph at the oval window and travel along the scala vestibuli, they pass through the scala tympani, enter the cochlear duct, and cause movement of the basilar membrane. The organ of Corti, also called the end organ for hearing, transforms mechanical energy into neural activity and separates sounds into different frequencies. This electrochemical impulse travels through the acoustic nerve to the temporal cortex of the brain to be interpreted as meaningful sound. In the internal auditory canal, the cochlear (acoustic) nerve, arising from the cochlea, joins the vestibular nerve, arising from the semicircular canals, utricle, and saccule, to become the vestibulocochlear nerve (cranial nerve VIII). This canal also houses the facial nerve and the blood supply from the ear to the brain.

## Function of the Ears

CONCEPTS IN ACTION

### *Hearing*

Hearing is conducted over two pathways: air and bone. Sounds transmitted by air conduction travel over the air-filled external and middle ear through vibration of the tympanic membrane and ossicles. Sounds transmitted by bone conduction travel directly through bone to the inner ear, bypassing the tympanic membrane and ossicles. Normally, air conduction is the more efficient pathway.

#### Sound Conduction and Transmission

Sound enters the ear through the external auditory canal and causes the tympanic membrane to vibrate. These vibrations transmit sound through the lever action of the ossicles to the oval window as mechanical energy. This mechanical energy is then transmitted through the inner ear fluids to the cochlea, stimulating the hair cells, and is subsequently converted to electrical energy. The electrical energy travels through the vestibulocochlear nerve to the central nervous system, where it is interpreted in its final form as sound.

Vibrations transmitted by the tympanic membrane to the ossicles of the middle ear are transmitted to the cochlea, located in the labyrinth of the inner ear. The stapes rocks, causing vibrations (waves) in fluids contained in the inner ear. These fluid waves cause movement of the basilar membrane, stimulating the hair cells of the organ of Corti in the cochlea to move in a wavelike manner. The movements of the tympanic membrane set up electrical currents that stimulate the various areas of the cochlea. The hair cells set up neural impulses that are encoded and then transferred to the auditory cortex in the brain, where they are decoded into a sound message.

The footplate of the stapes receives impulses transmitted by the incus and the malleus from the tympanic membrane. The round window, which opens on the opposite side of the cochlear duct, is protected from sound waves by the intact tympanic membrane, permitting motion of the inner ear fluids by sound wave stimulation. For example, in the normally intact tympanic membrane, sound waves stimulate the oval window first, and a lag occurs before the terminal effect of the stimulus reaches the round window. However, this lag phase is changed when a perforation of the tympanic membrane allows sound waves to impinge on the oval and round windows simultaneously. This effect cancels the lag and prevents the maximal effect of inner ear fluid motility and its subsequent effect in stimulating the hair cells in the organ of Corti. The result is a reduction in hearing ability (Fig. 59-3).

### *Balance and Equilibrium*

Body balance is maintained by the cooperation of the muscles and joints of the body (proprioceptive system), the eyes (visual system), and the labyrinth (vestibular system). These areas send their information about equilibrium, or balance, to the brain (cerebellar system) for coordination and perception in the cerebral cortex. The brain obtains its blood supply from the heart and arterial system. A problem in any of these areas, such as arteriosclerosis or impaired vision, can cause a disturbance of balance. The vestibular apparatus of the inner ear provides feedback regarding the movements and the position of the head and body in space.

# *Assessment*

WATCH & LEARN

Assessment of hearing and balance involves inspection of the external, middle, and inner ear. Evaluation of gross hearing acuity also is included in every physical examination.

## Inspection of the External Ear

Inspection of the external ear is a simple procedure, but it is often overlooked. The external ear is examined by inspection and direct palpation; the auricle and surrounding tissues should be inspected for deformities, lesions, and discharge, as well as size, symmetry, and angle of attachment to the head. Manipulation of the auricle does not normally elicit pain. If this maneuver is painful, acute external otitis is suspected. Tenderness on palpation in the area of the mastoid may indicate acute mastoiditis or inflammation of the posterior auricular node. Occasionally, sebaceous cysts and tophi (subcutaneous mineral deposits) are present on the pinna. A flaky scaliness on or behind the auricle usually indicates seborrheic dermatitis and can be present on the scalp and facial structures as well.

## Otoscopic Examination

The tympanic membrane is inspected with an otoscope and indirect palpation with a pneumatic otoscope. To examine the external auditory canal and tympanic membrane, the otoscope should be held in the examiner's right hand, in a

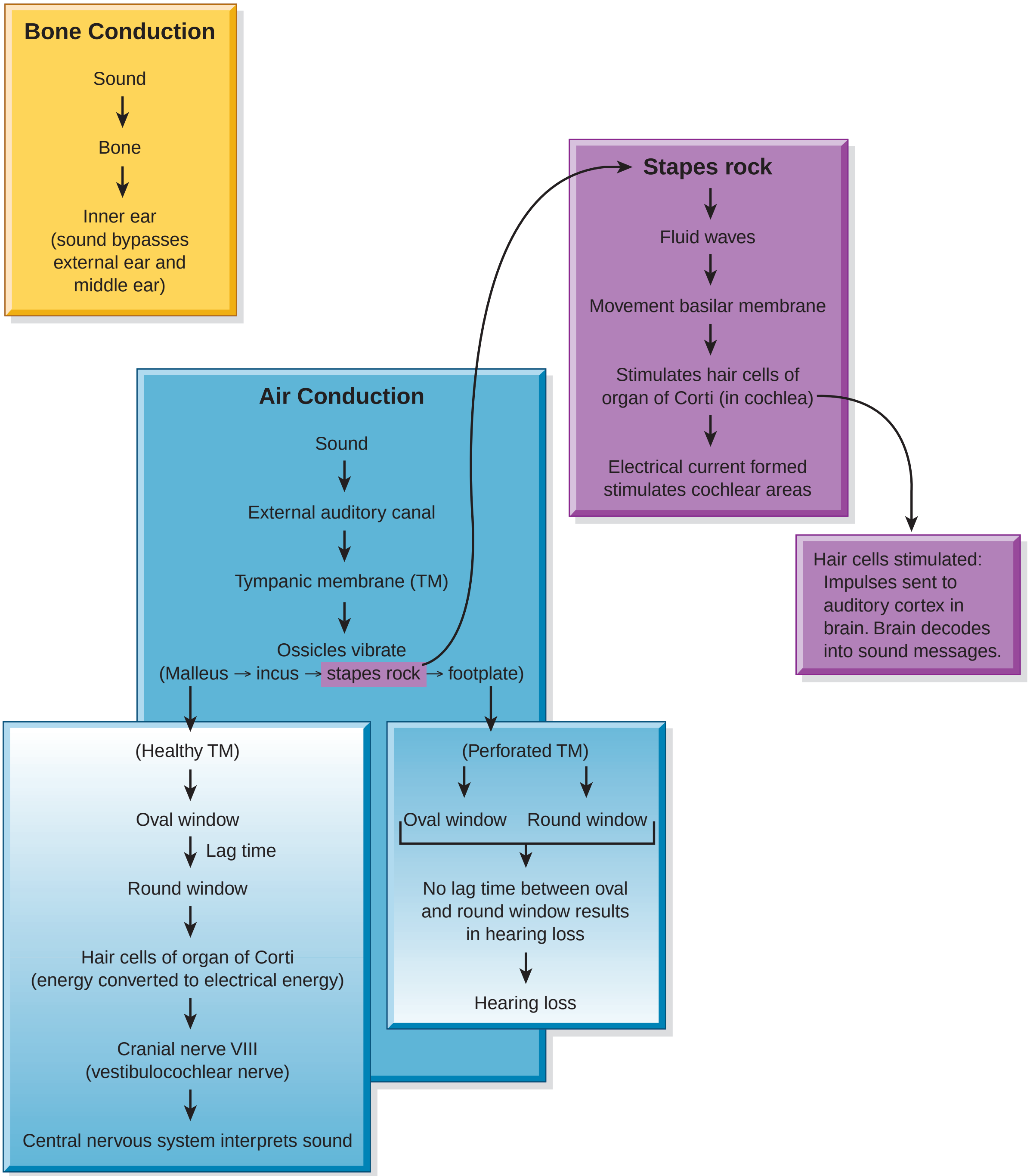



**Figure 59-3** Bone conduction compared to air conduction.

pencil-hold position, with the examiner's hand braced against the patient's face (Fig. 59-4). This position prevents the examiner from inserting the otoscope too far into the external canal. Using the opposite hand, the auricle is grasped and gently pulled back to straighten the canal in the adult. If the canal is not straightened with this technique, the tympanic membrane is more difficult to visualize because the canal obstructs the view.

The speculum is slowly inserted into the ear canal, with the examiner's eye held close to the magnifying lens of the otoscope to visualize the canal and tympanic membrane. The largest speculum that the canal can accommodate (usually 5 mm in an adult) is guided gently down into the canal and slightly forward. Because the distal portion of the canal is bony and covered by a sensitive layer of epithelium, only light pressure can be used without causing pain. The external auditory canal is examined for discharge, inflammation, or a foreign body.

The healthy tympanic membrane is pearly gray and is positioned obliquely at the base of the canal. The following



**Figure 59-4** Proper technique for examining the ear. Hold the otoscope in the right or left hand, in a "pencil-hold" position. Steady the hand against the patient's head to avoid inserting the otoscope too far into the external canal.

landmarks are identified, if visible (see Fig. 59-2): the pars tensa, the umbo, the manubrium of the malleus, and its short process. A slow, circular movement of the speculum allows further visualization of the malleolar folds and periphery. The position and color of the membrane and any unusual markings or deviations from normal are documented. The presence of fluid, air bubbles, blood, or masses in the middle ear also should be noted.

Proper otoscopic examination of the external auditory canal and tympanic membrane requires that the canal be free of large amounts of cerumen. Cerumen is normally present in the external canal, and small amounts should not interfere with otoscopic examination. If the tympanic membrane cannot be visualized because of cerumen, the cerumen may be removed by gently irrigating the external canal with warm water (unless contraindicated). If adherent cerumen is present, a small amount of mineral oil or over-the-counter cerumen softener may be instilled into the ear canal and the patient instructed to return for subsequent removal of the cerumen and inspection of the ear. The use of instruments such as a cerumen curette for cerumen removal is reserved for otolaryngologists and nurses with specialized training because of the danger of perforating the tympanic membrane or excoriating the external auditory canal. Cerumen buildup is a common cause of hearing loss and local irritation.

## Evaluation of Gross Auditory Acuity

A general estimate of hearing can be made by assessing the patient's ability to hear a whispered phrase or a ticking watch, testing one ear at a time. The Weber and Rinne tests may be used to distinguish conductive loss from sensorineural loss when hearing is impaired. These tests are part of the usual screening physical examination and are useful if a more specific assessment is needed, if hearing loss is detected, or if confirmation of audiometric results is desired.

### Whisper Test

To exclude one ear from the testing, the examiner covers the untested ear with the palm of the hand. Then the examiner whispers softly from a distance of 1 or 2 feet from the unoccluded ear and out of the patient's sight. The patient with normal acuity can correctly repeat what was whispered.

### Weber Test

The Weber test uses bone conduction to test lateralization of sound. A tuning fork (ideally, 512 Hz), set in motion by grasping it firmly by its stem and tapping it on the examiner's knee or hand, is placed on the patient's head or forehead (Fig. 59-5A). A person with normal hearing hears the sound equally in both ears or describes the sound as centered in the middle of the head. A person with **conductive hearing loss,** such as from otosclerosis or otitis media, hears the sound better in the affected ear. A person with **sensorineural hearing loss,** resulting from damage to the cochlear or vestibulocochlear nerve, hears the sound in the better-hearing ear. The Weber test is useful for detecting unilateral hearing loss (Table 59-1).

### Rinne Test

In the Rinne test (pronounced *rin-ay*), the examiner shifts the stem of a vibrating tuning fork between two positions: 2 inches from the opening of the ear canal (for air conduction) and against the mastoid bone (for bone conduction) (Fig. 59-5B). As the position changes, the patient is asked to indicate which tone is louder or when the tone is no longer audible.

The Rinne test is useful for distinguishing between conductive and sensorineural hearing loss. A person with normal hearing reports that air-conducted sound is louder than bone-conducted sound. A person with a conductive hearing loss hears bone-conducted sound as long as or longer than air-conducted sound. A person with a sensorineural hearing loss hears air-conducted sound longer than bone-conducted sound.

# Diagnostic Evaluation

Many diagnostic procedures are available to measure the auditory and vestibular systems indirectly. These tests are usually performed by an audiologist who is certified by the American Speech-Language-Hearing Association. Prior to each of the following tests, the nurse explains the procedure to the patient.

## Audiometry

In detecting hearing loss, audiometry is the single most important diagnostic instrument. Audiometric testing is of two kinds: pure-tone audiometry, in which the sound stimulus consists of a pure or musical tone (the louder the tone before the patient perceives it, the greater the hearing loss), and speech audiometry, in which the spoken word is used to determine the ability to hear and discriminate sounds and words.




**Figure 59-5** **A,** The Weber test assesses bone conduction of sound. **B,** The Rinne test assesses both air and bone conduction of sound.

When evaluating hearing, three characteristics are important: frequency, pitch, and intensity. *Frequency* refers to the number of sound waves emanating from a source per second, measured as cycles per second, or Hertz (Hz). The normal human ear perceives sounds ranging in frequency from 20 to 20,000 Hz. The frequencies from 500 to 2000 Hz are important in understanding everyday speech and are referred to as the speech range or speech frequencies. *Pitch* is the term used to describe frequency; a tone with 100 Hz is considered of low pitch, and a tone of 10,000 Hz is considered of high pitch.

The unit for measuring loudness (*intensity* of sound) is the decibel (dB), the pressure exerted by sound. Hearing loss is measured in decibels, a logarithmic function of intensity that is not easily converted into a percentage. The critical level of loudness is approximately 30 dB. The shuffling of papers in quiet surroundings is about 15 dB; a low conversation, 40 dB; and a jet plane 100 feet away, about 150 dB. Sound louder than 80 dB is perceived by the human ear to be harsh and can be damaging to the inner ear. Table 59-2 classifies hearing loss based on decibel level. In surgical treatment of patients with hearing loss, the aim is to improve the hearing level to 30 dB or better within the speech frequencies.

With audiometry, the patient wears earphones and signals to the audiologist when a tone is heard. When the tone is applied directly over the external auditory canal, air conduction is measured. When the stimulus is applied to the mastoid bone, bypassing the conductive mechanism (ie, the ossicles), nerve conduction is tested. For accuracy, testing is performed in a soundproof room. Responses are plotted on a graph known as an audiogram, which differentiates conductive from sensorineural hearing loss.

## Tympanogram

A tympanogram, or impedance audiometry, measures middle ear muscle reflex to sound stimulation and compliance of the tympanic membrane by changing the air pressure in a sealed ear canal. Compliance is impaired with middle ear disease.

## Auditory Brain Stem Response

The auditory brain stem response is a detectable electrical potential from cranial nerve VIII and the ascending auditory pathways of the brain stem in response to sound stimulation. Electrodes are placed on the patient's forehead. Acoustic stimuli (eg, clicks) are made in the ear. The resulting electrophysiologic measurements can determine at which decibel level a patient hears and whether there are any impairments along the nerve pathways (eg, tumor on cranial nerve VIII).

## Electronystagmography

Electronystagmography is the measurement and graphic recording of the changes in electrical potentials created by eye movements during spontaneous, positional, or calorically evoked nystagmus. It is also used to assess the

**Table 59-1 COMPARISON OF WEBER AND RINNE TESTS**

| Hearing Status | Weber | Rinne |
|---|---|---|
| Normal hearing | Sound is heard equally in both ears. | Air conduction is audible longer than bone conduction. |
| Conductive hearing loss | Sound is heard best in affected ear (hearing loss). | Sound is heard as long or longer in affected ear (hearing loss). |
| Sensorineural hearing loss | Sound is heard best in normal hearing ear. | Air conduction is audible longer than bone conduction in affected ear. |

**Table 59-2 SEVERITY OF HEARING LOSS**

| Loss in Decibels | Interpretation |
|---|---|
| 0–15 | Normal hearing |
| >15–25 | Slight hearing loss |
| >25–40 | Mild hearing loss |
| >40–55 | Moderate hearing loss |
| >55–70 | Moderate to severe hearing loss |
| >70–90 | Severe hearing loss |
| >90 | Profound hearing loss |

oculomotor and vestibular systems and their corresponding interaction. It helps diagnose conditions such as Ménière's disease and tumors of the internal auditory canal or posterior fossa. Any vestibular suppressants, such as sedatives, tranquilizers, antihistamines, and alcohol, are withheld for 24 hours before testing.

### Platform Posturography

Platform posturography is used to investigate postural control capabilities such as vertigo. It can be used to evaluate if a person's vertigo is becoming worse or to evaluate the person's response to treatment. The integration of visual, vestibular, and proprioceptive cues (ie, sensory integration) with motor response output and coordination of the lower limbs is tested. The patient stands on a platform, surrounded by a screen, and different conditions such as a moving platform with a moving screen or a stationary platform with a moving screen are presented. The responses from the patient on six different conditions are measured and indicate which of the anatomic systems may be impaired. Preparation for the testing is the same as for electronystagmography.

### Sinusoidal Harmonic Acceleration

Sinusoidal harmonic acceleration, or a rotary chair, is used to assess the vestibulo-ocular system by analyzing compensatory eye movements in response to the clockwise and counterclockwise rotation of the chair. Although such testing cannot identify the side of the lesion in unilateral disease, it helps identify disease (eg, Ménière's disease and tumors of the auditory canal) and evaluate the course of recovery. The same patient preparation is required as for electronystagmography.

### Middle Ear Endoscopy

With endoscopes with very small diameters and acute angles, the ear can be examined by an endoscopist specializing in otolaryngology. Middle ear endoscopy is performed safely and effectively as an office procedure to evaluate suspected perilymphatic fistula and new-onset conductive hearing loss, the anatomy of the round window before transtympanic treatment of Ménière's disease, and the tympanic cavity before ear surgery to treat chronic middle ear and mastoid infections.

The tympanic membrane is anesthetized topically for about 10 minutes before the procedure. Then, the external auditory canal is irrigated with sterile normal saline solution. With the aid of a microscope, a tympanotomy is created with a laser beam or a myringotomy knife, so that the endoscope can be inserted into the middle ear cavity. Video and photo documentation can be accomplished through the scope.

## HEARING LOSS

Hearing impairment has been reported to occur in 3 of every 1000 births, and approximately one half of the time it is related to genetic factors (U.S. Department of Health and Human Services [USDHHS], 2007). Chart 59-1 contains more information about hearing disorders that have a genetic cause. It has been reported that approximately 73% of hospitals or birthing centers are now offering universal hearing screenings for all newborns after birth and prior to discharge.

Hearing loss is greater in men than in women. By the year 2050, about one of every five people in the United States, or almost 58 million people, will be 55 years of age or older. Of this population, almost half can expect to have a hearing impairment (USDHHS, 2007). Hearing loss is an important health issue, and as people age, hearing screening and treatment are indicated.

Approximately 10 million people in the United States have irreversible hearing loss (Mitchell, 2006). It is estimated that more than 30 million people are exposed on a daily basis to noise levels that produce hearing loss. Occupations such as carpentry, plumbing, and coal mining have the highest risk of noise-induced hearing loss. Wise Ears was developed in 1999 by the National Institute on Deafness and Other Communication Disorders (NIDCD) and the National Institute for Occupational Safety and Health. It aims to educate the public about noise-induced hearing loss and ways to prevent this hearing loss (NIDCD, 2008)

Conductive hearing loss usually results from an external ear disorder, such as impacted cerumen, or a middle ear disorder, such as otitis media or otosclerosis. In such instances, the efficient transmission of sound by air to the inner ear is interrupted. A sensorineural loss involves damage to the cochlea or vestibulocochlear nerve.

Mixed hearing loss and functional hearing loss also may occur. Patients with mixed hearing loss have conductive loss and sensorineural loss, resulting from dysfunction of air and bone conduction. A functional (or psychogenic) hearing loss is nonorganic and unrelated to detectable structural changes in the hearing mechanisms; it is usually a manifestation of an emotional disturbance.

### Clinical Manifestations

Early manifestations of hearing impairment and loss may include tinnitus, increasing inability to hear when in a group, and a need to turn up the volume of the television. Hearing impairment can also trigger changes in attitude, the ability to communicate, the awareness of surroundings, and even the ability to protect oneself, affecting a person's quality of life. In a classroom, a student with impaired hearing may be uninterested and inattentive and have failing grades. A person at home may feel isolated because of an inability to hear the clock chime or to hear the telephone. A pedestrian who is hearing-impaired may attempt to cross the street and fail to hear an approaching car. People with impaired hearing may miss parts of a conversation. Many people are unaware

CHART 59-1

GENETICS IN NURSING PRACTICE

## Hearing Disorders

### Selected Hearing Disorders Influenced by Genetic Factors

- Autosomal dominant hearing loss
- Autosomal recessive hearing loss (eg, connexin 26 gene)
- Otosclerosis
- Pendred syndrome
- Usher syndrome
- Waardenburg syndrome

### Nursing Assessments

**Family History Assessment**

- Assess for other family members in several generations with hearing loss (autosomal dominant hearing loss)
- Inquire about genetic relatedness (eg, individuals who are related, such as first cousins, have a higher chance to share the same recessive genes—autosomal recessive hearing loss)
- Inquire about age at onset of hearing loss

**Patient Assessment**

- Assess for related genetic conditions, such as vision impairment (eg, retinitis pigmentosa in Usher syndrome; thyroid disorder in Pendred syndrome)
- Assess for iris, pigment, and hair alterations (white forelock) seen in Waardenburg syndrome

### Management Issues Specific to Genetics

- Inquire whether DNA gene mutation or other genetic testing has been performed on affected family members.
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetic testing, and gene-based interventions.
- Offer appropriate genetic information and resources.
- Assess patient's understanding of genetic information.
- Provide support to families with newly diagnosed genetic-related sensorineural disorders.
- Participate in management and coordination of care of patients with genetic conditions, and individuals predisposed to develop or pass on a genetic condition.

### Genetics Resources

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions; www.geneticalliance.org

**Gene Clinics**—a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling and testing information; www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders; www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions; www.ncbi.nlm.nih.gov/omim/stats/html

of their gradual hearing impairment. Often, it is not the person with the hearing loss but the people with whom he or she is communicating who recognizes the impairment first (Chart 59-2).

For various reasons, some people with hearing loss refuse to seek medical attention or wear a hearing aid. They may feel self-conscious wearing a hearing aid. Other more insightful people generally ask those with whom they are trying to communicate to let them know whether difficulties in communication exist. The attitudes and behaviors of patients who need hearing assistance should be taken into account when counseling them. The decision to wear a hearing aid is a personal one that is affected by these attitudes and behaviors.

CHART 59-2

## Assessing for Hearing Loss

Be alert for the following:

**Speech deterioration:** The person who slurs words or drops word endings, or produces flat-sounding speech, may not be hearing correctly. The ears guide the voice, both in loudness and in pronunciation.

**Fatigue:** If a person tires easily when listening to conversation or to a speech, fatigue may be the result of straining to hear. Under these circumstances, the person may become irritable very easily.

**Indifference:** It is easy for the person who cannot hear what others say to become depressed and disinterested in life in general.

**Social withdrawal:** Not being able to hear what is going on causes the hearing-impaired person to withdraw from situations that might prove embarrassing.

**Insecurity:** Lack of self-confidence and fear of mistakes create a feeling of insecurity in many hearing-impaired people. No one likes to say the wrong thing or do anything that might appear foolish.

**Indecision and procrastination:** Loss of self-confidence makes it increasingly difficult for a hearing-impaired person to make decisions.

**Suspiciousness:** The hearing-impaired person, who often hears only part of what is being said, may suspect that others are talking about him or her, or that portions of the conversation are deliberately spoken softly so that he or she will not hear them.

**False pride:** The hearing-impaired person wants to conceal the hearing loss and thus often pretends to be hearing when he or she actually is not.

**Loneliness and unhappiness:** Although everyone wishes for quiet now and then, *enforced* silence can be boring and even somewhat frightening. People with a hearing loss often feel isolated.

**Tendency to dominate the conversation:** Many hearing-impaired people tend to dominate the conversation, knowing that as long as it is centered on them and they can control it, they are not so likely to be embarrassed by some mistake.

## Prevention

Many environmental factors have an adverse effect on the auditory system and, with time, result in permanent sensorineural hearing loss. The most common is noise. Noise (unwanted and unavoidable sound) has been identified as one of today's environmental hazards. The volume of noise that surrounds us daily has increased into a potentially dangerous source of physical and psychological damage.

Loud, persistent noise has been found to cause constriction of peripheral blood vessels, increased blood pressure and heart rate (because of increased secretion of adrenalin), and increased gastrointestinal activity. Although research is needed to address the overall effects of noise on the human body, a quiet environment is more conducive to peace of mind. A person who is ill feels more at ease when noise is kept to a minimum.

Numerous factors contribute to hearing loss (Chart 59-3). *Noise-induced hearing loss* refers to hearing loss that follows a long period of exposure to loud noise (eg, heavy machinery, engines, artillery, rock-band music). *Acoustic trauma* refers to hearing loss caused by a single exposure to an extremely intense noise, such as an explosion. Usually, noise-induced hearing loss occurs at a high frequency (about 4000 Hz). However, with continued noise exposure, the hearing loss can become more severe and include adjacent frequencies. The minimum noise level known to cause noise-induced hearing loss, regardless of duration, is about 85 to 90 dB.

Noise exposure is inherent in many jobs (eg, mechanics, printers, pilots, flight attendants, musicians) and in hobbies such as woodworking and hunting. Noise level regulations are based on the amount of noise a person is exposed to, with the maximum legal amount being exposure to noise over an average working day or week of 80 dB, with a peak sound pressure of 135 dB (Health and Safety Executive, 2008). The Occupational Safety and Health Administration requires that workers wear ear protection to prevent noise-induced hearing loss when exposed to noise above the legal limits. Ear protection against noise is the most effective preventive measure available. Hearing loss due to noise is permanent because the hair cells in the organ of Corti are destroyed.

## Gerontologic Considerations

Approximately half of all people with hearing loss or **deafness** are 65 years of age or older. The cause is unknown; linkages to diet, metabolism, arteriosclerosis, stress, and heredity have been inconsistent (Mitchell, 2006).

**CHART 59-3** *Risk Factors for Hearing Loss*

- Family history of sensorineural impairment
- Congenital malformations of the cranial structure (ear)
- Low birth weight (<1500 g)
- Use of ototoxic medications (eg, gentamycin, loop diuretics)
- Recurrent ear infections
- Bacterial meningitis
- Chronic exposure to loud noises
- Perforation of the tympanic membrane

With aging, changes occur in the ear that may eventually lead to hearing deficits. Although few changes occur in the external ear, cerumen tends to become harder and drier, posing a greater chance of impaction. In the middle ear, the tympanic membrane may atrophy or become sclerotic. In the inner ear, cells at the base of the cochlea degenerate. A familial predisposition to sensorineural hearing loss is also seen, manifested by inability to hear high-frequency sounds, followed in time by the loss of middle and lower frequencies. The term **presbycusis** is used to describe this progressive hearing loss.

In addition to age-related changes, other factors can affect hearing in the elderly population, such as lifelong exposure to loud noises. Certain medications, such as aminoglycosides and aspirin, have ototoxic effects when renal changes (eg, in the older person) result in delayed medication excretion and increased levels of the medications in the blood. Many older people have taken quinine for treatment of leg cramps; this medication also can contribute to hearing loss. Psychogenic factors and other disease processes (eg, diabetes) also may be partially responsible for sensorineural hearing loss.

When hearing loss occurs, proper evaluation and treatment are warranted. *Healthy People 2010* identifies eight objectives for decreasing the problems caused by hearing loss. One of these objectives is for people diagnosed with hearing loss or deafness to use rehabilitation services and supplemental devices to improve communication with other people. Resources are available in workplaces and in schools. The Individuals with Disabilities Education Act (IDEA) was developed to ensure that children and adults, including elderly adults, receive the same opportunities in the educational system as those without hearing impairment (U.S. Department of Education, 2008).

Even with the best health care, people with hearing loss must learn to adjust to it. Care of elderly patients includes recognizing emotional reactions related to hearing loss, such as suspicion of others because of an inability to hear adequately; frustration and anger, with repeated statements such as, "I didn't hear what you said"; and feelings of insecurity because of the inability to hear the telephone or alarms. The Americans with Disabilities Act (ADA) of 1990 requires that all emergency services are accessible to people who have text message telephones (TTYs). In addition, in 1998, the Department of Justice mandated that all 911 centers in the United States be accessible to people with TTYs.

## Medical Management

If a hearing loss is permanent or untreatable or if the patient elects not to be treated, aural rehabilitation (discussed at the end of the chapter) may be beneficial.

## Nursing Management

Nurses who understand the different types of hearing loss are more successful in adopting a communication style to fit the needs and preferences of each patient. Trying to speak in a loud voice to a person who cannot hear high-frequency sounds only makes understanding more difficult. However, strategies such as talking into the less-impaired ear and using gestures and facial expressions can help (Chart 59-4).

A major issue for many people who are deaf or hearing-impaired is that they have other health problems that often do not receive attention, in large part because of

**Chart 59-4 • *Communicating With People Who Are Hearing-Impaired***

**For the Person Who is Hearing-impaired Whose Speech is Difficult to Understand:**

- Determine how the person prefers to communicate with others. Do not assume that writing, gestures, or other means are the best or preferred technique.
- Consider if the person uses sign language. Interpreters are available from the American Sign Language, Inc., Interpreting Service (ASLI). These specialists provide the best means of communication, providing accurate, professional services.
- Devote full attention to what the person is saying. Look and listen—do not try to attend to another task while listening.
- Engage the speaker in conversation when it is possible for you to anticipate the replies. This enables you to become accustomed to any peculiarities in speech patterns.
- Try to determine the essential context of what is being said; you can often fill in the details from context.
- Do not try to appear as if you understand if you do not.
- If you cannot understand at all or have serious doubt about your ability to understand what is being said, have the person write the message rather than risk misunderstanding. Having the person repeat the message in speech, after you know its content, also aids you in becoming accustomed to the person's pattern of speech.
- Written communication is an excellent resource. Written material should be written at a third-grade level so that the majority of people can understand it.

**For the Person Who is Hearing-impaired Who Speech Reads:**

- When speaking, always face the person as directly as possible.
- Make sure your face is as clearly visible as possible. Locate yourself so that your face is well lighted; avoid being silhouetted against strong light. Do not obscure the person's view of your mouth in any way; avoid talking with any object held in your mouth.
- Be sure that the patient knows the topic or subject before going ahead with what you plan to say. This enables the person to use contextual clues in speech reading.
- Speak slowly and distinctly, pausing more frequently than you would normally.
- If you question whether some important direction or instruction has been understood, check to be certain that the patient has the full meaning of your message.
- If for any reason your mouth must be covered (as with a mask) and you must direct or instruct the patient, write the message.

communication barriers with their health care practitioners. To meet the health care needs of these patients, practitioners are legally obligated to make accommodations for a patient's inability to hear. Providing interpreters for those who can communicate through sign language is essential in many situations so that the practitioner can effectively communicate with the patient.

During health care and screening procedures, the practitioner (eg, dentist, physician, nurse) must be aware that patients who are deaf or hearing-impaired are unable to read lips, see a signer, or read written materials in the dark rooms required during some diagnostic tests. The same situation exists if the practitioner is wearing a mask or is not in sight (eg, x-ray studies, magnetic resonance imaging [MRI], colonoscopy).

Nurses and other health care practitioners must work with patients who are deaf or hearing-impaired and their families to identify practical and effective means of communication. Nurses can serve as catalysts throughout the health care system to ensure that accommodations are made to meet the communication needs of these patients.

# CONDITIONS OF THE EXTERNAL EAR

## Cerumen Impaction

Cerumen normally accumulates in the external canal in various amounts and colors. Although wax does not usually need to be removed, impaction occasionally occurs, causing **otalgia,** a sensation of fullness or pain in the ear, with or without a hearing loss. Accumulation of cerumen as a cause of hearing loss is especially significant in the elderly population. Attempts to clear the external auditory canal with matches, hairpins, and other implements are dangerous because trauma to the skin, infection, and damage to the tympanic membrane can occur.

### Management

Cerumen can be removed by irrigation, suction, or instrumentation. Unless the patient has a perforated eardrum or an inflamed external ear (ie, otitis externa), gentle irrigation usually helps remove impacted cerumen, particularly if it is not tightly packed in the external auditory canal. For successful removal, the water stream must flow behind the obstructing cerumen to move it first laterally and then out of the canal. To prevent injury, the lowest effective pressure should be used. However, if the eardrum behind the impaction is perforated, water can enter the middle ear, producing acute vertigo and infection. If irrigation is unsuccessful, direct visual, mechanical removal can be performed on a cooperative patient by a trained health care provider.

Instilling a few drops of warmed glycerin, mineral oil, or half-strength hydrogen peroxide into the ear canal for 30 minutes can soften cerumen before its removal. Ceruminolytic agents, such as peroxide in glyceryl (Debrox), are available; however, these compounds may cause an allergic dermatitis reaction. Using any softening solution two or three times a day for several days is generally sufficient. If the cerumen cannot be dislodged by these methods, instruments, such as a cerumen curette, aural suction, and a binocular microscope for magnification, can be used.

## Foreign Bodies

Some objects are inserted intentionally into the ear by adults who may have been trying to clean the external canal or relieve itching or by children who introduce peas,

beans, pebbles, toys, and beads. Insects may also enter the ear canal. In either case, the effects may range from no symptoms to profound pain and decreased hearing.

### Management

Removing a foreign body from the external auditory canal can be quite challenging. The three standard methods for removing foreign bodies are the same as those for removing cerumen: irrigation, suction, and instrumentation. The contraindications for irrigation are also the same. Foreign vegetable bodies and insects tend to swell; thus, irrigation is contraindicated. Usually, an insect can be dislodged by instilling mineral oil, which will kill the insect and allow it to be removed.

Attempts to remove a foreign body from the external canal may be dangerous in unskilled hands. The object may be pushed completely into the bony portion of the canal, lacerating the skin and perforating the tympanic membrane. In rare circumstances, the foreign body may have to be extracted in the operating room with the patient under general anesthesia.

## External Otitis (Otitis Externa)

**External otitis,** or **otitis externa,** refers to an inflammation of the external auditory canal. Causes include water in the ear canal (swimmer's ear); trauma to the skin of the ear canal, permitting entrance of organisms into the tissues; and systemic conditions, such as vitamin deficiency and endocrine disorders. Bacterial or fungal infections are most frequently encountered. The most common bacterial pathogens associated with external otitis are *Staphylococcus aureus* and *Pseudomonas* species. The most common fungus isolated in both normal and infected ears is *Aspergillus*. External otitis is often caused by a dermatosis such as psoriasis, eczema, or seborrheic dermatitis. Even allergic reactions to hair spray, hair dye, and permanent wave lotions can cause dermatitis, which clears when the offending agent is removed.

### Clinical Manifestations

Patients usually report pain, discharge from the external auditory canal, aural tenderness (usually not present in middle ear infections), and occasionally fever, cellulitis, and lymphadenopathy. Other symptoms may include pruritus and hearing loss or a feeling of fullness. On otoscopic examination, the ear canal is erythematous and edematous. Discharge may be yellow or green and foul-smelling. In fungal infections, hairlike black spores may even be visible.

### Medical Management

The principles of therapy are aimed at relieving the discomfort, reducing the swelling of the ear canal, and eradicating the infection. Patients may require analgesic medications for the first 48 to 92 hours. If the tissues of the external canal are edematous, a wick should be inserted to keep the canal open so that liquid medications (eg, Burow's solution, antibiotic otic preparations) can be introduced. These medications may be administered by dropper at room temperature. Such medications usually combine antibiotic and corticosteroid agents to soothe the inflamed tissues. For cellulitis or fever, systemic antibiotics may be prescribed. For fungal disorders, antifungal agents are prescribed.

**CHART 59-5 PATIENT EDUCATION**
***Prevention of Otitis Externa***

- Protect the external canal when swimming, showering, or washing hair. Ear plugs or a swim cap should be worn. Drying the external canal afterward with a hair dryer on low heat may be suggested.
- Alcohol drops may be placed in the external canal to act as an astringent to help prevent infection after water exposure.
- Prevent trauma to the external canal. Procedures, foreign objects (eg, bobby pin), scratching, or any other trauma to the canal that breaks the skin integrity may cause infection.
- If otitis externa is diagnosed, refrain from any water sport activity for approximately 7 to 10 days to allow the canal to heal completely. Recurrence is highly likely unless you allow the external canal to heal completely.

### Nursing Management

Nurses should instruct patients not to clean the external auditory canal with cotton-tipped applicators and to avoid events that traumatize the external canal such as scratching the canal with the fingernail or other objects. Trauma may lead to infection of the canal. Patients should also avoid getting the canal wet when swimming or shampooing the hair. A cotton ball can be covered in a water-insoluble gel such as petroleum jelly and placed in the ear as a barrier to water contamination. Infection can be prevented by using antiseptic otic preparations after swimming (eg, Swim Ear, Ear Dry), unless there is a history of tympanic membrane perforation or a current ear infection (Chart 59-5).

## Malignant External Otitis

A more serious, although rare, external ear infection is malignant external otitis (temporal bone osteomyelitis). This is a progressive, debilitating, and occasionally fatal infection of the external auditory canal, the surrounding tissue, and the base of the skull. *Pseudomonas aeruginosa* is usually the infecting organism in patients with low resistance to infection (eg, patients with diabetes). Successful treatment includes control of the diabetes, administration of antibiotics (usually intravenously), and aggressive local wound care. Standard parenteral antibiotic treatment includes the combination of an antipseudomonal agent and an aminoglycoside, both of which have potentially serious side effects. Because aminoglycosides are nephrotoxic and ototoxic, serum aminoglycoside levels and renal and auditory function must be monitored during therapy. Local wound care includes limited débridement of the infected tissue, including bone and cartilage, depending on the extent of the infection.

## Masses of the External Ear

**Exostoses** are small, hard, bony protrusions found in the lower posterior bony portion of the ear canal; they usually occur bilaterally. The skin covering the exostosis is normal. It is believed that exostoses are caused by an exposure to cold water, as in scuba diving or surfing. The usual treatment, if any, is surgical excision.

Malignant tumors also may occur in the external ear. Most common are basal cell carcinomas on the pinna and squamous cell carcinomas in the ear canal. If untreated, squamous cell carcinoma may spread through the temporal bone, causing facial nerve paralysis and hearing loss. Carcinomas must be treated surgically.

## Gapping Earring Puncture

Gapping earring puncture results from wearing heavy pierced earrings for a long time or after an infection, or as a reaction from the earring or impurities in the earring. This deformity can only be corrected surgically.

# CONDITIONS OF THE MIDDLE EAR

## Tympanic Membrane Perforation

Perforation of the tympanic membrane is usually caused by infection or trauma. Sources of trauma include skull fracture, explosive injury, or a severe blow to the ear. Less frequently, perforation is caused by foreign objects (eg, cotton-tipped applicators, bobby pins, keys) that have been pushed too far into the external auditory canal. In addition to tympanic membrane perforation, injury to the ossicles and even the inner ear may result from this type of trauma. Attempts by patients to clear the external auditory canal should be discouraged. During infection, the tympanic membrane can rupture if the pressure in the middle ear exceeds the atmospheric pressure in the external auditory canal.

### Medical Management

Although most tympanic membrane perforations heal spontaneously within weeks after rupture, some may take several months to heal. Some perforations persist because scar tissue grows over the edges of the perforation, preventing extension of the epithelial cells across the margins and final healing. In the case of a head injury or temporal bone fracture, a patient is observed for evidence of cerebrospinal fluid **otorrhea** or **rhinorrhea**—a clear, watery drainage from the ear or nose, respectively. While healing, the ear must be protected from water.

#### Surgical Management

Perforations that do not heal on their own may require surgery. The decision to perform a **tympanoplasty** (surgical repair of the tympanic membrane) is usually based on the need to prevent potential infection from water entering the ear or the desire to improve the patient's hearing. Performed on an outpatient basis, tympanoplasty may involve a variety of surgical techniques. In all techniques, tissue (commonly from the temporalis fascia) is placed across the perforation to allow healing. Surgery is usually successful in closing the perforation permanently and improving hearing.

## Acute Otitis Media

Ear infections can occur at any age; however, they are most commonly seen in children. **Acute otitis media (AOM)** is an acute infection of the middle ear, usually lasting less than 6 weeks. The pathogens that cause acute otitis media are usually *Streptococcus pneumoniae, Haemophilus influenzae,* and *Moraxella catarrhalis,* which enter the middle ear after eustachian tube dysfunction caused by obstruction related to upper respiratory infections, inflammation of surrounding structures (eg, rhinosinusitis, adenoid hypertrophy), or allergic reactions (eg, allergic rhinitis). Bacteria can enter the eustachian tube from contaminated secretions in the nasopharynx and the middle ear from a tympanic membrane perforation. A purulent exudate is usually present in the middle ear, resulting in a conductive hearing loss.

### Clinical Manifestations

The symptoms of otitis media vary with the severity of the infection. The condition, usually unilateral in adults, may be accompanied by otalgia. The pain is relieved after spontaneous perforation or therapeutic incision of the tympanic membrane. Other symptoms may include drainage from the ear, fever, and hearing loss. On otoscopic examination, the external auditory canal appears normal. The tympanic membrane is erythematous and often bulging. Patients report no pain with movement of the auricle. Table 59-3 differentiates acute external otitis from AOM. Risk factors for AOM include age (younger than 12 months), chronic upper respiratory infections, medical conditions that predispose to ear infections (Down syndrome, cystic fibrosis, cleft palate), and chronic exposure to secondhand cigarette smoke.

**Table 59-3 CLINICAL FEATURES OF OTITIS**

| Feature | Acute Otitis Externa | Acute Otitis Media |
|---|---|---|
| Otorrhea | May or may not be present | Present if tympanic membrane perforates; discharge is profuse |
| Otalgia | Persistent, may awaken patient at night | Relieved if tympanic membrane ruptures |
| Aural tenderness | Present on palpation of auricle | Usually absent |
| Systemic symptoms | Absent | Fever, upper respiratory infection, rhinitis |
| Edema of external auditory canal | Present | Absent |
| Tympanic membrane | May appear normal | Erythema, bulging, may be perforated |
| Hearing loss | Conductive type | Conductive type |

## Medical Management

The outcome of AOM depends on the efficacy of therapy (the prescribed dose of an oral antibiotic and the duration of therapy), the virulence of the bacteria, and the physical status of the patient. With early and appropriate broad-spectrum antibiotic therapy, otitis media may resolve with no serious sequelae. If drainage occurs, an antibiotic otic preparation is usually prescribed. The condition may become subacute (lasting 3 weeks to 3 months), with persistent purulent discharge from the ear. Rarely does permanent hearing loss occur. Secondary complications involving the mastoid and other serious intracranial complications, such as meningitis or brain abscess, although rare, can occur.

### *Surgical Management*

An incision in the tympanic membrane is known as **myringotomy** (ie, **tympanotomy**). The tympanic membrane is numbed with a local anesthetic agent such as phenol or by iontophoresis (ie, electrical current flows through a lidocaine-and-epinephrine solution to numb the ear canal and tympanic membrane). The procedure is painless and takes less than 15 minutes. Under microscopic guidance, an incision is made through the tympanic membrane to relieve pressure and to drain serous or purulent fluid from the middle ear.

Normally, this procedure is unnecessary for treating AOM, but it may be performed if pain persists. Myringotomy also allows the drainage to be analyzed (by culture and sensitivity testing) so that the infecting organism can be identified and appropriate antibiotic therapy prescribed. The incision heals within 24 to 72 hours.

If AOM recurs and there is no contraindication, a ventilating, or pressure-equalizing, tube may be inserted. The ventilating tube, which temporarily takes the place of the eustachian tube in equalizing pressure, is retained for 6 to 18 months. The ventilating tube is then extruded with normal skin migration of the tympanic membrane, with the hole healing in nearly every case. Ventilating tubes are used to treat recurrent episodes of AOM.

# *Serous Otitis Media*

Serous otitis media **(middle ear effusion)** involves fluid, without evidence of active infection, in the middle ear. In theory, this fluid results from a negative pressure in the middle ear caused by eustachian tube obstruction. When this condition occurs in adults, an underlying cause for the eustachian tube dysfunction must be sought. Middle ear effusion is frequently seen in patients after radiation therapy or barotrauma and in patients with eustachian tube dysfunction from a concurrent upper respiratory infection or allergy. Barotrauma results from sudden pressure changes in the middle ear caused by changes in barometric pressure, as in scuba diving or airplane descent. A carcinoma (eg, nasopharyngeal cancer) obstructing the eustachian tube should be ruled out in adults with persistent unilateral serous otitis media.

## Clinical Manifestations

Patients may complain of hearing loss, fullness in the ear or a sensation of congestion, or popping and crackling noises that occur as the eustachian tube attempts to open. The tympanic membrane appears dull on otoscopy, and air bubbles may be visualized in the middle ear. Usually, the audiogram shows a conductive hearing loss.

## Management

Serous otitis media need not be treated medically unless infection (ie, AOM) occurs. If the hearing loss associated with middle ear effusion is significant, a myringotomy can be performed, and a tube may be placed to keep the middle ear ventilated. Corticosteroids in small doses may decrease the edema of the eustachian tube in cases of barotrauma. Decongestants have not proved effective. A Valsalva maneuver, which forcibly opens the eustachian tube by increasing nasopharyngeal pressure, may be cautiously performed; this maneuver may cause worsening pain or perforation of the tympanic membrane.

# *Chronic Otitis Media*

**Chronic otitis media** is the result of recurrent AOM causing irreversible tissue pathology and persistent perforation of the tympanic membrane. Chronic infections of the middle ear damage the tympanic membrane, destroy the ossicles, and involve the mastoid. Before the discovery of antibiotics, infections of the mastoid were life-threatening. Today, acute mastoiditis is rare in developed countries.

## Clinical Manifestations

Symptoms may be minimal, with varying degrees of hearing loss and a persistent or intermittent, foul-smelling otorrhea. Pain is not usually experienced, except in cases of acute mastoiditis, when the postauricular area is tender and may be erythematous and edematous. Otoscopic examination may show a perforation, and cholesteatoma can be identified as a white mass behind the tympanic membrane or coming through to the external canal from a perforation.

**Cholesteatoma** is an ingrowth of the skin of the external layer of the eardrum into the middle ear. It is generally caused by a chronic retraction pocket of the tympanic membrane, creating a persistently high negative pressure of the middle ear. The skin forms a sac that fills with degenerated skin and sebaceous materials. The sac can attach to the structures of the middle ear or mastoid, or both.

Chronic otitis media can cause chronic mastoiditis and lead to the formation of cholesteatoma. It can occur in the middle ear, mastoid cavity, or both, often dictating the type of surgery to be performed. If untreated, cholesteatoma will continue to enlarge, possibly causing damage to the facial nerve and horizontal canal and destruction of other surrounding structures.

Cholesteatomas are common benign tumors of the inner ear (Semaan & Megerian, 2006). They usually do not cause pain; however, if treatment or surgery is delayed, they may destroy structures of the temporal bone. These fast-growing tumors may cause severe sequelae such as hearing loss or

neurologic disorders. Congenital cholesteatomas are usually found in children and may cause severe bone loss of the incus. Cholesteatomas found in elderly patients generally develop in the external canal.

Cholesteatomas may be asymptomatic or they may cause hearing loss, facial pain and paralysis, tinnitus, or vertigo. Audiometric tests often show a conductive or mixed hearing loss. Based on presenting symptoms, diagnosis may be made by visual examination or by computed tomography (CT) or MRI. Therapy includes treatment of the acute infection and surgical removal of the mass to restore hearing.

## Medical Management

Local treatment of chronic otitis media consists of careful suctioning of the ear under otoscopic guidance. Instillation of antibiotic drops or application of antibiotic powder is used to treat purulent discharge. Systemic antibiotics are prescribed only in cases of acute infection.

### *Surgical Management*

Surgical procedures, including tympanoplasty, ossiculoplasty, and mastoidectomy, are used if medical treatments are ineffective.

#### Tympanoplasty

The most common surgical procedure for chronic otitis media is a tympanoplasty, or surgical reconstruction of the tympanic membrane. Reconstruction of the ossicles may also be required. The purposes of a tympanoplasty are to reestablish middle ear function, close the perforation, prevent recurrent infection, and improve hearing.

There are five types of tympanoplasties. The simplest surgical procedure, type I (myringoplasty), is designed to close a perforation in the tympanic membrane. The other procedures, types II through V, involve more extensive repair of middle ear structures. The structures and the degree of involvement can differ, but all tympanoplasty procedures include restoring the continuity of the sound conduction mechanism.

Tympanoplasty is performed through the external auditory canal with a transcanal approach or through a postauricular incision. The contents of the middle ear are carefully inspected, and the ossicular chain (malleus and incus unit) is evaluated. Ossicular interruption is most frequent in chronic otitis media, but problems of reconstruction can also occur with malformations of the middle ear and ossicular dislocations due to head injuries. Dramatic improvement in hearing can result from closure of a perforation and reestablishment of the ossicles. Surgery is usually performed in an outpatient facility under moderate sedation or general anesthesia.

#### Ossiculoplasty

**Ossiculoplasty** is the surgical reconstruction of the middle ear bones to restore hearing. Prostheses made of materials such as Teflon, stainless steel, and hydroxyapatite are used to reconnect the ossicles, thereby reestablishing the sound conduction mechanism. However, the greater the damage, the lower the success rate for restoring normal hearing.

#### Mastoidectomy

The objectives of mastoid surgery are to remove the cholesteatoma, gain access to diseased structures, and create a dry (noninfected) and healthy ear. If possible, the ossicles are reconstructed during the initial surgical procedure. Occasionally, extensive disease or damage dictates that this be performed as part of a two-stage operation.

A mastoidectomy is usually performed through a postauricular incision. Infection is eliminated by removing the mastoid air cells. A second mastoidectomy may be necessary to check for recurrent or residual cholesteatoma. The hearing mechanism may be reconstructed at this time. The success rate for correcting this conductive hearing loss is approximately 75%. Surgery is usually performed in an outpatient setting. The patient has a mastoid pressure dressing, which can be removed 24 to 48 hours after surgery. Although infrequently injured, the facial nerve, which runs through the middle ear and mastoid, is at some risk for injury during mastoid surgery. As the patient awakens from anesthesia, any evidence of facial paresis should be reported to the physician.

## NURSING PROCESS

### The Patient Undergoing Mastoid Surgery

Although several otologic surgical procedures are performed under moderate sedation, mastoid surgery is performed using general anesthesia.

#### Assessment

The health history includes a complete description of the ear disorder, including infection, otalgia, otorrhea, hearing loss, and vertigo. Data are collected about the duration and intensity of the disorder, its causes, and previous treatments. Information is obtained about other health problems and all medications that the patient is taking. Medication allergies and family history of ear disease also should be obtained.

Physical assessment addresses erythema, edema, otorrhea, lesions, and characteristics such as odor and color of discharge. The results of the audiogram are reviewed.

#### Nursing Diagnoses

Based on the assessment data, the major nursing diagnoses may include the following:

- Anxiety related to surgical procedure, potential loss of hearing, potential taste disturbance, and potential loss of facial movement
- Acute pain related to mastoid surgery
- Risk for infection related to mastoidectomy; placement of grafts, prostheses, and electrodes; and surgical trauma to surrounding tissues and structures
- Disturbed auditory sensory perception related to ear disorder, surgery, or packing
- Risk for trauma related to impaired balance or vertigo during the immediate postoperative period or from dislodgment of the graft or prosthesis
- Disturbed sensory perception related to potential damage to facial nerve (cranial nerve VII) and chorda tympani nerve
- Deficient knowledge about mastoid disease, surgical procedure, and postoperative care and expectations

## Planning and Goals

The major goals of caring for a patient undergoing mastoidectomy include reduction of anxiety; freedom from pain and discomfort; prevention of infection; stable or improved hearing and communication; absence of vertigo and related injury; absence of or adjustment to sensory or perceptual alterations; and increased knowledge regarding the disease, surgical procedure, and postoperative care.

## Nursing Interventions

### *Reducing Anxiety*

The nurse reinforces the information discussed by the otologic surgeon with the patient, including anesthesia, the location of the incision (postauricular), and expected surgical results (eg, hearing, balance, taste, facial movement). The patient also is encouraged to discuss any anxieties and concerns about the surgery.

### *Relieving Pain*

Although most patients complain very little about incisional pain after mastoid surgery, they do have some ear discomfort. Aural fullness or pressure after surgery is caused by residual blood or fluid in the middle ear. The prescribed analgesic medication may be taken for the first 24 hours after surgery and then only as needed.

A wick or external auditory canal packing is used if a tympanoplasty was performed at the time of the mastoidectomy. For the next 2 to 3 weeks after surgery, the patient may experience sharp, shooting pains intermittently as the eustachian tube opens and allows air to enter the middle ear. Constant, throbbing pain accompanied by fever may indicate infection and should be reported to the physician.

### *Preventing Infection*

Measures are initiated to prevent infection in the operated ear. The external auditory canal wick, or packing, may be impregnated with an antibiotic solution before instillation. Prophylactic antibiotics are administered as prescribed, and the patient is instructed to prevent water from entering the external auditory canal for 6 weeks. A cotton ball or lamb's wool covered with a water-insoluble substance (eg, petroleum jelly) and placed loosely in the ear canal usually prevents water contamination and should be used when the patient showers or washes his or her hair, or in any situations in which water may enter the ear. The postauricular incision should be kept dry for the first 2 days. Signs of infection such as an elevated temperature and purulent drainage should be reported. Some serosanguineous drainage from the external auditory canal is normal after surgery.

### *Improving Hearing and Communication*

Hearing in the operated ear may be reduced for several weeks because of edema, accumulation of blood and tissue fluid in the middle ear, and dressings or packing. Measures are initiated to improve hearing and communication, such as reducing environmental noise, facing the patient when speaking, speaking clearly and distinctly without shouting, providing good lighting if the patient relies on speech reading, and using nonverbal clues (eg, facial expression, pointing, gestures) and other forms of communication. Family members or significant others are instructed about effective ways to communicate with the patient. If the patient uses assistive hearing devices, one can be used in the unaffected ear.

### *Preventing Injury*

Vertigo may occur after mastoid surgery if the semicircular canals or other areas of the inner ear are traumatized. Antiemetic or antivertiginous medications (eg, antihistamines) can be prescribed if a balance disturbance or vertigo occurs. Safety measures such as assisted ambulation are implemented to prevent falls and injury. The patient is instructed to avoid heavy lifting, straining, exertion, and nose blowing for 2 to 3 weeks after surgery to prevent dislodging the tympanic membrane graft or ossicular prosthesis.

### *Preventing Altered Sensory Perception*

Facial nerve injury is a potential, although rare, complication of mastoid surgery. The patient is instructed to report immediately any evidence of facial nerve (cranial nerve VII) weakness, such as drooping of the mouth on the operated side, slurred speech, decreased sensation, and difficulty swallowing. A more frequent occurrence is a temporary disturbance in the chorda tympani nerve, a small branch of the facial nerve that runs through the middle ear. Patients experience a taste disturbance and dry mouth on the side of surgery for several months until the nerve regenerates.

### *Promoting Home and Community-Based Care*

TEACHING PATIENTS SELF-CARE. Patients require instruction about medication therapy, such as analgesic and antivertiginous agents (eg, antihistamines) prescribed for balance disturbance. Teaching includes information about the expected effects and potential side effects of the medication. Patients also need instruction about any activity restrictions. Possible complications such as infection, facial nerve weakness, or taste disturbances, including the signs and symptoms to report immediately, should be addressed (Chart 59-6).

CONTINUING CARE. Some patients, particularly elderly patients, who have had mastoid surgery may require the services of a home care nurse for a few days after returning home. However, most people find that assistance from a family member or a friend is sufficient. The caregiver and patient are cautioned that the patient may experience some vertigo and will therefore require help with ambulation to avoid falling. Any symptoms of complications are to be reported promptly to the surgeon. The importance of scheduling and keeping follow-up appointments is also stressed.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Demonstrates reduced anxiety about surgical procedure
    a. Verbalizes and exhibits less stress, tension, and irritability
    b. Verbalizes acceptance of the results of surgery and adjustment to possible hearing impairment

CHART 59-6

**PATIENT EDUCATION**

***Self-Care After Middle Ear or Mastoid Surgery***

Postoperative instructions for patients who have had middle ear and mastoid surgery may vary among otolaryngologists. General teaching guidelines for the patient may include:

- Take antibiotics and other medications as prescribed.
- Avoid nose blowing for 2 to 3 weeks after surgery.
- Sneeze and cough with the mouth open for a few weeks after surgery.
- Avoid heavy lifting (>10 lb), straining, and bending over for a few weeks after surgery.
- Popping and crackling sensations in the operative ear are normal for approximately 3 to 5 weeks after surgery.
- Temporary hearing loss is normal in the operative ear due to fluid, blood, or packing in the ear.
- Report excessive or purulent ear drainage to the physician.
- Avoid getting water in the operative ear for 2 weeks after surgery. You may shampoo the hair 2 to 3 days postoperatively if the ear is protected from water by saturating a cotton ball with petroleum jelly (or some other water-insoluble substance) and loosely placing it in the ear. If the postauricular suture line becomes wet, pat (not rub) the area and cover it with a thin layer of antibiotic ointment.

2. Remains free of discomfort or pain
   a. Exhibits no facial grimacing, moaning, or crying, and reports absence of pain
   b. Uses analgesic agents appropriately
3. Demonstrates no signs or symptoms of infection
   a. Has normal vital signs, including temperature
   b. Demonstrates absence of purulent drainage from the external auditory canal
   c. Describes method for preventing water from contaminating packing
4. Exhibits signs that hearing has stabilized or improved
   a. Describes surgical goal for hearing and judges whether the goal has been met
   b. Verbalizes that hearing has improved
5. Remains free of injury and trauma
   a. Reports absence of vertigo or balance disturbance
   b. Experiences no injury or fall
   c. Avoids activities that can cause dislodgement of graft or prosthesis
6. Adjusts to or remains free from altered sensory perception
   a. Reports no taste disturbance, mouth dryness, or facial weakness
7. Verbalizes the reasons for and methods of care and treatment
   a. Discusses the discharge plan formulated with the nurse with regard to rest periods, medication, and activities permitted and restricted
   b. Lists symptoms that should be reported to health care personnel
   c. Keeps follow-up appointments

## Otosclerosis

**Otosclerosis** involves the stapes and is thought to result from the formation of new, abnormal spongy bone, especially around the oval window, with resulting fixation of the stapes. The efficient transmission of sound is prevented because the stapes cannot vibrate and carry the sound as conducted from the malleus and incus to the inner ear. Otosclerosis is more common in women and frequently hereditary, and pregnancy may worsen it.

### Clinical Manifestations

Otosclerosis may involve one or both ears and manifests as a progressive conductive or mixed hearing loss. The patient may or may not complain of tinnitus. Otoscopic examination usually reveals a normal tympanic membrane. Bone conduction is better than air conduction on Rinne testing. The audiogram confirms conductive hearing loss or mixed loss, especially in the low frequencies.

### Medical Management

There is no known nonsurgical treatment for otosclerosis. However, some physicians believe the use of sodium fluoride can mature the abnormal spongy bone growth and prevent the breakdown of the bone tissue. Amplification with a hearing aid also may help (Porth & Matfin, 2009).

#### *Surgical Management*

One of two surgical procedures may be performed, the stapedectomy or the stapedotomy. A stapedectomy involves removing the stapes superstructure and part of the footplate and inserting a tissue graft and a suitable prosthesis (Fig. 59-6). The surgeon drills a small hole into the footplate to hold a prosthesis. The prosthesis bridges the gap between the incus and the inner ear, providing better sound conduction. Approximately 95% of patients experience resolution of conductive hearing loss following stapes surgery. Balance disturbance or true vertigo may occur during the postoperative period for several days. Long-term balance disorders are rare.

## Middle Ear Masses

Other than cholesteatoma, masses in the middle ear are rare. Glomus tympanicum is a tumor that arises from Jacobson's nerve (in the temporal bone of the skull) and remains limited to the middle ear. On otoscopy, a red blemish on or behind the tympanic membrane is seen. Glomus jugulare tumors are rarely malignant; however, because of their location, treatment may be necessary to relieve symptoms. The treatment is surgical excision, except in poor surgical candidates, in whom radiation therapy is used.

A facial nerve neuroma is a tumor on cranial nerve VII. These types of tumors are usually not visible on otoscopic

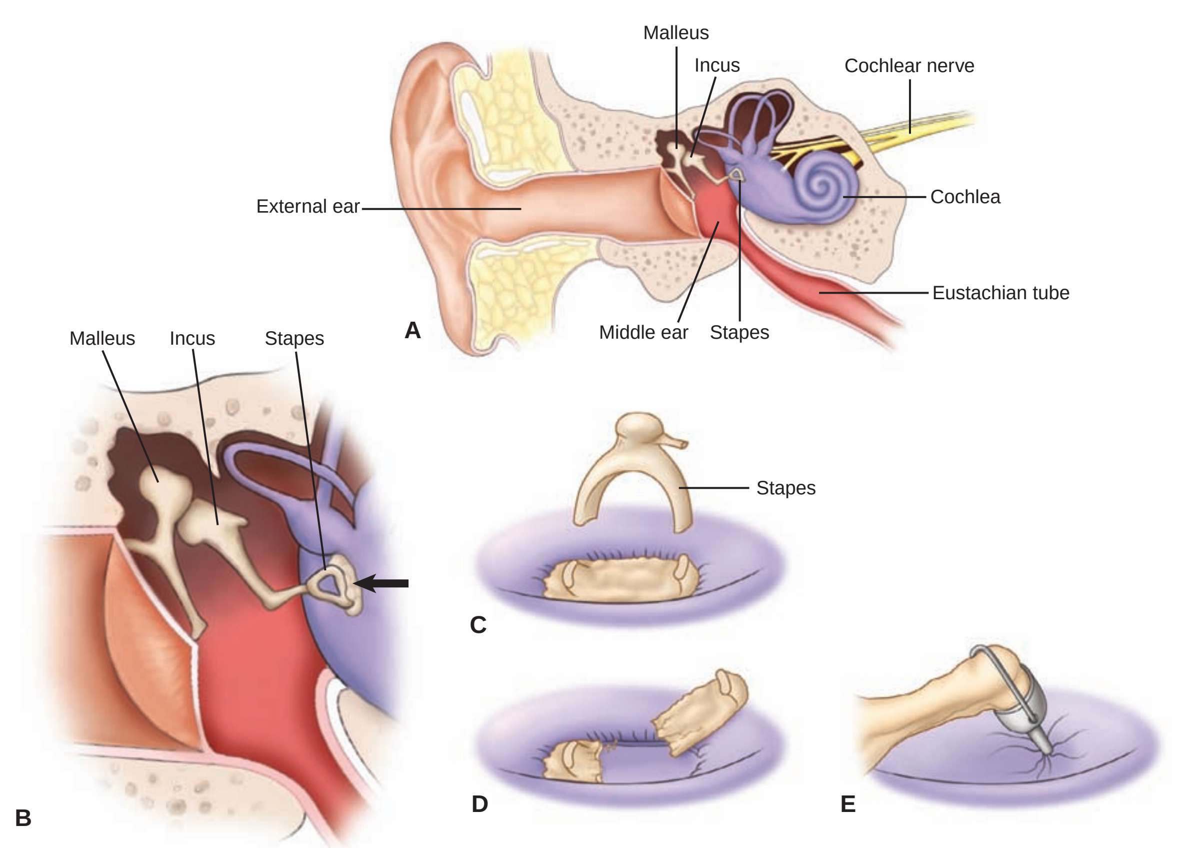



**Figure 59-6** Stapedectomy for otosclerosis. **A,** Normal anatomy. **B,** Arrow points to sclerotic process at the foot of the stapes. **C,** Stapes broken away surgically from its diseased base. The hole in the footplate provides an area where an instrument can grasp the plate. **D,** The footplate is removed from its base. Some otosclerotic tissue may remain, and tissue is placed over it. **E,** Robinson stainless steel prosthesis in position.

examination but are suspected when a patient presents with a facial nerve paresis. X-ray evaluation is used to identify the site of the tumor along the facial nerve. The treatment is surgical removal.

# CONDITIONS OF THE INNER EAR

Almost 8 million American adults are affected by a chronic problem with balance and an additional 2.4 million are affected by dizziness alone. Disorders of balance are a major cause of falls of elderly people (NIDCD, 2005).

The term **dizziness** is used frequently by patients and health care providers to describe any altered sensation of orientation in space. **Vertigo** is defined as the misperception or illusion of motion of the person or the surroundings. Most people with vertigo describe a spinning sensation or say they feel as though objects are moving around them. Ataxia is a failure of muscular coordination and may be present in patients with vestibular disease. Syncope, fainting, and loss of consciousness are not forms of vertigo and usually indicate disease in the cardiovascular system.

**Nystagmus** is an involuntary rhythmic movement of the eyes. Nystagmus occurs normally when a person watches a rapidly moving object (eg, through the side window of a moving car or train). However, pathologically it is an ocular disorder associated with vestibular dysfunction. Nystagmus can be horizontal, vertical, or rotary and can be caused by a disorder in the central or peripheral nervous system.

## Motion Sickness

Motion sickness is a disturbance of equilibrium caused by constant motion. For example, it can occur aboard a ship, while riding on a merry-go-round or swing, or in a car.

### Clinical Manifestations

The syndrome manifests itself in sweating, pallor, nausea, and vomiting caused by vestibular overstimulation. These manifestations may persist for several hours after the stimulation stops.

### Management

Over-the-counter antihistamines such as dimenhydrinate (Dramamine) or meclizine hydrochloride (Antivert) may provide some relief of nausea and vomiting by blocking the conduction of the vestibular pathway of the inner ear. Anticholinergic medications, such as scopolamine patches, may also be effective because they antagonize the histamine response. These must be replaced every few days. Side effects such as dry mouth and drowsiness may occur. Potentially hazardous activities such as driving a car or operating heavy machinery should be avoided if drowsiness occurs.

## Ménière's Disease

**Ménière's disease** is an abnormal inner ear fluid balance caused by a malabsorption in the endolymphatic sac or a blockage in the endolymphatic duct. **Endolymphatic hydrops,** a dilation in the endolymphatic space, develops, and either increased pressure in the system or rupture of the inner ear membrane occurs, producing symptoms of Ménière's disease.

Ménière's disease affects 15 to 50 people per 100,000 people in the United States (Kitahara, Kubo, Okumura, et al., 2008). More common in adults, it has an average age of onset in the 40s, with symptoms usually beginning between the ages of 20 and 60 years. Ménière's disease appears to be equally common in men and women, and it occurs bilaterally in about 20% of patients. About 50% of the patients who have Ménière's disease have a positive family history of the disease.

### Clinical Manifestations

Symptoms of Ménière's disease include fluctuating, progressive sensorineural hearing loss; **tinnitus** or a roaring sound; a feeling of pressure or fullness in the ear; and episodic, incapacitating vertigo, often accompanied by nausea and vomiting. These symptoms range in severity from a minor nuisance to extreme disability, especially if the attacks of vertigo are severe. At the onset of the disease, perhaps only one or two of the symptoms are manifested.

Some clinicians believe that there are two subsets of the disease: cochlear and vestibular. Cochlear Ménière's disease is recognized as a fluctuating, progressive sensorineural hearing loss associated with tinnitus and aural pressure in the absence of vestibular symptoms or findings. Vestibular Ménière's disease is characterized as the occurrence of episodic vertigo associated with aural pressure but no cochlear symptoms. Patients may experience either cochlear or vestibular disease symptoms; however, eventually all of these symptoms develop.

### Assessment and Diagnostic Findings

Vertigo is usually the most troublesome complaint related to Ménière's disease. A careful history is taken to determine the frequency, duration, severity, and character of the vertigo attacks. Vertigo may last minutes to hours, possibly accompanied by nausea or vomiting. Diaphoresis and a persistent feeling of imbalance or disequilibrium may waken patients at night. Some patients report that these feelings last for days. However, they usually feel well between attacks. Hearing loss may fluctuate, with tinnitus and aural pressure waxing and waning with changes in hearing. These feelings may occur during or before attacks, or they may be constant.

Physical examination findings are usually normal, with the exception of those of cranial nerve VIII. Sounds from a tuning fork (Weber test) may lateralize to the ear opposite the hearing loss, the one affected with Ménière's disease. An audiogram typically reveals a sensorineural hearing loss in the affected ear. This can be in the form of a "Pike's Peak" pattern, which looks like a hill or mountain. A sensorineural loss in the low frequencies occurs as the disease progresses. The electronystagmogram may be normal or may show reduced vestibular response.

### Medical Management

Most patients with Ménière's disease can be successfully treated with diet and medication. Many patients can control their symptoms by adhering to a low-sodium (1000 to 1500 mg/day or less) diet. Chart 59-7 describes dietary guidelines that may be useful in Ménière's disease. The amount of sodium is one of many factors that regulate the balance of fluid within the body. Sodium and fluid retention disrupts the delicate balance between endolymph and perilymph in the inner ear. Psychological evaluation may be indicated if a patient is anxious, uncertain, fearful, or depressed.

#### *Pharmacologic Therapy*

Pharmacologic therapy for Ménière's disease consists of antihistamines, such as meclizine (Antivert), which suppress the vestibular system. Tranquilizers such as diazepam (Valium) may be used in acute instances to help control vertigo. Antiemetic agents such as promethazine (Phenergan) suppositories help control the nausea and vomiting and the vertigo because of their antihistamine effect. Diuretic therapy (eg, hydrochlorothiazide [Dyazide], triamterene [Dyrenium]) may relieve symptoms by lowering the pressure in the endolymphatic system. Intake of foods containing potassium (eg, bananas, tomatoes, oranges) is necessary if the patient takes a diuretic that causes potassium loss. There is no scientific basis for the use of vasodilators, such as papaverine hydrochloride (Pavabid) to alleviate the symptoms, but they are often used in conjunction with other therapies, such as methantheline bromide (Banthine).

In patients who may be noncompliant with the therapeutic regimen, intratympanic injection of gentamicin (Garamycin) is being used to cause ablation of the vestibular

CHART 59-7 PATIENT EDUCATION
**Dietary Guidelines for Patients With Ménière's Disease**

- Limit foods high in salt or sugar. Be aware of foods with hidden salts and sugars.
- Eat meals and snacks at regular intervals to stay hydrated. Missing meals or snacks may alter the fluid level in the inner ear.
- Eat fresh fruits, vegetables, and whole grains. Limit the amount of canned, frozen, or processed foods with high sodium content.
- Drink plenty of fluids daily. Water, milk, and low-sugar fruit juices are recommended. Limit intake of coffee, tea, and soft drinks. Avoid caffeine because of its diuretic effect.
- Limit alcohol intake. Alcohol may change the volume and concentration of the inner ear fluid and may worsen symptoms.
- Avoid monosodium glutamate (MSG), which may increase symptoms.
- Avoid aspirin and aspirin-containing medications. Aspirin may increase tinnitus and dizziness.

hair cells. However, the risk of significant hearing loss is high (Swartz & Longwell, 2005).

### *Surgical Management*

Although most patients respond well to conservative therapy, some continue to have disabling attacks of vertigo. If these attacks reduce their quality of life, patients may elect to undergo surgery for relief. Surgical procedures include endolymphatic sac procedures and vestibular nerve section. However, hearing loss, tinnitus, and aural fullness may continue, because the surgical treatment of Ménière's disease is aimed at eliminating the attacks of vertigo (Mayo Clinic, 2008).

#### Endolymphatic Sac Decompression

Endolymphatic sac decompression, or shunting, theoretically equalizes the pressure in the endolymphatic space. A shunt or drain is inserted in the endolymphatic sac through a postauricular incision. This procedure is favored by many otolaryngologists as a first-line surgical approach to treat the vertigo of Ménière's disease because it is relatively simple and safe and can be performed on an outpatient basis.

#### Vestibular Nerve Sectioning

Vestibular nerve sectioning provides the greatest success rate (approximately 98%) in eliminating the attacks of vertigo. It can be performed by a translabyrinthine approach (ie, through the hearing mechanism) or in a manner that can conserve hearing (ie, suboccipital or middle cranial fossa), depending on the degree of hearing loss. Most patients with incapacitating Ménière's disease have little or no effective hearing. Cutting the nerve prevents the brain from receiving input from the semicircular canals. This procedure may require a brief hospital stay. A plan of nursing care for the patient with vertigo is presented in Chart 59-8.

## Benign Paroxysmal Positional Vertigo

Benign paroxysmal positional vertigo is a brief period of incapacitating vertigo that occurs when the position of the patient's head is changed with respect to gravity, typically by placing the head back with the affected ear turned down. The onset is sudden and followed by a predisposition for positional vertigo, usually for hours to weeks but occasionally for months or years.

Benign paroxysmal positional vertigo is thought to be due to the disruption of debris within the semicircular canal. This debris is formed from small crystals of calcium carbonate from the inner ear structure, the utricle. This is frequently stimulated by head trauma, infection, or other events. In severe cases, vertigo may easily be induced by any head movement. The vertigo is usually accompanied by nausea and vomiting; however, hearing impairment does not generally occur (Labuguen, 2006).

Bed rest is recommended for patients with acute symptoms. There are repositioning techniques that can be used to treat vertigo. The canalith repositioning procedure is commonly used. This noninvasive procedure, which involves quick movements of the body, rearranges the debris in the canal. The procedure is performed by placing the patient in a sitting position, turning the head to a 45-degree angle on the affected side, and then quickly moving the patient to the supine position. The procedure is safe, inexpensive, and easy to perform.

Patients with acute vertigo may be treated with meclizine for 1 to 2 weeks. After this time, the meclizine is stopped, and the patient is reassessed. Patients who continue to have severe positional vertigo may be premedicated with prochlorperazine (Compazine) 1 hour before the canalith repositioning procedure is performed.

Vestibular rehabilitation can be used in the management of vestibular disorders. This strategy promotes active use of the vestibular system through an interdisciplinary team approach, including medical and nursing care, stress management, biofeedback, vocational rehabilitation, and physical therapy. A physical therapist prescribes balance exercises that help the brain compensate for the impairment to the balance system (Swartz & Longwell, 2005).

## Tinnitus

Tinnitus is a symptom of an underlying disorder of the ear that is associated with hearing loss. This condition affects approximately 37 million people in the United States, and it is most prevalent between 40 and 70 years of age (Porth & Matfin, 2009). The severity of tinnitus may range from mild to severe. Patients describe tinnitus as a roaring, buzzing, or hissing sound in one or both ears. Numerous factors may contribute to the development of tinnitus, including several ototoxic substances (Chart 59-9). Underlying disorders that contribute to tinnitus may include thyroid disease, hyperlipidemia, vitamin $B_{12}$ deficiency, psychological disorders (eg, depression, anxiety), fibromyalgia, otologic disorders (Ménière's disease, acoustic neuroma), and neurologic disorders (head injury, multiple sclerosis).

A physical examination should be performed to determine the cause of tinnitus. Diagnostic testing determines if hearing loss is present. An audiograph speech discrimination test or a tympanogram may be used to help determine the cause. Some forms of tinnitus are irreversible; therefore, patients may need teaching and counseling about ways of adjusting to their treatment and dealing with tinnitus in the future.

## Labyrinthitis

**Labyrinthitis,** an inflammation of the inner ear, can be bacterial or viral in origin. Bacterial labyrinthitis is rare because of antibiotic therapy, but it sometimes occurs as a complication of otitis media. The infection can spread to the inner ear by penetrating the membranes of the oval or round windows. Viral labyrinthitis is a common diagnosis, but little is known about this disorder, which affects hearing and balance. The most common viral causes are mumps, rubella, rubeola, and influenza. Viral illnesses of the upper respiratory tract and herpetiform disorders of the facial and acoustic nerves (ie, Ramsay Hunt syndrome) also cause labyrinthitis.

### Clinical Manifestations

Labyrinthitis is characterized by a sudden onset of incapacitating vertigo, usually with nausea and vomiting, various degrees of hearing loss, and possibly tinnitus. The first

CHART 59-8

## PLAN OF NURSING CARE
## *Care of the Patient With Vertigo*

**NURSING DIAGNOSIS:** Risk for injury related to altered mobility because of gait disturbance and vertigo
**GOAL:** Remains free of any injuries associated with imbalance and/or falls

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess for vertigo, including history, onset, description of attacks, duration, frequency, and any associated ear symptoms (hearing loss, tinnitus, aural fullness). | 1. History provides basis for interventions. |
| 2. Assess extent of disability in relation to activities of daily living. | 2. Extent of disability indicates risk of falling. |
| 3. Teach or reinforce vestibular/balance therapy as prescribed. | 3. Exercises hasten labyrinthine compensation, which may decrease vertigo and gait disturbance. |
| 4. Administer, or teach administration of, antivertiginous medications and/or vestibular sedation medication; instruct patient about side effects. | 4. Alleviates acute symptoms of vertigo |
| 5. Encourage patient to sit down when dizzy. | 5. Decreases possibility of falling and injury |
| 6. Place pillow on each side of head to restrict movement. | 6. Movement aggravates vertigo. |
| 7. Assist patient in identifying aura that suggests an impending attack. | 7. Recognition of aura may trigger the need to take medication before an attack occurs, thereby minimizing the severity of effects. |
| 8. Recommend that the patient keep eyes open and stare straight ahead when lying down and experiencing vertigo. | 8. Sensation of vertigo decreases and motion decelerates if eyes are kept in a fixed position. |

**Expected Outcomes**

- Experiences no falls due to balance disturbance
- Fear and anxiety are reduced.
- Performs exercises as prescribed
- Takes prescribed medications appropriately
- Assumes safe position when vertigo is present
- Keeps head still when vertigo is present
- Identifies a characteristic fullness or sense of pressure in the ear as occurring before a full-blown attack
- Reports measures that help reduce vertigo

**NURSING DIAGNOSIS:** Risk-prone health behavior related to disability requiring change in lifestyle due to unpredictability of vertigo
**GOAL:** Modifies lifestyle to decrease disability and exert maximum control and independence within limits posed by chronic vertigo

| Nursing Interventions | Rationale |
|---|---|
| 1. Encourage patient to identify personal strengths and roles that can still be fulfilled. | 1. Maximizes sense of regaining control and independence |
| 2. Provide information about vertigo and what to expect. | 2. Reduces fear and anxiety |
| 3. Include family and significant others in rehabilitative process. | 3. Perceived beliefs of significant others are important for patient's adherence to medical regimen. |
| 4. Encourage patient to maintain sense of control by making decisions and assuming more responsibility for care. | 4. Reinforces positive psychological and social outcomes |

**Expected Outcomes**

- Exerts maximum control of environment and independence within limits imposed by vertigo
- Is informed about condition
- Family and significant others are included in rehabilitation process.
- Uses strengths and potentials to engage in the most independent and constructive lifestyle

**NURSING DIAGNOSIS:** Risk for deficient fluid volume related to increased fluid output, altered intake, and medications
**GOAL:** Maintains normal fluid and electrolyte balance

| Nursing Interventions | Rationale |
|---|---|
| 1. Assess, or have patient assess, intake and output (including emesis, liquid stools, urine, and diaphoresis). Monitor laboratory values. | 1. Accurate records provide basis for fluid replacement. |

**Expected Outcomes**

- Laboratory values within normal limits
- Alert and oriented; vital signs within normal limits, skin turgor normal; electrolytes normal

*Continued on following page*

CHART 59-8

PLAN OF NURSING CARE

## *Care of the Patient With Vertigo* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Assess indicators of dehydration, including blood pressure (orthostasis), pulse, skin turgor, mucous membranes, and level of consciousness. | 2. Prompt recognition of dehydration allows early intervention. | • Mucous membranes are moist.<br>• Vomiting or diarrhea has stopped; usual oral intake resumed |
| 3. Encourage oral fluids as tolerated; discourage beverages containing caffeine (a vestibular stimulant). | 3. Oral replacement is begun as soon as possible to replace losses. Caffeine may increase diarrhea. | |
| 4. Administer, or teach administration of, antiemetic and antidiarrheal medications as prescribed and needed. Instruct patient in side effects. | 4. Antiemetics medications reduce nausea and vomiting, reducing fluid losses and improving oral intake. Antidiarrheal medication reduces intestinal motility and fluid losses. | |

**NURSING DIAGNOSIS:** Anxiety related to threat of, or change in, health status and disability effects of vertigo
**GOAL:** Experiences less or no anxiety

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess level of anxiety. Help patient identify coping skills used successfully in the past. | 1. Guides therapeutic interventions and participation in self-care. Past coping skills can relieve anxiety. | • Fear and anxiety about attacks of vertigo reduced or eliminated<br>• Acquires knowledge and skills to deal with vertigo<br>• Feels less tension, apprehension, and uncertainty<br>• Uses stress management techniques when needed<br>• Avoids upsetting encounters<br>• Repeats instructions given and verbalizes understanding of treatments |
| 2. Provide information about vertigo and its treatment. | 2. Increased knowledge helps to decrease anxiety. | |
| 3. Encourage patient to discuss anxieties and explore concerns about vertigo attacks. | 3. Promotes awareness and understanding of relationship between anxiety level and behavior | |
| 4. Teach patient stress management techniques or make appropriate referral. | 4. Improved stress management can reduce the frequency and severity of some vertiginous attacks. | |
| 5. Provide comfort measures and avoid stress-producing activities. | 5. Stressful situations may exacerbate symptoms of the condition. | |
| 6. Instruct patient in aspects of treatment regimen. | 6. Patient knowledge helps to decrease anxiety. | |

**NURSING DIAGNOSIS:** Risk for trauma related to impaired balance
**GOAL:** Reduces the risk of trauma by adapting the home environment and by using assistive devices as necessary

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess for balance disturbance and/or vertigo by taking history and by examination for nystagmus, positive Romberg, and inability to perform tandem Romberg. | 1. Peripheral vestibular disorders cause these signs and symptoms. | • Has adapted home environment or uses rehabilitative devices to reduce risk of falling<br>• Ambulates with needed assistance<br>• Visual and proprioceptive risks identified<br>• Activity level increased<br>• Home environment free of hazards |
| 2. Assist with ambulation when indicated. | 2. Abnormal gait can predispose patient to unsteadiness and falls. | |
| 3. Assess for visual acuity and proprioceptive deficits. | 3. Balance depends on visual, vestibular, and proprioceptive systems. | |
| 4. Encourage increased activity level with or without use of assistive devices. | 4. Increased activity may help retrain balance system. | |
| 5. Help identify hazards in home environment. | 5. Adaptation of home environment can reduce risk of falls during rehabilitative process. | |

**NURSING DIAGNOSIS:** Self-care deficit: feeding, bathing/hygiene, dressing/grooming, toileting, related to labyrinth dysfunction and episodes of vertigo
**GOAL:** Able to care for self

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Administer, or teach administration of, antiemetic and other prescribed medications to relieve nausea and vomiting associated with vertigo. | 1. Antiemetic and sedative-type medications depress stimuli in the cerebellum. | • Carries out necessary functions during symptom-free periods. Takes medications to relieve nausea, vomiting, or vertigo |

Continued

**CHART 59-8** PLAN OF NURSING CARE
*Care of the Patient With Vertigo (Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Encourage patient to perform self-care when free of vertigo.<br>3. Review diet with patient and caregivers. Offer fluids as necessary. | 2. Spacing activities is important because episodes of vertigo vary in occurrence.<br>3. Sodium restriction helps improve an inner ear fluid imbalance in some patients, thereby decreasing vertigo. Fluids help prevent dehydration. | • Carries out daily activities<br>• Accepts dietary plan and reports its effectiveness.<br>• Drinks fluids in sufficient amounts |

**NURSING DIAGNOSIS:** Powerlessness related to illness regimen and being helpless in certain situations due to vertigo/balance disturbance
**GOAL:** Experiences increased sense of control over life and activities despite vertigo/balance disturbance

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient's needs, values, attitudes, and readiness to initiate activities.<br>2. Provide opportunities for patient to express feelings about self and illness.<br>3. Help patient identify previous coping behaviors that were successful. | 1. Involving patient in planning activities and care enhances potential for mastery.<br>2. Expressing feelings increases understanding of individual coping styles and defense mechanisms.<br>3. Awareness increases understanding of stressors that trigger feeling of powerlessness. Awareness of past successes enhances self-confidence. | • Does not restrict activities unnecessarily due to vertigo<br>• Verbalizes positive feelings about own ability to achieve a sense of power and control<br>• Identifies previous successful coping behaviors |

episode is usually the worst; subsequent attacks, which usually occur over a period of several weeks to months, are less severe.

### Management

Treatment of bacterial labyrinthitis includes IV antibiotic therapy, fluid replacement, and administration of an antihistamine (eg, meclizine [Antivert]) and antiemetic medications. Treatment of viral labyrinthitis is based on the patient's symptoms.

## Ototoxicity

A variety of medications may have adverse effects on the cochlea, vestibular apparatus, or cranial nerve VIII. All but a few, such as aspirin and quinine, cause irreversible hearing loss. At high doses, aspirin toxicity can produce bilateral tinnitus. IV medications, especially the aminoglycosides, are the most common cause of ototoxicity, and they destroy the hair cells in the organ of Corti (see Chart 59-9).

To prevent loss of hearing or balance, patients receiving potentially ototoxic medications should be counseled about the side effects of these medications. These medications should be used with caution in patients who are at high risk for complications, such as children, the elderly, pregnant patients, patients with kidney or liver problems, and patients with current hearing disorders. Blood levels of the medications should be monitored, and patients receiving long-term IV antibiotics should be monitored with an audiogram twice each week during therapy.

## Acoustic Neuroma

Acoustic neuromas are slow-growing, benign tumors of cranial nerve VIII, usually arising from the Schwann cells of the vestibular portion of the nerve. Most acoustic tumors arise within the internal auditory canal and extend into the cerebellopontine angle to press on the brain stem, possibly destroying the vestibular nerve. Most acoustic neuromas are unilateral, except in von Recklinghausen's disease (neurofibromatosis type 2), in which bilateral tumors occur (Porth & Matfin, 2009).

Acoustic neuromas develop in 1 of every 10,000 people per year. These neuromas account for 5% to 10% of all intracranial tumors and seem to occur with equal frequency in men and women at any age, although most occur during middle age.

**CHART 59-9** PHARMACOLOGY
*Selected Ototoxic Substances*

- **Diuretics:** ethacrynic acid, furosemide, acetazolamide
- **Chemotherapeutic agents:** cisplatin, nitrogen mustard
- **Antimalarial agents:** quinine, chloroquine
- **Anti-inflammatory agents:** salicylates (aspirin), indomethacin
- **Chemicals:** alcohol, arsenic
- **Aminoglycoside antibiotics:** amikacin, gentamicin, kanamycin, netilmicin, neomycin, streptomycin, tobramycin
- **Other antibiotics:** erythromycin, minocycline, polymyxin B, vancomycin
- **Metals:** gold, mercury, lead

### Assessment and Diagnostic Findings

The most common assessment findings of patients with acoustic neuromas are unilateral tinnitus and hearing loss with or without vertigo or balance disturbance. It is important to identify asymmetry in audiovestibular test results so that further workup can be performed to rule out an acoustic neuroma. MRI with a contrast agent (ie, gadolinium or Magnevist) is the imaging study of choice. If the patient is claustrophobic or cannot undergo an MRI for other reasons or if the scan is unavailable, a CT scan with contrast dye is performed. However, MRI is more sensitive than CT in delineating a small tumor.

### Management

Surgical removal of acoustic tumors is the treatment of choice because these tumors do not respond well to radiation or chemotherapy. Because treatment of acoustic tumors crosses several specialties, the interdisciplinary treatment approach involves a neurologist and a neurosurgeon. The objective of the surgery is to remove the tumor while preserving facial nerve function. Most acoustic tumors have damaged the cochlear portion of cranial nerve VIII, and hearing is impaired. In these patients, the surgery is performed using a translabyrinthine approach, and the hearing mechanism is destroyed. If hearing is still good before surgery, a suboccipital or middle cranial fossa approach to removing the tumor may be used. This procedure exposes the lateral third of the internal auditory canal and preserves hearing.

Complications of surgery include facial nerve paralysis, cerebrospinal fluid leakage, meningitis, and cerebral edema. Death from acoustic neuroma surgery is rare.

## AURAL REHABILITATION

If hearing loss is permanent or cannot be treated by medical or surgical means or if the patient elects not to undergo surgery, aural rehabilitation may be beneficial. The purpose of aural rehabilitation is to maximize the communication skills of the person with hearing impairment. Aural rehabilitation includes auditory training, speech reading, speech training, and the use of hearing aids and hearing guide dogs.

Auditory training emphasizes listening skills, so the person who is hearing-impaired concentrates on the speaker. Speech reading (also known as lip reading) can help fill the gaps left by missed or misheard words. The goals of speech training are to conserve, develop, and prevent deterioration of current communication skills.

It is important to identify the type of hearing impairment a person has so that rehabilitative efforts can be directed at his or her particular need. Surgical correction may be all that is necessary to treat and improve a conductive hearing loss by eliminating the cause of the hearing loss. With advances in hearing aid technology, amplification for patients with sensorineural hearing loss is more helpful than ever.

### Hearing Aids

A hearing aid is a device through which speech and environmental sounds are received by a microphone, converted to electrical signals, amplified, and reconverted to acoustic signals. Many aids available for sensorineural hearing loss depress the low frequencies, or tones, and enhance hearing for the high frequencies. A general guideline for assessing the patient's need for a hearing aid is a hearing loss exceeding 30 dB in the range of 500 to 2000 Hz in the better-hearing ear.

A hearing aid makes sounds louder, but it does not improve a patient's ability to discriminate words or understand speech. People who have low discrimination scores (ie, 20%) on audiograms may derive little benefit from a hearing aid. Hearing aids amplify all sounds, including background noise, which may be disturbing to the wearer. Chart 59-10 identifies additional problems associated with hearing aid use. Computerized hearing aids are available to compensate for background noise or allow amplification at certain programmed frequencies rather than at all frequencies. Occasionally, depending on the type of hearing loss, binaural aids (ie, one for each ear) may be indicated. Chart 59-11 provides tips for hearing aid care.

A hearing aid should be fitted according to the patient's needs (eg, type of hearing loss, manual dexterity, and preferences), rather than the brand name, by a certified audiologist licensed to dispense hearing aids. Many states have consumer protection laws that allow the hearing aid to be returned after a trial use if the patient is not completely satisfied. In addition, to protect the health and safety of people with hearing impairments, the U.S. Food and Drug Administration (FDA) has established certain regulations. A medical evaluation of the impairment by a physician must be obtained within 6 months before the purchase of a hearing aid. However, the written statement from a physician may be waived if the patient (a fully informed adult 18 years

**Chart 59-10 • *Hearing Aid Problems***

**Whistling Noise**

Loose ear mold
Improperly made
Improperly worn
Worn out

**Improper Aid Selection**

Too much power required in aid, with inadequate separation between microphone and receiver
Open mold used inappropriately

**Inadequate Amplification**

Dead batteries
Cerumen in ear
Cerumen or other material in mold
Wires or tubing disconnected from aid
Aid turned off or volume too low
Improper mold
Improper aid for degree of loss

**Pain from Mold**

Improperly fitted mold
Ear skin or cartilage infection
Middle ear infection
Ear tumor
Unrelated conditions of the temporomandibular joint, throat, or larynx

CHART 59-11 PATIENT EDUCATION
*Tips for Hearing Aid Care*

**Cleaning**

- The ear mold is the only part of the hearing aid that may be washed frequently.
- Wash ear mold daily with soap and water.
- Allow the ear mold to dry completely before it is snapped into the receiver.
- Clean the cannula with a small pipe cleaner–like device.
- Proper care of the ear device and keeping the ear canal clean and dry can prevent complications.

**Malfunctioning**

- Inadequate amplification, a whistling noise, or pain from the mold can occur when a hearing aid is not functioning properly.
- Check for malfunctions:
  - Is the switch on properly?
  - Are the batteries charged and positioned correctly?
- If the hearing aid is still not working properly, notify the hearing aid dealer.
- If the unit requires extended time for repair, the dealer may lend you a hearing aid until the repair can be accomplished.

**Recognizing Complications**

- Common medical complications include external otitis media and pressure ulcers in the external auditory canal. Signs and symptoms of these infections include painful ear, especially when the external ear is touched; canal swelling; redness; difficulty hearing; pain radiating to the jaw area; and fever.
- If any of these symptoms are present, notify your health care provider for evaluation. You may need medication to treat infection, pain, or both.

of age or older) signs a document to this effect. Health care professionals who dispense hearing aids are required to refer prospective users to a physician if any of the following otologic conditions are evident:

- Visible congenital or traumatic deformity of the ear
- Active drainage from the ear within the previous 90 days
- Sudden or rapidly progressive hearing loss within the previous 90 days
- Complaints of dizziness or tinnitus
- Unilateral hearing loss that occurred suddenly or within the previous 90 days
- Audiometric air–bone gap of 15 dB or more at 500, 1000, and 2000 Hz
- Significant accumulation of cerumen or a foreign body in the external auditory canal
- Pain or discomfort in the ear

A user instruction brochure is provided with every hearing aid device. In this brochure, the following information is presented:

- Notification that good health practice requires a medical evaluation before purchasing a hearing aid
- Notification that any of the eight otologic conditions previously listed should be investigated by a physician before purchase of a hearing aid
- Instructions for proper use, maintenance, and care of the hearing aid, as well as instructions for replacing or recharging the batteries
- Repair service information
- Description of avoidable conditions that could damage the hearing aid
- List of any known side effects that may warrant physician consultation (eg, skin irritation, accelerated cerumen accumulation)

The evolution in technology has led to the availability of many smaller and more effective hearing aids. It is estimated that 98% of all hearing aids sold today are behind-the-ear, in-the-ear, or in-the-canal types (Table 59-4). One of the newest in-the-ear models is the Lyric, and other new models are being developed. The Lyric is placed in the ear canal just 4 mm from the tympanic membrane. Its volume is controlled by a magnet, and when its batteries no longer function (1 to 4 months), a physician can remove it with the magnet and reinsert a new device. This device does not have many of the problems (eg, feedback noise, overamplification of background noise) associated with other hearing aids, and it does not involve the expense and uncertainty of surgical procedures. However, it is not an option for a person whose ear canal is too narrow to accommodate it.

## Implanted Hearing Devices

Three types of implanted hearing devices are commercially available or in the investigational stage: the cochlear implant, the bone conduction device, and the semi-implantable

**Table 59-4 HEARING AIDS**

| Site (and Range of Hearing Loss) | Advantages | Disadvantages |
|---|---|---|
| Body, usually on the trunk (mild–profound) | Separation of receiver and microphone prevents acoustic feedback, allowing high amplification. Generally used in a school setting | Bulky; requires long wire, which may be cosmetically displeasing; some loss of high-frequency response |
| Behind the ear (mild–profound) | Economical; powerful, with no long wires; easily used by children—adapts easily as the child grows, with only the ear mold needing replacement | Large size |
| In the ear (mild–moderately severe) | One-piece custom fit to contour of ear; no tubes or cords; miniature microphone is located in the ear, which is a more natural placement; more cosmetically appealing due to easy concealment | Smaller size limits output; patients who have arthritis or cannot perform tasks requiring good manual dexterity may have difficulty with the small size of aid and/or battery; can require more repair than the behind-the-ear aid |
| In the canal (mild–moderately severe) | Same as in-the-ear aids; less visible, so more cosmetically pleasing | Even smaller than in-the-ear aids; requires good manual dexterity |

hearing device. Cochlear implants are for patients with little or no hearing. Bone conduction devices, which transmit sound through the skull to the inner ear, are used in patients with a conductive hearing loss if a hearing aid is contraindicated (eg, those with chronic infection). The device is implanted postauricularly under the skin into the skull, and an external device—worn above the ear, not in the canal—transmits the sound through the skin. There are two types of implantable hearing aids. The bone anchored hearing aid (BAHA) is implanted behind the ear in the mastoid area. The middle ear implantation (MEI) is implanted in the middle ear cavity. The BAHA is used for conductive or mixed hearing loss, while the MEI is used for sensorineural hearing loss.

A cochlear implant is an auditory prosthesis used for people with profound sensorineural hearing loss bilaterally who do not benefit from conventional hearing aids. The hearing loss may be congenital or acquired. An implant does not restore normal hearing; rather, it helps the person detect medium to loud environmental sounds and conversation. The implant provides stimulation directly to the auditory nerve, bypassing the nonfunctioning hair cells of the inner ear. The microphone and signal processor, worn outside the body, transmit electrical stimuli to the implanted electrodes. The electrical signals stimulate the auditory nerve fibers and then the brain, where they are interpreted.

Worldwide, more than 112,000 people have received a cochlear implant. In the United States, more than 23,000 adults and 15,500 children have cochlear implants (NIDCD, 2007).

Candidates for a cochlear implant, who are usually at least 1 year of age, are selected after careful screening by otologic history, physical examination, audiologic testing, x-rays, and psychological testing. Criteria for choosing adults who may benefit from a cochlear implant include the following:

- Profound sensorineural hearing loss in both ears
- Inability to hear and recognize speech well with hearing aids
- No medical contraindication to a cochlear implant or general anesthesia
- Indications that being able to hear would enhance the patient's life

The surgery involves implanting a small receiver in the temporal bone through a postauricular incision and placing electrodes into the inner ear (Fig. 59-7). The microphone and transmitter are worn on an external unit. The patient undergoes extensive cochlear rehabilitation with the multidisciplinary team, which includes an audiologist and speech pathologist. Several months may be needed to learn to interpret the sounds heard. Children and adults who lost their hearing before they learned to speak take much longer to acquire speech. There are wide variations of success with cochlear implants, and there is also controversy about their use, especially among the deaf community. Patients who have had a cochlear implant are cautioned that an MRI will inactivate the implant; MRI should be used only when there is no other diagnostic option.

## Hearing Guide Dogs

Specially trained dogs (service dogs) are available to assist the person with a hearing loss. People who live alone are eligible to apply for a dog trained by International Hearing Dog, Inc. The dog reacts to the sound of a telephone, a doorbell, an alarm clock, a baby's cry, a knock at the door, a smoke alarm, or an intruder. The dog alerts its master by physical contact; the dog then runs to the source of the noise. In public, the dog positions itself between the person with hearing impairment and any potential hazard that the person cannot hear, such as an oncoming vehicle or a loud, hostile person. In many states, a certified hearing guide dog is legally permitted access to public transportation, public eating places, and stores, including food markets.

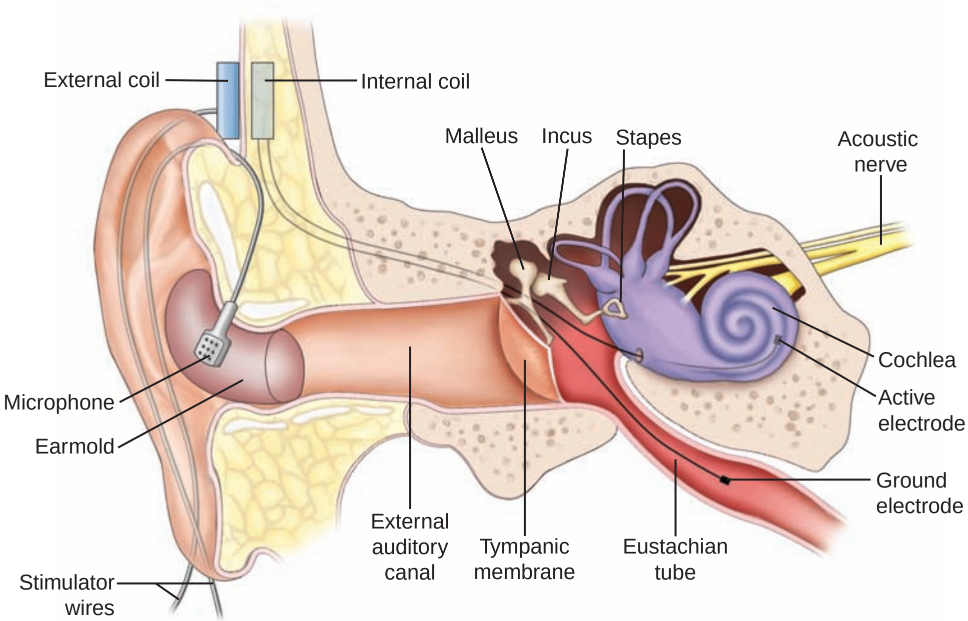



**Figure 59-7** The cochlear implant. The internal coil has a stranded electrode lead. The electrode is inserted through the round window into the scala tympani of the cochlea. The external coil (the transmitter) is held in alignment with the internal coil (the receiver) by a magnet. The microphone receives the sound. The stimulator wire receives the signal after it has been filtered, adjusted, and modified so that the sound is at a comfortable level for the patient. Sound is passed by the external transmitter to the inner coil receiver by magnetic conduction and is then carried by the electrode to the cochlea.

## CRITICAL THINKING EXERCISES

**1** You are a new nurse in the outpatient clinic and you notice that many of the preoperative patients whom you interview have some type of hearing impairment. Discuss barriers for patients with hearing impairment and techniques you can use to assess hearing. List how you can improve your practice and communication techniques with patients who are hearing-impaired.

EBP **2** A 20-year-old man, a member of a college swim team, has recurrent external otitis—his third episode in the past 6 weeks. He is being treated at an ear-nose-throat clinic. Devise an evidence-based practice teaching plan for this patient.

**3** A 44-year-old man has recently been diagnosed with Ménière's disease. Develop a teaching plan that focuses on control of the patient's symptoms. Provide rationale for each component of the teaching plan. Discuss the strength of the evidence that supports specific dietary strategies for controlling the symptoms of Ménière's disease.

**4** A 50-year-old man is scheduled for coronary artery bypass graft surgery. He has been profoundly deaf since childhood. How should the preoperative and postoperative plans of nursing care be modified to meet this patient's communication needs? How would you modify discharge teaching for him?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

Acoustic Neuroma Association, www.anausa.org
Alexander Graham Bell Association for the Deaf and Hard of Hearing, www.agbell.org
American Academy of Audiology, www.audiology.org
American Academy of Facial Plastic and Reconstructive Surgery, www.aafprs.org
American Academy of Otolaryngology–Head & Neck Surgery, www.entnet.org
American Board of Facial Plastic and Reconstructive Surgery, www.abfprs.org
American Speech-Language-Hearing Association, www.asha.org
American Tinnitus Association, www.ata.org
International Hearing Dog, Inc., www.ihdi.org
National Institute on Deafness and Other Communication Disorders (NIDCD), National Institutes of Health, www.nidcd.nih.gov
Society of Otorhinolaryngology and Head-Neck Nurses, Inc., www.sohnnurse.com
Vestibular Disorders Association, www.vestibular.org

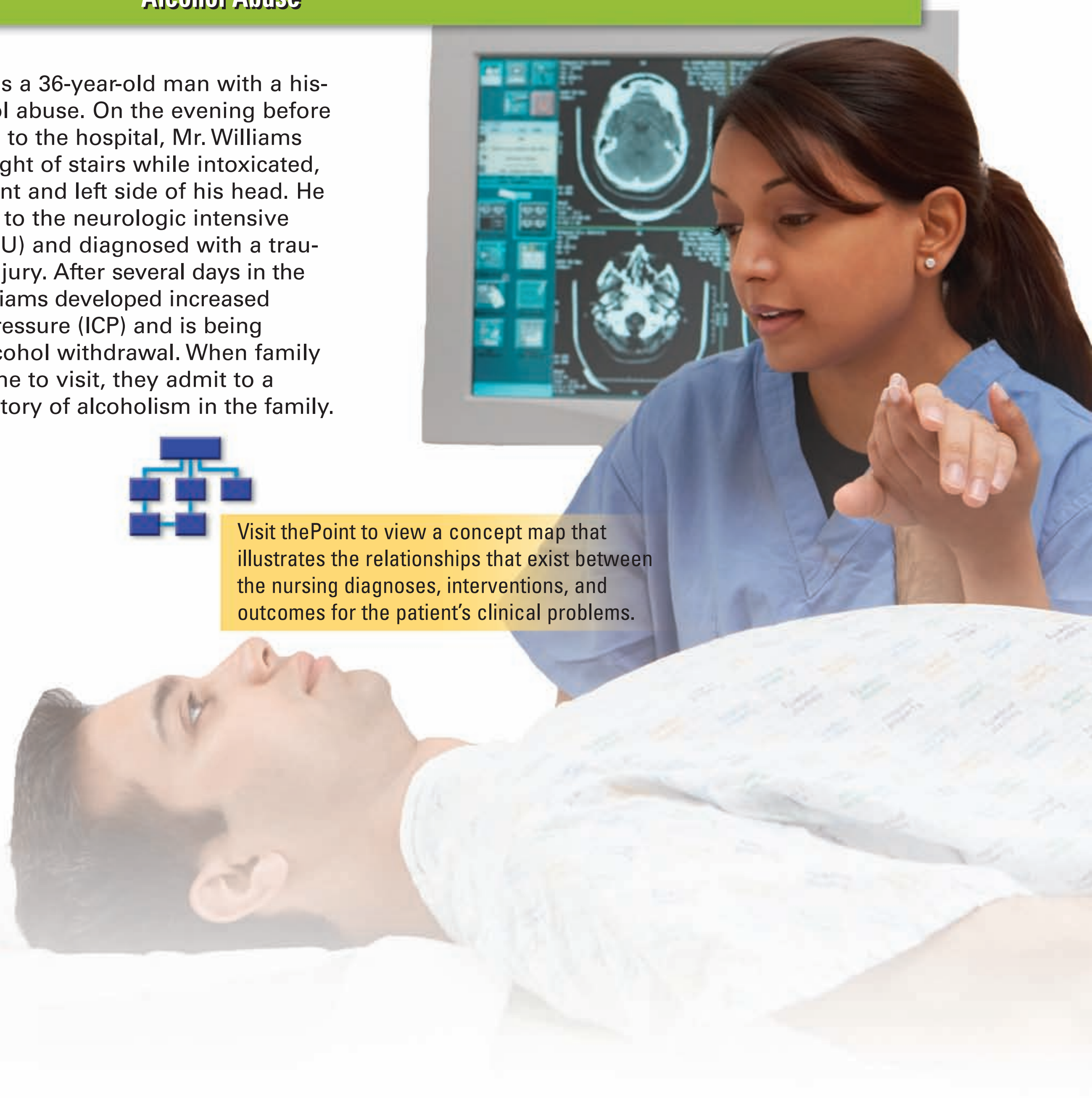
unit 14

# Neurologic Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Brain Injury and a History of Alcohol Abuse

**Mr. Williams** is a 36-year-old man with a history of alcohol abuse. On the evening before his admission to the hospital, Mr. Williams fell down a flight of stairs while intoxicated, hitting the front and left side of his head. He was admitted to the neurologic intensive care unit (NICU) and diagnosed with a traumatic brain injury. After several days in the NICU, Mr. Williams developed increased intracranial pressure (ICP) and is being treated for alcohol withdrawal. When family members come to visit, they admit to a significant history of alcoholism in the family.



Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **DECREASED INTRACRANIAL ADAPTIVE CAPACITY**—Intracranial fluid dynamic mechanisms that normally compensate for increases in intracranial volumes are compromised, resulting in repeated disproportionate increases in increased intracranial pressure (ICP) in response to a variety of noxious stimuli | **NEUROLOGIC MONITORING**—Collection and analysis of patient data to prevent or minimize neurologic complications | **NEUROLOGICAL STATUS**—Ability of the peripheral and central nervous system to receive, process, and respond to internal and external stimuli |
| **RISK FOR INJURY**—At risk of injury as a result of environmental conditions interacting with the individual's adaptive and defensive resources | **CEREBRAL EDEMA MANAGEMENT**—Limitation of secondary cerebral injury resulting from swelling of brain tissue | **SEIZURE CONTROL**—Personal actions to reduce or minimize the occurrence of seizure episodes |
| **DYSFUNCTIONAL FAMILY PROCESSES: ALCOHOLISM**—Psychosocial, spiritual, and physiological functions of the family unit are chronically disorganized, which leads to conflict, denial of problems, resistance to change, ineffective problem solving, and a series of self-perpetuating crises | **MEDICATION ADMINISTRATION**—Preparing, giving, and evaluating the effectiveness of prescription and nonprescription drugs | **PHYSICAL INJURY SEVERITY**—Severity of injuries from trauma |
| | **SURVEILLANCE: SAFETY**—Purposeful and ongoing collection and analysis of information about the patient and the environment for use in promoting and maintaining patient safety | **FAMILY COPING**—Family actions to manage stressors that tax family resources |
| | **FAMILY SUPPORT**—Promotion of family values, interests and goals | |


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# chapter 60 Assessment of Neurologic Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the structures and functions of the central and peripheral nervous systems.
2. Differentiate between pathologic changes that affect motor control and those that affect sensory pathways.
3. Compare the functioning of the sympathetic and parasympathetic nervous systems.
4. Describe the significance of physical assessment to the diagnosis of neurologic dysfunction.
5. Describe changes in neurologic function associated with aging and their impact on neurologic assessment findings.
6. Describe diagnostic tests used for assessment of suspected neurologic disorders and the related nursing implications.

## GLOSSARY

**agnosia:** loss of ability to recognize objects through a particular sensory system; may be visual, auditory, or tactile

**ataxia:** inability to coordinate muscle movements, resulting in difficulty in walking, talking, and performing self-care activities

**autonomic nervous system:** division of the nervous system that regulates the involuntary body functions

**axon:** portion of the neuron that conducts impulses away from the cell body

**Babinski reflex (sign):** a reflex action of the toes, indicative of abnormalities in the motor control pathways leading from the cerebral cortex

**clonus:** abnormal movement marked by alternating contraction and relaxation of a muscle occurring in rapid succession

**delirium:** transient loss of intellectual function, usually due to systemic problems

**dendrite:** portion of the neuron that conducts impulses toward the cell body

**flaccidity:** displaying lack of muscle tone; limp, floppy

**parasympathetic nervous system:** division of the autonomic nervous system active primarily during nonstressful conditions, controlling mostly visceral functions

**photophobia:** inability to tolerate light

**position (postural) sense:** awareness of position of parts of the body without looking at them; also referred to as proprioception

**reflex:** an automatic response to stimuli

**rigidity:** increase in muscle tone at rest characterized by increased resistance to passive stretch

**Romberg test:** test for cerebellar dysfunction requiring the patient to stand with feet together, eyes closed and arms extended; inability to maintain the position, with either significant stagger or sway, is a positive test

**spasticity:** sustained increase in tension of a muscle when it is passively lengthened or stretched

**sympathetic nervous system:** division of the autonomic nervous system with predominantly excitatory responses; the "fight-or-flight" system

**vertigo:** an illusion of movement, usually rotation

Nurses in many practice settings encounter patients with altered neurologic function. Disorders of the nervous system can occur at any time during the lifespan and can vary from mild, self-limiting symptoms to devastating, life-threatening disorders. Nurses must be skilled in the general assessment of neurologic function and be able to focus on specific areas as needed. Assessment requires knowledge of the anatomy and physiology of the nervous system and an understanding of the array of tests and procedures used to diagnose neurologic disorders. Knowledge about the nursing implications and interventions related to assessment and diagnostic testing is also essential.

## Anatomic and Physiologic Overview

The nervous system consists of two major parts: the central nervous system (CNS), including the brain and spinal cord, and the peripheral nervous system, which includes the cranial nerves, spinal nerves, and autonomic nervous system. The function of the nervous system is to control motor, sensory, autonomic, cognitive, and behavioral activities. The brain itself contains more than 100 billion cells that link the motor and sensory pathways, monitor the body's processes, respond to the internal and external environment, maintain homeostasis, and direct all psychological, biologic, and physical activity through complex chemical and electrical messages (Klein & Stewart-Amidei, 2009).

### Cells of the Nervous System

The basic functional unit of the brain is the neuron (Fig. 60-1). It is composed of dendrites, a cell body, and an axon. The **dendrites** are branch-type structures for receiving electrochemical messages. The **axon** is a long projection that carries electrical impulses away from the cell body. Some neurons have a myelinated sheath that increases speed of conduction. Nerve cell bodies occurring in clusters are called ganglia or nuclei. A cluster of cell bodies with the same function is called a center (eg, the respiratory center). Neuroglial cells, 50 times greater in number than neurons, serve to support, protect, and nourish neurons (Hickey, 2009).

### Neurotransmitters

Neurotransmitters communicate messages from one neuron to another or from a neuron to a specific target tissue. Neurotransmitters are manufactured and stored in synaptic vesicles. As an electrical action potential propagated along the axon reaches the nerve terminal, neurotransmitters are released into the synapse. The neurotransmitter diffuses or is transported across the synapse, binding to receptors in the postsynaptic cell membrane. A neurotransmitter potentiates, terminates, or modulates a specific action, and it can either excite or inhibit activity of the target cell. Usually, multiple neurotransmitters are at work in the neural synapse. The source and action of major neurotransmitters are described in Table 60-1. Once released, enzymes either destroy the neurotransmitter or reabsorb it into the cell for future use.

Many neurologic disorders are due, at least in part, to an imbalance in neurotransmitters. For example, Parkinson's disease develops from decreased availability of dopamine, while acetylcholine binding to muscle cells is impaired in myasthenia gravis (Porth & Matfin, 2009). All brain functions are modulated through neurotransmitter receptor site activity, including memory and other cognitive processes (Hickey, 2009).

Ongoing research is evaluating diagnostic tests that can detect abnormal levels of neurotransmitters in the brain. Positron emission tomography (PET), for example, can detect dopamine, serotonin, and acetylcholine. Single photon emission computed tomography (SPECT), similar to PET, can detect changes in some neurotransmitters such as dopamine in Parkinson's disease (Bremner, 2005). Both PET and SPECT are discussed in more detail later in this chapter.

### The Central Nervous System

#### *The Brain*

The brain accounts for approximately 2% of the total body weight; in an average young adult, the brain weighs approximately 1400 g, whereas in an average elderly person, the brain weighs approximately 1200 g (Hickey, 2009). The brain is divided into three major areas: the cerebrum, the brain stem, and the cerebellum. The cerebrum is composed of two hemispheres, the thalamus, the hypothalamus, and the basal ganglia. The brain stem includes the midbrain, pons, and medulla. The cerebellum is located under the cerebrum and behind the brain stem (Fig. 60-2).

**Cerebrum**

The outside surface of the hemispheres has a wrinkled appearance that is the result of many folded layers or

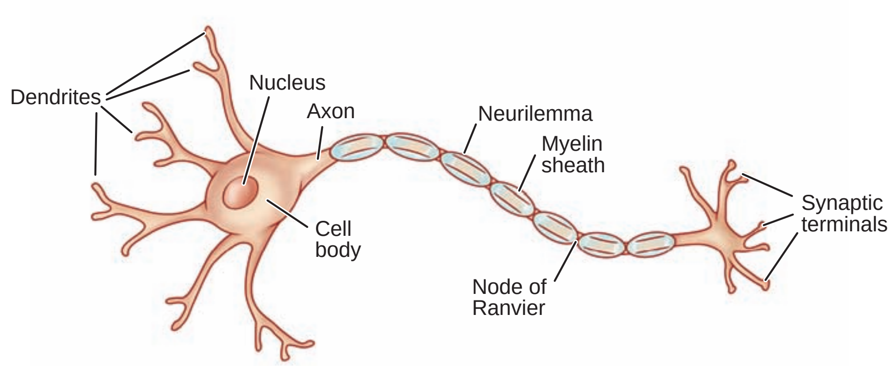



**Figure 60-1** Neuron.

**Table 60-1 MAJOR NEUROTRANSMITTERS**

| Neurotransmitter | Source | Action |
|---|---|---|
| Acetylcholine (major transmitter of the parasympathetic nervous system) | Many areas of the brain; autonomic nervous system | Usually excitatory; parasympathetic effects sometimes inhibitory (stimulation of heart by vagal nerve) |
| Serotonin | Brain stem, hypothalamus, dorsal horn of the spinal cord | Inhibitory, helps control mood and sleep, inhibits pain pathways |
| Dopamine | Substantia nigra and basal ganglia | Usually inhibits, affects behavior (attention, emotions) and fine movement |
| Norepinephrine (major transmitter of the sympathetic nervous system) | Brain stem, hypothalamus, postganglionic neurons of the sympathetic nervous system | Usually excitatory; affects mood and overall activity |
| Gamma-aminobutyric acid (GABA) | Spinal cord, cerebellum, basal ganglia, some cortical areas | Inhibitory |
| Enkephalin, endorphin | Nerve terminals in the spine, brain stem, thalamus and hypothalamus, pituitary gland | Excitatory; pleasurable sensation, inhibits pain transmission |

convolutions called gyri, which increase the surface area of the brain, accounting for the high level of activity carried out by such a small-appearing organ. Between each gyrus is a sulcus or fissure that serves as an anatomic division. In between the cerebral hemispheres is the great longitudinal fissure that separates the cerebrum into the right and left hemispheres. The two hemispheres are joined at the lower portion of the fissure by the corpus callosum. The external or outer portion of the hemispheres (the cerebral cortex) is made up of gray matter approximately 2 to 5 mm in depth; it contains billions of neuron cell bodies, giving it a gray appearance. White matter makes up the innermost layer and is composed of myelinated nerve fibers and neuroglia cells that form tracts or pathways connecting various parts of the brain with one another. These pathways also connect the cortex with lower portions of the brain and spinal cord. The cerebral hemispheres are divided into pairs of lobes as follows (see Fig. 60-2):

- Frontal—the largest lobe, located in the front of the brain. The major functions of this lobe are concentration, abstract thought, information storage or memory, and motor function. It contains Broca's area, which is located in the left hemisphere and is critical for motor control of speech. The frontal lobe is also responsible in large part for a person's affect, judgment, personality, and inhibitions (Hickey, 2009).
- Parietal—a predominantly sensory lobe posterior to the frontal lobe. This lobe analyzes sensory information and relays the interpretation of this information to other cortical areas and is essential to a person's awareness of body position in space, size and shape discrimination, and right–left orientation (Hickey, 2009).
- Temporal—located inferior to the frontal and parietal lobes, this lobe contains the auditory receptive areas and plays a role in memory of sound and understanding of language and music.
- Occipital—located posterior to the parietal lobe, this lobe is responsible for visual interpretation and memory.

The corpus callosum (Fig. 60-3), a thick collection of nerve fibers that connects the two hemispheres of the brain, is responsible for the transmission of information from one side of the brain to the other. Information transferred includes sensation, memory, and learned discrimination. Right-handed people and some left-handed people have cerebral dominance on the left side of the brain for verbal, linguistic, arithmetic, calculation, and analytic functions.

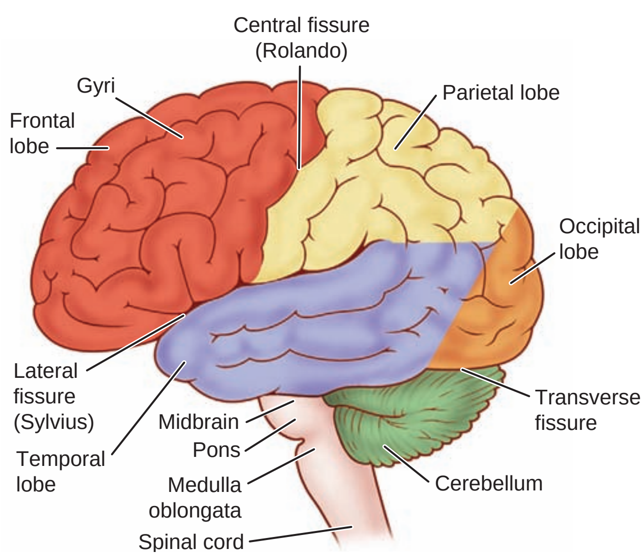



**Figure 60-2** View of the external surface of the brain showing lobes, cerebellum, and brain stem.

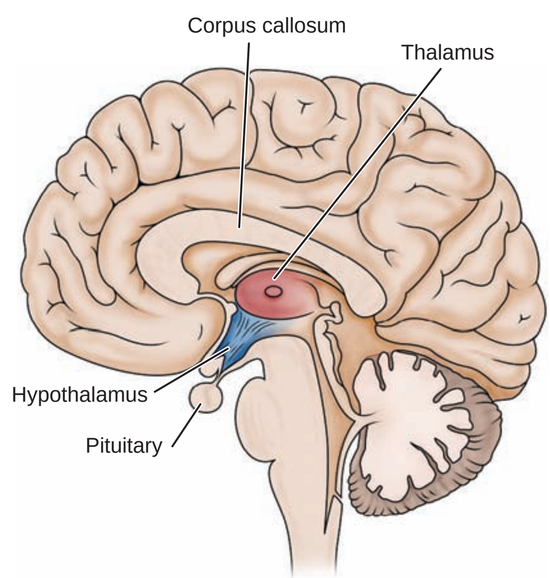



**Figure 60-3** Medial view of the brain.

The nondominant hemisphere is responsible for geometric, spatial, visual, pattern, and musical functions. Nuclei for cranial nerves I and II are also located in the cerebrum.

The basal ganglia are masses of nuclei located deep in the cerebral hemispheres that are responsible for control of fine motor movements, including those of the hands and lower extremities.

The thalamus (see Fig. 60-3) lies on either side of the third ventricle and acts primarily as a relay station for all sensation except smell. All memory, sensation, and pain impulses pass through this section of the brain.

The hypothalamus (see Fig. 60-3) is located anterior and inferior to the thalamus, and beneath and lateral to the third ventricle. The infundibulum of the hypothalamus connects it to the posterior pituitary gland. The hypothalamus plays an important role in the endocrine system because it regulates the pituitary secretion of hormones that influence metabolism, reproduction, stress response, and urine production. It works with the pituitary to maintain fluid balance through hormonal release and maintains temperature regulation by promoting vasoconstriction or vasodilatation. In addition, the hypothalamus is the site of the hunger center and is involved in appetite control. It contains centers that regulate the sleep–wake cycle, blood pressure, aggressive and sexual behavior, and emotional responses (ie, blushing, rage, depression, panic, and fear). The hypothalamus also controls and regulates the autonomic nervous system. The optic chiasm (the point at which the two optic tracts cross) and the mamillary bodies (involved in olfactory reflexes and emotional response to odors) are also found in this area.

### Brain Stem

The brain stem consists of the midbrain, pons, and medulla oblongata (see Fig. 60-2). The midbrain connects the pons and the cerebellum with the cerebral hemispheres; it contains sensory and motor pathways and serves as the center for auditory and visual reflexes. Cranial nerves III and IV originate in the midbrain. The pons is situated in front of the cerebellum between the midbrain and the medulla and is a bridge between the two halves of the cerebellum, and between the medulla and the midbrain. Cranial nerves V through VIII originate in the pons. The pons also contains motor and sensory pathways. Portions of the pons help regulate respiration.

Motor fibers from the brain to the spinal cord and sensory fibers from the spinal cord to the brain are located in the medulla. Most of these fibers cross, or decussate, at this level. Cranial nerves IX through XII originate in the medulla. Reflex centers for respiration, blood pressure, heart rate, coughing, vomiting, swallowing, and sneezing are located in the medulla as well. The reticular formation, responsible for arousal and the sleep–wake cycle, begins in the medulla and connects with numerous higher structures.

### Cerebellum

The cerebellum is posterior to the midbrain and pons, and below the occipital lobe (see Fig. 60-2). The cerebellum integrates sensory information to provide smooth coordinated movement. It controls fine movement, balance, and **position (postural) sense** or proprioception (awareness of where each part of the body is).

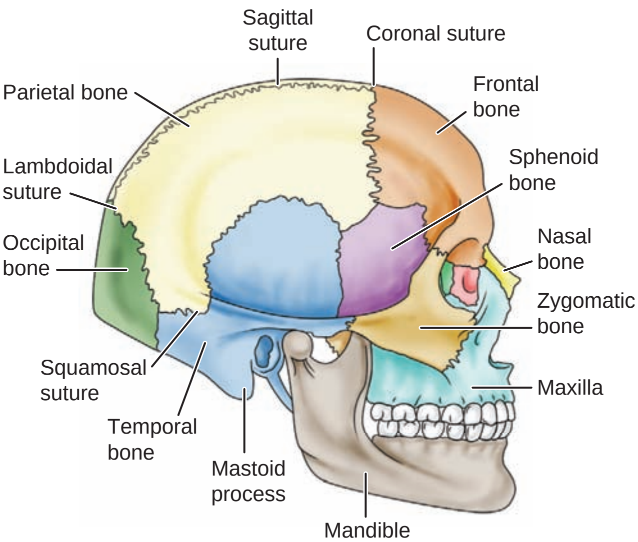



**Figure 60-4** Bones and sutures of the skull.

## *Structures Protecting the Brain*

The brain is contained in the rigid skull, which protects it from injury. The major bones of the skull are the frontal, temporal, parietal, occipital, and sphenoid bones. These bones join at the suture lines (Fig. 60-4) and form the base of the skull. Indentations in the skull base are known as fossae. The anterior fossa contains the frontal lobe, the middle fossa contains the temporal lobe, and the posterior fossa contains the cerebellum and brain stem.

The meninges, fibrous connective tissues that cover the brain and spinal cord, provide protection, support, and nourishment. The layers of the meninges are the dura mater, arachnoid, and pia mater (Fig. 60-5).

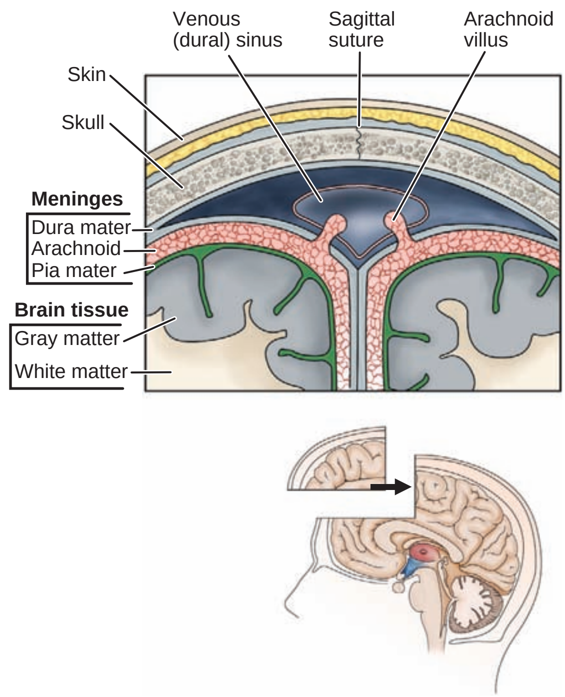



**Figure 60-5** Meninges and related structures.

- Dura mater—the outermost layer; covers the brain and the spinal cord. It is tough, thick, inelastic, fibrous, and gray. There are three major extensions of the dura: the falx cerebri, which folds between the two hemispheres; the tentorium, which folds between the occipital lobe and cerebellum to form a tough, membranous shelf; and the falx cerebelli, which is located between the right and left side of the cerebellum. When excess pressure occurs in the cranial cavity, brain tissue may be compressed against these dural folds or displaced around them or downward, a process called herniation. A potential space exists between the dura and the skull, and between the periosteum and the dura in the vertebral column, known as the epidural space. Another potential space, the subdural space, also exists below the dura. Blood or an abscess can accumulate in these potential spaces.
- Arachnoid—the middle membrane; an extremely thin, delicate membrane that closely resembles a spider web (hence the name arachnoid). The arachnoid membrane has cerebrospinal fluid (CSF) in the space below it, called the subarachnoid space. This membrane has unique fingerlike projections, called arachnoid villi, that absorb CSF into the venous system. When blood or bacteria enter the subarachnoid space, the villi become obstructed and *communicating* hydrocephalus (increased size of ventricles) may result.
- Pia mater—the innermost, thin, transparent layer that hugs the brain closely and extends into every fold of the brain's surface.

### Cerebrospinal Fluid

CSF is a clear and colorless fluid that is produced in the choroid plexus of the ventricles and circulates around the surface of the brain and the spinal cord. There are four ventricles: the right and left lateral and the third and fourth ventricles. The two lateral ventricles open into the third ventricle at the interventricular foramen or the foramen of Monro. The third and fourth ventricles connect via the aqueduct of Sylvius. The fourth ventricle drains CSF into the subarachnoid space on the surface of the brain and spinal cord, where it is absorbed by the arachnoid villi. Blockage of CSF flow anywhere in the ventricular system produces *obstructive* hydrocephalus.

CSF is important in immune and metabolic functions in the brain. It is produced at a rate of about 500 mL/day; the ventricles and subarachnoid space contain approximately 150 mL of fluid (Hickey, 2009). The composition of CSF is similar to other extracellular fluids (such as blood plasma), but the concentrations of the various constituents differ. A laboratory analysis of CSF indicates color (clear), specific gravity (normal 1.007), protein count, white blood cell count, glucose, and other electrolyte levels (see Appendix A, Table A-5). The CSF may also be tested for immunoglobulins or presence of bacteria. Normal CSF contains a minimal number of white blood cells and no red blood cells.

### Cerebral Circulation

The brain does not store nutrients and requires a constant supply of oxygen. These needs are met through cerebral circulation; the brain receives approximately 15% of the cardiac output, or 750 mL per minute of blood flow. Brain circulation is unique in several aspects. First, arterial and venous circulation are not parallel as in other organs in the body; this is due in part to the role the venous system plays in CSF absorption. Second, the brain has collateral circulation through the circle of Willis, allowing blood flow to be redirected on demand. Third, blood vessels in the brain have two rather than three layers, which may make them more prone to rupture when weakened or under pressure.

#### Arteries

Arterial blood supply to the brain originates from the common carotid artery, the first bifurcation off the aorta. The internal carotid arteries arise at the bifurcation of the common carotid and supply much of the anterior circulation of the brain. Branches of the internal carotid arteries, anterior and middle cerebral arteries, along with their connections, anterior and posterior communicating arteries, form the circle of Willis (Fig. 60-6).

The vertebral arteries branch from the subclavian arteries to supply most of the posterior circulation of the brain. At the level of the brain stem, the vertebral arteries join to form the basilar artery. The basilar artery divides to form the two branches of the posterior cerebral arteries. Functionally, the posterior portion of the circulation and the anterior or carotid circulation usually remain separate. However, the circle of Willis can provide collateral circulation if one of the vessels supplying it becomes occluded or is ligated.

The bifurcations along the circle of Willis are frequent sites of aneurysm formation. Aneurysms are outpouchings of the blood vessel due to vessel wall weakness. Aneurysms can rupture and cause a hemorrhagic stroke. Aneurysms are discussed in more detail in Chapter 62.

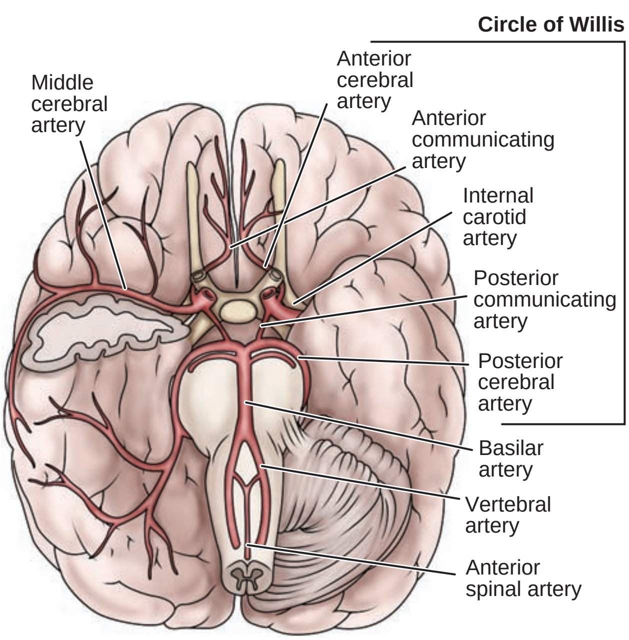



**Figure 60-6** Arterial blood supply of the brain, including the circle of Willis, as viewed from the ventral surface.

### Veins

Venous drainage for the brain does not follow the arterial circulation as in other body structures. The veins reach the brain's surface, join larger veins, then cross the subarachnoid space and empty into the dural sinuses, which are the vascular channels laying within the dura (see Fig. 60-5). The network of the sinuses carries venous outflow from the brain and empties into the internal jugular veins, returning the blood to the heart. Cerebral veins are unique because, unlike other veins in the body, they do not have valves to prevent blood from flowing backward and depend on both gravity and blood pressure for flow.

### Blood–Brain Barrier

The CNS is inaccessible to many substances that circulate in the blood plasma (eg, dyes, medications, and antibiotics) because of the blood–brain barrier. This barrier is formed by the endothelial cells of the brain's capillaries, which form continuous tight junctions, creating a barrier to macromolecules and many compounds. All substances entering the CSF must filter through the capillary endothelial cells and astrocytes. The blood–brain barrier has a protective function but can be altered by trauma, cerebral edema, and cerebral hypoxemia; this has implications in the treatment and selection of medication for CNS disorders (Hickey, 2009).

## The Spinal Cord

The spinal cord is continuous with the medulla, extending from the cerebral hemispheres and serving as the connection between the brain and the periphery. Approximately 45 cm (18 inches) long and about the thickness of a finger, it extends from the foramen magnum at the base of the skull to the lower border of the first lumbar vertebra, where it tapers to a fibrous band called the *conus medullaris*. Continuing below the second lumbar space are the nerve roots that extend beyond the conus, which are called the *cauda equina* because they resemble a horse's tail. Meninges surround the spinal cord.

In a cross-sectional view, the spinal cord has an H-shaped central core of nerve cell bodies (gray matter) surrounded by ascending and descending tracts (white matter) (Fig. 60-7). The lower portion of the H is broader than the upper portion and corresponds to the anterior horns. The anterior horns contain cells with fibers that form the anterior (motor) root and are essential for the voluntary and reflex activity of the muscles they innervate. The thinner posterior (upper horns) portion contains cells with fibers that enter over the posterior (sensory) root and thus serve as a relay station in the sensory/reflex pathway.

The thoracic region of the spinal cord has a projection from each side at the crossbar of the H-shaped structure of gray matter called the lateral horn. It contains the cells that give rise to the autonomic fibers of the sympathetic division. The fibers leave the spinal cord through the anterior roots in the thoracic and upper lumbar segments.

### The Spinal Tracts

The white matter of the spinal cord is composed of myelinated and unmyelinated nerve fibers. The fast-conducting myelinated fibers form bundles that also contain glial cells. Fiber bundles with a common function are called tracts.

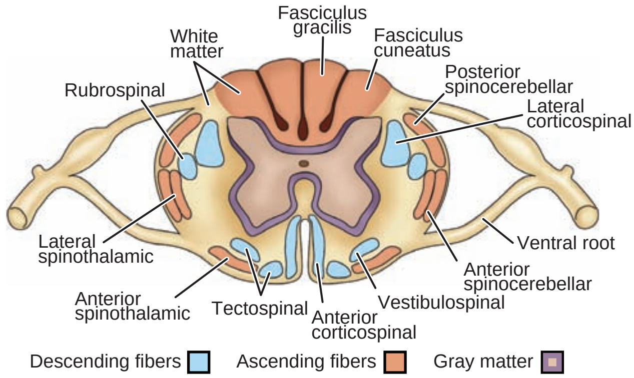



**Figure 60-7** Cross-sectional diagram of the spinal cord showing major spinal tracts.

There are six ascending tracts. Two tracts, known as the fasciculus cuneatus and gracilis or the posterior columns, conduct sensations of deep touch, pressure, vibration, position, and passive motion from the same side of the body. Before reaching the cerebral cortex, these fibers cross to the opposite side in the medulla. The anterior and posterior spinocerebellar tracts conduct sensory impulses from muscle spindles, providing necessary input for coordinated muscle contraction. They ascend essentially uncrossed and terminate in the cerebellum. The anterior and lateral spinothalamic tracts are responsible for conduction of pain, temperature, proprioception, fine touch, and vibratory sense from the upper body to the brain. They cross to the opposite side of the cord, and then ascend to the brain, terminating in the thalamus (Klein & Stewart-Amidei, 2009).

There are eight descending tracts. The anterior and lateral corticospinal tracts conduct motor impulses to the anterior horn cells from the opposite side of the brain, cross in the medulla, and control voluntary muscle activity. The three vestibulospinal tracts descend uncrossed and are involved in some autonomic functions (sweating, pupil dilation, and circulation) and involuntary muscle control. The corticobulbar tract conducts impulses responsible for voluntary head and facial muscle movement and crosses at the level of the brain stem. The rubrospinal and reticulospinal tracts conduct impulses involved with involuntary muscle movement.

### Vertebral Column

The bones of the vertebral column surround and protect the spinal cord and normally consist of 7 cervical, 12 thoracic, and 5 lumbar vertebrae, as well as the sacrum (a fused mass of 5 vertebrae), and terminate in the coccyx. Nerve roots exit from the vertebral column through the intervertebral foramina (openings). The vertebrae are separated by disks, except for the first and second cervical, the sacral, and the coccygeal vertebrae. Each vertebra has a ventral solid body and a dorsal segment or arch, which is posterior to the body. The arch is composed of two pedicles and two laminae supporting seven processes. The vertebral body, arch, pedicles, and laminae all encase and protect the spinal cord.

# The Peripheral Nervous System

The peripheral nervous system includes the cranial nerves, the spinal nerves, and the autonomic nervous system.

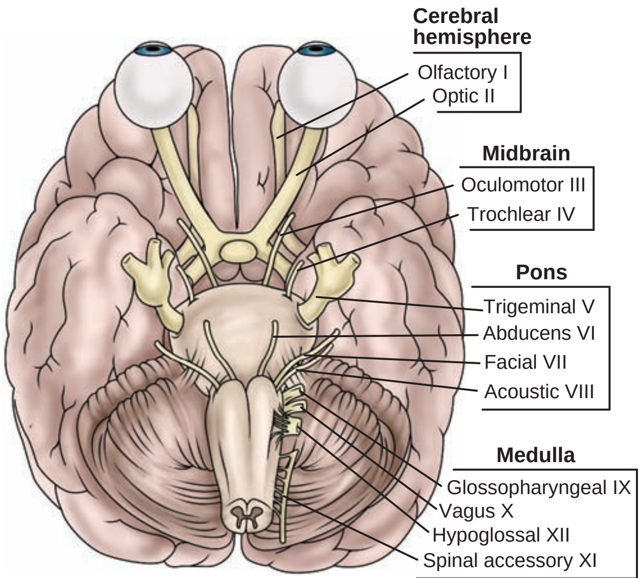



**Figure 60-8** Diagram of the base of the brain showing entrance or exit of the cranial nerves. The right column shows the anatomic location of the connection of each cranial nerve to the central nervous system.

**Table 60-2 CRANIAL NERVES**

| Cranial Nerve | Type | Function |
|---|---|---|
| I (olfactory) | Sensory | Sense of smell |
| II (optic) | Sensory | Visual acuity and visual fields |
| III (oculomotor) | Motor | Muscles that move the eye and lid, pupillary constriction, lens accommodation |
| IV (trochlear) | Motor | Muscles that move the eye |
| V (trigeminal) | Mixed | Facial sensation, corneal reflex, mastication |
| VI (abducens) | Motor | Muscles that move the eye |
| VII (facial) | Mixed | Facial expression and muscle movement, salivation and tearing, taste, sensation in the ear |
| VIII (acoustic) | Sensory | Hearing and equilibrium |
| IX (glossopharyngeal) | Mixed | Taste, sensation in pharynx and tongue, pharyngeal muscles, swallowing |
| X (vagus) | Mixed | Muscles of pharynx, larynx, and soft palate; sensation in external ear, pharynx, larynx, thoracic and abdominal viscera; parasympathetic innervation of thoracic and abdominal organs |
| XI (spinal accessory) | Motor | Sternocleidomastoid and trapezius muscles |
| XII (hypoglossal) | Motor | Movement of the tongue |

### *Cranial Nerves*

Twelve pairs of cranial nerves emerge from the lower surface of the brain and pass through openings in the base of the skull. Three are entirely sensory (I, II, VIII), five are motor (III, IV, VI, XI, and XII), and four are mixed sensory and motor (V, VII, IX, and X). The cranial nerves are numbered in the order in which they arise from the brain (Fig. 60-8). The cranial nerves innervate the head, neck, and special sense structures. Table 60-2 identifies primary functions of the cranial nerves.

### *Spinal Nerves*

The spinal cord is composed of 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. Each spinal nerve has a ventral root and a dorsal root. The dorsal roots are sensory and transmit sensory impulses from specific areas of the body known as dermatomes (Fig. 60-9) to the dorsal horn ganglia. The sensory fiber may be somatic, carrying information about pain, temperature, touch, and position sense (proprioception) from the tendons, joints, and body surfaces; or visceral, carrying information from the internal organs.

The ventral roots are motor and transmit impulses from the spinal cord to the body, and these fibers are also either somatic or visceral. The visceral fibers include autonomic fibers that control the cardiac muscles and glandular secretions.

### *Autonomic Nervous System*

The **autonomic nervous system** regulates the activities of internal organs such as the heart, lungs, blood vessels, digestive organs, and glands. Maintenance and restoration of internal homeostasis is largely the responsibility of the autonomic nervous system. There are two major divisions: the **sympathetic nervous system,** with predominantly excitatory responses, most notably the "fight-or-flight" response, and the **parasympathetic nervous system,** which controls mostly visceral functions.

The autonomic nervous system innervates most body organs. Although usually considered part of the peripheral nervous system, this system is regulated by centers in the spinal cord, brain stem, and hypothalamus. The autonomic nervous system has two neurons in a series extending between the centers in the CNS and the organs innervated. The first neuron, the preganglionic neuron, is located in the brain or spinal cord, and its axon extends to the autonomic ganglia. There, it synapses with the second neuron, the postganglionic neuron, located in the autonomic ganglia, and its axon synapses with the target tissue and innervates the effector organ. Its regulatory effects are exerted not on individual cells but on large expanses of tissue and on entire organs. The responses elicited do not occur instantaneously but after a lag period. These responses are sustained far longer than other neurogenic responses to ensure maximal functional efficiency on the part of receptor organs, such as blood vessels.

The hypothalamus is the major subcortical center for the regulation of visceral and somatic activities, serving an inhibitory–excitatory role in the autonomic nervous system. The hypothalamus has connections that link the autonomic system with the thalamus, the cortex, the olfactory apparatus, and the pituitary gland. Located here are the mechanisms for the control of visceral and somatic reactions that were originally important for defense or attack and are associated with emotional states (eg, fear, anger, anxiety); for the control of metabolic processes, including fat, carbohydrate, and water metabolism; for the regulation

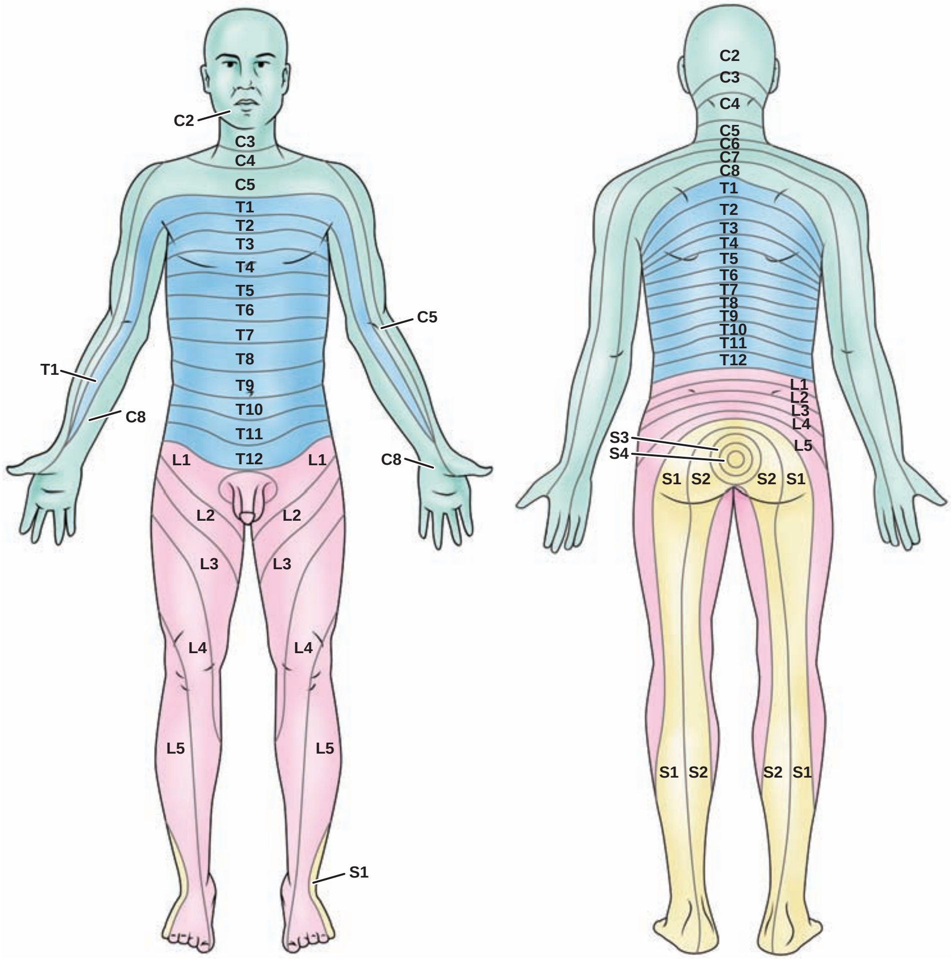



**Figure 60-9** Dermatome distribution.

of body temperature, arterial pressure, and all muscular and glandular activities of the gastrointestinal tract; for control of genital functions; and for the sleep cycle.

The autonomic nervous system is separated into the anatomically and functionally distinct sympathetic and parasympathetic divisions. Most of the tissues and the organs under autonomic control are innervated by both systems. For example, the parasympathetic division causes contraction (stimulation) of the urinary bladder muscles and a decrease (inhibition) in heart rate, whereas the sympathetic division produces relaxation (inhibition) of the urinary bladder and an increase (stimulation) in the rate and force of the heartbeat. Table 60-3 compares the sympathetic and the parasympathetic effects on the different systems of the body.

### Sympathetic Nervous System

The sympathetic division of the autonomic nervous system is best known for its role in the body's "fight-or-flight" response. Under stress from either physical or emotional causes, sympathetic impulses increase greatly. As a result, the bronchioles dilate for easier gas exchange; the heart's contractions are stronger and faster; the arteries to the heart and voluntary muscles dilate, carrying more blood to these organs; peripheral blood vessels constrict, making the skin feel cool but shunting blood to essential organs; the pupils dilate; the liver releases glucose for quick energy; peristalsis slows; hair stands on end; and perspiration increases. The main sympathetic neurotransmitter is norepinephrine (noradrenaline). A sympathetic discharge is the same as if the body has been given an injection of adrenalin—hence, the term *adrenergic* is often used to refer to this division.

Sympathetic neurons are located primarily in the thoracic and the lumbar segments of the spinal cord, and their axons, or the preganglionic fibers, emerge by way of anterior nerve roots from the eighth cervical or first thoracic segment to the second or third lumbar segment. A short distance from the cord, these fibers diverge to join a chain, composed of 22 linked ganglia, that extends the entire length of the spinal column, adjacent to the vertebral bodies on both sides. Some form multiple synapses with nerve cells within the chain. Others traverse the chain without making connections or losing continuity to join large "prevertebral" ganglia in the thorax, the abdomen, or the pelvis or one of the "terminal" ganglia in the vicinity of an organ, such as the bladder or the rectum (Fig. 60-10). Postganglionic nerve fibers originating in the sympathetic chain rejoin the spinal nerves that supply the extremities and are distributed to blood vessels, sweat glands, and smooth muscle tissue in the skin. Postganglionic fibers from the prevertebral plexuses

**Table 60-3 EFFECTS OF THE AUTONOMIC NERVOUS SYSTEM**

| Structure or Activity | Parasympathetic Effects | Sympathetic Effects |
|---|---|---|
| **Pupil of the Eye** | Constricted | Dilated |
| **Circulatory System** | | |
| Rate and force of heartbeat | Decreased | Increased |
| Blood vessels | | |
| In heart muscle | Constricted | Dilated |
| In skeletal muscle | * | Dilated |
| In abdominal viscera and the skin | * | Constricted |
| Blood pressure | Decreased | Increased |
| **Respiratory System** | | |
| Bronchioles | Constricted | Dilated |
| Rate of breathing | Decreased | Increased |
| **Digestive System** | | |
| Peristaltic movements of digestive tube | Increased | Decreased |
| Muscular sphincters of digestive tube | Relaxed | Contracted |
| Secretion of salivary glands | Thin, watery saliva | Thick, viscid saliva |
| Secretions of stomach, intestine, and pancreas | Increased | * |
| Conversion of liver glycogen to glucose | * | Increased |
| **Genitourinary System** | | |
| Urinary bladder | | |
| Muscle walls | Contracted | Relaxed |
| Sphincters | Relaxed | Contracted |
| Muscles of the uterus | Relaxed; variable | Contracted under some conditions; varies with menstrual cycle and pregnancy |
| Blood vessels of external genitalia | Dilated | * |
| **Integumentary System** | | |
| Secretion of sweat | * | Increased |
| Pilomotor muscles | * | Contracted (goose-flesh) |
| **Adrenal Medulla** | * | Secretion of epinephrine and norepinephrine |

*No direct effect.

From Hickey, J. (2009). *Clinical practice of neurological and neurosurgical nursing* (6th ed.). Philadelphia: Lippincott Williams & Wilkins.

(eg, the cardiac, pulmonary, splanchnic, and pelvic plexuses) supply structures in the head and neck, thorax, abdomen, and pelvis, respectively, having been joined in these plexuses by fibers from the parasympathetic division.

The adrenal glands, kidneys, liver, spleen, stomach, and duodenum are under the control of the giant celiac plexus, commonly known as the solar plexus. This receives its sympathetic nerve components by way of the three splanchnic nerves, composed of preganglionic fibers from nine segments of the spinal cord (T4 to L1), and is joined by the vagus nerve, representing the parasympathetic division. From the celiac plexus, fibers of both divisions travel along the course of blood vessels to their target organs.

***Sympathetic Syndromes.*** Certain syndromes are distinctive to diseases of the sympathetic nerve trunks. For example, sympathetic storm is a syndrome associated with changes in level of consciousness, altered vital signs, diaphoresis, and agitation that may result from hypothalamic stimulation of the sympathetic nervous system following traumatic brain injury (Diepenbrock, 2007).

### Parasympathetic Nervous System

The parasympathetic nervous system functions as the dominant controller for most visceral effectors; the primary neurotransmitter is acetylcholine. During quiet, nonstressful conditions, impulses from parasympathetic fibers (cholinergic) predominate. The fibers of the parasympathetic system are located in two sections, one in the brain stem and the other from spinal segments below L2. Because of the location of these fibers, the parasympathetic system is referred to as the craniosacral division, as distinct from the thoracolumbar (sympathetic) division of the autonomic nervous system.

The parasympathetic nerves arise from the midbrain and the medulla oblongata. Fibers from cells in the midbrain travel with the third oculomotor nerve to the ciliary ganglia, where postganglionic fibers of this division are joined by those of the sympathetic system, creating controlled opposition, with a delicate balance maintained between the two at all times.

## Motor and Sensory Pathways of the Nervous System

### *Motor Pathways*

The corticospinal tract begins in the motor cortex, a vertical band within each frontal lobe, and controls voluntary movements of the body. The exact locations within the brain at which the voluntary movements of the muscles of the face, thumb, hand, arm, trunk, and leg originate are known (Fig. 60-11). To initiate movement, these particular cells must send the stimulus along their fibers. Stimulation of these cells with an electric current also results in muscle contraction. En route to the pons, the motor fibers converge into a tight bundle known as the internal capsule. A comparatively small injury to the internal capsule results in a more severe paralysis than does a larger injury to the cortex itself.

At the medulla, the corticospinal tracts cross to the opposite side, continuing to the anterior horn of the spinal cord, in proximity to a motor nerve cell. Until this point, neurons are known as upper motor neurons. As they connect to motor fibers of the spinal nerves, they become lower motor neurons. The lower motor neurons receive the impulse in the posterior part of the cord and run to the myoneural junction located in the peripheral muscle.

Involuntary motor activity is also possible and is mediated through reflex arcs. Synaptic connections between anterior horn cells and sensory fibers that have entered adjacent or neighboring segments of the spinal cord serve as protective mechanisms. These connections are seen during deep tendon reflex testing.

### Upper and Lower Motor Neurons

The voluntary motor system consists of two groups of neurons: upper motor neurons and lower motor neurons. Upper motor neurons originate in the cerebral cortex, the cerebellum, and the brain stem. Their fibers make up the descending motor pathways, are located entirely within the CNS,

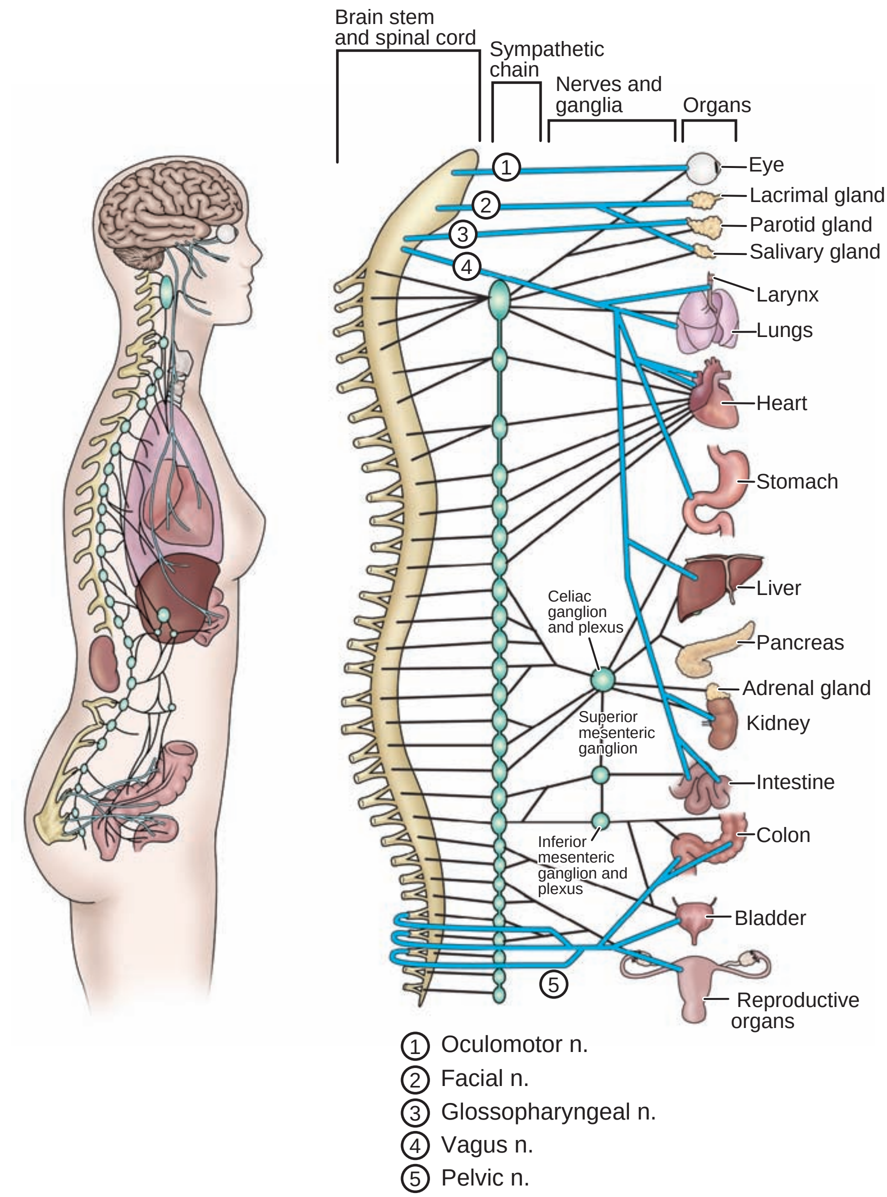



**Figure 60-10** Anatomy of the autonomic nervous system.

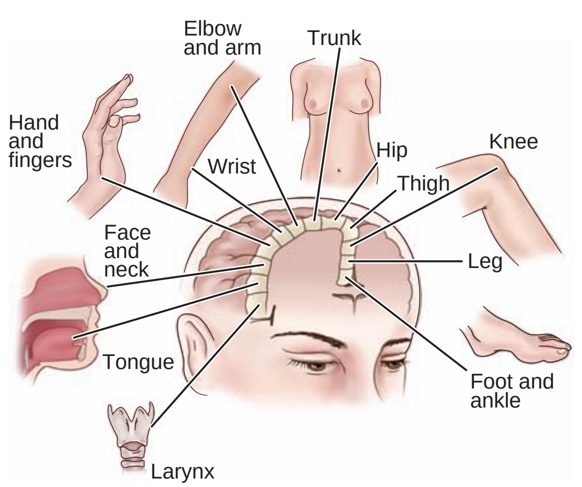



**Figure 60-11** Diagrammatic representation of the cerebrum showing locations for control of motor movement of various parts of the body.

and modulate the activity of the lower motor neurons. Lower motor neurons are located either in the anterior horn of the spinal cord gray matter or within cranial nerve nuclei in the brain stem. Axons of lower motor neurons in both sites extend through peripheral nerves and terminate in skeletal muscle. Lower motor neurons are located in both the CNS and the peripheral nervous system.

The motor pathways from the brain to the spinal cord, as well as from the cerebrum to the brain stem, are formed by upper motor neurons. They begin in the cortex of one side of the brain, descend through the internal capsule, cross to the opposite side in the brain stem, descend through the corticospinal tract, and synapse with the lower motor neurons in the cord. The lower motor neurons receive the impulse in the posterior part of the cord and run to the myoneural junction located in the peripheral muscle. The clinical features of lesions of upper and lower motor neurons are discussed in the following sections and in Table 60-4.

**Table 60-4 COMPARISON OF UPPER MOTOR NEURON AND LOWER MOTOR NEURON LESIONS**

| Upper Motor Neuron Lesions | Lower Motor Neuron Lesions |
|---|---|
| Loss of voluntary control | Loss of voluntary control |
| Increased muscle tone | Decreased muscle tone |
| Muscle spasticity | Flaccid muscle paralysis |
| No muscle atrophy | Muscle atrophy |
| Hyperactive and abnormal reflexes | Absent or decreased reflexes |

***Upper Motor Neuron Lesions.*** Upper motor neuron lesions can involve the motor cortex, the internal capsule, the spinal cord gray matter, and other structures of the brain through which the corticospinal tract descends. If the upper motor neurons are damaged or destroyed, as frequently occurs with stroke or spinal cord injury, paralysis (loss of voluntary movement) results. However, because the inhibitory influences of intact upper motor neurons are impaired, **reflex** (involuntary) movements are uninhibited, and hence hyperactive deep tendon reflexes, diminished or absent superficial reflexes, and pathologic reflexes such as a Babinski response occur. Severe leg spasms can occur as the result of an upper motor neuron lesion; the spasms result from the preserved reflex arc, which lacks inhibition along the spinal cord below the level of injury. There is little or no muscle atrophy, and muscles remain permanently tense, exhibiting spastic paralysis.

Paralysis associated with upper motor neuron lesions can affect a whole extremity, both extremities, or an entire half of the body. Hemiplegia (paralysis of an arm and leg on the same side of the body) can be the result of an upper motor neuron lesion. If hemorrhage, an embolus, or a thrombus destroys the fibers from the motor area in the internal capsule, the arm and the leg of the opposite side become stiff, weak, or paralyzed, and the reflexes are hyperactive (further discussion of hemiplegia is found in Chapter 62). If both legs are paralyzed, the condition is called paraplegia. If all four extremities are paralyzed, the condition is called tetraplegia. (Additional discussion of these disorders appears in Chapter 63.)

***Lower Motor Neuron Lesions.*** A patient is considered to have lower motor neuron damage if a motor nerve is damaged between the spinal cord and muscle. The result of lower motor neuron damage is muscle paralysis. Reflexes are lost, and the muscle becomes flaccid (limp) and atrophied from disuse. If the patient has injured the spinal trunk and it can heal, use of the muscles connected to that section of the spinal cord may be regained. However, if the anterior horn motor cells are destroyed, the nerves cannot regenerate and the muscles are never useful again.

Flaccid paralysis and atrophy of the affected muscles are the principal signs of lower motor neuron disease. Lower motor neuron lesions can be the result of trauma, infection (poliomyelitis), toxins, vascular disorders, congenital malformations, degenerative processes, and neoplasms. Compression of nerve roots by herniated intervertebral disks is a common cause of lower motor neuron dysfunction. The clinical features of lesions of upper and lower motor neurons are discussed in the following sections and in Table 60-4.

### Coordination of Movement

The motor system is complex, and motor function depends not only on the integrity of the corticospinal tracts but also on other pathways from the basal ganglia and cerebellum that control and coordinate voluntary motor function. The smoothness, accuracy, and strength that characterize the muscular movements of a normal person are attributable to the influence of the cerebellum and the basal ganglia.

Through the action of the cerebellum, the contractions of opposing muscle groups are adjusted in relation to each other to maximal mechanical advantage; muscle contractions can be sustained evenly at the desired tension and without significant fluctuation, and reciprocal movements can be reproduced at high and constant speed, in stereotyped fashion and with relatively little effort.

The basal ganglia play an important role in planning and coordinating motor movements and posture. Complex neural connections link the basal ganglia with the cerebral cortex. The major effect of these structures is to inhibit unwanted muscular activity.

Impaired cerebellar function, which may occur as a result of an intracranial injury or some type of an expanding mass (eg, a hemorrhage, an abscess, or a tumor), results in loss of muscle tone, weakness, and fatigue. Depending on the area of the brain affected, the patient has different motor symptoms or responses. The patient may demonstrate abnormal flexion, abnormal extension, or flaccid posturing. **Flaccidity** (lack of muscle tone) preceded by abnormal posturing in a patient with cerebral injury indicates severe neurologic impairment, which may herald brain death (Peiffer, 2007; Posner, Saper, Schiff, et al., 2007). For further explanation of this, see Figure 61-1 in Chapter 61.

Destruction or dysfunction of the basal ganglia leads not to paralysis but to muscle rigidity, disturbances of posture, and difficulty initiating or changing movement. The patient tends to have involuntary movements. These may take the form of coarse tremors, most often in the upper extremities, particularly in the distal portions; athetosis, movement of a slow, squirming, writhing, twisting type; or chorea, marked by spasmodic, purposeless, irregular, uncoordinated motions of the trunk and the extremities, and facial grimacing. Disorders affecting basal ganglia activity include Parkinson's and Huntington's diseases (see Chapter 65).

## Sensory System Function

### Receiving Sensory Impulses

Afferent impulses travel from their points of origin to their destinations in the cerebral cortex via the ascending pathways directly, or they may cross at the level of the spinal cord or in the medulla, depending on the type of sensation carried. Knowledge of these pathways is important for neurologic assessment and for understanding symptoms and their relationship to various lesions.

Sensory impulses convey sensations of heat, cold, pain, position and vibration sense. The axons enter the spinal cord by way of the posterior root, specifically in the posterior gray columns of the spinal cord, where they connect with the cells of secondary neurons. Pain and temperature fibers (located in the spinothalamic tract) cross immediately to the opposite side of the cord and course upward to

the thalamus. Fibers carrying sensations of touch, light pressure, and localization do not connect immediately with the second neuron but ascend the cord for a variable distance before entering the gray matter and completing this connection. The axon of the secondary neuron traverses the cord, crosses in the medulla, and proceeds upward to the thalamus.

Position and vibratory sensations are produced by stimuli arising from muscles, joints, and bones. These stimuli are conveyed, uncrossed, all the way to the brain stem by the axon of the primary neuron. In the medulla, synaptic connections are made with cells of the secondary neurons, whose axons cross to the opposite side and then proceed to the thalamus.

#### Integrating Sensory Impulses

The thalamus integrates all sensory impulses except olfaction. It plays a role in the conscious awareness of pain and the recognition of variation in temperature and touch. The thalamus is responsible for the sense of movement and position as well as the ability to recognize the size, shape, and quality of objects. Sensory information is relayed from the thalamus to the parietal lobe for interpretation.

#### Sensory Losses

Destruction of a sensory nerve results in total loss of sensation in its area of distribution (see Fig. 60-9). Lesions affecting the posterior spinal nerve roots may cause impairment of tactile sensation, including intermittent severe pain that is referred to their areas of distribution. Destruction of the spinal cord yields complete anesthesia below the level of injury. Selective destruction or degeneration of the posterior columns of the spinal cord is responsible for a loss of position and vibratory sense in segments distal to the lesion, without loss of touch, pain, or temperature perception. A cyst in the center of the spinal cord causes dissociation of sensation—loss of pain at the level of the lesion. This occurs because the fibers carrying pain and temperature cross within the cord immediately on entering; thus, any lesion that divides the cord longitudinally divides these fibers. Other sensory fibers ascend the cord for variable distances, some even to the medulla, before crossing, thereby bypassing the lesion and avoiding destruction. Lesions in the thalamus or parietal lobe result in impaired touch, pain, temperature, and proprioceptive sensations.

# Assessment of the Nervous System

## Health History

An important aspect of the neurologic assessment is the history of the present illness. The initial interview provides an excellent opportunity to systematically explore the patient's current condition and related events while simultaneously observing overall appearance, mental status, posture, movement, and affect. Depending on the patient's condition, the nurse may need to rely on yes-or-no answers to questions, a review of the medical record, input from witnesses or the family, or a combination of these.

Neurologic disease may be stable or progressive, characterized by symptom-free periods as well as fluctuations in symptoms. The health history therefore includes details about the onset, character, severity, location, duration, and frequency of symptoms and signs; associated complaints; precipitating, aggravating, and relieving factors; progression, remission, and exacerbation; and the presence or absence of similar symptoms among family members.

### Common Symptoms

The symptoms of neurologic disorders are as varied as the disease processes themselves. Symptoms may be subtle or intense, fluctuating or permanent, inconvenient or devastating. This chapter discusses the most common signs and symptoms associated with neurologic disease; the relationship of specific signs and symptoms to a particular disorder is presented in later chapters in this unit.

#### Pain

Pain is considered an unpleasant sensory perception and emotional experience associated with actual or potential tissue damage or described in terms of such damage. Pain is therefore considered multidimensional and entirely subjective. Pain can be acute or chronic. In general, acute pain lasts for a relatively short period of time and remits as the pathology resolves. In neurologic disease, acute pain may be associated with brain hemorrhage, spinal disk disease (Jarvis, 2007), or trigeminal neuralgia. In contrast, chronic or persistent pain extends for long periods of time and may represent a broader pathology. This type of pain can occur with many degenerative and chronic neurologic conditions (eg, multiple sclerosis). See Chapter 13 for a more detailed discussion of pain.

#### Seizures

Seizures are the result of abnormal paroxysmal discharges in the cerebral cortex, which then manifest as an alteration in sensation, behavior, movement, perception, or consciousness. The alteration may be short, such as in a blank stare that lasts only a second, or of longer duration, such as a tonic–clonic grand mal seizure that can last several minutes. The seizure activity reflects the area of the brain affected. Seizures can occur as isolated events, such as when induced by a high fever, alcohol or drug withdrawal, or hypoglycemia. A seizure may also be the first obvious sign of a brain lesion (Hickey, 2009).

#### Dizziness and Vertigo

Dizziness is an abnormal sensation of imbalance or movement. It is fairly common in the elderly and one of the most common complaints encountered by health professionals (Jarvis, 2007). Dizziness can have a variety of causes, including viral syndromes, hot weather, roller coaster rides, and middle ear infections, to name a few. One difficulty confronting health care providers when assessing dizziness is the vague and varied terms patients use to describe the sensation.

About 50% of all patients with dizziness have **vertigo,** which is defined as an illusion of movement, usually rotation (Jarvis, 2007). Vertigo is usually a manifestation of vestibular dysfunction. It can be so severe as to result in spatial disorientation, lightheadedness, loss of equilibrium (staggering), and nausea and vomiting.

### Visual Disturbances

Visual defects that cause people to seek health care can range from the decreased visual acuity associated with aging to sudden blindness caused by glaucoma. Normal vision depends on functioning visual pathways through the retina and optic chiasm and the radiations into the visual cortex in the occipital lobes. Lesions of the eye itself (eg, cataract), lesions along the pathway (eg, tumor), or lesions in the visual cortex (eg, stroke) interfere with normal visual acuity. Abnormalities of eye movement (as in the nystagmus associated with multiple sclerosis) can also compromise vision by causing diplopia or double vision. See Chapter 58 for a more detailed discussion of disorders that affect vision.

### Muscle Weakness

Muscle weakness is a common manifestation of neurologic disease. It frequently coexists with other symptoms of disease and can affect a variety of muscles, causing a wide range of disability. Weakness can be sudden and permanent, as in stroke, or progressive, as in neuromuscular diseases such as amyotrophic lateral sclerosis. Any muscle group can be affected.

### Abnormal Sensation

Abnormal sensation is a neurologic manifestation of both central and peripheral nervous system disease. Altered sensation can affect small or large areas of the body. It is frequently associated with weakness or pain and is potentially disabling. Lack of sensation places a person at risk for falls and injury.

### *Past Health, Family, and Social History*

The nurse may inquire about any family history of genetic diseases (Chart 60-1). A review of the medical history, including a system-by-system evaluation, is part of the health history. The nurse should be aware of any history of trauma or falls that may have involved the head or spinal cord. Questions regarding the use of alcohol, medications, and illicit drugs are also relevant. The history-taking portion of the neurologic assessment is critical and, in many cases of neurologic disease, leads to an accurate diagnosis.

## Physical Assessment

The neurologic examination is a systematic process that includes a variety of clinical tests, observations, and assessments designed to evaluate the neurologic status of a complex system. Many neurologic rating scales exist (Herndon, 2006), and some of the more common ones are discussed in this chapter.

The brain and spinal cord cannot be examined as directly as other systems of the body. Thus, much of the neurologic examination is an indirect evaluation that assesses

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**CHART 60-1** GENETICS IN NURSING PRACTICE
***Neurologic Disorders***

**Diseases and Conditions Influenced by Genetic Factors**

- Alzheimer's disease
- Amyotrophic lateral sclerosis (ALS)
- Duchenne muscular dystrophy
- Epilepsy
- Friedrich ataxia
- Huntington disease
- Myotonic dystrophy
- Neurofibromatosis type I
- Parkinson's disease
- Spina bifida
- Tourette syndrome

**Nursing Assessments**

**Family History Assessment**

- Assess for other similarly affected relatives with neurologic impairment.
- Inquire about age of onset (eg, present at birth—spina bifida; developed in childhood—Duchenne muscular dystrophy; developed in adulthood—Huntington disease, Alzheimer's disease, amyotrophic lateral sclerosis).
- Inquire about the presence of related conditions such as mental retardation and/or learning disabilities (neurofibromatosis type I).

**Patient Assessment**

- Assess for the presence of other physical features suggestive of an underlying genetic condition, such as skin lesions seen in neurofibromatosis type 1 (café-au-lait spots).
- Assess for other congenital abnormalities (eg, cardiac, ocular).

**Management Specific to Genetics**

- Inquire whether DNA mutation or other genetic testing has been performed on affected family members.
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, availability of genetic testing, and gene-based interventions.
- Offer appropriate genetic information and resources.
- Assess patient's understanding of genetic information.
- Provide support to families with newly diagnosed genetic-related neurologic disorders.
- Participate in management and coordination of care of patients with genetic conditions and individuals predisposed to develop or pass on a genetic condition.

**Genetics Resources for Nurses and Their Patients on the Web**

**Genetic Alliance**—a directory of support groups for patients and families with genetic conditions, www.geneticalliance.org

**Gene Clinics**—a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling, and testing information, www.geneclinics.org

**National Organization of Rare Disorders**—a directory of support groups and information for patients and families with rare genetic disorders, www.rarediseases.org

**OMIM: Online Mendelian Inheritance in Man**—a complete listing of inherited genetic conditions, www.nchi.nlm.nih.gov/omim/stats/html

the function of the specific body part or parts controlled by the nervous system. A neurologic assessment is divided into five components: consciousness and cognition, cranial nerves, motor system, sensory system, and reflexes. One or more components may become the priority assessment, depending on the patient's condition. For example, motor, sensory, and reflex assessments are the priority in patients with spinal injury, while in a comatose patient, the cranial nerves and level of consciousness become the priority.

### *Assessing Consciousness and Cognition*

Cerebral abnormalities may cause disturbances in mental status, intellectual functioning, thought content, and emotional status. There may also be alterations in language abilities, as well as lifestyle. The examiner must also be aware of the patient's overall level of consciousness and any changes over time (Posner, et al., 2007).

The examiner records and reports specific observations regarding mental status, intellectual function, thought content, and emotional status, all of which permit comparison by others over time. Alterations should be described in specific and nonjudgmental terms. Use of terms such as "inappropriate" or "demented" are avoided as they often mean different things to different people and are therefore not useful when describing behavior. Analysis and the conclusions that may be drawn from these findings usually depend on the examiner's knowledge of neuroanatomy, neurophysiology, and neuropathology.

#### Mental Status

An assessment of mental status begins by observing the patient's appearance and behavior, noting dress, grooming, and personal hygiene. Posture, gestures, movements, and facial expressions often provide important information about the patient. Does the patient appear to be aware of and interact with the surroundings?

Assessing orientation to time, place, and person assists in evaluating mental status. Does the patient know what day it is, what year it is, and the name of the president of the United States? Is the patient aware of where he or she is? Is the patient aware of who the examiner is and of his or her purpose for being in the room? Assessment of immediate and remote memory is also important. Is the capacity for immediate memory intact? (See Chapter 12.)

#### Intellectual Function

A person with an average IQ can repeat seven digits without faltering and can recite five digits backward. The examiner might ask the patient to count backward from 100 or to subtract 7 from 100, then 7 from that, and so forth (called serial 7s). The capacity to interpret well-known proverbs tests abstract reasoning, which is a higher intellectual function; for example, does the patient know what is meant by "a stitch in time saves nine"? The intellectual function of patients with damage to the frontal cortex appears intact until one or more tests of intellectual capacity are performed. Questions designed to assess this capacity might include the ability to recognize similarities: for example, how are a mouse and dog or pen and pencil alike? Can the patient make judgments about situations: for example, if the patient arrived home without a house key, what alternatives are there?

#### Thought Content

During the interview, it is important to assess the patient's thought content. Are the patient's thoughts spontaneous, natural, clear, relevant, and coherent? Does the patient have any fixed ideas, illusions, or preoccupations? What are his or her insights into these thoughts? Preoccupation with death or morbid events, hallucinations, and paranoid ideation are examples of unusual thoughts or perceptions that require further evaluation.

#### Emotional Status

An assessment of consciousness and cognition also includes the patient's emotional status. Is the patient's affect (external manifestation of mood) natural and even, or irritable and angry, anxious, apathetic or flat, or euphoric? Does his or her mood fluctuate normally, or does the patient unpredictably swing from joy to sadness during the interview? Is affect appropriate to words and thought content? Are verbal communications consistent with nonverbal cues?

#### Language Ability

The person with normal neurologic function can understand and communicate in spoken and written language. Does the patient answer questions appropriately? Can he or she read a sentence from a newspaper and explain its meaning? Can the patient write his or her name or copy a simple figure that the examiner has drawn? A deficiency in language function is called aphasia. Different types of aphasia result from injury to different parts of the brain (Table 60-5). Aphasia is discussed in detail in Chapter 62.

#### Impact on Lifestyle

The nurse assesses the impact any impairment has on the patient's lifestyle. Issues to consider include the limitations imposed on the patient by any cognitive deficit and the patient's role in society, including family and community roles. The plan of care that the nurse develops needs to address and support adaptation to the neurologic deficit and continued function to the extent possible within the patient's support system.

#### Level of Consciousness

Consciousness is the patient's wakefulness and ability to respond to the environment. Level of consciousness is the most sensitive indicator of neurologic function. To assess level of consciousness, the examiner observes for alertness and ability to follow commands.

If the patient is not alert or able to follow commands, the examiner observes for eye opening; verbal response and motor response to stimuli, if any; and the type of stimuli needed to obtain a response. Noxious stimuli should be used first, then painful stimuli if no response is observed. In the

**Table 60-5 TYPES OF APHASIA AND REGION OF BRAIN INVOLVED**

| Type of Aphasia | Brain Area Involved |
|---|---|
| Auditory-receptive | Temporal lobe |
| Visual-receptive | Parietal-occipital area |
| Expressive speaking | Inferior posterior frontal areas |
| Expressive writing | Posterior frontal area |

CHART 60-2

NURSING RESEARCH PROFILE

### *Early Identification of Vasospasm Following Subarachnoid Hemorrhage*

Doerksen, K. & Naimark, B. (2006). Nonspecific behaviors as early indicators of cerebral vasospasm. *Journal of Neuroscience Nursing, 38*(6), 409–415.

**Purpose**

The significance of behavioral changes seen early after subarachnoid hemorrhage is not understood. The purpose of this study was to delineate nonspecific behaviors seen after subarachnoid hemorrhage and to determine the prevalence of those behaviors in patients with vasospasm (a complication of subarachnoid hemorrhage). If significant, such behaviors may be better early predictors of problems as compared to other assessment findings.

**Design**

This prospective study evaluated nursing documentation of nonspecific behaviors during the acute phase of care of 60 patients (39 female and 21 male) with subarachnoid hemorrhage. After record reviews, behavioral descriptors were quantified. The prevalence of the behavioral descriptors was determined in the 31 patients who developed vasospasm and compared to those who did not develop vasospasm.

**Findings**

Twenty-four of the 31 patients who developed vasospasm demonstrated nonspecific behaviors prior to development of the traditional signs and symptoms of vasospasm (decreased level of consciousness, focal deficits, or aphasia). The three primary nonspecific behaviors were acting restless, impulsive, or strange.

**Nursing Implications**

More research is needed but this study illustrates that nursing assessment can reveal nonspecific behaviors that are useful in the early identification of vasospasm after subarachnoid hemorrhage. Use of earlier identification may result in earlier intervention and prevention of brain ischemia.

patient with decreased level of consciousness, motor and cranial nerve function become the priority assessments, as abnormalities can indicate the area of involvement in the absence of responsiveness. Further discussion of changes in level of consciousness is found in Chapter 61. See Chart 60-2.

## *Examining the Cranial Nerves*

Cranial nerves are assessed when level of consciousness is decreased, with brain stem pathology, or in the presence of peripheral nervous system disease. Chart 60-3 describes assessment of the cranial nerves and significant findings. Right and left cranial nerve functions are compared throughout the examination.

## *Examining the Motor System*

### Motor Ability

A thorough examination of the motor system includes an assessment of muscle size and tone as well as strength, coordination, and balance. The patient is instructed to walk across the room, if possible, while the examiner observes posture and gait. The muscles are inspected, and palpated if necessary, for their size and symmetry. Any evidence of atrophy or involuntary movements (tremors, tics) is noted. Muscle tone (the tension present in a muscle at rest) is evaluated by palpating various muscle groups at rest and during passive movement. Resistance to these movements is assessed and documented. Abnormalities in tone include **spasticity** (increased muscle tone), **rigidity** (resistance to passive stretch), and **flaccidity**.

### Muscle Strength

Assessing the patient's ability to flex or extend the extremities against resistance tests muscle strength. The function of an individual muscle or group of muscles is evaluated by placing the muscle at a disadvantage. The quadriceps, for example, is a powerful muscle responsible for straightening the leg. Once the leg is straightened, it is exceedingly difficult for the examiner to flex the knee. If the knee is flexed and the patient is asked to straighten the leg against resistance, weakness can be elicited. The evaluation of muscle strength compares the sides of the body to each other. For example, the right upper extremity is compared to the left upper extremity. Subtle differences in strength may be evaluated by testing for drift. For example, both arms are out in front of the patient with palms up; drift is seen as pronation of the palm, indicating a subtle weakness that may not have been detected on the resistance examination.

Clinicians use a 5-point scale to rate muscle strength. A 5 indicates full power of contraction against gravity and resistance or normal muscle strength; 4 indicates fair but not full strength against gravity and a moderate amount of resistance or slight weakness; 3 indicates just sufficient strength to overcome the force of gravity or moderate weakness; 2 indicates the ability to move but not to overcome the force of gravity or severe weakness; 1 indicates minimal contractile power (weak muscle contraction can be palpated but no movement is noted) or very severe weakness; and 0 indicates no movement (Jarvis, 2007). A stick figure may be used to record muscle strength and is a precise form of documenting findings. Distal and proximal strength in both upper and lower extremities is recorded using the 5-point scale (Fig. 60-12).

Assessment of muscle strength may be as detailed as necessary. One may quickly test the strength of the proximal muscles of the upper and lower extremities, always comparing both sides. The strength of the finer muscles that control the function of the hand (hand grasp) and the foot (dorsiflexion and plantar flexion) can then be assessed.

### Balance and Coordination

Cerebellar and basal ganglia influence on the motor system is reflected in balance control and coordination. Coordination in the hands and upper extremities is tested by having the patient perform rapid, alternating movements and

CHART 60-3

## Guidelines for Assessing Cranial Nerve Function

### Equipment

- Tongue depressor
- Flashlight
- Sugar and salt samples
- Watch
- Cotton-tipped swab
- Snellen chart
- Ophthalmoscope
- Samples of familiar odors
- Tuning fork

### Implementation

| Step | Rationale |
|---|---|
| 1. Assess cranial nerve (CN) I (olfactory). With eyes closed, patient is asked to identify familiar odors (coffee, tobacco). Each nostril is tested separately. | The significant finding is loss of sense of smell (anosmia). |
| 2. Assess CN II (optic). Assess vision using a Snellen eye chart. Assess visual fields. Perform ophthalmoscopic examination. | Significant findings include visual field defects (hemianopias) and decreased visual acuity or blindness. |
| 3. Assess CN III (oculomotor). Test for eye movement toward the nose; inspect for conjugate movements and nystagmus. Evaluate papillary size and test for pupillary reactivity to light; inspect ability to open eyelids. | Significant findings include dysconjugate gaze; gaze weakness or paralysis; double vision; dilated pupil, with or without impaired pupillary reaction to light; and inability to open the affected eyelid. |
| 4. Assess CN IV (trochlear). Test for upward eye movement; inspect for conjugate movements and nystagmus. | Significant findings include dysconjugate gaze, gaze weakness or paralysis, and double vision. |
| 5. Assess CN V (trigeminal). Have patient close the eyes. Touch cotton to forehead, cheeks, and jaw. Sensitivity to superficial pain is tested in these same three areas by using the sharp and dull ends of a broken tongue blade. Alternate between the sharp point and the dull end. Patient reports "sharp" or "dull" with each movement. If responses are incorrect, test for temperature sensation. Test tubes of cold and hot water are used alternately.<br>While patient looks up, *lightly* touch a wisp of cotton against the temporal surface of each cornea. A blink and tearing are normal responses.<br>Have patient clench and move the jaw from side to side. Palpate the masseter and temporal muscles, noting strength and equality. | Significant findings include impaired or absent corneal reflex, facial numbness, and jaw weakness. |
| 6. Assess CN VI (abducens). Test for lateral eye movement; inspect for conjugate movement. | Significant findings include dysconjugate gaze, gaze weakness or paralysis, and double vision. |
| 7. Assess CN VII (facial). Observe for symmetry while patient performs facial movements: smiles, whistles, elevates eyebrows, frowns, tightly closes eyelids against resistance (examiner attempts to open them). Observe face for flaccid paralysis (shallow nasolabial folds). Have patient extend tongue. Test ability to discriminate between sugar and salt. | Significant findings include facial weakness, inability to completely close the eyelid, and impaired taste. |
| 8. Assess CN VIII (acoustic). Perform whisper or watch-tick test. Test for lateralization (Weber test). Test for air and bone conduction (Rinne test). Assess standing balance with eyes closed (Romberg test). | Significant findings include decreased hearing or deafness and impaired balance. |
| 9. Assess CN IX (glossopharyngeal). Assess patient's ability to swallow and discriminate between sugar and salt on posterior third of the tongue. | Significant findings include difficulty swallowing (dysphagia) and impaired taste. |
| 10. Assess CN X (vagus). Depress a tongue blade on posterior tongue, or stimulate posterior pharynx to elicit gag reflex. Note any hoarseness in voice. Check ability to swallow. Have patient say "ah." Observe for symmetric rise of uvula and soft palate. | Significant findings include weak or absent gag reflex, difficulty swallowing, aspiration, hoarseness, and slurred speech (dysarthria). |

*Continued on following page*

## CHART 60-3 Guidelines for Assessing Cranial Nerve Function *(Continued)*

| | |
|---|---|
| 11. Assess CN XI (spinal accessory). While patient shrugs shoulders against resistance, palpate and note strength of trapezius muscles. As patient turns head against opposing pressure of the examiner's hand, palpate and note strength of each sternocleidomastoid muscle. | Significant findings include weak or absent shoulder shrug and inability to turn the head to the side. |
| 12. Assess CN XII (hypoglossal). While patient protrudes the tongue, note any deviation or tremors. Test the strength of the tongue by having patient move the protruded tongue from side to side against a tongue depressor. | Significant findings include difficulty swallowing and slurred speech. |

point-to-point testing. First, the patient is instructed to pat his or her thigh as fast as possible with each hand separately. Then the patient is instructed to alternately pronate and supinate the hand as rapidly as possible. Last, the patient is asked to touch each of the fingers with the thumb in a consecutive motion. Speed, symmetry, and degree of difficulty are noted. Point-to-point testing is accomplished by having the patient touch the examiner's extended finger and then his or her own nose. This is repeated several times.

Coordination in the lower extremities is tested by having the patient run the heel down the anterior surface of the tibia of the other leg. Each leg is tested in turn. **Ataxia** is defined as incoordination of voluntary muscle action, particularly of the muscle groups used in activities such as walking or reaching for objects. Tremors (rhythmic, involuntary movements) noted at rest or during movement suggest a problem in the anatomic areas responsible for balance and coordination.

The **Romberg test** is a screening test for balance. The patient stands with feet together and arms at the side, first with eyes open and then with both eyes closed for 20 to 30 seconds. The examiner stands close to support the patient if he or she begins to fall. Slight swaying is normal, but a loss of balance is abnormal and is considered a positive Romberg test. Additional cerebellar tests for balance in the ambulatory patient include hopping in place, alternating knee bends, and heel-to-toe walking (both forward and backward).

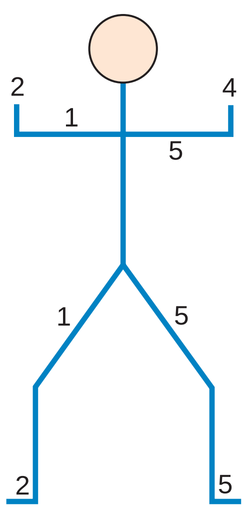



**Figure 60-12** A stick figure may be used to record muscle strength as follows: 5, full range of motion against gravity and resistance; 4, full range of motion against gravity and a moderate amount of resistance; 3, full range of motion against gravity only; 2, full range of motion when gravity is eliminated; 1, a weak muscle contraction when muscle is palpated, but no movement; and 0, complete paralysis.

### *Examining the Sensory System*

The sensory system is even more complex than the motor system, because sensory modalities are more widespread throughout the central and peripheral nervous systems. The sensory examination is largely subjective and requires the cooperation of the patient. The examiner should be familiar with dermatomes that represent the distribution of the peripheral nerves that arise from the spinal cord (see Fig. 60-9) (Bickley, 2009; Jarvis, 2007).

Assessment of the sensory system involves tests for tactile sensation, superficial pain, temperature, vibration, and position sense (proprioception). During the sensory assessment, the patient's eyes are closed. Simple directions and reassurance that the examiner will not hurt or startle the patient encourage the cooperation of the patient.

Tactile sensation is assessed by lightly touching a cotton wisp or fingertip to corresponding areas on each side of the body. The sensitivity of proximal parts of the extremities is compared with that of distal parts, and the right and left sides are compared.

Pain and temperature sensations are transmitted together in the lateral part of the spinal cord, so it is unnecessary to test for temperature sense in most circumstances. Determining the patient's sensitivity to a sharp object can assess superficial pain perception. However, pain sensation is usually reserved for patients who do not respond to or cannot discriminate touch stimulation. The patient is asked to differentiate between the sharp and dull ends of a broken wooden cotton swab or tongue blade; using a safety pin is inadvisable because it breaks the integrity of the skin. Both the sharp and dull sides of the object are applied with equal intensity at all times, and the two sides are compared.

Vibration and proprioception are transmitted together in the posterior part of the cord. Vibration may be evaluated through the use of a low-frequency (128- or 256-Hz) tuning fork. The handle of the vibrating fork is placed against a bony prominence, and the patient is asked if he or she feels a sensation and is instructed to signal the examiner when the sensation ceases. Common locations used to test for vibratory sense include the distal joint of the great toe and the

proximal thumb joint. If the patient does not perceive the vibrations at the distal bony prominences, the examiner progresses upward with the tuning fork until the patient perceives the vibrations. As with all measurements of sensation, a side-to-side comparison is made.

Position sense or proprioception may be determined by asking the patient to close both eyes and indicate, as the great toe or index finger is alternately moved up and down, in which direction movement has taken place. Vibration and position sense are often lost together, frequently in circumstances in which all other sensation remains intact.

Integration of sensation in the brain is evaluated by testing two-point discrimination. When the patient is touched with two sharp objects simultaneously, are they perceived as two or as one? If touched simultaneously on opposite sides of the body, the patient should normally report being touched in two places. If only one site is reported, the one not being recognized is said to demonstrate extinction. Another test of higher cortical sensory ability is tactile identification. The patient is instructed to close both eyes and identify an object (eg, key, coin) that is placed in one hand by the examiner; inability to identify an object by touch is known as tactile agnosia or astereognosis. **Agnosia** is the general loss of ability to recognize objects through a particular sensory system. The patient can also be shown a familiar object and asked to identify it by name; inability to identify a visualized object is known as visual agnosia. Each of these dysfunctions implicates a different part of the brain (Table 60-6).

Decreased or absent sensations occur with problems anywhere along the sensory pathway. Sensory deficits resulting from peripheral neuropathy or spinal cord injury follow anatomic dermatomes. Destructive lesions of the brain may affect sensation on an entire side of the body. Stroke affecting a portion of the sensory cortex will produce altered sensory discrimination.

### *Examining the Reflexes*

Reflexes are involuntary contractions of muscles or muscle groups in response to a stimulus. Reflexes are classified as deep tendon, superficial, or pathologic. Testing reflexes enables the examiner to assess involuntary reflex arcs that depend on the presence of afferent stretch receptors, spinal or brain stem synapses, efferent motor fibers, and a variety of modifying influences from higher levels.

#### Deep Tendon Reflexes

A reflex hammer is used to elicit a deep tendon reflex. The handle of the hammer is held loosely between the thumb and index finger, allowing a full swinging motion. The wrist motion is similar to that used during percussion. The extremity is positioned so that the tendon is slightly stretched. This requires a sound knowledge of the location of muscles and their tendon attachments. The tendon is then struck briskly (Fig. 60-13), and the response is compared with that on the opposite side of the body. A wide variation in reflex response may be considered normal; however, it is more important that the reflexes be symmetrically equivalent. When the comparison is made, both sides should be equivalently relaxed and each tendon struck with equal force.

Valid findings depend on several factors: proper use of the reflex hammer, proper positioning of the extremity, and a relaxed patient (Bickley, 2007; Jarvis, 2007). If the reflexes are symmetrically diminished or absent, the examiner may use isometric contraction of other muscle groups to increase reflex activity. For example, if lower extremity reflexes are diminished or absent, the patient is instructed to lock the fingers together and pull in opposite directions. Having the patient clench the jaw or press the heels against the floor or examining table may similarly elicit more reliable biceps, triceps, and brachioradialis reflexes.

The absence of reflexes is significant, although ankle jerks (Achilles reflex) may be normally absent in older people. Deep tendon reflex responses are often graded on a scale of 0 to 4+ (Chart 60-4). As stated previously, scale ratings are highly subjective. Findings can be recorded as a fraction, indicating the scale range (eg, 2/4). Some examiners prefer to use the terms *present*, *absent*, and *diminished* when describing reflexes. As with muscle strength recording, a stick figure may be used to record numerical findings.

***Biceps Reflex.*** The biceps reflex is elicited by striking the biceps tendon over a slightly flexed elbow (see Fig. 60-13A). The examiner supports the forearm with one arm while placing the thumb against the tendon and striking the thumb with the reflex hammer. The normal response is flexion at the elbow and contraction of the biceps.

***Triceps Reflex.*** To elicit a triceps reflex, the patient's arm is flexed at the elbow and positioned in front of the chest. The examiner supports the patient's arm and identifies the triceps tendon by palpating 2.5 to 5 cm (1 to 2 inches) above the elbow. A direct blow on the tendon (see Fig. 60-13B) normally produces contraction of the triceps muscle and extension of the elbow.

***Brachioradialis Reflex.*** With the patient's forearm resting on the lap or across the abdomen, the brachioradialis reflex is assessed. A gentle strike of the hammer 2.5 to 5 cm (1 to 2 inches) above the wrist results in flexion and supination of the forearm (Weber & Kelley, 2007).

***Patellar Reflex.*** The patellar reflex is elicited by striking the patellar tendon just below the patella. The patient may be in a sitting or a lying position. If the patient is supine, the examiner supports the legs to facilitate relaxation of the muscles (see Fig. 60-13C). Contractions of the quadriceps and knee extension are normal responses.

***Achilles Reflex.*** To elicit an Achilles reflex, the foot is dorsiflexed at the ankle and the hammer strikes the stretched Achilles tendon (see Fig. 60-13D). This reflex normally produces plantar flexion. If the examiner cannot

**Table 60-6 TYPES OF AGNOSIA AND CORRESPONDING SITES OF LESIONS**

| Type of Agnosia | Affected Cerebral Area |
|---|---|
| Visual | Occipital lobe |
| Auditory | Temporal lobe (lateral and superior portions) |
| Tactile | Parietal lobe |
| Body parts and relationships | Parietal lobe (posteroinferior regions) |

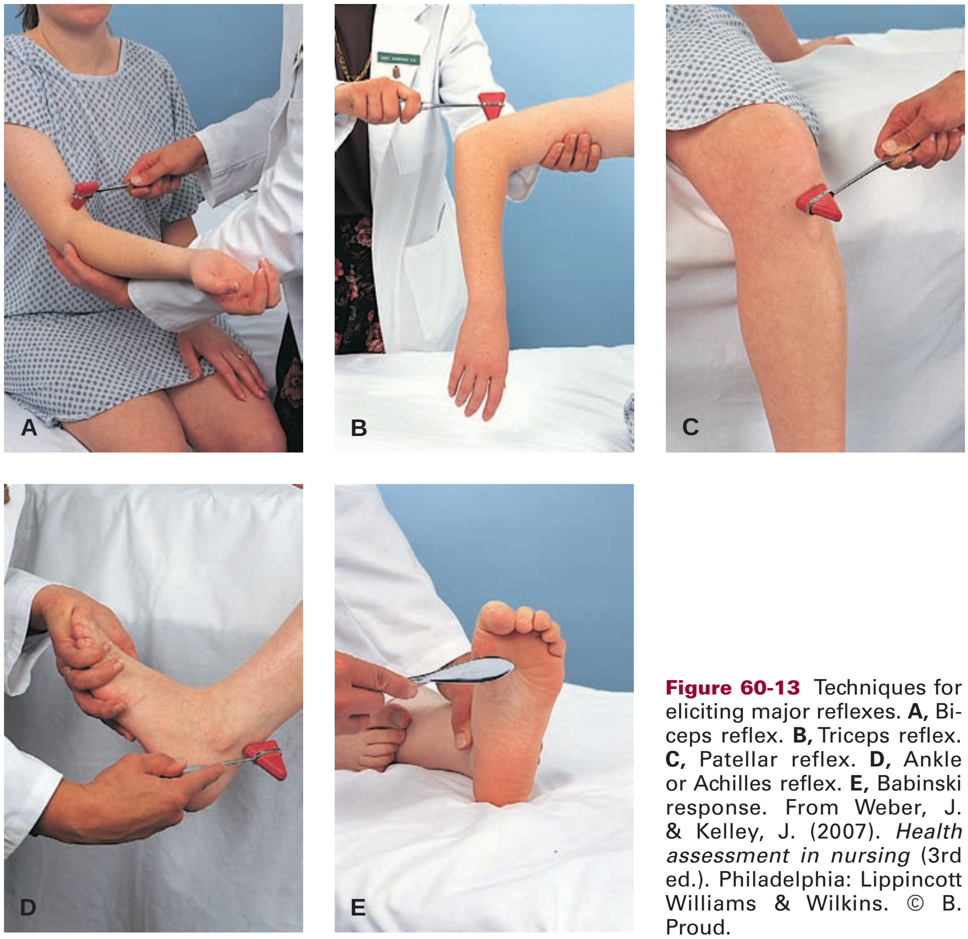


**Figure 60-13** Techniques for eliciting major reflexes. **A,** Biceps reflex. **B,** Triceps reflex. **C,** Patellar reflex. **D,** Ankle or Achilles reflex. **E,** Babinski response. From Weber, J. & Kelley, J. (2007). *Health assessment in nursing* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins. © B. Proud.

elicit the ankle reflex and suspects that the patient cannot relax, the patient is instructed to kneel on a chair or similar elevated, flat surface. This position places the ankles in dorsiflexion and reduces any muscle tension in the gastrocnemius. The Achilles tendons are struck in turn, and plantar flexion is usually demonstrated (Weber & Kelley, 2007).

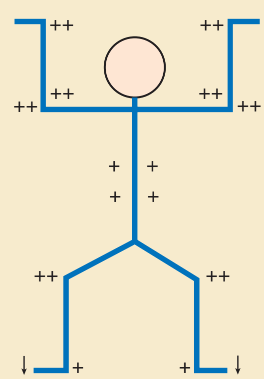
***Clonus.*** When reflexes are very hyperactive, a phenomenon called **clonus** may be elicited. If the foot is abruptly dorsiflexed, it may continue to "beat" two or three times before it settles into a position of rest. Occasionally with central nervous system disease this activity persists, and the foot does not come to rest while the tendon is being stretched but persists in repetitive activity. The unsustained clonus associated with normal but hyperactive reflexes is not considered pathologic. Sustained clonus always indicates the presence of central nervous system disease and requires further evaluation.

## Chart 60-4 • *Documenting Reflexes*

Deep tendon reflexes are graded on a scale of 0 to 4:

- 0 No response
- 1+ Diminished (hypoactive)
- 2+ Normal
- 3+ Increased (may be interpreted as normal)
- 4+ Hyperactive (hyperreflexia)

The deep tendon responses and plantar reflexes are commonly recorded on stick figures. The arrow points downward if the plantar response is normal and upward if the response is abnormal.



#### Superficial Reflexes

The major superficial reflexes include corneal, palpebral, gag, upper/lower abdominal, cremasteric (men only), plantar, and perianal. These reflexes are graded differently than the motor reflexes and are noted to be present (+) or absent (−). Of these, only the corneal, gag, and plantar reflexes are tested commonly.

The corneal reflex is tested carefully using a clean wisp of cotton and lightly touching the outer corner of each eye on the sclera. The reflex is present if the action elicits a blink. A stroke or brain injury might result in loss of this reflex, either unilaterally or bilaterally. Loss of this reflex indicates the need for eye protection and possible lubrication to prevent corneal damage.

The gag reflex is elicited by gently touching the back of the pharynx with a cotton-tipped applicator, first on one side of the uvula and then the other. Positive response is an equal elevation of the uvula and "gag" with stimulation. Absent response on one or both sides can be seen following a stroke and requires careful evaluation and treatment of the resultant swallowing dysfunction to prevent aspiration of food and fluids.

The plantar reflex is elicited by stroking the sole of the foot with a tongue blade or the handle of a reflex hammer. Stimulation normally causes toe flexion.

#### Pathologic Reflexes

Pathologic reflexes are seen in the presence of neurologic disease; they often represent emergence of earlier reflexes that disappeared with maturity of the nervous system. A well-known pathologic reflex indicative of central nervous system disease affecting the corticospinal tract is the **Babinski reflex.** In a person with an intact central nervous system, if the lateral aspect of the sole of the foot is stroked, the toes contract and draw together (see Fig. 60-13E). However, in a person who has central nervous system disease of the motor system, the toes fan out and draw back (Jarvis, 2007; Weber & Kelley, 2007). This is normal in newborns but represents a serious abnormality in adults. Several other pathologic reflexes convey similar information. Although many of them are interesting, they are not particularly informative.

## Gerontologic Considerations

During the normal aging process, the nervous system undergoes many changes, and is more vulnerable to illness. Changes throughout the nervous system that occur with age vary in degree. Nervous system changes due to aging must be distinguished from those due to disease; it is important for clinicians not to attribute abnormality or dysfunction to aging without appropriate investigation (Neal-Boylan, 2007). For example, while diminished strength and agility are a normal part of aging, localized weakness can only be attributed to disease.

### *Structural and Physiologic Changes*

A number of alterations occur with increasing age. A loss of neurons occurs, leading to a decrease in the number of synapses and neurotransmitters. This results in slowed nerve conduction and response time. Brain weight is decreased and the ventricle size increases to maintain cranial volume. Cerebral blood flow and metabolism are reduced, leading to slower mental functions. Temperature regulation becomes less efficient. In the peripheral nervous system, myelin is lost, resulting in a decrease in conduction velocity in some nerves. Visual and auditory nerves degenerate, leading to loss of visual acuity and hearing. Taste buds atrophy and nerve cell fibers in the olfactory bulb degenerate (Jarvis, 2007). Nerve cells in the vestibular system of the inner ear, cerebellum, and proprioceptive pathways also degenerate, leading to balance difficulties. Deep tendon reflexes can be decreased or in some cases absent. Hypothalamic function is modified such that stage IV sleep is reduced. There is an overall slowing of autonomic nervous system responses. Pupillary responses are reduced or may not appear at all in the presence of cataracts.

### *Motor Alterations*

Reduced nerve input into muscle contributes to an overall reduction in muscle bulk, with atrophy most easily noted in the hands. Changes in motor function often result in decreased strength and agility, with increased reaction time. Gait is often slowed and wide based. These changes can create difficulties in maintaining balance, predisposing the older person to falls.

### *Sensory Alterations*

Tactile sensation is dulled in the elderly person due to a decrease in the number of sensory receptors. There may be difficulty in identifying objects by touch, because fewer tactile cues are received from the bottom of the feet and the person may become confused about body position and location (Wickremaratchi & Llewelyn, 2006).

Sensitivity to glare, decreased peripheral vision, and a constricted visual field occur due to degeneration of visual pathways, resulting in disorientation, especially at night when there is little or no light in the room. Because the elderly person takes longer to recover visual sensitivity when moving from a light to dark area, nightlights and a safe and familiar arrangement of furniture are essential.

Loss of hearing can contribute to confusion, anxiety, disorientation, misinterpretation of the environment, feelings of inadequacy, and social isolation. A decreased sense of taste and smell may contribute to weight loss and disinterest in food. A decreased sense of smell may present a safety hazard, because elderly people living alone may be unable to detect household gas leaks or fires. Smoke and carbon monoxide detectors, important for all, are critical for the elderly.

### *Temperature Regulation and Pain Perception*

The elderly patient may feel cold more readily than heat and may require extra covering when in bed; a room temperature somewhat higher than usual may be desirable. Reaction to painful stimuli may be decreased with age. Because pain is an important warning signal, caution must be used when hot or cold packs are used. The older patient may be burned or suffer frostbite before being aware of any discomfort. Complaints of pain, such as abdominal discomfort or chest pain, may be more serious than the patient's perception might indicate and thus require careful evaluation (Neal-Boylan, 2007). Two pain syndromes that are common in the neurologic system in older adults are diabetic neuropathies and postherpetic neuropathies (Bickley, 2007).

#### Mental Status

Although mental processing time decreases with age, memory, language, and judgment capacities remain intact. Change in mental status should never be assumed to be a normal part of aging. **Delirium** (mental confusion, usually with delusions and hallucinations) is seen in elderly patients who have underlying central nervous system damage or are experiencing an acute condition such as infection, adverse medication reaction, or dehydration. Drug toxicity and depression may produce impairment of attention and memory, and should be evaluated as a possible cause of mental status change. Delirium must be differentiated from dementia, which is a chronic and irreversible deterioration of cognitive status. Chapter 12 contains further discussion of delirium and dementia.

#### Nursing Implications

Nursing care for patients with age-related changes to the nervous system and for patients with long-term neurologic disability who are aging should include the previously described modifications. In addition, the consequences of any neurologic deficit and its impact on overall function such as activities of daily living, use of assistive devices, and individual coping should be assessed and considered in planning patient care. Fall risk must be evaluated, and fall prevention measures instituted for the hospitalized patient as well as in the home.

The nurse must understand the altered responses and the changing needs of the elderly patient before providing education. Visual and hearing deficits require adaptations in activities such as preoperative teaching, diet therapy, and instruction about new medications. When using visual materials for teaching or menu selection, adequate lighting without glare, contrasting colors, and large print are used to offset visual difficulties caused by rigidity and opacity of the lens in the eye and slower pupillary reaction. Procedures and preparations needed for diagnostic tests are explained, taking into account the possibility of impaired hearing and slowed responses in the elderly. Even with hearing loss, the elderly patient often hears adequately if the speaker uses a low-pitched, clear voice; shouting only makes it harder for the patient to understand the speaker. Providing auditory and visual cues aids understanding; if the patient has a significant hearing or visual loss, assistive devices, a signer, an interpreter, or a translator may be needed.

Teaching at an unrushed pace and using reinforcement enhance learning and retention. Material should be short, concise, and concrete. Vocabulary is matched to the patient's ability, and terms are clearly defined. The elderly patient requires adequate time to receive and respond to stimuli, learn, and react. These measures allow comprehension, memory, and formation of association and concepts.

## Diagnostic Evaluation

### Computed Tomography Scanning

Computed tomography (CT) scanning uses a narrow x-ray beam to scan body parts in successive layers. The images provide cross-sectional views of the brain, distinguishing differences in tissue densities of the skull, cortex, subcortical structures, and ventricles. An intravenous (IV) contrast agent may be used to highlight differences further. The brightness of each slice of the brain in the final image is proportional to the degree to which it absorbs x-rays. The image is displayed on an oscilloscope or TV monitor and is photographed and stored digitally (Bremner, 2005). CT scanning is usually performed first without contrast material and then with IV contrast, if needed. The patient lies on an adjustable table with the head in a head rest while the scanning system rotates around the head and produces cross-sectional images. The patient must lie with the head held perfectly still without talking or moving the face, because head motion distorts the image. CT scanning is quick and painless and uses a small amount of radiation to produce images; it has a high degree of sensitivity for detecting lesions.

Brain lesions have a different tissue density from the surrounding normal brain tissue. Abnormalities detected on brain CT include tumor or other masses, infarction, hemorrhage, displacement of the ventricles, and cortical atrophy (Bremner, 2005). CT angiography allows visualization of blood vessels; in some situations this eliminates the need for formal angiography. Whole-body CT scanners allow cross-sections of the spinal cord to be visualized. The injection of a water-soluble iodinated contrast agent into the subarachnoid space through lumbar puncture improves the visualization of the spinal and intracranial contents on these images. The CT scan, along with magnetic resonance imaging (MRI), has largely replaced myelography as a diagnostic procedure for the diagnosis of herniated lumbar disks.

#### Nursing Interventions

Essential nursing interventions include preparation for the procedure and patient monitoring. Preparation includes teaching the patient about the need to lie quietly throughout the procedure. A review of relaxation techniques may be helpful for patients with claustrophobia. Sedation can be used if agitation, restlessness, or confusion interferes with a successful study. Ongoing patient monitoring during sedation is necessary. If a contrast agent is used, the patient must be assessed before the CT scan for an iodine/shellfish allergy, because the contrast agent used may be iodine based. Renal function must also be evaluated, as the contrast material is cleared through the kidneys. A suitable IV line for contrast injection and a period of fasting (usually 4 hours) are required prior to the study. Patients who receive an IV contrast agent are monitored during and after the procedure for allergic reactions and changes in kidney function (Karpoff & Labus, 2008).

### Magnetic Resonance Imaging

MRI uses a powerful magnetic field to obtain images of different areas of the body. The magnetic field causes the hydrogen nuclei (protons) within the body to align like small magnets in a magnetic field. In combination with radiofrequency pulses, the protons emit signals, which are converted to images. An MRI scan can be performed with or without a contrast agent and can identify a cerebral abnormality earlier and more clearly than other diagnostic tests (Bremner, 2005). It can provide information about the chemical changes within cells, allowing the clinician to monitor a tumor's response to treatment. It is particularly useful in the diagnosis of brain tumor, stroke, and multiple

sclerosis, and does not involve ionizing radiation. A complete MRI scan may take an hour or longer to complete, so use in emergency situations is limited.

Newer MRI applications allow imaging of brain blood flow and metabolism via special imaging techniques added to the MRI. Such techniques include diffusion-weighted imaging (DWI), perfusion-weighted imaging (PWI), magnetic resonance spectroscopy, and fluid attenuation inversion recovery (FLAIR) (Bremner, 2005). Magnetic resonance angiography (MRA) allows separate visualization of the cerebral vasculature without the administration of an arterial contrast agent. Both MRI and CT images are used as tools to plan and direct surgical intervention.

### *Nursing Interventions*

Patient preparation includes teaching and obtaining an adequate history. Ferromagnetic substances in the body may become dislodged by the magnet, so history of working with metal fragments must be reviewed. The patient is questioned about any implants of any metal objects (eg, aneurysm clips, orthopedic hardware, pacemakers, artificial heart valves, intrauterine devices). These objects could malfunction, be dislodged, or heat up as they absorb energy. Cochlear implants will be inactivated by MRI; therefore, other imaging procedures are considered. A complete list of metal compatibility may be found on MRI manufacturers' Web sites contained in the resource section at the end of the chapter.

Before the patient enters the room where the MRI is to be performed, all metal objects and credit cards (the magnetic field can erase them) must be removed. This includes medication patches that have a metal backing and metallic lead wires; these can cause burns if not removed (Bremner, 2005). No metal objects may be brought into the room where the MRI is located; this includes oxygen tanks, IV poles, ventilators, or even stethoscopes. The magnetic field generated by the unit is so strong that any metal-containing items will be strongly attracted and literally can be pulled away with such force that they fly like projectiles toward the magnet. There is a risk of severe injury and death. Further, damage to expensive equipment may occur.

*NURSING ALERT*

**For patient safety, the nurse must make sure that no patient care equipment (eg, portable oxygen tanks) that contains metal or metal parts enters the room where the MRI is located. The patient must be assessed for the presence of medication patches with foil backing (such as nicotine) that may cause a burn.**

For the MRI, the patient lies with the head in a frame on a flat platform that is moved into a tube housing the magnet (Fig. 60-14). The tube is narrow; persons with a wide girth may not fit into the scanner. Patients who are unable to lie flat will not be able to tolerate an MRI. The scanning process is painless, but the patient hears loud thumping of the magnetic coils as the magnetic field is being pulsed. Patients may experience claustrophobia while inside the narrow tube; sedation may be prescribed in these circumstances. Newer versions of MRI machines (open MRI) are less claustrophobic than the earlier devices and are available in some locations. However, the images produced on these machines are often not as detailed, and traditional devices are preferable for accurate diagnosis. The patient may be taught to use relaxation techniques while in the scanner. The patient is informed that he or she will be able to talk to the staff during the scan through a microphone inside the scanner (Karpoff & Labus, 2008).



**Figure 60-14** Technician explains what to expect during a magnetic resonance imaging procedure.

## Positron Emission Tomography

PET is a computer-based nuclear imaging technique that produces images of actual organ functioning. The patient either inhales a radioactive gas or is injected with a radioactive substance that emits positively charged particles. When these positrons combine with negatively charged electrons (normally found in the body's cells), the resultant gamma rays can be detected by a scanning device that produces a series of two-dimensional views at various levels of the brain. This information is integrated by a computer and gives a composite picture of the brain at work.

PET permits the measurement of blood flow, tissue composition, and brain metabolism and thus indirectly evaluates brain function. The brain is one of the most metabolically active organs, consuming 80% of the glucose the body uses. PET measures this activity in specific areas of the brain and can detect changes in glucose use.

PET is useful in showing metabolic changes in the brain (Alzheimer's disease), locating lesions (brain tumor, epileptogenic lesions), identifying blood flow and oxygen metabolism in patients with strokes, distinguishing tumor from areas of necrosis, and revealing biochemical abnormalities associated with mental illness. The isotopes used have a very short half-life and are expensive to produce, requiring specialized equipment for production. PET scanning has been useful in research settings for the last 20 years and is becoming more available in clinical settings. Improvement in the scanning procedure and production of isotopes, as well as the advent of reimbursement by third-party payers, has increased the availability of PET studies.

### *Nursing Interventions*

Key nursing interventions include patient preparation, which involves explaining the test and teaching the patient about inhalation techniques and the sensations (eg, dizziness, lightheadedness, and headache) that may occur. The IV injection

of the radioactive substance produces similar side effects. Relaxation exercises may reduce anxiety during the test.

## Single Photon Emission Computed Tomography

SPECT is a three-dimensional imaging technique that uses radionuclides and instruments to detect single photons. It is a perfusion study that captures a moment of cerebral blood flow at the time of injection of a radionuclide. Gamma photons are emitted from a radiopharmaceutical agent administered to the patient and are detected by a rotating gamma camera or cameras; the image is sent to a minicomputer. This approach allows areas behind overlying structures or background to be viewed, greatly increasing the contrast between normal and abnormal tissue. It is relatively inexpensive, and the duration is similar to that of a CT scan.

SPECT is useful in detecting the extent and location of abnormally perfused areas of the brain, thus allowing detection, localization, and sizing of stroke (before it is visible by CT scan); localization of seizure foci in epilepsy; detection of tumor progression (Bremner, 2005); and evaluation of perfusion before and after neurosurgical procedures. Pregnancy and breast-feeding are contraindications to SPECT.

### *Nursing Interventions*

The nursing interventions for SPECT primarily include patient preparation and patient monitoring. Teaching about what to expect before the test can allay anxiety and ensure patient cooperation during the test. Premenopausal women are advised to practice effective contraception before and for several days after testing, and the woman who is breastfeeding is instructed to stop nursing for the time period recommended by the nuclear medicine department (Pagana & Pagana, 2006).

The nurse may need to accompany and monitor the patient during transport to the nuclear medicine department for the scan. Patients are monitored during and after the procedure for allergic reactions to the radiopharmaceutical agent.

## Cerebral Angiography

Cerebral angiography is an x-ray study of the cerebral circulation with a contrast agent injected into a selected artery. A valuable tool in investigating vascular disease or anomalies, it is used to determine vessel patency, identify presence of collateral circulation, and provide detail on vascular anomalies that can be used in planning interventions. With the advent of additional imaging techniques, formal cerebral angiography is less frequently performed.

Cerebral angiograms are performed by threading a catheter through the femoral artery in the groin and up to the desired vessel. Alternatively, direct puncture of the carotid artery or retrograde injection of a contrast agent into the brachial artery may be performed. X-ray images are obtained as the contrast agent flows through the vessels; the carotid and vertebral arterial systems are visualized, as well as venous drainage. Arterial access may also be used for interventional procedures, such as placing coils in an aneurysm or arteriovenous malformation.

### *Nursing Interventions*

Prior to the angiography, the patient's blood urea nitrogen and creatinine should be checked to ensure the kidneys will be able to clear the contrast agent. The patient should be well hydrated, and clear liquids are usually permitted up to the time of the test. The patient is instructed to void immediately before the test, and locations of the appropriate peripheral pulses are marked with a felt-tip pen. The patient is instructed to remain immobile during the angiogram process and is told to expect a brief feeling of warmth in the face, behind the eyes, or in the jaw, teeth, tongue, and lips, and a metallic taste when the contrast agent is injected.

After the groin is shaved and prepared, a local anesthetic agent is administered to minimize pain at the insertion site and to reduce arterial spasm. A catheter is introduced into the femoral artery, flushed with heparinized saline, and filled with contrast agent. Fluoroscopy is used to guide the catheter to the appropriate vessels. Neurologic assessment is conducted during and immediately following cerebral angiography to observe for embolism or arterial dissection that may occur during the test. Signs of these complications include new onset of alterations in the level of consciousness, weakness on one side of the body, motor or sensory deficits, and speech disturbances.

Nursing care after cerebral angiography includes observation of the injection site for bleeding or hematoma formation (a localized collection of blood). Because a hematoma at the puncture site or embolization to a distal artery affects the peripheral pulses, peripheral pulses that were marked prior to the test are monitored frequently. The color and temperature of the involved extremity are assessed to detect possible embolism (Karpoff & Labus, 2008).

## Myelography

A myelogram is an x-ray of the spinal subarachnoid space taken after the injection of a contrast agent into the spinal subarachnoid space through a lumbar puncture. The water-based contrast agent disperses upward through the CSF to outline the spinal subarachnoid space and show any distortion of the spinal cord or spinal dural sac caused by tumors, cysts, herniated vertebral disks, or other lesions. Myelography is performed infrequently today because of the sensitivity of CT and MRI scanning (Bremner, 2005).

### *Nursing Interventions*

Because many patients have misconceptions about myelography, the nurse clarifies the explanation given by the physician and answers questions. The patient is informed about what to expect during the procedure and made aware that changes in position may be made during the procedure. After myelography, the patient lies in bed with the head of the bed elevated 30 to 45 degrees. The patient is advised to remain in bed in the recommended position for 3 hours or as prescribed. Drinking liberal amounts of fluid for rehydration and replacement of CSF may decrease the incidence of post–lumbar puncture headache. The blood pressure, pulse, respiratory rate, and temperature are monitored, as well as the patient's ability to void. Untoward signs include headache, fever, stiff neck, **photophobia** (sensitivity to

light), seizures, and signs of chemical or bacterial meningitis (Hickey, 2009).

## Noninvasive Carotid Flow Studies

Noninvasive carotid flow studies use ultrasound imagery and Doppler measurements of arterial blood flow to evaluate carotid and deep orbital circulation. The graph produced indicates blood velocity. Increased blood velocity can indicate stenosis or partial obstruction. These tests are often obtained before more invasive tests such as arteriography, or used as screening tools. Carotid Doppler, carotid ultrasonography, oculoplethysmography, and ophthalmodynamometry are four common noninvasive vascular techniques that permit evaluation of arterial blood flow and detection of arterial stenosis, occlusion, and plaques. These vascular studies allow noninvasive imaging of extracranial and intracranial circulation (Diepenbrock, 2007).

## Transcranial Doppler

Transcranial Doppler uses the same noninvasive techniques as carotid flow studies except that it records the blood flow velocities of the intracranial vessels. Arterial flow velocities can be measured through thin areas of the temporal and occipital bones of the skull. A handheld Doppler probe emits a pulsed beam; the signal is reflected by the moving red blood cells within the blood vessels. Transcranial Doppler is a noninvasive technique that is helpful in assessing vasospasm (a complication following subarachnoid hemorrhage), altered cerebral blood flow found in occlusive vascular disease, other cerebral pathology, and brain death.

### Nursing Interventions

When a carotid flow study or transcranial Doppler is scheduled, the procedure is described to the patient. The patient is informed that this is a noninvasive test, that a handheld transducer will be placed over the neck and the orbits of the eyes, and that a water-soluble jelly is used on the transducer. Either one of these low-risk tests can be performed at the patient's bedside (Littlejohns & Bader, 2009).

## Electroencephalography

An electroencephalogram (EEG) represents a record of the electrical activity generated in the brain (Hickey, 2009). It is obtained through electrodes applied on the scalp or through microelectrodes placed within the brain tissue. It provides an assessment of cerebral electrical activity. It is useful for diagnosing and evaluating seizure disorders, coma, or organic brain syndrome. Tumors, brain abscesses, blood clots, and infection may cause abnormal patterns in electrical activity. The EEG is also used in making a determination of brain death.

Electrodes are applied to the scalp to record the electrical activity in various regions of the brain. The amplified activity of the neurons between any two of these electrodes is recorded on continuously moving paper; this record is called the encephalogram.

For a baseline recording, the patient lies quietly with both eyes closed. The patient may be asked to hyperventilate for 3 to 4 minutes or to look at a bright, flashing light for photic stimulation. These activation procedures are performed to evoke abnormal electrical discharges, such as seizure potentials. A sleep EEG may be recorded after sedation because some abnormal brain waves are seen only when the patient is asleep. If the epileptogenic area is inaccessible to conventional scalp electrodes, nasopharyngeal electrodes may be used.

Depth recording of EEG is performed by introducing electrodes stereotactically (radiologically placed using instrumentation) into a target area of the brain, as indicated by the patient's seizure pattern and scalp EEG. It is used to identify patients who may benefit from surgical excision of epileptogenic foci. Special transsphenoidal, mandibular, and nasopharyngeal electrodes can be used, and video recording combined with EEG monitoring and telemetry is used in hospital settings to capture epileptiform abnormalities and their sequelae. Some epilepsy centers provide long-term ambulatory EEG monitoring with portable recording devices.

### Nursing Interventions

To increase the chances of recording seizure activity, it is sometimes recommended that the patient be deprived of sleep on the night before the EEG. Antiseizure agents, tranquilizers, stimulants, and depressants should be withheld 24 to 48 hours before an EEG because these medications can alter the EEG wave patterns or mask the abnormal wave patterns of seizure disorders (Pagana & Pagana, 2006). Coffee, tea, chocolate, and cola drinks are omitted in the meal before the test because of their stimulating effect. However, the meal is not omitted, because an altered blood glucose level can cause changes in brain wave patterns.

The patient is informed that the standard EEG takes 45 to 60 minutes; a sleep EEG requires 12 hours. The patient is assured that the procedure does not cause an electric shock and that the EEG is a diagnostic test, not a form of treatment. An EEG requires the patient to lie quietly during the test. Sedation is not advisable, because it may lower the seizure threshold in patients with a seizure disorder and it alters brain wave activity in all patients. The nurse needs to check the physician's prescription regarding the administration of antiseizure medication prior to testing.

Routine EEGs use a water-soluble lubricant for electrode contact, which can be wiped off and removed by shampooing later. Sleep EEGs involve the use of collodion glue for electrode contact, which requires acetone for removal.

## Electromyography

An electromyogram (EMG) is obtained by inserting needle electrodes into the skeletal muscles to measure changes in the electrical potential of the muscles (Pagana & Pagana, 2006). The electrical potentials are shown on an oscilloscope and amplified so that both the sound and appearance of the waves can be analyzed and compared simultaneously.

An EMG is useful in determining the presence of neuromuscular disorders and myopathies. It helps distinguish weakness due to neuropathy (functional or pathologic changes in the peripheral nervous system) from weakness resulting from other causes.

### Nursing Interventions

The procedure is explained, and the patient is warned to expect a sensation similar to that of an intramuscular injection as the needle is inserted into the muscle. The muscles examined may ache for a short time after the procedure.

## Nerve Conduction Studies

Nerve conduction studies are performed by stimulating a peripheral nerve at several points along its course and recording the muscle action potential or the sensory action potential that results. Surface or needle electrodes are placed on the skin over the nerve to stimulate the nerve fibers. This test is useful in the study of peripheral neuropathies and is often included as part of the EMG.

## Evoked Potential Studies

Evoked potential studies involve application of an external stimulus to specific peripheral sensory receptors with subsequent measurement of the electrical potential generated. Electrical changes are detected with the aid of computerized devices that extract the signal, display it on an oscilloscope, and store the data on magnetic tape or disk. In neurologic diagnosis, they reflect nerve conduction times in the peripheral nervous system. In clinical practice, the visual, auditory, and somatosensory systems are most often tested.

In visual evoked responses, the patient looks at a visual stimulus (flashing lights, a checkerboard pattern on a screen). The average of several hundred stimuli is recorded by EEG leads placed over the occipital lobe. The transit time from the retina to the occipital area is measured using computer-averaging methods.

Brain stem auditory evoked responses (BAERs) are measured by applying an auditory stimulus (repetitive auditory click) and measuring the transit time via the brain stem into the cortex. Specific lesions in the auditory pathway modify or delay the response. BAERs may be used in the diagnosis of brain stem abnormalities and in determination of brain death.

In somatosensory evoked responses (SERs), the peripheral nerves are stimulated (electrical stimulation through skin electrodes) and the transit time along the spinal cord to the cortex is measured and recorded from scalp electrodes. SERs are used to detect deficits in spinal cord or peripheral nerve conduction and to monitor spinal cord function during surgical procedures. It is also useful in the diagnosis of demyelinating diseases, such as multiple sclerosis and polyneuropathies, where nerve conduction is slowed.

### *Nursing Interventions*

The nurse explains the procedure and reassures the patient and encourages him or her to relax. The patient is advised to remain perfectly still throughout the recording to prevent artifacts (signals not generated by the brain) that interfere with the recording and interpretation of the test.

## Lumbar Puncture and Examination of Cerebrospinal Fluid

A lumbar puncture (spinal tap) is carried out by inserting a needle into the lumbar subarachnoid space to withdraw CSF. The test may be performed to obtain CSF for examination, to measure and reduce CSF pressure, to determine the presence or absence of blood in the CSF, and to administer medications intrathecally (into the spinal canal).

The needle is usually inserted into the subarachnoid space between the third and fourth or fourth and fifth lumbar vertebrae. Because the spinal cord ends at the first lumbar vertebra, insertion of the needle below the level of the third lumbar vertebra prevents puncture of the spinal cord.

A successful lumbar puncture requires that the patient be relaxed; an anxious patient is tense, and this may increase the pressure reading. CSF pressure with the patient in a lateral recumbent position is normally 50 to 1800 mm $H_2O$ (Karpoff & Labus, 2008).

A lumbar puncture may be risky in the presence of an intracranial mass lesion because intraspinal pressure is decreased by removal of CSF, and the brain may herniate downward through the foramen magnum. See Chart 60-5 for instructions for assisting with a lumbar puncture.

### *Cerebrospinal Fluid Analysis*

The CSF should be clear and colorless. Pink, blood-tinged, or grossly bloody CSF may indicate a subarachnoid hemorrhage. The CSF may be bloody initially because of local trauma but becomes clearer as more fluid is drained. Specimens are obtained for cell count, culture, glucose, protein, and other tests as indicated. The specimens should be sent to the laboratory immediately because changes will take place and alter the result if the specimens are allowed to stand. (See Table A-5 in Appendix A for the normal values of CSF.)

### *Post–Lumbar Puncture Headache*

A post–lumbar puncture headache, ranging from mild to severe, may occur a few hours to several days after the procedure. This complication occurs in 15% to 30% of patients. It is a throbbing bifrontal or occipital headache, dull and deep in character. It is particularly severe on sitting or standing but lessens or disappears when the patient lies down.

The headache is caused by CSF leakage at the puncture site. The fluid continues to escape into the tissues by way of the needle track from the spinal canal. As a result of a leak, the supply of CSF in the cranium is depleted to a point at which it is insufficient to maintain proper mechanical stabilization of the brain. When the patient assumes an upright position, tension and stretching of the venous sinuses and pain-sensitive structures occur.

Post–lumbar puncture headache may be avoided if a small-gauge needle is used and if the patient remains prone after the procedure. When more than 20 mL of CSF is removed, the patient is positioned supine for several hours. Keeping the patient flat overnight may reduce the incidence of headaches.

A postpuncture headache is usually managed by bed rest, analgesic agents, and hydration. Occasionally, if the headache persists, the epidural blood patch technique may be used. Blood is withdrawn from the antecubital vein and injected into the epidural space, usually at the site of the previous spinal puncture. The rationale is that the blood acts as a gelatinous plug to seal the hole in the dura, preventing further loss of CSF.

### *Other Complications of Lumbar Puncture*

Herniation of the intracranial contents, spinal epidural abscess, spinal epidural hematoma, and meningitis are rare but serious complications of lumbar puncture. Other

## Chart 60-5 • *Assisting With a Lumbar Puncture*

A needle is inserted into the subarachnoid space through the third and fourth or fourth and fifth lumbar interface to withdraw spinal fluid.

**Preprocedure**

1. Determine whether written consent for the procedure has been obtained.
2. Explain the procedure to the patient and describe sensations that are likely during the procedure (ie, a sensation of cold as the site is cleansed with solution, a needle prick when local anesthetic agent is injected).
3. Determine whether the patient has any questions or misconceptions about the procedure; reassure the patient that the needle will not enter the spinal cord or cause paralysis.
4. Instruct the patient to void before the procedure.

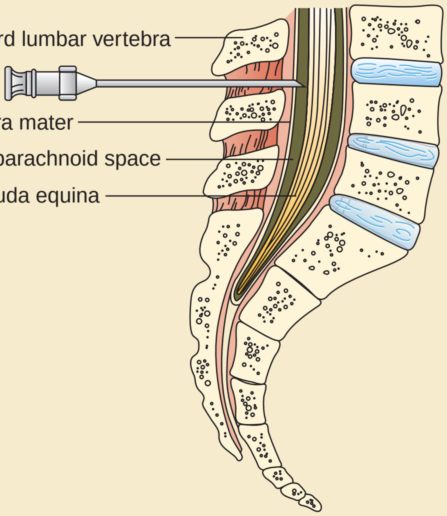
**Procedure**

1. The patient is positioned on one side at the edge of the bed or examining table with back toward the physician; the thighs and legs are flexed as much as possible to increase the space between the spinous processes of the vertebrae, for easier entry into the subarachnoid space.



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2. A small pillow may be placed under the patient's head to maintain the spine in a horizontal position; a pillow may be placed between the legs to prevent the upper leg from rolling forward.
3. The nurse assists the patient to maintain the position to avoid sudden movement, which can produce a traumatic (bloody) tap.
4. The patient is encouraged to relax and is instructed to breathe normally, because hyperventilation may lower an elevated pressure.
5. The nurse describes the procedure step by step to the patient as it proceeds.
6. The physician cleanses the puncture site with an antiseptic agent solution and drapes the site.
7. The physician injects local anesthetic agent to numb the puncture site, and then inserts a spinal needle into the subarachnoid space through the third and fourth or fourth and fifth lumbar interspace. A pressure reading may be obtained.
8. A specimen of CSF is removed and usually collected in three test tubes, labeled in order of collection. The needle is withdrawn.
9. The physician applies a small dressing to the puncture site.
10. The tubes of CSF are sent to the laboratory immediately.




**Postprocedure**

1. Instruct the patient to lie prone for 2 to 3 hours to separate the alignment of the dural and arachnoid needle punctures in the meninges, to reduce leakage of CSF.
2. Monitor the patient for complications of lumbar puncture; notify physician if complications occur.
3. Encourage increased fluid intake to reduce the risk of postprocedure headache.

complications include temporary voiding problems, slight elevation of temperature, backache or spasms, and stiffness of the neck.

## Promoting Home and Community-Based Care

### *Teaching Patients Self-Care*

Many diagnostic tests that were once performed as part of a hospital stay are now carried out in short-procedure units or outpatient testing settings or units. As a result, family members often provide the postprocedure care. Therefore, the patient and family must receive clear verbal and written instructions about precautions to take after the procedure, complications to watch for, and steps to take if complications occur. Because many patients undergoing neurologic diagnostic studies are elderly or have neurologic deficits, provisions must be made to ensure that transportation, postprocedure care, and appropriate monitoring are available.

### Continuing Care

Contacting the patient and family after diagnostic testing enables the nurse to determine whether they have any questions about the procedure or whether the patient had any untoward results. Teaching is reinforced and the patient and family are reminded to make and keep follow-up appointments. Patients, family members, and health care providers are focused on the immediate needs, issues, or deficits that necessitated the diagnostic testing.

## CRITICAL THINKING EXERCISES

**1** A patient is admitted to your unit with lower extremity paralysis. What findings in your examination help distinguish between upper motor neuron and lower motor neuron causes for the paralysis? How do those findings affect your care?

**2** A 78-year-old patient is scheduled for an MRI. Explain why the MRI is indicated and what, if any, precautions must be taken. What nursing observations and assessments are indicated? What safety precautions are essential in the MRI suite, and why?

EBP **3** Your patient complains of a headache following a lumbar puncture. What resources would you use to identify the current guidelines for treatment of headache following lumbar puncture? What is the evidence base for these practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American Headache Society, www.ahsnet.org
Brain Injury Association, www.biausa.org
Brain Trauma Foundation, www.braintrauma.org
Epilepsy Foundation, www.epilepsyfoundation.org
Harvard Health Publications, HMS Office of Public Affairs, www.health.harvard.edu/diagnostic-tests/#brain
National Headache Foundation, www.headaches.org



chapter 61

# Management of Patients With Neurologic Dysfunction

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the nursing needs of patients with various neurologic dysfunctions.
2. Describe the multiple needs of the patient with altered level of consciousness.
3. Use the nursing process as a framework for care of the patient with altered level of consciousness.
4. Identify the early and late clinical manifestations of increased intracranial pressure.
5. Use the nursing process as a framework for care of the patient with increased intracranial pressure.
6. Describe the needs of the patient undergoing intracranial or transsphenoidal surgery.
7. Use the nursing process as a framework for care of the patient undergoing intracranial or transsphenoidal surgery.
8. Identify the various types and causes of seizures.
9. Use the nursing process to develop a plan of care for the patient experiencing seizures.
10. Identify the needs of the patient experiencing headaches.

## GLOSSARY

**akinetic mutism:** unresponsiveness to the environment; the patient makes no movement or sound but sometimes opens the eyes

**altered level of consciousness:** condition of being less responsive to and aware of environmental stimuli

**autoregulation:** ability of cerebral blood vessels to dilate or constrict to maintain stable cerebral blood flow despite changes in systemic arterial blood pressure

**brain death:** irreversible loss of all functions of the entire brain, including the brain stem

**coma:** prolonged state of unconsciousness

**craniectomy:** a surgical procedure that involves removal of a portion of the skull

**craniotomy:** a surgical procedure that involves entry into the cranial vault

**Cushing's response:** the brain's attempt to restore blood flow by increasing arterial pressure to overcome the increased intracranial pressure

**Cushing's triad:** three classic signs—bradycardia, hypertension, and bradypnea—seen with pressure on the medulla as a result of brain stem herniation

## GLOSSARY *(Continued)*

**decerebration:** an abnormal body posture associated with a severe brain injury, characterized by extreme extension of the upper and lower extremities

**decortication:** an abnormal posture associated with severe brain injury, characterized by abnormal flexion of the upper extremities and extension of the lower extremities

**epidural monitor:** a sensor placed between the skull and the dura to monitor intracranial pressure

**epilepsy:** a group of syndromes characterized by paroxysmal transient disturbances of brain function

**fiberoptic monitor:** a system that uses light refraction to determine intracranial pressure

**herniation:** abnormal protrusion of tissue through a defect or natural opening

**intracranial pressure:** pressure exerted by the volume of the intracranial contents within the cranial vault

**locked-in syndrome:** condition resulting from a lesion in the pons in which the patient lacks all distal motor activity (paralysis) but cognition is intact

**microdialysis:** procedure in which an intracranial catheter is inserted near an injured area of brain to measure lactate, pyruvate, glutamate, and glucose levels

**migraine headache:** a severe, unrelenting headache often accompanied by symptoms such as nausea, vomiting, and visual disturbances

**Monro-Kellie hypothesis:** theory that states that due to limited space for expansion within the skull, an increase in any one of the cranial contents—brain tissue, blood, or cerebrospinal fluid—causes a change in the volume of the others

**persistent vegetative state:** condition in which the patient is wakeful but devoid of conscious content, without cognitive or affective mental function

**primary headache:** a headache for which no specific organic cause can be found

**secondary headache:** headache identified as a symptom of another organic disorder (eg, brain tumor, hypertension)

**seizures:** paroxysmal transient disturbance of the brain resulting from a discharge of abnormal electrical activity

**status epilepticus:** episode in which the patient experiences multiple seizure bursts with no recovery time in between

**subarachnoid screw or bolt:** device placed into the subarachnoid space to measure intracranial pressure

**transsphenoidal:** surgical approach to the pituitary via the sphenoid sinuses

**ventriculostomy:** a catheter placed in one of the lateral ventricles of the brain to measure intracranial pressure and allow for drainage of fluid

This chapter presents an overview of care of the patient with an altered level of consciousness, the patient with increased **intracranial pressure (ICP),** and the patient who is undergoing neurosurgical procedures, experiencing seizures, or experiencing headaches. Some of the disorders in this chapter, such as headaches and seizures, may be symptoms of dysfunction in another body system. Alternatively, headaches and seizures can be symptoms of a disruption of the neurologic system. These disorders can also be diagnosed at times as "idiopathic," or without an identifiable cause. The commonalities of these disorders are often the behaviors and needs of the patient and the approaches nurses use to support the patient.

The central nervous system (CNS) contains a vast network of neurons that control the body's vital functions. Yet this system is vulnerable, and its optimal function depends on several key factors. First, the neurologic system relies on its structural integrity for support and homeostasis, but this integrity may be disrupted. Examples of structural disruption include head injury, brain tumor, intracranial hemorrhage, infection, and stroke. As brain tissue expands in the inflexible cranium, ICP rises, and cerebral perfusion is impaired. Further expansion places pressure on vital centers, which can cause permanent neurologic deficits or lead to brain death.

Second, the neurologic system relies on the body's ability to maintain a homeostatic environment. It requires the delivery of the essential elements of oxygen and glucose, as well as filtration of substrates that are toxic to the neurons. The functions of the neurologic system may be decreased or absent because of the effect of toxic substrates or the body's inability to provide essential substrates. Sepsis, hypovolemia, myocardial infarction, respiratory arrest, hypoglycemia, electrolyte imbalance, drug and/or alcohol overdose, encephalopathy, and ketoacidosis are all examples of such circumstances. Some conditions can be treated and reversed; others result in permanent neurologic deficits and disabilities.

Although the specialty of neuroscience nursing requires an understanding of neuroanatomy, neurophysiology, neurodiagnostic testing, critical care nursing, and rehabilitation nursing, nurses in all settings care for patients with neurologic disorders. Ongoing assessment of the patient's neurologic function and health needs, identification of problems, mutual goal setting, development and implementation of care plans (including teaching, counseling, and coordinating activities), and evaluation of the outcomes of care are nursing actions integral to the recovery of the patient. The nurse also collaborates with other members of the health care team to provide essential care, offer a variety of solutions to problems, help the patient and family gain control of their lives, and explore the educational and supportive resources available in the community. The goals are to achieve as high a level of function as possible and to enhance the quality of life for the patient with neurologic impairment and his or her family.

# ALTERED LEVEL OF CONSCIOUSNESS

An **altered level of consciousness (LOC)** is apparent in the patient who is not oriented, does not follow commands, or needs persistent stimuli to achieve a state of alertness. LOC is gauged on a continuum, with a normal state of alertness and full cognition (consciousness) on one end and coma on the other end. **Coma** is a clinical state of unarousable unresponsiveness in which there are no purposeful responses to internal or external stimuli, although nonpurposeful responses to painful stimuli and brain stem reflexes may be present (Gusa, Miers, Pfrimmer, et al., 2007). The usual duration of coma is 2 to 4 weeks. **Akinetic mutism** is a state of unresponsiveness to the environment in which the patient makes no voluntary movement. **Persistent vegetative state** is a condition in which the unresponsive patient resumes sleep–wake cycles after coma but is devoid of cognitive or affective mental function. **Locked-in syndrome** results from a lesion affecting the pons and results in paralysis and the inability to speak, but vertical eye movements and lid elevation remain intact and are used to indicate responsiveness (Maurer, 2008). The level of responsiveness and consciousness is the most important indicator of the patient's condition.

## Pathophysiology

Altered LOC is not a disorder itself; rather, it is a result of multiple pathophysiologic phenomena. The cause may be neurologic (head injury, stroke), toxicologic (drug overdose, alcohol intoxication), or metabolic (hepatic or renal failure, diabetic ketoacidosis).

The underlying cause of neurologic dysfunction is disruption in the cells of the nervous system, neurotransmitters, or brain anatomy (see Chapter 60). Disruptions result from cellular edema or other mechanisms, such as disruption of chemical transmission at receptor sites by antibodies.

Intact anatomic structures of the brain are needed for normal function. The two hemispheres of the cerebrum must communicate, via an intact corpus callosum, and the lobes of the brain (frontal, parietal, temporal, and occipital) must communicate and coordinate their specific functions (see Chapter 60). Other anatomic structures of importance are the cerebellum and the brain stem. The cerebellum has both excitatory and inhibitory actions and is largely responsible for coordination of movement. The brain stem contains areas that control the heart, respiration, and blood pressure. Disruptions in the anatomic structures result from trauma, edema, pressure from tumors, or other mechanisms, such as an increase or decrease in the circulation of blood or cerebrospinal fluid (CSF).

## Clinical Manifestations

Alterations in LOC occur along a continuum, and the clinical manifestations depend on where the patient is on this continuum. As the patient's state of alertness and consciousness decreases, changes occur in the pupillary response, eye opening response, verbal response, and motor response. However, initial alterations in LOC may be reflected by subtle behavioral changes, such as restlessness or increased anxiety. The pupils, normally round and quickly reactive to light, become sluggish (response is slower); as the patient becomes comatose, the pupils become fixed (no response to light). The patient in a coma does not open the eyes, respond verbally, or move the extremities in response to a request to do so.

## Assessment and Diagnostic Findings

The patient with an altered LOC is at risk for alterations in every body system. A complete assessment is performed, with particular attention to the neurologic system. The

neurologic examination should be as complete as the LOC allows (American Association of Neuroscience Nurses [AANN], 2005). It includes an evaluation of mental status, cranial nerve function, cerebellar function (balance and coordination), reflexes, and motor and sensory function. LOC, a sensitive indicator of neurologic function, is assessed based on the criteria in the Glasgow Coma Scale: eye opening, verbal response, and motor response (Gusa, et al., 2007). The patient's responses are rated on a scale from 3 to 15. A score of 3 indicates severe impairment of neurologic function, brain death, or pharmacologic inhibition of the neurologic response. A score of 15 indicates that the patient is fully responsive (see Chapter 63).

If the patient is comatose and has localized signs such as abnormal pupillary and motor responses, it is assumed that neurologic disease is present until proven otherwise. If the patient is comatose but pupillary light reflexes are preserved, a toxic or metabolic disorder is suspected. Common diagnostic procedures used to identify the cause of unconsciousness include computed tomography (CT) scanning, magnetic resonance imaging (MRI), and electroencephalography (EEG). Less common procedures include positron emission tomography (PET) and single photon emission computed tomography (SPECT; see Chapter 60). Laboratory tests include analysis of blood glucose, electrolytes, serum ammonia, and liver function tests; blood urea nitrogen (BUN) levels; serum osmolality; calcium level; and partial thromboplastin and prothrombin times. Other studies may be used to evaluate serum ketones, alcohol and drug concentrations, and arterial blood gases.

## Medical Management

The first priority of treatment for the patient with altered LOC is to obtain and maintain a patent airway. The patient may be orally or nasally intubated, or a tracheostomy may be performed. Until the ability of the patient to breathe is determined, a mechanical ventilator is used to maintain adequate oxygenation and ventilation. The circulatory status (blood pressure, heart rate) is monitored to ensure adequate perfusion to the body and brain. An intravenous (IV) catheter is inserted to provide access for IV fluids and medications. Neurologic care focuses on the specific neurologic pathology, if known. Nutritional support, via a feeding tube or a gastrostomy tube, is initiated as soon as possible. In addition to measures designed to determine and treat the underlying causes of altered LOC, other medical interventions are aimed at pharmacologic management and prevention of complications.

## NURSING PROCESS

## The Patient With an Altered Level of Consciousness

### Assessment

Assessment of the patient with an altered LOC often starts with assessing the verbal response through determining the patient's orientation to time, person, and place. Patients are asked to identify the day, date, or season of the year and to identify where they are or to identify the clinicians, family members, or visitors present. Other questions such as, "Who is the president?" or "What is the next holiday?" may be helpful in determining the patient's processing of information. (Verbal response cannot be evaluated if the patient is intubated or has a tracheostomy, and this should be clearly documented.)

Alertness is measured by the patient's ability to open the eyes spontaneously or in response to a vocal or noxious stimulus (pressure or pain). Patients with severe neurologic dysfunction cannot do this. The nurse assesses for periorbital edema (swelling around the eyes) or trauma, which may prevent the patient from opening the eyes, and documents any such condition that interferes with eye opening.

Motor response includes spontaneous, purposeful movement (eg, the awake patient can move all four extremities with equal strength on command), movement only in response to painful stimuli, or abnormal posturing (Olsen & Graffagnino, 2005). If the patient is not responding to commands, the motor response is tested by applying a painful stimulus (firm but gentle pressure) to the nail bed or by squeezing a muscle. If the patient attempts to push away or withdraw, the response is recorded as purposeful or appropriate ("patient withdraws to painful stimulus"). This response is considered purposeful if the patient can cross the midline from one side of the body to the other in response to a painful stimulus. An inappropriate or nonpurposeful response is random and aimless. Posturing may be decorticate or decerebrate (Fig. 61-1; see also Chapter 60). The most severe neurologic impairment results in flaccidity. The motor response cannot be elicited or assessed when the patient has been administered pharmacologic paralyzing agents.

In addition to LOC, the nurse monitors parameters such as respiratory status, eye signs, and reflexes on an ongoing basis. Table 61-1 summarizes the assessment and the clinical significance of the findings. Body functions (circulation, respiration, elimination, fluid and electrolyte balance) are examined in a systematic and ongoing manner.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses may include the following:

- Ineffective airway clearance related to altered LOC
- Risk of injury related to decreased LOC
- Deficient fluid volume related to inability to take fluids by mouth
- Impaired oral mucous membrane related to mouth breathing, absence of pharyngeal reflex, and altered fluid intake
- Risk for impaired skin integrity related to prolonged immobility
- Impaired tissue integrity of cornea related to diminished or absent corneal reflex
- Ineffective thermoregulation related to damage to hypothalamic center
- Impaired urinary elimination (incontinence or retention) related to impairment in neurologic sensing and control
- Bowel incontinence related to impairment in neurologic sensing and control and also related to changes in nutritional delivery methods

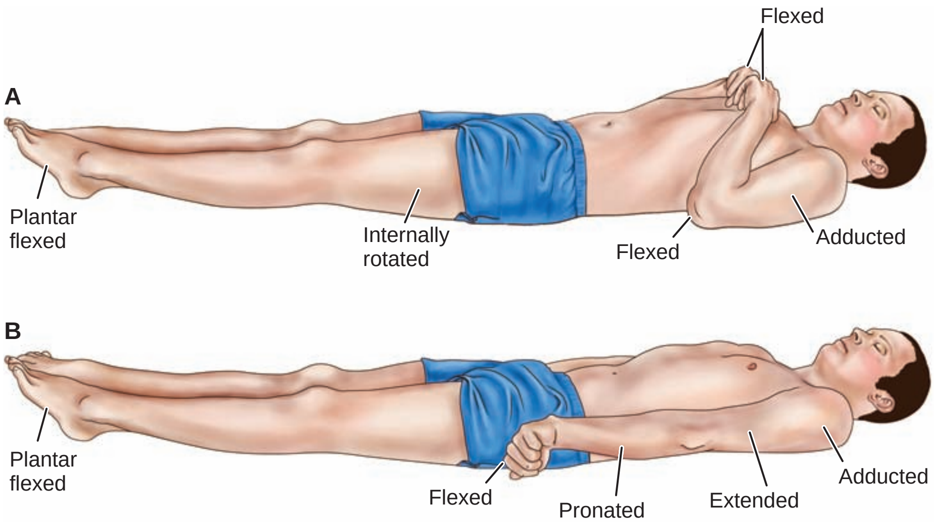



**Figure 61-1** Abnormal posture response to stimuli. **A,** Decorticate posturing and flexion of the upper extremities, internal rotation of the lower extremities, and plantar flexion of the feet. **B,** Decerebrate posturing, involving extension and outward rotation of upper extremities and plantar flexion of the feet.

- Disturbed sensory perception related to neurologic impairment
- Interrupted family processes related to health crisis

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include:

- Respiratory distress or failure
- Pneumonia
- Aspiration
- Pressure ulcer
- Deep vein thrombosis (DVT)
- Contractures

## Planning and Goals

The patient with altered LOC is subject to all the complications associated with immobility. Therefore, the goals of care for the patient with altered LOC include maintenance of a clear airway, protection from injury, attainment of fluid volume balance, achievement of intact oral mucous membranes, maintenance of normal skin integrity, absence of corneal irritation, attainment of effective thermoregulation, and effective urinary elimination. Additional goals include bowel continence, accurate perception of environmental stimuli, maintenance of intact family or support system, and absence of complications.

Because the unconscious patient's protective reflexes are impaired, the quality of nursing care provided may mean the difference between life and death. The nurse must assume responsibility for the patient until the basic reflexes (coughing, blinking, and swallowing) return and the patient becomes conscious and oriented. Therefore, the major nursing goal is to compensate for the absence of these protective reflexes.

## Nursing Interventions

#### *Maintaining the Airway*

The most important consideration in managing the patient with altered LOC is to establish an adequate airway and ensure ventilation. Obstruction of the airway is a risk because the epiglottis and tongue may relax, occluding the oropharynx, or the patient may aspirate vomitus or nasopharyngeal secretions.

The accumulation of secretions in the pharynx presents a serious problem. Because the patient cannot swallow and lacks pharyngeal reflexes, these secretions must be removed to eliminate the danger of aspiration. Elevating the head of the bed to 30 degrees helps prevent aspiration. Positioning the patient in a lateral or semiprone position also helps, because it allows the jaw and tongue to fall forward, thus promoting drainage of secretions.

Positioning alone is not always adequate, however. Suctioning and oral hygiene may be required. Suctioning is performed to remove secretions from the posterior pharynx and upper trachea. Before and after suctioning, the patient is adequately ventilated to prevent hypoxia (Hickey, 2009). Chest physiotherapy and postural drainage may be initiated to promote pulmonary hygiene, unless contraindicated by the patient's underlying condition. The chest should be auscultated at least every 8 hours to detect adventitious breath sounds or absence of breath sounds.

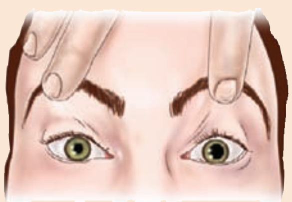
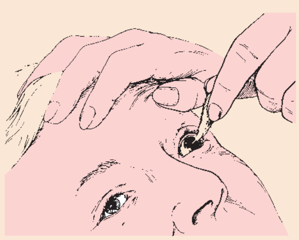
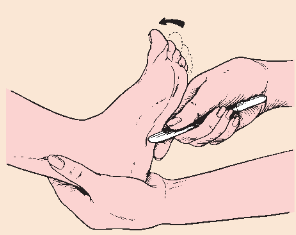
Despite these measures, or because of the severity of impairment, the patient with altered LOC often requires intubation and mechanical ventilation. Nursing actions for the mechanically ventilated patient include maintaining the patency of the endotracheal tube or tracheostomy, providing frequent oral care, monitoring arterial blood gas measurements, and maintaining ventilator settings (see Chapter 25).

#### *Protecting the Patient*

For the protection of the patient, side rails are padded. Two rails are kept in the raised position during the day and three at night; however, raising all four side rails is considered a restraint by the Joint Commission if the intent is to limit the patient's mobility. Care should be taken to prevent injury from invasive lines and equipment, and other potential sources of injury should be identified, such as restraints, tight dressings, environmental irritants, damp bedding or dressings, and tubes and drains.

Protection also includes ensuring the patient's dignity during altered LOC. Simple measures such as providing privacy and speaking to the patient during nursing care

**Table 61-1 NURSING ASSESSMENT OF THE UNCONSCIOUS PATIENT**

| Examination | Clinical Assessment | Clinical Significance |
|---|---|---|
| Level of responsiveness or consciousness | Eye opening; verbal and motor responses; pupils (size, equality, reaction to light) | Obeying commands is a favorable response and demonstrates a return to consciousness. |
| Pattern of respiration | Respiratory pattern | Disturbances of respiratory center of brain may result in various respiratory patterns. |
| | Cheyne-Stokes respiration | Suggests lesions deep in both hemispheres; area of basal ganglia and upper brain stem |
| | Hyperventilation | Suggests onset of metabolic problem or brain stem damage |
| | Ataxic respiration with irregularity in depth/rate | Ominous sign of damage to medullary center |
| Eyes | | |
| Pupils (size, equality, reaction to light)  | Equal, normally reactive pupils<br>Equal or unequal diameter<br>Progressive dilation<br>Fixed dilated pupils | Suggests that coma is toxic or metabolic in origin<br>Helps determine location of lesion<br>Indicates increasing intracranial pressure<br>Indicates injury at level of midbrain |
| Eye movements | Normally, eyes should move from side to side. | Functional and structural integrity of brain stem is assessed by inspection of extraocular movements; usually absent in deep coma. |
| Corneal reflex  | When cornea is touched with a wisp of clean cotton, blink response is normal. | Tests cranial nerves V and VII; helps determine location of lesion if unilateral; absent in deep coma |
| Facial symmetry | Asymmetry (sagging, decrease in wrinkles) | Sign of paralysis |
| Swallowing reflex | Drooling versus spontaneous swallowing | Absent in coma<br>Paralysis of cranial nerves X and XII |
| Neck | Stiff neck<br>Absence of spontaneous neck movement | Subarachnoid hemorrhage, meningitis<br>Fracture or dislocation of cervical spine |
| Response of extremity to noxious stimuli | Firm pressure on a joint of the upper and lower extremity<br>Observe spontaneous movements. | Asymmetric response in paralysis<br><br>Absent in deep coma |
| Deep tendon reflexes | Tap patellar and biceps tendons. | Brisk response may have localizing value<br>Asymmetric response in paralysis<br>Absent in deep coma |
| Pathologic reflexes  | Firm pressure with blunt object on sole of foot, moving along lateral margin and crossing to the ball of foot | Flexion of the toes, especially the great toe, is normal except in newborn.<br>Dorsiflexion of toes (especially great toe) indicates contralateral pathology of corticospinal tract (Babinski reflex).<br>Helps determine location of lesion in brain |
| Abnormal posture | Observation for posturing (spontaneous or in response to noxious stimuli)<br>Flaccidity with absence of motor response<br>Decorticate posture (flexion and internal rotation of forearms and hands)<br>Decerebrate posture (extension and external rotation) | Deep extensive brain lesion<br>Seen with cerebral hemisphere pathology and in metabolic depression of brain function<br>Decerebrate posturing indicates deeper and more severe dysfunction than does decorticate posturing; implies brain pathology; poor prognostic sign. |

activities preserve the patient's dignity. Not speaking negatively about the patient's condition or prognosis is also important, because patients in a light coma may be able to hear. The comatose patient has an increased need for advocacy, and the nurse is responsible for seeing that these advocacy needs are met.

> **NURSING ALERT**
>
> **If the patient begins to emerge from unconsciousness, every measure that is available and appropriate for calming and quieting the patient should be used. Any form of restraint is likely to be countered with resistance, leading to self-injury or to a dangerous increase in ICP. Therefore, physical restraints should be avoided if possible; a written prescription must be obtained if their use is essential for the patient's well-being.**

#### *Maintaining Fluid Balance and Managing Nutritional Needs*

Hydration status is assessed by examining tissue turgor and mucous membranes, assessing intake and output trends, and analyzing laboratory data. Fluid needs are met initially by administering the required IV fluids. However, IV solutions (and blood component therapy) for patients with intracranial conditions must be administered slowly. If they are administered too rapidly, they can increase ICP. The quantity of fluids administered may be restricted to minimize the possibility of cerebral edema.

If the patient does not recover quickly and sufficiently enough to take adequate fluids and calories by mouth, a feeding or gastrostomy tube will be inserted for the administration of fluids and enteral feedings (Dudek, 2006).

#### *Providing Mouth Care*

The mouth is inspected for dryness, inflammation, and crusting. The unconscious patient requires careful oral care, because there is a risk of parotitis if the mouth is not kept scrupulously clean. The mouth is cleansed and rinsed carefully to remove secretions and crusts and to keep the mucous membranes moist. A thin coating of petrolatum on the lips prevents drying, cracking, and encrustations. If the patient has an endotracheal tube, the tube should be moved to the opposite side of the mouth daily to prevent ulceration of the mouth and lips. If the patient is intubated and mechanically ventilated, good oral care is also necessary. Recent evidence shows that a routine of toothbrushing every 8 hours significantly decreases ventilator-associated pneumonia (Fields, 2008).

#### *Maintaining Skin and Joint Integrity*

Preventing skin breakdown requires continuing nursing assessment and intervention. Special attention is given to unconscious patients, because they cannot respond to external stimuli. Assessment includes a regular schedule of turning to avoid pressure, which can cause breakdown and necrosis of the skin. Turning also provides kinesthetic (sensation of movement), proprioceptive (awareness of position), and vestibular (equilibrium) stimulation. After turning, the patient is carefully repositioned to prevent ischemic necrosis over pressure areas. Dragging or pulling the patient up in bed must be avoided, because this creates a shearing force and friction on the skin surface (see Chapter 11).

Maintaining correct body position is important; equally important is passive exercise of the extremities to prevent contractures. The use of splints or foam boots aids in the prevention of foot drop and eliminates the pressure of bedding on the toes. The use of trochanter rolls to support the hip joints keeps the legs in proper alignment. The arms are in abduction, the fingers lightly flexed, and the hands in slight supination. The heels of the feet are assessed for pressure areas. Specialty beds, such as fluidized or low-air-loss beds, may be used to decrease pressure on bony prominences (Hickey, 2009).

#### *Preserving Corneal Integrity*

Some unconscious patients have their eyes open and have inadequate or absent corneal reflexes. The cornea may become irritated, dried out, or scratched, leading to ulceration. The eyes may be cleansed with cotton balls moistened with sterile normal saline to remove debris and discharge. If artificial tears are prescribed, they may be instilled every 2 hours. Periorbital edema (swelling around the eyes) often occurs after cranial surgery. If cold compresses are prescribed, care must be exerted to avoid contact with the cornea. Eye patches should be used cautiously because of the potential for corneal abrasion from contact with the patch.

#### *Maintaining Body Temperature*

High fever in the unconscious patient may be caused by infection of the respiratory or urinary tract, drug reactions, or damage to the hypothalamic temperature-regulating center. A slight elevation of temperature may be caused by dehydration. The environment can be adjusted, depending on the patient's condition, to promote a normal body temperature. If body temperature is elevated, a minimum amount of bedding is used. The room may be cooled to 18.3°C (65°F). However, if the patient is elderly and does not have an elevated temperature, a warmer environment is needed.

Because of damage to the temperature-regulating center in the brain or severe intracranial infection, unconscious patients often develop very high temperatures. Such temperature elevations must be controlled, because the increased metabolic demands of the brain can exceed cerebral circulation and oxygen delivery, potentially resulting in cerebral deterioration (Hickey, 2009). Studies suggest that hyperthermia may contribute to poor outcome after brain injury but not through a decreased brain oxygen level (Spiotta, Stiefel, Heuer, et al., 2008). Persistent hyperthermia with no identified clinical source of infection indicates brain stem damage and a poor prognosis.

> **NURSING ALERT**
>
> **The body temperature of an unconscious patient is never taken by mouth. Rectal or tympanic (if not contraindicated) temperature measurement is preferred to the less accurate axillary temperature.**

Strategies for reducing fever include:

- Removing all bedding over the patient (with the possible exception of a light sheet, towel, or small drape)

- Administering acetaminophen as prescribed
- Giving cool sponge baths and allowing an electric fan to blow over the patient to increase surface cooling
- Using a hypothermia blanket
- Frequent temperature monitoring to assess the patient's response to the therapy and to prevent an excessive decrease in temperature and shivering

#### *Preventing Urinary Retention*

The patient with an altered LOC is often incontinent or has urinary retention. The bladder is palpated or scanned at intervals to determine whether urinary retention is present, because a full bladder may be an overlooked cause of overflow incontinence. A portable bladder ultrasound instrument is a useful tool in bladder management and retraining programs (Wu & Baguley, 2005).

If the patient is not voiding, an indwelling urinary catheter is inserted and connected to a closed drainage system. A catheter may also be inserted during the acute phase of illness to monitor urinary output. Because catheters are a major cause of urinary tract infection, the patient is observed for fever and cloudy urine. The area around the urethral orifice is inspected for drainage. The urinary catheter is usually removed if the patient has a stable cardiovascular system and if no diuresis, sepsis, or voiding dysfunction existed before the onset of coma. Although many unconscious patients urinate spontaneously after catheter removal, the bladder should be palpated or scanned with a portable ultrasound device periodically for urinary retention (Wu & Baguley, 2005). An intermittent catheterization program may be initiated to ensure complete emptying of the bladder at intervals, if indicated.

An external catheter (condom catheter) for the male patient and absorbent pads for the female patient can be used for unconscious patients who can urinate spontaneously, although involuntarily. As soon as consciousness is regained, a bladder-training program is initiated (Hickey, 2009). The incontinent patient is monitored frequently for skin irritation and skin breakdown. Appropriate skin care is implemented to prevent these complications.

#### *Promoting Bowel Function*

The abdomen is assessed for distention by listening for bowel sounds and measuring the girth of the abdomen with a tape measure. There is a risk of diarrhea from infection, antibiotics, and hyperosmolar fluids. Frequent loose stools may also occur with fecal impaction. Commercial fecal collection bags are available for patients with fecal incontinence.

Immobility and lack of dietary fiber can cause constipation. The nurse monitors the number and consistency of bowel movements and performs a rectal examination for signs of fecal impaction. Stool softeners may be prescribed and can be administered with tube feedings. To facilitate bowel emptying, a glycerin suppository may be indicated. The patient may require an enema every other day to empty the lower colon.

#### *Providing Sensory Stimulation*

Once increased ICP is not a problem, sensory stimulation can help overcome the profound sensory deprivation of the unconscious patient. This involves using auditory, visual, olfactory, gustatory, tactile, and kinesthetic activities to stimulate the patient emerging from coma (Gerber, 2005). Efforts are made to restore the sense of daily rhythm by maintaining usual day and night patterns for activity and sleep. The nurse touches and talks to the patient and encourages family members and friends to do so. Communication is extremely important and includes touching the patient and spending enough time with the patient to become sensitive to his or her needs. It is also important to avoid making any negative comments about the patient's status or prognosis in the patient's presence.

The nurse orients the patient to time and place at least once every 8 hours. Sounds from the patient's usual environment may be introduced using a tape recorder. Family members can read to the patient from a favorite book and may suggest radio and television programs that the patient previously enjoyed as a means of enriching the environment and providing familiar input.

When arousing from coma, many patients experience a period of agitation, indicating that they are becoming more aware of their surroundings but still cannot react or communicate in an appropriate fashion. Although this is disturbing for many family members, it is actually a positive clinical sign. At this time, it is necessary to minimize stimulation by limiting background noises, having only one person speak to the patient at a time, giving the patient a longer period of time to respond, and allowing for frequent rest or quiet times. After the patient has regained consciousness, videotaped family or social events may assist the patient in recognizing family and friends and allow him or her to experience missed events.

Various programs of structured sensory stimulation for patients with brain injury have been developed to improve outcomes. Although these are controversial programs with inconsistent results, some research supports the concept of providing structured stimulation (Gerber, 2005).

#### *Meeting the Family's Needs*

The family of the patient with altered LOC may be thrown into a sudden state of crisis and go through the process of severe anxiety, denial, anger, remorse, grief, and reconciliation. Depending on the disorder that caused the altered LOC and the extent of the patient's recovery, the family may be unprepared for the changes in the cognitive and physical status of their loved one. If the patient has significant residual deficits, the family may require considerable time, assistance, and support to come to terms with these changes. To help family members mobilize resources and coping skills, the nurse reinforces and clarifies information about the patient's condition, permits the family to be involved in care, and listens to and encourages ventilation of feelings and concerns while supporting decision making about management and placement after hospitalization. Families may benefit from participation in support groups offered through the hospital, rehabilitation facility, or community organizations.

In some circumstances, the family may need to face the death of their loved one. The patient with a neurologic disorder is often pronounced brain dead before the heart stops beating. The term **brain death** describes irreversible loss of

all functions of the entire brain, including the brain stem (Burck, Anderson-Shaw, Sheldon, et al., 2006). The term may be misleading to the family because, although brain function has ceased, the patient appears to be alive, with the heart rate and blood pressure sustained by vasoactive medications and breathing continued by mechanical ventilation. When discussing a patient who is brain dead with family members, it is important to provide accurate, timely, understandable, and consistent information (Peiffer, 2007). End-of-life care is discussed in Chapter 17.

#### *Monitoring and Managing Potential Complications*

Pneumonia, aspiration, and respiratory failure are potential complications in any patient who has a depressed LOC and who cannot protect the airway or turn, cough, and take deep breaths. The longer the period of unconsciousness, the greater the risk is of pulmonary complications.

Vital signs and respiratory function are monitored closely to detect any signs of respiratory failure or distress. Total blood count and arterial blood gas measurements are assessed to determine whether there are adequate red blood cells to carry oxygen and whether ventilation is effective. Chest physiotherapy and suctioning are initiated to prevent respiratory complications such as pneumonia. Oral care interventions are performed for patients receiving mechanical ventilation to decrease the incidence of pneumonia (Fields, 2008). If pneumonia develops, cultures are obtained to identify the organism so that appropriate antibiotics can be administered.

The patient with altered LOC is monitored closely for evidence of impaired skin integrity, and strategies to prevent skin breakdown and pressure ulcers are continued through all phases of care, including hospitalization, rehabilitation, and home care. Factors that contribute to impaired skin integrity (eg, incontinence, inadequate dietary intake, pressure on bony prominences, edema) are addressed. If pressure ulcers develop, strategies to promote healing are undertaken. Care is taken to prevent bacterial contamination of pressure ulcers, which may lead to sepsis and septic shock. Assessment and management of pressure ulcers are discussed in Chapter 11.

The patient should also be monitored for signs and symptoms of deep vein thrombosis (DVT). Patients who develop DVT are at risk for pulmonary embolism. Prophylaxis such as subcutaneous heparin or low-molecular-weight heparin (Fragmin, Orgaran) should be prescribed if not contraindicated (Vergouwen, Roos & Kamphuisen, 2008). Anti-embolism stockings or pneumatic compression devices should also be prescribed to reduce the risk of clot formation. The nurse observes for signs and symptoms of DVT.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Maintains clear airway and demonstrates appropriate breath sounds
2. Experiences no injuries
3. Attains or maintains adequate fluid balance
   a. Has no clinical signs or symptoms of dehydration
   b. Demonstrates normal range of serum electrolytes
   c. Has no clinical signs or symptoms of overhydration
4. Achieves healthy oral mucous membranes
5. Maintains normal skin integrity
6. Has no corneal irritation
7. Attains or maintains thermoregulation
8. Has no urinary retention
9. Has no diarrhea or fecal impaction
10. Receives appropriate sensory stimulation
11. Has family members who cope with crisis
    a. Verbalize fears and concerns
    b. Participate in patient's care and provide sensory stimulation by talking and touching
12. Is free of complications
    a. Has arterial blood gas values or $O_2$ saturation levels within normal range
    b. Displays no signs or symptoms of pneumonia
    c. Exhibits intact skin over pressure areas
    d. Does not develop DVT or pulmonary embolism (PE)

## INCREASED INTRACRANIAL PRESSURE

The rigid cranial vault contains brain tissue (1400 g), blood (75 mL), and CSF (75 mL). The volume and pressure of these three components are usually in a state of equilibrium and produce the ICP. ICP is usually measured in the lateral ventricles, with the normal pressure being 0 to 10 mm Hg, and 15 mm Hg being the upper limit of normal (Hickey, 2009).

The **Monro-Kellie hypothesis** states that, because of the limited space for expansion within the skull, an increase in any one of the components causes a change in the volume of the others. Because brain tissue has limited space to expand, compensation typically is accomplished by displacing or shifting CSF, increasing the absorption or diminishing the production of CSF, or decreasing cerebral blood volume. Without such changes, ICP begins to rise. Under normal circumstances, minor changes in blood volume and CSF volume occur constantly as a result of alterations in intrathoracic pressure (coughing, sneezing, straining), posture, blood pressure, and systemic oxygen and carbon dioxide levels (Hickey, 2009).

### Pathophysiology

Increased ICP affects many patients with acute neurologic conditions because pathologic conditions alter the relationship between intracranial volume and ICP. Although elevated ICP is most commonly associated with head injury, it also may be seen as a secondary effect in other conditions, such as brain tumors, subarachnoid hemorrhage, and toxic and viral encephalopathies. Increased ICP from any cause decreases cerebral perfusion, stimulates further swelling (edema), and may shift brain tissue, resulting in **herniation,** a dire and frequently fatal event.

#### *Decreased Cerebral Blood Flow*

Increased ICP may reduce cerebral blood flow, resulting in ischemia and cell death. In the early stages of cerebral

ischemia, the vasomotor centers are stimulated and the systemic pressure rises to maintain cerebral blood flow. Usually, this is accompanied by a slow bounding pulse and respiratory irregularities. These changes in blood pressure, pulse, and respiration are important clinically because they suggest increased ICP.

The concentration of carbon dioxide in the blood and in the brain tissue also plays a role in the regulation of cerebral blood flow. An increase in the arterial partial pressure of carbon dioxide ($PaCO_2$) causes cerebral vasodilation, leading to increased cerebral blood flow and increased ICP. A decrease in $PaCO_2$ has a vasoconstrictive effect, limiting blood flow to the brain. Decreased venous outflow may also increase cerebral blood volume, thus raising ICP.

### Cerebral Edema

Cerebral edema or swelling is defined as an abnormal accumulation of water or fluid in the intracellular space, extracellular space, or both, associated with an increase in the volume of brain tissue. Edema can occur in the gray, white, or interstitial matter. As brain tissue swells within the rigid skull, several mechanisms attempt to compensate for the increasing ICP. These compensatory mechanisms include autoregulation as well as decreased production and flow of CSF. **Autoregulation** refers to the brain's ability to change the diameter of its blood vessels to maintain a constant cerebral blood flow during alterations in systemic blood pressure. This mechanism can be impaired in patients who are experiencing a pathologic and sustained increase in ICP.

### Cerebral Response to Increased Intracranial Pressure

As ICP rises, compensatory mechanisms in the brain work to maintain blood flow and prevent tissue damage. The brain can maintain a steady perfusion pressure if the arterial systolic blood pressure is 50 to 150 mm Hg and the ICP is less than 40 mm Hg. Changes in ICP are closely linked with cerebral perfusion pressure (CPP). The CPP is calculated by subtracting the ICP from the mean arterial pressure (MAP). For example, if the MAP is 100 mm Hg and the ICP is 15 mm Hg, then the CPP is 85 mm Hg. The normal CPP is 70 to 100 mm Hg (Hickey, 2009). As ICP rises and the autoregulatory mechanism of the brain is overwhelmed, the CPP can increase to greater than 100 mm Hg or decrease to less than 50 mm Hg. Patients with a CPP of less than 50 mm Hg experience irreversible neurologic damage. Therefore, the CPP must be maintained at 70 to 80 mm Hg to ensure adequate blood flow to the brain. If ICP is equal to MAP, cerebral circulation ceases.

A clinical phenomenon known as the **Cushing's response** (or Cushing's reflex) is seen when cerebral blood flow decreases significantly. When ischemic, the vasomotor center triggers an increase in arterial pressure in an effort to overcome the increased ICP. A sympathetically mediated response causes an increase in the systolic blood pressure with a widening of the pulse pressure and cardiac slowing. This response is seen clinically as an increase in systolic blood pressure, widening of the pulse pressure, and reflex slowing of the heart rate. It is a late sign requiring immediate intervention; however, perfusion may be recoverable if the Cushing's response is treated rapidly.

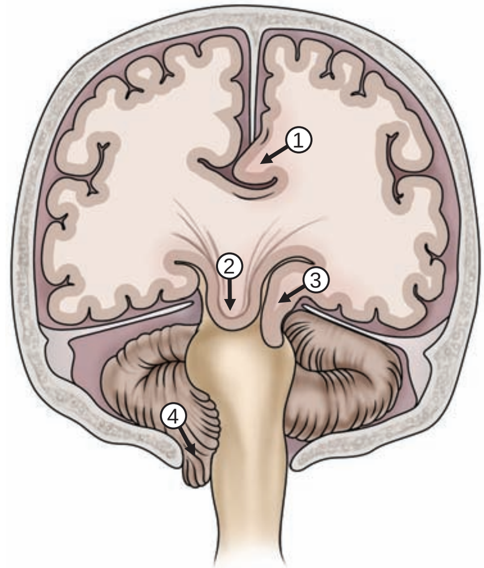



**Figure 61-2** Brain with intracranial shifts from supratentorial lesions. *1,* Herniation of the cingulate gyrus under the falx cerebri. *2,* Central transtentorial herniation. *3,* Uncal herniation of the temporal lobe into the tentorial notch. *4,* Infratentorial herniation of the cerebral tonsils. Adapted from Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

At a certain point, the brain's ability to autoregulate becomes ineffective and decompensation (ischemia and infarction) begins. When this occurs, the patient exhibits significant changes in mental status and vital signs. The bradycardia, hypertension, and bradypnea associated with this deterioration are known as **Cushing's triad,** a grave sign. At this point, herniation of the brain stem and occlusion of the cerebral blood flow occur if therapeutic intervention is not initiated. Herniation refers to the shifting of brain tissue from an area of high pressure to an area of lower pressure (Fig. 61-2). The herniated tissue exerts pressure on the brain area into which it has shifted, which interferes with the blood supply in that area. Cessation of cerebral blood flow results in cerebral ischemia, infarction, and brain death.

## Clinical Manifestations

If ICP increases to the point at which the brain's ability to adjust has reached its limits, neural function is impaired; this may be manifested at first by clinical changes in LOC and later by abnormal respiratory and vasomotor responses.

> *NURSING ALERT*
>
> **The earliest sign of increasing ICP is a change in LOC. Slowing of speech and delay in response to verbal suggestions are other early indicators.**

Any sudden change in the patient's condition, such as restlessness (without apparent cause), confusion, or increasing drowsiness, has neurologic significance. These signs may result from compression of the brain due to swelling from

hemorrhage or edema, an expanding intracranial lesion (hematoma or tumor), or a combination of both.

As ICP increases, the patient becomes stuporous, reacting only to loud or painful stimuli. At this stage, serious impairment of brain circulation is probably taking place, and immediate intervention is required. As neurologic function deteriorates further, the patient becomes comatose and exhibits abnormal motor responses in the form of **decortication** (abnormal flexion of the upper extremities and extension of the lower extremities), **decerebration** (extreme extension of the upper and lower extremities), or flaccidity (see Fig. 61-1). If the coma is profound, with the pupils dilated and fixed and respirations impaired or absent, death is usually inevitable (Posner, Saper, Schiff, et al., 2007).

## Assessment and Diagnostic Findings

The diagnostic studies used to determine the underlying cause of increased ICP are discussed in detail in Chapter 60. The most common diagnostic tests are CT scanning and MRI. The patient may also undergo cerebral angiography, PET, or SPECT. Transcranial Doppler studies provide information about cerebral blood flow. The patient with increased ICP may also undergo electrophysiologic monitoring to observe cerebral blood flow indirectly. Evoked potential monitoring measures the electrical potentials produced by nerve tissue in response to external stimulation (auditory, visual, or sensory). Lumbar puncture is avoided in patients with increased ICP, because the sudden release of pressure in the lumbar area can cause the brain to herniate (Mazzoni, Pearson & Rowland, 2006). (See Chapter 60 for further discussion of lumbar puncture and other diagnostic tests.)

## Complications

Complications of increased ICP include brain stem herniation, diabetes insipidus, and syndrome of inappropriate antidiuretic hormone (SIADH).

Brain stem herniation results from an excessive increase in ICP in which the pressure builds in the cranial vault and the brain tissue presses down on the brain stem. This increasing pressure on the brain stem results in cessation of blood flow to the brain, leading to irreversible brain anoxia and brain death.

Diabetes insipidus is the result of decreased secretion of antidiuretic hormone (ADH). The patient has excessive urine output, decreased urine osmolality, and serum hyperosmolarity (Porth & Matfin, 2009). Therapy consists of administration of fluids, electrolyte replacement, and vasopressin (desmopressin, [DDAVP]) therapy. Diabetes insipidus is discussed in Chapters 14 and 42.

SIADH is the result of increased secretion of ADH. The patient becomes volume overloaded, urine output diminishes, and serum sodium concentration becomes dilute. Treatment of SIADH includes fluid restriction (less than 800 mL/day with no free water), which is usually sufficient to correct the hyponatremia. In severe cases, careful administration of a 3% hypertonic saline solution may be therapeutic (Mortimer & Jancik, 2006). The change in serum sodium concentration should not exceed a correction rate of approximately 1.3 mEq/L/h. Further discussion of SIADH is presented in Chapters 14 and 42.

## Medical Management

Increased ICP is a true emergency and must be treated promptly. Invasive monitoring of ICP is an important component of management. Immediate management to relieve increased ICP requires decreasing cerebral edema, lowering the volume of CSF, or decreasing cerebral blood volume while maintaining cerebral perfusion. These goals are accomplished by administering osmotic diuretics, restricting fluids, draining CSF, controlling fever, maintaining systemic blood pressure and oxygenation, and reducing cellular metabolic demands. Management of increased ICP is discussed in Chapter 63.

### *Monitoring Intracranial Pressure and Cerebral Oxygenation*

The purposes of ICP monitoring are to identify increased pressure early in its course (before cerebral damage occurs), to quantify the degree of elevation, to initiate appropriate treatment, to provide access to CSF for sampling and drainage, and to evaluate the effectiveness of treatment. ICP can be monitored with the use of an intraventricular catheter (ventriculostomy), a subarachnoid bolt, an epidural or subdural catheter, or a fiberoptic transducer-tipped catheter placed in the subdural space or in the ventricle (Fig. 61-3).

When a **ventriculostomy** or ventricular catheter monitoring device is used for monitoring ICP, a fine-bore catheter is inserted into a lateral ventricle, preferably in the nondominant hemisphere of the brain (Hickey, 2009). The catheter is connected by a fluid-filled system to a transducer, which records the pressure in the form of an electrical impulse. In addition to obtaining continuous ICP recordings, the ventricular catheter allows CSF to drain, particularly during acute increases in pressure. The ventriculostomy can also be

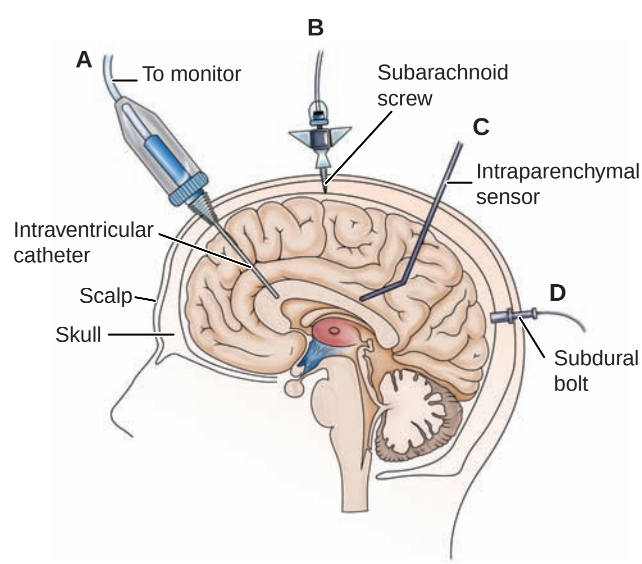



**Figure 61-3** Intracranial pressure monitoring. A device may be placed in **(A)** the ventricle **(B)** the subarachnoid space **(C)** the intraparenchymal space or **(D)** the subdural space.

used to drain blood from the ventricle. Continuous drainage of CSF under pressure control is an effective method of treating intracranial hypertension. Another advantage of a ventricular catheter is access for the intraventricular administration of medications and the occasional instillation of air or a contrast agent for ventriculography. Complications associated with its use include infection, meningitis, ventricular collapse, occlusion of the catheter by brain tissue or blood, and problems with the monitoring system.

The **subarachnoid screw or bolt** is a hollow device that is inserted through the skull and dura mater into the cranial subarachnoid space (Hickey, 2009). It has the advantage of not requiring a ventricular puncture. The subarachnoid screw is attached to a pressure transducer, and the output is recorded on an oscilloscope. The hollow screw technique also has the advantage of avoiding complications from brain shift and small ventricle size. Complications include infection and blockage of the screw by clot or brain tissue, which leads to a loss of pressure tracing and a decrease in accuracy at high ICP readings.

An **epidural monitor** uses a pneumatic flow sensor to detect ICP. The epidural ICP monitoring system has a low incidence of infection and complications and appears to read pressures accurately. Calibration of the system is maintained automatically, and abnormal pressure waves trigger an alarm system. One disadvantage of the epidural catheter is the inability to withdraw CSF for analysis.

A **fiberoptic monitor,** or transducer-tipped catheter, is an alternative to other intraventricular, subarachnoid, and subdural systems (Haitsma & Maas, 2007). The miniature transducer reflects pressure changes, which are converted to electrical signals in an amplifier and displayed on a digital monitor. The catheter can be inserted into the ventricle, subarachnoid space, subdural space, or brain parenchyma or under a bone flap. If inserted into the ventricle, it can also be used in conjunction with a CSF drainage device.

### Interpreting Intracranial Pressure Waveforms

Waves of high pressure and troughs of relatively normal pressure indicate changes in ICP. Waveforms are captured and recorded on an oscilloscope. These waves have been classified as A waves (plateau waves), B waves, and C waves (Fig. 61-4). The plateau waves (A waves) are transient, paroxysmal, recurring elevations of ICP that may last 5 to 20 minutes and range in amplitude from 50 to 100 mm Hg (AANN, 2005). Plateau waves have clinical significance and indicate changes in vascular volume within the intracranial compartment that are beginning to compromise cerebral perfusion. The A waves may increase in amplitude and frequency, reflecting cerebral ischemia and brain damage that can occur before overt signs and symptoms of raised ICP are seen clinically. B waves are shorter (30 seconds to 2 minutes) and have smaller amplitude (up to 50 mm Hg). They have less clinical significance, but if seen in a series in a patient with depressed consciousness, they may precede the appearance of A waves. B waves may be seen in patients with intracranial hypertension and decreased intracranial compliance. C waves are small, rhythmic oscillations with frequencies of approximately six per minute. They appear to be related to rhythmic variations of the systemic arterial blood pressure and respirations. The clinical significance of C waves is unknown (Littlejohns & Bader, 2009).

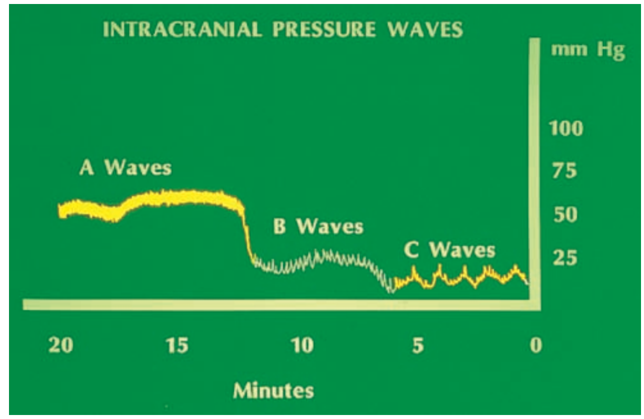



**Figure 61-4** Intracranial pressure waves. Composite diagram of A (plateau) waves, which indicate cerebral ischemia; B waves, which indicate intracranial hypertension and variations in the respiratory cycle; and C waves, which relate to variations in systemic arterial pressure and respirations.

### Other Neurologic Monitoring Systems

Additional trends in neurologic monitoring include **microdialysis** of the patient with a brain injury (McAdoo & Wu, 2008). Cortical probes are placed near the injured area and are used to measure levels of glutamate, lactate, pyruvate, and glucose, substances that reflect the metabolic function of the brain. Some researchers theorize that direct measurements of glucose and energy byproducts in the brain will lead to better management of these patients and, ultimately, to improved outcomes.

An additional trend is monitoring of cerebral oxygenation through monitoring of the oxygen saturation in the jugular venous bulb ($SjvO_2$) or via a catheter in the brain. Cerebral oxygenation is thought to be important because changes in cerebral perfusion may reflect an increase in ICP. Readings taken from a catheter residing in the jugular outflow tract allow for a comparison of arterial and venous oxygen saturation, and the balance of cerebral oxygen supply and demand is demonstrated. Venous jugular desaturations can reflect early cerebral ischemia, alerting the clinician before an increase in ICP occurs. Minimizing cerebral desaturations can potentially improve outcomes (Haitsma & Maas, 2007). This type of monitoring is now widely available and has been successfully used to identify secondary brain insults. A limiting factor is that this saturation reflects overall perfusion of the brain rather than that of a specific injured area (Lescot, Abdennour, Boch, et al., 2008).

Another method of measuring cerebral oxygenation and temperature is by inserting a fiberoptic catheter into the brain matter (Jaeger, Soehle & Meixenberger, 2005). The most common system is LICOX (manufactured by Integra NeuroSciences, Plainsboro, NJ; Fig. 61-5). The system includes a monitor with a screen for the display of oxygen and temperature values and cables that connect to the monitoring probes in the brain (Hickey, 2009).

#### *Decreasing Cerebral Edema*

Osmotic diuretics such as mannitol may be administered to dehydrate the brain tissue and reduce cerebral edema. They

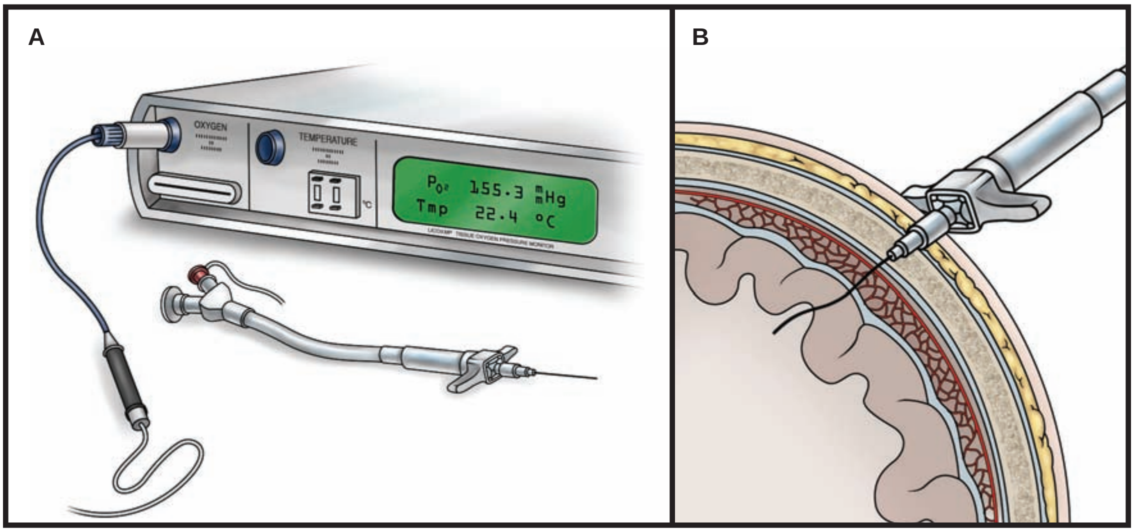



**Figure 61-5** LICOX catheter system. **A,** The brain tissue oxygen catheter and monitor. **B,** Placement of the catheter in brain white matter. Redrawn with permission of Integra NeuroSciences, Plainsboro, NJ.

act by drawing water across intact membranes, thereby reducing the volume of the brain and extracellular fluid. An indwelling urinary catheter is usually inserted to monitor urinary output and to manage the resulting diuresis. If the patient is receiving osmotic diuretics, serum osmolality should be determined to assess hydration status. If a brain tumor is the cause of the increased ICP, corticosteroids (eg, dexamethasone) help reduce the edema surrounding the tumor.

Another method for decreasing cerebral edema is fluid restriction (Hickey, 2009). Limiting overall fluid intake leads to dehydration and hemoconcentration, which draws fluid across the osmotic gradient and decreases cerebral edema. Conversely, overhydration of the patient with increased ICP is avoided, because it increases cerebral edema.

Researchers have long hypothesized that lowering body temperature would decrease cerebral edema by reducing the oxygen and metabolic requirements of the brain, thus protecting the brain from continued ischemia. If body metabolism can be reduced by lowering the body temperature, the collateral circulation in the brain may be able to provide an adequate blood supply to the brain. The effect of hypothermia on ICP requires more study; thus far, induced hypothermia has not consistently been shown to be beneficial for patients with brain injury. Inducing and maintaining hypothermia is a major clinical treatment and requires knowledge and skilled nursing observation and management. The type and length of rewarming techniques after hypothermia may also be factors in the outcome of patients with neurologic injuries (Lescot, et al., 2008).

### Maintaining Cerebral Perfusion

Cardiac output may be manipulated to provide adequate perfusion to the brain. Improvements in cardiac output are made using fluid volume and inotropic agents such as dobutamine (Dobutrex) and norepinephrine (Levophed). The effectiveness of the cardiac output is reflected in the CPP, which is maintained at greater than 70 mm Hg (Lescot, et al., 2008). A lower CPP indicates that the cardiac output is insufficient to maintain adequate cerebral perfusion. $SjvO_2$ and LICOX, described earlier, assist in monitoring cerebral perfusion.

### Reducing Cerebrospinal Fluid and Intracranial Blood Volume

CSF drainage is frequently performed, because the removal of CSF with a ventriculostomy drain can dramatically reduce ICP and restore CPP. Caution should be used in draining CSF, however, because excessive drainage may result in collapse of the ventricles and herniation. The reduction in $PaCO_2$ may result in hypoxia, ischemia, and an increase in cerebral lactate levels. Maintaining the $PaCO_2$ at greater than 30 mm Hg may prove beneficial (Hickey, 2009).

### Controlling Fever

Preventing a temperature elevation is critical, because fever increases cerebral metabolism and the rate at which cerebral edema forms. Strategies to reduce body temperature include administration of antipyretic medications, as prescribed, and use of a hypothermia blanket. Additional strategies for reducing fever were previously discussed in the Nursing Process section on altered LOC. The patient's temperature is monitored closely, and the patient is observed for shivering, which should be avoided because it is associated with increased oxygen consumption, increased levels of circulating catecholamines, and increased vasoconstriction (Mcilvoy, 2007).

### Maintaining Oxygenation and Reducing Metabolic Demands

Arterial blood gases and pulse oximetry are monitored to ensure that systemic oxygenation remains optimal. Metabolic demands may be reduced through the administration of high doses of barbiturates if the patient is unresponsive to conventional treatment. The mechanism by which barbiturates decrease ICP and protect the brain is uncertain, but

the resultant comatose state is thought to reduce the metabolic requirements of the brain, thus providing cerebral protection (Bader, Arbour & Palmer, 2005).

Another method of reducing cellular metabolic demand and improving oxygenation is the administration of paralyzing medication such as propofol (Diprivan). The patient who receives these agents cannot move; this decreases the metabolic demands and results in a decrease in cerebral oxygen demand. Paralyzing agents do not produce either sedation or analgesia, which must be provided, because the patient cannot respond to or report pain. The most common agents used for barbiturate or paralytic therapy are pentobarbital (Nembutal), thiopental (Pentothal), and propofol (Bader, et al., 2005).

If barbiturates or paralyzing agents are used, the ability to perform serial neurologic assessments is lost. Therefore, other monitoring tools are needed to assess the patient's status and response to therapy. Important parameters that must be assessed include ICP, blood pressure, heart rate, respiratory rate, and the patient's response to ventilator therapy (eg, "bucking the ventilator"). The level of pharmacologic paralysis is adjusted based on serum levels of the medications administered and the assessed parameters. Potential complications include hypotension caused by decreased sympathetic tone and myocardial depression.

Patients receiving high doses of barbiturates or pharmacologic paralyzing agents require continuous cardiac monitoring, endotracheal intubation, mechanical ventilation, and arterial pressure monitoring, as well as ICP monitoring. In addition, serum barbiturate levels must be routinely monitored (Lescot, et al., 2008).

## NURSING PROCESS

## The Patient With Increased Intracranial Pressure

### Assessment

Initial assessment of the patient with increased ICP includes obtaining a history of events leading to the present illness and the pertinent past medical history. It is usually necessary to obtain this information from family or friends. The neurologic examination should be as complete as the patient's condition allows. It includes an evaluation of mental status, LOC, cranial nerve function, cerebellar function (balance and coordination), reflexes, and motor and sensory function. Because the patient is critically ill, ongoing assessment is more focused, including pupil checks, assessment of selected cranial nerves, frequent measurements of vital signs and ICP, and use of the Glasgow Coma Scale. Assessment of the patient with altered LOC is summarized in Table 61-1.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses for patients with increased ICP include the following:

- Ineffective airway clearance related to diminished protective reflexes (cough, gag)
- Ineffective breathing patterns related to neurologic dysfunction (brain stem compression, structural displacement)
- Ineffective cerebral tissue perfusion related to the effects of increased ICP
- Deficient fluid volume related to fluid restriction
- Risk for infection related to ICP monitoring system (fiberoptic or intraventricular catheter)

Other relevant nursing diagnoses are included in the section on altered LOC.

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications include:

- Brain stem herniation
- Diabetes insipidus
- SIADH

### Planning and Goals

The goals for the patient include maintenance of a patent airway, normalization of respiration, adequate cerebral tissue perfusion through reduction in ICP, restoration of fluid balance, absence of infection, and absence of complications.

### Nursing Interventions

#### *Maintaining a Patent Airway*

The patency of the airway is assessed. Secretions that are obstructing the airway must be suctioned with care, because transient elevations of ICP occur with suctioning (Hickey, 2009). Hypoxia caused by poor oxygenation leads to cerebral ischemia and edema. Coughing is discouraged because it increases ICP. The lung fields are auscultated at least every 8 hours to determine the presence of adventitious sounds or any areas of congestion. Elevating the head of the bed may aid in clearing secretions and improve venous drainage of the brain.

#### *Achieving an Adequate Breathing Pattern*

The patient must be monitored constantly for respiratory irregularities. Increased pressure on the frontal lobes or deep midline structures may result in Cheyne-Stokes respirations, whereas pressure in the midbrain can cause hyperventilation. If the lower portion of the brain stem (the pons and medulla) is involved, respirations become irregular and eventually cease.

If hyperventilation therapy is deemed appropriate to reduce ICP (by causing cerebral vasoconstriction and a decrease in cerebral blood volume), the nurse collaborates with the respiratory therapist in monitoring the $PaCO_2$, which is usually maintained at less than 30 mm Hg (Hickey, 2009).

A neurologic observation record (Fig. 61-6) is maintained, and all observations are made in relation to the patient's baseline condition. Repeated assessments of the patient are made (sometimes minute by minute) so that improvement or deterioration may be noted immediately. If the patient's condition deteriorates, preparations are made for surgical intervention.

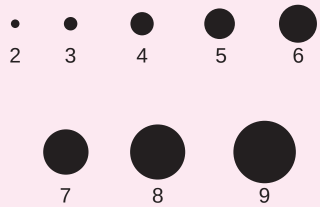
#### *Optimizing Cerebral Tissue Perfusion*

In addition to ongoing nursing assessment, strategies are initiated to reduce factors contributing to the elevation of ICP (Table 61-2).

| NURSING NEUROLOGICAL CRITICAL CARE FLOWSHEET | ADDRESSOGRAPH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | | | | | | | | | | | | |
| | Time | | | | | | | | | | | | |
| | Initials | | | | | | | | | | | | |
| Level of orientation (✓) | Person | | | | | | | | | | | | |
| | Place | | | | | | | | | | | | |
| | Date and time | | | | | | | | | | | | |
| | No orientation | | | | | | | | | | | | |
| Awakens to (✓) | Voice | | | | | | | | | | | | |
| | Touch | | | | | | | | | | | | |
| | Noxious stimuli | | | | | | | | | | | | |
| | Painful stimuli | | | | | | | | | | | | |
| | No response | | | | | | | | | | | | |
| Best verbal response (✓) | Clear and appropriate | | | | | | | | | | | | |
| | Clear and inappropriate | | | | | | | | | | | | |
| | Difficulty speaking* | | | | | | | | | | | | |
| | Perseveration | | | | | | | | | | | | |
| | Aphasic expressive (non-fluent) | | | | | | | | | | | | |
| | Aphasic receptive (fluent) | | | | | | | | | | | | |
| | Sounds no speech | | | | | | | | | | | | |
| | No verbal response | | | | | | | | | | | | |
| | ETT/TRACH | | | | | | | | | | | | |
| Best motor response (✓) | Moves all extremities purposefully | | | | | | | | | | | | |
| | Withdraws and lifts to painful stimuli | | | | | | | | | | | | |
| | Moves to painful stimuli | | | | | | | | | | | | |
| | Decorticates (spinal reflex) | | | | | | | | | | | | |
| | Decerebrates (spinal reflex) | | | | | | | | | | | | |
| | No motor response | | | | | | | | | | | | |
| Best motor strength upper extremities (✓) | No drifts (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Drift (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Can only lift forearm (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Trace movement of hand or arm (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Trace movement of fingers only (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | No motor response (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| Best strength lower extremities (✓) | Raises leg off bed (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Drags heel on bed and lifts knee (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Trace movement of foot or leg (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Trace movement of toes only (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | No response (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| Seizure activity (✓) | No seizure activity | | | | | | | | | | | | |
| | With loss of consciousness* | | | | | | | | | | | | |
| | Without loss of consciousness* | | | | | | | | | | | | |
| Ataxia (✓) | Gross ataxia | | | | | | | | | | | | |
| | Fine motor ataxia | | | | | | | | | | | | |
| | Does not apply | | | | | | | | | | | | |
| ICP monitoring | Ventriculostomy mL | | | | | | | | | | | | |
| | ICP mm Hg | | | | | | | | | | | | |
| | Not applicable | | | | | | | | | | | | |
| *= FURTHER DOCUMENTATION IS REQUIRED TO VALIDATE ASSESSMENT | | | | | | | | | | | | | |

**Figure 61-6** A neurologic assessment flow chart.

PUPIL GAUGE (mm)




B=Brisk, S=Sluggish, F=Fixed

ADDRESSOGRAPH

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | | | | | | | | | | | | |
| | Time | | | | | | | | | | | | |
| | Initials | | | | | | | | | | | | |
| Incision +/– | Dry and intact | | | | | | | | | | | | |
| | Drainage | | | | | | | | | | | | |
| Pupils: refer to above gauge (✓) (+)=Present (–)=Absent | Size (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Regular (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Irregular* (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Reaction (R/L) (B) - (S) - (F) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Ptosis (R/L) (+) (–) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Gaze preference (R/L) (+)* (–) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| Meningeal signs (+)=Present (–)=Absent | Headache | | | | | | | | | | | | |
| | Nuchal rigidity | | | | | | | | | | | | |
| | Photophobia | | | | | | | | | | | | |
| Visual fields (+)=Present (–)=Absent* NA=Not applicable | Right upper outer | | | | | | | | | | | | |
| | Right lower outer | | | | | | | | | | | | |
| | Left upper outer | | | | | | | | | | | | |
| | Left lower outer | | | | | | | | | | | | |
| Nystagmus (+)=Present (–)=Absent | Lateral (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | Vertical (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| Cranial nerves (+)=Present (–)=Absent | III, IV, VI, Extraocular movements | | | | | | | | | | | | |
| | VII – Peripheral facial droop (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | XII – Tongue deviation (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | IX – Gag reflex | | | | | | | | | | | | |
| | V, VII – Corneal reflex (R/L) | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L | R L |
| | X, IX – Cough reflex | | | | | | | | | | | | |
| | Doll's eyes if appropriate | | | | | | | | | | | | |
| Follows commands | Two step verbal command | | | | | | | | | | | | |
| | One step verbal command | | | | | | | | | | | | |
| | Unable to follow command | | | | | | | | | | | | |

*= **FURTHER DOCUMENTATION IS REQUIRED TO VALIDATE ASSESSMENT**

| Initials | Signature | Title | Initials | Signature | Title |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Figure 61-6** (*Continued*).

**Table 61-2 INCREASED INTRACRANIAL PRESSURE AND INTERVENTIONS**

| Factor | Physiology | Interventions | Rationale |
|---|---|---|---|
| Cerebral edema | Can be caused by contusion, tumor, or abscess; water intoxication (hypo-osmolality); alteration in the blood–brain barrier (protein leaks into the tissue, causing water to follow) | Administer osmotic diuretics as prescribed (monitor serum osmolality). | Promotes venous return |
| | | Maintain head of bed elevated 30 degrees. Maintain alignment of the head. | Prevents impairment of venous return through the jugular veins |
| Hypoxia | A decrease in the $PaO_2$ causes cerebral vasodilation at <60 mm Hg. | Maintain $PaO_2$ >60 mm Hg. Maintain oxygen therapy. Monitor arterial blood gas values. Suction when needed. Maintain a patent airway. | Prevents hypoxia and vasodilation |
| Hypercapnia (elevated $PaCO_2$) | Causes vasodilation | Maintain $PaCO_2$ (normally 35–45 mm Hg) by establishing ventilation. | Normalizing $PaCO_2$ minimizes vasodilation and thus reduces the cerebral blood volume |
| Impaired venous return | Increases the cerebral blood volume | Maintain head alignment. Elevate head of bed 30 degrees. | Hyperextension, rotation, or hyperflexion of the neck causes decreased venous return |
| Increase in intrathoracic or abdominal pressure | An increase in these presures due to coughing, PEEP, or Valsalva maneuver causes a decrease in venous return. | Monitor arterial blood gas values and keep PEEP as low as possible. Provide humidified oxygen. | To keep secretions loose and easy to suction or expectorate |
| | | Administer stool softeners as prescribed. | Soft bowel movements will prevent straining or Valsalva maneuver |

Proper positioning helps reduce ICP. The patient's head is kept in a neutral (midline) position, maintained with the use of a cervical collar if necessary, to promote venous drainage. Elevation of the head is maintained at 30 to 45 degrees unless contraindicated (Littlejohns & Bader, 2009). Extreme rotation of the neck and flexion of the neck are avoided, because compression or distortion of the jugular veins increases ICP. Extreme hip flexion is also avoided, because this position causes an increase in intra-abdominal and intrathoracic pressures, which can produce an increase in ICP. Relatively minor changes in position can significantly affect ICP. If monitoring reveals that turning the patient raises ICP, rotating beds, turning sheets, and holding the patient's head during turning may minimize the stimuli that increase ICP.

The Valsalva maneuver, which can be produced by straining at defecation or even moving in bed, raises ICP and is to be avoided. Stool softeners may be prescribed. If the patient is alert and able to eat, a diet high in fiber may be indicated. Abdominal distention, which increases intra-abdominal and intrathoracic pressure and ICP, should be noted. Enemas and cathartics are avoided if possible. When moving or being turned in bed, the patient can be instructed to exhale (which opens the glottis) to avoid the Valsalva maneuver.

Mechanical ventilation presents unique problems for the patient with increased ICP. Before suctioning, the patient should be preoxygenated and briefly hyperventilated using 100% oxygen on the ventilator. Suctioning should not last longer than 15 seconds. High levels of positive end-expiratory pressure (PEEP) are avoided, because they may decrease venous return to the heart and decrease venous drainage from the brain through increased intrathoracic pressure (Littlejohns & Bader, 2009).

Activities that increase ICP, as indicated by changes in waveforms, should be avoided if possible. Spacing of nursing interventions may prevent transient increases in ICP. During nursing interventions, the ICP should not increase more than 25 mm Hg, and it should return to baseline levels within 5 minutes. Patients with increased ICP should not demonstrate a significant increase in pressure or change in the ICP waveform. Patients with the potential for a significant increase in ICP may need sedation and a paralytic agent before initiation of nursing activities (Olsen & Graffagnino, 2005).

Emotional stress and frequent arousal from sleep are avoided. A calm atmosphere is maintained. Environmental stimuli (eg, noise, conversation) should be minimal.

### *Maintaining Negative Fluid Balance*

The administration of osmotic and loop diuretics is part of the treatment protocol to reduce ICP. Corticosteroids may be used to reduce cerebral edema (except when it results from trauma), and fluids may be restricted. All of these treatment modalities promote dehydration.

Skin turgor, mucous membranes, urine output, and serum and urine osmolality are monitored to assess fluid status. If IV fluids are prescribed, the nurse ensures that they are administered at a slow to moderate rate with an IV infusion pump, to prevent too-rapid administration and avoid overhydration. For the patient receiving mannitol, the nurse observes for the possible development of heart failure and pulmonary edema, because the intent of treatment is to promote a shift of fluid from the intracellular to the intravascular compartment, thus controlling cerebral edema.

For patients undergoing dehydrating procedures, vital signs, including blood pressure, must be monitored to assess fluid volume status. An indwelling urinary catheter is inserted to permit assessment of renal function and fluid status. During the acute phase, urine output is monitored hourly. An output greater than 200 mL/h for 2 consecutive hours may indicate the onset of diabetes insipidus (Hickey, 2009).

These patients need careful oral hygiene, because mouth dryness occurs with dehydration. Frequently rinsing the mouth with nondrying solutions, lubricating the lips, and removing encrustations relieve dryness and promote comfort.

### *Preventing Infection*

The risk of infection is greatest when ICP is monitored with an intraventricular catheter and increases with the duration of the monitoring. Most health care facilities have written protocols for managing these systems and maintaining their sterility; strict adherence to the protocols is essential.

Aseptic technique must be used when managing the system and changing the ventricular drainage bag. The drainage system is also checked for loose connections, because they can cause leakage and contamination of the CSF as well as inaccurate readings of ICP. The nurse observes the character of the CSF drainage and reports increasing cloudiness or blood. The patient is monitored for signs and symptoms of meningitis: fever, chills, nuchal (neck) rigidity, and increasing or persistent headache. (See Chapter 64 for a discussion of meningitis.)

### *Monitoring and Managing Potential Complications*

The primary complication of increased ICP is brain herniation resulting in death (see Fig. 61-2). Nursing management focuses on detecting early signs of increasing ICP, because medical interventions are usually ineffective once later signs develop. Frequent neurologic assessments and documentation and analysis of trends will reveal the subtle changes that may indicate increasing ICP.

**DETECTING EARLY INDICATIONS OF INCREASING INTRACRANIAL PRESSURE.** The nurse assesses for and immediately reports any of the following early signs or symptoms of increasing ICP:

- Disorientation, restlessness, increased respiratory effort, purposeless movements, and mental confusion; these are early clinical indications of increasing ICP because the brain cells responsible for cognition are extremely sensitive to decreased oxygenation
- Pupillary changes and impaired extraocular movements; these occur as the increasing pressure displaces the brain against the oculomotor and optic nerves (cranial nerves II, III, IV, and VI), which arise from the midbrain and brain stem (see Chapter 60)
- Weakness in one extremity or on one side of the body; this occurs as increasing ICP compresses the pyramidal tracts
- Headache that is constant, increasing in intensity, and aggravated by movement or straining; this occurs as increasing ICP causes pressure and stretching of venous and arterial vessels in the base of the brain

**DETECTING LATER INDICATIONS OF INCREASING INTRACRANIAL PRESSURE.** As ICP increases, the patient's condition worsens, as manifested by the following signs and symptoms:

- The LOC continues to deteriorate until the patient is comatose.
- The pulse rate and respiratory rate decrease or become erratic, and the blood pressure and temperature increase. The pulse pressure (the difference between the systolic and the diastolic pressures) widens. The pulse fluctuates rapidly, varying from bradycardia to tachycardia.
- Altered respiratory patterns develop, including Cheyne-Stokes breathing (rhythmic waxing and waning of rate and depth of respirations alternating with brief periods of apnea) and ataxic breathing (irregular breathing with a random sequence of deep and shallow breaths).
- Projectile vomiting may occur with increased pressure on the reflex center in the medulla.
- Hemiplegia or decorticate or decerebrate posturing may develop as pressure on the brain stem increases; bilateral flaccidity occurs before death.
- Loss of brain stem reflexes, including pupillary, corneal, gag, and swallowing reflexes, is an ominous sign of approaching death.

**MONITORING INTRACRANIAL PRESSURE.** Because clinical assessment is not always a reliable guide in recognizing increased ICP, especially in comatose patients, monitoring of ICP and cerebral oxygenation is an essential part of management. ICP is monitored closely for continuous elevation or significant increase over baseline. The trend of ICP measurements over time is an important indication of the patient's underlying status. Vital signs are assessed when an increase in ICP is noted.

Strict aseptic technique is used when handling any part of the monitoring system. The insertion site is inspected for signs of infection. Temperature, pulse, and respirations are closely monitored for systemic signs of infection. All connections and stopcocks are checked for leaks, because even small leaks can distort pressure readings and lead to infection (Littlejohns & Bader, 2009).

When ICP is monitored with a fluid system, the transducer is calibrated at a particular reference point, usually 2.5 cm (1 inch) above the ear with the patient in the supine position; this point corresponds to the level of the foramen of Monro (Fig. 61-7). CSF pressure readings depend on the patient's position. For subsequent pressure readings, the head should be in the same position relative to the transducer. Fiberoptic catheters are calibrated before insertion and do not require further referencing; they do not require the head of the bed to be at a specific position to obtain an accurate reading.

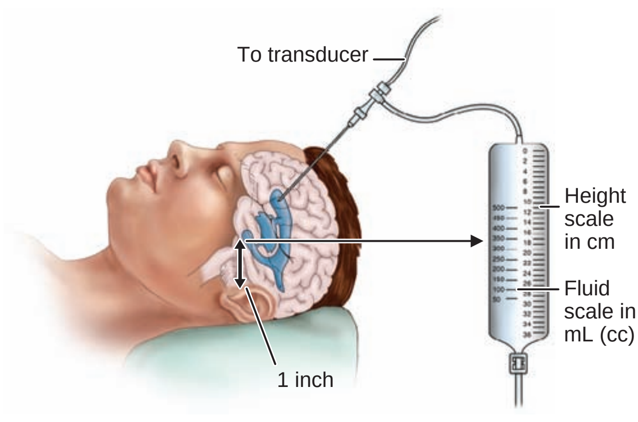



**Figure 61-7** Location of the foramen of Monro for calibration of intracranial pressure monitoring system.

When technology is associated with patient management, the nurse must be certain that the technologic equipment is functioning properly. The most important concern must be the patient to whom equipment is attached. The patient and family must be informed about the technology and the goals of its use. The patient's response is monitored, and appropriate comfort measures are implemented to ensure that the patient's stress is minimized.

ICP measurement is only one parameter; repeated neurologic checks and clinical examinations remain important measures. Astute observation, comparison of findings with previous observations, and interventions can assist in preventing life-threatening ICP elevations.

**MONITORING FOR SECONDARY COMPLICATIONS.** The nurse also assesses for complications of increased ICP, including diabetes insipidus and SIADH (see Chapters 14 and 42). Urine output should be monitored closely. Diabetes insipidus requires fluid and electrolyte replacement, along with the administration of vasopressin, to replace and slow the urine output. Serum electrolyte levels are monitored for imbalances. SIADH requires fluid restriction and monitoring of serum electrolyte levels.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Maintains patent airway
2. Attains optimal breathing pattern
   a. Breathes in a regular pattern
   b. Attains or maintains arterial blood gas values within acceptable range
3. Demonstrates optimal cerebral tissue perfusion
   a. Increasingly oriented to time, place, and person
   b. Follows verbal commands; answers questions correctly
4. Attains desired fluid balance
   a. Maintains fluid restriction
   b. Demonstrates serum and urine osmolality values within acceptable range
5. Has no signs or symptoms of infection
   a. Has no fever
   b. Shows no redness, swelling, or drainage at arterial, IV, and urinary catheter sites
   c. Has no redness, swelling, or purulent drainage from invasive intracranial monitoring device
6. Absence of complications
   a. Has ICP values that remain within normal limits
   b. Demonstrates urine output and serum electrolyte levels within acceptable limits

# INTRACRANIAL SURGERY

A **craniotomy** involves opening the skull surgically to gain access to intracranial structures. This procedure is performed to remove a tumor, relieve elevated ICP, evacuate a blood clot, or control hemorrhage. The surgeon cuts the skull to create a bony flap, which can be repositioned after surgery and held in place by periosteal or wire sutures. One of two approaches through the skull is used: (1) above the tentorium (supratentorial craniotomy) into the supratentorial compartment, or (2) below the tentorium into the infratentorial (posterior fossa) compartment. A third approach, the **transsphenoidal** approach (through the mouth and nasal sinuses) is often used to gain access to the pituitary gland (Musleh, Sonabend & Lesniak, 2006). Table 61-3 compares the three different surgical approaches: supratentorial, infratentorial, and transsphenoidal.

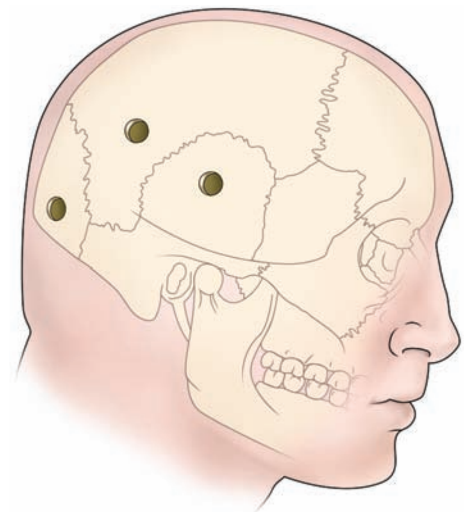


**Figure 61-8** Burr holes may be used in neurosurgical procedures to make a bone flap in the skull, to aspirate a brain abscess, or to evacuate a hematoma.

Alternatively, intracranial structures may be approached through burr holes (Fig. 61-8), which are circular openings made in the skull by either a hand drill or an automatic craniotome (which has a self-controlled system to stop the drill when the bone is penetrated). Burr holes may be used to determine the presence of cerebral swelling and injury and the size and position of the ventricles. They are also a means of evacuating an intracranial hematoma or abscess and for making a bone flap in the skull that allows access to the ventricles for decompression, ventriculography, or shunting procedures. Other cranial procedures include **craniectomy** (excision of a portion of the skull) and cranioplasty (repair of a cranial defect using a plastic or metal plate).

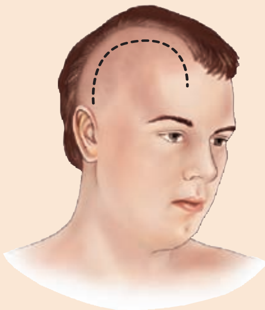
## *Supratentorial and Infratentorial Approaches*

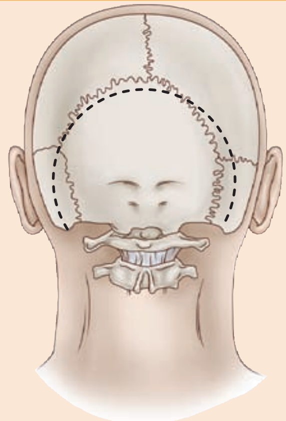
### PREOPERATIVE MANAGEMENT

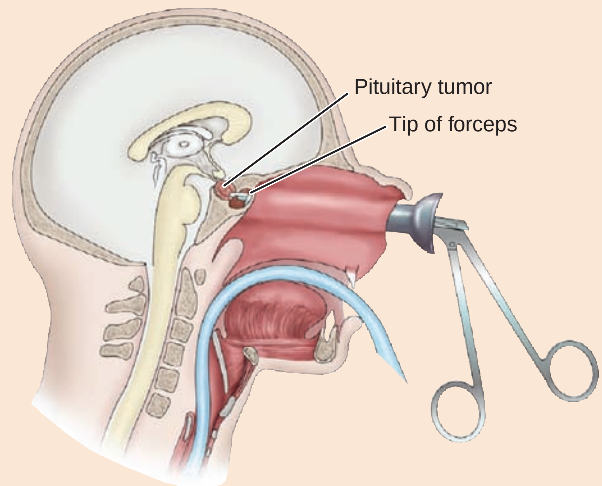
#### Medical Management

Preoperative diagnostic procedures may include a CT scan to demonstrate the lesion and show the degree of surrounding brain edema, the ventricular size, and the displacement. An MRI scan provides information similar to that of a CT scan with improved tissue contrast, resolution,

**Table 61-3 COMPARISON OF CRANIAL SURGICAL APPROACHES**








| Supratentorial | Infratentorial | Transsphenoidal |
|---|---|---|
| **Site of Surgery** | | |
| Above the tentorium | Below the tentorium, brain stem | Sella turcica and pituitary region |
| **Incision Location** | | |
| Incision is made above the area to be operated on; usually located behind the hairline. | Incision is made at the nape of the neck, around the occipital lobe. | Incision is made beneath the upper lip to gain access into the nasal cavity. |
| **Selected Nursing Interventions** | | |
| Maintain head of bed elevated 30–45 degrees, with neck in neutral alignment. | Maintain neck in straight alignment.<br>Avoid flexion of the neck to prevent possible tearing of the suture line. | Maintain nasal packing in place and reinforce as needed.<br>Instruct patient to avoid blowing the nose.<br>Provide frequent oral care. |
| Position patient on either side or back. (Avoid positioning patient on operative side if a large tumor has been removed.) | Position the patient on either side. (Check surgeon's preference for positioning of patient.) | Keep head of bed elevated to promote venous drainage and drainage from the surgical site. |

and anatomic definition. Cerebral angiography may be used to study a tumor's blood supply or obtain information about vascular lesions. Transcranial Doppler flow studies are used to evaluate the blood flow within intracranial blood vessels.

Most patients are prescribed an antiseizure medication such as phenytoin (Dilantin) or a phenytoin metabolite (Cerebyx) before surgery to reduce the risk of postoperative **seizures** (paroxysmal transient disturbances of the brain resulting from a discharge of abnormal electrical activity) (Karch, 2008). Before surgery, corticosteroids such as dexamethasone (Decadron) may be administered to reduce cerebral edema if the patient has a brain tumor. Fluids may be restricted. A hyperosmotic agent (mannitol) and a diuretic agent such as furosemide (Lasix) may be administered IV immediately before and sometimes during surgery if the patient tends to retain fluid, as do many who have intracranial dysfunction. Antibiotics may be administered if there is a chance of cerebral contamination; diazepam (Valium) or lorazepam (Ativan) may be prescribed before surgery to allay anxiety.

## Nursing Management

The preoperative assessment serves as a baseline against which postoperative status and recovery are compared. This assessment includes evaluating the LOC and responsiveness to stimuli and identifying any neurologic deficits, such as paralysis, visual dysfunction, alterations in personality or speech, and bladder and bowel disorders. Distal and proximal motor strength in both upper and lower extremities is recorded on a 5-point scale. Testing of motor function is discussed in Chapter 60.

The patient's and family's understanding of and reactions to the anticipated surgical procedure and its possible sequelae are assessed, as is the availability of support systems for the patient and family. Adequate preparation for surgery, with attention to the patient's physical and emotional status, can reduce the risk of anxiety, fear, and postoperative complications. The patient is assessed for neurologic deficits and their potential impact after surgery. For motor deficits or weakness or paralysis of the arms or legs, trochanter rolls are applied to the extremities, and the feet are positioned

against a footboard or the ankles are supported in a neutral position with orthotic boots. A patient who can ambulate is encouraged to do so. If the patient is aphasic, writing materials or picture and word cards showing the bedpan, glass of water, blanket, and other frequently used items may help improve communication.

Preparation of the patient and family includes providing information about what to expect during and after surgery. Hair is removed with the use of clippers and the surgical site prepared immediately before surgery (usually in the operating room), to decrease the chance of infection. An indwelling urinary catheter is inserted in the operating room to drain the bladder during the administration of diuretics and to permit urinary output to be monitored. The patient may have a central and arterial line placed for fluid administration and monitoring of pressures after surgery. The large head dressing applied after surgery may impair hearing temporarily. Vision may be limited if the eyes are swollen shut. If a tracheostomy or endotracheal tube is in place, the patient will be unable to speak until the tube is removed, so an alternative method of communication must be established.

An altered cognitive state may make the patient unaware of the impending surgery (Chart 61-1). Even so, encouragement and attention to the patient's needs are necessary. Whatever the state of awareness of the patient, the family needs reassurance and support, because they usually recognize the seriousness of brain surgery.

## POSTOPERATIVE MANAGEMENT

Postoperatively, an arterial line and a central venous pressure line may be in place to monitor and manage blood pressure and central venous pressure. The patient may be intubated and may receive supplemental oxygen therapy. Ongoing postoperative management is aimed at detecting and reducing cerebral edema, relieving pain and preventing seizures, and monitoring ICP and neurologic status.

> **CHART 61-1** *Ethics and Related Issues*
>
> **What Ethical Principles Are Involved With Surrogate Consent?**
>
> **Situation**
>
> A 35-year-old woman has had a brain injury, is in and out of a comatose state, and needs a craniotomy for removal of an epidural hematoma. The health care provider determines that the patient is unable to give informed consent for the procedure, so consent is obtained from the next of kin.
>
> **Dilemma**
>
> The principle of autonomy for the patient conflicts with the principle of paternalism for the health care providers.
>
> **Discussion**
>
> 1. What are the essential elements of informed consent pertinent to this situation?
> 2. What mechanisms can the nursing staff use to assist them in resolving any dilemma they have regarding the patient's right to autonomy?

### Reducing Cerebral Edema

Medications to reduce cerebral edema include mannitol, which increases serum osmolality and draws free water from areas of the brain (with an intact blood–brain barrier). The fluid is then excreted by osmotic diuresis. Dexamethasone (Decadron) may be administered IV every 6 hours for 24 to 72 hours; the route is changed to oral as soon as possible, and the dosage is tapered over 5 to 7 days (Karch, 2008).

### Relieving Pain and Preventing Seizures

Acetaminophen is usually prescribed for temperatures exceeding 37.5°C (99.6°F) and for pain. The patient usually has a headache after a craniotomy as a result of stretching and irritation of nerves in the scalp during surgery. Codeine, administered IV, is often sufficient to relieve headache. Morphine sulfate may also be used in the management of postoperative pain in patients who have undergone a craniotomy (Nemergut, Durieaux, Missaghi, et al., 2007).

Antiseizure medication (phenytoin, diazepam) is often prescribed prophylactically for patients who have undergone supratentorial craniotomy because of the high risk of seizures after these procedures (Hickey, 2009). Serum levels are monitored to check that the medication levels are within the therapeutic range.

### Monitoring Intracranial Pressure

A patient undergoing intracranial surgery may have an ICP or cerebral oxygenation monitor inserted during surgery. Strict adherence to written protocols for managing these systems is essential, as discussed earlier, for preventing infection and managing ICP. The system is removed after the ICP or cerebral oxygenation is normal and stable. The neurosurgeon must be notified immediately if the system is not functioning.

## NURSING PROCESS

### The Patient Who Has Undergone Intracranial Surgery

#### Assessment

After surgery, the frequency of postoperative monitoring is based on the patient's clinical status. Assessing respiratory function is essential, because even a small degree of hypoxia can increase cerebral ischemia. The respiratory rate and pattern are monitored, and arterial blood gas values are assessed frequently. Fluctuations in vital signs are carefully monitored and documented, because they may indicate increased ICP. The patient's temperature is measured to assess for hyperthermia secondary to infection or damage to the hypothalamus. Neurologic checks are made frequently to detect increased ICP resulting from cerebral edema or bleeding. A change in LOC or response to stimuli may be the first sign of increasing ICP.

The surgical dressing is inspected for evidence of bleeding and CSF drainage. The incision is monitored for redness, tenderness, bulging, separation, or foul odor. Sodium retention may occur in the immediate postoperative period. Serum and urine electrolytes, BUN, blood glucose, weight,

and clinical status are monitored. Intake and output are measured in view of losses associated with fever, respiration, and CSF drainage. The nurse must be alert to the development of complications; all assessments are carried out with these problems in mind. Seizures are a potential complication, and any seizure activity is carefully recorded and reported. Restlessness may occur as the patient becomes more responsive, or restlessness may be caused by pain, confusion, hypoxia, or other stimuli.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses after intracranial surgery may include the following:

- Ineffective cerebral tissue perfusion related to cerebral edema
- Risk for imbalanced body temperature related to damage to the hypothalamus, dehydration, and infection
- Potential for impaired gas exchange related to hypoventilation, aspiration, and immobility
- Disturbed sensory perception related to periorbital edema, head dressing, endotracheal tube, and effects of ICP
- Body image disturbance related to change in appearance or physical disabilities

Other nursing diagnoses may include impaired communication (aphasia) related to insult to brain tissue and high risk for impaired skin integrity related to immobility, pressure, and incontinence; impaired physical mobility related to a neurologic deficit secondary to the neurosurgical procedure or to the underlying disorder may also occur.

### *Collaborative Problems/Potential Complications*

Potential complications include the following:

- Increased ICP
- Bleeding and hypovolemic shock
- Fluid and electrolyte disturbances
- Infection
- Seizures

## Planning and Goals

The major goals for the patient include neurologic homeostasis to improve cerebral tissue perfusion, adequate thermoregulation, normal ventilation and gas exchange, ability to cope with sensory deprivation, adaptation to changes in body image, and absence of complications.

## Nursing Interventions

### *Maintaining Cerebral Tissue Perfusion*

Attention to the patient's respiratory status is essential, because even slight decreases in the oxygen level (hypoxia) or slight increases in the carbon dioxide level (hypercarbia) can affect cerebral perfusion, the clinical course, and the patient's outcome. The endotracheal tube is left in place until the patient shows signs of awakening and has adequate spontaneous ventilation, as evaluated clinically and by arterial blood gas analysis. Secondary brain damage can result from impaired cerebral oxygenation.

Some degree of cerebral edema occurs after brain surgery; it tends to peak 24 to 36 hours after surgery, producing decreased responsiveness on the second postoperative day. The control of cerebral edema was discussed earlier. Nursing strategies used to control factors that may raise ICP were presented in the previous Nursing Process section on increased ICP. Intraventricular drainage is carefully monitored, using strict asepsis when any part of the system is handled.

Vital signs and neurologic status (LOC and responsiveness, pupillary and motor responses) are assessed every 15 to 60 minutes. Extreme head rotation is avoided, because this raises ICP. After supratentorial surgery, the patient is placed on his or her back or side (on the unoperated side if a large lesion was removed) with one pillow under the head. The head of the bed may be elevated 30 degrees, depending on the level of the ICP and the neurosurgeon's preference. After posterior fossa (infratentorial) surgery, the patient is kept flat on one side (off the back) with the head on a small, firm pillow. The patient may be turned on either side, keeping the neck in a neutral position. When the patient is being turned, the body should be turned as a unit to prevent placing strain on the incision and possibly tearing the sutures. The head of the bed may be elevated slowly as tolerated by the patient.

The patient's position is changed every 2 hours, and skin care is given frequently. During position changes, care is taken to prevent disruption of the ICP monitoring system. A turning sheet placed under the patient's head to midthigh makes it easier to move and turn the patient safely.

### *Regulating Temperature*

Moderate temperature elevation can be expected after intracranial surgery because of the reaction to blood at the operative site or in the subarachnoid space. Injury to the hypothalamic centers that regulate body temperature can occur during surgery. Fever is treated vigorously to combat the effect of an elevated temperature on brain metabolism and function.

Nursing interventions include monitoring the patient's temperature and using the following measures to reduce body temperature: removing blankets, applying ice bags to axilla and groin areas, using a hypothermia blanket as prescribed, and administering prescribed medications to reduce fever (Thompson, Kirkness, Mitchell, et al., 2007).

Conversely, hypothermia may be seen after lengthy neurosurgical procedures. Therefore, frequent measurements of rectal temperatures are necessary. Rewarming should occur slowly to prevent shivering, which increases cellular oxygen demands.

### *Improving Gas Exchange*

The patient undergoing neurosurgery is at risk for impaired gas exchange and pulmonary infections due to immobility, immunosuppression, decreased LOC, and fluid restriction. Immobility compromises the respiratory system by causing pooling and stasis of secretions in dependent areas and the development of atelectasis. The patient whose fluid intake is restricted may be more vulnerable to atelectasis as a result of inability to expectorate thickened secretions. Pneumonia can develop due to aspiration and restricted mobility.

Repositioning the patient every 2 hours helps to mobilize pulmonary secretions and prevent stasis. After the patient regains consciousness, additional measures to expand collapsed alveoli can be instituted, such as yawning, sighing, deep breathing, incentive spirometry, and coughing (unless contraindicated). If necessary, the oropharynx and trachea are suctioned to remove secretions that cannot be raised by coughing; however, coughing and suctioning increase ICP. Therefore, suctioning should be used cautiously. Increasing the humidity in the oxygen delivery system may help to loosen secretions. The nurse and the respiratory therapist work together to monitor the effects of chest physical therapy.

### *Managing Sensory Deprivation*

Periorbital edema is a common consequence of intracranial surgery, because fluid drains into the dependent periorbital areas when the patient has been positioned in a prone position during surgery. A hematoma may form under the scalp and spread down to the orbit, producing an area of ecchymosis (black eye).

Before surgery, the patient and family should be informed that one or both eyes may be edematous temporarily after surgery. After surgery, elevating the head of the bed (if not contraindicated) and applying cold compresses over the eyes will help reduce the edema. If periorbital edema increases significantly, the surgeon is notified, because this may indicate that a postoperative clot is developing or that there is increasing ICP and poor venous drainage. Health care personnel should announce their presence when entering the room to avoid startling the patient whose vision is impaired due to periorbital edema or neurologic deficits.

Additional factors that can affect sensation include a bulky head dressing, the presence of an endotracheal tube, and effects of increased ICP. The first postoperative dressing change is usually performed by the neurosurgeon. In the absence of bleeding or a CSF leak, every effort is made to minimize the size of the head dressing. If the patient requires an endotracheal tube for mechanical ventilation, every effort is made to extubate the patient as soon as clinical signs indicate it is possible. The patient is monitored closely for the effects of elevated ICP.

### *Enhancing Self-Image*

The patient is encouraged to verbalize feelings and frustrations about any change in appearance. Nursing support is based on the patient's reactions and feelings. Factual information may need to be provided if the patient has misconceptions about puffiness about the face, periorbital bruising, and hair loss. Attention to grooming, the use of the patient's own clothing, and covering the head with a turban (and later a wig until hair growth occurs) are encouraged. Social interaction with close friends, family, and hospital personnel may increase the patient's sense of self-worth.

The family and social support system can be of assistance while the patient recovers from surgery.

### *Monitoring and Managing Potential Complications*

The nurse must be vigilant for complications that may develop within hours of surgery and require close collaboration with the neurosurgeon. These include increased ICP, bleeding and hypovolemic shock, altered fluid and electrolyte balance (eg, water intoxication and diabetes insipidus), infection, and seizures.

**MONITORING FOR INCREASED INTRACRANIAL PRESSURE AND BLEEDING.** Increased ICP and bleeding are life-threatening to the patient who has undergone intracranial surgery. The following points must be kept in mind when caring for any patient who has undergone such surgery:

- An increase in blood pressure and decrease in pulse with respiratory failure may indicate increased ICP.
- An accumulation of blood under the bone flap (extradural, subdural, or intracerebral hematoma) may pose a threat to life. A clot must be suspected in any patient who does not awaken as expected or whose condition deteriorates. An intracranial hematoma is suspected if the patient has any new postoperative neurologic deficits (especially a dilated pupil on the operative side). In these circumstances, the patient is returned to the operating room immediately for evacuation of the clot if indicated.
- Cerebral edema, infarction, metabolic disturbances, and hydrocephalus are conditions that may mimic the clinical manifestations of a clot.

The patient is monitored closely for indicators of complications, and early signs and trends in clinical status are reported to the surgeon. Treatments are initiated promptly, and the nurse assists in evaluating the patient's response to treatment. The nurse also provides support to the patient and family.

If signs and symptoms of increased ICP occur, efforts to decrease the ICP are initiated: alignment of the head in a neutral position without flexion to promote venous drainage, elevation of the head of the bed to 30 degrees (when prescribed), administration of mannitol (an osmotic diuretic), and possible administration of pharmacologic paralyzing agents.

**MANAGING FLUID AND ELECTROLYTE DISTURBANCES.** Fluid and electrolyte imbalances may occur because of the patient's underlying condition and its management or as complications of surgery. These disturbances can contribute to the development of cerebral edema.

The postoperative fluid regimen depends on the type of neurosurgical procedure and is determined on an individual basis. The volume and composition of fluids are adjusted based on daily serum electrolyte values, along with fluid intake and output. Fluids may have to be restricted in patients with cerebral edema.

Oral fluids are usually resumed after the first 24 hours. The presence of gag and swallowing reflexes must be checked before initiation of oral fluids. Some patients with posterior fossa tumors have impaired swallowing, so fluids may need to be administered by alternative routes. The patient should be observed for signs and symptoms of nausea and vomiting as the diet is progressed (Hickey, 2009).

Patients undergoing surgery for brain tumors often receive large doses of corticosteroids and therefore tend to develop hyperglycemia. Serum glucose levels are measured every 4 to 6 hours. These patients are prone to stress ulcers, so histamine-2 receptor antagonists ($H_2$ blockers) are

prescribed to suppress the secretion of gastric acid. Patients also are monitored for bleeding and assessed for gastric pain.

If the surgical site is near to (or causes edema to) the pituitary gland and hypothalamus, the patient may develop symptoms of diabetes insipidus, which is characterized by excessive urinary output, elevated serum osmolality, decreased urine osmolality, hypernatremia, and a low urine specific gravity. The urine specific gravity is measured hourly, and fluid intake and output are monitored. Fluid replacement must compensate for urine output, and serum potassium levels must be monitored.

SIADH, which results in water retention with hyponatremia and serum hypo-osmolality, occurs in a wide variety of central nervous system disorders (eg, brain tumor, head trauma) causing fluid disturbances. Nursing management includes careful intake and output measurements, specific gravity determinations of urine, and monitoring of serum and urine electrolyte levels while following directives for fluid restriction. SIADH is usually self-limited.

**PREVENTING INFECTION.** The patient undergoing neurosurgery is at risk for infection related to the neurosurgical procedure (brain exposure, bone exposure, wound hematomas) and the presence of IV and arterial lines for fluid administration and monitoring. Risk for infection is increased in patients who undergo lengthy intracranial operations, in those who have external ventricular drains in place longer than 5 days, and with those who have ventricular catheters placed outside of the operating room (March, 2005).

The dressing is often stained with blood in the immediate postoperative period. Because blood is an excellent culture medium for bacteria, the dressing is reinforced with sterile pads so that contamination and infection are avoided. A heavily stained or displaced dressing should be reported immediately. A drain is sometimes placed in the craniotomy incision to facilitate drainage.

After suboccipital surgical procedures, CSF may leak through the incision. This complication is dangerous because of the possibility of meningitis. Any sudden discharge of fluid from a cranial incision is reported at once, because a massive leak requires surgical repair. Attention should be paid to the patient who complains of a salty taste or "postnasal drip," because this can be caused by CSF trickling down the throat. After a craniotomy, the patient is instructed to avoid coughing, sneezing, or nose blowing, which can cause CSF leakage by creating pressure on the operative site.

Aseptic technique is used when handling dressings, drainage systems, and IV and arterial lines. The patient is monitored carefully for signs and symptoms of infection, and cultures are obtained if infection is suspected. Appropriate antibiotics are administered as prescribed. Other causes of infection in the patient undergoing intracranial surgery, such as pneumonia and urinary tract infections, are similar to those in other postoperative patients.

**MONITORING FOR SEIZURE ACTIVITY.** Seizures may occur as complications after any intracranial neurosurgical procedure. Preventing seizures is essential to avoid further cerebral edema. Administering the prescribed antiseizure medication before and after surgery may prevent the development of seizures in subsequent months and years. **Status epilepticus** (prolonged seizures without recovery of consciousness in the intervals between seizures) may occur after craniotomy and also may be related to the development of complications (hematoma, ischemia). The management of status epilepticus is described later in this chapter.

**MONITORING AND MANAGING OTHER COMPLICATIONS.** Other complications may occur during the first 2 weeks or later and may compromise the patient's recovery. The most important of these are thromboembolic complications (DVT, pulmonary embolism), pulmonary and urinary tract infection, and pressure ulcers. Most of these complications may be avoided with frequent changes of position, adequate suctioning of secretions, thrombosis prophylaxis, early ambulation, and skin care.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The recovery of a neurosurgical patient at home depends on the extent of the surgical procedure and its success. The patient's strengths as well as limitations are assessed and explained to the family, along with the family's part in promoting recovery. Because administration of antiseizure medication is a priority, the patient and family are taught to use a check-off system, pill boxes, and alarms to ensure that the medication is taken as prescribed.

The patient and family are taught what to expect after surgery. Dietary restrictions usually are not required unless another health problem necessitates a special diet. Although showering or tub bathing is permitted, the scalp should be kept dry until all the sutures have been removed. A clean scarf or cap may be worn until a wig or hairpiece is purchased. If skull bone has been removed, the neurosurgeon may prescribe a protective helmet. After a craniotomy, the patient may require rehabilitation, depending on the postoperative level of function. The patient may require physical therapy for residual weakness and mobility issues. An occupational therapist is consulted to assist with self-care issues. If the patient is aphasic, speech therapy may be necessary.

**CONTINUING CARE.** Barring complications, patients are discharged from the hospital as soon as possible. Patients with severe motor deficits require extensive physical therapy and rehabilitation. Those with postoperative cognitive and speech impairments require psychological evaluation, speech therapy, and rehabilitation. The nurse collaborates with the physician and other health care professionals during hospitalization and home care to achieve as complete a rehabilitation as possible and to assist the patient in living with residual disability.

If tumor, injury, or disease makes the prognosis poor, care is directed toward making the patient as comfortable as possible. With return of the tumor or cerebral compression, the patient becomes less alert and aware. Other possible consequences include paralysis, blindness, and seizures. The home care nurse, hospice nurse, and social worker collaborate with the family to plan for additional home health care or hospice services or placement of the patient in an extended-care facility (see also the section on cerebral metastases in Chapter 65). The patient and family are encouraged to discuss end-of-life preferences for care; the patient's end-of-life preferences must be respected (see Chapter 17). The nurse involved in home and continuing care of patients after cranial surgery also needs to remind patients and family

members of the need for health promotion and recommended health screening.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Achieves optimal cerebral tissue perfusion
   a. Opens eyes on request; uses recognizable words, progressing to normal speech
   b. Obeys commands with appropriate motor responses
2. Maintains normal body temperature
   a. Registers normal body temperature
3. Has normal gas exchange
   a. Has arterial blood gas values within normal ranges
   b. Breathes easily; lung sounds are clear without adventitious sounds
   c. Takes deep breaths and changes position as directed
4. Copes with sensory deprivation
5. Demonstrates improving self-concept
   a. Pays attention to grooming
   b. Visits and interacts with others
6. Exhibits absence of complications
   a. Exhibits ICP within normal range
   b. Has minimal bleeding at surgical site; surgical incision is healing without evidence of infection
   c. Shows fluid balance and electrolyte levels within desired ranges
   d. Exhibits no evidence of seizures

## *Transsphenoidal Approach*

Tumors within the sella turcica and small adenomas of the pituitary can be removed through a transsphenoidal approach: An incision is made beneath the upper lip, and entry is then gained successively into the nasal cavity, sphenoidal sinus, and sella turcica (see Table 61-3). Although an otorhinolaryngologist may make the initial opening, the neurosurgeon completes the opening into the sphenoidal sinus and exposes the floor of the sella. Microsurgical techniques provide improved illumination, magnification, and visualization so that nearby vital structures can be avoided.

The transsphenoidal approach offers direct access to the sella turcica with minimal risk of trauma and hemorrhage (Musleh, et al., 2006). It avoids many of the risks of craniotomy, and the postoperative discomfort is similar to that of other transnasal surgical procedures. It may also be used for pituitary ablation (destruction) in patients with disseminated breast or prostatic cancer.

### Complications

Manipulation of the posterior pituitary gland during surgery may produce transient diabetes insipidus of several days' duration (Hickey, 2009). It is treated with vasopressin but occasionally persists. Other complications include CSF leakage, visual disturbances, postoperative meningitis, pneumocephalus (air in the intracranial cavity), and SIADH (see Chapter 42).

## PREOPERATIVE MANAGEMENT

### Medical Management

The preoperative workup includes a series of endocrine tests, rhinologic evaluation (to assess the status of the sinuses and nasal cavity), and neuroradiologic studies. Funduscopic examination and visual field determinations are performed, because the most serious effect of pituitary tumor is localized pressure on the optic nerve or chiasm. In addition, the nasopharyngeal secretions are cultured, because a sinus infection is a contraindication to an intracranial procedure using this approach. Corticosteroids may be administered before and after surgery, because the surgery involves removal of the pituitary, the source of adrenocorticotropic hormone (ACTH). Antibiotics may or may not be administered prophylactically.

### Nursing Management

Deep breathing is taught before surgery. The patient is instructed that after the surgery he or she will need to avoid vigorous coughing, blowing the nose, sucking through a straw, or sneezing, because these actions may place increased pressure at the surgical site and cause a CSF leak (Hickey, 2009).

## POSTOPERATIVE MANAGEMENT

### Medical Management

Because the procedure disrupts the oral and nasal mucous membranes, management focuses on preventing infection and promoting healing. Medications include antimicrobial agents (which are continued until the nasal packing inserted at the time of surgery is removed), corticosteroids, analgesic agents for discomfort, and agents for the control of diabetes insipidus if necessary (Hickey, 2009).

### Nursing Management

Vital signs are measured to monitor hemodynamic, cardiac, and ventilatory status. Because of the anatomic proximity of the pituitary gland to the optic chiasm, visual acuity and visual fields are assessed at regular intervals. One method is to ask the patient to count the number of fingers held up by the nurse. Evidence of decreasing visual acuity suggests an expanding hematoma.

The head of the bed is raised to decrease pressure on the sella turcica and to promote normal drainage. The patient is cautioned against blowing the nose or engaging in any activity that raises ICP, such as bending over or straining during urination or defecation.

Intake and output are measured as a guide to fluid and electrolyte replacement and to assess for diabetes insipidus. The urine specific gravity is measured after each voiding. Daily weight is monitored. Fluids are usually given after nausea ceases, and the patient then progresses to a regular diet.

The nasal packing inserted during surgery is checked frequently for blood or CSF drainage. The major discomfort is related to the nasal packing and to mouth dryness and thirst caused by mouth breathing. Oral care is provided every 4 hours or more frequently. Usually, the teeth are not brushed until the incision above the teeth has healed. Warm saline mouth rinses and the use of a cool mist vaporizer are helpful. Petrolatum is soothing when applied to the lips. A room humidifier assists in keeping the mucous membranes moist. The packing is removed in 3 to 4 days, and only then can the area around the nares be cleaned with the prescribed solution to remove crusted blood and moisten the mucous membranes (Hickey, 2009).

Home care considerations include advising the patient to use a room humidifier to keep the mucous membranes moist and to soothe irritation. The head of the bed is elevated for at least 2 weeks after surgery.

# SEIZURE DISORDERS

Seizures are episodes of abnormal motor, sensory, autonomic, or psychic activity (or a combination of these) that result from sudden excessive discharge from cerebral neurons (Hickey, 2009). A part or all of the brain may be involved. The international classification of seizures differentiates between two main types: partial seizures that begin in one part of the brain, and generalized seizures that involve electrical discharges in the whole brain (Chart 61-2). In a simple partial seizure, consciousness remains intact, whereas in a complex partial seizure, consciousness is impaired. Unclassified seizures are so termed because of incomplete data.

The underlying cause is an electrical disturbance (dysrhythmia) in the nerve cells in one section of the brain; these cells emit abnormal, recurring, uncontrolled electrical discharges. The characteristic seizure is a manifestation of this excessive neuronal discharge. Associated loss of consciousness, excess movement or loss of muscle tone or movement, and disturbances of behavior, mood, sensation, and perception may also occur.

The specific causes of seizures are varied and can be categorized as idiopathic (genetic, developmental defects) and acquired. Causes of acquired seizures include:

- Cerebrovascular disease
- Hypoxemia of any cause, including vascular insufficiency
- Fever (childhood)
- Head injury
- Hypertension
- Central nervous system infections
- Metabolic and toxic conditions (eg, renal failure, hyponatremia, hypocalcemia, hypoglycemia, pesticide exposure)
- Brain tumor
- Drug and alcohol withdrawal
- Allergies

**Chart 61-2 • *International Classification of Seizures***

**Partial Seizures (seizures beginning locally)**

**Simple Partial Seizures (with elementary symptoms, generally without impairment of consciousness)**

- With motor symptoms
- With special sensory or somatosensory symptoms
- With autonomic symptoms
- Compound forms

**Complex Partial Seizures (with complex symptoms, generally with impairment of consciousness)**

- With impairment of consciousness only
- With cognitive symptoms
- With affective symptoms
- With psychosensory symptoms
- With psychomotor symptoms (automatisms)
- Compound forms

**Partial Seizures Secondarily Generalized**

**Generalized Seizures (convulsive or nonconvulsive, bilaterally symmetric, without local onset)**

Tonic–clonic seizures
Tonic seizures
Clonic seizures
Absence (petit mal) seizures
Atonic seizures
Myoclonic seizures (bilaterally massive epileptic)
Unclassified seizures

## Nursing Management

### *During a Seizure*

A major responsibility of the nurse is to observe and record the sequence of signs. The nature of the seizure usually indicates the type of treatment that is required (AANN, 2007). Before and during a seizure, the patient is assessed and the following items are documented:

- The circumstances before the seizure (visual, auditory, or olfactory stimuli; tactile stimuli; emotional or psychological disturbances; sleep; hyperventilation) (Chart 61-3)
- The occurrence of an aura (a premonitory or warning sensation, which can be visual, auditory, or olfactory)
- The first thing the patient does in the seizure—where the movements or the stiffness begins, conjugate gaze position, and the position of the head at the beginning of the seizure. This information gives clues to the location of the seizure origin in the brain. (In recording, it is important to state whether the beginning of the seizure was observed.)
- The type of movements in the part of the body involved
- The areas of the body involved (turn back bedding to expose patient)
- The size of both pupils and whether the eyes are open
- Whether the eyes or head turned to one side
- The presence or absence of automatisms (involuntary motor activity, such as lip smacking or repeated swallowing)
- Incontinence of urine or stool
- Duration of each phase of the seizure
- Unconsciousness, if present, and its duration

## CHART 61-3 NURSING RESEARCH PROFILE
### *Seizure Events During Computer-Based Assessment*

Dilorio, C., Reisinger, E. L., Yeager, K., et al. (2008). A descriptive analysis of seizure events among adults who participated in a computer-based assessment. *Journal of Neuroscience Nursing, 40*(3), 134–141.

**Purpose**

It is known that seizures can be induced by visual stimuli such as television and video games in some people; therefore, it is important to understand how computer monitors affect people with epilepsy. This study both documented seizure events associated with a computer-based assessment and described contextual factors surrounding seizure episodes.

**Design**

This descriptive study was part of a larger, longitudinal study of self-management in adults with epilepsy. For this portion of the study, participants underwent three computer-based assessments at baseline, 3 months, and 6 months. Investigators collected data on demographic characteristics and seizure characteristics and used various psychosocial instruments to assess self-management practices.

**Findings**

A total of 14 seizure events occurred during the 896 computer-based assessments, which constituted 1.6% of the assessments and affected 4.4% of the participants. The mean age of people who experienced the seizure events was 41 years; 70% were female, and 70% were Caucasian. Contextual factors that could have precipitated seizure events included hunger, fatigue, stress, and medication changes. In two instances, participants indicated that the computer monitor could have triggered their seizure.

**Nursing Implications**

Although some seizures can be induced by visual stimuli, nurses working with people with epilepsy can be fairly confident that computer-based assessments pose minimal risks for inducing seizures. With increases in computer technology use in health care, these are reassuring findings for nurses and patients.

- Any obvious paralysis or weakness of arms or legs after the seizure
- Inability to speak after the seizure
- Movements at the end of the seizure
- Whether or not the patient sleeps afterward
- Cognitive status (confused or not confused) after the seizure

In addition to providing data about the seizure, nursing care is directed at preventing injury and supporting the patient, not only physically but also psychologically. Consequences such as anxiety, embarrassment, fatigue, and depression can be devastating to the patient.

### *After a Seizure*

After a patient has a seizure, the nurse's role is to document the events leading to and occurring during and after the seizure and to prevent complications (eg, aspiration, injury). The patient is at risk for hypoxia, vomiting, and pulmonary aspiration. To prevent complications, the patient is placed in the side-lying position to facilitate drainage of oral secretions, and suctioning is performed, if needed, to maintain a patent airway and prevent aspiration (Chart 61-4). Seizure precautions are maintained, including having available functioning suction equipment with a suction catheter and oral airway. The bed is placed in a low position with two to three side rails up and padded, if necessary, to prevent injury to the patient. The patient may be drowsy and may wish to sleep after the seizure; he or she may not remember events leading up to the seizure and for a short time thereafter.

# *The Epilepsies*

**Epilepsy** is a group of syndromes characterized by unprovoked, recurring seizures (AANN, 2007). Epileptic syndromes are classified by specific patterns of clinical features, including age at onset, family history, and seizure type. Types of epilepsies are differentiated by how the seizure activity manifests (see Chart 61-3), the most common syndromes being those with generalized seizures and those with partial-onset seizures (Hickey, 2009). Epilepsy can be primary (idiopathic) or secondary (when the cause is known and the epilepsy is a symptom of another underlying condition, such as a brain tumor).

Epilepsy affects an estimated 3% of people during their lifetime, and most forms of epilepsy occur in childhood. The improved treatment of cerebrovascular disorders, head injuries, brain tumors, meningitis, and encephalitis has increased the number of patients at risk for seizures after recovery from these conditions. Also, advances in EEG have aided in the diagnosis of epilepsy. The general public has been educated about epilepsy, which has reduced the stigma associated with it; as a result, more people are willing to acknowledge that they have epilepsy.

Although some evidence suggests that susceptibility to some types of epilepsy may be inherited, the cause of seizures in many people is idiopathic (unknown). Epilepsy can follow birth trauma, asphyxia neonatorum, head injuries, some infectious diseases (bacterial, viral, parasitic), toxicity (carbon monoxide and lead poisoning), circulatory problems, fever, metabolic and nutritional disorders, or drug or alcohol intoxication. It is also associated with brain tumors, abscesses, and congenital malformations.

## Pathophysiology

Messages from the body are carried by the neurons (nerve cells) of the brain by means of discharges of electrochemical energy that sweep along them. These impulses occur in bursts whenever a nerve cell has a task to perform. Sometimes, these cells or groups of cells continue firing after a task is finished. During the period of unwanted discharges,

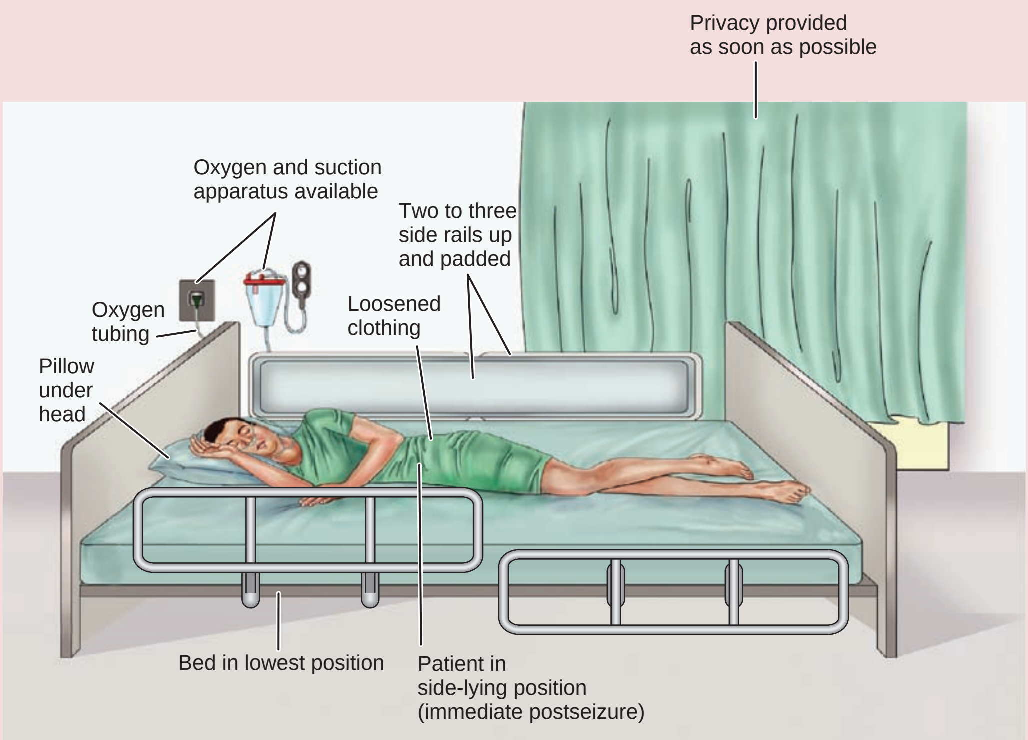
CHART 61-4 *Guidelines for Seizure Care*

**Nursing Care During a Seizure**

- Provide privacy and protect the patient from curious onlookers. (The patient who has an aura [warning of an impending seizure] may have time to seek a safe, private place.)
- Ease the patient to the floor, if possible.
- Protect the head with a pad to prevent injury (from striking a hard surface).
- Loosen constrictive clothing.
- Push aside any furniture that may injure the patient during the seizure.
- If the patient is in bed, remove pillows and raise side rails.
- If an aura precedes the seizure, insert an oral airway to reduce the possibility of the patient's biting the tongue or cheek.
- *Do not attempt to pry open jaws that are clenched in a spasm or to insert anything.* Broken teeth and injury to the lips and tongue may result from such an action.
- No attempt should be made to restrain the patient during the seizure, because muscular contractions are strong and restraint can produce injury.
- If possible, place the patient on one side with head flexed forward, which allows the tongue to fall forward and facilitates drainage of saliva and mucus. If suction is available, use it if necessary to clear secretions.

**Nursing Care After the Seizure**

- Keep the patient on one side to prevent aspiration. Make sure the airway is patent.
- There is usually a period of confusion after a grand mal seizure.
- A short apneic period may occur during or immediately after a generalized seizure.
- The patient, on awakening, should be reoriented to the environment.
- If the patient becomes agitated after a seizure (postictal), use persuasion and gentle restraint to assist him or her to stay calm.




parts of the body controlled by the errant cells may perform erratically. Resultant dysfunction ranges from mild to incapacitating and often causes loss of consciousness (Hickey, 2009). If these uncontrolled, abnormal discharges occur repeatedly, a person is said to have an epileptic syndrome. Epilepsy is not associated with intellectual level. People who have epilepsy without other brain or nervous system disabilities fall within the same intelligence ranges as the overall population. Epilepsy is not synonymous with mental retardation or illness. However, many people who have developmental disabilities because of serious neurologic damage also have epilepsy.

## Clinical Manifestations

Depending on the location of the discharging neurons, seizures may range from a simple staring episode (absence seizure) to prolonged convulsive movements with loss of consciousness.

The initial pattern of the seizures indicates the region of the brain in which the seizure originates (see Chart 61-3). In simple partial seizures, only a finger or hand may shake, or the mouth may jerk uncontrollably. The person may talk unintelligibly; may be dizzy; and may experience unusual or unpleasant sights, sounds, odors, or tastes, but without loss of consciousness (Hickey, 2009).

In complex partial seizures, the person either remains motionless or moves automatically but inappropriately for time and place, or he or she may experience excessive emotions of fear, anger, elation, or irritability. Whatever the manifestations, the person does not remember the episode when it is over.

Generalized seizures, previously referred to as grand mal seizures, involve both hemispheres of the brain, causing both sides of the body to react (Hickey, 2009). Intense rigidity of the entire body may occur, followed by alternating muscle relaxation and contraction (generalized tonic–clonic contraction). The simultaneous contractions of the diaphragm and chest muscles may produce a characteristic epileptic cry. The tongue is often chewed, and the patient is incontinent of urine and feces. After 1 or 2 minutes, the convulsive movements begin to subside; the patient relaxes and lies in deep coma, breathing noisily. The respirations at this point are chiefly abdominal. In the postictal state (after the seizure), the patient is often confused and hard to arouse and may sleep for hours. Many patients report headache, sore muscles, fatigue, and depression (AANN, 2007).

## Assessment and Diagnostic Findings

The diagnostic assessment is aimed at determining the type of seizures, their frequency and severity, and the factors that precipitate them. A developmental history is taken, including events of pregnancy and childbirth, to seek evidence of preexisting injury. The patient is also questioned about illnesses or head injuries that may have affected the brain. In addition to physical and neurologic evaluations, diagnostic examinations include biochemical, hematologic, and serologic studies. MRI is used to detect structural lesions such as focal abnormalities, cerebrovascular abnormalities, and cerebral degenerative changes (AANN, 2007).

The EEG furnishes diagnostic evidence for a substantial proportion of patients with epilepsy and assists in classifying the type of seizure (Karpoff & Labus, 2008). Abnormalities in the EEG usually continue between seizures or, if not apparent, may be elicited by hyperventilation or during sleep (Kotagal & Yardi, 2008). Microelectrodes (depth electrodes) can be inserted deep in the brain to probe the action of single brain cells. Some people with clinical seizures have normal EEGs, whereas others who have never had seizures have abnormal EEGs. Telemetry and computerized equipment are used to monitor electrical brain activity while the patient pursues his or her normal activities and to store the readings on computer tapes for analysis. Video recording of seizures taken simultaneously with EEG telemetry is useful in determining the type of seizure as well as its duration and magnitude. This type of intensive monitoring is changing the treatment of severe epilepsy (Dilorio, Reisinger, Yeager, et al., 2008).

SPECT is an additional tool that is sometimes used in the diagnostic workup. It is useful for identifying the epileptogenic zone so that the area in the brain giving rise to seizures can be removed surgically (AANN, 2007).

## Epilepsy in Women

More than 1 million American women have epilepsy, and they face particular needs associated with the syndrome. Women with epilepsy often note an increase in seizure frequency during menses; this has been linked to the increase in sex hormones that alter the excitability of neurons in the cerebral cortex. The effectiveness of contraceptives is decreased by antiseizure medications. Therefore, patients should be encouraged to discuss family planning with their primary health care provider and to obtain preconception counseling if they are considering childbearing (Meador, Pennell, Harden, et al., 2008).

Women of childbearing age who have epilepsy require special care and guidance before, during, and after pregnancy. Many women note a change in the pattern of seizure activity during pregnancy. The risk of congenital fetal anomaly is two to three times higher in women with epilepsy. Maternal seizures, antiseizure medications, and genetic predisposition all contribute to possible malformations. Women who take certain antiseizure medications for epilepsy are at risk and need careful monitoring, including blood studies to detect the level of antiseizure medications taken throughout pregnancy. High-risk mothers (teenagers, women with histories of difficult deliveries, women who use illicit drugs [eg, crack, cocaine], and women with diabetes or hypertension) should be identified and monitored closely during pregnancy, because damage to the fetus during pregnancy and delivery can increase the risk of epilepsy. All of these issues need further study (Meador, et al., 2008).

Because of bone loss associated with the long-term use of antiseizure medications, patients receiving antiseizure agents should be assessed for low bone mass and osteoporosis. They should be instructed about strategies to reduce their risks of osteoporosis (AANN, 2007).

## Gerontologic Considerations

Elderly people have a high incidence of new-onset epilepsy (Hickey, 2009). Cerebrovascular disease is the leading cause of seizures in the elderly. The increased incidence is also associated with stroke, head injury, dementia, infection, alcoholism, and aging. Treatment depends on the underlying cause. Because many elderly people have chronic health problems, they may be taking other medications that can interact with medications prescribed for seizure control. In addition, the absorption, distribution, metabolism, and excretion of medications are altered in the elderly as a result of age-related changes in renal and liver function. Therefore, elderly patients must be monitored closely for adverse and toxic effects of antiseizure medications and for osteoporosis. The cost of antiseizure medications can lead to poor adherence to the prescribed regimen in elderly patients on fixed incomes.

## Prevention

Society-wide efforts are the key to prevention of epilepsy. Head injury is one of the main causes of epilepsy that can be prevented. Through highway safety programs and occupational safety precautions, lives can be saved and epilepsy due to head injury prevented; these programs are discussed in Chapter 63.

## Medical Management

The management of epilepsy is individualized to meet the needs of each patient and not just to manage and prevent seizures. Management differs from patient to patient, because some forms of epilepsy arise from brain damage and others result from altered brain chemistry.

### Pharmacologic Therapy

Many medications are available to control seizures, although the exact mechanisms of action are unknown. The objective is to achieve seizure control with minimal side effects. Medication therapy controls rather than cures seizures. Medications are selected on the basis of the type of seizure being treated and the effectiveness and safety of the medications. If properly prescribed and taken, medications control seizures in 70% to 80% of patients with seizures. However, 20% of patients with generalized seizures and 30% of those with partial seizures do not demonstrate improvement with any prescribed medication or may be unable to tolerate the side effects of medications (AANN, 2007). Table 61-4 lists the medications in current use.

*NURSING ALERT*

**Nurses must take care when administering lamotrigine (Lamictal), an antiseizure medication. The drug packaging was recently changed in an attempt to reduce medication errors, because this medication has been confused with terbinafine (Lamisil), labetalol hydrochloride (Trandate), lamivudine (Epivir), maprotiline (Ludiomil), and the combination of diphenoxylate and atropine (Lomotil). Patients with epilepsy are at risk for status epilepticus from having their medication regimen interrupted.**

Treatment usually starts with a single medication. The starting dose and the rate at which the dosage is increased depend on the occurrence of side effects. The medication levels in the blood are monitored, because the rate of drug absorption varies among patients. Changing to another medication may be necessary if seizure control is not achieved or if toxicity makes it impossible to increase the dosage. The medication may need to be adjusted because of concurrent illness, weight changes, or increases in stress. Side effects of antiseizure medications may be divided into three groups: (1) idiosyncratic or allergic disorders, which manifest primarily as skin reactions; (2) acute toxicity, which may occur when the medication is initially prescribed; and (3) chronic toxicity, which occurs late in the course of therapy.

The manifestations of drug toxicity are variable, and any organ system may be involved. Gingival hyperplasia

**Table 61-4 MAJOR ANTISEIZURE MEDICATIONS**

| Medication | Dose-Related Side Effects | Toxic Effects |
|---|---|---|
| carbamazepine (Tegretol) | Dizziness, drowsiness, unsteadiness, nausea and vomiting, diplopia, mild leukopenia | Severe skin rash, blood dyscrasias, hepatitis |
| clonazepam (Klonopin) | Drowsiness, behavior changes, headache, hirsutism, alopecia, palpitations | Hepatotoxicity, thrombocytopenia, bone marrow failure, ataxia |
| ethosuximide (Zarontin) | Nausea and vomiting, headache, gastric distress | Skin rash, blood dyscrasias, hepatitis, systemic lupus erythematosus |
| felbamate (Felbatol) | Cognitive impairments, insomnia, nausea, headache, fatigue | Aplastic anemia, hepatotoxicity |
| gabapentin (Neurotonin) | Dizziness, drowsiness, somnolence, fatigue, ataxia, weight gain, nausea | Leukopenia, hepatotoxicity |
| lamotrigine (Lamictal) | Drowsiness, tremor, nausea, ataxia, dizziness, headache, weight gain | Severe rash (Stevens-Johnson syndrome) |
| levetiracetam (Keppra) | Somnolence, dizziness, fatigue | Unknown |
| oxacarbazepine (Trileptal) | Dizziness, somnolence, double vision, fatigue, nausea, vomiting, loss of coordination, abnormal vision, abdominal pain, tremor, abnormal gait | Hepatotoxicity |
| phenobarbital (Luminal) | Sedation, irritability, diplopia, ataxia | Skin rash, anemia |
| phenytoin (Dilantin) | Visual problems, hirsutism, gingival hyperplasia, dysrhythmias, dysarthria, nystagmus | Severe skin reaction, peripheral neuropathy, ataxia, drowsiness, blood dyscrasias |
| primidone (Mysoline) | Lethargy, irritability, diplopia, ataxia, impotence | Skin rash |
| tiagabine (Gabitril) | Dizziness, fatigue, nervousness, tremor, difficulty concentrating, dysarthria, weak or buckling knees, abdominal pain | Unknown |
| topiramate (Topamax) | Fatigue, somnolence, confusion, ataxia, anorexia, depression, weight loss | Nephrolithiasis |
| valproate (Depakote, Depakene) | Nausea and vomiting, weight gain, hair loss, tremor, menstrual irregularities | Hepatotoxicity, skin rash, blood dyscrasias, nephritis |
| zonisamide (Zonegran, Excegran) | Somnolence, dizziness, anorexia, headache, nausea, agitation, rash | Leukopenia, hepatotoxicity |

(swollen and tender gums) can be associated with long-term use of phenytoin (Dilantin), for example (Karch, 2008). Periodic physical and dental examinations and laboratory tests are performed for patients receiving medications that are known to have hematopoietic, genitourinary, or hepatic effects.

#### *Surgical Management*

Surgery is indicated for patients whose epilepsy results from intracranial tumors, abscesses, cysts, or vascular anomalies. Some patients have intractable seizure disorders that do not respond to medication. A focal atrophic process may occur secondary to trauma, inflammation, stroke, or anoxia. If the seizures originate in a reasonably well-circumscribed area of the brain that can be excised without producing significant neurologic deficits, the removal of the area generating the seizures may produce long-term control and improvement (AANN, 2007).

This type of neurosurgery has been aided by several advances, including microsurgical techniques, EEGs with depth electrodes, improved illumination and hemostasis, and the introduction of neuroleptanalgesic agents (droperidol and fentanyl). These techniques, combined with use of local anesthetic agents, enable the neurosurgeon to perform surgery on an alert and cooperative patient. Using special testing devices, electrocortical mapping, and the patient's responses to stimulation, the boundaries of the epileptogenic focus (ie, abnormal area of the brain) are determined. Any abnormal epileptogenic focus is then excised (AANN, 2007). Resection surgery significantly reduces the incidence of seizures in patients with refractory epilepsy.

When seizures are refractory to medication in adolescents and adults with partial seizures, a generator may be implanted under the clavicle. The device is connected to the vagus nerve in the cervical area, where it delivers electrical signals to the brain to control and reduce seizure activity (AANN, 2007). An external programming system is used by the physician to change stimulator settings. Patients can turn the stimulator on and off with a magnet (Krapohl, Deutinger & Komurcu, 2007).

More research is needed to determine the effects of the various surgical approaches on complication rates, quality of life, anxiety, and depression, all of which are issues for patients with epilepsy.

## NURSING PROCESS

### The Patient With Epilepsy

### Assessment

The nurse elicits information about the patient's seizure history. The patient is asked about the factors or events that may precipitate the seizures. Alcohol intake is documented. The nurse determines whether the patient has an aura before an epileptic seizure, which may indicate the origin of the seizure (eg, seeing a flashing light may indicate that the seizure originated in the occipital lobe). Observation and assessment during and after a seizure assist in identifying the type of seizure and its management.

The effects of epilepsy on the patient's lifestyle are assessed (AANN, 2007). What limitations are imposed by the seizure disorder? Does the patient participate in any recreational activities? Have any social contacts? Is the patient working, and is it a positive or stressful experience? What coping mechanisms are used?

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Risk for injury related to seizure activity
- Fear related to the possibility of seizures
- Ineffective individual coping related to stresses imposed by epilepsy
- Deficient knowledge related to epilepsy and its control

#### *Collaborative Problems/Potential Complications*

The major potential complications for patients with epilepsy are status epilepticus and medication side effects (toxicity).

### Planning and Goals

The major goals for the patient may include prevention of injury, control of seizures, achievement of a satisfactory psychosocial adjustment, acquisition of knowledge and understanding about the condition, and absence of complications.

### Nursing Interventions

#### *Preventing Injury*

Injury prevention for the patient with seizures is a priority. Patients for whom seizure precautions are instituted should have pads applied to the side rails while in bed. Steps to prevent or minimize injury are presented in Chart 61-4.

#### *Reducing Fear of Seizures*

Fear that a seizure may occur unexpectedly can be reduced by the patient's adherence to the prescribed treatment regimen. Cooperation of the patient and family and their trust in the prescribed regimen are essential for control of seizures. The nurse emphasizes that the prescribed antiseizure medication must be taken on a continuing basis and that drug dependence or addiction does not occur. Periodic monitoring is necessary to ensure the adequacy of the treatment regimen, to prevent side effects, and to monitor for drug resistance (Hickey, 2009).

In an effort to control seizures, factors that may precipitate them are identified, such as emotional disturbances, new environmental stressors, onset of menstruation in female patients, or fever (AANN, 2007). The patient is encouraged to follow a regular and moderate routine in lifestyle, diet (avoiding excessive stimulants), exercise, and rest (sleep deprivation may lower the seizure threshold). Moderate activity is therapeutic, but excessive exercise should be avoided. An additional dietary intervention, referred to as the ketogenic diet, may be helpful for control of seizures in some patients. This high-protein, low-carbohydrate, high-fat diet is most effective in children whose seizures have not been controlled with two

antiepileptic medications, but it is sometimes used for adults who have had poor seizure control (Yudkoff, Daikhin, Melo, et al., 2007).

Photic stimulation (eg, bright flickering lights, television viewing) may precipitate seizures; wearing dark glasses or covering one eye may be preventive. Tension states (anxiety, frustration) induce seizures in some patients. Classes in stress management may be of value. Because seizures are known to occur with alcohol intake, alcoholic beverages should be avoided.

#### *Improving Coping Mechanisms*

The social, psychological, and behavioral problems that frequently accompany epilepsy can be more of a disability than the actual seizures. Epilepsy may be accompanied by feelings of stigmatization, alienation, depression, and uncertainty. The patient must cope with the constant fear of a seizure and the psychological consequences (AANN, 2007). Children with epilepsy may be ostracized and excluded from school and peer activities. These problems are compounded during adolescence and add to the challenges of dating, not being able to drive, and feeling different from other people. Adults face these problems in addition to the burden of finding employment, concerns about relationships and childbearing, insurance problems, and legal barriers. Alcohol abuse may complicate matters. Family reactions may vary from outright rejection of the person with epilepsy to overprotection.

Counseling assists the patient and family to understand the condition and the limitations it imposes. Social and recreational opportunities are necessary for good mental health. Nurses can improve the quality of life for patients with epilepsy by teaching them and their families about symptoms and their management (AANN, 2007) (see Chart 61-3).

#### *Providing Patient and Family Education*

Perhaps the most valuable facets of care contributed by the nurse to the person with epilepsy are education and efforts to modify the attitudes of the patient and family toward the disorder. The person who experiences seizures may consider every seizure a potential source of humiliation and shame. This may result in anxiety, depression, hostility, and secrecy on the part of the patient and family. Ongoing education and encouragement should be given to patients to enable them to overcome these reactions. The patient with epilepsy should carry an emergency medical identification card or wear a medical information bracelet. The patient and family need to be educated about medications as well as care during a seizure.

#### *Monitoring and Managing Potential Complications*

Status epilepticus, the major complication, is described later in this chapter. Another complication is the toxicity of medications. The patient and family are instructed about side effects and are given specific guidelines to assess and report signs and symptoms that indicate medication overdose. Antiseizure medications require careful monitoring for therapeutic levels. The patient should plan to have serum drug levels assessed at regular intervals. Many known drug interactions occur with antiseizure medications. A complete pharmacologic profile should be reviewed with the patient to avoid interactions that either potentiate or inhibit the effectiveness of the medications.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Thorough oral hygiene after each meal, gum massage, daily flossing, and regular dental care are essential to prevent or control gingival hyperplasia in patients receiving phenytoin (Dilantin). The patient is also instructed to inform all health care providers of the medication being taken, because of the possibility of drug interactions. An individualized comprehensive teaching plan is needed to assist the patient and family to adjust to this chronic disorder. Written patient education materials must be appropriate for the patient's reading level and must be provided in alternative formats if warranted. See Chart 61-5 for home care instruction points.

**CONTINUING CARE.** Because epilepsy is a long-term disorder, the use of costly medications can create a significant financial burden. The Epilepsy Foundation of America (EFA) offers a mail-order program to provide medications at minimal cost and access to life insurance. This organization also serves as a referral source for special services for people with epilepsy.

For many, overcoming employment problems is a challenge. State vocational rehabilitation agencies can provide information about job training. The EFA has a training and placement service. If seizures are not well controlled, information about sheltered workshops or home employment programs may be obtained. Federal and state agencies and federal legislation may be of assistance to people with epilepsy who experience job discrimination. As a result of the Americans with Disabilities Act, the number of employers who knowingly hire people with epilepsy is increasing, but barriers to employment still exist.

People who have uncontrollable seizures accompanied by psychological and social difficulties can be referred to comprehensive epilepsy centers where continuous audio-video and EEG monitoring, specialized treatment, and rehabilitation services are available (AANN, 2007). Patients and their families need to be reminded of the importance of following the prescribed treatment regimen and of keeping follow-up appointments. In addition, they are reminded of the importance of participating in health promotion activities and recommended health screenings to promote a healthy lifestyle. Genetic and preconception counseling is advised.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Sustains no injury during seizure activity
   a. Complies with treatment regimen and identifies the hazards of stopping the medication
   b. Can identify appropriate care during seizure; caregivers can also do so
2. Indicates a decrease in fear
3. Displays effective individual coping
4. Exhibits knowledge and understanding of epilepsy
   a. Identifies the side effects of medications

CHART 61-5

HOME CARE CHECKLIST
*The Patient With Epilepsy*

| At the completion of the home instruction, the patient and caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Take medications daily as prescribed to keep the drug level constant to prevent seizures. The patient should never discontinue medications, even if there is no seizure activity. | ✔ | |
| • Keep a medication and seizure chart, noting when medications are taken and any seizure activity. | ✔ | ✔ |
| • Notify the patient's physician if patient cannot take medications due to illness. | ✔ | ✔ |
| • Have antiseizure medication serum levels checked regularly. When testing is prescribed, the patient should report to the laboratory for blood sampling before taking morning medication. | ✔ | |
| • Avoid activities that require alertness and coordination (driving, operating machinery) until after the effects of the medication have been evaluated. | ✔ | |
| • Report signs of toxicity so dosage can be adjusted. Common signs include drowsiness, lethargy, dizziness, difficulty walking, hyperactivity, confusion, inappropriate sleep, and visual disturbances. | ✔ | ✔ |
| • Avoid over-the-counter medications unless approved by the patient's physician. | ✔ | |
| • Carry a medical alert bracelet or identification card specifying the name of the patient's antiseizure medication and physician. | ✔ | |
| • Avoid seizure triggers, such as alcoholic beverages, electrical shocks, stress, caffeine, constipation, fever, hyperventilation, and hypoglycemia. | ✔ | |
| • Take showers rather than tub baths to avoid drowning if seizure occurs; never swim alone. | ✔ | |
| • Exercise in moderation in a temperature-controlled environment to avoid excessive heat. | ✔ | |
| • Develop regular sleep patterns to minimize fatigue and insomnia. | ✔ | ✔ |
| • Use the Epilepsy Foundation of America's special services, including help in obtaining medications, vocational rehabilitation, and coping with epilepsy. | ✔ | ✔ |

b. Avoids factors or situations that may precipitate seizures (eg, flickering lights, hyperventilation, alcohol)
c. Follows a healthy lifestyle by getting adequate sleep and eating meals at regular times to avoid hypoglycemia

5. Absence of complications

## Status Epilepticus

Status epilepticus (acute prolonged seizure activity) is a series of generalized seizures that occur without full recovery of consciousness between attacks (Tocco, 2007). The term has been broadened to include continuous clinical or electrical seizures (on EEG) lasting at least 30 minutes, even without impairment of consciousness. It is considered a medical emergency. Status epilepticus produces cumulative effects. Vigorous muscular contractions impose a heavy metabolic demand and can interfere with respirations. Some respiratory arrest at the height of each seizure produces venous congestion and hypoxia of the brain. Repeated episodes of cerebral anoxia and edema may lead to irreversible and fatal brain damage. Factors that precipitate status epilepticus include withdrawal of antiseizure medication, fever, and concurrent infection.

### Medical Management

The goals of treatment are to stop the seizures as quickly as possible, to ensure adequate cerebral oxygenation, and to maintain the patient in a seizure-free state. An airway and adequate oxygenation are established. If the patient remains unconscious and unresponsive, a cuffed endotracheal tube is inserted. IV diazepam (Valium), lorazepam (Ativan), or fosphenytoin (Cerebyx) is administered slowly in an attempt to halt seizures immediately. Other medications (phenytoin, phenobarbital) are administered later to maintain a seizure-free state.

An IV line is established, and blood samples are obtained to monitor serum electrolytes, glucose, and phenytoin levels. EEG monitoring may be useful in determining the nature of the seizure activity. Vital signs and neurologic signs are monitored on a continuing basis. An IV infusion of dextrose is administered if the seizure is caused by hypoglycemia. If initial treatment is unsuccessful, general anesthesia with a short-acting barbiturate may be used. The serum concentration of the antiseizure medication is measured, because a low level suggests that the patient was not taking the medication or that the dosage was too low. Cardiac involvement or respiratory depression may be life-threatening. The potential for postictal cerebral edema also exists.

### Nursing Management

The nurse initiates ongoing assessment and monitoring of respiratory and cardiac function because of the risk for delayed depression of respiration and blood pressure secondary

to administration of antiseizure medications and sedatives to halt the seizures. Nursing assessment also includes monitoring and documenting the seizure activity and the patient's responsiveness.

The patient is turned to a side-lying position, if possible, to assist in draining pharyngeal secretions. Suction equipment must be available because of the risk of aspiration. The IV line is closely monitored, because it may become dislodged during seizures.

A person who has received long-term antiseizure therapy has a significant risk for fractures resulting from bone disease (osteoporosis, osteomalacia, and hyperparathyroidism), a side effect of therapy. Therefore, during seizures, the patient is protected from injury with the use of seizure precautions and is monitored closely. The patient having seizures can inadvertently injure nearby people, so nurses should protect themselves. Additional nursing interventions for the person having seizures are presented in Chart 61-4.

## HEADACHE

Headache, or cephalgia, is one of the most common of all human physical complaints. Headache is a symptom rather than a disease entity; it may indicate organic disease (neurologic or other disease), a stress response, vasodilation (migraine), skeletal muscle tension (tension headache), or a combination of factors. A **primary headache** is one for which no organic cause can be identified. These types of headache include migraine, tension-type, and cluster headaches (Hickey, 2009). Cranial arteritis is another common cause of headache. A classification of headaches was issued first by the Headache Classification Committee of the International Headache Society in 1988. The International Headache Society revised the headache classification in 2004; an abbreviated list is shown in Chart 61-6.

### Chart 61-6 • *International Headache Society Classification of Headache*

1. Migraine
2. Tension-type headache
3. Cluster headache and other trigeminal-autonomic cephalalgias
4. Other primary headaches
5. Headache attributed to head and/or neck trauma
6. Headache attributed to cranial or cervical vascular disorder
7. Headache attributed to nonvascular intracranial disorder
8. Headache attributed to a substance or its withdrawal
9. Headache attributed to infection
10. Headache attributed to disorder of homeostasis
11. Headache or facial pain attributed to disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth, or other facial or cranial structures
12. Headache attributed to psychiatric disorder
13. Cranial neuralgias and central causes of facial pain
14. Other headache

From Headache Classification Subcommittee of the International Headache Society. (2004). International classification of headache disorders (2nd ed.). *Cephalalgia, 24*(Suppl 1), 1–150.

*Migraine* is a complex of symptoms characterized by periodic and recurrent attacks of severe headache lasting from 4 to 72 hours in adults. The cause of migraine has not been clearly demonstrated, but it is primarily a vascular disturbance that occurs more commonly in women and has a strong familial tendency. The typical time of onset is at puberty, and the incidence is 18% in women and 6% in men (Lipton, Bigal, Diamond, et al., 2007).

There are six subtypes of **migraine headache,** including migraine with and without aura. Most patients have migraine without an aura. *Tension-type headaches* tend to be chronic and less severe and are probably the most common type of headache. *Cluster headaches* are a severe form of vascular headache. They are seen five times more frequently in men than in women. Types of headaches not subsumed under these categories fall into the *Other Primary Headache* group and include headaches triggered by cough, exertion, and sexual activity.

*Cranial arteritis* is a cause of headache in the older population, reaching its greatest incidence in those older than 70 years of age. Inflammation of the cranial arteries is characterized by a severe headache localized in the region of the temporal arteries. The inflammation may be generalized (in which case cranial arteritis is part of a vascular disease) or focal (in which case only the cranial arteries are involved).

A **secondary headache** is a symptom associated with an organic cause, such as a brain tumor or an aneurysm. Although most headaches do not indicate serious disease, persistent headaches require further investigation. Serious disorders related to headache include brain tumors, subarachnoid hemorrhage, stroke, severe hypertension, meningitis, and head injuries.

### Pathophysiology

The cerebral signs and symptoms of *migraine* result from dysfunction of the brain stem pathways that normally modulate sensory input. Abnormal metabolism of serotonin, a vasoactive neurotransmitter found in platelets and cells of the brain, plays a major role. The headache is preceded by a rise in plasma serotonin, which dilates the cerebral vessels, but migraines are more than just vascular headaches. The exact mechanism of pain in migraine is poorly understood but is thought to be related to the cranial blood vessels, the innervation of the vessels, and the reflex connections in the brain stem (Porth & Matfin, 2009).

Migraines can be triggered by menstrual cycles, bright lights, stress, depression, sleep deprivation, fatigue, overuse of certain medications, and certain foods containing tyramine, monosodium glutamate, nitrites, or milk products. Food triggers also include aged cheese and many processed foods. Use of oral contraceptives may be associated with increased frequency and severity of attacks in some women (Kelman, 2007).

Emotional or physical stress may cause contraction of the muscles in the neck and scalp, resulting in *tension* headache. The pathophysiology of *cluster* headache is not fully understood. One theory is that it is caused by dilation of orbital and nearby extracranial arteries. *Cranial arteritis* is thought to represent an immune vasculitis in which immune complexes are deposited within the walls of affected blood vessels,

producing vascular injury and inflammation. A biopsy may be performed on the involved artery to make the diagnosis.

## Clinical Manifestations

### Migraine

The migraine with aura can be divided into four phases: prodrome, aura, the headache, and recovery (headache termination and postdrome).

#### Prodrome Phase

The prodrome phase is experienced by 60% of patients, with symptoms that occur hours to days before a migraine headache. Symptoms may include depression, irritability, feeling cold, food cravings, anorexia, change in activity level, increased urination, diarrhea, or constipation. Patients usually experience the same prodrome with each migraine headache.

#### Aura Phase

Aura occurs in a minority of patients who experience migraines (Cutrer & Heurter, 2007). The aura usually lasts less than 1 hour and may provide enough time for the patient to take the prescribed medication to avert an attack (see later discussion). This period is characterized by focal neurologic symptoms. Visual disturbances (ie, light flashes and bright spots) are most common and may be hemianopic (affecting only half of the visual field). Other symptoms that may follow include numbness and tingling of the lips, face, or hands; mild confusion; slight weakness of an extremity; drowsiness; and dizziness.

This period of aura corresponds to the phenomenon of cortical spreading depression that is associated with reduced metabolic demand in abnormally functioning neurons. This is associated with decreased blood flow that is the initial physiologic change characteristic of classic migraine (Cutrer & Heurter, 2007). Cerebral blood flow studies performed during migraine headaches demonstrate that during all phases of migraine, cerebral blood flow is reduced throughout the brain, with subsequent loss of autoregulation and impaired carbon dioxide responsiveness.

#### Headache Phase

As vasodilation and a decline in serotonin levels occur, a throbbing headache (unilateral in 60% of patients) intensifies over several hours. This headache is severe and incapacitating and is often associated with photophobia, nausea, and vomiting. Its duration varies, ranging from 4 to 72 hours (Hickey, 2009).

#### Recovery Phase

In the recovery phase (termination and postdrome), the pain gradually subsides. Muscle contraction in the neck and scalp is common, with associated muscle ache and localized tenderness, exhaustion, and mood changes. Any physical exertion exacerbates the headache pain. During this post-headache phase, patients may sleep for extended periods.

### Other Headache Types

The *tension-type headache* is characterized by a steady, constant feeling of pressure that usually begins in the forehead, temple, or back of the neck. It is often bandlike or may be described as "a weight on top of my head."

*Cluster headaches* are unilateral and come in clusters of one to eight daily, with excruciating pain localized to the eye and orbit and radiating to the facial and temporal regions. The pain is accompanied by watering of the eye and nasal congestion. Each attack lasts 15 minutes to 3 hours and may have a crescendo–decrescendo pattern (Hickey, 2009). The headache is often described as penetrating.

*Cranial arteritis* often begins with general manifestations, such as fatigue, malaise, weight loss, and fever. Clinical manifestations associated with inflammation (heat, redness, swelling, tenderness, or pain over the involved artery) usually are present. Sometimes a tender, swollen, or nodular temporal artery is visible. Visual problems are caused by ischemia of the involved structures.

## Assessment and Diagnostic Findings

The diagnostic evaluation includes a detailed history, a physical assessment of the head and neck, and a complete neurologic examination. Headaches may manifest differently in the same person over the course of a lifetime, and the same type of headache may manifest differently from patient to patient. The health history focuses on assessing the headache itself, with emphasis on the factors that precipitate or provoke it. The patient is asked to describe the headache in his or her own words.

Because headache is often the presenting symptom of various physiologic and psychological disturbances, a general health history is an essential component of the patient database. Headache may be a symptom of endocrine, hematologic, gastrointestinal, infectious, renal, cardiovascular, or psychiatric disease. Therefore, questions addressed in the health history should cover major medical and surgical illness as well as a body systems review.

The medication history can provide insight into the patient's overall health status and indicate medications that may be provoking headaches. Antihypertensive agents, diuretic medications, anti-inflammatory agents, and monoamine oxidase (MAO) inhibitors are a few of the categories of medications that can provoke headaches. Emotional factors can play a role in precipitating headaches. Stress is thought to be a major initiating factor in migraine headaches; therefore, sleep patterns, level of stress, recreational interests, appetite, emotional problems, and family stressors are relevant. There is a strong familial tendency for headache disorders, and a positive family history may help in making a diagnosis.

A direct relationship may exist between exposure to toxic substances and headache. Careful questioning may uncover chemicals to which a worker has been exposed. Under the Right to Know law, employees have access to the material safety data sheets (commonly referred to as MSDSs) for all the substances with which they come in contact in the workplace. The occupational history also includes assessment of the workplace as a possible source of stress and for a possible ergonomic basis of muscle strain and headache.

A complete description of the headache itself is crucial. The nurse reviews the age at onset of headache; the headache's frequency, location, and duration; the type of pain; factors that relieve and precipitate the event; and associated symptoms. The data obtained should include the

patient's own words about the headache in response to the following questions:

- What is the location? Is it unilateral or bilateral? Does it radiate?
- What is the quality—dull, aching, steady, boring, burning, intermittent, continuous, paroxysmal?
- How many headaches occur during a given period of time?
- What are the precipitating factors, if any—environmental (eg, sunlight, weather change), foods, exertion, other?
- What makes the headache worse (eg, coughing, straining)?
- What time (day or night) does it occur?
- How long does a typical headache last?
- Are there any associated symptoms, such as facial pain, lacrimation (excessive tearing), or scotomas (blind spots in the field of vision)?
- What usually relieves the headache (aspirin, nonsteroidal anti-inflammatory drugs, ergot preparation, food, heat, rest, neck massage)?
- Does nausea, vomiting, weakness, or numbness in the extremities accompany the headache?
- Does the headache interfere with daily activities?
- Do you have any allergies?
- Do you have insomnia, poor appetite, loss of energy?
- Is there a family history of headache?
- What is the relationship of the headache to your lifestyle or physical or emotional stress?
- What medications are you taking?

Diagnostic testing often is not helpful in the investigation of headache, because often there are few objective findings. In patients who demonstrate abnormalities on the neurologic examination, CT, cerebral angiography, or MRI may be used to detect underlying causes, such as tumor or aneurysm. Electromyography (EMG) may reveal a sustained contraction of the neck, scalp, or facial muscles. Laboratory tests may include complete blood count, erythrocyte sedimentation rate, electrolytes, glucose, creatinine, and thyroid hormone levels.

## Prevention

Prevention begins by having the patient avoid specific triggers that are known to initiate the headache syndrome. Preventive medical management of migraine involves the daily use of one or more agents that are thought to block the physiologic events leading to an attack. Treatment regimens vary greatly, as do patient responses; therefore, close monitoring is indicated.

Several widely used medications for the prevention of migraine are available. Two beta-blocking agents, propranolol (Inderal) and metoprolol (Lopressor), inhibit the action of beta-receptors—cells in the heart and brain that control the dilation of blood vessels. This is thought to be a major reason for their antimigraine action. Other medications that are prescribed for migraine prevention include amitriptyline hydrochloride (Elavil), divalproex (Valproate), flunarizine (Sibelium), and serotonin antagonists (Pizotyline) (Bigal & Lipton, 2007).

Calcium antagonists (eg, verapamil) are widely used but may require several weeks at a therapeutic dosage before improvement is noted. Calcium channel blockers are not as effective as beta-blockers for prevention but may be more appropriate for some patients, such as those with bradycardia, diabetes mellitus, or asthma (Bigal & Lipton, 2007).

Researchers are evaluating several antiseizure medications for migraine prevention. Topiramate (Topamax), the most extensively studied preventive agent, has been shown to be effective. Started at a low dose, topiramate is titrated to 100 to 200 mg/day in divided doses (Bigal & Lipton, 2007). Other research suggests that the use of topiramate and gabapentin (Neurontin), another antiseizure medication, for migraine prevention may impair cognitive ability (Salinsky, Strorzbach, Spencer, et al., 2005).

Alcohol, nitrites, vasodilators, and histamines may precipitate cluster headaches. Elimination of these factors helps prevent the headaches. Other prophylactic medication therapy may include antiseizure medications, ergotamine tartrate (occasionally), lithium, naproxen (Naprosyn), and methysergide (Sansert) (Bigal & Lipton, 2007).

## Medical Management

Therapy for migraine headache is divided into abortive (symptomatic) and preventive approaches. The abortive approach, best used in those patients who have less frequent attacks, is aimed at relieving or limiting a headache at the onset or while it is in progress. The preventive approach is used in patients who experience more frequent attacks at regular or predictable intervals and may have a medical condition that precludes the use of abortive therapies (Hickey, 2009).

The triptans, serotonin receptor agonists, are the most specific antimigraine agents available. These agents cause vasoconstriction, reduce inflammation, and may reduce pain transmission. The five triptans in routine clinical use include sumatriptan (Imitrex), naratriptan (Amerge), rizatriptan (Maxalt), zolmitriptan (Zomig), and almotriptan (Axert) (Mett & Tfelt-Hansen, 2008). Numerous serotonin receptor agonists are under study. Many of the triptan medications are available in a variety of formulations, such as nasal sprays, inhalers, suppositories, or injections. The nasal sprays are useful for patients experiencing nausea and vomiting (Hickey, 2009).

The most widely used triptan is sumatriptan succinate (Imitrex) and is effective for the treatment of acute migraine and cluster headaches in adults (Bigal & Lipton, 2007). The subcutaneous form usually relieves symptoms within 1 hour and is available in an autoinjector for immediate patient use, although this form is expensive. Sumatriptan has been found to be effective in relieving moderate to severe migraine headaches in a large number of adult patients. Sumatriptan can cause chest pain and is contraindicated in patients with ischemic heart disease. Careful administration and dosing instructions to patients are important to prevent adverse reactions such as increased blood pressure, drowsiness, muscle pain, sweating, and anxiety. Interactions are possible if the medication is taken in conjunction with St. John's wort (Karch, 2008).

Ergotamine preparations (taken orally, sublingually, subcutaneously, intramuscularly, by rectum, or by inhalation) may be effective in aborting the headache if taken early in the migraine process. They are low in cost. Ergotamine

tartrate acts on smooth muscle, causing prolonged constriction of the cranial blood vessels. Each patient's dosage is based on individual needs. Side effects include aching muscles, paresthesias (numbness and tingling), nausea, and vomiting. Cafergot, a combination of ergotamine and caffeine, can arrest or reduce the severity of the headache if it is taken at the first sign of an attack (Karch, 2008). None of the triptan medications should be taken concurrently with medications containing ergotamine, because of the potential for a prolonged vasoactive reaction (Karch, 2008).

The medical management of an acute attack of cluster headaches may include 100% oxygen by face mask for 15 minutes, ergotamine tartrate, sumatriptan, corticosteroids, or a percutaneous sphenopalatine ganglion blockade (Hickey, 2009).

The medical management of cranial arteritis consists of early administration of a corticosteroid to prevent the possibility of loss of vision due to vascular occlusion or rupture of the involved artery. The patient is instructed not to stop the medication abruptly, because this can lead to relapse. Analgesic agents are prescribed for comfort.

## Nursing Management

When migraine or the other types of headaches have been diagnosed, the goal of nursing management is to enhance pain relief. It is reasonable to try nonpharmacologic interventions first, but the use of medications should not be delayed. The goal is to treat the acute event of the headache and to prevent recurrent episodes. Prevention involves patient education regarding precipitating factors, possible lifestyle or habit changes that may be helpful, and pharmacologic measures.

### *Relieving Pain*

Individualized treatment depends on the type of headache and differs for migraine, cluster headaches, cranial arteritis, and tension headache. Nursing care is directed toward treatment of the acute episode. A migraine or a cluster headache in the early phase requires abortive medication therapy instituted as soon as possible. Some headaches can be prevented if the appropriate medications are taken before the onset of pain. Nursing care during an attack includes comfort measures such as a quiet, dark environment; elevation of the head of the bed to 30 degrees; and symptomatic treatment (ie, administration of antiemetic medication) (Hickey, 2009).

Symptomatic pain relief for tension headache may be obtained by application of local heat or massage. Additional strategies may include administration of analgesic agents, antidepressant medications, and muscle relaxants.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

Headaches, especially migraines, are more likely to occur when the patient is ill, overly tired, or stressed. Nonpharmacologic therapies are important and include patient education about the type of headache, its mechanism (if known), and appropriate changes in lifestyle to avoid triggers. Regular sleep, meals, exercise, relaxation, and avoidance of dietary triggers may be helpful in avoiding headaches (Hickey, 2009).

The patient with tension headaches needs teaching and reassurance that the headache is not the result of a brain tumor; this is a common unspoken fear. Stress reduction techniques, such as biofeedback, exercise programs, and meditation, are examples of nonpharmacologic therapies that may prove helpful. The patient and family need to be reminded of the importance of following the prescribed treatment regimen for headache and keeping follow-up appointments. In addition, the patient is reminded of the importance of participating in health promotion activities and recommended health screenings to promote a healthy lifestyle. Chart 61-7 presents a home care checklist for the patient with migraine headaches.

CHART 61-7 HOME CARE CHECKLIST
*The Patient With Migraine Headaches*

| At the completion of the home instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Define migraine headaches and describe characteristics and manifestations. | ✔ | ✔ |
| • Identify triggers of migraine headaches and how to avoid such triggers as: | | |
|   • Foods that contain tyramine, such as chocolate, cheese, coffee, dairy products | ✔ | ✔ |
|   • Dietary habits that result in long periods between meals | ✔ | ✔ |
|   • Menstruation and ovulation (caused by hormone fluctuation) | ✔ | ✔ |
|   • Alcohol (causes vasodilation of blood vessels) | ✔ | ✔ |
|   • Fatigue and fluctuations in sleep patterns | ✔ | ✔ |
| • State importance of developing and using a headache diary. | ✔ | ✔ |
| • State stress management and lifestyle changes to minimize the frequency of headaches. | ✔ | ✔ |
| • State pharmacologic management: acute therapy and prophylaxis, to include medication regimen and side effects. | ✔ | ✔ |
| • Identify comfort measures during headache attacks, such as resting in a quiet and dark environment, applying cold compresses to the painful area, and elevating the head. | ✔ | ✔ |
| • Identify resources for education and support, such as the National Headache Foundation. | ✔ | ✔ |

### Continuing Care

The National Headache Foundation (see Resources) provides a list of clinics in the United States and the names of physicians who specialize in headache and who are members of the American Association for the Study of Headache.

## CRITICAL THINKING EXERCISES

EBP **1** Your 25-year-old patient with a brain injury has signs of ICP. Describe the nursing measures that are indicated. How would you determine whether your interventions were effective in alleviating the increased ICP? What is the evidence base for practices to decrease ICP? Identify the criteria used to evaluate the strength of the evidence for these practices.

**2** A patient is admitted to your unit after undergoing transsphenoidal surgery for a pituitary tumor. Describe the major complications to assess for, along with the signs and symptoms of each. Describe the pharmacologic treatment and nursing measures that are indicated postoperatively. What patient and family teaching is important for the patient and family? How would you modify your teaching and discharge planning if the patient understands little English?

EBP **3** You are caring for a 35-year-old patient who is admitted to the hospital for evaluation of her seizures. What resources would you use to identify the current guidelines for classification and treatment of seizures? What is the evidence base for treatment practices? Identify the criteria used to evaluate the strength of the evidence for these practices.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisks indicate nursing research.*
***Double asterisk indicates classic references.*


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## RESOURCES

American Headache Society, www.ahsnet.org
Brain Injury Association, www.biausa.org
Brain Trauma Foundation, www.braintrauma.org
Epilepsy Foundation, www.epilepsyfoundation.org
Hydrocephalus Association, hydroassoc@aol.com.
National Headache Foundation, www.headaches.org



chapter 62

# Management of Patients With Cerebrovascular Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the incidence and social impact of cerebrovascular disorders.
2. Identify the risk factors for cerebrovascular disorders and related measures for prevention.
3. Compare the various types of cerebrovascular disorders: their causes, clinical manifestations, and medical management.
4. Apply the principles of nursing management to the care of a patient in the acute stage of an ischemic stroke.
5. Use the nursing process as a framework for care of a patient recovering from an ischemic stroke.
6. Use the nursing process as a framework for care of a patient with a hemorrhagic stroke.
7. Identify essential elements for family teaching and preparation for home care of the patient who has had a stroke.

## GLOSSARY

**agnosia:** failure to recognize familiar objects perceived by the senses

**aneurysm:** a weakening or bulge in an arterial wall

**aphasia:** inability to express oneself or to understand language

**apraxia:** inability to perform previously learned purposeful motor acts on a voluntary basis

**dysarthria:** defects of articulation due to neurologic causes

**expressive aphasia:** inability to express oneself; often associated with damage to the left frontal lobe area

**hemianopsia:** blindness of half of the field of vision in one or both eyes

**hemiplegia/hemiparesis:** weakness/paralysis of one side of the body, or part of it, due to an injury in the motor area of the brain

**infarction:** a zone of tissue deprived of blood supply

**Korsakoff's syndrome:** disorder characterized by psychosis, disorientation, delirium, insomnia, and hallucinations

**penumbra region:** area of low cerebral blood flow

**receptive aphasia:** inability to understand what someone else is saying; often associated with damage to the temporal lobe area

*Cerebrovascular disorders* is an umbrella term that refers to a functional abnormality of the central nervous system (CNS) that occurs when the normal blood supply to the brain is disrupted. Stroke is the primary cerebrovascular disorder in the United States, and it is the third leading cause of death after heart disease and cancer. Approximately 780,000 people experience a stroke each year in the United States. Approximately 600,000 of these are new strokes, and 180,000 are recurrent strokes (Rosamond, Flegal, Furie, et al., 2008). About 5.6 million noninstitutionalized stroke survivors are alive today; stroke is a leading cause of serious, long-term disability in the United States. The financial impact of stroke is profound, with estimated direct and indirect costs of $65.5 billion in 2008 (Rosamond, et al., 2008).

Strokes can be divided into two major categories: ischemic (85%), in which vascular occlusion and significant hypoperfusion occur, and hemorrhagic (15%), in which there is extravasation of blood into the brain or subarachnoid space (Hinkle & Guanci, 2007). Although there are some similarities between the two broad types of stroke, differences exist in etiology, pathophysiology, medical management, surgical management, and nursing care. Table 62-1 compares ischemic and hemorrhagic strokes.

## Ischemic Stroke

An ischemic stroke, cerebrovascular accident (CVA), or "brain attack" is a sudden loss of function resulting from disruption of the blood supply to a part of the brain. The term *brain attack* is being used to suggest to health care practitioners and the public that a stroke is an urgent health care issue similar to a heart attack. With the approval of thrombolytic therapy for the treatment of acute ischemic stroke in 1996 came a revolution in the care of patients after a stroke. Early treatment with thrombolytic therapy for ischemic stroke results in fewer stroke symptoms and less loss of function (National Institute of Neurologic Disorders and Stroke [NINDS], 1995). Currently approved thrombolytic therapy has a treatment window of only 3 hours after the onset of a stroke. Urgency is needed on the part of the public and health care practitioners for rapid transport of the patient to a hospital for assessment and administration of the medication.

Ischemic strokes are subdivided into five different types based on the cause: large artery thrombotic strokes (20%), small penetrating artery thrombotic strokes (25%), cardiogenic embolic strokes (20%), cryptogenic strokes (30%), and other (5%) (see Table 62-1). Large artery thrombotic strokes are caused by atherosclerotic plaques in the large blood vessels of the brain. Thrombus formation and occlusion at the site of the atherosclerosis result in ischemia and **infarction** (deprivation of blood supply) (Hinkle & Guanci, 2007).

Small penetrating artery thrombotic strokes affect one or more vessels and are the most common type of ischemic stroke. Small artery thrombotic strokes are also called lacunar strokes because of the cavity that is created after the death of infarcted brain tissue (American Association of Neuroscience Nurses [AANN], 2008).

Cardiogenic embolic strokes are associated with cardiac dysrhythmias, usually atrial fibrillation. Embolic strokes can also be associated with valvular heart disease and thrombi in the left ventricle. Emboli originate from the heart and circulate to the cerebral vasculature, most commonly the left middle cerebral artery, resulting in a stroke. Embolic strokes may be prevented by the use of anticoagulation therapy in patients with atrial fibrillation.

The last two classifications of ischemic strokes are cryptogenic strokes, which have no known cause, and strokes from other causes, such as illicit drug use, coagulopathies, migraine, and spontaneous dissection of the carotid or vertebral arteries.

### Pathophysiology

In an ischemic brain attack, there is disruption of the cerebral blood flow due to obstruction of a blood vessel. This disruption in blood flow initiates a complex series of cellular metabolic events referred to as the ischemic cascade (Fig. 62-1).

The ischemic cascade begins when cerebral blood flow decreases to less than 25 mL per 100 g of blood per minute. At this point, neurons are no longer able to maintain aerobic respiration. The mitochondria must then switch to anaerobic respiration, which generates large amounts of lactic acid, causing a change in the pH. This switch to the less efficient anaerobic respiration also renders the neuron incapable of producing sufficient quantities of adenosine triphosphate (ATP) to fuel the depolarization processes. The membrane pumps that maintain electrolyte balances begin to fail, and the cells cease to function.

Early in the cascade, an area of low cerebral blood flow, referred to as the **penumbra region,** exists around the area of infarction. The penumbra region is ischemic brain tissue that may be salvaged with timely intervention. The ischemic cascade threatens cells in the penumbra because

**Table 62-1 COMPARISON OF MAJOR TYPES OF STROKE**

| Item | Ischemic | Hemorrhagic |
|---|---|---|
| Causes | Large artery thrombosis<br>Small penetrating artery thrombosis<br>Cardiogenic embolic<br>Cryptogenic (no known cause)<br>Other | Intracerebral hemorrhage<br>Subarachnoid hemorrhage<br>Cerebral aneurysm<br>Arteriovenous malformation |
| Main presenting symptoms | Numbness or weakness of the face, arm, or leg, especially on one side of the body | "Exploding headache"<br>Decreased level of consciousness |
| Functional recovery | Usually plateaus at 6 months | Slower, usually plateaus at about 18 months |

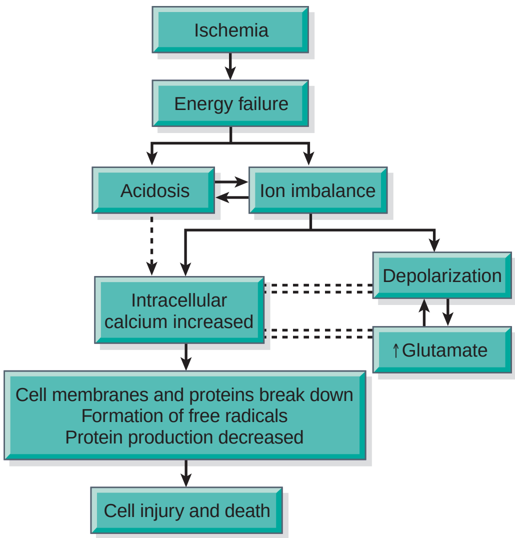



**Figure 62-1** Processes contributing to ischemic brain cell injury. Courtesy of National Stroke Association, Englewood, Colorado.

membrane depolarization of the cell wall leads to an increase in intracellular calcium and the release of glutamate. The influx of calcium and the release of glutamate, if continued, activate a number of damaging pathways that result in the destruction of the cell membrane, the release of more calcium and glutamate, vasoconstriction, and the generation of free radicals. These processes enlarge the area of infarction into the penumbra, extending the stroke. A person experiencing a stroke typically loses 1.9 million neurons each minute that a stroke is not treated, and the ischemic brain ages 3.6 years each hour without treatment (Saver, 2006).

Each step in the ischemic cascade represents an opportunity for intervention to limit the extent of secondary brain damage caused by a stroke. The penumbra area may be revitalized by administration of tissue plasminogen activator (t-PA). Medications that protect the brain from secondary injury are called neuroprotectants. A number of ongoing clinical trials focus on neuroprotective medications and strategies to improve stroke recovery and survival (Lapchak & Araujo, 2007).

## Clinical Manifestations

An ischemic stroke can cause a wide variety of neurologic deficits, depending on the location of the lesion (which vessels are obstructed), the size of the area of inadequate perfusion, and the amount of collateral (secondary or accessory) blood flow (see Chapter 60 for discussion of anatomy and brain blood supply). The patient may present with any of the following signs or symptoms:

- Numbness or weakness of the face, arm, or leg, especially on one side of the body
- Confusion or change in mental status
- Trouble speaking or understanding speech
- Visual disturbances
- Difficulty walking, dizziness, or loss of balance or coordination
- Sudden severe headache

Motor, sensory, cranial nerve, cognitive, and other functions may be disrupted. Table 62-2 reviews the neurologic deficits frequently seen in patients with strokes. Table 62-3 compares the symptoms and behaviors seen in right hemispheric stroke with those seen in left hemispheric stroke.

### Motor Loss

A stroke is an upper motor neuron lesion and results in loss of voluntary control over motor movements. Because the upper motor neurons decussate (cross), a disturbance of voluntary motor control on one side of the body may reflect damage to the upper motor neurons on the opposite side of the brain. The most common motor dysfunction is **hemiplegia** (paralysis of one side of the body) caused by a lesion of the opposite side of the brain. **Hemiparesis,** or weakness of one side of the body, is another sign. The concept of upper and lower motor neuron lesions is described in more detail in Table 60-4 in Chapter 60.

In the early stage of stroke, the initial clinical features may be flaccid paralysis and loss of or decrease in the deep tendon reflexes. When these deep reflexes reappear (usually by 48 hours), increased tone is observed along with spasticity (abnormal increase in muscle tone) of the extremities on the affected side.

### Communication Loss

Other brain functions affected by stroke are language and communication. In fact, stroke is the most common cause of aphasia. The following are dysfunctions of language and communication:

- **Dysarthria** (difficulty in speaking), caused by paralysis of the muscles responsible for producing speech
- Dysphasia (impaired speech) or **aphasia** (loss of speech), which can be **expressive aphasia, receptive aphasia,** or global (mixed) aphasia
- **Apraxia** (inability to perform a previously learned action), as may be seen when a patient makes verbal substitutions for desired syllables or words

### Perceptual Disturbances

Perception is the ability to interpret sensation. Stroke can result in visual-perceptual dysfunctions, disturbances in visual-spatial relations, and sensory loss.

Visual-perceptual dysfunctions are caused by disturbances of the primary sensory pathways between the eye and visual cortex. Homonymous **hemianopsia** (loss of half of the visual field) may occur from stroke and may be temporary or permanent. The affected side of vision corresponds to the paralyzed side of the body.

Disturbances in visual-spatial relations (perceiving the relationship of two or more objects in spatial areas) are frequently seen in patients with right hemispheric damage.

### Sensory Loss

The sensory losses from stroke may take the form of slight impairment of touch, or it may be more severe, with loss of proprioception (ability to perceive the position and motion of body parts) as well as difficulty in interpreting visual, tactile, and auditory stimuli. **Agnosias** are deficits in the ability to recognize previously familiar objects perceived by one or more of the senses.

**Table 62-2 NEUROLOGIC DEFICITS OF STROKE: MANIFESTATIONS AND NURSING IMPLICATIONS**

| Neurologic Deficit | Manifestation | Nursing Implications/Patient Teaching Applications |
|---|---|---|
| **Visual Field Deficits** | | |
| Homonymous hemianopsia (loss of half of the visual field) | • Unaware of persons or objects on side of visual loss<br>• Neglect of one side of the body<br>• Difficulty judging distances | Place objects within intact field of vision.<br>Approach the patient from side of intact field of vision.<br>Instruct/remind the patient to turn head in the direction of visual loss to compensate for loss of visual field.<br>Encourage the use of eyeglasses if available.<br>When teaching the patient, do so within patient's intact visual field. |
| Loss of peripheral vision | • Difficulty seeing at night<br>• Unaware of objects or the borders of objects | Place objects in center of patient's intact visual field.<br>Encourage the use of a cane or other object to identify objects in the periphery of the visual field.<br>Driving ability will need to be evaluated. |
| Diplopia | • Double vision | Explain to the patient the location of an object when placing it near the patient.<br>Consistently place patient care items in the same location. |
| **Motor Deficits** | | |
| Hemiparesis | • Weakness of the face, arm, and leg on the same side (due to a lesion in the opposite hemisphere) | Place objects within the patient's reach on the nonaffected side.<br>Instruct the patient to exercise and increase the strength on the unaffected side. |
| Hemiplegia | • Paralysis of the face, arm, and leg on the same side (due to a lesion in the opposite hemisphere) | Encourage the patient to provide range-of-motion exercises to the affected side.<br>Provide immobilization as needed to the affected side.<br>Maintain body alignment in functional position.<br>Exercise unaffected limb to increase mobility, strength, and use. |
| Ataxia | • Staggering, unsteady gait<br>• Unable to keep feet together; needs a broad base to stand | Support patient during the initial ambulation phase.<br>Provide supportive device for ambulation (walker, cane).<br>Instruct the patient not to walk without assistance or supportive device. |
| Dysarthria | • Difficulty in forming words | Provide the patient with alternative methods of communicating.<br>Allow the patient sufficient time to respond to verbal communication.<br>Support patient and family to alleviate frustration related to difficulty in communicating. |
| Dysphagia | • Difficulty in swallowing | Test the patient's pharyngeal reflexes before offering food or fluids.<br>Assist the patient with meals.<br>Place food on the unaffected side of the mouth.<br>Allow ample time to eat. |
| **Sensory Deficits** | | |
| Paresthesia (occurs on the side opposite the lesion) | • Numbness and tingling of extremity<br>• Difficulty with proprioception | Instruct patient that sensation may be altered.<br>Provide range of motion to affected areas and apply corrective devices as needed. |
| **Verbal Deficits** | | |
| Expressive aphasia | • Unable to form words that are understandable; may be able to speak in single-word responses | Encourage patient to repeat sounds of the alphabet.<br>Explore the patient's ability to write as an alternative means of communication. |
| Receptive aphasia | • Unable to comprehend the spoken word; can speak but may not make sense | Speak slowly and clearly to assist the patient in forming the sounds.<br>Explore the patient's ability to read as an alternative means of communication. |
| Global (mixed) aphasia | • Combination of both receptive and expressive aphasia | Speak clearly and in simple sentences; use gestures or pictures when able.<br>Establish alternative means of communication. |
| **Cognitive Deficits** | | |
| | • Short- and long-term memory loss<br>• Decreased attention span<br>• Impaired ability to concentrate<br>• Poor abstract reasoning<br>• Altered judgment | Reorient patient to time, place, and situation frequently.<br>Use verbal and auditory cues to orient patient.<br>Provide familiar objects (family photographs, favorite objects).<br>Use noncomplicated language.<br>Match visual tasks with a verbal cue; holding a toothbrush, simulate brushing of teeth while saying, "I would like you to brush your teeth now."<br>Minimize distracting noises and views when teaching the patient.<br>Repeat and reinforce instructions frequently. |
| **Emotional Deficits** | | |
| | • Loss of self-control<br>• Emotional lability | Support patient during uncontrollable outbursts.<br>Discuss with the patient and family that the outbursts are due to the disease process. |
| | • Decreased tolerance to stressful situations<br>• Depression<br>• Withdrawal<br>• Fear, hostility, and anger<br>• Feelings of isolation | Encourage patient to participate in group activity.<br>Provide stimulation for the patient.<br>Control stressful situations, if possible.<br>Provide a safe environment.<br>Encourage patient to express feelings and frustrations related to disease process. |

**Table 62-3 COMPARISON OF LEFT AND RIGHT HEMISPHERIC STROKES**

| Left Hemispheric Stroke | Right Hemispheric Stroke |
|---|---|
| Paralysis or weakness on right side of body | Paralysis or weakness on left side of body |
| Right visual field deficit | Left visual field deficit |
| Aphasia (expressive, receptive, or global) | Spatial-perceptual deficits |
| | Increased distractibility |
| Altered intellectual ability | Impulsive behavior and poor judgment |
| Slow, cautious behavior | Lack of awareness of deficits |

Adapted from Hickey, J. V. (2009). *The clinical practice of neurological and neurosurgical nursing* (6th ed., p. 600). Philadelphia: Lippincott Williams & Wilkins.

### Cognitive Impairment and Psychological Effects

If damage has occurred to the frontal lobe, learning capacity, memory, or other higher cortical intellectual functions may be impaired. Such dysfunction may be reflected in a limited attention span, difficulties in comprehension, forgetfulness, and a lack of motivation. These changes can cause the patient to become easily frustrated during rehabilitation. Depression is common and may be exaggerated by the patient's natural response to this catastrophic event. Emotional lability, hostility, frustration, resentment, lack of cooperation, and other psychological problems may occur.

## Assessment and Diagnostic Findings

Any patient with neurologic deficits needs a careful history and a complete physical and neurologic examination. Initial assessment focuses on airway patency, which may be compromised by loss of gag or cough reflexes and altered respiratory pattern; cardiovascular status (including blood pressure, cardiac rhythm and rate, carotid bruit); and gross neurologic deficits.

Patients may present to the acute care facility with temporary neurologic symptoms. A transient ischemic attack (TIA) is a neurologic deficit typically lasting less than 1 hour. A TIA is manifested by a sudden loss of motor, sensory, or visual function. The symptoms result from temporary ischemia (impairment of blood flow) to a specific region of the brain but when brain imaging is performed there is no evidence of ischemia. A TIA may serve as a warning of impending stroke. Lack of evaluation and treatment of a patient who has experienced previous TIAs may result in a stroke and irreversible deficits (Lewandowski, Rao & Silver, 2008).

The initial diagnostic test for a stroke is usually a noncontrast computed tomography (CT) scan performed emergently to determine if the event is ischemic or hemorrhagic (the category of stroke determines treatment). Further diagnostic workup for ischemic stroke involves attempting to identify the source of the thrombi or emboli. A 12-lead electrocardiogram (ECG) and a carotid ultrasound are standard tests. Other studies may include CT angiography or magnetic resonance imaging and angiography (MRI and MRA) of the brain and neck vessels; transcranial Doppler flow studies; transthoracic or transesophageal echocardiography; xenon-enhanced CT scan; and single photon emission CT (SPECT) scan (Adams, Zoppo, Alberts, et al., 2007).

## Prevention

Primary prevention of ischemic stroke remains the best approach. Leading a healthy lifestyle, which includes not smoking, maintaining a healthy weight, following a healthy diet (including modest alcohol consumption), and daily exercise, can reduce the risk of having a stroke by about one half (Chiuve, Rexrode, Spiegelman, et al., 2008). The risk of coronary heart disease and stroke has decreased in women on the Dietary Approaches to Stop Hypertension (DASH) diet. The DASH diet is high in fruits and vegetables, moderate in low-fat dairy products, and low in animal protein (has a substantial amount of plant protein from legumes and nuts) (Fung, Chiuve, McCullough, et al., 2008). Stroke risk screenings are an ideal opportunity to lower stroke risk by identifying people or groups of people who are at high risk for stroke and by educating patients and the community about recognition and prevention of stroke. Research findings suggest that low-dose aspirin may lower the risk of stroke in women who are at risk (Ridker, Cook, Lee, et al., 2005).

Advanced age, gender, and race are well-known nonmodifiable risk factors for stroke. High-risk groups include people older than 55 years of age; the incidence of stroke more than doubles in each successive decade. Men have a higher rate of stroke than that of women. Another high-risk group is African Americans; the incidence of first stroke in African Americans is almost twice that in Caucasian Americans (Rosamond, et al., 2008).

Modifiable risk factors for ischemic stroke include hypertension, atrial fibrillation, hyperlipidemia, obesity, smoking, and diabetes (Chart 62-1). For people who are at high risk, interventions that alter modifiable factors, such as treating hypertension and hyperglycemia and stopping smoking, reduce stroke risk. Other treatable conditions that increase risk of stroke are asymptomatic carotid stenosis and valvular heart disease (eg, endocarditis, prosthetic heart valves). Periodontal disease has also been linked to stroke risk. The association between periodontal disease and stroke may result from the host inflammatory response and the chronic bacterial infection, but the exact mechanism is not fully understood. Periodontal disease is a treatable and preventable condition.

Several methods of preventing recurrent stroke have been identified for patients with TIAs or ischemic stroke. Patients with moderate to severe carotid stenosis are treated with carotid endarterectomy (Sacco, Adams, Albers, et al., 2006). In patients with atrial fibrillation, which increases the risk of emboli, administration of warfarin (Coumadin), an anticoagulant that inhibits clot formation, may prevent both thrombotic and embolic strokes.

**CHART 62-1 *Modifiable Risk Factors for Ischemic Stroke***

- Hypertension (controlling hypertension, the major risk factor, is the key to preventing stroke)
- Atrial fibrillation
- Hyperlipidemia
- Diabetes mellitus (associated with accelerated atherogenesis)
- Smoking
- Asymptomatic carotid stenosis
- Obesity
- Excessive alcohol consumption

## Medical Management

Patients who have experienced a TIA or stroke should have medical management for secondary prevention. Those with atrial fibrillation (or cardioembolic strokes) are treated with dose-adjusted warfarin (Coumadin) unless contraindicated. The international normalized ratio (INR) target is 2 to 3. If warfarin is contraindicated, aspirin is the best option, although other medications may be used if both are contraindicated (Karch, 2008).

Platelet-inhibiting medications, including aspirin, extended-release dipyridamole (Persantine) plus aspirin, clopidogrel (Plavix), and ticlopidine (Ticlid), decrease the incidence of cerebral infarction in patients who have experienced TIAs and stroke from suspected embolic or thrombotic causes. The specific medication that is used is based on the patient's health history.

Research has found that medications classified as 3-hydroxy-2-methyl-glutaryl-coenzyme A reductase inhibitors (also known as statins) reduce coronary events and strokes. Benefits were independent of cholesterol levels, and these medications are now widely used for stroke prevention. The U.S. Food and Drug Administration (FDA) has recently updated indications for a statin medication, such as simvastatin (Zocor), to include secondary stroke prevention (Nassief & Marsh, 2008). After the acute stroke period, antihypertensive medications are also used, if indicated, for secondary stroke prevention. Angiotensin-converting enzyme (ACE) inhibitors and thiazide diuretics may also have benefits in stroke prevention (Luders, 2007).

Ongoing research is focusing on several aspects of the medical management of acute ischemic stroke. The FDA has approved a clot retrieval device (shaped like a tiny corkscrew) that opens the blocked artery and restores blood flow to the brain (Felton, Ogden, Pena, et al., 2005). Other clot retrieval devices are under investigation, including catheters using vacuum and ultrasound techniques to assist in the removal of clots in the brain.

### *Thrombolytic Therapy*

Thrombolytic agents are used to treat ischemic stroke by dissolving the blood clot that is blocking blood flow to the brain. Recombinant t-PA is a genetically engineered form of t-PA, a thrombolytic substance made naturally by the body. It works by binding to fibrin and converting plasminogen to plasmin, which stimulates fibrinolysis of the atherosclerotic lesion. Rapid diagnosis of stroke and initiation of thrombolytic therapy (within 3 hours) in patients with ischemic stroke leads to a decrease in the size of the stroke and an overall improvement in functional outcome after 3 months (Adams, et al., 2007; NINDS, 1995). Ongoing clinical trials continue to investigate other thrombolytic agents (Lapchak & Araujo, 2007).

To realize the full potential of thrombolytic therapy, community education directed at recognizing the symptoms of stroke and obtaining appropriate emergency care is necessary to ensure rapid transport to a hospital and initiation of therapy within the 3-hour period. Delays make the patient ineligible for thrombolytic therapy, because revascularization of necrotic tissue (which develops after 3 hours) increases the risk of cerebral edema and hemorrhage.

#### Enhancing Prompt Diagnosis

After being notified by emergency medical service personnel, the emergency department contacts the appropriate staff (neurologist, neuroradiologist, radiology department, nursing staff, ECG, and laboratory technicians) and informs them of the patient's imminent arrival at the hospital. Many institutions have acute stroke teams that respond rapidly, ensuring that treatment occurs within the allotted period (AANN, 2008).

Initial management requires the definitive diagnosis of an ischemic stroke by brain imaging and a careful history to determine whether the patient meets the criteria for t-PA therapy (Chart 62-2). Some of the absolute contraindications for thrombolytic therapy include symptom onset greater than 3 hours before admission, a patient who is anticoagulated (with an INR above 1.7), or a patient who has recently had any type of intracranial pathology (eg, previous stroke, head injury, trauma). Once it is determined that the patient is a candidate for t-PA therapy, no anticoagulants are administered for the next 24 hours.

Before receiving t-PA, the patient is assessed using the National Institutes of Health Stroke Scale (NIHSS), a standardized assessment tool that helps evaluate stroke severity (Table 62-4). Total NIHSS scores range from 0 (normal) to 42 (severe stroke) (Kasner, 2006). Certification in the administration of the scale is recommended and is available for nurses and other health care professionals.

#### Dosage and Administration

The patient is weighed to determine the dose of t-PA. The dosage for t-PA is 0.9 mg/kg, with a maximum dose of 90 mg. Ten percent of the calculated dose is administered as an intravenous (IV) bolus over 1 minute. The remaining dose (90%) is administered IV over 1 hour via an infusion pump.

The patient is admitted to the intensive care unit or an acute stroke unit, where continuous cardiac monitoring and frequent neurologic assessments are conducted. Vital signs are obtained frequently, with particular attention to blood

### Chart 62-2 • *Eligibility Criteria for t-PA Administration*

- Age 18 years or older
- Clinical diagnosis of ischemic stroke
- Time of onset of stroke known and is 3 hours or less
- Systolic blood pressure ≤185 mm Hg; diastolic ≤110 mm Hg
- Not a minor stroke or rapidly resolving stroke
- No seizure at onset of stroke
- Not taking warfarin (Coumadin)
- Prothrombin time ≤15 seconds or INR ≤1.7
- Not receiving heparin during the past 48 hours with elevated partial thromboplastin time
- Platelet count ≥100,000/mm$^3$
- No prior intracranial hemorrhage, neoplasm, arteriovenous malformation, or aneurysm
- No major surgical procedures within 14 days
- No stroke, serious head injury, or intracranial surgery within 3 months
- No gastrointestinal or urinary bleeding within 21 days

**Table 62-4 SUMMARY OF NATIONAL INSTITUTES OF HEALTH STROKE SCALE (NIHSS)**

| Category | Description | Score |
|---|---|---|
| 1a. Level of consciousness (LOC) | Alert | 0 |
| | Arousable by minor stimulation | 1 |
| | Obtunded, strong stimulation to attend | 2 |
| | Unresponsive, or reflexic responses only | 3 |
| 1b. LOC questions (month, age) | Answers both correctly | 0 |
| | Answers one correctly | 1 |
| | Both incorrect | 2 |
| 1c. LOC commands (open, close eyes; make fist, let go) | Obeys both correctly | 0 |
| | Obeys one correctly | 1 |
| | Both incorrect | 2 |
| 2. Best gaze (eyes open—patient follows examiner's finger or face) | Normal | 0 |
| | Partial gaze palsy | 1 |
| | Forced deviation | 2 |
| 3. Visual (introduce visual stimulus/threat to patient's visual field quadrants) | No visual loss | 0 |
| | Partial hemianopsia | 1 |
| | Complete hemianopsia | 2 |
| | Bilateral hemianopsia | 3 |
| 4. Facial palsy (show teeth, raise eyebrows and squeeze eyes shut) | Normal | 0 |
| | Minor | 1 |
| | Partial | 2 |
| | Complete | 3 |
| 5a. Motor; arm—left (elevate extremity to 90° and score drift/movement) | No drift | 0 |
| | Drift but maintains in air | 1 |
| | Unable to maintain in air | 2 |
| | No effort against gravity | 3 |
| | No movement | 4 |
| | Amputation, joint fusion (explain) | N/A |
| 5b. Motor; arm—right (elevate extremity to 90° and score drift/movement) | No drift | 0 |
| | Drift but maintains in air | 1 |
| | Unable to maintain in air | 2 |
| | No effort against gravity | 3 |
| | No movement | 4 |
| | Amputation, joint fusion (explain) | N/A |
| 6a. Motor; leg—left (elevate extremity to 30° and score drift/movement) | No drift | 0 |
| | Drift but maintains in air | 1 |
| | Unable to maintain in air | 2 |
| | No effort against gravity | 3 |
| | No movement | 4 |
| | Amputation, joint fusion (explain) | N/A |
| 6b. Motor; leg—right (elevate extremity to 30° and score drift/movement) | No drift | 0 |
| | Drift but maintains in air | 1 |
| | Unable to maintain in air | 2 |
| | No effort against gravity | 3 |
| | No movement | 4 |
| | Amputation, joint fusion (explain) | N/A |
| 7. Limb ataxia (finger-to-nose and heel-to-shin testing) | Absent | 0 |
| | Present in one limb | 1 |
| | Present in two limbs | 2 |
| 8. Sensory (pinprick to face, arm, trunk, and leg—compare side to side) | Normal | 0 |
| | Mild to moderate loss | 1 |
| | Severe to total loss | 2 |
| 9. Best language (name items, describe a picture and read sentences) | No aphasia | 0 |
| | Mild to moderate aphasia | 1 |
| | Severe aphasia | 2 |
| | Mute | 3 |
| 10. Dysarthria (evaluate speech clarity by having patient repeat words) | Normal | 0 |
| | Mild to moderate dysarthria | 1 |
| | Severe dysarthria, mostly unintelligible or worse | 2 |
| | Intubated or other physical barrier | N/A |
| 11. Extinction and inattention (use information from prior testing to score) | No abnormality | 0 |
| | Visual, tactile, auditory, or other extinction to bilateral simultaneous stimulation | 1 |
| | Profound hemiattention or extinction to more than one modality. | 2 |
| Total score | | |

Adapted from the version available at the National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD 20892, www.ninds.nih.gov/doctors/NIH_Stroke_Scale.pdf. It is recommended that the full scale with all instructions be used.

pressure (with the goal of lowering the risk of intracranial hemorrhage). An example of a standard protocol would be to obtain vital signs every 15 minutes for the first 2 hours, every 30 minutes for the next 6 hours, then every hour until 24 hours after treatment. Blood pressure should be maintained with the systolic pressure less than 180 mm Hg and the diastolic pressure less than 105 mm Hg (Adams, et al., 2007). Airway management is instituted based on the patient's clinical condition and arterial blood gas values.

**Side Effects**

Bleeding is the most common side effect of t-PA administration, and the patient is closely monitored for any bleeding (IV insertion sites, urinary catheter site, endotracheal tube, nasogastric tube, urine, stool, emesis, other secretions). A 24-hour delay in placement of nasogastric tubes, urinary catheters, and intra-arterial pressure catheters is recommended. Intracranial bleeding is a major complication that occurred in approximately 6.4% of patients in the initial t-PA study (NINDS, 1995). A number of factors are associated with the occurrence of symptomatic intracranial bleeding: age greater than 70 years, baseline NIHSS score greater than 20, serum glucose concentration 300 mg/dL or higher, and edema or mass effect observed on the patient's initial CT scan.

### Therapy for Patients With Ischemic Stroke Not Receiving t-PA

Not all patients are candidates for t-PA therapy. Other treatments may include anticoagulant administration (IV heparin or low-molecular-weight heparin). Because of the risks associated with anticoagulation, their general use is no longer recommended for patients with acute ischemic stroke, whether treated with t-PA or not (Adams, et al., 2007).

Careful maintenance of cerebral hemodynamics to maintain cerebral perfusion is extremely important after a stroke. Increased intracranial pressure (ICP) from brain edema, and associated complications, may occur after a large ischemic stroke. Interventions during this period include measures to reduce ICP, such as administering an osmotic diuretic (eg, mannitol), maintaining the partial pressure of carbon dioxide ($PaCO_2$) within the range of 30 to 35 mm Hg, and positioning to avoid hypoxia. Other treatment measures include the following:

- Elevation of the head of the bed to promote venous drainage and to lower increased ICP
- Possible hemicraniectomy for increased ICP from brain edema in a very large stroke
- Intubation with an endotracheal tube to establish a patent airway, if necessary
- Continuous hemodynamic monitoring (the goals for blood pressure remain controversial for a patient who has not received thrombolytic therapy; antihypertensive treatment may be withheld unless the systolic blood pressure exceeds 220 mm Hg or the diastolic blood pressure exceeds 120 mm Hg)
- Neurologic assessment to determine if the stroke is evolving and if other acute complications are developing; such complications may include seizures, bleeding from anticoagulation, or medication-induced bradycardia, which can result in hypotension and subsequent decreases in cardiac output and cerebral perfusion pressure

An acute ischemic stroke clinical pathway is shown in Appendix B.

### Managing Potential Complications

Adequate cerebral blood flow is essential for cerebral oxygenation. If cerebral blood flow is inadequate, the amount of oxygen supplied to the brain will decrease, and tissue ischemia will result. Adequate oxygenation begins with pulmonary care, maintenance of a patent airway, and administration of supplemental oxygen as needed. The importance of adequate gas exchange in these patients cannot be overemphasized as many are at risk for aspiration pneumonia.

Other potential complications after a stroke include urinary tract infections, cardiac dysrhythmias, and complications of immobility.

### Surgical Prevention of Ischemic Stroke

The main surgical procedure for selected patients with TIAs and mild stroke is carotid endarterectomy, which is currently the most frequently performed noncardiac vascular procedure. A carotid endarterectomy is the removal of an atherosclerotic plaque or thrombus from the carotid artery to prevent stroke in patients with occlusive disease of the extracranial cerebral arteries (Fig. 62-2). This surgery is indicated for patients with symptoms of TIA or mild stroke found to be caused by severe (70% to 99%) carotid artery stenosis or moderate (50% to 69%) stenosis with other significant risk factors (Chaturvedi, Bruno, Feasby, et al., 2005).

Carotid stenting, with or without angioplasty, is a less invasive procedure that is used, at times, for severe stenosis. It is used for selected patients who are at high risk for surgery, and its efficacy continues to be investigated. In a recent

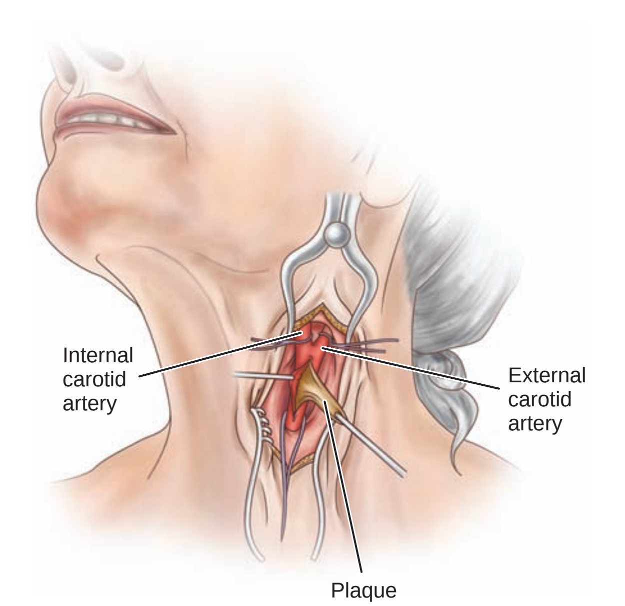



**Figure 62-2** Plaque, a potential source of emboli in transient ischemic attack and stroke, is surgically removed from the carotid artery.

**Table 62-5 SELECTED COMPLICATIONS OF CAROTID ENDARTERECTOMY AND NURSING INTERVENTIONS**

| Complication | Characteristics | Nursing Interventions |
|---|---|---|
| Incision hematoma | Occurs in 5.5% of patients. Large or rapidly expanding hematomas require emergency treatment. If the airway is obstructed by the hematoma, the incision may be opened at the bedside. | Monitor neck discomfort and wound expansion. Report swelling, subjective feelings of pressure in the neck, difficulty breathing. |
| Hypertension | Poorly controlled hypertension increases the risk of postoperative complications, including hematoma and hyperperfusion syndrome. There is an increased incidence of neurologic impairment and death due to intracerebral hemorrhage. May be related to surgically induced abnormalities of carotid baroreceptor sensitivity. | Risk is highest in the first 48 h after surgery. Check blood pressure frequently and report deviations from baseline. Observe for and report new onset of neurologic deficits. |
| Postoperative hypotension | Occurs in approximately 5% of patients. Treated with fluids and low-dose phenylephrine infusion. Usually resolves in 24–48 h. Patients with hypotension should have serial ECGs to rule out myocardial infarction. | Monitor blood pressure and observe for signs and symptoms of hypotension. |
| Hyperperfusion syndrome | Occurs when cerebral vessel autoregulation fails. Arteries accustomed to diminished blood flow may be permanently dilated; increased blood flow after endarterectomy coupled with insufficient vasoconstriction leads to capillary bed damage, edema, and hemorrhage. | Observe for severe unilateral headache improved by sitting upright or standing. |
| Intracerebral hemorrhage | Occurs infrequently, but is often fatal (60%) or results in serious neurologic impairment. Can occur secondary to hyperperfusion syndrome. Increased risk with advanced age, hypertension, presence of high-grade stenosis, poor collateral flow, and slow flow in the region of the middle cerebral artery. | Monitor neurologic status and report any changes in mental status or neurologic functioning immediately. |

study, 334 patients with severe carotid artery stenosis and at high risk for surgery underwent stenting with the use of an emboli protection device or carotid endarterectomy. This study demonstrated that this procedure is not inferior to carotid endarterectomy as it resulted in similar long-term outcomes (Gurm, Yadav, Fayad, et al., 2008).

**Nursing Management**

The primary complications of carotid endarterectomy are stroke, cranial nerve injuries, infection or hematoma at the incision, and carotid artery disruption. It is important to maintain adequate blood pressure levels in the immediate postoperative period. Hypotension is avoided to prevent cerebral ischemia and thrombosis. Uncontrolled hypertension may precipitate cerebral hemorrhage, edema, hemorrhage at the surgical incision, or disruption of the arterial reconstruction. Medications are used to reduce the blood pressure to previous levels. Close cardiac monitoring is necessary, because these patients have a high incidence of coronary artery disease.

After carotid endarterectomy, a neurologic flow sheet is used to monitor and document assessment parameters for all body systems, with particular attention to neurologic status. The surgeon is notified immediately if a neurologic deficit develops. Formation of a thrombus at the site of the endarterectomy is suspected if there is a sudden increase in neurologic deficits, such as weakness on one side of the body. The patient should be prepared for repeat endarterectomy.

Difficulty in swallowing, hoarseness, or other signs of cranial nerve dysfunction must be assessed. The nurse focuses on assessment of the following cranial nerves: facial (VII), vagus (X), spinal accessory (XI), and hypoglossal (XII). Some edema in the neck after surgery is expected; however, extensive edema and hematoma formation can obstruct the airway. Emergency airway supplies, including those needed for a tracheostomy, must be available. Table 62-5 provides more information about potential complications of carotid surgery.

## NURSING PROCESS

### The Patient Recovering From an Ischemic Stroke

The acute phase of an ischemic stroke may last 1 to 3 days, but ongoing monitoring of all body systems is essential as long as the patient requires care. The patient who has had a stroke is at risk for multiple complications, including deconditioning and other musculoskeletal problems, swallowing difficulties, bowel and bladder dysfunction, inability to perform self-care, and skin breakdown. After the stroke is complete, management focuses on the prompt initiation of rehabilitation for any deficits.

#### Assessment

During the acute phase, a neurologic flow sheet is maintained to provide data about the following important measures of the patient's clinical status:

- Change in level of consciousness or responsiveness as evidenced by movement, resistance to changes of position, and response to stimulation; orientation to time, place, and person
- Presence or absence of voluntary or involuntary movements of the extremities; muscle tone; body posture; and position of the head

- Stiffness or flaccidity of the neck
- Eye opening, comparative size of pupils and pupillary reactions to light, and ocular position
- Color of the face and extremities; temperature and moisture of the skin
- Quality and rates of pulse and respiration; arterial blood gas values as indicated, body temperature, and arterial pressure
- Ability to speak
- Volume of fluids ingested or administered; volume of urine excreted each 24 hours
- Presence of bleeding
- Maintenance of blood pressure within the desired parameters

After the acute phase, the nurse assesses mental status (memory, attention span, perception, orientation, affect, speech/language), sensation/perception (usually the patient has decreased awareness of pain and temperature), motor control (upper and lower extremity movement), swallowing ability, nutritional and hydration status, skin integrity, activity tolerance, and bowel and bladder function. Ongoing nursing assessment continues to focus on any impairment of function in the patient's daily activities, because the quality of life after stroke is closely related to the patient's functional status.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses for a patient with a stroke may include the following:

- Impaired physical mobility related to hemiparesis, loss of balance and coordination, spasticity, and brain injury
- Acute pain (painful shoulder) related to hemiplegia and disuse
- Self-care deficits (bathing, hygiene, toileting, dressing, grooming, and feeding) related to stroke sequelae
- Disturbed sensory perception (kinesthetic, tactile or visual) related to altered sensory reception, transmission, and/or integration
- Impaired swallowing
- Impaired urinary elimination related to flaccid bladder, detrusor instability, confusion, or difficulty in communicating
- Disturbed thought processes related to brain damage
- Impaired verbal communication related to brain damage
- Risk for impaired skin integrity related to hemiparesis, hemiplegia, or decreased mobility
- Interrupted family processes related to catastrophic illness and caregiving burdens
- Sexual dysfunction related to neurologic deficits or fear of failure

### *Collaborative Problems/Potential Complications*

Potential complications include:

- Decreased cerebral blood flow due to increased ICP
- Inadequate oxygen delivery to the brain
- Pneumonia

## Planning and Goals

Although rehabilitation begins on the day the patient has the stroke, the process is intensified during convalescence and requires a coordinated team effort. It is helpful for the team to know what the patient was like before the stroke: his or her illnesses, abilities, mental and emotional state, behavioral characteristics, and activities of daily living (ADLs). It is also helpful for clinicians to be knowledgeable about the relative importance of predictors of stroke outcome (age, NIHSS score, and level of consciousness at time of admission) in order to provide stroke survivors and their families with realistic goals (Adams, et al., 2007).

The major goals for the patient (and family) may include improved mobility, avoidance of shoulder pain, achievement of self-care, relief of sensory and perceptual deprivation, prevention of aspiration, continence of bowel and bladder, improved thought processes, achieving a form of communication, maintaining skin integrity, restored family functioning, improved sexual function, and absence of complications.

## Nursing Interventions

Nursing care has a significant impact on the patient's recovery. Often, many body systems are impaired as a result of the stroke, and conscientious care and timely interventions can prevent debilitating complications. During and after the acute phase, nursing interventions focus on the whole person. In addition to providing physical care, the nurse encourages and fosters recovery by listening to the patient and asking questions to elicit the meaning of the stroke experience.

### *Improving Mobility and Preventing Joint Deformities*

A patient with hemiplegia has unilateral paralysis (paralysis on one side). When control of the voluntary muscles is lost, the strong flexor muscles exert control over the extensors. The arm tends to adduct (adductor muscles are stronger than abductors) and to rotate internally. The elbow and the wrist tend to flex, the affected leg tends to rotate externally at the hip joint and flex at the knee, and the foot at the ankle joint supinates and tends toward plantar flexion.

Correct positioning is important to prevent contractures; measures are used to relieve pressure, assist in maintaining good body alignment, and prevent compressive neuropathies, especially of the ulnar and peroneal nerves. Because flexor muscles are stronger than extensor muscles, a splint applied at night to the affected extremity may prevent flexion and maintain correct positioning during sleep. (See Chapter 11 for additional information.)

**PREVENTING SHOULDER ADDUCTION.** To prevent adduction of the affected shoulder while the patient is in bed, a pillow is placed in the axilla when there is limited external rotation; this keeps the arm away from the chest. A pillow is placed under the arm, and the arm is placed in a neutral (slightly flexed) position, with distal joints positioned higher than the more proximal joints (ie, the elbow is positioned higher than the shoulder and the wrist higher than the elbow). This helps to prevent edema and the resultant joint fibrosis that will limit range of motion if the patient regains control of the arm (Fig. 62-3).

**POSITIONING THE HAND AND FINGERS.** The fingers are positioned so that they are barely flexed. The hand is placed in slight supination (palm faces upward), which is its most functional position. If the upper extremity is flaccid, a splint can be used to support the wrist and hand in a functional



**Figure 62-3** Correct positioning to prevent shoulder adduction.

position. If the upper extremity is spastic, a hand roll is not used, because it stimulates the grasp reflex. In this instance a dorsal wrist splint is useful in allowing the palm to be free of pressure. Every effort is made to prevent hand edema.

Spasticity, particularly in the hand, can be a disabling complication after stroke. Researchers have reported that repeated intramuscular injections of botulinum toxin type A into wrist and finger muscles reduced upper limb spasticity after stroke, resulting in significant and sustained improvements in muscle tone, lessened disability, and improved quality of life (Elovic, Brashear, Kaelin, et al., 2008). Other treatments for spasticity may include stretching and splinting.

**CHANGING POSITIONS.** The patient's position should be changed every 2 hours. To place a patient in a lateral (side-lying) position, a pillow is placed between the legs before the patient is turned. To promote venous return and prevent edema, the upper thigh should not be acutely flexed. The patient may be turned from side to side, but if sensation is impaired, the amount of time spent on the affected side should be limited.

If possible, the patient is placed in a prone position for 15 to 30 minutes several times a day. A small pillow or a support is placed under the pelvis, extending from the level of the umbilicus to the upper third of the thigh (Fig. 62-4). This position helps promote hyperextension of the hip joints, which is essential for normal gait and helps prevent knee and hip flexion contractures. The prone position also helps drain bronchial secretions and prevents contractural deformities of the shoulders and knees. During positioning, it is important to reduce pressure and change position frequently to prevent pressure ulcers.

**ESTABLISHING AN EXERCISE PROGRAM.** The affected extremities are exercised passively and put through a full range of motion four or five times a day to maintain joint mobility, regain motor control, prevent contractures in the paralyzed extremity, prevent further deterioration of the neuromuscular system, and enhance circulation. Exercise is helpful in preventing venous stasis, which may predispose the patient to thrombosis and pulmonary embolus.

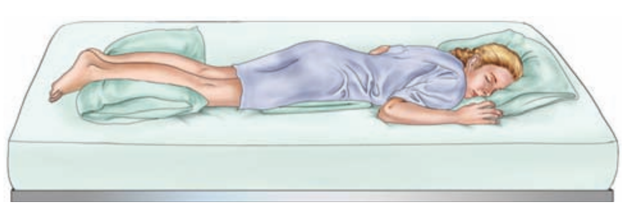


**Figure 62-4** Prone position with pillow support helps prevent hip flexion.

Repetition of an activity forms new pathways in the CNS and therefore encourages new patterns of motion. At first, the extremities are usually flaccid. If tightness occurs in any area, the range-of-motion exercises should be performed more frequently (see Chapter 11).

The patient is observed for signs and symptoms that may indicate pulmonary embolus or excessive cardiac workload during exercise; these include shortness of breath, chest pain, cyanosis, and increasing pulse rate with exercise. Frequent short periods of exercise always are preferable to longer periods at infrequent intervals. Regularity in exercise is most important. Improvement in muscle strength and maintenance of range of motion can be achieved only through daily exercise.

The patient is encouraged and reminded to exercise the unaffected side at intervals throughout the day. It is helpful to develop a written schedule to remind the patient of the exercise activities. The nurse supervises and supports the patient during these activities. The patient can be taught to put the unaffected leg under the affected one to assist in moving it when turning and exercising. Flexibility, strengthening, coordination, endurance, and balancing exercises prepare the patient for ambulation. Quadriceps muscle setting and gluteal setting exercises are started early to improve the muscle strength needed for walking; these are performed at least five times daily for 10 minutes at a time.

**PREPARING FOR AMBULATION.** As soon as possible, the patient is assisted out of bed and an active rehabilitation program is started. The patient is first taught to maintain balance while sitting and then to learn to balance while standing. If the patient has difficulty in achieving standing balance, a tilt table, which slowly brings the patient to an upright position, can be used. Tilt tables are especially helpful for patients who have been on bed rest for prolonged periods and have orthostatic blood pressure changes.

If the patient needs a wheelchair, the folding type with hand brakes is the most practical because it allows the patient to manipulate the chair. The chair should be low enough to allow the patient to propel it with the uninvolved foot and narrow enough to permit it to be used in the home. When the patient is transferred from the wheelchair, the brakes must be applied and locked on both sides of the chair.

The patient is usually ready to walk as soon as standing balance is achieved. Parallel bars are useful in these first efforts. A chair or wheelchair should be readily available in case the patient suddenly becomes fatigued or feels dizzy.

The training periods for ambulation should be short and frequent. As the patient gains strength and confidence, an adjustable cane can be used for support. Generally, a three- or four-pronged cane provides a stable support in the early phases of rehabilitation.

### *Preventing Shoulder Pain*

As many as 72% of patients who have had a stroke have pain in the shoulder (Duncan, Zorowitz, Bates, et al., 2005). That pain may prevent them from learning new skills and

affect their quality of life (Chae, Mascarenhas, Yu, et al., 2007). Shoulder function is essential in achieving balance and performing transfers and self-care activities. Three problems can occur: painful shoulder, subluxation of the shoulder, and shoulder–hand syndrome.

A flaccid shoulder joint may be overstretched by the use of excessive force in turning the patient or from overstrenuous arm and shoulder movement. To prevent shoulder pain, the nurse should never lift the patient by the flaccid shoulder or pull on the affected arm or shoulder. Overhead pulleys should also be avoided. If the arm is paralyzed, subluxation (incomplete dislocation) at the shoulder can occur as a result of overstretching of the joint capsule and musculature by the force of gravity when the patient sits or stands in the early stages after a stroke. This results in severe pain. Shoulder–hand syndrome (painful shoulder and generalized swelling of the hand) can cause a frozen shoulder and ultimately atrophy of subcutaneous tissues. When a shoulder becomes stiff, it is usually painful.

Many shoulder problems can be prevented by proper patient movement and positioning. The flaccid arm is positioned on a table or with pillows while the patient is seated. Some clinicians advocate the use of a properly worn sling when the patient first becomes ambulatory, to prevent the paralyzed upper extremity from dangling without support. Range-of-motion exercises are important in preventing painful shoulder. Overstrenuous arm movements are avoided. The patient is instructed to interlace the fingers, place the palms together, and push the clasped hands slowly forward to bring the scapulae forward; he or she then raises both hands above the head. This is repeated throughout the day. The patient is instructed to flex the affected wrist at intervals and move all the joints of the affected fingers. The patient is encouraged to touch, stroke, rub, and look at both hands. Pushing the heel of the hand firmly down on a surface is useful. Elevation of the arm and hand is also important in preventing dependent edema of the hand. Patients with continuing pain after attempted movement and positioning may require the addition of analgesia to their treatment program. Other treatments may include injections to the shoulder joint with corticosteroid medications, electrical stimulation, heat or ice, and soft tissue massage (Duncan, et al., 2005).

Medications are helpful in the management of poststroke pain. Amitriptyline hydrochloride (Elavil) has been used, but it can cause cognitive problems, has a sedating effect, and is not effective in all patients. The antiseizure medications lamotrigine (Lamictal) and pregabalin (Lyrica) have been found to be effective for poststroke pain, and they may serve as alternatives for patients who cannot tolerate amitriptyline (Vranken, Dijkgraaf, Kruis, et al., 2008).

### *Enhancing Self-Care*

As soon as the patient can sit up, personal hygiene activities are encouraged. The patient is helped to set realistic goals; if feasible, a new task is added daily. The first step is to carry out all self-care activities on the unaffected side. Such activities as combing the hair, brushing the teeth, shaving with an electric razor, bathing, and eating can be carried out with one hand and should be encouraged. Although the patient may feel awkward at first, these motor skills can be learned by repetition, and the unaffected side will become stronger with use. The nurse must be sure that the patient does not neglect the affected side. Assistive devices will help make up for some of the patient's deficits (Chart 62-3). A small towel is easier to control while drying after bathing, and boxed paper tissues are easier to use than a roll of toilet tissue.

Return of functional ability is important to the patient recovering after a stroke. An early baseline assessment of functional ability with an instrument such as the Functional Independence Measure (FIM) is important in team planning and goal setting for the patient. The FIM is a widely used instrument in stroke rehabilitation and provides valuable information about motor, social, and cognitive function (Kasner, 2006). The patient's morale may improve if ambulatory activities are carried out in street clothes. The family is instructed to bring in clothing that is preferably a size larger than that normally worn. Clothing fitted with front or side fasteners or Velcro closures is the most suitable. The patient has better balance if most of the dressing activities are carried out while seated.

Perceptual problems may make it difficult for the patient to dress without assistance because of an inability to match the clothing to the body parts. To assist the patient, the nurse can take steps to keep the environment organized and uncluttered, because the patient with a perceptual problem is easily distracted. The clothing is placed on the affected side in the order in which the garments are to be put on. Using a large mirror while dressing promotes the patient's awareness of what he or she is putting on the affected side. The patient has to make many compensatory movements when dressing; these can produce fatigue and painful twisting of the intercostal muscles. Support and encouragement

## Chart 62-3 • *Assistive Devices to Enhance Self-Care After Stroke*

**Eating Devices**

- Nonskid mats to stabilize plates
- Plate guards to prevent food from being pushed off plate
- Wide-grip utensils to accommodate a weak grasp

**Bathing and Grooming Devices**

- Long-handled bath sponge
- Grab bars, nonskid mats, handheld shower heads
- Electric razors with head at 90 degrees to handle
- Shower and tub seats, stationary or on wheels

**Toileting Aids**

- Raised toilet seat
- Grab bars next to toilet

**Dressing Aids**

- Velcro closures
- Elastic shoelaces
- Long-handled shoe horn

**Mobility Aids**

- Canes, walkers, wheelchairs
- Transfer devices such as transfer boards and belts

are provided to prevent the patient from becoming overly fatigued and discouraged. Even with intensive training, not all patients can achieve independence in dressing.

### *Managing Sensory-Perceptual Difficulties*

Patients with a decreased field of vision should be approached on the side where visual perception is intact. All visual stimuli (eg, clock, calendar, television) should be placed on this side. The patient can be taught to turn the head in the direction of the defective visual field to compensate for this loss. The nurse should make eye contact with the patient and draw his or her attention to the affected side by encouraging the patient to move the head. The nurse may also want to stand at a position that encourages the patient to move or turn to visualize who is in the room. Increasing the natural or artificial lighting in the room and providing eyeglasses are important aids to increasing vision.

The patient with homonymous hemianopsia (loss of half of the visual field) turns away from the affected side of the body and tends to neglect that side and the space on that side; this is called amorphosynthesis. In such instances, the patient cannot see food on half of the tray, and only half of the room is visible. It is important for the nurse to constantly remind the patient of the other side of the body, to maintain alignment of the extremities, and, if possible, to place the extremities where the patient can see them.

### *Assisting With Nutrition*

Stroke can result in swallowing problems (dysphagia) due to impaired function of the mouth, tongue, palate, larynx, pharynx, or upper esophagus. Patients must be observed for paroxysms of coughing, food dribbling out of or pooling in one side of the mouth, food retained for long periods in the mouth, or nasal regurgitation when swallowing liquids. Swallowing difficulties place the patient at risk for aspiration, pneumonia, dehydration, and malnutrition.

A speech therapist will evaluate the patient's swallowing ability. If swallowing function is partially impaired, it may return over time, or the patient may be taught alternative swallowing techniques, advised to take smaller boluses of food, and taught about types of foods that are easier to swallow. The patient may be started on a thick liquid or puréed diet, because these foods are easier to swallow than thin liquids. Having the patient sit upright, preferably out of bed in a chair, and instructing him or her to tuck the chin toward the chest as he or she swallows will help prevent aspiration. The diet may be advanced as the patient becomes more proficient at swallowing. If the patient cannot resume oral intake, a gastrointestinal feeding tube is placed for ongoing tube feedings and medication administration.

Enteral tubes can be either nasogastric (placed in the stomach) or nasoenteral (placed in the duodenum) to reduce the risk of aspiration. Nursing responsibilities in feeding include elevating the head of the bed at least 30 degrees to prevent aspiration, checking the position of the tube before feeding, ensuring that the cuff of the tracheostomy tube (if in place) is inflated, and giving the tube feeding slowly. The feeding tube is aspirated periodically to ensure that the feedings are passing through the gastrointestinal tract. Retained or residual feedings increase the risk of aspiration. Patients with retained feedings may benefit from the placement of a gastrostomy tube or a percutaneous endoscopic gastrostomy tube. In a patient with a nasogastric tube, the feeding tube should be placed in the duodenum to reduce the risk of aspiration. For long-term feedings, a gastrostomy tube is preferred. Management of patients with tube feedings is discussed in Chapter 36.

### *Attaining Bowel and Bladder Control*

After a stroke, the patient may have transient urinary incontinence due to confusion, inability to communicate needs, and inability to use the urinal or bedpan because of impaired motor and postural control. Occasionally after a stroke, the bladder becomes atonic, with impaired sensation in response to bladder filling. Sometimes control of the external urinary sphincter is lost or diminished. During this period, intermittent catheterization with sterile technique is carried out. After muscle tone increases and deep tendon reflexes return, bladder tone increases and spasticity of the bladder may develop. Because the patient's sense of awareness is clouded, persistent urinary incontinence or urinary retention may be symptomatic of bilateral brain damage. The voiding pattern is analyzed, and the urinal or bedpan is offered on this pattern or schedule. The upright posture and standing position are helpful for male patients during this aspect of rehabilitation.

Patients may have problems with bowel control, particularly constipation. Unless contraindicated, a high-fiber diet and adequate fluid intake (2 to 3 L/day) should be provided and a regular time (usually after breakfast) should be established for toileting. See Chapter 11 for additional information about bowel and bladder control.

### *Improving Thought Processes*

After a stroke, the patient may have problems with cognitive, behavioral, and emotional deficits related to brain damage. However, in many instances, a considerable degree of function can be recovered, because not all areas of the brain are equally damaged; some remain more intact and functional than others.

After assessment that delineates the patient's deficits, the neuropsychologist, in collaboration with the primary care physician, psychiatrist, nurse, and other professionals, structures a training program using cognitive-perceptual retraining, visual imagery, reality orientation, and cueing procedures to compensate for losses.

The role of the nurse is supportive. The nurse reviews the results of neuropsychological testing, observes the patient's performance and progress, gives positive feedback, and, most importantly, conveys an attitude of confidence and hope. Interventions capitalize on the patient's strengths and remaining abilities while attempting to improve performance of affected functions. Other interventions are similar to those for improving cognitive functioning after a head injury (see Chapter 63).

### *Improving Communication*

Aphasia, which impairs the patient's ability to express himself or herself and to understand what is being said, may become apparent in various ways. The cortical area that is responsible for integrating the myriad pathways required for

the comprehension and formulation of language is called Broca's area. It is located in a convolution adjoining the middle cerebral artery. This area is responsible for control of the combinations of muscular movements needed to speak each word. Broca's area is so close to the left motor area that a disturbance in the motor area often affects the speech area. This is why so many patients who are paralyzed on the right side (due to damage or injury to the left side of the brain) cannot speak, whereas those paralyzed on the left side are less likely to have speech disturbances.

The speech therapist assesses the communication needs of the stroke patient, describes the precise deficit, and suggests the best overall method of communication. Most language intervention strategies can be tailored for the individual patient. The patient is expected to take an active part in establishing goals.

A person with aphasia may become depressed. The inability to talk on the telephone, answer a question, or participate in conversation often causes anger, frustration, fear of the future, and hopelessness. Nursing interventions include strategies to make the atmosphere conducive to communication. This includes being sensitive to the patient's reactions and needs and responding to them in an appropriate manner, while always treating the patient as an adult. The nurse provides strong emotional support and understanding to allay anxiety and frustration.

A common pitfall is for the nurse or other health care team member to complete the thoughts or sentences of the patient. This should be avoided, because it causes the patient to become more frustrated at not being allowed to speak and may deter efforts to practice putting thoughts together and completing sentences. A consistent schedule, routines, and repetition help the patient to function despite significant deficits. A written copy of the daily schedule, a folder of personal information (birth date, address, names of relatives), checklists, and an audiotaped list help improve the patient's memory and concentration. The patient may also benefit from a communication board, which has pictures of common needs and phrases. The board may be translated into any language.

When talking with the patient, it is important for the nurse to gain the patient's attention, speak slowly, and keep the language of instruction consistent. One instruction is given at a time, and time is allowed for the patient to process what has been said. The use of gestures may enhance comprehension. Speaking is thinking out loud, and the emphasis is on thinking. Listening and sorting out incoming messages requires mental effort; the patient must struggle against mental inertia and needs time to organize a response.

In working with the patient with aphasia, the nurse must remember to talk to the patient during care activities. This provides social contact for the patient. Chart 62-4 describes points to keep in mind when communicating with the patient with aphasia.

**Chart 62-4 • *Communicating With the Patient With Aphasia***

- Face the patient and establish eye contact.
- Speak in a normal manner and tone.
- Use short phrases, and pause between phrases to allow the patient time to understand what is being said.
- Limit conversation to practical and concrete matters.
- Use gestures, pictures, objects, and writing.
- As the patient uses and handles an object, say what the object is. It helps to match the words with the object or action.
- Be consistent in using the same words and gestures each time you give instructions or ask a question.
- Keep extraneous noises and sounds to a minimum. Too much background noise can distract the patient or make it difficult to sort out the message being spoken.

### *Maintaining Skin Integrity*

The patient who has had a stroke may be at risk for skin and tissue breakdown because of altered sensation and inability to respond to pressure and discomfort by turning and moving. Preventing skin and tissue breakdown requires frequent assessment of the skin, with emphasis on bony areas and dependent parts of the body. During the acute phase, a specialty bed (eg, low-air-loss bed) may be used until the patient can move independently or assist in moving.

A regular turning schedule (eg, every 2 hours) is adhered to even if pressure-relieving devices are used to prevent tissue and skin breakdown. When the patient is positioned or turned, care must be used to minimize shear and friction forces, which cause damage to tissues and predispose the skin to breakdown.

The patient's skin must be kept clean and dry; gentle massage of healthy (nonreddened) skin and adequate nutrition are other factors that help to maintain normal skin and tissue integrity (see Chapter 11).

### *Improving Family Coping*

Family members play an important role in the patient's recovery. Family members are encouraged to participate in counseling and to use support systems that will help with the emotional and physical stress of caring for the patient. Involving others in the patient's care and teaching stress management techniques and methods for maintaining personal health also facilitate family coping.

The family may have difficulty accepting the patient's disability and may be unrealistic in their expectations. They are given information about the expected outcomes and are counseled to avoid doing activities for the patient that he or she can do. They are assured that their love and interest are part of the patient's therapy.

The family needs to be informed that the rehabilitation of the hemiplegic patient requires many months and that progress may be slow. The gains made by the patient in the hospital or rehabilitation unit must be maintained. All caregivers should approach the patient with a supportive and optimistic attitude, focusing on the patient's remaining abilities. The rehabilitation team, the medical and nursing team, the patient, and the family must all be involved in developing attainable goals for the patient at home.

Most relatives of patients with stroke handle the physical changes better than the emotional aspects of care. The family should be prepared to expect occasional episodes of

emotional lability. The patient may laugh or cry easily and may be irritable and demanding or depressed and confused. The nurse can explain to the family that the patient's laughter does not necessarily connote happiness, nor does crying reflect sadness, and that emotional lability usually improves with time.

### *Helping the Patient Cope With Sexual Dysfunction*

Sexual functioning can be profoundly altered by stroke. Although research in this area of stroke management is limited, it appears that patients who have had a stroke consider sexual function important, and many have sexual dysfunction. Sexual dysfunction after stroke is multifactorial. There may be medical reasons for the dysfunction (neurologic and cognitive deficits, previous diseases, medications), as well as various psychosocial factors, including depression. A stroke is such a catastrophic illness that the patient experiences loss of self-esteem and value as a sexual being. These psychosocial factors play an important role in determining sexual drive, activity, and satisfaction after a stroke.

Nurses in the rehabilitation setting play a crucial role in beginning a dialogue between the patient and his or her partner about sexuality after a stroke. In-depth assessments to determine sexual history before and after the stroke should be followed by appropriate interventions. Interventions for the patient and partner focus on providing relevant information, education, reassurance, adjustment of medications, counseling regarding coping skills, suggestions for alternative sexual positions, and a means of sexual expression and satisfaction (Kautz, 2007).

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patient and family education is a fundamental component of rehabilitation. The nurse provides teaching about stroke, its causes and prevention, and the rehabilitation process. In both acute care and rehabilitation facilities, the focus is on teaching the patient to resume as much self-care as possible. This may entail using assistive devices or modifying the home environment to help the patient live with a disability.

An occupational therapist may be helpful in assessing the home environment and recommending modifications to help the patient become more independent. For example, a shower is more convenient than a tub for the patient with hemiplegia because most patients do not gain sufficient strength to get up and down from a tub. Sitting on a stool of medium height with rubber suction tips allows the patient to wash with greater ease. A long-handled bath brush with a soap container is helpful to the patient who has only one functional hand. If a shower is not available, a stool may be placed in the tub and a portable shower hose attached to the faucet. Handrails may be attached alongside the bathtub and the toilet. Other assistive devices include special utensils for eating, grooming, dressing, and writing (see Chart 62-3).

A program of physical therapy can be beneficial, whether it takes places in the home or in an outpatient program. Recent research has focused on techniques using robotics and constraint-induced movement therapy. Constraint-induced movement therapy involves constraint of the less affected upper limb with a mitt and intensely training the more affected limb. This technique has shown improved arm function in patients who had a stroke 3 to 9 months prior to receiving the treatment (Wolf, Winstein, Miller, et al., 2006). Robot-assisted therapy uses sensorimotor training of the upper limb. This method allows patients to train without the presence of a therapist.

**CONTINUING CARE.** The recovery and rehabilitation process after stroke may be prolonged and requires patience and perseverance on the part of both the patient and the family. Depending on the specific neurologic deficits resulting from the stroke, the patient at home may require the services of a number of health care professionals. The nurse often coordinates the care of the patient at home and considers the many educational needs of caregivers and patients. The family (often the spouse) requires education as well as assistance in planning and providing care.

The family is advised that the patient may tire easily, may become irritable and upset by small events, and may be less interested in events than expected. Emotional problems associated with stroke are often related to speech dysfunction and the frustrations of being unable to communicate. A speech therapist allows the family to be involved and gives the family practical instructions to help the patient between therapy sessions.

Depression is a common and serious problem in the patient who has had a stroke. Incidence of depression in patients who have had a stroke ranges from less than 10% to more than 50%. Risk factors include increased severity of stroke, a history of depression, and cognitive or physical impairment (Johnson, Minarik, Nyström, et al., 2006). Nurses should identify patients who may be at risk while they are in the hospital. In the home or in the rehabilitation setting, nurses may be involved in coordinating care and referring patients and family to appropriate resources. The family can help by continuing to support the patient and by giving positive reinforcement for the progress that is being made. Antidepressant therapy may help if depression dominates the patient's life.

Community-based stroke support groups may allow the patient and family to learn from others with similar problems and to share their experiences. Support groups take the form of in-person meetings as well as Internet-based support programs. The patient is encouraged to continue hobbies and recreational and leisure interests and to maintain contact with friends to prevent social isolation. All nurses coming in contact with the patient should encourage the patient to keep active, adhere to the exercise program, and remain as self-sufficient as possible.

The nurse should recognize the potential effects of caregiving on the family. Not all families have the adaptive coping skills and adequate psychological functioning necessary for the long-term care of another person. The patient's spouse may be elderly, with his or her own health concerns; in some instances, the patient may have been the provider of care to the spouse. A spouse may have to take on new roles and responsibilities in the relationship and around the home. He or she may also feel a sense of loss (of freedom and leisure time as well as of the marital relationship) (Chart 62-5).

Depression is common in caregivers of stroke survivors, and it may last 18 months or more (Berg, Palomäki,

CHART 62-5

**NURSING RESEARCH PROFILE**

***Spouses Caring for Stroke Survivors***

Coombs, U. (2007). Spousal caregiving for stroke survivors. *Journal of Neuroscience Nursing, 39*(2), 112–119.

**Purpose**

Survivors of a stroke may be discharged to an acute rehabilitation facility or skilled nursing facility. The ultimate goal after a stroke is to have survivors return home. A spouse plays an important role in caring for stroke survivors and also provides much-needed emotional support. The purpose of this study was to explore the phenomenon of spousal caregiving from the perspective of the spousal caregivers (the lived experience of spousal caregivers).

**Design**

This phenomenologic study was guided by the research question: What is it like for older caregivers to care for a spouse who has survived a stroke? This study used eight interviews from adults who were at least 50 years of age and were caring for a stroke survivor who was at least 1 year poststroke. Data were collected through taped interviews. Each participant had two separate interviews lasting 60 to 120 minutes using an interview guide containing five to six questions. Participants were asked to describe their caregiving experience, and the interview guide questions were used as prompts if needed.

**Findings**

Five females and three males participated, the mean age was 65 years, and all were married. The number of years caring for their spouses ranged from 1.5 to 5 years. The mean age of the stroke survivors was 68 years. Six themes emerged for this study: experiencing a profound sense of loss, adjusting to a new relationship with the spouse, taking on a new responsibility, feeling the demands of caregiving, having to depend on others, and maintaining hope and optimism.

**Nursing Implications**

The findings of this study may help nurses working in hospital, rehabilitation, community, or home health care settings understand the impact of caregiving on spouses. More attention should be given to the spouse in the acute care setting, and support resources should be provided. By being aware of the particular concerns of caregivers, nurses may anticipate problems and stresses that caregivers may encounter.

Lönnqvist, et al., 2005). Nurses should assess caregivers for signs of depression (Lightbody, Auton, Baldwin, et al., 2007). Caregivers who are depressed may be more likely to resort to physical or emotional abuse of the patient and to place the patient in a nursing home.

Caregivers may require reminders to attend to their own health concerns and well-being. Even healthy caregivers may find it difficult to maintain a schedule that includes being available around the clock. The nurse encourages the family to arrange for respite care services (planned short-term care to relieve the family from having to provide continuous 24-hour care), which may be available from an adult day care center. Some hospitals also offer weekend respite care that can provide caregivers with needed time for themselves. The nurse involved in home and continuing care also needs to remind the patient and family of the need for respite care as well as continuing health promotion and screening practices.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Achieves improved mobility
   a. Avoids deformities (contractures and footdrop)
   b. Participates in prescribed exercise program
   c. Achieves sitting balance
   d. Uses unaffected side to compensate for loss of function of hemiplegic side
2. Reports absence of shoulder pain
   a. Demonstrates shoulder mobility; exercises shoulder
   b. Elevates arm and hand at intervals
3. Achieves self-care; performs hygiene care; uses adaptive equipment
4. Demonstrates techniques to compensate for altered sensory reception, such as turning the head to see people or objects
5. Demonstrates safe swallowing
6. Achieves normal bowel and bladder elimination
7. Participates in cognitive improvement program
8. Demonstrates improved communication
9. Maintains intact skin without breakdown
   a. Demonstrates normal skin turgor
   b. Participates in turning and positioning activities
10. Family members demonstrate a positive attitude and coping mechanisms
    a. Encourage patient in exercise program
    b. Take an active part in rehabilitation process
    c. Contact respite care programs or arrange for other family members to assume some responsibilities for care
11. Develops alternative approaches to sexual expression

# *Hemorrhagic Stroke*

Hemorrhagic strokes account for 15% to 20% of cerebrovascular disorders and are primarily caused by intracranial or subarachnoid hemorrhage. Hemorrhagic strokes are caused by bleeding into the brain tissue, the ventricles, or the subarachnoid space. Primary intracerebral hemorrhage from a spontaneous rupture of small vessels accounts for approximately 80% of hemorrhagic strokes and is caused chiefly by uncontrolled hypertension. Subarachnoid hemorrhage results from a ruptured intracranial **aneurysm** (a weakening in the arterial wall) in about half the cases (Hickey, 2009).

Another common cause of intracerebral hemorrhage in the elderly is cerebral amyloid angiopathy, which involves damage caused by the deposit of beta-amyloid protein in the small and medium-sized blood vessels of the brain. Secondary intracerebral hemorrhage is associated with arteriovenous malformations (AVMs), intracranial aneurysms, intracranial neoplasms, or certain medications (eg, anticoagulants, amphetamines). The mortality rate has been reported to be as high as 48% at 30 days after an intracranial hemorrhage (Flaherty, Haverbusch, Sekar, et al., 2006). Patients who survive the acute phase of care usually have more severe deficits and a longer recovery phase compared to those with ischemic stroke.

## Pathophysiology

The pathophysiology of hemorrhagic stroke depends on the cause and type of cerebrovascular disorder. Symptoms are produced when a primary hemorrhage, aneurysm, or AVM presses on nearby cranial nerves or brain tissue or, more dramatically, when an aneurysm or AVM ruptures, causing subarachnoid hemorrhage (hemorrhage into the cranial subarachnoid space). Normal brain metabolism is disrupted by the brain's exposure to blood; by an increase in ICP resulting from the sudden entry of blood into the subarachnoid space, which compresses and injures brain tissue; or by secondary ischemia of the brain resulting from the reduced perfusion pressure and vasospasm that frequently accompany subarachnoid hemorrhage.

### Intracerebral Hemorrhage

An intracerebral hemorrhage, or bleeding into the brain tissue, is most common in patients with hypertension and cerebral atherosclerosis, because degenerative changes from these diseases cause rupture of the blood vessel. An intracerebral hemorrhage may also result from certain types of arterial pathology, brain tumors, and the use of medications (eg, oral anticoagulants, amphetamines, and illicit drug use).

Bleeding occurs most commonly in the cerebral lobes, basal ganglia, thalamus, brain stem (mostly the pons), and cerebellum (Hickey, 2009). Occasionally, the bleeding ruptures the wall of the lateral ventricle and causes intraventricular hemorrhage, which is frequently fatal.

### Intracranial (Cerebral) Aneurysm

An intracranial (cerebral) aneurysm is a dilation of the walls of a cerebral artery that develops as a result of weakness in the arterial wall. The cause of aneurysms is unknown, although research is ongoing. An aneurysm may be due to atherosclerosis, which results in a defect in the vessel wall with subsequent weakness of the wall; a congenital defect of the vessel wall; hypertensive vascular disease; head trauma; or advancing age.

Any artery within the brain can be the site of a cerebral aneurysm, but these lesions usually occur at the bifurcations of the large arteries at the circle of Willis (Fig. 62-5). The cerebral arteries most commonly affected by an aneurysm are the internal carotid artery (ICA), anterior cerebral artery (ACA), anterior communicating artery (ACoA), posterior communicating artery (PCoA), posterior cerebral artery (PCA), and middle cerebral artery (MCA). Multiple cerebral aneurysms are not uncommon.

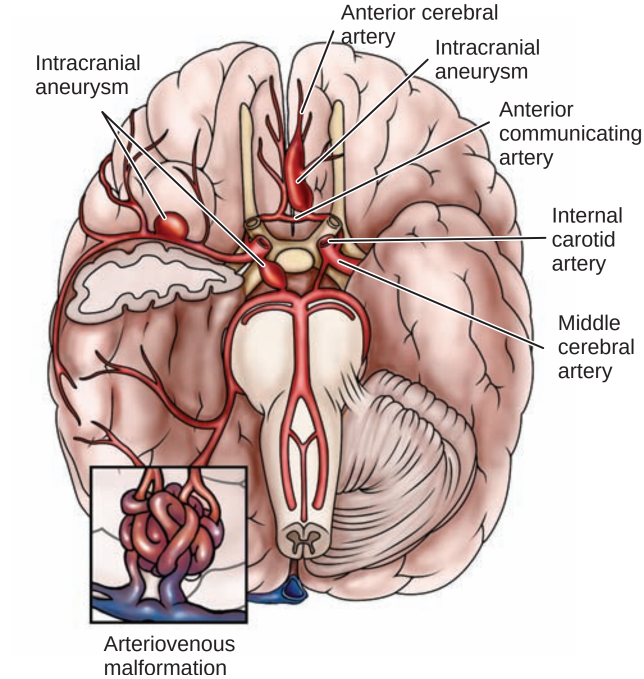



**Figure 62-5** Common sites of intracranial aneurysms and an arteriovenous malformation.

### Arteriovenous Malformations

Most AVMs are caused by an abnormality in embryonal development that leads to a tangle of arteries and veins in the brain that lacks a capillary bed (see Fig. 62-5). The absence of a capillary bed leads to dilation of the arteries and veins and eventual rupture. AVM is a common cause of hemorrhagic stroke in young people.

### Subarachnoid Hemorrhage

A subarachnoid hemorrhage (hemorrhage into the subarachnoid space) may occur as a result of an AVM, intracranial aneurysm, trauma, or hypertension. The most common causes are a leaking aneurysm in the area of the circle of Willis and a congenital AVM of the brain.

## Clinical Manifestations

The patient with a hemorrhagic stroke can present with a wide variety of neurologic deficits, similar to the patient with ischemic stroke. The conscious patient most commonly reports a severe headache. A comprehensive assessment reveals the extent of the neurologic deficits. Many of the same motor, sensory, cranial nerve, cognitive, and other functions that are disrupted after ischemic stroke are also altered after a hemorrhagic stroke. Table 62-2 reviews the neurologic deficits frequently seen in stroke patients. Table 62-3 compares the symptoms seen in right hemispheric stroke with those seen in left hemispheric stroke. Other symptoms that may be observed more frequently in patients with acute intracerebral hemorrhage (compared with ischemic stroke) are vomiting, an early sudden change in level of consciousness, and possibly focal seizures due to frequent brain stem involvement (Hickey, 2009).

In addition to the neurologic deficits (similar to those of ischemic stroke), the patient with an intracranial aneurysm or AVM may have some unique clinical manifestations. Rupture of an aneurysm or AVM usually produces a sudden, unusually severe headache and often loss of consciousness for a variable period of time. There may be pain and rigidity of the back of the neck (nuchal rigidity) and spine due to meningeal irritation. Visual disturbances (visual loss, diplopia, ptosis) occur if the aneurysm is adjacent to the oculomotor nerve. Tinnitus, dizziness, and hemiparesis may also occur.

At times, an aneurysm or AVM leaks blood, leading to the formation of a clot that seals the site of rupture. In this instance, the patient may show little neurologic deficit. In other cases, severe bleeding occurs, resulting in cerebral damage, followed rapidly by coma and death.

Prognosis depends on the neurologic condition of the patient, the patient's age, associated diseases, and the extent and location of the hemorrhage or intracranial aneurysm. Subarachnoid hemorrhage from an aneurysm is a catastrophic event with significant morbidity and mortality. Chart 62-6 presents ethical issues related to the patient with a severe hemorrhagic stroke.

## Assessment and Diagnostic Findings

Any patient with suspected stroke should undergo a CT scan or MRI to determine the type of stroke, the size and location of the hematoma, and the presence or absence of ventricular blood and hydrocephalus. Cerebral angiography confirms the diagnosis of an intracranial aneurysm or AVM. These tests show the location and size of the lesion and provide information about the affected arteries, veins, adjoining vessels, and vascular branches. Lumbar puncture is performed if there is no evidence of increased ICP, the CT scan results are negative, and subarachnoid hemorrhage must be confirmed. Lumbar puncture in the presence of increased ICP could result in brain stem herniation or rebleeding. When diagnosing a hemorrhagic stroke in a patient younger than 40 years of age, some clinicians obtain a toxicology screen for illicit drug use.

## Prevention

Primary prevention of hemorrhagic stroke is the best approach and includes managing hypertension and ameliorating other significant risk factors. Control of hypertension, especially in people older than 55 years of age, reduces the risk of hemorrhagic stroke (Luders, 2007). Additional risk factors are increased age, male gender, and excessive alcohol intake. Stroke risk screenings provide an ideal opportunity to lower hemorrhagic stroke risk by identifying high-risk individuals or groups and educating patients and the community about recognition and prevention.

## Complications

Potential complications of hemorrhagic stroke include rebleeding or hematoma expansion; cerebral vasospasm resulting in cerebral ischemia; acute hydrocephalus, which results when free blood obstructs the reabsorption of cerebrospinal fluid (CSF) by the arachnoid villi; and seizures.

### *Cerebral Hypoxia and Decreased Blood Flow*

Immediate complications of a hemorrhagic stroke include cerebral hypoxia, decreased cerebral blood flow, and extension of the area of injury. Providing adequate oxygenation of blood to the brain minimizes cerebral hypoxia. Brain function depends on delivery of oxygen to the tissues. Administering supplemental oxygen and maintaining the hemoglobin and hematocrit at acceptable levels will assist in maintaining tissue oxygenation.

Cerebral blood flow is dependent on the blood pressure, cardiac output, and integrity of cerebral blood vessels. Adequate hydration (IV fluids) must be ensured to reduce blood viscosity and improve cerebral blood flow. Extremes of hypertension or hypotension need to be avoided to prevent changes in cerebral blood flow and the potential for extending the area of injury.

A seizure can also compromise cerebral blood flow, resulting in further injury to the brain. Observing for seizure activity and initiating appropriate treatment are important components of care after a hemorrhagic stroke.

### *Vasospasm*

The development of cerebral vasospasm (narrowing of the lumen of the involved cranial blood vessel) is a serious complication of subarachnoid hemorrhage and is the leading cause of morbidity and mortality in those who survive the initial subarachnoid hemorrhage (Kosty, 2005). The mechanism responsible for vasospasm is not clear, but it is associated with increasing amounts of blood in the subarachnoid cisterns and cerebral fissures, as visualized by CT scan. Monitoring for vasospasm may be performed through the use of bedside transcranial Doppler ultrasonography (TCD) or follow-up cerebral angiography.

CHART 62-6 *Ethics and Related Issues*

**What Are the Ethical Issues Related to DNR Orders After Severe Stroke?**

**Situation**

An 85-year-old patient is admitted with a large intracerebral hemorrhage, severe neurologic deficits, and a past medical history of coronary artery bypass graft surgery, hypertension, atrial fibrillation, and gout. The patient does not have an advanced directive. The attending physician suggests a do-not-resuscitate (DNR) order to the family.

**Dilemma**

The principle of autonomy for the patient (including death with dignity) conflicts with the principle of beneficence for the health care providers.

**Discussion**

1. What arguments would you pose in favor of the DNR order?
2. What arguments would you pose against the DNR order?
3. Does the family have the right to refuse?
4. Is a DNR order an example of "patient abandonment" by health care workers, or an attempt to limit treatment and avoid CPR in a patient with an anticipated poor outcome?

Vasospasm frequently occurs 3 to 14 days after initial hemorrhage, when the clot undergoes lysis (dissolution), and the chance of rebleeding is increased (Hickey, 2009). It leads to increased vascular resistance, which impedes cerebral blood flow and causes brain ischemia and infarction. The signs and symptoms reflect the areas of the brain involved. Vasospasm is often heralded by a worsening headache, a decrease in level of consciousness (confusion, lethargy, and disorientation), or a new focal neurologic deficit (aphasia, hemiparesis).

Management of vasospasm remains difficult and controversial. It is believed that early surgery to clip the aneurysm prevents rebleeding and that removal of blood from the basal cisterns around the major cerebral arteries may prevent vasospasm. Advances in technology have led to the introduction of interventional neuroradiology for the treatment of aneurysms. Endovascular techniques may be used in selected patients to occlude the artery supplying the aneurysm with a balloon, coils, or other techniques to occlude the aneurysm itself. As more studies on these techniques are completed, their use will increase.

Medication may be effective in the treatment of vasospasm. Based on one theory, that vasospasm is caused by an increased influx of calcium into the cell, medication therapy may be used to block or antagonize this action and prevent or reverse the action of vasospasm if already present. The most frequently used calcium channel blocker is nimodipine (Nimotop) (Devlin, 2008). Another therapy for vasospasm, referred to as "triple-H therapy," is aimed at minimizing the deleterious effects of the associated cerebral ischemia and includes (1) fluid volume expanders (hypervolemia), (2) induced arterial hypertension, and (3) hemodilution (Kosty, 2005).

#### Increased Intracranial Pressure

An increase in ICP can occur after either an ischemic or a hemorrhagic stroke but almost always follows a subarachnoid hemorrhage, usually because of disturbed circulation of CSF caused by blood in the basal cisterns. Neurologic assessments are performed frequently, and if there is evidence of deterioration from increased ICP (due to cerebral edema, herniation, hydrocephalus, or vasospasm), CSF drainage may be instituted by ventricular catheter drainage. Mannitol may be administered to reduce ICP. When mannitol is used as a long-term measure to control ICP, dehydration and disturbances in electrolyte balance (hyponatremia or hypernatremia; hypokalemia or hyperkalemia) may occur. Mannitol pulls water out of the brain tissue by osmosis and reduces total-body water through diuresis. The patient is monitored for signs of dehydration and for rebound elevation of ICP. Other interventions may include elevating the head of the bed, sedation, and hyperosmolar therapy (discussed in the vasospasm section) (Broderick, Connolly, Feldmann, et al., 2007; Presciutti, 2006).

#### Hypertension

Hypertension is the most common cause of intracerebral hemorrhage, and its treatment is critical. Specific goals for blood pressure management, which are individualized for each patient, remain controversial. Blood pressure goals may be dependent on the presence of increased ICP. Clinical trials are currently ongoing to further investigate control of blood pressure in intracerebral hemorrhage (Broderick, et al., 2007). Systolic blood pressure may be lowered to prevent hematoma enlargement. If blood pressure is elevated, antihypertensive therapy (labetalol [Trandate], nicardipine [Cardene], nitroprusside [Nitropress], hydralazine [Apresoline]) may be prescribed. During the administration of antihypertensives, arterial hemodynamic monitoring is important to detect and avoid a precipitous drop in blood pressure, which can produce brain ischemia. Stool softeners are used to prevent straining, which can elevate the blood pressure.

### Medical Management

The goals of medical treatment for hemorrhagic stroke are to allow the brain to recover from the initial insult (bleeding), to prevent or minimize the risk of rebleeding, and to prevent or treat complications. Management may consist of bed rest with sedation to prevent agitation and stress, management of vasospasm, and surgical or medical treatment to prevent rebleeding. If the bleeding is caused by anticoagulation with warfarin (Coumadin), the INR may be corrected with fresh-frozen plasma and vitamin K. Because seizures can occur after intracerebral hemorrhage, antiseizure agents are often administered prophylactically for a brief period of time. Analgesic agents may be prescribed for head and neck pain. The patient is fitted with sequential compression devices or anti-embolism stockings to prevent deep vein thrombosis (DVT). Fever should be treated. Hyperglycemia should also be treated (an IV insulin drip may be required to achieve control) (Broderick, et al., 2007; Presciutti, 2006). After discharge most patients will require antihypertensive medications to decrease their risk of another intracerebral hemorrhage.

#### Surgical Management

In many cases, a primary intracerebral hemorrhage is not treated surgically. However, if the diameter of the hematoma exceeds 3 cm and the Glasgow Coma Scale score decreases, surgical evacuation is strongly recommended for the patient with a cerebellar hemorrhage (Broderick, et al., 2007). Surgical evacuation is most frequently accomplished via a craniotomy (see Chapter 61).

The patient with an intracranial aneurysm is prepared for surgical intervention as soon as his or her condition is considered stable. Surgical treatment of the patient with an unruptured aneurysm is an option. The goal of surgery is to prevent bleeding in an unruptured aneurysm or further bleeding in an already ruptured aneurysm. This objective is accomplished by isolating the aneurysm from its circulation or by strengthening the arterial wall. An aneurysm may be excluded from the cerebral circulation by means of a ligature or a clip across its neck. If this is not anatomically possible, the aneurysm can be reinforced by wrapping it with some substance to provide support and induce scarring.

Less invasive endovascular treatments are now being used for aneurysms. These procedures are performed by neurosurgeons in neurointerventional radiology facilities. Two procedures include endovascular treatment (occlusion of the parent artery) and aneurysm coiling (obstruction of the aneurysm site with a coil). Although these techniques are

associated with lower risks than intracranial surgery in general, secondary stroke and rupture of the aneurysm are still potential complications.

Postoperative complications include psychological symptoms (disorientation, amnesia, **Korsakoff's syndrome,** personality changes), intraoperative embolization, postoperative internal artery occlusion, fluid and electrolyte disturbances (from dysfunction of the neurohypophyseal system), and gastrointestinal bleeding.

## NURSING PROCESS

### The Patient With a Hemorrhagic Stroke

#### Assessment

A complete neurologic assessment is performed initially and includes evaluation for the following:

- Altered level of consciousness
- Sluggish pupillary reaction
- Motor and sensory dysfunction
- Cranial nerve deficits (extraocular eye movements, facial droop, presence of ptosis)
- Speech difficulties and visual disturbance
- Headache and nuchal rigidity or other neurologic deficits

All patients should be monitored in the intensive care unit after an intracerebral or subarachnoid hemorrhage. Neurologic assessment findings are documented and reported as indicated. The frequency of these assessments varies depending on the patient's condition. Any changes in the patient's condition require reassessment and thorough documentation; changes should be reported immediately.

Alteration in level of consciousness often is the earliest sign of deterioration in a patient with a hemorrhagic stroke. Because nurses have the most frequent contact with patients, they are in the best position to detect subtle changes. Mild drowsiness and slight slurring of speech may be early signs that the level of consciousness is deteriorating.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective tissue perfusion (cerebral) related to bleeding or vasospasm
- Disturbed sensory perception related to medically imposed restrictions (aneurysm precautions)
- Anxiety related to illness and/or medically imposed restrictions (aneurysm precautions)

##### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include the following:

- Vasospasm
- Seizures
- Hydrocephalus
- Rebleeding
- Hyponatremia

#### Planning and Goals

The goals for the patient may include improved cerebral tissue perfusion, relief of sensory and perceptual deprivation, relief of anxiety, and the absence of complications.

#### Nursing Interventions

##### *Optimizing Cerebral Tissue Perfusion*

The patient is closely monitored for neurologic deterioration resulting from recurrent bleeding, increasing ICP, or vasospasm. A neurologic flow record is maintained. The blood pressure, pulse, level of consciousness (an indicator of cerebral perfusion), pupillary responses, and motor function are checked hourly. Respiratory status is monitored, because a reduction in oxygen in areas of the brain with impaired autoregulation increases the chances of a cerebral infarction. Any changes are reported immediately.

**IMPLEMENTING ANEURYSM PRECAUTIONS.** Cerebral aneurysm precautions are implemented for the patient with a diagnosis of aneurysm to provide a nonstimulating environment, prevent increases in ICP, and prevent further bleeding. The patient is placed on immediate and absolute bed rest in a quiet, nonstressful environment, because activity, pain, and anxiety elevate the blood pressure, which increases the risk for bleeding. Visitors, except for family, are restricted.

The head of the bed is elevated 15 to 30 degrees to promote venous drainage and decrease ICP. Some neurologists, however, prefer that the patient remain flat to increase cerebral perfusion.

Any activity that suddenly increases the blood pressure or obstructs venous return is avoided. This includes the Valsalva maneuver, straining, forceful sneezing, pushing oneself up in bed, acute flexion or rotation of the head and neck (which compromises the jugular veins), and cigarette smoking. Any activity requiring exertion is contraindicated. The patient is instructed to exhale through the mouth during voiding or defecation to decrease strain. No enemas are permitted, but stool softeners and mild laxatives are prescribed. Both prevent constipation, which would cause an increase in ICP, as would enemas. Dim lighting is helpful, because photophobia (visual intolerance of light) is common. Coffee and tea, unless decaffeinated, are usually eliminated.

Anti-embolism stockings or sequential compression devices may be prescribed to decrease the incidence of DVT resulting from immobility. The legs are observed for signs and symptoms of DVT (tenderness, redness, swelling, warmth, and edema), and abnormal findings are reported.

The nurse administers all personal care. The patient is fed and bathed to prevent any exertion that might increase the blood pressure. External stimuli are kept to a minimum, including no television, no radio, and no reading. Visitors are restricted in an effort to keep the patient as quiet as possible. This precaution must be individualized based on the patient's condition and response to visitors. A sign indicating this restriction should be placed on the door of the room, and the restrictions should be discussed with both patient and family. The purpose of aneurysm precautions should be thoroughly explained to both the patient (if possible) and family.

#### *Relieving Sensory Deprivation and Anxiety*

Sensory stimulation is kept to a minimum for patients on aneurysm precautions. For patients who are awake, alert, and oriented, an explanation of the restrictions helps reduce the patient's sense of isolation. Reality orientation is provided to help maintain orientation.

Keeping the patient well informed of the plan of care provides reassurance and helps minimize anxiety. Appropriate reassurance also helps relieve the patient's fears and anxiety. The family also requires information and support.

#### *Monitoring and Managing Potential Complications*

**VASOSPASM.** The patient is assessed for signs of possible vasospasm: intensified headaches, a decrease in level of responsiveness (confusion, disorientation, lethargy), or evidence of aphasia or partial paralysis. These signs may develop several days after surgery or on the initiation of treatment and must be reported immediately. If vasospasm is diagnosed, calcium channel blockers or fluid volume expanders may be prescribed.

**SEIZURES.** Seizure precautions are maintained for every patient who may be at risk for seizure activity. Should a seizure occur, maintaining the airway and preventing injury are the primary goals. Medication therapy is initiated at this time, if not already prescribed. The medication of choice for many years has been phenytoin (Dilantin). Its use is being questioned based on the results of research including 527 patients that suggested that phenytoin may increase functional and cognitive disability after subarachnoid hemorrhage (Naidech, Kreiter, Janjua, et al., 2005).

**HYDROCEPHALUS.** Blood in the subarachnoid space or ventricles impedes the circulation of CSF, resulting in hydrocephalus. A CT scan that indicates dilated ventricles confirms the diagnosis. Hydrocephalus can occur within the first 24 hours (acute) after subarachnoid hemorrhage or several days (subacute) to several weeks (delayed) later. Symptoms vary according to the time of onset and may be nonspecific. Acute hydrocephalus is characterized by sudden onset of stupor or coma and is managed with a ventriculostomy drain to decrease ICP. Symptoms of subacute and delayed hydrocephalus include gradual onset of drowsiness, behavioral changes, and ataxic gait. A ventriculoperitoneal shunt is surgically placed to treat chronic hydrocephalus. Changes in patient responsiveness are reported immediately.

**REBLEEDING.** The rate of recurrent hemorrhage is approximately 2% after a primary intracerebral hemorrhage. Hypertension is the most serious risk factor, suggesting the importance of appropriate antihypertensive treatment.

Aneurysm rebleeding occurs most frequently during the first 2 weeks after the initial hemorrhage and is considered a major complication. Symptoms of rebleeding include sudden severe headache, nausea, vomiting, decreased level of consciousness, and neurologic deficit. Rebleeding is confirmed by CT scan. Blood pressure is carefully maintained with medications. The most effective preventive treatment is to secure the aneurysm if the patient is a candidate for surgery or endovascular treatment.

**HYPONATREMIA.** After subarachnoid hemorrhage, hyponatremia is found in up to 30% of patients (Naval, Stevens, Mirski, et al., 2006). Laboratory data must be checked frequently, and hyponatremia (defined as a serum sodium concentration of less than 135 mEq/L) must be identified as early as possible. The patient's primary health care provider needs to be notified of a low serum sodium level that has persisted for 24 hours or longer. The patient is then evaluated for syndrome of inappropriate antidiuretic hormone (SIADH) or cerebral salt-wasting syndrome. (SIADH is described in Chapter 14.) Cerebral salt-wasting syndrome occurs when the kidneys are unable to conserve sodium and volume depletion results. The treatment most often is the use of hypertonic 3% saline.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient and family are provided with information that will enable them to cooperate with the care and restrictions required during the acute phase of hemorrhagic stroke and to prepare them to return home. Patient and family teaching includes information about the causes of hemorrhagic stroke and its possible consequences. In addition, the patient and family are informed about the medical treatments that are implemented, including surgical intervention if warranted, and the importance of interventions taken to prevent and detect complications (ie, aneurysm precautions, close monitoring of the patient). Depending on the presence and severity of neurologic impairment and other complications resulting from the stroke, the patient may be transferred to a rehabilitation unit or center for additional patient and family teaching about strategies to regain self-care ability. Teaching addresses the use of assistive devices or modification of the home environment to help the patient live with the disability. Modifications of the home may be required to provide a safe environment.

**CONTINUING CARE.** The acute and rehabilitation phase of care focuses on obvious needs, issues, and deficits for the patient with a hemorrhagic stroke. The patient and family are reminded of the importance of following recommendations to prevent further hemorrhagic stroke and keeping follow-up appointments with health care providers for monitoring of risk factors. Referral for home care may be warranted to assess the home environment and the ability of the patient and to ensure that the patient and family are able to manage at home. Home visits provide opportunities to monitor the physical and psychological status of the patient and the ability of the family to cope with any alterations in the patient's status. In addition, the home care nurse reminds the patient and family of the importance of continuing health promotion and screening practices. Chart 62-7 lists teaching points for the patient recovering from a stroke.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Demonstrates intact neurologic status and normal vital signs and respiratory patterns
   a. Is alert and oriented to time, place, and person

CHART 62-7

HOME CARE CHECKLIST
## The Patient Recovering From a Stroke

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Discuss measures to prevent subsequent strokes. | ✔ | ✔ |
| • Identify signs and symptoms of specific complications. | ✔ | ✔ |
| • Identify potential complications and discuss measures to prevent them (blood clots, aspiration, pneumonia, urinary tract infection, fecal impaction, skin breakdown, contracture). | ✔ | ✔ |
| • Identify psychosocial consequences of stroke and appropriate interventions. | ✔ | ✔ |
| • Identify safety measures to prevent falls. | ✔ | ✔ |
| • State names, doses, indications, and side effects of medications. | ✔ | ✔ |
| • Demonstrate adaptive techniques for accomplishing ADLs. | ✔ | ✔ |
| • Demonstrate swallowing techniques (for patients with dysphagia). | ✔ | ✔ |
| • Demonstrate care of enteric feeding tube, if applicable. | ✔ | ✔ |
| • Demonstrate home exercises, use of splints or orthotics, proper positioning, and frequent repositioning. | ✔ | ✔ |
| • Describe procedures for maintaining skin integrity. | ✔ | ✔ |
| • Demonstrate indwelling catheter care, if applicable. Describe a bowel and bladder elimination program as appropriate. | ✔ | ✔ |
| • Identify appropriate recreational or diversional activities, support groups, and community resources. | ✔ | ✔ |

b. Demonstrates normal speech patterns and intact cognitive processes
c. Demonstrates normal and equal strength, movement, and sensation of all four extremities
d. Exhibits normal deep tendon reflexes and pupillary responses

2. Demonstrates normal sensory perceptions
   a. States rationale for aneurysm precautions
   b. Exhibits clear thought processes
3. Exhibits reduced anxiety level
   a. Is less restless
   b. Exhibits absence of physiologic indicators of anxiety (eg, has normal vital signs; normal respiratory rate; absence of excessive, fast speech)
4. Is free of complications
   a. Exhibits absence of vasospasm
   b. Exhibits normal vital signs and neuromuscular activity without seizures
   c. Verbalizes understanding of seizure precautions
   d. Exhibits normal mental status and normal motor and sensory status
   e. Reports no visual changes

## CRITICAL THINKING EXERCISES

**1** A patient had symptoms of an ischemic stroke approximately 1 hour ago and is undergoing a CT scan. What are the time frames, criteria, and dosage for t-PA administration? What nursing assessments and actions would you take? What is your rationale for these assessments and actions?

**2** A 58-year-old man is admitted with an ischemic stroke and has left-sided hemiplegia. He is concerned about how to resume sexual relations with his wife and the possibility of not being able to resume sexual intimacy. Identify possible causes of sexual dysfunction after a stroke. What interventions can the nurse implement to address his concerns?

**3** A 50-year-old patient with a history of hypertension is expected to be discharged to home today after a 7-day stay for a stroke. She has residual right-sided weakness and a visual field deficit. What teaching would be indicated to prevent another stroke? What resources may be needed to enable her to go home as scheduled?

EBP **4** A patient is admitted to the hospital following a hemorrhagic stroke and is at high risk for vasospasm. What medical and nursing measures should be implemented to prevent vasospasm? Identify the evidence for and the criteria used to evaluate the strength of the evidence for the specific measures identified for prevention of vasospasm.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisks indicate nursing research.*
***Double asterisks indicate classic references.*

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## RESOURCES

American Association of Neuroscience Nurses, www.aann.org

American Stroke Association, a Division of the American Heart Association, www.strokeassociation.org

National Institute of Neurological Disorders and Stroke, www.ninds.nih.gov

National Stroke Association, www.stroke.org



chapter 63

# Management of Patients With Neurologic Trauma

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the mechanisms of injury, clinical signs and symptoms, diagnostic testing, and treatment options for patients with traumatic brain and spinal cord injuries.
2. Describe the nursing management of patients with brain injury.
3. Use the nursing process as a framework for care of patients with traumatic brain injury.
4. Identify the population at risk for spinal cord injury.
5. Describe the clinical features and management of the patient with neurogenic shock.
6. Discuss the pathophysiology of autonomic dysreflexia and describe the appropriate nursing interventions.
7. Use the nursing process as a framework for care of patients with spinal cord injury.

## GLOSSARY

**autonomic dysreflexia:** a life-threatening emergency in spinal cord injury patients that causes a hypertensive emergency; also called autonomic hyperreflexia

**brain injury:** an injury to the skull or brain that is severe enough to interfere with normal functioning

**brain injury, closed (blunt):** occurs when the head accelerates and then rapidly decelerates or collides with another object and brain tissue is damaged, but there is no opening through the skull and dura

**brain injury, open:** occurs when an object penetrates the skull, enters the brain, and damages the soft brain tissue in its path (penetrating injury), or when blunt trauma to the head is so severe that it opens the scalp, skull, and dura to expose the brain

**complete spinal cord lesion:** a condition that involves total loss of sensation and voluntary muscle control below the lesion

**concussion:** a temporary loss of neurologic function with no apparent structural damage to the brain

**contusion:** bruising of the brain surface

**halo vest:** a lightweight vest with an attached halo that stabilizes the cervical spine

**head injury:** an injury to the scalp, skull, and/or brain

**incomplete spinal cord lesion:** a condition in which there is preservation of the sensory or motor fibers, or both, below the lesion

**neurogenic bladder:** bladder dysfunction that results from a disorder or dysfunction of the nervous system; may result in either urinary retention or bladder overactivity

**paraplegia:** paralysis of the lower extremities with dysfunction of the bowel and bladder from a lesion in the thoracic, lumbar, or sacral region of the spinal cord

**primary injury:** initial damage to the brain that results from the traumatic event

**secondary injury:** an insult to the brain subsequent to the original traumatic event

**spinal cord injury:** an injury to the spinal cord, vertebral column, supporting soft tissue, or intervertebral disks caused by trauma

**tetraplegia (quadriplegia):** paralysis of both arms and legs, with dysfunction of bowel and bladder from a lesion of the cervical segments of the spinal cord

**transection:** severing of the spinal cord itself; transection can be complete (all the way through the cord) or incomplete (partially through)

Trauma involving the central nervous system can be life-threatening. Even if it is not life-threatening, brain and spinal cord injury may result in major physical and psychological dysfunction and can alter the patient's life completely. Neurologic trauma affects the patient, the family, the health care system, and society as a whole because of its major sequelae and the costs of acute and long-term care of patients with trauma to the brain and spinal cord.

## Head Injuries

**Head injury** is a broad classification that includes injury to the scalp, skull, or brain. It is estimated that 1.4 million people sustain a head injury each year in the United States, and approximately 50,000 people die, 235,000 are hospitalized, and 1.1 million are treated and released from an emergency department (Langlois, Rutland-Brown & Thomas, 2006). A head injury may lead to conditions ranging from mild concussion to coma and death; the most serious form is known as a traumatic brain injury (TBI). The most common causes of TBIs are falls (28%), motor vehicle crashes (20%), being struck by objects (19%), and assaults (11%). People at highest risk for TBI are those in the 15- to 19-year age group. Males are twice as likely as females to sustain a TBI. Adults 75 years of age or older have the highest TBI-related hospitalization and death rates, and African Americans also have high mortality rates (Langlois, et al., 2006). An estimated 5.3 million Americans are currently living with a TBI-related disability (National Center for Injury Prevention and Control, 2007). The best approach to head injury is prevention (Chart 63-1).

### Pathophysiology

Research suggests that not all brain damage occurs at the moment of impact. Damage to the brain from traumatic injury takes two forms: primary injury and secondary injury. **Primary injury** is the initial damage to the brain that results from the traumatic event. This may include contusions, lacerations, and torn blood vessels due to impact, acceleration/deceleration, or foreign object penetration. **Secondary injury** evolves over the ensuing hours and days after the initial injury and results from inadequate delivery of nutrients and oxygen to the cells (Littlejohns & Bader, 2005).

**Physiology ■■■ Pathophysiology**

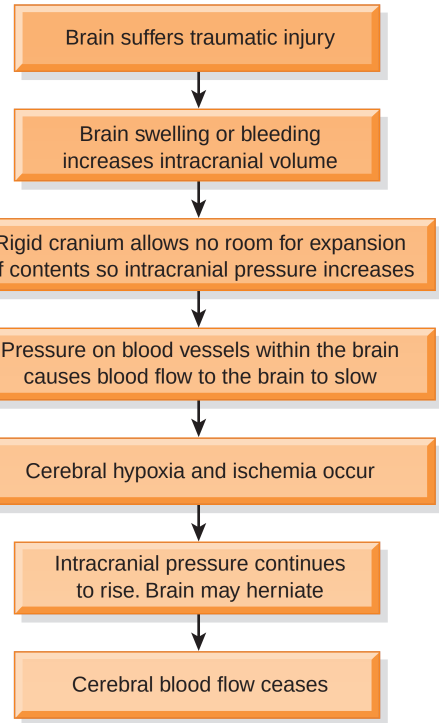



**Figure 63-1** Pathophysiology of traumatic brain injury.

The cranial vault contains three main components: brain, blood, and cerebrospinal fluid (CSF). According to the Monro-Kellie doctrine, the cranial vault is a closed system, and if one of the three components increases in volume, at least one of the other two must decrease in volume, or the pressure increases. Any bleeding or swelling within the skull increases the volume of contents within the skull and therefore causes increased intracranial pressure (ICP) (see Chapter 61). If the pressure increases enough, it can cause displacement of the brain through or against the rigid structures of the skull. This causes restriction of blood flow to the brain, decreasing oxygen delivery and waste removal. Cells within the brain become anoxic and cannot metabolize properly, producing ischemia, infarction, irreversible brain damage, and, eventually, brain death (Fig. 63-1).

CHART 63-1

HEALTH PROMOTION

*Preventing Head and Spinal Cord Injuries*

- Advise drivers to obey traffic laws, and to avoid speeding or driving when under the influence of drugs or alcohol.
- Advise all drivers and passengers to wear seat belts and shoulder harnesses. Children younger than 12 years of age should be restrained in an age/size-appropriate system in the back seat.
- Caution passengers against riding in the back of pickup trucks.
- Advise motorcyclists, scooter riders, bicyclists, skateboarders, and roller skaters to wear helmets.
- Promote educational programs that are directed toward violence and suicide prevention in the community.
- Provide water safety instruction.
- Teach patients steps that can be taken to prevent falls, particularly in the elderly.
- Advise athletes to use protective devices. Recommend that coaches be educated in proper coaching techniques.
- Advise owners of firearms to keep them locked in a secure area where children cannot access them.

### Scalp Injury

Isolated scalp trauma is generally classified as a minor injury. Because its many blood vessels constrict poorly, the scalp bleeds profusely when injured. Trauma may result in an abrasion (brush wound), contusion, laceration, or hematoma beneath the layers of tissue of the scalp (subgaleal hematoma). A large avulsion (tearing away) of the scalp may be potentially life-threatening and is a true emergency. Diagnosis of a scalp injury is based on physical examination, inspection, and palpation. Scalp wounds are potential portals of entry for organisms that cause intracranial infections. Therefore, the area is irrigated before the laceration is sutured, to remove foreign material and to reduce the risk for infection. Subgaleal hematomas (hematomas below the outer covering of the skull) usually reabsorb and do not require any specific treatment.

### Skull Fractures

A skull fracture is a break in the continuity of the skull caused by forceful trauma. It may occur with or without damage to the brain. Skull fractures can be classified as simple, comminuted, depressed, or basilar. A simple (linear) fracture is a break in the continuity of the bone. A comminuted skull fracture refers to a splintered or multiple fracture line. Depressed skull fractures occur when the bones of the skull are forcefully displaced downward and can vary from a slight depression to bones of the skull being splintered and embedded within brain tissue. A fracture of the base of the skull is called a basilar skull fracture (Fig. 63-2) (Porth & Matfin, 2009). A fracture may be open, indicating a scalp laceration or tear in the dura (eg, from a bullet or an ice pick), or closed, in which case the dura is intact.

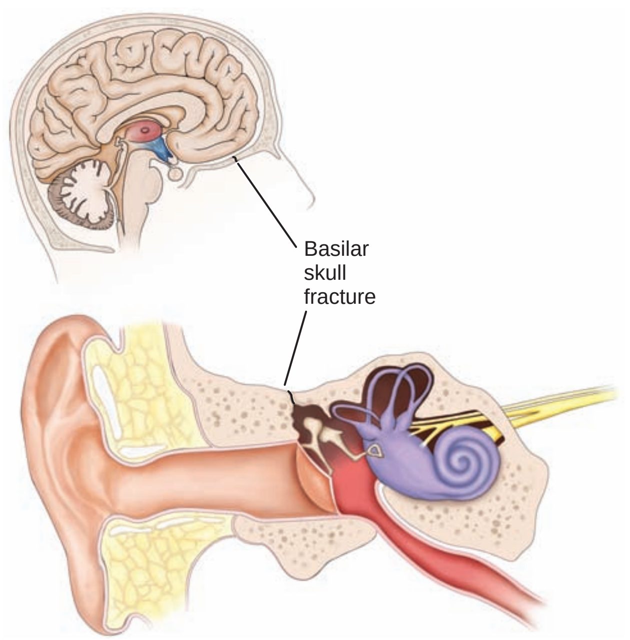



**Figure 63-2** Basilar fractures allow cerebrospinal fluid to leak from the nose and ears. Adapted from Hickey, J. V. (2009). *The clinical practice of neurological and neurosurgical nursing* (6th ed.). Philadelphia: Lippincott Williams & Wilkins.

## Clinical Manifestations

Symptoms, apart from those of the local injury, depend on the severity and the anatomic location of the underlying brain injury. Persistent, localized pain usually suggests that a fracture is present. Fractures of the cranial vault may or may not produce swelling in the region of the fracture; therefore, an x-ray is needed for diagnosis.

Fractures of the base of the skull tend to traverse the paranasal sinus of the frontal bone or the middle ear located in the temporal bone (see Fig. 63-2). Therefore, they frequently produce hemorrhage from the nose, pharynx, or ears, and blood may appear under the conjunctiva. An area of ecchymosis (bruising) may be seen over the mastoid (Battle's sign). Basilar skull fractures are suspected when CSF escapes from the ears (CSF otorrhea) and the nose (CSF rhinorrhea). Drainage of CSF is a serious problem, because meningeal infection can occur if organisms gain access to the cranial contents via the nose, ear, or sinus through a tear in the dura.

## Assessment and Diagnostic Findings

X-rays confirm the presence and extent of a skull fracture (Porth & Matfin, 2009). A rapid physical examination and evaluation of neurologic status detects obvious brain injuries, and a computed tomography (CT) scan uses high-speed x-ray scanning to detect less apparent abnormalities. It is a fast, accurate, and safe diagnostic procedure that shows the presence, nature, location, and extent of acute lesions. It is also helpful in the ongoing management of head injury, because it can disclose cerebral edema, contusion, intracerebral or extracerebral hematoma, subarachnoid and intraventricular hemorrhage, and late changes (infarction, hydrocephalus) (Torpy, Lynm & Glass, 2005).

Magnetic resonance imaging (MRI) is used to evaluate patients with head injury when a more accurate picture of the anatomic nature of the injury is warranted and when the patient is stable enough to undergo this longer diagnostic procedure (Torpy, et al., 2005).

Cerebral angiography may also be used to identify supratentorial, extracerebral, and intracerebral hematomas and cerebral contusions. Lateral and anteroposterior views of the skull are obtained.

## Gerontologic Considerations

Elderly patients must be assessed carefully (Scheetz, 2005). Older patients with head injuries differ from those who are younger in terms of etiology of injury, higher mortality rates, and poorer functional outcomes (Flanagan, Hibbard & Gordon, 2005). The most common causes of injury in elderly patients are falls and motor vehicle crashes (Thompson & Bourbonniere, 2006). Physiologic changes related to aging may place the older adult at increased risk for injury, alter the type and severity of injury that occurs, or promote the development of complications. Two major factors place older adults at increased risk for hematomas. First, the dura becomes more adherent to the skull with increasing age. Second, many older adults take aspirin and anticoagulants as part of routine management of chronic conditions.

## Medical Management

Nondepressed skull fractures generally do not require surgical treatment; however, close observation of the patient is essential. Nursing personnel may observe the patient in the hospital, but if no underlying brain injury is present, the patient may be allowed to return home. If the patient is discharged home, specific instructions must be given to the family (see later discussion of concussion).

Depressed skull fractures usually require surgery with elevation of the skull and débridement, usually within 24 hours of injury. Skull fractures can be a combination of open, compound, closed, or simple. Associated injuries include concurrent scalp laceration, dural tears, and brain injury directly below the fracture from compression of the tissue below the bony injury and from lacerations produced by the bony fragments (Hickey, 2009).

# Brain Injury

The most important consideration in any head injury is whether the brain is injured. Even seemingly minor injury can cause significant brain damage secondary to obstructed blood flow and decreased tissue perfusion. The brain cannot store oxygen or glucose to any significant degree. Because the cerebral cells need an uninterrupted blood supply to obtain these nutrients, irreversible brain damage and cell death occur if the blood supply is interrupted for even a few minutes. Clinical manifestations of **brain injury** (injury to the brain that is severe enough to interfere with normal functioning) are listed in Chart 63-2. **Closed (blunt) brain injury** occurs when the head accelerates and then rapidly decelerates or collides with another object (eg, a wall, the dashboard of a car) and brain tissue is damaged but there is no opening through the skull and dura. **Open brain injury** occurs when an object penetrates the skull, enters the brain, and damages the soft brain tissue in its path (penetrating injury), or when blunt trauma to the head is so severe that it opens the scalp, skull, and dura to expose the brain.

### CHART 63-2 *Assessing Traumatic Brain Injury*

Be alert for the following signs and symptoms:

- Altered level of consciousness
- Confusion
- Pupillary abnormalities (changes in shape, size, and response to light)
- Altered or absent gag reflex
- Absent corneal reflex
- Sudden onset of neurologic deficits
- Changes in vital signs (altered respiratory pattern, widened pulse pressure, bradycardia, tachycardia, hypothermia, or hyperthermia)
- Vision and hearing impairment
- Sensory dysfunction
- Headache
- Seizures

## Types of Brain Injury

### *Concussion*

A **concussion** after head injury is a temporary loss of neurologic function with no apparent structural damage. A concussion (also referred to as a mild TBI) may or may not produce a brief loss of consciousness. The mechanism of injury is usually blunt trauma from an acceleration-deceleration force, a direct blow, or a blast injury (Hoge, McGurk, Thomas, et al., 2008; Martin, Lu, Helmick, et al., 2008). If brain tissue in the frontal lobe is affected, the patient may exhibit bizarre irrational behavior, whereas involvement of the temporal lobe can produce temporary amnesia or disorientation.

There are two types of concussion: mild and classic. A mild concussion may lead to a period of observed or self-reported transient confusion, disorientation, or impaired consciousness. Commonly, there is a memory lapse at the time of injury and a loss of consciousness lasting less than 30 minutes. Other signs and symptoms of neurologic or neuropsychological dysfunction may include seizures, headache, dizziness, irritability, fatigue, or poor concentration (Hickey, 2009).

A classic concussion is an injury that results in a loss of consciousness; characteristically, this usually lasts less than 6 hours. This loss of consciousness is always accompanied by some degree of posttraumatic amnesia. Diagnostic studies may show no apparent structural sign of injury, but the duration of unconsciousness is an indicator of the severity of the concussion.

The patient may be hospitalized overnight for observation or discharged from the hospital in a relatively short time after a concussion. Monitoring includes observing the patient for headache, dizziness, lethargy, irritability, emotional lability, fatigue, poor concentration, decreased attention span, memory difficulties, and intellectual dysfunction that may occur from 1 week to 1 year after the initial injury (Hickey, 2009). The occurrence of these symptoms after injury is referred to as postconcussion syndrome. Recovery may appear complete, but long-term sequelae are possible. Problems at work and at home can result in interpersonal relationship problems or the loss of employment (Bay & McLean, 2007). The family is instructed to observe for the following signs and symptoms and to notify the physician or clinic (or bring the patient to the emergency department) if they occur: difficulty in awakening or speaking, confusion, severe headache, vomiting, and weakness of one side of the body.

### *Contusion*

In cerebral **contusion,** a moderate to severe head injury, the brain is bruised and damaged in a specific area because of severe acceleration-deceleration force or blunt trauma. The impact of the brain against the skull leads to a contusion. Although a contusion may occur in any area of the brain, most are usually located in the anterior portions of the frontal and temporal lobes, around the sylvian fissure, at the orbital areas, and, less commonly, at the parietal and occipital areas.

Contusions are characterized by loss of consciousness associated with stupor and confusion. Other characteristics

can include tissue alteration and neurologic deficit without hematoma formation, alteration in consciousness without localizing signs, and hemorrhage into the tissue that varies in size and is surrounded by edema. The effects of injury (hemorrhage and edema) peak after about 18 to 36 hours. Patient outcome depends on the area and severity of the injury. Temporal lobe contusions carry a greater risk of swelling, rapid deterioration, and brain herniation. Deep contusions are more often associated with hemorrhage and destruction of the reticular activating fibers altering arousal (Hickey, 2009).

### Diffuse Axonal Injury

Diffuse axonal injury (DAI) results from widespread shearing and rotational forces that produce damage throughout the brain—to axons in the cerebral hemispheres, corpus callosum, and brain stem. The injured area may be diffuse, with no identifiable focal lesion. DAI is associated with prolonged traumatic coma; it is more serious and is associated with a poorer prognosis than a focal lesion or ischemia (Bay & McLean, 2007).

The patient with DAI in severe head trauma experiences no lucid interval, immediate coma, decorticate and decerebrate posturing (see Fig. 61-1 in Chapter 61), and global cerebral edema. Diagnosis is made by clinical signs in conjunction with a CT or MRI scan. Recovery depends on the severity of the axonal injury.

### Intracranial Hemorrhage

Hematomas are collections of blood in the brain that may be epidural (above the dura), subdural (below the dura), or intracerebral (within the brain) (Fig. 63-3). Major symptoms are frequently delayed until the hematoma is large enough to cause distortion of the brain and increased ICP. The signs and symptoms of cerebral ischemia resulting from compression by a hematoma are variable and depend on the speed with which vital areas are affected and the area that is injured (American Association of Neuroscience Nurses [AANN], 2005). In general, a rapidly developing hematoma, even if small, may be fatal, whereas a larger but slowly developing one may allow compensation for increases in ICP.

#### Epidural Hematoma

After a head injury, blood may collect in the epidural (extradural) space between the skull and the dura mater. This can result from a skull fracture that causes a rupture or laceration of the middle meningeal artery, the artery that runs between the dura and the skull inferior to a thin portion of temporal bone. Hemorrhage from this artery causes rapid pressure on the brain (Vacca, 2007b).

Symptoms are caused by the expanding hematoma. Epidural hematomas are often characterized by a brief loss of consciousness followed by a lucid interval in which the patient is awake and conversant. During this lucid interval, compensation for the expanding hematoma takes place by rapid absorption of CSF and decreased intravascular volume, both of which help maintain a normal ICP. When these mechanisms can no longer compensate, even a small increase in the volume of the blood clot produces a marked elevation in ICP. The patient then becomes increasingly

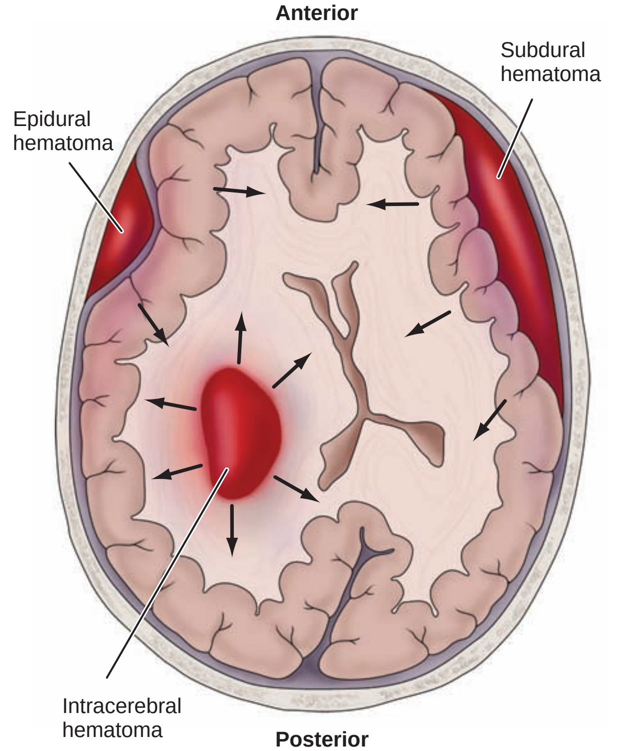



**Figure 63-3** Location of epidural, subdural, and intracerebral hematomas.

restless, agitated, and confused as the condition progresses to coma. Then, often suddenly, signs of herniation appear (usually deterioration of consciousness and signs of focal neurologic deficits, such as dilation and fixation of a pupil or paralysis of an extremity), and the patient's condition deteriorates rapidly. The most common type of herniation syndrome associated with an epidural hematoma is uncal herniation (Vacca, 2007b).

An epidural hematoma is considered an extreme emergency; marked neurologic deficit or even respiratory arrest can occur within minutes. Treatment consists of making openings through the skull (burr holes) to decrease ICP emergently, remove the clot, and control the bleeding. A craniotomy may be required to remove the clot and control the bleeding. A drain is usually inserted after creation of burr holes or a craniotomy to prevent reaccumulation of blood.

#### Subdural Hematoma

A subdural hematoma is a collection of blood between the dura and the brain, a space normally occupied by a thin cushion of fluid. The most common cause of subdural hematoma is trauma, but it can also occur as a result of coagulopathies or rupture of an aneurysm. A subdural hemorrhage is more frequently venous in origin and is caused by the rupture of small vessels that bridge the subdural space (Vacca, 2007c). The subdural hematoma that results may be acute, subacute, or chronic, depending on the size of the involved vessel and the amount of bleeding.

***Acute and Subacute Subdural Hematoma.*** Acute subdural hematomas are associated with major head injury involving

contusion or laceration. Clinical symptoms develop over 24 to 48 hours. Signs and symptoms include changes in the level of consciousness (LOC), pupillary signs, and hemiparesis. There may be minor or even no symptoms with small collections of blood. Coma, increasing blood pressure, decreasing heart rate, and slowing respiratory rate are all signs of a rapidly expanding mass requiring immediate intervention. Subacute subdural hematomas are the result of less severe contusions and head trauma. Clinical manifestations usually appear between 48 hours and 2 weeks after the injury. Signs and symptoms are similar to those of an acute subdural hematoma.

If the patient can be transported rapidly to the hospital, an immediate craniotomy is performed to open the dura, allowing the subdural clot to be evacuated. Successful outcome also depends on the control of ICP and careful monitoring of respiratory function (see the discussion of intracranial surgery in Chapter 61). The mortality rate for patients with acute or subacute subdural hematoma is high because of associated brain damage.

***Chronic Subdural Hematoma.*** Chronic subdural hematomas can develop from seemingly minor head injuries and are seen most frequently in the elderly. The elderly are prone to this type of head injury secondary to brain atrophy, which is a frequent consequence of the aging process. Seemingly minor head trauma may produce enough impact to shift the brain contents abnormally. The time between injury and onset of symptoms can be lengthy (eg, 3 weeks to months), so the actual injury may be forgotten.

A chronic subdural hematoma can resemble other conditions; for example, it may be mistaken for a stroke. The bleeding is less profuse, but compression of the intracranial contents still occurs. The blood within the brain changes in character in 2 to 4 days, becoming thicker and darker. In a few weeks, the clot breaks down and has the color and consistency of motor oil. Eventually, calcification or ossification of the clot takes place. The brain adapts to this foreign body invasion, and the clinical signs and symptoms fluctuate. Symptoms include severe headache, which tends to come and go; alternating focal neurologic signs; personality changes; mental deterioration; and focal seizures. The patient may be labeled neurotic or psychotic if the cause is overlooked.

The treatment of a chronic subdural hematoma consists of surgical evacuation of the clot. The procedure may be carried out through multiple burr holes, or a craniotomy may be performed for a sizable subdural mass that cannot be suctioned or drained through burr holes.

#### Intracerebral Hemorrhage and Hematoma

Intracerebral hemorrhage is bleeding into the substance of the brain. It is commonly seen in head injuries when force is exerted to the head over a small area (eg, missile injuries, bullet wounds, stab injuries). These hemorrhages within the brain may also result from the following:

- Systemic hypertension, which causes degeneration and rupture of a vessel
- Rupture of a saccular aneurysm
- Vascular anomalies
- Intracranial tumors
- Bleeding disorders such as leukemia, hemophilia, aplastic anemia, and thrombocytopenia
- Complications of anticoagulant therapy

Nontraumatic causes of intracerebral hemorrhage are discussed in Chapter 62.

The onset may be insidious, beginning with the development of neurologic deficits followed by headache. Management includes supportive care, control of ICP, and careful administration of fluids, electrolytes, and antihypertensive medications. Surgical intervention by craniotomy or craniectomy permits removal of the blood clot and control of hemorrhage but may not be possible because of the inaccessible location of the bleeding or the lack of a clearly circumscribed area of blood that can be removed.

## Management of Brain Injuries

Assessment and diagnosis of the extent of injury are accomplished by the initial physical and neurologic examinations. CT and MRI scans are the primary neuroimaging diagnostic tools and are useful in evaluating the brain structure. Positron emission tomography (PET) is available in some trauma centers for assessing brain function. A flow chart developed by the Brain Trauma Foundation (2007) for the initial management of brain injury is presented in Figure 63-4.

Any patient with a head injury is presumed to have a cervical spine injury until proven otherwise. The patient is transported from the scene of the injury on a board with the head and neck maintained in alignment with the axis of the body. A cervical collar should be applied and maintained until cervical spine x-rays have been obtained and the absence of cervical spinal cord injury documented.

All therapy is directed toward preserving brain homeostasis and preventing secondary brain injury, which is injury to the brain that occurs after the original traumatic event (Littlejohns & Bader, 2005). Common causes of secondary injury are cerebral edema, hypotension, and respiratory depression that may lead to hypoxemia and electrolyte imbalance. Treatments to prevent secondary injury include stabilization of cardiovascular and respiratory function to maintain adequate cerebral perfusion, control of hemorrhage and hypovolemia, and maintenance of optimal blood gas values.

### *Treatment of Increased Intracranial Pressure*

As the damaged brain swells with edema or as blood collects within the brain, an increase in ICP occurs; this requires aggressive treatment. See Chapter 61 for a discussion of the relationship of ICP to cerebral perfusion pressure (CPP). If the ICP remains elevated, it can decrease the CPP. Initial management is based on the principle of preventing secondary injury and maintaining adequate cerebral oxygenation (see Fig. 63-4).

Surgery is required for evacuation of blood clots, débridement and elevation of depressed fractures of the skull, and suture of severe scalp lacerations. ICP is monitored closely; if increased, it is managed by maintaining adequate oxygenation, elevating the head of the bed, and maintaining normal blood volume. Devices to monitor ICP or drain CSF can be inserted during surgery or at the bedside

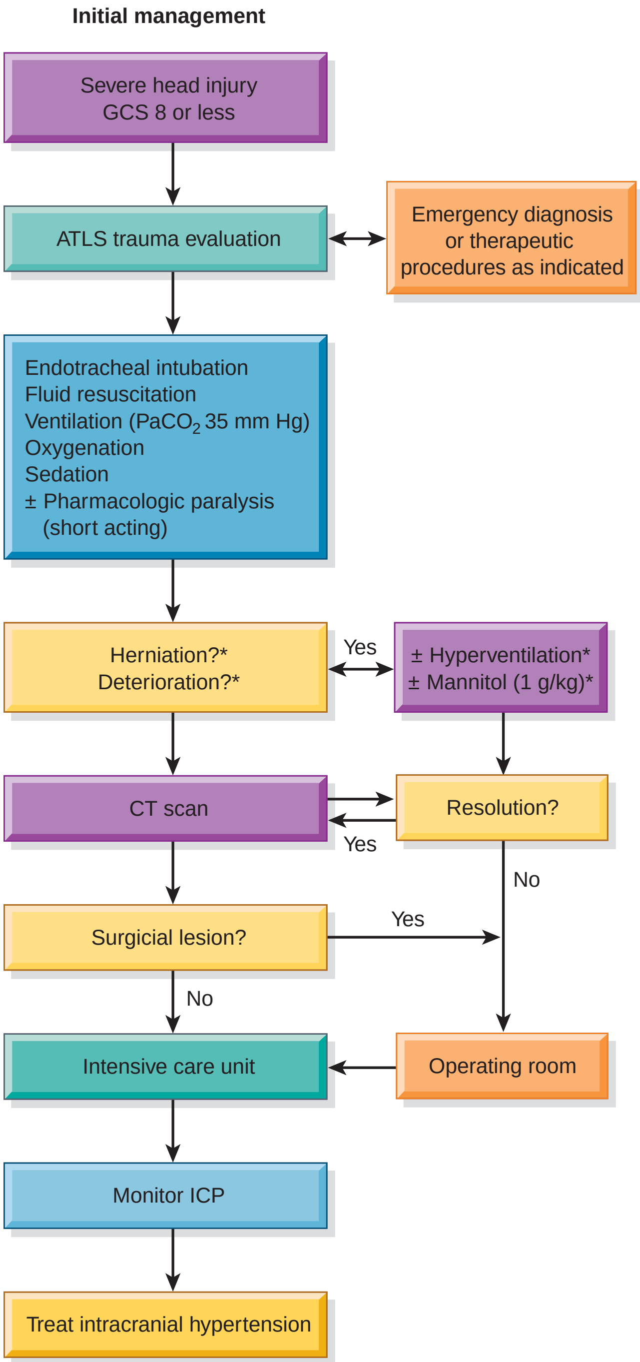



**Figure 63-4** Initial management of the patient with traumatic brain injury (treatment option). Copyright © 2007 Brain Trauma Foundation. *Only in the presence of signs of herniation or progressive neurologic deterioration not attributable to extracranial factors. ATLS, Advanced Trauma Life Support; CT, computed tomography; GCS, Glasgow Coma Score; ICP, intracranial pressure.

using aseptic technique. The patient is cared for in the intensive care unit, where expert nursing care and medical treatment are readily available (AANN, 2005).

### *Supportive Measures*

Treatment also includes ventilatory support, seizure prevention, fluid and electrolyte maintenance, nutritional support, and management of pain and anxiety. Comatose patients are intubated and mechanically ventilated to ensure adequate oxygenation and protect the airway.

Because seizures can occur after head injury and can cause secondary brain damage from hypoxia, antiseizure agents may be administered. If the patient is very agitated, benzodiazepines may be prescribed to calm the patient without decreasing LOC. These medications do not affect ICP or CPP, making them good choices for the patient with head injury. A nasogastric tube may be inserted, because reduced gastric motility and reverse peristalsis are associated with head injury, making regurgitation and aspiration common in the first few hours.

### *Brain Death*

When a patient has sustained a severe head injury incompatible with life, the patient is a potential organ donor. The nurse may assist in the clinical examination for determination of brain death and in the process of organ procurement. All 50 states recognize the Uniform Determination of Brain Death Act that states death will be determined by accepted medical standards and indicates irreversible loss of all brain function, including the brain stem (Morton, Fontaine, Hudak, et al., 2010). The three cardinal signs of brain death on clinical examination are coma, the absence of brain stem reflexes, and apnea. Adjunctive tests, such as cerebral blood flow studies, electroencephalogram (EEG), transcranial Doppler, and brain stem auditory evoked potential, are often used to confirm brain death (Hickey, 2009). The health care team provides information to the family and assists them with the decision-making process about end-of-life care (Calvin, Kite-Powell & Hickey, 2007). For aspects of neuroscience-related end-of-life care, see Chart 63-3.

## NURSING PROCESS

## The Patient With a Traumatic Brain Injury

### Assessment

Depending on the patient's neurologic status, the nurse may elicit information from the patient, from the family, or from witnesses or emergency rescue personnel. Although all usual baseline data may not be collected initially, the immediate health history should include the following questions:

- When did the injury occur?
- What caused the injury? A high-velocity missile? An object striking the head? A fall?
- What was the direction and force of the blow?

A history of unconsciousness or amnesia after a head injury indicates a significant degree of brain damage, and changes that occur minutes to hours after the initial injury can reflect recovery or indicate the development of secondary brain damage. The nurse should determine if there was a loss of consciousness, the duration of the unconscious period, and if the patient could be aroused.

In addition to asking questions that establish the nature of the injury and the patient's condition immediately after

CHART 63-3

## NURSING RESEARCH PROFILE
### *Perceptions About End-of-Life Care*

Calvin, A. O., Kite-Powell, D. M. & Hickey, J. (2007). The neuroscience ICU nurse's perceptions about end-of-life care. *Journal of Neuroscience Nursing, 39*(3), 143–150.

**Purpose**

Little is known about palliative or end-of-life care in intensive care units. The purpose of this study was to explore nurses' perceptions of their roles in neuroscience intensive care units, especially their responsibilities in decision making during end-of-life care.

**Design**

Twelve registered nurses, all employed at the same hospital, volunteered to participate in this qualitative descriptive study. Researchers conducted moderately structured interviews using an interview guide that contained four questions for the first interview. During the second interview, participants were given an opportunity to read and react to a summary of the findings of their first interview. All interviews, which were audiotaped, were private and lasted approximately 1 hour.

**Findings**

Nurses described three major themes about end-of-life care. The first theme involved providing guidance to the patient and the family members during the end-of-life decision-making process. The second theme was being positioned at the "hub" of the communication process as they became intermediaries between the family members and physicians. The third theme was feeling emotions that covered a wide range from confusion, helplessness, and frustration to feeling emotionally drained, being overcome by very mixed feelings, and feeling privileged.

**Nursing Implications**

Little research has addressed the perceptions of nurses in neuroscience intensive care units about end-of-life care. This study shows that nurses working in such a unit have unique, central roles in the communication process surrounding the patient's end-of-life care and adds to the limited body of knowledge concerning critical care nurses' experiences with end-of-life care.

the injury, the nurse examines the patient thoroughly. This assessment includes determining the patient's LOC using the Glasgow Coma Scale (GCS) and assessing the patient's response to tactile stimuli (if unconscious), pupillary response to light, corneal and gag reflexes, and motor function. The GCS (Chart 63-4) is based on the three criteria of eye opening, verbal responses, and motor responses to verbal commands or painful stimuli. It is particularly useful for monitoring changes during the acute phase, the first few days after a head injury. It does not take the place of an in-depth neurologic assessment. Additional detailed assessments are made initially and at frequent intervals throughout the acute phase of care (Hickey, 2009). Baseline and ongoing assessments are critical in nursing assessment of the patient with brain injury, whose condition can worsen dramatically and irrevocably if subtle signs are overlooked. More information on assessment is provided in the following sections and in Figure 63-5 and Table 63-1.

CHART 63-4

### *Assessment for Glasgow Coma Scale*

The Glasgow Coma Scale is a tool for assessing a patient's response to stimuli. Scores range from 3 (deep coma) to 15 (normal).

| | | |
|---|---|---|
| Eye opening response | Spontaneous | 4 |
| | To voice | 3 |
| | To pain | 2 |
| | None | 1 |
| Best verbal response | Oriented | 5 |
| | Confused | 4 |
| | Inappropriate words | 3 |
| | Incomprehensible sounds | 2 |
| | None | 1 |
| Best motor response | Obeys command | 6 |
| | Localizes pain | 5 |
| | Withdraws | 4 |
| | Flexion | 3 |
| | Extension | 2 |
| | None | 1 |
| Total | | 3 to 15 |

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective airway clearance and impaired gas exchange related to brain injury
- Ineffective cerebral tissue perfusion related to increased ICP, decreased CPP, and possible seizures
- Deficient fluid volume related to decreased LOC and hormonal dysfunction
- Imbalanced nutrition, less than body requirements, related to increased metabolic demands, fluid restriction, and inadequate intake
- Risk for injury (self-directed and directed at others) related to seizures, disorientation, restlessness, or brain damage
- Risk for imbalanced body temperature related to damaged temperature-regulating mechanisms in the brain
- Risk for impaired skin integrity related to bed rest, hemiparesis, hemiplegia, immobility, or restlessness
- Disturbed thought processes (deficits in intellectual function, communication, memory, information processing) related to brain injury
- Disturbed sleep pattern related to brain injury and frequent neurologic checks
- Interrupted family processes related to unresponsiveness of patient, unpredictability of outcome, prolonged




**Figure 63-5** Assessment parameters for the patient with a head injury include **(A)** eye opening and responsiveness, **(B)** vital signs, and **(C, D)** motor response reflected in hand strength or response to painful stimulus. Photo © B. Proud.

recovery period, and the patient's residual physical disability and emotional deficit
- Deficient knowledge about brain injury, recovery, and the rehabilitation process

The nursing diagnoses for the unconscious patient and the patient with increased ICP also apply (see Chapter 61).

### *Collaborative Problems/Potential Complications*

Based on all the assessment data, the major complications include the following:

- Decreased cerebral perfusion
- Cerebral edema and herniation
- Impaired oxygenation and ventilation
- Impaired fluid, electrolyte, and nutritional balance
- Risk of posttraumatic seizures

## Planning and Goals

The goals for the patient may include maintenance of a patent airway, adequate CPP, fluid and electrolyte balance, adequate nutritional status, prevention of secondary injury, maintenance of normal body temperature, maintenance of skin integrity, improvement of cognitive function, prevention of sleep deprivation, effective family coping, increased knowledge about the rehabilitation process, and absence of complications.

## Nursing Interventions

The nursing interventions for the patient with a head injury are extensive and diverse. They include making nursing assessments, setting priorities for nursing interventions, anticipating needs and complications, and initiating rehabilitation.

### *Monitoring Neurologic Function*

The importance of ongoing assessment and monitoring of the patient with brain injury cannot be overstated. The following parameters are assessed initially and as frequently as the patient's condition requires. As soon as the initial assessment is made, the use of a neurologic flow chart is started and maintained.

LEVEL OF CONSCIOUSNESS. The GCS is used to assess LOC at regular intervals, because changes in the LOC precede all other changes in vital and neurologic signs. The patient's best responses to predetermined stimuli are recorded (see Chart 63-4). Each response is scored (the greater the number, the better the functioning), and the sum of these scores gives an indication of the severity of coma and a prediction of possible outcome. The lowest score is 3 (least responsive); the highest is 15 (most responsive). A GCS between 3 and 8 is generally accepted as indicating a severe head injury (Martin, et al., 2008).

**Table 63-1 SUMMARY OF MULTISYSTEM ASSESSMENT MEASURES FOR THE PATIENT WITH TRAUMATIC BRAIN INJURY**

| System-Specific Considerations | Assessment Data |
|---|---|
| **Neurologic System**<br>• Severe head injury results in unconsciousness and alters many neurologic functions.<br>• All body functions must be supported.<br>• Increased ICP and herniation syndromes are life-threatening.<br>• Measures are instituted to control elevated ICP. | • Assessment of neurologic signs<br>• Assessment for signs and symptoms of ICP elevation<br>• Calculation of cerebral perfusion pressure if ICP monitor is in place<br>• Monitoring of antiseizure medication blood levels |
| **Integumentary System (Skin and Mucous Membranes)**<br>• Immobility secondary to injury and unconsciousness contributes to the development of pressure areas and skin breakdown.<br>• Intubation causes irritation of the mucous membrane. | • Assessment of skin integrity and character of the skin<br>• Assessment of oral mucous membrane |
| **Musculoskeletal System**<br>• Immobility contributes to musculoskeletal changes.<br>• Decerebrate or decorticate posturing makes proper positioning difficult. | • Assessment of range of motion of joints and development of deformities or spasticity |
| **Gastrointestinal System**<br>• Administration of corticosteroids places the patient at high risk for GI hemorrhage.<br>• Injury to the GI tract can result in paralytic ileus.<br>• Constipation can result from bed rest, NPO status, fluid restriction, and opioids given for pain control.<br>• Bowel incontinence is related to the patient's unconscious state or altered mental state. | • Assessment of abdomen for bowel sounds and distention<br>• Monitoring for decreased hemoglobin |
| **Genitourinary System**<br>• Fluid restriction or use of diuretics can alter the amount of urinary output.<br>• Urinary incontinence is related to the patient's unconscious state. | • Intake and output record |
| **Metabolic (Nutritional) System**<br>• The patient receives all fluids IV for the first few days until the GI tract is functioning.<br>• A nutritional consultation is initiated within the first 24–48 h; parenteral or enteral nutrition may be started. | • Assessment of fluid and electrolyte balance<br>• Recording of weight, if possible<br>• Hematocrit<br>• Electrolyte studies |
| **Respiratory System**<br>• Complete or partial airway obstruction will compromise the oxygen supply to the brain.<br>• An altered respiratory pattern can result in cerebral hypoxia.<br>• A short period of apnea at the moment of impact can result in spotty atelectasis.<br>• Systemic disturbances from head injury can cause hypoxemia.<br>• Brain injury can alter brain stem respiratory function.<br>• Shunting of blood to the lungs as a result of a sympathetic discharge at the time of injury can cause neurogenic pulmonary edema. | • Assessment of respiratory function<br>— Auscultate chest for breath sounds.<br>— Note the respiratory pattern if possible (not possible if a ventilator is being used).<br>— Note the respiratory rate.<br>— Note whether the cough reflex is intact.<br>• Arterial blood gas levels<br>• Complete blood count<br>• Chest x-ray studies<br>• Sputum cultures<br>• $O_2$ saturation using pulse oximetry |
| **Cardiovascular System**<br>• The patient may develop cardiac dysrhythmias, tachycardia, or bradycardia.<br>• The patient may develop hypotension or hypertension.<br>• Because of immobility and unconsciousness, the patient is at high risk for deep vein thromboses and pulmonary emboli.<br>• Fluid and electrolyte imbalance can be related to several problems, including alterations in antidiuretic hormone (ADH) secretion, the stress response, or fluid restriction.<br>• Specific conditions may occur:<br>— Diabetes insipidus (DI)<br>— Syndrome of inappropriate secretion of ADH (SIADH)<br>— Electrolyte imbalance<br>— Hyperosmolar nonketotic hyperglycemia | • Assessment of vital signs<br>• Monitoring for cardiac dysrhythmias<br>• Assessment for deep vein thromboses of legs<br>• Electrocardiogram<br>• Electrolyte studies<br>• Blood coagulation studies<br>• $I^{125}$ fibrinogen scan of legs<br>• Blood glucose level<br>• Blood acetone level<br>• Blood osmolality<br>• Urine specific gravity |
| **Psychological/Emotional Response**<br>• The traumatic head-injured patient is unconscious.<br>• The family needs emotional support to deal with the crisis. | • Collection of information about the family and the role of the head-injured person within the family<br>• Assessment of the family to determine how functional it was before the injury occurred |

**VITAL SIGNS.** Although a change in LOC is the most sensitive neurologic indication of deterioration of the patient's condition, vital signs also are monitored at frequent intervals to assess the intracranial status. Table 63-1 depicts the general assessment parameters for the patient with a head injury.

Signs of increasing ICP include slowing of the heart rate (bradycardia), increasing systolic blood pressure, and widening pulse pressure (Cushing's reflex). As brain compression increases, respirations become rapid, the blood pressure may decrease, and the pulse slows further. This is an ominous development, as is a rapid fluctuation of vital signs (Hickey, 2009). A rapid increase in body temperature is regarded as unfavorable because hyperthermia increases the metabolic demands of the brain and may indicate brain stem damage, a poor prognostic sign. The temperature is maintained at less than 38°C (100.4°F). Tachycardia and arterial hypotension may indicate that bleeding is occurring elsewhere in the body.

**MOTOR FUNCTION.** Motor function is assessed frequently by observing spontaneous movements, asking the patient to raise and lower the extremities, and comparing the strength and equality of the upper and lower extremities at periodic intervals. To assess upper extremity strength, the nurse instructs the patient to squeeze the examiner's fingers tightly. The nurse assesses lower extremity motor strength by placing the hands on the soles of the patient's feet and asking the patient to push down against the examiner's hands. Examination of the motor system is discussed in Chapter 60 in more detail. The presence or absence of spontaneous movement of each extremity is also noted, and speech and eye signs are assessed.

If the patient does not demonstrate spontaneous movement, responses to painful stimuli are assessed (Hickey, 2009). Motor response to pain is assessed by applying a central stimulus, such as pinching the pectoralis major muscle, to determine the patient's best response. Peripheral stimulation may provide inaccurate assessment data because it may result in a reflex movement rather than a voluntary motor response. Abnormal responses (lack of motor response; extension responses) are associated with a poorer prognosis.

**OTHER NEUROLOGIC SIGNS.** In addition to the patient's spontaneous eye opening, evaluated with the GCS, the size and equality of the pupils and their reaction to light are assessed. A unilaterally dilated and poorly responding pupil may indicate a developing hematoma, with subsequent pressure on the third cranial nerve due to shifting of the brain. If both pupils become fixed and dilated, this indicates overwhelming injury and intrinsic damage to the upper brain stem and is a poor prognostic sign (Adoni & McNett, 2007).

The patient with a head injury may develop deficits such as anosmia (lack of sense of smell), eye movement abnormalities, aphasia, memory deficits, and posttraumatic seizures or epilepsy. Patients may be left with residual psychological deficits (impulsiveness, emotional lability, or uninhibited, aggressive behaviors) and, as a consequence of the impairment, may lack insight into their emotional responses.

### *Maintaining the Airway*

One of the most important nursing goals in the management of head injury is to establish and maintain an adequate airway. The brain is extremely sensitive to hypoxia, and a neurologic deficit can worsen if the patient is hypoxic. Therapy is directed toward maintaining optimal oxygenation to preserve cerebral function. An obstructed airway causes carbon dioxide retention and hypoventilation, which can produce cerebral vessel dilation and increased ICP.

Interventions to ensure an adequate exchange of air are discussed in Chapter 61 and include the following:

- Maintaining the unconscious patient in a position that facilitates drainage of oral secretions, with the head of the bed elevated about 30 degrees to decrease intracranial venous pressure (Bader, 2006b)
- Establishing effective suctioning procedures (pulmonary secretions produce coughing and straining, which increase ICP)
- Guarding against aspiration and respiratory insufficiency
- Closely monitoring arterial blood gas values to assess the adequacy of ventilation. The goal is to keep blood gas values within the normal range to ensure adequate cerebral blood flow.
- Monitoring the patient who is receiving mechanical ventilation for pulmonary complications such as acute respiratory distress syndrome (ARDS) and pneumonia (Hickey, 2009)

### *Monitoring Fluid and Electrolyte Balance*

Brain damage can produce metabolic and hormonal dysfunctions. The monitoring of serum electrolyte levels is important, especially in patients receiving osmotic diuretics, those with syndrome of inappropriate antidiuretic hormone (SIADH) secretion, and those with posttraumatic diabetes insipidus.

Serial studies of blood and urine electrolytes and osmolality are carried out because head injuries may be accompanied by disorders of sodium regulation. Hyponatremia is common after head injury due to shifts in extracellular fluid, electrolytes, and volume. Hyperglycemia, for example, can cause an increase in extracellular fluid that lowers sodium. Hypernatremia may also occur as a result of sodium retention that may last several days, followed by sodium diuresis. Increasing lethargy, confusion, and seizures may be the result of electrolyte imbalance.

Endocrine function is evaluated by monitoring serum electrolytes, blood glucose values, and intake and output. Urine is tested regularly for acetone. A record of daily weights is maintained, especially if the patient has hypothalamic involvement and is at risk for the development of diabetes insipidus.

### *Promoting Adequate Nutrition*

Head injury results in metabolic changes that increase calorie consumption and nitrogen excretion. Protein demand increases. Early initiation of nutritional therapy has been shown to improve outcomes in patients with head injury. Patients with brain injury are assumed to be catabolic and nutritional support consultation should be considered as soon as the patient is admitted. Parenteral nutrition via a central line or enteral feedings administered via a nasogastric or nasojejunal feeding tube should be considered (Hickey, 2009). If CSF rhinorrhea occurs, an oral feeding tube should be inserted instead of a nasal tube.

Laboratory values should be monitored closely in patients receiving parenteral nutrition. Elevating the head of the bed and aspirating the enteral tube for evidence of residual feeding before administering additional feedings can help prevent distention, regurgitation, and aspiration. A continuous-drip infusion or pump may be used to regulate the feeding. The principles and technique of enteral feedings are discussed in Chapter 36. Enteral or parenteral feedings are usually continued until the swallowing reflex returns and the patient can meet caloric requirements orally.

***Preventing Injury***

Often, as the patient emerges from coma, a period of lethargy and stupor is followed by a period of agitation. Each phase is variable and depends on the individual person, the location of the injury, the depth and duration of coma, and the patient's age. Restlessness may be caused by hypoxia, fever, pain, or a full bladder. It may indicate injury to the brain but may also be a sign that the patient is regaining consciousness. (Some restlessness may be beneficial because the lungs and extremities are exercised.) Agitation may also be the result of discomfort from catheters, intravenous (IV) lines, restraints, and repeated neurologic checks. Alternatives to restraints must be used whenever possible.

Strategies to prevent injury include the following:

- The patient is assessed to ensure that oxygenation is adequate and the bladder is not distended. Dressings and casts are checked for constriction.
- Padded side rails are used or the patient's hands are wrapped in mitts to protect the patient from self-injury and dislodging of tubes. Restraints are avoided, because straining against them can increase ICP or cause other injury. Enclosed or floor-level specialty beds may be indicated.
- Opioids are avoided as a means of controlling restlessness, because they depress respiration, constrict the pupils, and alter responsiveness.
- Environmental stimuli are reduced by keeping the room quiet, limiting visitors, speaking calmly, and providing frequent orientation information (eg, explaining where the patient is and what is being done).
- Adequate lighting is provided to prevent visual hallucinations.
- Efforts are made to minimize disruption of the patient's sleep–wake cycles.
- The patient's skin is lubricated with oil or emollient lotion to prevent irritation due to rubbing against the sheet.
- If incontinence occurs, an external sheath catheter may be used on a male patient. Because prolonged use of an indwelling catheter inevitably produces infection, the patient may be placed on an intermittent catheterization schedule.

***Maintaining Body Temperature***

Fever in the patient with a TBI can be the result of damage to the hypothalamus, cerebral irritation from hemorrhage, or infection. The nurse monitors the patient's temperature every 2 to 4 hours. If the temperature increases, efforts are made to identify the cause and to control it using acetaminophen and cooling blankets to maintain normothermia (Thompson, Kirkness & Mitchell, 2007). Cooling blankets should be used with caution so as not to induce shivering, which increases ICP. If infection is suspected, potential sites of infection are cultured and antibiotics are prescribed and administered.

Use of mild hypothermia to 34°C to 35°C (94°F to 96°F) has been tested in small randomized controlled trials for at least 12 hours versus normothermia (control) in patients with closed head injury. Early research showed improvement in patient outcomes but needs to be repeated in larger trials. Because hypothermia increases the risk of pneumonia and has other side effects, this treatment is not currently recommended outside of controlled clinical trials (Brain Trauma Foundation, 2007).

***Maintaining Skin Integrity***

Patients with TBI often require assistance in turning and positioning because of immobility or unconsciousness. Prolonged pressure on the tissues decreases circulation and leads to tissue necrosis. Potential areas of breakdown need to be identified early to avoid the development of pressure ulcers. Specific nursing measures include the following:

- Assessing all body surfaces and documenting skin integrity every 8 hours
- Turning and repositioning the patient every 2 hours
- Providing skin care every 4 hours
- Assisting the patient to get out of bed to a chair three times a day

***Improving Cognitive Functioning***

Although many patients with head injury survive because of resuscitative and supportive technology, they frequently have significant cognitive sequelae that may not be detected during the acute phase of injury. Cognitive impairment includes memory deficits, decreased ability to focus and sustain attention to a task (distractibility), reduced ability to process information, and slowness in thinking, perceiving, communicating, reading, and writing. Psychiatric, emotional, and relationship problems develop in many patients after head injury. Resulting psychosocial, behavioral, emotional, and cognitive impairments are devastating to the family as well as to the patient (Bay & Bergman, 2006; Jumisko, Lexell & Soderberg, 2005).

These problems require collaboration among many disciplines. A neuropsychologist (specialist in evaluating and treating cognitive problems) plans a program and initiates therapy or counseling to help the patient reach maximal potential. Cognitive rehabilitation activities help the patient to devise new problem-solving strategies. The retraining is carried out over an extended period and may include the use of sensory stimulation and reinforcement, behavior modification, reality orientation, computer training programs, and video games. Assistance from many disciplines is necessary during this phase of recovery. Even if intellectual ability does not improve, social and behavioral abilities may.

The patient recovering from a TBI may experience fluctuations in the level of cognitive function, with orientation, attention, and memory frequently affected. Many types of sensory stimulation programs have been tried, and research on these programs is ongoing (Hickey, 2009). When pushed to a level greater than the impaired cortical functioning allows, the patient may show symptoms of fatigue, anger, and

stress (headache, dizziness). The Rancho Los Amigos Level of Cognitive Function scale is frequently used to assess cognitive function and evaluate ongoing recovery from head injury. Progress through the levels of cognitive function can vary widely for individual patients. Nursing management and a description of each level are included in Table 63-2.

***Preventing Sleep Pattern Disturbance***

Patients who require frequent monitoring of neurologic status may experience sleep deprivation as they are awakened hourly for assessment of LOC. To allow the patient longer times of uninterrupted sleep and rest, the nurse can group nursing care activities so that the patient is disturbed less frequently. Environmental noise is decreased, and the room lights are dimmed. Back rubs and other measures to increase comfort may promote sleep and rest.

***Supporting Family Coping***

Having a loved one sustain a TBI produces a great deal of stress in the family. This stress can result from the patient's physical and emotional deficits, the unpredictable outcome, and altered family relationships. Families report difficulties in coping with changes in the patient's temperament, behavior, and personality. Such changes are associated with disruption in family cohesion, loss of leisure pursuits, and loss of work capacity, as well as social isolation of the caretaker. The family may experience marital disruption, anger, grief, guilt, and denial in recurring cycles.

To promote effective coping, the nurse can ask the family how the patient is different now, what has been lost, and what is most difficult about coping with this situation. Helpful interventions include providing family members with accurate and honest information and encouraging them to continue to set well-defined short-term goals. Family counseling helps address the family members' overwhelming feelings of loss and helplessness and gives them guidance for the management of inappropriate behaviors. Support groups help the family members share problems, develop insight, gain information, network, and gain assistance in maintaining realistic expectations and hope.

The Brain Injury Association (see Resources) serves as a clearinghouse for information and resources for patients with head injuries and their families, including specific information on coma, rehabilitation, behavioral consequences of head injury, and family issues. This organization can provide names of facilities and professionals who work with patients with head injuries and can assist families in organizing local support groups.

Many patients with severe head injury die from their injuries, and many of those who survive experience long-term disabilities that prevent them from resuming their previous roles and functions. During the most acute phase of injury, family members need factual information and support from the health care team.

Many patients with severe head injuries that result in brain death are young and otherwise healthy and are therefore considered for organ donation. Family members of patients with such injuries need support during this extremely stressful time and assistance in making decisions to end life support and permit donation of organs. They need to know that the patient who is brain dead and whose respiratory and cardiovascular systems are maintained through life support is not going to survive and that the severe head injury, not the removal of the patient's organs or the removal of life support, is the cause of the patient's death. Bereavement counselors and members of the organ procurement team are often very helpful to family members in making decisions about organ donation and in helping them cope with stress.

***Monitoring and Managing Potential Complications***

DECREASED CEREBRAL PERFUSION PRESSURE. Maintenance of adequate CPP is important to prevent serious complications of head injury due to decreased cerebral perfusion. Adequate CPP is greater than 60 mm Hg. If CPP falls below a patient's threshold, a vasodilating cascade occurs, causing the volume of blood to increase inside the brain, causing ICP to increase. A decrease in CPP can impair cerebral perfusion and cause brain hypoxia and ischemia, leading to permanent brain damage. Once the threshold CPP is reached, vasoconstriction of the cerebral blood vessels occurs, causing ICP to decrease (Bader & Arbour, 2005). Therapy (eg, elevation of the head of the bed and increased IV fluids) is directed toward decreasing cerebral edema and increasing venous outflow from the brain. Systemic hypotension, which causes vasoconstriction and a significant decrease in CPP, is treated with increased IV fluids or vasopressors.

CEREBRAL EDEMA AND HERNIATION. The patient with a head injury is at risk for additional complications such as increased ICP and brain stem herniation. Cerebral edema is the most common cause of increased ICP in the patient with a head injury, with the swelling peaking approximately 48 to 72 hours after injury. Bleeding also may increase the volume of contents within the rigid, closed compartment of the skull, causing increased ICP and herniation of the brain stem and resulting in irreversible brain anoxia and brain death (Morton, et al., 2010). Measures to control ICP are discussed in Chapter 61 and listed in Chart 63-5.

IMPAIRED OXYGENATION AND VENTILATION. Impaired oxygen and ventilation may require mechanical ventilatory support. The patient must be monitored for a patent airway, altered breathing patterns, and hypoxemia and pneumonia. Interventions may include endotracheal intubation, mechanical ventilation, and positive end-expiratory pressure. These topics are discussed in further detail in Chapters 25 and 61.

**Chart 63-5 • *Controlling Intracranial Pressure in Patients With Severe Brain Injury***

- Elevate the head of the bed as prescribed.
- Maintain the patient's head and neck in neutral alignment (no twisting or flexing the neck).
- Initiate measures to prevent the Valsalva maneuver (eg, stool softeners).
- Maintain normal body temperature.
- Administer $O_2$ to maintain $PaO_2$ >90 mm Hg.
- Maintain fluid balance with normal saline solution.
- Avoid noxious stimuli (eg, excessive suctioning, painful procedures).
- Administer sedation to reduce agitation.
- Maintain cerebral perfusion pressure >70 mm Hg.

**Table 63-2 RANCHO LOS AMIGOS SCALE: LEVELS OF COGNITIVE FUNCTION**

| Cognitive Level | Description | Nursing Management |
|---|---|---|
| | **For levels I–III, the key approach is to *provide stimulation*.** | |
| I: No response | Completely unresponsive to all stimuli, including painful stimuli | Multiple modalities of sensory input should be used. Examples are listed here, but management should be individualized and expanded based on available materials and patient preferences (determined by obtaining information from the family). |
| II: Generalized response | Nonpurposeful response; responds to pain, but in a nonpurposeful manner | *Olfactory*: perfumes, flowers, shaving lotion<br>*Visual*: family pictures, card, personal items |
| III: Localized response | Responses more focused: withdraws to pain; turns toward sound; follows moving objects that pass within visual field; pulls on sources of discomfort (eg, tubes, restraints); may follow simple commands but inconsistently and in a delayed manner | *Auditory*: radio, television, tapes of family voices or favorite recordings, talking to patient (nurse, family members). The nurse should tell patient what is going to be done, discuss the environment, provide encouragement.<br>*Tactile*: touching of skin, rubbing various textures on skin<br>*Movement*: range-of-motion exercises, turning, repositioning, use of water mattress |
| | **For levels IV–VI, the key approach is to *provide structure*.** | |
| IV: Confused, agitated response | Alert, hyperactive state in which patient responds to internal confusion/agitation; behavior nonpurposeful in relation to the environment; aggressive, bizarre behavior common | For level IV, which lasts 2–4 weeks, interventions are directed at decreasing agitation, increasing environmental awareness, and promoting safety.<br>• Approach patient in a calm manner, and use a soft voice.<br>• Screen patient from environmental stimuli (eg, sounds, sights); provide a quiet, controlled environment.<br>• Remove devices that contribute to agitation (eg, tubes), if possible.<br>• Functional goals cannot be set, because the patient is unable to cooperate. |
| V: Confused, inappropriate response | When agitation occurs, it is the result of external rather than internal stimuli; focused attention is difficult; memory is severely impaired; responses are fragmented and inappropriate to the situation; there is no carryover of learning from one situation to the other. | For levels V and VI, interventions are directed at decreasing confusion, improving cognitive function, and improving independence in performing ADLs.<br>• Provide supervision.<br>• Use repetition and cues to teach ADLs. Focus the patient's attention and help to increase his or her concentration. |
| VI: Confused, appropriate response | Follows simple directions consistently but is inconsistently oriented to time and place; short-term memory worse than long-term memory; can perform some ADLs | • Help the patient organize activity.<br>• Clarify misinformation and reorient when confused.<br>• Provide a consistent, predictable schedule (eg, post daily schedule on large poster board). |
| | **For levels VII–X, the key approach is *integration into the community*.** | |
| VII: Automatic, appropriate response | Appropriately responsive and oriented within the hospital setting; needs little supervision in ADLs; some carryover of learning; patient has superficial insight into disabilities; has decreased judgment and problem-solving abilities; lacks realistic planning for future | For levels VII–X, interventions are directed at increasing the patient's ability to function with minimal or no supervision in the community.<br>• Reduce environmental structure.<br>• Help the patient plan for adapting ADLs for self into the home environment.<br>• Discuss and adapt home living skills (eg, cleaning, cooking) to patient's ability. |
| VIII: Purposeful, appropriate | Alert, oriented, intact memory; has realistic goals for the future. Able to complete familiar tasks for 1 h in a distracting environment; overestimates or underestimates abilities, argumentative, easily frustrated, self-centered; uncharacteristically dependent/independent | • Provide stand-by assistance as needed for ADLs and home living skills. |
| IX: Purposeful, appropriate | Independently shifts back and forth between tasks and completes them accurately for at least 2 consecutive hours; uses assistive memory devices to recall schedule and activities; aware of and acknowledges impairments and disabilities when they interfere with task completion; depression may continue; may be easily irritable and have a low frustration tolerance | • Provide assistance on request for adapting ADLs and home living skills. |
| X: Purposeful, appropriate | Able to handle multiple tasks simultaneously in all environments but may require periodic breaks; independently initiates and carries out familiar and unfamiliar tasks but may require more than usual amount of time and/or compensatory strategies to complete them; accurately estimates abilities and independently adjusts to task demands; periodic periods of depression may occur; irritability and low frustration tolerance when sick, fatigued, and/or under stress | • Monitor for signs and symptoms of depression.<br>• Help the patient plan, anticipate concerns, and solve problems. |

**IMPAIRED FLUID, ELECTROLYTE, AND NUTRITIONAL BALANCE.** Fluid, electrolyte, and nutritional imbalances are common in the patient with a head injury. Common imbalances include hyponatremia, which is often associated with SIADH (see Chapters 14 and 42), hypokalemia, and hyperglycemia. Modifications in fluid intake with tube feedings or IV fluids, including hypertonic saline, may be necessary to treat these imbalances (Hickey, 2009). Insulin administration may be prescribed to treat hyperglycemia.

Undernutrition is also a common problem in response to the increased metabolic needs associated with severe head injury. Decisions about early feeding should be individualized; options include IV hyperalimentation or placement of a feeding tube (jejunal or gastric). Caloric expenditure can increase up to 120% to 140% with TBI, requiring close monitoring of nutritional status. Feeding tubes should be placed 3 to 7 days after neurologic injury to replace energy and nitrogen losses, prevent increased mortality, and improve outcomes (Hickey, 2009).

**POSTTRAUMATIC SEIZURES.** Patients with head injury are at an increased risk for posttraumatic seizures. Posttraumatic seizures are classified as immediate (within 24 hours after injury), early (within 1 to 7 days after injury), or late (more than 7 days after injury) (Hickey, 2009). Seizure prophylaxis is the practice of administering antiseizure medications to patients with head injury to prevent seizures. It is important to prevent posttraumatic seizures, especially in the immediate and early phases of recovery, because seizures may increase ICP and decrease oxygenation. However, many antiseizure medications impair cognitive performance and can prolong the duration of rehabilitation. Therefore, it is important to weigh the overall benefit of these medications against their side effects. Research evidence supports the use of prophylactic antiseizure agents to prevent immediate and early seizures after head injury, but not for prevention of late seizures (Barker, 2008). The nursing management of seizures is addressed in Chapter 61.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Teaching early in the course of head injury often focuses on reinforcing information given to the family about the patient's condition and prognosis. As the patient's status and expected outcome change over time, family teaching may focus on interpretation and explanation of changes in the patient's physical and psychological responses.

If the patient's physical status allows discharge to home, the patient and family are instructed about limitations that can be expected and complications that may occur. The nurse explains to the patient and family, verbally and in writing, how to monitor for complications that merit contacting the neurosurgeon. Depending on the patient's prognosis and physical and cognitive status, the patient may be included in teaching about self-care management strategies.

If the patient is at risk for late posttraumatic seizures, antiseizure medications may be prescribed at discharge. The patient and family require instruction about the side effects of these medications and the importance of continuing to take them as prescribed.

**CONTINUING CARE.** The rehabilitation phase of care for the patient with a TBI begins at hospital admission. Admission to the rehabilitation unit is a milestone in a patient's recovery and requires intense work by the patient to complete the daily schedule of therapies. The goals of rehabilitation are to maximize the patient's ability to return to his or her highest level of functioning and to his or her home and the community, address concerns before discharge for a smooth transition to home or rehabilitation, and promote independence with adaptation to deficits (Hickey, 2009). The patient is encouraged to continue the rehabilitation program after discharge, because improvement in status may continue 3 or more years after injury. Changes in the patient with a TBI and the effects of long-term rehabilitation on the family and their coping abilities need ongoing assessment. Continued teaching and support of the patient and family are essential as their needs and the patient's status change. Teaching points to address with the family of the patient who is about to return home are described in Chart 63-6.

Depending on his or her status, the patient is encouraged to return to normal activities gradually. Referral to support

**CHART 63-6** HOME CARE CHECKLIST
***The Patient With a Traumatic Brain Injury***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Explain the need for monitoring for changes in neurologic status and for complications. | ✔ | ✔ |
| • Identify changes in neurologic status and signs and symptoms of complications that should be reported to the neurosurgeon or nurse. | | ✔ |
| • Demonstrate safe techniques to assist patient with self-care, hygiene, and ambulation. | | ✔ |
| • Demonstrate safe technique for eating, feeding patient, or assisting patient with eating. | ✔ | ✔ |
| • Explain rationale for taking medications as prescribed. | ✔ | ✔ |
| • Identify need for close monitoring of behavior due to changes in cognitive functioning. | | ✔ |
| • Describe household modifications needed to ensure safe environment for the patient. | | ✔ |
| • Describe strategies for reinforcing positive behaviors. | | ✔ |
| • State importance of continuing follow-up by health care team. | ✔ | ✔ |

groups and to the Brain Injury Association may be warranted.

During the acute and rehabilitation phases of care, the focus of teaching is on obvious needs, issues, deficits, and complications. Complications after TBI include infections (eg, pneumonia, urinary tract infection [UTI], septicemia, wound infection, osteomyelitis, meningitis, ventriculitis, brain abscess) and heterotrophic ossification (painful bone overgrowth in weight-bearing joints).

The nurse needs to remind the patient and family of the need for continuing health promotion and screening practices after the initial phase of care. Patients who have not been involved in these practices in the past are educated about their importance and are referred to appropriate health care providers.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Attains or maintains effective airway clearance, ventilation, and brain oxygenation
   a. Achieves normal blood gas values and has normal breath sounds on auscultation
   b. Mobilizes and clears secretions
2. Achieves satisfactory fluid and electrolyte balance
   a. Demonstrates serum electrolytes within normal range
   b. Has no clinical signs of dehydration or overhydration
3. Attains adequate nutritional status
   a. Has less than 50 mL of aspirate in stomach before each tube feeding
   b. Is free of gastric distention and vomiting
   c. Shows minimal weight loss
4. Avoids injury
   a. Shows lessening agitation and restlessness
   b. Is oriented to time, place, and person
5. Maintains normal body temperature
   a. Absence of fever
   b. Absence of hypothermia
6. Demonstrates intact skin integrity
   a. Exhibits no redness or breaks in skin integrity
   b. Exhibits no pressure ulcers
7. Shows improvement in cognitive function and improved memory
8. Demonstrates normal sleep–wake cycle
9. Demonstrates absence of complications
   a. Exhibits normal vital signs and body temperature, and increasing orientation to time, place, and person
   b. Demonstrates normal or reduced ICP
10. Experiences no posttraumatic seizures
    a. Takes antiseizure medications as prescribed
    b. Identifies side effects/adverse effects of antiseizure medications
11. Family demonstrates adaptive family processes
    a. Joins support group
    b. Shares feelings with appropriate health care personnel
    c. Makes end-of-life decisions, if needed
12. Participates in rehabilitation process as indicated for patient and family members
    a. Takes active role in identifying rehabilitation goals and participating in recommended patient care activities
    b. Prepares for discharge

# Spinal Cord Injury

**Spinal cord injury (SCI)** is a major health disorder. Almost 200,000 people in the United States live each day with a disability from SCI, and an estimated 11,000 new injuries occur each year (Hickey, 2009). SCI is primarily an injury of young adult males and 50% of those injured are between 16 and 30 years of age. Patients over the age of 60 years account for 10% of SCIs, and this figure has steadily risen over the past 25 years (Dawodu, 2007).

Motor vehicle crashes account for 48% of reported cases of SCI, with falls (23%), violence primarily from gunshot wounds (14%), recreational sporting activities (9%), and other events accounting for the remaining injuries. **Paraplegia** (paralysis of the lower body) and **tetraplegia** (formerly quadriplegia—paralysis of all four extremities) can occur, with incomplete tetraplegia (formerly quadriplegia) the largest category, followed by complete paraplegia, complete tetraplegia, and paraplegia.

The predominant risk factors for SCI include young age, male gender, and alcohol and drug use. The frequency with which these risk factors are associated with SCI serves to emphasize the importance of primary prevention. The same interventions suggested earlier in this chapter for head injury prevention serve to decrease the incidence of SCI as well (see Chart 63-1).

Most (80%) people who live with SCIs are men. The approximate ethnic distribution is 62% Caucasian, 22% African American, 13% Hispanic, and 3% other racial or ethnic groups (Dawodu, 2007). Life expectancy continues to increase for people with SCI because of improved health care but remains slightly lower than for those without SCI. The major causes of death are pneumonia, pulmonary emboli (PE), and septicemia (Dawodu, 2007; Hickey, 2009).

## Pathophysiology

Damage in SCI ranges from transient concussion (from which the patient fully recovers), to contusion, laceration, and compression of the spinal cord substance (either alone or in combination), to complete **transection** (severing) of the spinal cord (which renders the patient paralyzed below the level of the injury). The vertebrae most frequently involved are the 5th, 6th, and 7th cervical vertebrae (C5 to C7), the 12th thoracic vertebra (T12), and the 1st lumbar vertebra (L1). These vertebrae are most susceptible because there is a greater range of mobility in the vertebral column in these areas (Sherwood, Crago, Spiro, et al., 2007).

SCIs can be separated into two categories: primary injuries and secondary injuries. Primary injuries are the result of the initial insult or trauma and are usually permanent. Secondary injuries are usually the result of a contusion or

tear injury, in which the nerve fibers begin to swell and disintegrate. A secondary chain of events produces ischemia, hypoxia, edema, and hemorrhagic lesions, which in turn result in destruction of myelin and axons. The secondary injury is of primary concern for critical care nurses. Experts believe secondary injury is the principal cause of spinal cord degeneration at the level of injury and that it is reversible during the first 4 to 6 hours after injury. Methods of early treatment are essential to prevent partial damage from becoming total and permanent (Sherwood, et al., 2007).

## Clinical Manifestations

Manifestations of SCI depend on the type and level of injury (Chart 63-7). The type of injury refers to the extent of injury to the spinal cord itself. **Incomplete spinal cord lesions** (the sensory or motor fibers, or both, are preserved below the lesion) are classified according to the area of spinal cord damage: central, lateral, anterior, or peripheral. The American Spinal Injury Association (ASIA) provides classification of SCI according to the degree of sensory and motor function present after injury (Chart 63-8). "Neurologic level" refers to the lowest level at which sensory and motor functions are normal. Below the neurologic level, there is total sensory and motor paralysis, loss of bladder and bowel control (usually with urinary retention and bladder distention), loss of sweating and vasomotor tone, and marked reduction of blood pressure from loss of peripheral vascular resistance. A **complete spinal cord lesion** (total loss of sensation and voluntary muscle control below the lesion) can result in paraplegia or tetraplegia.

If conscious, the patient usually complains of acute pain in the back or neck, which may radiate along the involved nerve. However, absence of pain does not rule out spinal injury, and a careful assessment of the spine should be conducted if there has been a significant force and mechanism of injury (ie, concomitant head injury). Often the patient speaks of fear that the neck or back is broken.

Respiratory dysfunction is related to the level of injury. The muscles contributing to respiration are the abdominals and intercostals (T1 to T11) and the diaphragm (C4). In high cervical cord injury, acute respiratory failure is the leading cause of death. Functional abilities by level of injury are described in Table 63-3.

## Assessment and Diagnostic Findings

A detailed neurologic examination is performed. Diagnostic x-rays (lateral cervical spine x-rays) and CT scanning are usually performed initially. An MRI scan may be ordered as a further workup if a ligamentous injury is suspected, because significant spinal cord damage may exist even in the absence of bony injury (Hickey, 2009). If an MRI scan is contraindicated, a myelogram may be used to visualize the spinal axis. An assessment is made for other injuries, because spinal trauma often is accompanied by concomitant injuries, commonly to the head and chest. Continuous electrocardiographic monitoring may be indicated if a spinal cord injury is suspected, because bradycardia (slow heart rate) and asystole (cardiac standstill) are common in patients with acute spinal cord injuries.

## Emergency Management

The immediate management at the scene of the injury is critical, because improper handling of the patient can cause further damage and loss of neurologic function. Any patient who is involved in a motor vehicle crash, a diving or contact sports injury, a fall, or any direct trauma to the head and neck must be considered to have SCI until such an injury is ruled out. Initial care must include a rapid assessment, immobilization, extrication, and stabilization or control of life-threatening injuries, and transportation to the most appropriate medical facility. Immediate transportation to a trauma center with the capacity to manage major neurologic trauma is then necessary (Hickey, 2009).

At the scene of the injury, the patient must be immobilized on a spinal (back) board, with the head and neck maintained in a neutral position, to prevent an incomplete injury from becoming complete. One member of the team must assume control of the patient's head to prevent flexion, rotation, or extension; this is done by placing the hands on both sides of the patient's head at about ear level to limit movement and maintain alignment while a spinal board or cervical immobilizing device is applied. If possible, at least four people should slide the patient carefully onto a board for transfer to the hospital. Any twisting movement may irreversibly damage the spinal cord by causing a bony fragment of the vertebra to cut into, crush, or sever the cord completely.

The standard of care is that the patient is referred to a regional spinal injury or trauma center because of the multidisciplinary personnel and support services required to counteract the destructive changes that occur in the first 24 hours after injury. However, no randomized controlled trials have been conducted to confirm that referral results in better outcomes for the patient with SCI (Jones & Bagnall, 2008). During treatment in the emergency and x-ray departments, the patient is kept on the transfer board. The patient must always be maintained in an extended position. No part of the body should be twisted or turned, and the patient is not allowed to sit up. Once the extent of the injury has been determined, the patient may be placed on a rotating specialty bed (Fig. 63-6) or in a cervical collar (Fig. 63-7). Later, if SCI and bone instability have been ruled out, the patient may be moved to a conventional bed or the collar may be removed without harm. If a specialty bed is needed but not available, the patient should be placed in a cervical collar and on a firm mattress.

## Medical Management (Acute Phase)

The goals of management are to prevent secondary injury, to observe for symptoms of progressive neurologic deficits, and to prevent complications. The patient is resuscitated as necessary, and oxygenation and cardiovascular stability are maintained. SCI is a devastating event; new treatment methods and medications are continually being investigated for the acute and chronic phases of care (Fehlings & Baptiste, 2005).

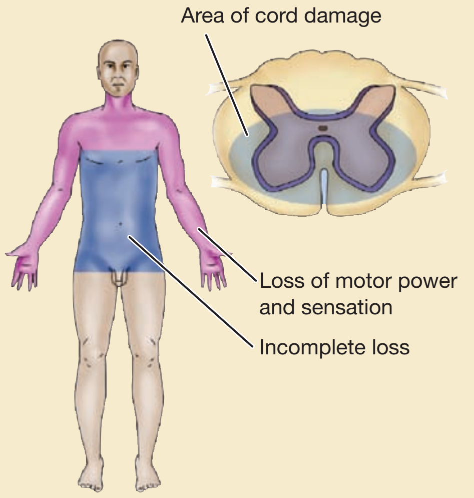
### *Pharmacologic Therapy*

Administration of high-dose IV corticosteroids or methylprednisolone sodium succinate in the first 24 or 48 hours is

## Chart 63-7 • *Effects of Spinal Cord Injuries*

### Central Cord Syndrome

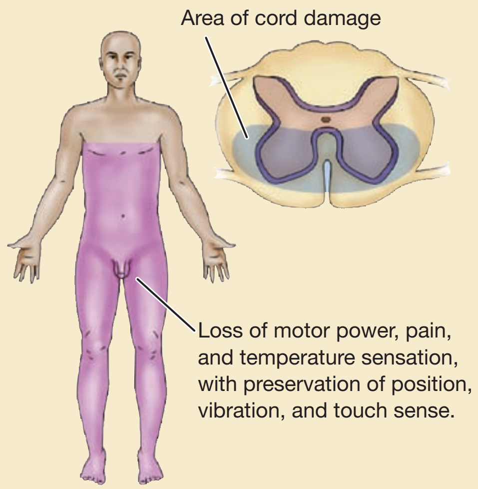
- Characteristics: Motor deficits (in the upper extremities compared to the lower extremities; sensory loss varies but is more pronounced in the upper extremities); bowel/bladder dysfunction is variable, or function may be completely preserved.
- Cause: Injury or edema of the central cord, usually of the cervical area. May be caused by hyperextension injuries.



Central Cord Syndrome

### Anterior Cord Syndrome

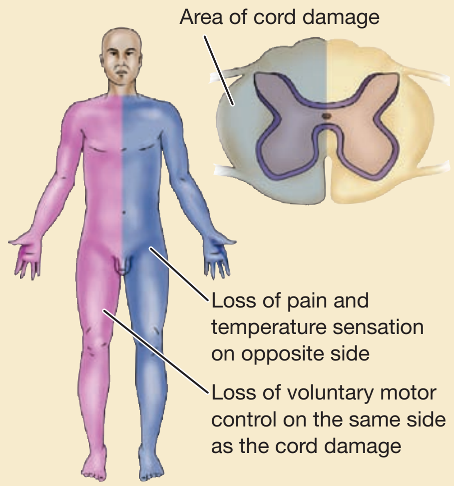
- Characteristics: Loss of pain, temperature, and motor function is noted below the level of the lesion; light touch, position, and vibration sensation remain intact.
- Cause: The syndrome may be caused by acute disk herniation or hyperflexion injuries associated with fracture-dislocation of vertebra. It also may occur as a result of injury to the anterior spinal artery, which supplies the anterior two thirds of the spinal cord.



Anterior Cord Syndrome

### Brown-Séquard Syndrome (Lateral Cord Syndrome)

- Characteristics: Ipsilateral paralysis or paresis is noted, together with ipsilateral loss of touch, pressure, and vibration and contralateral loss of pain and temperature.
- Cause: The lesion is caused by a transverse hemisection of the cord (half of the cord is transected from north to south), usually as a result of a knife or missile injury, fracture-dislocation of a unilateral articular process, or possibly an acute ruptured disk.



Brown-Séquard Syndrome

Adapted from Hickey, L. (2009). *The clinical practice of neurological and neurosurgical nursing* (6th ed.). Philadelphia: Lippincott Williams & Wilkins.

## Chart 63-8 • *ASIA Impairment Scale*

**A = Complete:** No motor or sensory function is preserved in the sacral segments S4–S5.
**B = Incomplete:** Sensory but not motor function is preserved below the neurologic level, and includes the sacral segments S4–S5.
**C = Incomplete:** Motor function is preserved below the neurologic level, and more than half of key muscles below the neurologic level have a muscle grade less than 3.
**D = Incomplete:** Motor function is preserved below the neurologic level, and at least half of key muscles below the neurologic level have a muscle grade of 3 or greater.
**E = Normal:** Motor and sensory function are normal.



controversial. Despite the ongoing controversy surrounding the practice, the use of IV high-dose methylprednisolone is accepted as standard therapy for SCI in many countries and remains an established clinical practice in most trauma centers in the United States (Hickey, 2009).

### *Respiratory Therapy*

Oxygen is administered to maintain a high partial pressure of oxygen ($PaO_2$), because hypoxemia can create or worsen a neurologic deficit of the spinal cord. If endotracheal intubation is necessary, extreme care is taken to avoid flexing or extending the patient's neck, which can result in extension of a cervical injury.

In high cervical spine injuries, spinal cord innervation to the phrenic nerve, which stimulates the diaphragm, is lost. Diaphragmatic pacing (electrical stimulation of the phrenic nerve) attempts to stimulate the diaphragm to help the patient breathe (Sole, Klein & Moseley, 2009). Intramuscular diaphragmatic pacing is currently in the clinical trial phase for the patient with a high cervical injury. This is implanted via laparoscopic surgery, usually after the acute phase.

### *Skeletal Fracture Reduction and Traction*

Management of SCI requires immobilization and reduction of dislocations (restoration of normal position) and stabilization of the vertebral column.

Cervical fractures are reduced, and the cervical spine is aligned with some form of skeletal traction, such as skeletal tongs or calipers, or with use of the halo device (Sole, et al., 2009). A variety of skeletal tongs are available, all of which involve fixation in the skull in some manner. The Gardner-Wells tongs require no predrilled holes in the skull. Crutchfield and Vinke tongs are inserted through holes made in the skull with a special drill under local anesthesia.

Traction is applied to the skeletal traction device by weights, the amount depending on the size of the patient and the degree of fracture displacement. The traction force is exerted along the longitudinal axis of the vertebral bodies, with the patient's neck in a neutral position. The traction is then gradually increased by adding more weights. As the amount of traction is increased, the spaces between the intervertebral disks widen and the vertebrae are given a chance to slip back into position. Reduction usually occurs after correct alignment has been restored. Once reduction is

**Table 63-3 FUNCTIONAL ABILITIES BY LEVEL OF CORD INJURY**

| Injury Level | Segmental Sensorimotor Function | Dressing, Eating | Elimination | Mobility* |
|---|---|---|---|---|
| C1 | Little or no sensation or control of head and neck; no diaphragm control; requires continuous ventilation | Dependent | Dependent | Limited. Voice or sip-n-puff controlled electric wheelchair |
| C2 to C3 | Head and neck sensation; some neck control; independent of mechanical ventilation for short periods | Dependent | Dependent | Same as for C1 |
| C4 | Good head and neck sensation and motor control; some shoulder elevation; diaphragm movement | Dependent, may be able to eat with adaptive sling | Dependent | Limited to voice, mouth, head, chin, or shoulder-controlled electric wheelchair |
| C5 | Full head and neck control; shoulder strength; elbow flexion | Independent with assistance | Maximal assistance | Electric or modified manual wheelchair, needs transfer assistance |
| C6 | Fully innervated shoulder; wrist extension or dorsiflexion | Independent or with minimal assistance | Independent or with minimal assistance | Independent in transfers and wheelchair |
| C7 to C8 | Full elbow extension; wrist plantar flexion; some finger control | Independent | Independent | Independent; manual wheelchair |
| T1 to T5 | Full hand and finger control; use of intercostal and thoracic muscles | Independent | Independent | Independent; manual wheelchair |
| T6 to T10 | Abdominal muscle control, partial to good balance with trunk muscles | Independent | Independent | Independent; manual wheelchair |
| T11 to L5 | Hip flexors, hip abductors (L1–L3); knee extension (L2–L4); knee flexion and ankle dorsiflexion (L4–L5) | Independent | Independent | Short distance to full ambulation with assistance |
| S1 to S5 | Full leg, foot, and ankle control; innervation of perineal muscles for bowel, bladder, and sexual function (S2–S4) | Independent | Normal to impaired bowel and bladder function | Ambulate independently with or without assistance |

* Assistance refers to adaptive equipment, setup, or physical assistance.
From Porth, C. M. & Matfin, G. (2009). *Pathophysiology: Concepts of altered health states* (8th ed.). Philadelphia: Lippincott Williams & Wilkins.

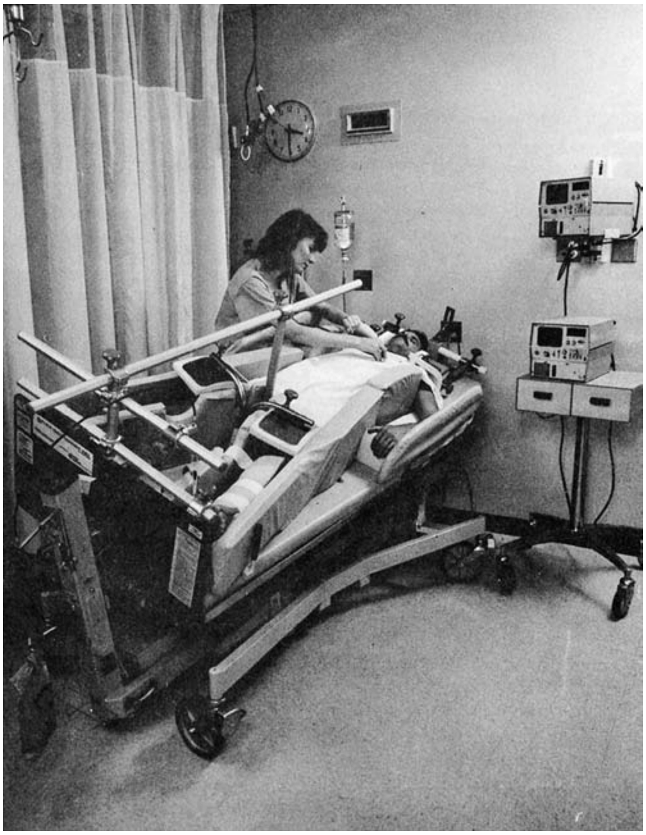


**Figure 63-6** Roro Rest bed. Courtesy of Kinetic Concepts, San Antonio, TX.

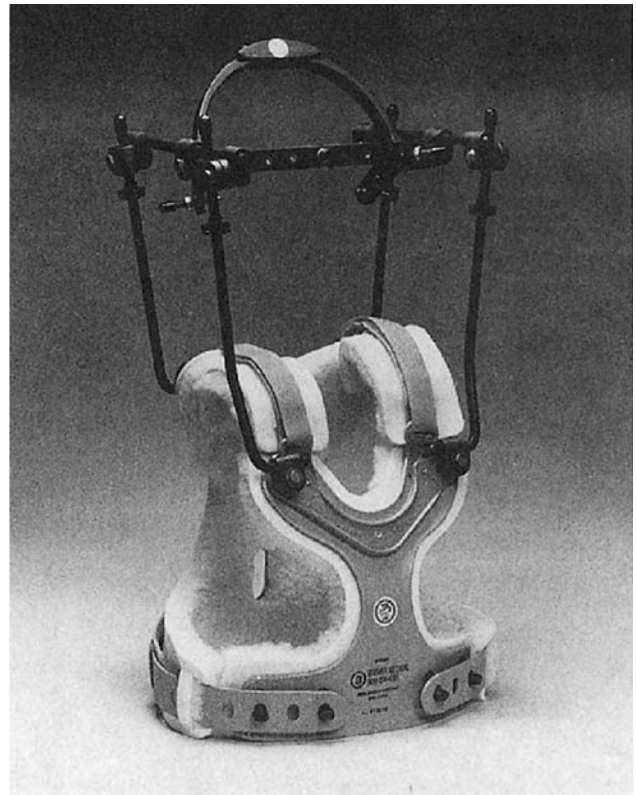


**Figure 63-8** Halo and vest for cervical and thoracic injuries. Courtesy of Acromed Corp., Cleveland, OH.

achieved, as verified by cervical spine x-rays and neurologic examination, the weights are gradually removed until the amount of weight needed to maintain the alignment is identified. The weights should hang freely so as not to interfere with the traction. Traction is sometimes supplemented with manual manipulation of the neck by a surgeon to help achieve realignment of the vertebral bodies.

A halo device may be used initially with traction, or may be applied after removal of the tongs. It consists of a stainless steel halo ring that is fixed to the skull by four pins. The ring is attached to a removable **halo vest,** a device that suspends the weight of the unit circumferentially around the chest. A metal frame connects the ring to the chest. Halo devices provide immobilization of the cervical spine while allowing early ambulation (Fig. 63-8).



**Figure 63-7** Cervical collar. Courtesy of Aspen Medical Products, Irvine, CA.

Thoracic and lumbar injuries are usually treated with surgical intervention followed by immobilization with a fitted brace. Traction is not indicated either before or after surgery, due to the relative stability of the spine in these regions.

*NURSING ALERT*

**The patient's vital organ functions and body defenses must be supported and maintained until spinal and neurogenic shock abates and the neurologic system has recovered from the traumatic insult; this can take up to 4 months (Hickey, 2009).**

### *Surgical Management*

Surgery is indicated in any of the following situations:

- Compression of the cord is evident.
- The injury results in a fragmented or unstable vertebral body.
- The injury involves a wound that penetrates the cord.
- Bony fragments are in the spinal canal.
- The patient's neurologic status is deteriorating.

Research indicates that early surgical stabilization improves the clinical outcome of patients compared to surgery

performed later during the clinical course. The goals of surgical treatment are to preserve neurologic function by removing pressure from the spinal cord and to provide stability (Sherwood, et al., 2007).

## Management of Acute Complications of Spinal Cord Injury

### *Spinal and Neurogenic Shock*

The spinal shock associated with SCI reflects a sudden depression of reflex activity in the spinal cord (areflexia) below the level of injury. The muscles innervated by the part of the spinal cord segment below the level of the lesion are without sensation, paralyzed, and flaccid, and the reflexes are absent. In particular, the reflexes that initiate bladder and bowel function are affected. Bowel distention and paralytic ileus can be caused by depression of the reflexes and are treated with intestinal decompression by insertion of a nasogastric tube (Dawodu, 2007).

Neurogenic shock develops as a result of the loss of autonomic nervous system function below the level of the lesion (Dawodu, 2007). The vital organs are affected, causing decreases in blood pressure, heart rate, and cardiac output, as well as venous pooling in the extremities and peripheral vasodilation. In addition, the patient does not perspire in the paralyzed portions of the body, because sympathetic activity is blocked; therefore, close observation is required for early detection of an abrupt onset of fever. Further discussion of neurogenic shock can be found in Chapter 15.

With injuries to the cervical and upper thoracic spinal cord, innervation to the major accessory muscles of respiration is lost and respiratory problems develop. These include decreased vital capacity, retention of secretions, increased partial pressure of arterial carbon dioxide ($PaCO_2$) levels and decreased oxygen levels, respiratory failure, and pulmonary edema.

### *Deep Vein Thrombosis*

Deep vein thrombosis (DVT) is a potential complication of immobility and is common in patients with SCI. Patients who develop DVT are at risk for PE, a life-threatening complication. Manifestations of PE include pleuritic chest pain, anxiety, shortness of breath, and abnormal blood gas values (increased $PaCO_2$ and decreased $PaO_2$). Low-dose anticoagulation therapy usually is initiated to prevent DVT and PE, along with the use of anti-embolism stockings or pneumatic compression devices. In some cases, permanent indwelling filters (see Chapter 23) may be placed prophylactically in the vena cava to prevent emboli (dislodged clots) from migrating to the lungs and causing a PE (Hickey, 2009).

*NURSING ALERT*

**The calves or thighs should never be massaged because of the danger of dislodging an undetected thromboemboli.**

### *Other Complications*

In addition to respiratory complications (respiratory failure, pneumonia) and **autonomic dysreflexia** (characterized by pounding headache, profuse sweating, nasal congestion, piloerection ["goose bumps"], bradycardia, and hypertension), other complications that may occur include pressure ulcers and infection (urinary, respiratory, and local infection at the skeletal traction pin sites) (Vacca, 2007a).

## NURSING PROCESS

## The Patient With Acute Spinal Cord Injury

### Assessment

The patient's breathing pattern and the strength of the cough are assessed, and the lungs are auscultated, because paralysis of abdominal and respiratory muscles diminishes coughing and makes clearing of bronchial and pharyngeal secretions difficult. Reduced excursion of the chest also results.

The patient is monitored closely for any changes in motor or sensory function and for symptoms of progressive neurologic damage. In the early stages of SCI, determining whether the cord has been severed may not be possible, because signs and symptoms of cord edema are indistinguishable from those of cord transection. Edema of the spinal cord may occur with any severe cord injury and may further compromise spinal cord function.

Motor and sensory functions are assessed through careful neurologic examination. These findings are recorded on a flow sheet so that changes in the baseline neurologic status can be monitored closely and accurately. The ASIA classification is commonly used to describe level of function for patients with SCI (see Chart 63-8). Chart 63-7 gives examples of the effects of altered spinal cord function. At the minimum:

- Motor ability is tested by asking the patient to spread the fingers, squeeze the examiner's hand, and move the toes or turn the feet.
- Sensation is evaluated by gently pinching the skin or touching it lightly with an object such as a tongue blade, starting at shoulder level and working down both sides of the extremities. The patient should have both eyes closed so that the examination reveals true findings, not what the patient hopes to feel. The patient is asked where the sensation is felt.
- Any decrease in neurologic function is reported immediately.

The patient is also assessed for spinal shock, a complete loss of all reflex, motor, sensory, and autonomic activity below the level of the lesion that causes bladder paralysis and distention. The lower abdomen is palpated for signs of urinary retention and overdistention of the bladder. Further assessment is made for gastric dilation and paralytic ileus caused by an atonic bowel, a result of autonomic disruption.

Temperature is monitored, because the patient may have periods of hyperthermia as a result of alteration in temperature control due to autonomic disruption.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective breathing patterns related to weakness or paralysis of abdominal and intercostal muscles and inability to clear secretions
- Ineffective airway clearance related to weakness of intercostal muscles
- Impaired bed and physical mobility related to motor and sensory impairments
- Disturbed sensory perception related to motor and sensory impairment
- Risk for impaired skin integrity related to immobility and sensory loss
- Impaired urinary elimination related to inability to void spontaneously
- Constipation related to presence of atonic bowel as a result of autonomic disruption
- Acute pain and discomfort related to treatment and prolonged immobility

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include:

- DVT
- Orthostatic hypotension
- Autonomic dysreflexia

### Planning and Goals

The goals for the patient may include improved breathing pattern and airway clearance, improved mobility, improved sensory and perceptual awareness, maintenance of skin integrity, relief of urinary retention, improved bowel function, promotion of comfort, and absence of complications.

### Nursing Interventions

#### *Promoting Adequate Breathing and Airway Clearance*

Possible impending respiratory failure is detected by observing the patient, measuring vital capacity, monitoring oxygen saturation through pulse oximetry, and monitoring arterial blood gases. Early and vigorous attention to clearing bronchial and pharyngeal secretions can prevent retention of secretions and atelectasis. Suctioning may be indicated, but it should be used with caution to avoid stimulating the vagus nerve and producing bradycardia and cardiac arrest.

If the patient cannot cough effectively because of decreased inspiratory volume and inability to generate sufficient expiratory pressure, chest physical therapy and assisted coughing may be indicated. Specific breathing exercises are supervised by the nurse to increase the strength and endurance of the inspiratory muscles, particularly the diaphragm. Assisted coughing promotes clearing of secretions from the upper respiratory tract and is similar to the use of abdominal thrusts to clear an airway (see Chapter 25). Proper humidification and hydration are important to prevent secretions from becoming thick and difficult to remove even with coughing. The patient is assessed for signs of respiratory infection (eg, cough, fever, dyspnea).

Ascending edema of the spinal cord in the acute phase may cause respiratory difficulty that requires immediate intervention. Therefore, the patient's respiratory status must be monitored closely.

#### *Improving Mobility*

Proper body alignment is maintained at all times. The patient is repositioned frequently and is assisted out of bed as soon as the spinal column is stabilized. The feet are prone to footdrop; therefore, various types of splints are used to prevent footdrop. When used, the splints are removed and reapplied every 2 hours. Trochanter rolls, applied from the crest of the ilium to the midthigh of both legs, help prevent external rotation of the hip joints.

Patients with lesions above the midthoracic level have loss of sympathetic control of peripheral vasoconstrictor activity, leading to hypotension. These patients may tolerate changes in position poorly and require monitoring of blood pressure when positions are changed. If not on a rotating specialty bed, the patient should not be turned unless the spine is stable and the physician has indicated that it is safe to do so.

Contractures can develop rapidly with immobility and muscle paralysis. A joint that is immobilized too long becomes fixed as a result of contractures of the tendon and joint capsule. Atrophy of the extremities results from disuse. Contractures and other complications may be prevented by range-of-motion exercises that help preserve joint motion and stimulate circulation. Passive range-of-motion exercises should be implemented as soon as possible after injury. Toes, metatarsals, ankles, knees, and hips should be put through a full range of motion at least four, and ideally five, times daily.

For most patients who have a cervical fracture without neurologic deficit, reduction in traction followed by rigid immobilization for 6 to 8 weeks restores skeletal integrity. These patients are allowed to move gradually to an erect position. A neck brace or molded collar is applied when the patient is mobilized after traction is removed (see Fig. 63-7).

#### *Promoting Adaptation to Sensory and Perceptual Alterations*

The nurse assists the patient to compensate for sensory and perceptual alterations that occur with SCI. The intact senses above the level of the injury are stimulated through touch, aromas, flavorful food and beverages, conversation, and music. Additional strategies include the following:

- Providing prism glasses to enable the patient to see from the supine position
- Encouraging use of hearing aids, if indicated, to enable the patient to hear conversations and environmental sounds
- Providing emotional support to the patient
- Teaching the patient strategies to compensate for or cope with sensory deficits

#### *Maintaining Skin Integrity*

Pressure ulcers are a significant complication of SCI. The most common sites are over the ischial tuberosity, the greater trochanter, the sacrum, and the occiput (back of head). In the acute care setting, during the initial phase of hospitalization, it may be necessary to delay rehabilitation in 20% to 30% of patients because of pressure ulcers. Pressure ulcers may begin within hours of an acute SCI where pressure is continuous and where the peripheral circulation

is inadequate as a result of spinal shock and a recumbent position. It is important to move the patient from the backboard as soon as possible and inspect the skin. In addition, patients who wear cervical collars for prolonged periods may develop breakdown from the pressure of the collar under the chin, on the shoulders, and at the occiput. In addition, pressure ulcers can add substantially to the personal and economic costs of living with a SCI. The prevalence of this complication ranges from 17% for people 2 months after injury to 33% for those living with an SCI.

The most effective approach to addressing this costly complication of SCI is prevention (King, Porter & Vertiz, 2008). The patient's position is changed at least every 2 hours. Turning not only assists in the prevention of pressure ulcers but also prevents pooling of blood and edema in the dependent areas. Careful inspection of the skin is made each time the patient is turned. The skin over the pressure points is assessed for redness or breaks; the perineum is checked for soilage, and the catheter is observed for adequate drainage. The patient's general body alignment and comfort are assessed. Special attention should be given to pressure areas in contact with the transfer board.

In addition, the patient's skin should be kept clean by washing with a mild soap, rinsing well, and blotting dry. Pressure-sensitive areas should be kept well lubricated and soft with hand cream or lotion. The patient is educated about the danger of pressure ulcers and is encouraged to take control and make decisions about appropriate skin care (King, et al., 2008). See Chapter 11 for other aspects of the prevention of pressure ulcers.

#### *Maintaining Urinary Elimination*

Immediately after SCI, the urinary bladder becomes atonic and cannot contract by reflex activity. Urinary retention is the immediate result. Because the patient has no sensation of bladder distention, overstretching of the bladder and detrusor muscle may occur, delaying the return of bladder function.

Intermittent catheterization is carried out to avoid overdistention of the bladder and UTI. If this is not feasible, an indwelling catheter is inserted temporarily. At an early stage, family members are shown how to carry out intermittent catheterization and are encouraged to participate in this facet of care, because they will be involved in long-term follow-up and must be able to recognize complications so that treatment can be instituted.

The patient is taught to record fluid intake, voiding pattern, amounts of residual urine after catheterization, characteristics of urine, and any unusual sensations that may occur. The management of a **neurogenic bladder** (bladder dysfunction that results from a disorder or dysfunction of the nervous system) is discussed in detail in Chapter 11.

#### *Improving Bowel Function*

Immediately after SCI, a paralytic ileus usually develops as a result of neurogenic paralysis of the bowel; therefore, a nasogastric tube is often required to relieve distention and to prevent vomiting and aspiration.

Bowel activity usually returns within the first week. As soon as bowel sounds are heard on auscultation, the patient is given a high-calorie, high-protein, high-fiber diet, with the amount of food gradually increased. The nurse administers prescribed stool softeners to counteract the effects of immobility and analgesic agents. A bowel program is instituted as early as possible.

#### *Providing Comfort Measures: The Patient in Halo Traction*

A patient who has had pins, tongs, or calipers placed for cervical stabilization may have a slight headache or discomfort for several days after the pins are inserted. Patients initially may be bothered by the rather startling appearance of these devices, but usually they readily adapt to it because the device provides comfort for the unstable neck (see Fig. 63-8). The patient may complain of being caged in and of noise created by any object coming in contact with the steel frame of a halo device, but he or she can be reassured that adaptation will occur.

The areas around the four pin sites of a halo device are cleaned daily and observed for redness, drainage, and pain. The pins are observed for loosening, which may contribute to infection. If one of the pins becomes detached, the head is stabilized in a neutral position by one person while another notifies the neurosurgeon. A torque screwdriver should be readily available in case the screws on the frame need tightening.

The skin under the halo vest is inspected for excessive perspiration, redness, and skin blistering, especially on the bony prominences. The vest is opened at the sides to allow the torso to be washed. The liner of the vest should not become wet, because dampness causes skin excoriation. Powder is not used inside the vest, because it may contribute to the development of pressure ulcers. The liner should be changed periodically to promote hygiene and good skin care. If the patient is to be discharged with the vest, detailed instructions must be given to the family, with time allowed for them to demonstrate the necessary skills of halo vest care (Chart 63-9).

#### *Monitoring and Managing Potential Complications*

THROMBOPHLEBITIS. Thrombophlebitis is a relatively common complication in patients after SCI. The patient must be assessed for symptoms of thrombophlebitis and PE. Chest pain, shortness of breath, and changes in arterial blood gas values must be reported promptly to the physician. The circumferences of the thighs and calves are measured and recorded daily; further diagnostic studies are performed if a significant increase is noted. Patients remain at high risk for thrombophlebitis for several months after the initial injury. Patients with paraplegia or tetraplegia are at increased risk for the rest of their lives. Immobilization and the associated venous stasis, as well as varying degrees of autonomic disruption, contribute to the high risk and susceptibility for DVT (Hickey, 2009).

Anticoagulation is initiated once head injury and other systemic injuries have been ruled out. Low-dose fractionated or unfractionated heparin may be followed by long-term oral anticoagulation (ie, warfarin) or subcutaneous fractionated heparin injections. Additional measures such as range-of-motion exercises, anti-embolism stockings, and adequate hydration are important preventive measures.

CHART 63-9

HOME CARE CHECKLIST

## *The Patient With a Halo Vest*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the rationale for use of the halo vest. | ✔ | ✔ |
| • Demonstrate assessment of frame, traction, tongs, and pins. | | ✔ |
| • Describe emergency measures if respiratory or other complications develop while patient is in halo vest or if frame becomes dislodged. | | ✔ |
| • Demonstrate pin care using correct technique. | | ✔ |
| • Identify signs and symptoms of infection. | ✔ | ✔ |
| • Assess the skin for reddened or irritated areas and breakdown. | | ✔ |
| • Demonstrate care of skin. | | ✔ |
| • Explain the reasons for and the method for changing the vest liner. | ✔ | ✔ |
| • Demonstrate safe techniques to assist patient with self-care, hygiene, and ambulation. | | ✔ |
| • Identify signs and symptoms of complications (DVT, respiratory impairment, urinary tract infection). | | ✔ |

Pneumatic compression devices may also be used to reduce venous pooling and promote venous return. It is also important to avoid external pressure on the lower extremities that may result from flexion of the knees while the patient is in bed.

**ORTHOSTATIC HYPOTENSION.** For the first 2 weeks after SCI, the blood pressure tends to be unstable and quite low. It gradually returns to preinjury levels, but periodic episodes of severe orthostatic hypotension frequently interfere with efforts to mobilize the patient. Interruption in the reflex arcs that normally produce vasoconstriction in the upright position, coupled with vasodilation and pooling in abdominal and lower extremity vessels, can result in blood pressure readings of 40 mm Hg systolic and 0 mm Hg diastolic. Orthostatic hypotension is a particularly common problem for patients with lesions above T7. In some patients with tetraplegia, even slight elevations of the head can result in dramatic decreases in blood pressure.

A number of techniques can be used to reduce the frequency of hypotensive episodes. Close monitoring of vital signs before and during position changes is essential. Vasopressor medication can be used to treat the profound vasodilation. Anti-embolism stockings should be applied to improve venous return from the lower extremities. Abdominal binders may also be used to encourage venous return and provide diaphragmatic support when the patient is upright. Activity should be planned in advance, and adequate time should be allowed for a slow progression of position changes from recumbent to sitting and upright. Tilt tables frequently are helpful in assisting patients to make this transition.

**AUTONOMIC DYSREFLEXIA.** Autonomic dysreflexia (autonomic hyperreflexia) is an acute emergency that occurs as a result of exaggerated autonomic responses to stimuli that are harmless in normal people. It occurs only after spinal shock has resolved. This syndrome is characterized by a severe, pounding headache with paroxysmal hypertension, profuse diaphoresis (most often of the forehead), nausea, nasal congestion, and bradycardia. It occurs among patients with cord lesions above T6 (the sympathetic visceral outflow level) after spinal shock has subsided. The sudden increase in blood pressure may cause a rupture of one or more cerebral blood vessels or lead to increased ICP. A number of stimuli may trigger this reflex: distended bladder (the most common cause); distention or contraction of the visceral organs, especially the bowel (from constipation, impaction); or stimulation of the skin (tactile, pain, thermal stimuli, pressure ulcer). Because this is an emergency situation, the objectives are to remove the triggering stimulus and to avoid the possibly serious complications.

The following measures are carried out:

- The patient is placed immediately in a sitting position to lower blood pressure.
- Rapid assessment is performed to identify and alleviate the cause.
- The bladder is emptied immediately via a urinary catheter. If an indwelling catheter is not patent, it is irrigated or replaced with another catheter.
- The rectum is examined for a fecal mass. If one is present, a topical anesthetic agent is inserted 10 to 15 minutes before the mass is removed, because visceral distention or contraction can cause autonomic dysreflexia.
- The skin is examined for any areas of pressure, irritation, or broken skin.
- Any other stimulus that could be the triggering event, such as an object next to the skin or a draft of cold air, must be removed.
- If these measures do not relieve the hypertension and excruciating headache, a ganglionic blocking agent (hydralazine hydrochloride [Apresoline]) is prescribed and administered slowly by the IV route.
- The medical record or chart is labeled with a clearly visible note about the risk of autonomic dysreflexia.
- The patient is instructed about prevention and management measures.
- Any patient with a lesion above the T6 segment is informed that such an episode is possible and may occur even many years after the initial injury.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** In most cases, patients with SCI (ie, patients with tetraplegia or paraplegia) need long-term rehabilitation. The process begins during hospitalization, as acute symptoms begin to subside or come under better control and the overall deficits and long-term effects of the injury become clear. The goals begin to shift from merely surviving the injury to learning strategies necessary to cope with the alterations that the injury imposes on activities of daily living (ADLs). The emphasis shifts from ensuring that the patient is stable and free of complications to specific assessment and planning designed to meet the patient's rehabilitation needs. Patient teaching may initially focus on the injury and its effects on mobility, dressing, and bowel, bladder, and sexual function. As the patient and family acknowledge the consequences of the injury and the resulting disability, the focus of teaching broadens to address issues necessary for carrying out the tasks of daily living and taking charge of their lives (Kinder, 2005). Teaching begins in the acute phase and continues throughout rehabilitation and throughout the patient's life as changes occur, the patient ages, and problems arise (Capoor & Stein, 2005).

Caring for the patient with SCI at home may at first seem a daunting task to the family. They will require dedicated nursing support to gradually assume full care of the patient. Although maintaining function and preventing complications will remain important, goals regarding self-care and preparation for discharge will assist in a smooth transition to rehabilitation and eventually to the community.

**CONTINUING CARE.** The goal of the rehabilitation process is independence. The nurse becomes a support to both the patient and the family, assisting them to assume responsibility for increasing aspects of patient care and management. Care for the patient with SCI involves members of all the health care disciplines, which may include nursing, medicine, rehabilitation, respiratory therapy, physical and occupational therapy, case management, and social services. The nurse often serves as coordinator of the management team and as a liaison with rehabilitation centers and home care agencies. The patient and family often require assistance in dealing with the psychological impact of the injury and its consequences; referral to a psychiatric clinical nurse specialist or other mental health care professional often is helpful.

The nurse should reassure female patients with SCI that pregnancy is not contraindicated and fertility is relatively unaffected, but that pregnant women with acute or chronic SCI pose unique management challenges. The normal physiologic changes of pregnancy may predispose women with SCI to many potentially life-threatening complications, including autonomic dysreflexia, pyelonephritis, respiratory insufficiency, thrombophlebitis, PE, and unattended delivery. Preconception assessment and counseling are strongly recommended to ensure that the woman is in optimal health and to increase the likelihood of an uneventful pregnancy and healthy outcomes (Smeltzer, 2007; Smeltzer & Wetzel-Effinger, 2009).

As more patients survive acute SCI, they face the changes associated with aging with a disability. Therefore, teaching in the home and community focuses on health promotion and addresses the need to minimize risk factors (eg, smoking, alcohol and drug abuse, obesity). Routine health screening and preventive services are needed for the older adult with SCI (Barker, 2008). Home care nurses and others who have contact with patients with SCI are in a position to teach patients about healthy lifestyles, remind them of the need for health screenings, and make referrals as appropriate. Assisting patients to identify accessible health care providers, clinical facilities, and imaging centers may increase the likelihood that they will participate in health screening.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Demonstrates improvement in gas exchange and clearance of secretions, as evidenced by normal breath sounds on auscultation
   a. Breathes easily without shortness of breath
   b. Performs hourly deep-breathing exercises, coughs effectively, and clears pulmonary secretions
   c. Is free of respiratory infection (ie, has normal temperature, respiratory rate, and pulse; normal breath sounds; absence of purulent sputum)
2. Moves within limits of the dysfunction and demonstrates completion of exercises within functional limitations
3. Demonstrates adaptation to sensory and perceptual alterations
   a. Uses assistive devices (eg, prism glasses, hearing aids, computers) as indicated
   b. Describes sensory and perceptual alterations as a consequence of injury
4. Demonstrates optimal skin integrity
   a. Exhibits normal skin turgor; skin is free of reddened areas or breaks
   b. Participates in skin care and monitoring procedures within functional limitations
5. Regains urinary bladder function
   a. Exhibits no signs of UTI (ie, has normal temperature; voids clear, dilute urine)
   b. Has adequate fluid intake
   c. Participates in bladder training program within functional limitations
6. Regains bowel function
   a. Reports regular pattern of bowel movement
   b. Consumes adequate dietary fiber and oral fluids
   c. Participates in bowel training program within functional limitations
7. Reports absence of pain and discomfort
8. Is free of complications
   a. Demonstrates no signs of thrombophlebitis, DVT, or PE
   b. Maintains blood pressure within normal limits
   c. Reports no lightheadedness with position changes
   d. Exhibits no manifestations of autonomic dysreflexia (ie, absence of headache, diaphoresis, nasal congestion, bradycardia, or diaphoresis)

## Medical Management of Long-Term Complications of Spinal Cord Injury

The patient faces a lifetime of disability, requiring ongoing follow-up and care. The expertise of a number of health professionals, including physicians (specifically a physiatrist), rehabilitation nurses, occupational therapists, physical therapists, psychologists, social workers, rehabilitation engineers, and vocational counselors, is necessary at different times as the need arises.

As people with SCI age, they have the same medical problems as other people. In addition, they face the threat of complications associated with their disability (Hickey, 2009). Usually, patients are encouraged to attend a spine clinic when complications and other issues arise. Lifetime care includes assessment of the urinary tract at prescribed intervals, because there is the likelihood of continuing alteration in detrusor and sphincter function, and the patient is prone to UTI.

Long-term problems and complications of SCI include premature aging, disuse syndrome, autonomic dysreflexia (discussed earlier), bladder and kidney infections, spasticity, and depression (Capoor & Stein, 2005). Pressure ulcers with potential complications of sepsis, osteomyelitis, and fistulas occur in about 10% of patients. Spasticity may be particularly disabling. Heterotopic ossification (overgrowth of bone) in the hips, knees, shoulders, and elbows occurs in many patients after SCI. Both of these complications are painful and can produce a loss of range of motion (Hickey, 2009). Management includes observing for and addressing any alteration in physiologic status and psychological outlook, as well as the prevention and treatment of long-term complications. The nursing role involves emphasizing the need for vigilance in self-assessment and care.

## NURSING PROCESS

### The Patient With Tetraplegia or Paraplegia

#### Assessment

Assessment focuses on the patient's general condition, complications, and how the patient is managing at that particular point in time. A head-to-toe assessment and review of systems should be part of the database, with emphasis on the areas that are prone to problems in this population. A thorough inspection of all areas of the skin for redness or breakdown is critical. The nurse reviews the established bowel and bladder program with the patient, because the program must continue uninterrupted. Patients with tetraplegia or paraplegia have varying degrees of loss of motor power, deep and superficial sensation, vasomotor control, bladder and bowel control, and sexual function. They are faced with potential complications related to immobility, skin breakdown and pressure ulcers, recurring UTIs, and contractures. Knowledge about these particular issues can further guide the assessment in any setting. Nurses in all settings, including home care, must be aware of these potential complications in the lifetime management of these patients.

An understanding of the emotional and psychological responses to tetraplegia or paraplegia is achieved by observing the responses and behaviors of the patient and family and by listening to their concerns. Documenting these assessments and reviewing the plan with the entire team on a regular basis provide insight into how both the patient and the family are coping with the changes in lifestyle and body functioning. Additional information frequently can be gathered from the social worker or psychiatric/mental health worker.

It takes time for the patient and family to comprehend the magnitude of the disability. They may go through stages of grief, including shock, disbelief, denial, anger, depression, and acceptance. During the acute phase of the injury, denial can be a protective mechanism to shield the patient from the overwhelming reality of what has happened. As the patient realizes the permanent nature of paraplegia or tetraplegia, the grieving process may be prolonged and all-encompassing because of the recognition that long-held plans and expectations are interrupted or permanently altered. A period of depression often follows as the patient experiences a loss of self-esteem in areas of self-identity, sexual functioning, and social and emotional roles. Exploration and assessment of these issues can assist in developing a meaningful plan of care.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, the major nursing diagnoses of the patient with tetraplegia or paraplegia may include the following:

- Impaired bed and physical mobility related to loss of motor function
- Risk for disuse syndrome
- Risk for impaired skin integrity related to permanent sensory loss and immobility
- Impaired urinary elimination related to level of injury
- Constipation related to effects of spinal cord disruption
- Sexual dysfunction related to neurologic dysfunction
- Ineffective coping related to impact of disability on daily living
- Deficient knowledge about requirements for long-term management

##### *Collaborative Problems/Potential Complications*

Based on all the assessment data, potential complications of tetraplegia or paraplegia that may develop include:

- Spasticity
- Infection and sepsis

#### Planning and Goals

The goals for the patient may include attainment of some form of mobility; maintenance of healthy, intact skin; achievement of bladder management without infection; achievement of bowel control; achievement of sexual expression; strengthening of coping mechanisms; and absence of complications.

#### Nursing Interventions

The patient requires extensive rehabilitation, which is less difficult if appropriate nursing management has been

carried out during the acute phase of the injury or illness. Nursing care is one of the key factors determining the success of the rehabilitation program. The main objective is for the patient to live as independently as possible in the home and community.

### *Increasing Mobility*

**EXERCISE PROGRAMS.** The unaffected parts of the body are built up to optimal strength to promote maximal self-care. The muscles of the hands, arms, shoulders, chest, spine, abdomen, and neck must be strengthened in the patient with paraplegia, because he or she must bear full weight on these muscles to ambulate. The triceps and the latissimus dorsi are important muscles used in crutch walking. The muscles of the abdomen and the back also are necessary for balance and for maintaining the upright position.

To strengthen these muscles, the patient can do push-ups when in a prone position and sit-ups when in a sitting position. Extending the arms while holding weights (traction weights can be used) also develops muscle strength. Squeezing rubber balls or crumbling newspaper promotes hand strength.

With encouragement from all members of the rehabilitation team, the patient with paraplegia can develop the increased exercise tolerance needed for gait training and ambulation activities. The importance of maintaining cardiovascular fitness is stressed to the patient. Alternative exercises to increase the heart rate to target levels must be designed within the patient's abilities.

**MOBILIZATION.** After the spine is stable enough to allow the patient to assume an upright posture, mobilization activities are initiated. A brace or vest may be used, depending on the level of the lesion. A patient whose paralysis is a result of complete transection of the cord can begin weight bearing early, because no further damage can be incurred. The sooner muscles are used, the less chance there is of disuse atrophy. The earlier the patient is brought to a standing position, the less opportunity there is for osteoporotic changes to take place in the long bones. Weight bearing also reduces the possibility of renal calculi and enhances many other metabolic processes.

Braces and crutches enable some patients with paraplegia to ambulate for short distances. Ambulation using crutches requires a high expenditure of energy. Motorized wheelchairs and specially equipped vans can provide greater independence and mobility for patients with high-level SCI or other lesions. Every effort should be made to encourage the patient to be as mobile and active as possible.

### *Preventing Disuse Syndrome*

Patients are at high risk for development of contractures as a result of disuse syndrome due to the musculoskeletal system changes (atrophy) brought about by the loss of motor and sensory functions below the level of injury. Range-of-motion exercises must be provided at least four times a day, and care is taken to stretch the Achilles tendon with exercises. The patient is repositioned frequently and is maintained in proper body alignment whether in bed or in a wheelchair.

Contractures can complicate day-to-day care, increasing the difficulty of positioning and decreasing mobility. A number of surgical procedures have been tried with varying degrees of success. These techniques are used if more conservative approaches fail, but the best treatment is prevention.

### *Promoting Skin Integrity*

Because these patients spend a great portion of their lives in wheelchairs, pressure ulcers are an ever-present threat. Contributing factors are permanent sensory loss over pressure areas; immobility, which makes relief of pressure difficult; trauma from bumps (against the wheelchair, toilet, furniture, and so forth) that cause unnoticed abrasions and wounds; loss of protective function of the skin from excoriation and maceration due to excessive perspiration and possible incontinence; and poor general health (anemia, edema, malnutrition), leading to poor tissue perfusion. The prevention and management of pressure ulcers are discussed in detail in Chapter 11.

The person with tetraplegia or paraplegia must take responsibility for monitoring (or directing monitoring) of his or her skin status. This involves relieving pressure and not remaining in any position for longer than 2 hours, in addition to ensuring that the skin receives meticulous attention and cleansing. The patient is taught that ulcers develop over bony prominences that are exposed to unrelieved pressure in the lying and sitting positions. The most vulnerable areas are identified. The patient with paraplegia is instructed to use mirrors, if possible, to inspect these areas morning and night, observing for redness, slight edema, or any abrasions. While in bed, the patient should turn at 2-hour intervals and then inspect the skin again for redness that does not fade on pressure. The bottom sheet should be checked for wetness and for creases. The patient with tetraplegia or paraplegia who cannot perform these activities is encouraged to direct others to check these areas and prevent ulcers from developing.

The patient is taught to relieve pressure while in the wheelchair by doing push-ups, leaning from side to side to relieve ischial pressure, and tilting forward while leaning on a table. The caregiver for the patient with tetraplegia will need to perform these activities if the patient cannot do so independently. A wheelchair cushion is prescribed to meet individual needs, which may change in time with changes in posture, weight, and skin tolerance. A referral can be made to a rehabilitation engineer, who can measure pressure levels while the patient is sitting and then tailor the cushion and other necessary aids and assistive devices to the patient's needs.

The diet for the patient with tetraplegia or paraplegia should be high in protein, vitamins, and calories to ensure minimal wasting of muscle and the maintenance of healthy skin, and high in fluids to maintain well-functioning kidneys. Excessive weight gain and obesity should be avoided, because they further limit mobility.

### *Improving Bladder Management*

The effect of the spinal cord lesion on the bladder depends on the level of injury, the degree of cord damage, and the length of time after injury. A patient with tetraplegia or

paraplegia usually has either a reflex or a nonreflex bladder (see Chapter 11). Both bladder types increase the risk of UTI.

The nurse emphasizes the importance of maintaining an adequate flow of urine by encouraging a fluid intake of about 2.5 L daily. The patient should empty the bladder frequently so that there is minimal residual urine and should pay attention to personal hygiene, because infection of the bladder and kidneys almost always occurs by the ascending route. The perineum must be kept clean and dry, and attention must be given to the perianal skin after defecation. Underwear should be cotton (which is more absorbent) and should be changed at least once a day.

If an external catheter (condom catheter) is used, the sheath is removed nightly; the penis is cleansed to remove urine and is dried carefully, because warm urine on the periurethral skin promotes the growth of bacteria. Attention also is given to the collection bag. The nurse emphasizes the importance of monitoring for signs of UTI: cloudy, foul-smelling urine or hematuria (blood in the urine); fever; or chills.

The female patient who cannot achieve reflex bladder control or self-catheterization may need to wear pads or waterproof undergarments. Surgical intervention may be indicated in some patients to create a urinary diversion.

#### *Establishing Bowel Control*

The objective of a bowel training program is to establish bowel evacuation through reflex conditioning, a technique described in Chapter 11. If the SCI occurs above the sacral segments or nerve roots and there is reflex activity, the anal sphincter may be massaged (digital stimulation) to stimulate defecation. If the cord lesion involves the sacral segment or nerve roots, anal massage is not performed, because the anus may be relaxed and lack tone. Massage is also contraindicated if there is spasticity of the anal sphincter. The anal sphincter is massaged by inserting a gloved finger (which has been adequately lubricated) 2.5 to 3.7 cm (1 to 1.5 inches) into the rectum and moving it in a circular motion or from side to side. It soon becomes apparent which area triggers the defecation response. This procedure should be performed at regular time intervals (usually every 48 hours), after a meal, and at a time that will be convenient for the patient at home. The patient also is taught the symptoms of impaction (frequent loose stools; constipation) and is cautioned to watch for hemorrhoids. A diet with sufficient fluids and fiber is essential to developing a successful bowel training program, avoiding constipation, and decreasing the risk of autonomic dysreflexia.

#### *Counseling on Sexual Expression*

Many patients with tetraplegia and paraplegia can have some form of meaningful sexual relationship, although modifications are necessary. The patient and partner benefit from counseling about the range of sexual expression possible, special techniques and positions, exploration of body sensations offering sensual feelings, and urinary and bowel hygiene as related to sexual activity. For men with erectile failure, penile prostheses enable them to have and sustain an erection, and impotence drugs may be helpful. Sildenafil (Viagra), vardenafil (Levitra), and tadalafil (Cialis), for example, are oral smooth muscle relaxants that cause blood to flow into the penis, resulting in an erection (see Chapter 49).

Sexual education and counseling services are included in the rehabilitation services at spinal centers. Small-group meetings in which patients can share their feelings, receive information, and discuss sexual concerns and practical aspects are helpful in producing effective attitudes and adjustments.

#### *Enhancing Coping Mechanisms*

The impact of the disability and loss becomes marked when the patient returns home. Each time something new enters the patient's life (eg, a new relationship, going to work), the patient is reminded anew of his or her limitations. Grief reactions and depression are common.

To work through this depression, the patient must have some hope for relief in the future. The nurse can encourage the patient to feel confident in his or her ability to achieve self-care and relative independence. The role of the nurse ranges from caretaker during the acute phase to teacher, counselor, and facilitator as the patient gains mobility and independence.

The patient's disability affects not only the patient but also the entire family. In many cases, family therapy is helpful in working through issues as they arise. Adjustment to the disability leads to the development of realistic goals for the future, making the best of the abilities that are left intact and reinvesting in other activities and relationships. Rejection of the disability causes self-destructive neglect and noncompliance with the therapeutic program, which leads to more frustration and depression. Crises for which interventions may be sought include social, psychological, marital, sexual, and psychiatric problems. The family usually requires counseling, social services, and other support systems to help them cope with the changes in their lifestyle and socioeconomic status.

A major goal of nursing management is to help the patient overcome his or her sense of futility and to encourage the patient in the emotional adjustment that must be made before he or she is willing to venture into the outside world. However, an excessively sympathetic attitude on the part of the nurse may cause the patient to develop an overdependence that defeats the purpose of the entire rehabilitation program. The patient is taught and assisted when necessary, but the nurse should avoid performing activities that the patient can do independently with a little effort. This approach to care more than repays itself in the satisfaction of seeing a completely demoralized and helpless patient become independent and find meaning in a newly emerging lifestyle.

#### *Monitoring and Managing Potential Complications*

SPASTICITY. Muscle spasticity is one of the most problematic complications of tetraplegia and paraplegia. These incapacitating flexor or extensor spasms, which occur below the level of the spinal cord lesion, interfere with both the rehabilitation process and ADLs. Spasticity results from an imbalance between the facilitatory and inhibitory effects on neurons that exist normally. The area of the cord distal to the site of injury or lesion becomes disconnected from the higher inhibitory centers located in the brain, so facilitatory impulses, which originate from muscles, skin, and ligaments, predominate.

Spasticity is defined as a condition of increased muscle tone in a muscle that is weak. Initial resistance to stretching is quickly followed by sudden relaxation. The stimulus that precipitates spasm can be obvious, such as movement or a position change, or subtle, such as a slight jarring of the wheelchair. Most patients with tetraplegia or paraplegia have some degree of spasticity. With SCI, the onset of spasticity usually occurs from a few weeks to 6 months after the injury. The same muscles that are flaccid during the period of spinal shock develop spasticity during recovery. The intensity of spasticity tends to peak approximately 2 years after the injury, after which the spasms tend to regress.

Management of spasticity is based on the severity of symptoms and the degree of incapacitation. The antispasmodic medication baclofen (Lioresal) is one of the most commonly used agents because it is available in an oral and an intrathecal form. Other medications such as diazepam (Valium) and dantrolene (Dantrium) are also effective in controlling spasm (Saulino & Jacobs, 2006). All of the antispasmodic medications cause drowsiness, weakness, and vertigo in some patients. Passive range-of-motion exercises and frequent turning and repositioning are helpful, because stiffness tends to increase spasticity. These activities also are essential in the prevention of contractures, pressure ulcers, and bowel and bladder dysfunction.

**INFECTION AND SEPSIS.** Patients with tetraplegia and paraplegia are at increased risk for infection and sepsis from a variety of sources: urinary tract, respiratory tract, and pressure ulcers. Sepsis remains a major cause of complications and death in these patients. Prevention of infection and sepsis is essential through maintenance of skin integrity, complete emptying of the bladder at regular intervals, and prevention of urinary and fecal incontinence. The risk for respiratory infection can be decreased by avoiding contact with people who have symptoms of respiratory infection, performing coughing and deep-breathing exercises to prevent pooling of respiratory secretions, receiving yearly influenza vaccines, and giving up smoking. A high-protein diet is important in maintaining an adequate immune system, as is avoiding factors that may reduce immune system function, such as excessive stress, drug abuse, and excessive alcohol intake.

If infection occurs, the patient requires thorough assessment and prompt treatment. Antibiotic therapy and adequate hydration, in addition to local measures (depending on the site of infection), are initiated immediately.

UTIs are minimized or prevented by aseptic technique in catheter management, adequate hydration, bladder training program, and prevention of overdistention of the bladder and urinary stasis.

Skin breakdown and infection are prevented by maintenance of a turning schedule; frequent back care; regular assessment of all skin areas; regular cleaning and lubrication of the skin; passive range-of-motion exercise to prevent contractures; pressure relief over broken skin areas, bony prominences, and heels; and wrinkle-free bed linen.

Pulmonary infections are managed and prevented by frequent coughing, turning, and deep-breathing exercises and chest physiotherapy; aggressive respiratory care and suctioning of the airway if a tracheostomy is present; assisted coughing as needed; and adequate hydration.

Infections of any kind can be life-threatening. Aggressive nursing interventions are key to prevention, detection, and early management.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients with tetraplegia or paraplegia are at risk for complications for the rest of their lives. Therefore, a major aspect of nursing care is teaching the patient and family about these complications and about strategies to minimize risks. UTIs, contractures, infected pressure ulcers, and sepsis may necessitate hospitalization. Other late complications that may occur include lower extremity edema, joint contractures, respiratory dysfunction, and pain. To avoid these and other complications, the patient and a family member are taught skin care, catheter care, range-of-motion exercises, breathing exercises, and other care techniques. Teaching is initiated as soon as possible and extends into the rehabilitation or long-term care facility and home. In all aspects of care, it is important for the nurse and patient to set mutual goals and discuss the tasks the patient is capable of doing independently and which tasks the patient needs assistance to complete. (See Chapter 11 for a more detailed discussion of rehabilitation.)

**CONTINUING CARE.** Referral for home care is often appropriate for assessment of the home setting, patient teaching, and evaluation of the patient's physical and emotional status. During visits by the home care nurse, teaching about strategies to prevent or minimize potential complications is reinforced. The home environment is assessed for adequacy for care and for safety. Environmental modifications are made, and specialized equipment is obtained, ideally before the patient goes home.

The home care nurse also assesses the patient's and the family's adherence to recommendations and their use of coping strategies. The use of inappropriate coping strategies (eg, drug and alcohol use) is assessed, and referrals to counseling are made for the patient and family. Appropriate and effective coping strategies are reinforced. The nurse reviews previous teaching and determines the need for further physical or psychological assistance. The patient's self-esteem and body image may be very poor at this time. Because people with high levels of social support often report feelings of well-being despite major physical disability, it is beneficial for the nurse to assess and promote further development of the support system and effective coping strategies for each patient.

The patient requires continuing, lifelong follow-up by the physician, physical therapist, and other rehabilitation team members, because the neurologic deficit is usually permanent and new deficits, complications, and secondary conditions can develop. These require prompt attention before they take their toll in additional physical impairment, time, morale, and financial costs. The local counselor for the Office of Vocational Rehabilitation works with the patient with respect to job placement or additional educational or vocational training.

The nurse is in a good position to remind patients and family members of the need for continuing health promotion and screening practices. Referral to accessible health care providers and imaging centers is important in health

promotion and health screening. Chapter 10 has more information on chronic illness and disability.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Attains some form of mobility
2. Contractures do not develop
3. Maintains healthy, intact skin
4. Achieves bladder control, absence of UTI
5. Achieves bowel control
6. Reports sexual satisfaction
7. Shows improved adaptation to environment and others
8. Exhibits reduction in spasticity
   a. Reports understanding of the precipitating factors
   b. Uses measures to reduce spasticity
9. Describes long-term management required
10. Exhibits absence of complications

## CRITICAL THINKING EXERCISES

**1** A 75-year-old man is brought to the emergency department by his family, who report that he fell approximately 2 weeks ago in the bathroom. The patient does not recall the event. His family states that he is sleeping more than usual and seems forgetful. The patient is prescribed warfarin (Coumadin) daily. What type of injury has he most likely sustained? What type of medical treatment might he undergo? What discharge instructions are warranted for this patient's family or caregiver?

**2** A 19-year-old man with a spinal cord injury at the T6 level complains of a severe headache. He is diaphoretic and flushed above the level of injury. His blood pressure is 230/110 mm Hg. What do you suspect is happening? What are the possible causes of his condition, and how would you intervene? What is included in your teaching plan for the patient and family before discharge?

EBP **3** A 56-year-old man who is married and the father of two children was involved in a motor vehicle crash 2 days ago, and he sustained a C4 fracture with spinal cord injury. As a result, he has tetraplegia and is on a mechanical ventilator in a neurologic intensive care unit. What recommendations would you make for the care of this patient to prevent secondary injury? What is the evidence base for these recommendations? Identify the criteria used to evaluate the strength of the evidence for these practices.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicate classic reference.*

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## RESOURCES

American Association of Neuroscience Nurses (AANN), www.aann.org
American Association of Spinal Cord Injury Nurses (AASCIN), www.aascin.org
Association of Rehabilitation Nurses, www.rehabnurse.org
Brain Trauma Foundation, www.braintrauma.org
Centers for Disease Control and Prevention, http://www.cdc.gov
Information Center for Individuals with Disabilities, www.disability.net
National Spinal Cord Injury Association, www.spinalcord.org
Paralyzed Veterans of America, www.pva.org
Waiting.com, www.waiting.com




# Management of Patients With Neurologic Infections, Autoimmune Disorders, and Neuropathies

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Differentiate among the infectious disorders of the nervous system according to causes, manifestations, medical care, and nursing management.
2. Describe the pathophysiology, clinical manifestations, and medical and nursing management of multiple sclerosis, myasthenia gravis, and Guillain-Barré syndrome.
3. Use the nursing process as a framework for care of patients with multiple sclerosis and Guillain-Barré syndrome.
4. Describe disorders of the cranial nerves, their manifestations, and indicated nursing interventions.
5. Develop a plan of nursing care for the patient with a cranial nerve disorder.

## GLOSSARY

**ataxia:** impaired coordination of movements

**bulbar paralysis:** immobility of muscles innervated by cranial nerves with their cell bodies in the lower portion of the brain stem

**diplopia:** double vision, or the awareness of two images of the same object occurring in one or both eyes

**dyskinesia:** impaired ability to execute voluntary movements

**dysphagia:** difficulty swallowing, causing the patient to be at risk for aspiration

**dysphonia:** voice impairment or altered voice production

**neuropathy:** general term indicating a disorder of the nervous system

**paresthesia:** a sensation of numbness or tingling or a "pins and needles" sensation

**prion:** a particle smaller than a virus that is resistant to standard sterilization procedures

**spasticity:** muscular hypertonicity with increased resistance to stretch often associated with weakness, increased deep tendon reflexes, and diminished superficial reflexes

**spongiform:** having the appearance or quality of a sponge

The diverse group of neurologic disorders that make up infectious and autoimmune disorders and cranial and peripheral neuropathies presents unique challenges for nursing care. The nurse who cares for patients with these disorders must have a clear understanding of the pathologic processes and the clinical outcomes. Some of the issues nurses must help patients and families confront include adaptation to the effects of the disease, potential changes in family dynamics, and, possibly, end-of-life issues.

# INFECTIOUS NEUROLOGIC DISORDERS

The infectious disorders of the nervous system include meningitis, brain abscesses, various types of encephalitis, and Creutzfeldt-Jakob and variant Creutzfeldt-Jakob disease. The clinical manifestations, assessment, and diagnostic findings as well as the medical and nursing management are related to the specific infectious process.

## *Meningitis*

Meningitis is an inflammation of the lining around the brain and spinal cord caused by bacteria or viruses (Igulden, 2006). Meningitis can be the primary reason a patient is hospitalized or can develop during hospitalization and is classified as septic or aseptic. Septic meningitis is caused by bacteria. In aseptic meningitis, the cause is viral or secondary to lymphoma, leukemia, or human immunodeficiency virus (HIV). The bacteria *Streptococcus pneumoniae* and *Neisseria meningitides* are responsible for 80% of cases of meningitis in adults (van de Beek, de Gans, Tunkel, et al., 2006). *Haemophilus influenzae* was once a common cause of meningitis in children, but, because of vaccination, infection with this organism is now rare in developed countries (Mazzoni, Pearson & Rowland, 2006).

Outbreaks of *N. meningitidis* infection are most likely to occur in dense community groups, such as college campuses and military installations. Although infections occur year round, the peak incidence is in the winter and early spring. Factors that increase the risk of bacterial meningitis include tobacco use and viral upper respiratory infection, because they increase the amount of droplet production. Otitis media and mastoiditis increase the risk of bacterial meningitis, because the bacteria can cross the epithelial membrane and enter the subarachnoid space. People with immune system deficiencies are also at greater risk for development of bacterial meningitis.

### Pathophysiology

Meningeal infections generally originate in one of two ways: through the bloodstream as a consequence of other infections or by direct spread, such as might occur after a traumatic injury to the facial bones or secondary to invasive procedures.

*N. meningitidis* concentrates in the nasopharynx and is transmitted by secretion or aerosol contamination. Bacterial or meningococcal meningitis also occurs as an opportunistic infection in patients with acquired immunodeficiency syndrome (AIDS) and as a complication of Lyme disease (Chart 64-1).

Once the causative organism enters the bloodstream, it crosses the blood–brain barrier and proliferates in the cerebrospinal fluid (CSF). The host immune response stimulates the release of cell wall fragments and lipopolysaccharides, facilitating inflammation of the subarachnoid and pia mater. Because the cranial vault contains little room for

**Chart 64-1 • *Meningitis in Specific Populations***

Meningitis can occur as a complication of other diseases and is an opportunistic infection seen with greater frequency in patients who are immunocompromised.

**Meningitis in Patients with Acquired Immunodeficiency Syndrome (AIDS)**

- Aseptic, cryptococcal, and tuberculous forms of meningitis have been reported in patients with AIDS.
- Acute and chronic forms of aseptic meningitis may occur with AIDS; both are accompanied by headache, but signs of meningeal irritation usually occur with the acute form.
- Aseptic meningitis may be accompanied by cranial nerve palsies. The meningitis is thought to be related to direct infection of the central nervous system by human immunodeficiency virus (HIV) because it can be isolated from the cerebrospinal fluid (CSF).
- Cryptococcal meningitis is the most common fungal infection of the central nervous system in patients with AIDS. Patients may experience headache, nausea, vomiting, seizures, confusion, and lethargy. Treatment consists of IV administration of amphotericin B followed by fluconazole. Maintenance therapy with fluconazole may be necessary to prevent relapse.
- Some immunosuppressed patients develop few if any symptoms because of blunted inflammatory responses; others develop atypical features.

**Meningitis in Patients with Lyme Disease**

- Lyme disease is a multisystem inflammatory process caused by the tick-transmitted spirochete *Borrelia burgdorferi.*
- Neurologic abnormalities are seen in later stages (stages 2 or 3). Stage 2 occurs with the start of a characteristic rash or 1 to 6 months after the rash has disappeared.
- Neurologic abnormalities include aseptic meningitis, chronic lymphocytic meningitis, and encephalitis.
- Cranial nerve inflammation, including Bell's palsy and other peripheral neuropathies, is common.
- Stage 3 (the chronic form of the disease) begins years after the initial tick infection and is characterized by arthritis, skin lesions, and neurologic abnormalities.
- Most patients with stage 2 and 3 Lyme disease are treated with IV antibiotics, usually ceftriaxone or penicillin G.
- Meningeal and systemic symptoms begin to improve within days, although other symptoms, such as headache, may persist for weeks.

expansion, the inflammation may cause increased intracranial pressure (ICP). CSF circulates through the subarachnoid space, where inflammatory cellular materials from the affected meningeal tissue enter and accumulate.

The prognosis for bacterial meningitis depends on the causative organism, the severity of the infection and illness, and the timeliness of treatment. Acute fulminant presentation may include adrenal damage, circulatory collapse, and widespread hemorrhages (Waterhouse-Friderichsen syndrome). This syndrome is the result of endothelial damage and vascular necrosis caused by the bacteria. Complications include visual impairment, deafness, seizures, paralysis, hydrocephalus, and septic shock.

## Clinical Manifestations

Headache and fever are frequently the initial symptoms. Fever tends to remain high throughout the course of the illness. The headache is usually either steady or throbbing and very severe as a result of meningeal irritation (Bickley, 2007). Meningeal irritation results in a number of other well-recognized signs common to all types of meningitis:

- Neck mobility: A stiff and painful neck (nuchal rigidity) can be an early sign and any attempts at flexion of the head are difficult because of spasms in the muscles of the neck. Normally the neck is supple, and the patient can easily bend the head and neck forward.
- Positive Kernig's sign: When the patient is lying with the thigh flexed on the abdomen, the leg cannot be completely extended (Fig. 64-1).
- Positive Brudzinski's sign: When the patient's neck is flexed (after ruling out cervical trauma or injury), flexion of the knees and hips is produced; when the lower extremity of one side is passively flexed, a similar movement is seen in the opposite extremity (see Fig. 64-1). Brudzinski's sign is a more sensitive indicator of meningeal irritation than Kernig's sign.
- Photophobia (extreme sensitivity to light): This finding is common, although the cause is unclear.

A rash can be a striking feature of *N. meningitidis* infection, occurring in about half of patients with this type of meningitis. Skin lesions develop, ranging from a petechial rash with purpuric lesions to large areas of ecchymosis.

Disorientation and memory impairment are common early in the course of the illness. The changes depend on the severity of the infection as well as the individual response to the physiologic processes. Behavioral manifestations are also common. As the illness progresses, lethargy, unresponsiveness, and coma may develop.

Seizures can occur and are the result of areas of irritability in the brain. ICP increases secondary to diffuse brain swelling or hydrocephalus (van de Beek, et al., 2006). The initial signs of increased ICP include decreased level of consciousness and focal motor deficits. If ICP is not controlled, the uncus of the temporal lobe may herniate through the tentorium, causing pressure on the brain stem. Brain stem herniation is a life-threatening event that causes cranial nerve dysfunction and depresses the centers of vital functions, such as the medulla. See Chapter 61 for discussion of the patient with a change in level of consciousness (LOC) or increased ICP.

An acute fulminant infection occurs in about 10% of patients with meningococcal meningitis, producing signs of overwhelming septicemia: an abrupt onset of high fever, extensive purpuric lesions (over the face and extremities), shock, and signs of disseminated intravascular coagulation (DIC). Death may occur within a few hours after onset of the infection.

## Assessment and Diagnostic Findings

If the clinical presentation suggests meningitis, diagnostic testing is conducted to identify the causative organism. A computed tomography (CT) scan or magnetic resonance imaging (MRI) scan is used to detect a shift in brain contents (which may lead to herniation) prior to a lumbar puncture. Bacterial culture and Gram staining of CSF and blood are key diagnostic tests. CSF studies demonstrate low glucose, high protein levels, and high white blood cell count (Mazzoni, et al., 2006). Gram staining allows for rapid identification of the causative bacteria and initiation of appropriate antibiotic therapy (van de Beek, et al., 2006).

Researchers have developed a bedside risk score for use in adults with bacterial meningitis. Risks for an unfavorable outcome include older age, a heart rate of greater than 120 bpm, low Glasgow Coma score, cranial nerve palsies, and a positive Gram stain 1 hour after presentation to the hospital (Weisfelt, van de Beek, Spanjaard, et al., 2007).

## Prevention

The Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention (CDC) (2008) recommends that the meningococcal conjugated vaccine be given to adolescents entering high school and to college freshmen living in dormitories. Freshmen living in dormitories have a three times greater risk of developing meningococcal meningitis as compared with the general population and students living off campus. Most states mandate education addressing meningococcal meningitis

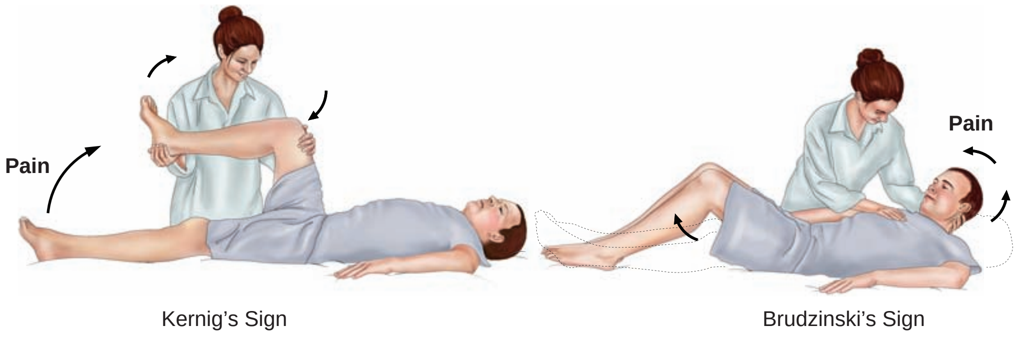



**Figure 64-1** Testing for meningeal irritation. **A,** Kernig's sign. **B,** Brudzinski's sign.

and the availability of vaccination so that families can make informed decisions.

People in close contact with patients with meningococcal meningitis should be treated with antimicrobial chemoprophylaxis using rifampin (Rifadin), ciprofloxacin hydrochloride (Cipro), or ceftriaxone sodium (Rocephin). Therapy should be started within 24 hours after exposure because a delay in the initiation of therapy limits the effectiveness of the prophylaxis. Vaccination should also be considered as an adjunct to antibiotic chemoprophylaxis for anyone living with a person who develops meningococcal infection. Vaccination against *H. influenzae* and *S. pneumoniae* should be encouraged for children and at-risk adults (Matthews, Miller & Mott, 2007).

### Medical Management

Successful outcomes depend on the early administration of an antibiotic that crosses the blood–brain barrier into the subarachnoid space in sufficient concentration to halt the multiplication of bacteria. Vancomycin hydrochloride in combination with one of the cephalosporins (eg, ceftriaxone sodium, cefotaxime sodium) is administered intravenously (IV) (van de Beek, et al., 2006).

Dexamethasone (Decadron) has been shown to be beneficial as adjunct therapy in the treatment of acute bacterial meningitis and in pneumococcal meningitis if it is administered 15 to 20 minutes before the first dose of antibiotic and every 6 hours for the next 4 days. Studies indicate that dexamethasone improves the outcome in adults and does not increase the risk of gastrointestinal bleeding (van de Beek, et al., 2006).

Dehydration and shock are treated with fluid volume expanders. Seizures, which may occur early in the course of the disease, are controlled with phenytoin (Dilantin). Increased ICP is treated as necessary (see Chapter 61).

### Nursing Management

The patient with meningitis is critically ill; therefore, many of the nursing interventions are collaborative with the physician, respiratory therapist, and other members of the health care team. The patient's safety and well-being depend on sound nursing judgment.

Neurologic status and vital signs are continually assessed. Pulse oximetry and arterial blood gas values are used to quickly identify the need for respiratory support if increasing ICP compromises the brain stem. Insertion of a cuffed endotracheal tube (or tracheotomy) and mechanical ventilation may be necessary to maintain adequate tissue oxygenation.

Blood pressure (usually monitored using an arterial line) is assessed for incipient shock, which precedes cardiac or respiratory failure. Rapid IV fluid replacement may be prescribed, but care is taken to prevent fluid overload. Fever also increases the workload of the heart and cerebral metabolism. ICP will increase in response to increased cerebral metabolic demands. Therefore, measures are taken to reduce body temperature as quickly as possible.

Other important components of nursing care include the following measures:

- Protecting the patient from injury secondary to seizure activity or altered LOC
- Monitoring daily body weight; serum electrolytes; and urine volume, specific gravity, and osmolality, especially if syndrome of inappropriate antidiuretic hormone (SIADH) is suspected
- Preventing complications associated with immobility, such as pressure ulcers and pneumonia
- Instituting infection control precautions until 24 hours after initiation of antibiotic therapy (oral and nasal discharge is considered infectious)

Any sudden, critical illness can be devastating to the family. Because the patient's condition is often critical and the prognosis guarded, the family needs to be informed about the patient's condition. Periodic family visits are essential to facilitate coping of the patient and family. An important aspect of the nurse's role is to support the family and assist them in identifying others who can be supportive to them during the crisis.

## Brain Abscess

Brain abscesses account for less than 2% of space-occupying brain lesions in the United States and are more common in males during the first two decades of life (Mazzoni, et al., 2006). Brain abscesses are rare in immunocompetent people; they are more frequently diagnosed in people who are immunosuppressed as a result of an underlying disease or use of immunosuppressive mediations.

### Pathophysiology

A brain abscess is a collection of infectious material within the tissue of the brain. Bacteria are the most common causative organisms. The most common predisposing conditions for abscesses among immunocompetent adults are otitis media and rhinosinusitis. An abscess can result from intracranial surgery, penetrating head injury, or tongue piercing. Organisms causing brain abscess may reach the brain by hematologic spread from the lungs, gums, tongue, or heart, or from a wound or intra-abdominal infection (Mazzoni, et al., 2006). Brain abscesses in immunocompromised people may result from various pathogens. To prevent brain abscess, otitis media, mastoiditis, rhinosinusitis, dental infections, and systemic infections should be treated promptly.

### Clinical Manifestations

The clinical manifestations of a brain abscess result from alterations in intracranial dynamics (edema, brain shift), infection, or the location of the abscess (Chart 64-2).

Headache, usually worse in the morning, is the most prevailing symptom. Fever, vomiting, and focal neurologic deficits occur as well. Focal deficits such as weakness and decreasing vision reflect the area of brain that is involved. As the abscess expands, symptoms of increased ICP such as decreasing LOC and seizures are observed.

### Assessment and Diagnostic Findings

Neuroimaging studies such as MRI or CT scanning identify the size and location of the abscess. The MRI or CT scans reveal a ring around a hypodense area (Mazzoni, et al., 2006). Aspiration of the abscess, guided by CT or MRI, is

CHART 64-2 **Assessing for Brain Abscesses**

Be alert for the following signs and symptoms:

**Frontal Lobe**

Hemiparesis
Aphasia (expressive)
Seizures
Frontal headache

**Temporal Lobe**

Localized headache
Changes in vision
Facial weakness
Aphasia

**Cerebellar Abscess**

Occipital headache
Ataxia (inability to coordinate movements)
Nystagmus (rhythmic, involuntary movements of the eye)

the best method to culture and identify the infectious organism. Blood cultures are obtained if the abscess is believed to arise from a distant source. Chest x-ray is performed to rule out predisposing lung infections and an electroencephalogram (EEG) may help localize the lesion (Hickey, 2009).

### Medical Management

Treatment is aimed at controlling increased ICP, draining the abscess, and providing antimicrobial therapy directed at the abscess and the primary source of infection. Large IV doses of antibiotics are administered to penetrate the blood–brain barrier and reach the abscess. The choice of the specific antibiotic medication is based on culture and sensitivity testing and directed at the causative organism. A stereotactic CT-guided aspiration may be used to drain the abscess and identify the causative organism. Corticosteroids may be prescribed to help reduce the inflammatory cerebral edema if the patient shows evidence of an increasing neurologic deficit. Antiseizure medications (phenytoin, phenobarbital) may be prescribed to prevent or treat seizures.

### Nursing Management

Nursing care focuses on continuing to assess the neurologic status, administering medications, assessing the response to treatment, and providing supportive care.

Ongoing neurologic assessment alerts the nurse to changes in ICP, which may indicate a need for more aggressive intervention. The nurse also assesses and documents the responses to medications. Blood laboratory test results, specifically blood glucose and serum potassium levels, need to be closely monitored when corticosteroids are prescribed. Administration of insulin or electrolyte replacement may be required to return these values to normal or acceptable levels.

Patient safety is another key nursing responsibility. Injury may result from decreased LOC or falls related to motor weakness or seizures (Hughes, 2008).

The patient with a brain abscess is very ill, and neurologic deficits, such as hemiparesis, seizures, visual deficits, and cranial nerve palsies, may remain after treatment. Seizures are common sequelae. The nurse must assess the family's ability to express distress at the patient's condition, cope with the patient's illness and deficits, and obtain support.

## Herpes Simplex Virus Encephalitis

Encephalitis is an acute inflammatory process of the brain tissue. Herpes simplex virus (HSV) is the most common cause of acute encephalitis in the United States (Mazzoni, et al., 2006). There are two herpes simplex viruses: HSV-1 and HSV-2. HSV-1 typically affects children and adults. HSV-2 most commonly affects neonates and is discussed in pediatric textbooks.

### Pathophysiology

The pathology of encephalitis involves local necrotizing hemorrhage that becomes more generalized, followed by edema. There is also progressive deterioration of nerve cell bodies (Porth & Matfin, 2009).

### Clinical Manifestations

The initial symptoms of HSV-1 encephalitis include fever, headache, and confusion. Focal neurologic symptoms reflect the areas of cerebral inflammation and necrosis and include fever, headache, behavioral changes, focal seizures, dysphasia, hemiparesis, and altered LOC (Porth & Matfin, 2009).

### Assessment and Diagnostic Findings

Neuroimaging studies, such as EEG, and CSF examination are used to diagnose HSV encephalitis. MRI is the neuroimaging study of choice for detection of early changes caused by HSV-1; the study shows edema in the temporal lobe. The EEG shows diffuse slowing or focal changes in the temporal lobe in about 80% of patients (Mazzoni, et al., 2006). Lumbar puncture often reveals a high opening pressure and low glucose and high protein levels in CSF samples. Viral cultures are almost always negative. The polymerase chain reaction (PCR) is the standard test for early diagnosis of HSV-1 encephalitis. PCR identifies the DNA bands of HSV-1 in the CSF. The validity of PCR is very high between the 3rd and 10th days after symptom onset.

### Medical Management

Acyclovir (Zovirax) or ganciclovir (Cytovene), antiviral agents, are the medications of choice in the treatment of HSV (Matthews, et al., 2007). Early administration of antiviral agents (usually well tolerated) improves the prognosis associated with HSV-1 encephalitis. The mode of action is inhibition of viral DNA replication. To prevent relapse, treatment should continue for up to 3 weeks. Slow IV administration over 1 hour prevents crystallization of the medication in the urine. The usual dose of acyclovir is decreased if the patient has a history of renal insufficiency. Studies are in progress to determine the effectiveness of an oral agent, valacyclovir hydrochloride (Valtrex), in the treatment of HSV-1 encephalitis.

## Nursing Management

Assessment of neurologic function is key to monitoring the progression of disease. Comfort measures to reduce headache include dimming the lights, limiting noise and visitors, grouping nursing interventions, and administering analgesic agents (Matthews, et al., 2007). Opioid analgesic medications may mask neurologic symptoms; therefore, they are used cautiously. Seizures and altered LOC require care directed at injury prevention and safety. Nursing care addressing patient and family anxieties is ongoing throughout the illness. Monitoring of blood chemistry test results and urinary output alert the nurse to the presence of renal complications related to antiviral therapy.

# *Arthropod-Borne Virus Encephalitis*

Arthropod vectors transmit several types of viruses that cause encephalitis. The primary vector in North America is the mosquito. In cases of West Nile virus, humans are the secondary host; birds are the primary host. Arbovirus infection (transmitted by arthropod vectors) occurs in specific geographic areas during the summer and fall. In the United States, West Nile and St. Louis are the most common types of arboviral encephalitis; both are members of the Japanese encephalitis serogroup. West Nile virus develops in 1 out of 150 cases of encephalitis (Matthews, et al., 2007; Mazzoni, et al., 2006).

## Pathophysiology

Viral replication occurs at the site of the mosquito bite. The host immune response attempts to control viral replication. If the immune response is inadequate, viremia will ensue. The virus gains access to the central nervous system (CNS) via the cerebral capillaries, resulting in encephalitis. It spreads from neuron to neuron, predominantly affecting the cortical gray matter, the brain stem, and the thalamus. Meningeal exudates compound the clinical presentation by irritating the meninges and increasing ICP.

## Clinical Manifestations

St. Louis and West Nile encephalitis most commonly affect adults. Climate, an environment conducive to arthropod proliferation, and human behavior contribute to the occurrence of St. Louis and West Nile encephalitis. An arboviral encephalitis begins with early flulike symptoms, but specific neurologic manifestations depend on the viral type. A unique clinical feature of St. Louis encephalitis is SIADH with hyponatremia. Signs and symptoms specific to West Nile encephalitis include a maculopapular or morbilliform rash on the neck, trunk, and arms; enlarged lymph nodes and legs; and flaccid paralysis (Matthews, et al., 2007). Both West Nile and St. Louis encephalitis can result in parkinsonianlike movements, reflecting inflammation of the basal ganglia. Seizures, a poor prognostic indicator, are present in both types of encephalitis but are more common in the St. Louis type.

## Assessment and Diagnostic Findings

After a brief febrile prodrome, neurologic symptoms reflect the area of the brain that is involved. Neuroimaging and CSF evaluation are useful in the diagnosis of arboviral encephalitis. The MRI scan demonstrates inflammation of the basal ganglia in cases of St. Louis encephalitis and inflammation in the periventricular area in cases of West Nile encephalitis. Immunoglobulin M antibodies to West Nile virus are observed in serum and CSF. Serum cultures are not useful, because the viremia is brief. PCR evaluation of CSF may demonstrate viral ribonucleic acid (RNA).

## Medical Management

No specific medication for arboviral encephalitis includes controlling the seizures and the increased ICP. Interferon may be useful in treating St. Louis encephalitis. Ribavirin and interferon alpha-2b show some effect against West Nile virus but have not been evaluated in controlled studies (Tunkel, Glaser, Block, et al., 2008). Neuropsychiatric complications, such as emotional outbursts and other behavior changes, occur frequently.

## Nursing Management

If the patient is very ill, hospitalization may be required. The nurse carefully assesses neurologic status and identifies improvement or deterioration in the patient's condition. Injury prevention is key in light of the potential for falls or seizures. Arboviral encephalitis may result in death or lifelong residual health issues such as neurologic deficits and seizures (Mazzoni, et al., 2006). The family will need support and teaching to cope with these outcomes.

Public education addressing the prevention of arboviral encephalitis is a key nursing role. Clothing that provides coverage and insect repellents containing 25% to 30% diethyltoluamide (DEET) should be used on exposed clothing and skin in high-risk areas to decrease mosquito and tick bites. Screens should be in good repair in the home, and standing water should be removed. Blood donation centers screen all blood for West Nile virus. Cases of West Nile virus must be reported to the CDC.

# *Fungal Encephalitis*

Fungal infections of the CNS occur rarely in healthy people. The presentation of fungal encephalitis is related to geographic area or to an immune system that is compromised due to disease or immunosuppressive medication. Causes of fungal infections include *Cryptococcus neoformans*, *Blastomyces dermatitidis*, *Histoplasma capsulatum*, *Aspergillus fumigatus*, *Candida*, and *Coccidioides immitis* (Mazzoni, et al., 2006). *C. immitis* is found mainly in California, Arizona, New Mexico, and Texas. *B. dermatitidis* exists in the southeastern United States and in the Ohio, St. Lawrence, and Mississippi River basins. It is a risk for coal miners, construction workers, and farmers. *C. neoformans* is associated with exposure to bird droppings and may be seen in bird handlers.

## Pathophysiology

The fungal spores enter the body via inhalation. They initially infect the lungs, causing vague respiratory symptoms or pneumonitis. The fungi may enter the bloodstream, causing a fungemia. If the fungemia overwhelms the person's immune system, the fungus may spread to the CNS. The

fungal invasion may cause meningitis, encephalitis, brain abscess, granuloma, or arterial thrombus (Mazzoni, et al., 2006).

### Clinical Manifestations

The common symptoms of fungal encephalitis include fever, malaise, headache, meningeal signs, and change in LOC or cranial nerve dysfunction. Symptoms of increased ICP related to hydrocephalus often occur. *C. neoformans* and *C. immitis* are associated with specific skin lesions. *H. capsulatum* is associated with seizures, and *A. fumigatus* may cause ischemic or hemorrhagic strokes.

### Assessment and Diagnostic Findings

A history of immunosuppression associated with AIDS or use of immunosuppressive medications may indicate fungal disease of the brain. Occupational and travel history may point to a fungal cause of CNS infection. Infections caused by *H. capsulatum* and *C. immitis* will demonstrate fungal antibodies in serologic tests. The CSF usually demonstrates elevated white cell and protein levels; glucose levels are decreased. *C. neoformans* is easily identified in CSF fungal cultures. *Candida* may be cultured from the blood or CSF. To identify *B. dermatitidis*, cisternal or ventricular cultures of CSF may need to be obtained. *A. fumigatus* is difficult to isolate in CSF and is diagnosed by lung biopsy. Neuroimaging is used to identify CNS changes related to fungal infection. MRI is the study of choice; it demonstrates areas of hemorrhage, abscess, or enhanced meninges indicating inflammation.

### Medical Management

Medical management is directed at the causative fungus and the neurologic consequences of the infection. Seizures are controlled by standard antiseizure medications. Increased ICP is controlled by repeated lumbar punctures or shunting of CSF.

Antifungal agents are administered for a specific period to cure the infection in patients with competent immune systems. Patients with compromised immune systems receive antifungal therapy until the infection is controlled, after which they receive a maintenance dose of the medication for an indefinite period. Although the dose and duration of treatment depend on the causative fungi, amphotericin B is the standard antifungal agent used in treatment. Dosing depends on the causative organism, and it is usually administered by IV. The most common adverse reactions are fever, nausea and vomiting, anemia, uremia, and hypokalemia (Mazzoni, et al., 2006). Renal insufficiency is a serious reaction to amphotericin B that can occur. Fluconazole (Diflucan) or flucytosine (Ancobon) may be administered orally in conjunction with amphotericin B as maintenance therapy. Potential side effects of fluconazole include nausea, vomiting, and a transient increase in liver enzymes. The most common adverse reaction to flucytosine is bone marrow suppression. Therefore, patients receiving flucytosine should have leukocyte and platelet counts monitored regularly.

### Nursing Management

The ICP will increase if hydrocephalus develops and the inflammatory response progresses. Nursing assessment aimed at early identification of increased ICP is necessary to ensure early control and management. (See Chapter 61 for management of the patient with increased ICP.) Administering nonopioid analgesic agents, limiting environmental stimuli, and positioning may optimize patient comfort. Administering diphenhydramine (Benadryl) and acetaminophen (Tylenol) approximately 30 minutes before giving amphotericin B may prevent flulike side effects. If renal insufficiency develops, the dose may need to be reduced. Increasing levels of serum creatinine and blood urea nitrogen (BUN) may alert the nurse to the development of renal insufficiency and the need to address the patient's renal status.

Providing support assists the patient and family to cope with the illness. Workup of the patient for immunodeficiency diseases such as AIDS may put additional stress on the family. The nurse may need to mobilize community support systems for the patient and family, because the recovery may be long.

## *Creutzfeldt-Jakob and Variant Creutzfeldt-Jakob Disease*

Creutzfeldt-Jakob disease (CJD) and variant Creutzfeldt-Jakob disease (vCJD) belong to a group of degenerative, infectious neurologic disorders called transmissible spongiform encephalopathies (TSE). CJD is very rare and has no identifiable cause. vCJD is the human variation of bovine spongiform encephalopathy (BSE); it results from the ingestion by humans of prions in infected beef. TSEs are caused by **prions,** proteinaceous particles that are smaller than a virus and are resistant to standard methods of sterilization. Although CJD and vCJD have distinct clinical features, one characteristic they share is a lack of CNS inflammation. CJD may lie dormant for decades before causing neurologic degeneration. The incubation period of vCJD seems to be shorter (less than 10 years). It is not known whether an increased number of cases will appear in the future. In both diseases, the symptoms are progressive, there is no definitive treatment, and the outcome is fatal.

About 150 cases of vCJD have been reported, almost all in the United Kingdom (Mazzoni, et al., 2006). The risk of vCJD in the United States is thought to be low, because cattle are fed primarily with soy-derived feed as opposed to feed containing animal parts.

### Pathophysiology

The prion is a unique pathogen because it lacks nucleic acid, which enables the organism to withstand conventional means of sterilization. How the prion replicates in the absence of nucleic acid is unknown (Glatzel, Stoeck, Seeger, et al., 2005). In both CJD and vCJD, the prion crosses the blood–brain barrier and is deposited in brain tissue and causes degeneration of brain tissue. Cell death occurs, and spongy vacuoles are produced in the brain (**spongiform** changes). The spongiform vacuoles are surrounded by amyloid plaque.

Ninety percent of the cases of CJD appear sporadically; the incidence is 1 case per 1 million people. Although it is not transmittable by typical human contact, 5% of cases of sporadic CJD result from contaminated neurosurgical instruments, cadaver-derived growth factor, or corneal

transplants. Ten percent of cases appear to be familial (Ward, Everington, Cousens, et al., 2007).

In 1996 the first case of vCJD was described. The mode of transmission was linked to the ingestion of beef contaminated with neurologic tissue. In 1998, additional concerns were raised about the safety of the blood supply in the United Kingdom. The prion exists in lymphoid tissue and blood in both vCJD and CJD. Both prion diseases are believed to be bloodborne. No method is available to screen blood for infectivity. The American Red Cross will not accept blood from anyone who has traveled to Europe in the past 6 months.

### Clinical Manifestations

CJD and vCJD have several clinically distinct features. Psychiatric symptoms occur early in vCJD, whereas they are a late symptom in CJD. The mean age at onset of vCJD is 27 years, whereas the mean age for CJD onset is 50 years. The presenting symptoms of vCJD include affective symptoms (ie, behavioral changes), sensory disturbance, and limb pain. Muscle spasms and rigidity, dysarthria, incoordination, cognitive impairment, and sleep disturbances follow. Patients with sporadic CJD present with mental deterioration, ataxia, and visual disturbance. Memory loss, involuntary movement, paralysis, and mutism occur as the disease progresses. After clinical presentation, people with vCJD survive an average of 22 months; those with CJD survive for about 6 months (Mazzoni, et al., 2006).

### Assessment and Diagnostic Findings

Historically, brain biopsy was used to diagnose CJD. The three diagnostic tests currently used in suspicious clinical presentations to support the diagnosis of CJD are immunologic assessment, electroencephalography, and MRI scanning. Immunologic assessment of CSF detects a protein kinase inhibitor called 14-3-3. The presence of this inhibitor indicates neuronal cell death, which is not specific to CJD but does support the diagnosis. The EEG reveals a characteristic pattern over the duration of the disease. After initial slowing, the EEG shows periodic activity. Later in the course of the disease, the EEG shows burst-suppressions characterized by periodic spikes alternating with slow periods. The MRI scan demonstrates symmetric or unilateral hyperintense signals arising from the basal ganglia.

Patients with vCJD do not demonstrate EEG or CSF changes, and the MRI scan shows bilateral hyperintensity of the posterior thalamus. The prion associated with vCJD has been shown to accumulate in the tonsils and other lymphoreticular tissues; therefore, tonsillar biopsy may be used in the diagnosis of vCJD.

### Medical Management

After the onset of specific neurologic symptoms, progression of disease occurs quickly. There is no effective treatment for CJD or vCJD. The care of the patient is supportive and palliative. Goals of care include prevention of injury related to immobility and dementia, promotion of patient comfort, and provision of support and education for the family.

### Nursing Management

The nursing care of patients is primarily supportive and palliative. Psychological and emotional support of the patient and family throughout the course of the illness is needed. Care extends to providing for a dignified death and supporting the family through the processes of grief and loss. Hospice services are appropriate either at home or at an inpatient facility. See Chapter 17 for an in-depth discussion of end-of-life issues.

Prevention of disease transmission is an important part of nursing care. Although patient isolation is not necessary, use of standard precautions is important. Institutional protocols are followed for blood and body fluid exposure and decontamination of equipment. In the operating room, it is recommended that disposable instruments be used and then incinerated, because conventional methods of sterilization do not destroy the prion. The World Health Organization has guidelines that outline the stringent sterilization methods that must be used to destroy prions on surfaces.

# AUTOIMMUNE PROCESSES

Autoimmune nervous system disorders include multiple sclerosis, myasthenia gravis, and Guillain-Barré syndrome.

## *Multiple Sclerosis*

Multiple sclerosis (MS) is an immune-mediated, progressive demyelinating disease of the CNS. Demyelination refers to the destruction of myelin, the fatty and protein material that surrounds certain nerve fibers in the brain and spinal cord; it results in impaired transmission of nerve impulses (Fig. 64-2). MS may occur at any age but typically manifests in young adults between the ages of 20 and 40 years; it affects women more frequently than men (Porth & Matfin, 2009).

The cause of MS is an area of ongoing research (Costello & Sipe, 2008). Autoimmune activity results in demyelination, but the sensitized antigen has not been identified. Multiple factors play a role in the initiation of the immune process. Geographic prevalence is highest in Europe, New Zealand, southern Australia, the northern United States, and southern Canada (Olek, 2005). Researchers believe that some environmental exposure at a young age may play a role in the development of MS later in life.

Genetic predisposition is indicated by the presence of a specific cluster (haplotype) of human leukocyte antigens (HLAs) on the cell wall. Its presence may increase susceptibility to factors, such as viruses, that trigger the autoimmune response activated in MS. A specific virus capable of initiating the autoimmune response has not been identified. It is believed that deoxyribonucleic acid (DNA) on the virus mimics the amino acid sequence of myelin, resulting in an immune system cross-reaction in the presence of a defective immune system.

### Pathophysiology

Sensitized T and B lymphocytes cross the blood–brain barrier; their function is to check the CNS for antigens and then leave. In MS, sensitized T cells remain in the CNS and promote the infiltration of other agents that damage the immune system. The immune system attack leads to inflammation that destroys myelin (which normally insulates the

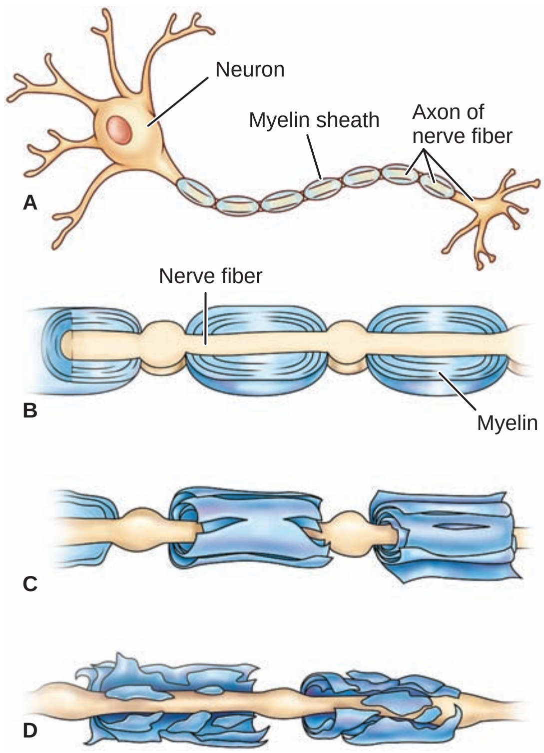



**Figure 64-2** The process of demyelination. **A** and **B** depict a normal nerve cell and axon with myelin. **C** and **D** show the slow disintegration of myelin, resulting in a disruption in axon function.

axon and speeds the conduction of impulses along the axon) and the oligodendroglial cells that produce myelin in the CNS.

Demyelination interrupts the flow of nerve impulses and results in a variety of manifestations, depending on the nerves affected. Plaques appear on demyelinated axons, further interrupting the transmission of impulses. Demyelinated axons are scattered irregularly throughout the CNS (Fig. 64-3). The areas most frequently affected are the optic nerves, chiasm, and tracts; the cerebrum; the brain stem and cerebellum; and the spinal cord. The axons themselves begin to degenerate, resulting in permanent and irreversible damage (Costello & Sipe, 2008; Porth & Matfin, 2009).

## Clinical Manifestations

The course of MS may assume many different patterns (Fig. 64-4) (Lublin & Reingold, 1996). In some patients, the disease follows a benign course, and symptoms are so mild that the patient does not seek health care or treatment. Between 80% and 85% of patients with MS have a relapsing-remitting (RR) course. With each relapse, recovery is usually complete; however, residual deficits may occur and accumulate over time, contributing to functional decline. Fifty percent of those with the RR course of MS progress to a secondary progressive course, in which disease progression occurs with or without relapses. Ten percent of patients have a primary progressive course, in which disabling symptoms steadily increase, with rare plateaus and temporary improvement. Primary progressive MS may result in quadriparesis, cognitive dysfunction,

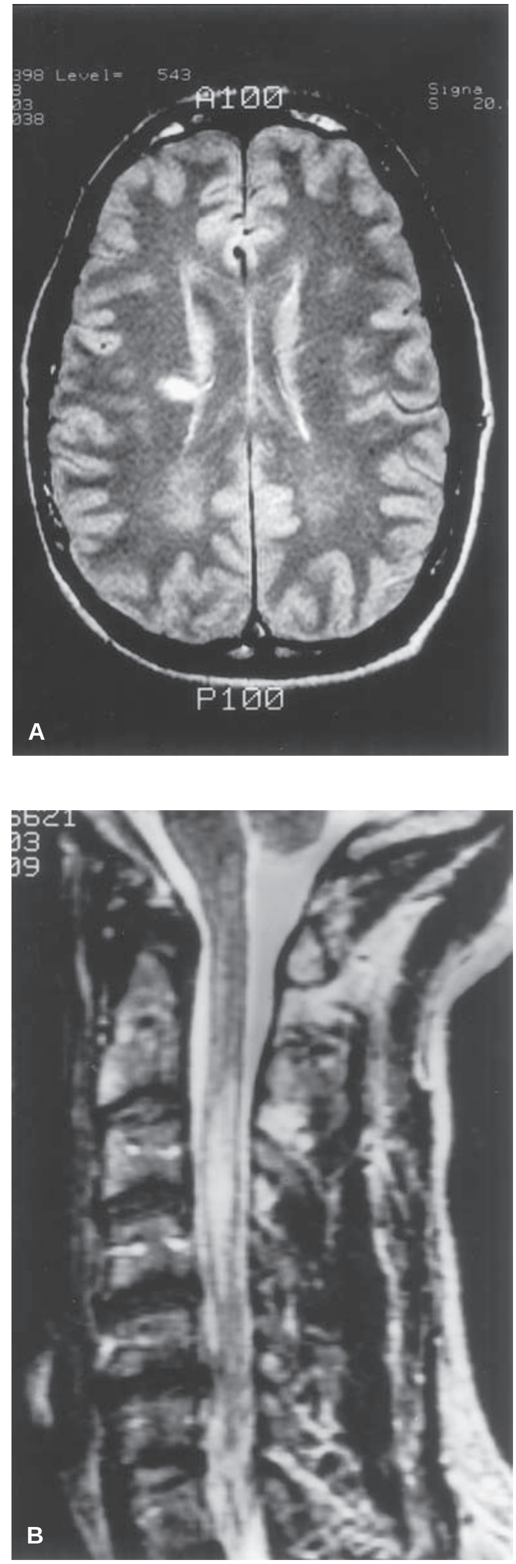



**Figure 64-3** Multiple sclerosis. **A,** A computed tomography scan of brain demonstrates an area of demyelination in the periventricular white matter of the right frontal lobe. The plaque is perpendicular to the lateral ventricle, a typical finding in multiple sclerosis. **B,** A magnetic resonance image of the spinal cord in the same patient highlights another typical finding: a flame-shaped area of demyelination within the midcervical region of the spinal cord. Courtesy of the Danbury Hospital Department of Radiology.

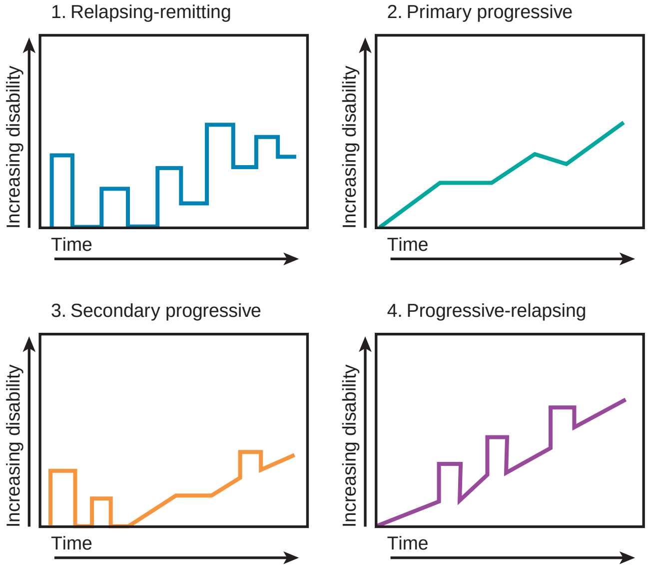



**Figure 64-4** Types and courses of multiple sclerosis (MS). **1,** Relapsing-remitting (RR) MS is characterized by clearly acute attacks with full recovery or with sequelae and residual deficit upon recovery. Periods between disease relapses are characterized by lack of disease progression. **2,** Primary progressive (PP) MS is characterized by disease showing progression of disability from onset, without plateaus and temporary minor improvements. **3,** Secondary progressive (SP) MS begins with an initial RR course, followed by progression of variable rate, which may also include occasional relapses and minor remissions. **4,** Progressive-relapsing (PR) MS shows progression from onset but with clear acute relapses with or without recovery. From Lublin, F. D. & Reingold, S. C. (1996). Defining the clinical course of multiple sclerosis: Results of an international survey. *Neurology, 46*(64), 907–911. Used with permission from Lippincott Williams & Wilkins.

visual loss, and brain stem syndromes. The least common presentation (about 5% of cases) is the progressive relapsing course. It is characterized by relapses with continuous disabling progression between exacerbations (Mazzoni, et al., 2006).

The signs and symptoms of MS are varied and multiple, reflecting the location of the lesion (plaque) or combination of lesions. The primary symptoms most commonly reported are fatigue, depression, weakness, numbness, difficulty in coordination, loss of balance, and pain (Johnson, 2008; Newland, 2008). Visual disturbances due to lesions in the optic nerves or their connections may include blurring of vision, **diplopia** (double vision), patchy blindness (scotoma), and total blindness.

Fatigue affects most people with MS and is often the most disabling symptom. Heat, depression, anemia, deconditioning, and medication may contribute to fatigue. Avoiding hot temperatures, effective treatment of depression and anemia, and occupational and physical therapies may help control fatigue. Additional strategies include a balance of rest and activities, good nutrition, and a healthy lifestyle including avoidance of alcohol and cigarette smoking (Iggulden, 2006; Johnson, 2008).

Pain is another common symptom of MS that can contribute to social isolation. Lesions on the sensory pathways cause pain. Additional sensory manifestations include paresthesias, dysesthesias, and proprioception loss (Stern, 2005). Many people with MS need daily analgesic medications. In some cases, pain is managed with opioids, antiseizure medications, or antidepressants. Rarely, surgery may be needed to interrupt pain pathways.

Among perimenopausal women, those with MS are more likely to have pain related to osteoporosis. In addition to estrogen loss, immobility and corticosteroid therapy play a role in the development of osteoporosis among women with MS. Bone mineral density testing is recommended for this high-risk group (Smeltzer, Zimmerman & Capriotti, 2005). Diagnosis and treatment of osteoporosis are discussed in Chapter 68.

**Spasticity** (muscle hypertonicity) of the extremities and loss of the abdominal reflexes result from involvement of the main motor pathways (pyramidal tracts) of the spinal cord. Cognitive and psychosocial problems may reflect frontal or parietal lobe involvement. Some degree of cognitive change (eg, memory loss, decreased concentration) occurs in about half of patients, but severe cognitive changes with dementia (progressive organic mental disorder) are rare.

Involvement of the cerebellum or basal ganglia can produce **ataxia** (impaired coordination of movements) and tremor. Loss of the control connections between the cortex and the basal ganglia may occur and cause emotional lability and euphoria. Bladder, bowel, and sexual dysfunctions are common.

Secondary complications of MS include urinary tract infections, constipation, pressure ulcers, contracture deformities, dependent pedal edema, pneumonia, reactive depression, and osteoporosis. Emotional, social, marital, economic, and vocational problems may also occur.

Exacerbations and remissions are characteristic of MS. During exacerbations, new symptoms appear and existing ones worsen; during remissions, symptoms decrease or disappear. Relapses may be associated with emotional and physical stress.

## Gerontologic Considerations

The life expectancy for patients with MS is not dramatically different from that of patients without MS; those diagnosed with secondary progressive disease live an average of 35 years after onset (Mazzoni, et al., 2006). Patients with MS who are elderly have specific physical and psychosocial challenges. They may have chronic health problems, for which they may be taking additional medications that could interact with medications prescribed for MS. The absorption, distribution, metabolism, and excretion of medications are altered in the elderly as a result of age-related changes in renal and liver functions. Therefore, elderly patients must be monitored closely for adverse and toxic effects of MS medications and for osteoporosis (particularly with frequent corticosteroid use that may be needed to treat exacerbations). The cost of medications may lead to poor adherence to the prescribed regimen in elderly patients on fixed incomes.

Elderly patients with MS are particularly concerned about increasing disability, family burden, marital concern, and the possible future need for nursing home care. Immobility

resulting in fewer social opportunities contributes to loneliness and depression. Along with functional loss, spasticity, pain and bladder dysfunction, impaired sleep, and an increased need for assistance with self-care contribute to the physical challenges experienced by the elderly patient with MS (Stern, 2005).

## Assessment and Diagnostic Findings

The diagnosis of MS is based on the presence of multiple plaques in the CNS observed with MRI (Mazzoni, et al., 2006). Electrophoresis of CSF identifies the presence of oligoclonal banding (several bands of immunoglobulin G bonded together, indicating an immune system abnormality). Evoked potential studies can help define the extent of the disease process and monitor changes. Underlying bladder dysfunction is diagnosed by urodynamic studies. Neuropsychological testing may be indicated to assess cognitive impairment. A sexual history helps identify changes in sexual function.

## Medical Management

No cure exists for MS. An individual treatment program is indicated to relieve the patient's symptoms and provide continuing support, particularly for patients with cognitive changes, who may need more structure and support. The goals of treatment are to delay the progression of the disease, manage chronic symptoms, and treat acute exacerbations. Many patients with MS have a stable disease course and require only intermittent treatment, whereas others experience steady progression of their disease. Symptoms requiring intervention include spasticity, fatigue, bladder dysfunction, and ataxia. Management strategies target the various motor and sensory symptoms and effects of immobility that can occur.

### *Pharmacologic Therapy*

Medications prescribed for MS include those for disease modification and those for symptom management. The disease-modifying therapies available to treat MS include immunomodulating therapies and immunosuppressive agents (Ross, Hackbarth, Rohl, et al., 2008).

#### Disease-Modifying Therapies

The disease-modifying medications reduce the frequency of relapse, the duration of relapse, and the number and size of plaques observed on MRI. All of the medications require injection.

Interferon beta-1a (Rebif) and interferon beta-1b (Betaseron) are administered subcutaneously. Another preparation of interferon beta-1a, Avonex, is administered intramuscularly once a week. Side effects of all the interferon-beta medications include flulike symptoms that can be managed with acetaminophen and ibuprofen and resolve after a few months. Additional side effects include potential liver damage, fetal abnormalities, and depression. For optimal control of disability, disease-modifying medications should be started early in the course of the disease (Ross, et al., 2008).

Glatiramer acetate (Copaxone) reduces the rate of relapse in the RR course of MS. It decreases the number of plaques noted on MRI and increases the time between relapses. Copaxone is administered subcutaneously daily. It acts by increasing the antigen-specific suppressor T cells. Side effects are minimal and manageable (Miller & Jezewski, 2006). Copaxone is an option for those with an RR course; however, it may take 6 months for evidence of an immune response to appear.

IV methylprednisolone, the key agent in treating acute relapse in the RR course, shortens the duration of relapse. It exerts anti-inflammatory effects by acting on T cells and cytokines. One gram is administered IV daily for 3 days, followed by an oral taper of prednisone. Side effects include mood swings, weight gain, and electrolyte imbalances (Mazzoni, et al., 2006).

The medication mitoxantrone (Novantrone) is administered via IV infusion every 3 months. Novantrone can reduce the frequency of clinical relapses in patients with secondary-progressive or worsening relapsing-remitting MS. Patients must be very closely monitored for side effects, especially cardiac toxicity.

#### Symptom Management

Medications are also prescribed for management of specific symptoms. Baclofen (Lioresal), a gamma-aminobutyric acid (GABA) agonist, is the medication of choice for treating spasticity. It can be administered orally or by intrathecal injection for severe spasticity (Ridley & Rawlings, 2006). Benzodiazepines (Valium), tizanidine (Zanaflex), and dantrolene (Dantrium) may also be used to treat spasticity. Patients with disabling spasms and contractures may require nerve blocks or surgical intervention. Fatigue that interferes with activities of daily living (ADLs) may be treated with amantadine (Symmetrel), pemoline (Cylert), or fluoxetine (Prozac). Ataxia is a chronic problem most resistant to treatment. Medications used to treat ataxia include beta-adrenergic blockers (Inderal), antiseizure agents (Neurontin), and benzodiazepines (Klonopin).

Bladder and bowel problems are often among the most difficult ones for patients, and a variety of medications (anticholinergic agents, alpha-adrenergic blockers, antispasmodic agents) may be prescribed. Nonpharmacologic strategies also assist in establishing effective bowel and bladder elimination (see later discussion).

Urinary tract infection is often superimposed on the underlying neurologic dysfunction. Ascorbic acid (vitamin C) may be prescribed to acidify the urine, making bacterial growth less likely. Antibiotics are prescribed when appropriate.

## NURSING PROCESS

### The Patient With Multiple Sclerosis

#### Assessments

Nursing assessment addresses neurologic deficits, secondary complications, and the impact of the disease on the patient and family. The patient's mobility and balance are observed to determine whether there is risk of falling. Assessment of function is carried out both when the patient is well rested and when fatigued. The patient is assessed for weakness, spasticity, visual impairment, incontinence, and

disorders of swallowing and speech. Additional areas of assessment include how MS has affected the patient's lifestyle, how the patient is coping, and what the patient would like to improve.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Impaired bed and physical mobility related to weakness, muscle paresis, spasticity
- Risk for injury related to sensory and visual impairment
- Impaired urinary and bowel elimination (urgency, frequency, incontinence, constipation) related to nervous system dysfunction
- Impaired verbal communication and risk for aspiration related to cranial nerve involvement
- Disturbed thought processes (loss of memory, dementia, euphoria) related to cerebral dysfunction
- Ineffective individual coping related to uncertainty of course of MS
- Impaired home maintenance management related to physical, psychological, and social limits imposed by MS
- Potential for sexual dysfunction related to lesions or psychological reaction

## Planning and Goals

The major goals for the patient may include promotion of physical mobility, avoidance of injury, achievement of bladder and bowel continence, promotion of speech and swallowing mechanisms, improvement of cognitive function, development of coping strengths, improved home maintenance management, and adaptation to sexual dysfunction.

## Nursing Interventions

An individualized program of physical therapy, rehabilitation, and education is combined with emotional support. An educational plan of care is developed to enable the person with MS to deal with the physiologic, social, and psychological problems that accompany chronic disease. Research shows that depression, pain, fatigue, and walking difficulty all decrease physical activity (Motl, Snook & Schapiro, 2007). Assisting patients with management of these symptoms may help increase the level of physical activity and overall sense of well-being. (Chart 64-3).

### *Promoting Physical Mobility*

Relaxation and coordination exercises promote muscle efficiency. Progressive resistive exercises are used to strengthen weak muscles, because diminishing muscle strength is often significant in MS.

**EXERCISES.** Walking improves the gait, particularly the problem of loss of position sense of the legs and feet. If certain muscle groups are irreversibly affected, other muscles can be trained to compensate. Instruction in the use of assistive devices may be needed to ensure their safe and correct use.

**MINIMIZING SPASTICITY AND CONTRACTURES.** Muscle spasticity is common and, in its later stages, is characterized by severe adductor spasm of the hips with flexor spasm of the hips and knees. Without relief, fibrous contractures of these joints occur. Warm packs may be beneficial, but hot baths should be avoided because of risk of burn injury secondary to sensory loss and increasing symptoms that may occur with elevation of the body temperature.

**CHART 64-3** NURSING RESEARCH PROFILE

### *Physical Activity in People With Multiple Sclerosis*

Motl, R. W., Snook, E. M. & Schapiro, R. T. (2007). Symptoms and physical activity behavior in individuals with multiple sclerosis. *Research in Nursing & Health, 31*(5), 466–475.

#### Purpose

Physical activity is a unique challenge for people with multiple sclerosis (MS). This study examined the relationships among overall and specific symptoms, such as difficulty walking and other physical activity issues in people with MS.

#### Design

In this cross-sectional descriptive study, 133 people (104 women and 78 men) with MS completed questionnaires measuring overall and specific symptoms (ie, depression, pain, and fatigue), difficulty walking, and physical activity. The purpose was to examine the relationships between overall and specific symptoms, difficulty walking, and physical activity. Participants in the study were recruited from local MS support groups over a 6-month time period.

#### Findings

The descriptive findings of the study showed that those with MS who have more intense overall symptoms had more difficulty walking and lower levels of physical activity. The path analysis suggested that higher levels of physical symptoms were directly and indirectly related to lower levels of physical activity. Another important finding was that the indirect pathway involved difficulty walking.

#### Nursing Implications

People with MS who have intense overall symptoms have a reduction in physical activity in comparison to those with MS and less intense overall symptoms. This study found that the reduction in physical activity can be partly explained by walking difficulty. The authors suggest that nursing interventions to promote physical activity in people with MS might need to include adaptive activities that do not require a lot of walking.

Daily exercises for muscle stretching are prescribed to minimize joint contractures. Special attention is given to the hamstrings, gastrocnemius muscles, hip adductors, biceps, and wrist and finger flexors. Muscle spasticity is common and interferes with normal function. A stretch–hold–relax routine is helpful for relaxing and treating muscle spasticity. Swimming and stationary bicycling are useful, and progressive weight bearing can relieve spasticity in the legs. The patient should not be hurried in any of these activities, because this often increases spasticity.

**ACTIVITY AND REST.** The patient is encouraged to work and exercise to a point just short of fatigue. Very strenuous physical exercise is not advisable, because it raises the body temperature and may aggravate symptoms. The patient is advised to take frequent short rest periods, preferably lying down. Extreme fatigue may contribute to the exacerbation of symptoms.

**MINIMIZING EFFECTS OF IMMOBILITY.** Because of the decrease in physical activity that often occurs with MS, complications associated with immobility, including pressure ulcers, expiratory muscle weakness, and accumulation of bronchial secretions, need to be considered and steps taken to prevent them. Measures to prevent such complications include assessing and maintaining skin integrity and having the patient perform coughing and deep-breathing exercises.

### *Preventing Injury*

If motor dysfunction causes problems of incoordination and clumsiness, or if ataxia is apparent, the patient is at risk for falling. To overcome this disability, the patient is taught to walk with feet apart to widen the base of support and to increase walking stability. If loss of position sense occurs, the patient is taught to watch the feet while walking. Gait training may require assistive devices (walker, cane, braces, crutches, parallel bars) and instruction about their use by a physical therapist. If the gait remains inefficient, a wheelchair or motorized scooter may be the solution. The occupational therapist is a valuable resource person in suggesting and securing aids to promote independence. If incoordination is a problem and tremor of the upper extremities occurs when voluntary movement is attempted (intention tremor), weighted bracelets or wrist cuffs are helpful. The patient is trained in transfer and activities of daily living (ADLs).

Because sensory loss may occur in addition to motor loss, pressure ulcers are a continuing threat to skin integrity. The need to use a wheelchair continuously increases the risk. See Chapter 11 for a discussion of the prevention and treatment of pressure ulcers.

### *Enhancing Bladder and Bowel Control*

Generally, bladder symptoms fall into the following categories: (1) inability to store urine (hyperreflexic, uninhibited); (2) inability to empty the bladder (hyporeflexic, hypotonic); and (3) a mixture of both types. The patient with urinary frequency, urgency, or incontinence requires special support. The sensation of the need to void must be heeded immediately, so the bedpan or urinal should be readily available. A voiding time schedule is set up (every 1.5 to 2 hours initially, with gradual lengthening of the interval). The patient is instructed to drink a measured amount of fluid every 2 hours and then attempt to void 30 minutes after drinking. Use of a timer or wristwatch with an alarm may be helpful for the patient who does not have enough sensation to signal the need to empty the bladder. The nurse encourages the patient to take the prescribed medications to treat bladder spasticity, because this allows greater independence. Intermittent self-catheterization (see Chapter 11) has been successful in maintaining bladder control in patients with MS. If a female patient has permanent urinary incontinence, urinary diversion procedures may be considered. The male patient may wear a condom appliance for urine collection.

Bowel problems include constipation, fecal impaction, and incontinence. Adequate fluids, dietary fiber, and a bowel-training program are frequently effective in solving these problems. See Chapter 11 for a discussion of promoting bowel continence.

### *Enhancing Communication and Managing Swallowing Difficulties*

If the cranial nerves that control the mechanisms of speech and swallowing are affected, dysarthrias (defects of articulation) marked by slurring, low volume of speech, and difficulties in phonation may occur. **Dysphagia** (difficulty swallowing) may also occur. A speech therapist evaluates speech and swallowing and instructs the patient, family, and health team members about strategies to compensate for speech and swallowing problems. The nurse reinforces this instruction and encourages the patient and family to adhere to the plan. Impaired swallowing increases the patient's risk of aspiration; therefore, strategies are needed to reduce that risk. Such strategies include having suction apparatus available, careful feeding, and proper positioning for eating.

### *Improving Sensory and Cognitive Function*

Measures may be taken if visual defects or changes in cognitive status occur.

**VISION.** The cranial nerves affecting vision may be affected by MS. An eye patch or a covered eyeglass lens may be used to block the visual impulses of one eye if the patient has diplopia (double vision). Prism glasses may be helpful for patients who are confined to bed and have difficulty reading in the supine position. People who are unable to read regular-print materials are eligible for the free "talking book" services of the Library of Congress or may obtain large-print or audio books from local libraries.

**COGNITION AND EMOTIONAL RESPONSES.** Cognitive impairment and emotional lability occur early in MS in some patients and may impose numerous stresses on the patient and family. Some patients with MS are forgetful and easily distracted and may exhibit emotional lability.

Patients adapt to illness in a variety of ways, including denial, depression, withdrawal, and hostility. Emotional support assists patients and their families to adapt to the changes and uncertainties associated with MS and to cope with the disruption in their lives. The family should be made aware of the nature and degree of cognitive impairment. Patients with MS have identified that the support of family and friends is a primary need (Koopman, Benbow &

Vandervoort, 2006). The patient is assisted to set meaningful and realistic goals, to remain as active as possible, and to maintain interests and activities. Hobbies may help the patient's morale and provide satisfying interests if the disease progresses to the stage in which formerly enjoyed activities can no longer be pursued. The environment is kept structured, and lists and other memory aids are used to help the patient with cognitive changes maintain a daily routine. The occupational therapist can be helpful in formulating a structured daily routine.

**STRENGTHENING COPING MECHANISMS.** The diagnosis of MS is always distressing to the patient and family. They need to know that no two patients with MS have identical symptoms or courses of illness. Although some patients do experience significant disability early, others have a near-normal lifespan with minimal disability. Some families, however, face overwhelming frustrations and problems. MS affects people who are often in a productive stage of life and concerned about career and family responsibilities. Family conflict, disintegration, separation, and divorce are not uncommon. Often, very young family members assume the responsibility of caring for a parent with MS. Nursing interventions in this area include alleviating stress and making appropriate referrals for counseling and support to minimize the adverse effects of dealing with chronic illness.

The nurse, mindful of these complex problems, initiates home care and coordinates a network of services, including social services, speech therapy, physical therapy, and homemaker services. To strengthen the patient's coping skills, as much information as possible is provided. Patients need an updated list of available assistive devices, services, and resources.

Coping through problem solving involves helping the patient define the problem and develop alternatives for its management. Careful planning and maintaining flexibility and a hopeful attitude are useful for psychological and physical adaptation.

#### *Improving Home Management*

MS can affect every facet of daily living. Certain abilities are often impossible to regain after they are lost. Physical function may vary from day to day. Modifications that allow independence in home management should be implemented (eg, assistive eating devices, raised toilet seat, bathing aids, telephone modifications, long-handled comb, tongs, modified clothing). Exposure to heat increases fatigue and muscle weakness, so air conditioning is recommended in at least one room. Exposure to extreme cold may increase spasticity.

#### *Promoting Sexual Functioning*

Patients with MS and their partners face problems that interfere with sexual activity, both as a direct consequence of nerve damage and also from psychological reactions to the disease. Easy fatigability, conflicts arising from dependency and depression, emotional lability, and loss of self-esteem compound the problem. Erectile and ejaculatory disorders in men and orgasmic dysfunction and adductor spasms of the thigh muscles in women can make sexual intercourse difficult or impossible. Bladder and bowel incontinence and urinary tract infections add to the difficulties.

Collaboration between the patient, family, and health care provider is essential for supporting intimacy (Moore, 2007). A sexual counselor can help bring into focus the patient's or partner's sexual resources and suggest relevant information and supportive therapy. Sharing and communicating feelings, planning for sexual activity (to minimize the effects of fatigue), and exploring alternative methods of sexual expression may open up a wide range of sexual enjoyment and experiences.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** As the disease progresses, the patient and family need to learn new strategies to maintain optimal independence. Teaching of new self-care techniques may be initiated in the hospital or clinic setting and reinforced in the home. Self-care education may address the use of assistive devices, self-catheterization, and administration of medications that affect the course of the disease or treat complications. A teaching plan that addresses intramuscular or subcutaneous administration of medications is developed for the patient and his or her family (Cox & Stone, 2006). One research study showed that use of a local anesthetic cream reduced pain and fear associated with intramuscular medication administration in 18 patients with MS (Buhse, 2006). Exercises that enable the patient to continue some form of activity or that maintain or improve swallowing, speech, or respiratory function may be taught to the patient and family (Chart 64-4).

**CONTINUING CARE.** After discharge, the home care nurse often provides teaching and reinforcement of new interventions in the patient's home. Nurses in the home setting assess for changes in the patient's physical and emotional status, provide physical care to the patient if required, coordinate outpatient services and resources, and encourage health promotion, appropriate health screenings, and adaptation. If changes in the disease or its course are noted, the home care nurse encourages the patient to contact the primary care provider, because treatment of an acute exacerbation or new problem may be indicated. Continuing health care and follow-up are recommended.

The patient with MS is encouraged to contact the local chapter of the National Multiple Sclerosis Society for services, publications, and contact with others who have MS (see Resources). Local chapters also provide direct services to patients. Through group participation, the patient has an opportunity to meet others with similar problems, share experiences, and learn self-help methods in a social environment.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Improves physical mobility
   a. Participates in gait-training and rehabilitation program
   b. Establishes a balanced program of rest and exercise
   c. Uses assistive devices correctly and safely
2. Is free of injury
   a. Uses visual cues to compensate for decreased sense of touch or position
   b. Asks for assistance when necessary

CHART 64-4

**HOME CARE CHECKLIST**

***The Patient With Multiple Sclerosis (MS)***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State how to access the local chapter of the National MS Society and available resources. | ✔ | ✔ |
| • Discuss the clinical course of MS. | ✔ | ✔ |
| • Identify strategies to manage symptoms (pain, cognitive responses, dysphagia, tremors, visual disturbances). | ✔ | ✔ |
| • State how to prevent complications (pressure ulcers, pneumonia, depression). | ✔ | ✔ |
| • Identify coping strategies. | ✔ | ✔ |
| • Identify ways to minimize fatigue. | ✔ | ✔ |
| • Explain how to prevent injury. | ✔ | ✔ |
| • State ways to adapt to sexual dysfunction. | ✔ | ✔ |
| • Discuss ways to control bowel and bladder function. | ✔ | ✔ |
| • Name benefits of exercise and physical activity. | ✔ | ✔ |
| • Identify ways to minimize immobility and spasticity. | ✔ | ✔ |
| • Describe medication regimen and potential adverse effects. | ✔ | ✔ |
| • Demonstrate correct techniques of administering injectable medications, if prescribed. | ✔ | ✔ |

3. Attains or maintains control of bladder and bowel patterns
   a. Monitors self for urine retention and employs intermittent self-catheterization technique, if indicated
   b. Identifies the signs and symptoms of urinary tract infection
   c. Maintains adequate fluid and fiber intake
4. Participates in strategies to improve speech and swallowing
   a. Practices exercises recommended by speech therapist
   b. Maintains adequate nutritional intake without aspiration
5. Compensates for altered thought processes
   a. Uses lists and other aids to compensate for memory losses
   b. Discusses problems with trusted advisor or friend
   c. Substitutes new activities for those that are no longer possible
6. Demonstrates effective coping strategies
   a. Maintains sense of control
   b. Modifies lifestyle to fit goals and limitations
   c. Verbalizes desire to pursue goals and developmental tasks of adulthood
7. Adheres to plan for home maintenance management
   a. Uses appropriate techniques to maintain independence
   b. Engages in health promotion activities and health screenings as appropriate
8. Adapts to changes in sexual function
   a. Is able to discuss problem with partner and appropriate health professional
   b. Identifies alternative means of sexual expression

## Myasthenia Gravis

Myasthenia gravis, an autoimmune disorder affecting the myoneural junction, is characterized by varying degrees of weakness of the voluntary muscles. Approximately 60,000 people have myasthenia gravis in the United States. Women are affected more frequently than men, and they tend to develop the disease at an earlier age (20 to 40 years of age, versus 60 to 70 years for men) (Mazzoni, et al., 2006).

### Pathophysiology

Normally, a chemical impulse precipitates the release of acetylcholine from vesicles on the nerve terminal at the myoneural junction. The acetylcholine attaches to receptor sites on the motor endplate and stimulates muscle contraction. Continuous binding of acetylcholine to the receptor site is required for muscular contraction to be sustained.

In myasthenia gravis, antibodies directed at the acetylcholine receptor sites impair transmission of impulses across the myoneural junction. Therefore, fewer receptors are available for stimulation, resulting in voluntary muscle weakness that escalates with continued activity (Fig. 64-5). These antibodies are found in 80% to 90% of people with myasthenia gravis (Hickey, 2009). Eighty percent of people with myasthenia gravis have either thymic hyperplasia or a thymic tumor, and the thymus gland is believed to be the site of antibody production. In patients who are antibody negative, researchers believe that the offending antibody is directed at a portion of the receptor site rather than the whole complex.

### Clinical Manifestations

The initial manifestation of myasthenia gravis in two thirds of patients involves the ocular muscles. Diplopia (double

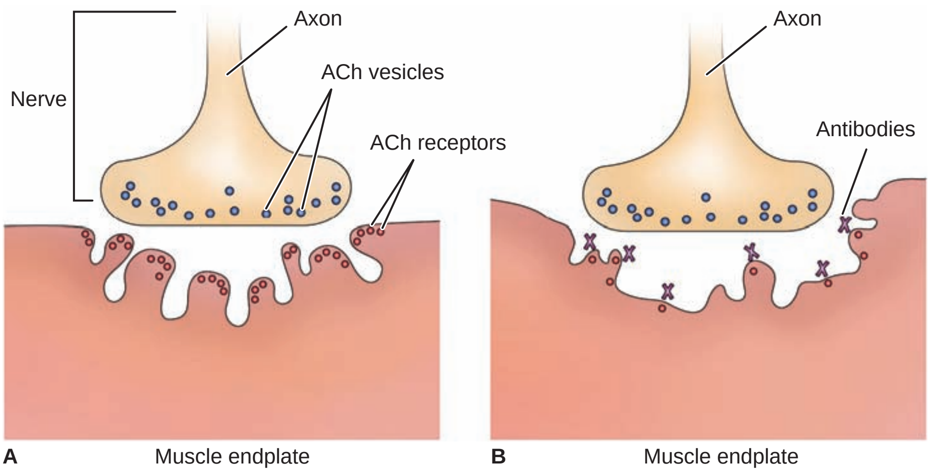



**Figure 64-5** Myasthenia gravis. **A,** Normal acetylcholine (Ach) receptor site. **B,** ACh receptor site in myasthenia gravis.

vision) and ptosis (drooping of the eyelids) are common (Allen, 2006). Many patients also experience weakness of the muscles of the face and throat (bulbar symptoms) and generalized weakness. Weakness of the facial muscles results in a bland facial expression. Laryngeal involvement produces **dysphonia** (voice impairment) and increases the risk of choking and aspiration. Generalized weakness affects all the extremities and the intercostal muscles, resulting in decreasing vital capacity and respiratory failure. Myasthenia gravis is purely a motor disorder with no effect on sensation or coordination.

## Assessment and Diagnostic Findings

An acetylcholinesterase inhibitor test is used to diagnose myasthenia gravis. The acetylcholinesterase inhibitor stops the breakdown of acetylcholine, thereby increasing availability at the neuromuscular junction. Edrophonium chloride (Tensilon), a fast-acting acetylcholinesterase inhibitor, is administered IV to diagnose myasthenia gravis. Thirty seconds after injection, facial muscle weakness and ptosis should resolve for about 5 minutes (Hickey, 2009). Immediate improvement in muscle strength after administration of this agent represents a positive test and usually confirms the diagnosis. Atropine should be available to control the side effects of edrophonium, which include bradycardia, sweating, and cramping.

The presence of acetylcholine receptor antibodies is identified in the serum (Mazzoni, et al., 2006). Repetitive muscle stimulation demonstrates a decrease in successive action potentials. The thymus gland, a site of acetylcholine receptor antibody production, may be enlarged in myasthenia gravis, and may be identified by MRI scan. A single-fiber electromyography (EMG) detects a delay or failure of neuromuscular transmission and is about 99% sensitive in confirming the diagnosis of myasthenia gravis (Hickey, 2009; Karpoff & Labus, 2008).

## Medical Management

Management of myasthenia gravis is directed at improving function and reducing and removing circulating antibodies. Therapeutic modalities include administration of anticholinesterase medications and immunosuppressive therapy, plasmapheresis, and thymectomy. There is no cure for myasthenia gravis; treatments do not stop the production of the acetylcholine receptor antibodies.

### *Pharmacologic Therapy*

Pyridostigmine bromide (Mestinon), an anticholinesterase medication, is the first line of therapy. It provides symptomatic relief by inhibiting the breakdown of acetylcholine and increasing the relative concentration of available acetylcholine at the neuromuscular junction. The dosage is gradually increased to a daily maximum and is administered in divided doses (usually four times a day). Adverse effects of anticholinesterase medications include fasciculations, abdominal pain, diarrhea, and increased oropharyngeal secretions (Allen, 2006). Pyridostigmine tends to have fewer side effects than other anticholinesterase medications (Chart 64-5).

If pyridostigmine bromide does not improve muscle strength and control fatigue, the next agents used are the immunomodulating drugs. The goal of immunosuppressive therapy is to reduce production of the antibody. Corticosteroids suppress the patient's immune response, decreasing the amount of antibody production, and this correlates with clinical improvement. An initial dose of prednisone is given daily; as symptoms improve, the medication is tapered and a maintenance dose may be given indefinitely (Mazzoni, et al., 2006). As the corticosteroid medications take effect the dosage of anticholinesterase medication can usually be lowered. Cytotoxic medications are used to treat myasthenia gravis if there is inadequate response to steroids. Azathioprine (Imuran) inhibits T lymphocytes and reduces acetylcholine receptor antibody levels. Therapeutic effects may not be evident for 3 to 12 months. Leukopenia and hepatotoxicity are serious adverse effects, so monthly evaluation of liver enzymes and white blood cell count is necessary.

Intravenous immune globulin (IVIG) is also used to treat exacerbations, and, in selected patients, it is used on a long-term adjunctive basis. IVIG treatment is easy to administer and involves the administration of pooled human gamma-globulin, and improvement occurs in a few days (Hickey, 2009).

A number of medications are contraindicated for patients with myasthenia gravis because they exacerbate the symptoms. The physician and the patient should weigh risks and benefits before any new medications are prescribed,

CHART 64-5

PHARMACOLOGY

## Potential Adverse Effects of Anticholinesterase Medications

**Central Nervous System**

Irritability
Anxiety
Insomnia
Headache
Dysarthria
Syncope
Seizures
Coma
Diaphoresis

**Respiratory**

Bronchial relaxation
Increased bronchial secretions

**Cardiovascular**

Tachycardia
Hypotension

**Gastrointestinal**

Abdominal cramps
Nausea
Vomiting
Diarrhea
Anorexia
Increased salivation

**Skeletal Muscles**

Fasciculations
Spasms
Weakness

**Genitourinary**

Frequency
Urgency

**Integumentary**

Rash
Flushing

including antibiotics, cardiovascular medications, antiseizure and psychotropic medications, morphine, quinine and related agents, beta-blockers, and nonprescription medications (Allen, 2006). Procaine (Novocain) should be avoided, and the patient's dentist is informed of the diagnosis of myasthenia gravis.

### *Plasmapheresis*

Plasmapheresis (plasma exchange) is a technique used to treat exacerbations. The patient's plasma and plasma components are removed through a centrally placed large-bore double-lumen catheter. The blood cells and antibody-containing plasma are separated, after which the cells and a plasma substitute are reinfused. Plasma exchange produces a temporary reduction in the level of circulating antibodies. The typical course of plasmapheresis consists of daily or alternate-day treatment, and the number of treatments is determined by the patient's response. Plasma exchange improves symptoms in 75% of patients; however, improvement lasts only a few weeks after treatment is completed (Hickey, 2009).

### *Surgical Management*

Thymectomy (surgical removal of the thymus gland) can produce antigen-specific immunosuppression and result in clinical improvement. The procedure results in either partial or complete remission. A course of preoperative plasmapheresis decreases the time needed for postoperative mechanical ventilation. The entire gland must be removed for optimal clinical outcomes; therefore, surgeons prefer the transsternal surgical approach. After surgery, the patient is monitored in an intensive care unit, with special attention to respiratory function. The patient is weaned from mechanical ventilation after thorough respiratory assessment. After the thymus gland is removed, it may take up to 3 years for the patient to benefit from the procedure, because of the long life of circulating T cells (Allen, 2006).

## Complications

### *Respiratory Failure*

A myasthenic crisis is an exacerbation of the disease process characterized by severe generalized muscle weakness and respiratory and bulbar weakness that may result in respiratory failure. Crisis may result from disease exacerbation or a specific precipitating event. The most common precipitator is respiratory infection; others include medication change, surgery, pregnancy, and medications that exacerbate myasthenia. A cholinergic crisis caused by overmedication with cholinesterase inhibitors is rare; atropine sulfate should be on hand to treat bradycardia or respiratory distress (Hickey, 2009).

Neuromuscular respiratory failure is the critical complication in myasthenic and cholinergic crises. Respiratory muscle and bulbar weakness combine to cause respiratory compromise. Weak respiratory muscles do not support inhalation. An inadequate cough and an impaired gag reflex, caused by bulbar weakness, result in poor airway clearance. A downward trend of two respiratory function tests, the negative inspiratory force and vital capacity, is the first clinical sign of respiratory compromise.

Endotracheal intubation and mechanical ventilation may be needed (see Chapter 25). Noninvasive positive-pressure ventilation uses an external device that provides respiratory support without endotracheal intubation. Cholinesterase inhibitors are stopped when respiratory failure occurs and gradually restarted after the patient demonstrates improvement with a course of plasmapheresis or IVIG. Nutritional support may be needed if the patient is intubated for a long period.

## Nursing Management

Because myasthenia gravis is a chronic disease and most patients are seen on an outpatient basis, much of the nursing care focuses on patient and family teaching. Educational topics for outpatient self-care include medication management, energy conservation, strategies to help with ocular manifestations, and prevention and management of complications.

Medication management is a crucial component of ongoing care. Understanding the actions of the medications and taking them on schedule is emphasized, as are the consequences of delaying medication and the signs and symptoms of myasthenic and cholinergic crises. The patient can determine the best times for daily dosing by keeping a diary to determine fluctuation of symptoms and to learn when the medication is wearing off. The medication schedule can then be manipulated to maximize strength throughout the day.

**NURSING ALERT**

**Maintenance of stable blood levels of anticholinesterase medications is imperative to stabilize muscle strength. Therefore, the anticholinesterase medications must be administered on time. Any delay in administration of medications may exacerbate muscle weakness and make it impossible for the patient to take medications orally.**

The patient is also taught strategies to conserve energy. To do this, the nurse helps the patient identify the optimal times for rest throughout the day. If the patient lives in a two-story home, the nurse can suggest that frequently used items (eg, hygiene products, cleaning products, snacks) be kept on each floor to minimize travel between floors. The patient is encouraged to apply for a handicapped license plate to minimize walking from parking spaces, and to schedule activities to coincide with peak energy and strength levels.

To minimize the risk of aspiration, mealtimes should coincide with the peak effects of anticholinesterase medication. In addition, rest before meals is encouraged to reduce muscle fatigue. The patient is advised to sit upright during meals, with the neck slightly flexed to facilitate swallowing. Soft foods in gravy or sauces can be swallowed more easily; if choking occurs frequently, the nurse can suggest puréed food with a puddinglike consistency. Suction should be available at home, with the patient and family instructed in its use. Supplemental feedings may be necessary in some patients to ensure adequate nutrition (Randell, Byars, Williams, et al., 2008).

Impaired vision results from ptosis of one or both eyelids, decreased eye movement, or double vision. To prevent corneal damage when the eyelids do not close completely, the patient is instructed to tape the eyes closed for short intervals and to regularly instill artificial tears. Patients who wear eyeglasses can have "crutches" attached to help lift the eyelids. Patching of one eye can help with double vision.

The patient is reminded of the importance of maintaining health promotion practices and of following health care screening recommendations. Factors that exacerbate symptoms and potentially cause crisis should be noted and avoided: emotional stress, infections (particularly respiratory infections), vigorous physical activity, some medications, and high environmental temperature. The Myasthenia Gravis Foundation of America provides support groups, services, and educational materials for patients, families, and health care providers (see Resources).

### Myasthenic Crisis

Respiratory distress and varying degrees of dysphagia (difficulty swallowing), dysarthria (difficulty speaking), eyelid ptosis, diplopia, and prominent muscle weakness are symptoms of myasthenic crisis. The patient is placed in an intensive care unit for constant monitoring because of associated intense and sudden fluctuations in clinical condition.

Providing ventilatory assistance takes precedence in the immediate management of the patient with myasthenic crisis. Ongoing assessment for respiratory failure is essential. The nurse assesses the respiratory rate, depth, and breath sounds and monitors pulmonary function parameters (vital capacity and negative inspiratory force) to detect pulmonary problems before respiratory dysfunction progresses. Blood is drawn for arterial blood gas analysis. Endotracheal intubation and mechanical ventilation may be needed (see Chapter 25).

If the abdominal, intercostal, and pharyngeal muscles are severely weak, the patient cannot cough, take deep breaths, or clear secretions. Chest physical therapy, including postural drainage to mobilize secretions and suctioning to remove secretions, may have to be performed frequently. (Postural drainage should not be performed for 30 minutes after feeding.)

Assessment strategies and supportive measures include the following:

- Arterial blood gases, serum electrolytes, input and output, and daily weight are monitored.
- If the patient cannot swallow, nasogastric tube feedings may be prescribed.
- Sedatives and tranquilizers are avoided, because they aggravate hypoxia and hypercapnia and can cause respiratory and cardiac depression.

## Guillain-Barré Syndrome

Guillain-Barré syndrome is an autoimmune attack on the peripheral nerve myelin. The result is acute, rapid segmental demyelination of peripheral nerves and some cranial nerves, producing ascending weakness with **dyskinesia** (inability to execute voluntary movements), hyporeflexia, and **paresthesias** (numbness). An antecedent event (most often a viral infection) precipitates clinical presentation (Palmieri, 2005). *Campylobacter jejuni*, cytomegalovirus, Epstein-Barr virus, *Mycoplasma pneumoniae*, *H. influenzae*, and HIV are the most common infectious agents that are associated with the development of Guillain-Barré syndrome.

The annual incidence of Guillain-Barré syndrome is 1 to 2 cases per 100,000, and it is more frequent in males between 16 and 25 years of age and between 45 and 60 years of age (Palmieri, 2005). Results of studies on recovery rates

differ, but most indicate that 60% to 75% of patients recover completely. Residual deficits of varying degree occur in 20% to 25% of patients. Residual deficits are most likely in patients with rapid disease progression, those who require mechanical ventilation, and those 60 years of age or older. Death occurs in 5% of cases, resulting from respiratory failure, autonomic dysfunction, sepsis, or pulmonary emboli (Mazzoni, et al., 2006).

## Pathophysiology

Myelin is a complex substance that covers nerves, providing insulation and speeding the conduction of impulses from the cell body to the dendrites. The cell that produces myelin in the peripheral nervous system is the Schwann cell. In Guillain-Barré syndrome, the Schwann cell is spared, allowing for remyelination in the recovery phase of the disease.

Guillain-Barré syndrome is the result of a cell-mediated and humoral immune attack on peripheral nerve myelin proteins that causes inflammatory demyelination. The best-accepted theory of cause is molecular mimicry, in which an infectious organism contains an amino acid that mimics the peripheral nerve myelin protein. The immune system cannot distinguish between the two proteins and attacks and destroys peripheral nerve myelin. The exact location of the immune attack within the peripheral nervous system is the ganglioside GM1b. With the autoimmune attack, there is an influx of macrophages and other immune-mediated agents that attack myelin and cause inflammation and destruction, interruption of nerve conduction, and axonal loss (Ho, Thakur, Gorson, et al., 2008; Palmieri, 2005).

## Clinical Manifestations

Guillain-Barré syndrome typically begins with muscle weakness and diminished reflexes of the lower extremities. Hyporeflexia and weakness may progress to tetraplegia. Demyelination of the nerves that innervate the diaphragm and intercostal muscles results in neuromuscular respiratory failure. Sensory symptoms include paresthesias of the hands and feet and pain related to the demyelination of sensory fibers.

The antecedent event usually occurs 2 weeks before symptoms begin. Weakness usually begins in the legs and progresses upward. Maximum weakness, the plateau, varies in length but usually includes neuromuscular respiratory failure and bulbar weakness. The duration of the symptoms is variable; complete functional recovery may take up to 2 years. Any residual symptoms are permanent and reflect axonal damage from demyelination.

Cranial nerve demyelination can result in a variety of clinical manifestations. Optic nerve demyelination may result in blindness. Bulbar muscle weakness related to demyelination of the glossopharyngeal and vagus nerves results in the inability to swallow or clear secretions. Vagus nerve demyelination results in autonomic dysfunction, manifested by instability of the cardiovascular system. The presentation is variable and may include tachycardia, bradycardia, hypertension, or orthostatic hypotension. The symptoms of autonomic dysfunction occur and resolve rapidly. Guillain-Barré syndrome does not affect cognitive function or LOC.

Although the classic clinical features include areflexia and ascending weakness, variation in presentation occurs. There may be a sensory presentation, with progressive sensory symptoms; an atypical axonal destruction; or the Miller-Fisher variant, which includes paralysis of the ocular muscles, ataxia, and areflexia (Iggulden, 2006).

## Assessment and Diagnostic Findings

The patient presents with symmetric weakness, diminished reflexes, and upward progression of motor weakness. A history of a viral illness in the previous few weeks suggests the diagnosis. Changes in vital capacity and negative inspiratory force are assessed to identify impending neuromuscular respiratory failure. Serum laboratory tests are not useful in the diagnosis. However, elevated protein levels are detected in CSF evaluation, without an increase in other cells. Evoked potential studies demonstrate a progressive loss of nerve conduction velocity.

## Medical Management

Because of the possibility of rapid progression and neuromuscular respiratory failure, Guillain-Barré syndrome is a medical emergency, requiring management in an intensive care unit. After baseline values are identified, assessment of changes in muscle strength and respiratory function alert the clinician to the physical and respiratory needs of the patient. Respiratory therapy or mechanical ventilation may be necessary to support pulmonary function and adequate oxygenation. Some clinicians recommend elective intubation before the onset of extreme respiratory muscle fatigue. Emergent intubation may result in autonomic dysfunction (Mazzoni, et al., 2006). Mechanical ventilation may be required for an extended period. The patient is weaned from mechanical ventilation after the respiratory muscles can again support spontaneous respiration and maintain adequate tissue oxygenation.

Other interventions are aimed at preventing the complications of immobility. These may include the use of anticoagulant agents and anti-embolism stockings or sequential compression boots to prevent thrombosis and pulmonary emboli.

Plasmapheresis and IVIG are used to directly affect the peripheral nerve myelin antibody level (Mazzoni, et al., 2006). Both therapies decrease circulating antibody levels and reduce the amount of time the patient is immobilized and dependent on mechanical ventilation. Studies indicate that IVIG and plasmapheresis are equally effective in treating Guillain-Barré syndrome; however, IVIG is the therapy of choice because it is associated with fewer side effects. The cardiovascular risks posed by autonomic dysfunction require continuous electrocardiographic (ECG) monitoring. Tachycardia and hypertension are treated with short-acting medications such as alpha-adrenergic blocking agents. The use of short-acting agents is important, because autonomic dysfunction is very labile. Hypotension is managed by increasing the amount of IV fluid administered.

# NURSING PROCESS

## The Patient With Guillain-Barré Syndrome

### Assessment

Ongoing assessment for disease progression is critical. The patient is monitored for life-threatening complications (respiratory failure, cardiac dysrhythmias, deep vein thrombosis [DVT]), so that appropriate interventions can be initiated. Because of the threat to the patient in this sudden, potentially life-threatening disease, the nurse must assess the patient's and family's ability to cope and their use of coping strategies.

### Diagnosis

#### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Ineffective breathing pattern and impaired gas exchange related to rapidly progressive weakness and impending respiratory failure
- Impaired bed and physical mobility related to paralysis
- Imbalanced nutrition, less than body requirements, related to inability to swallow
- Impaired verbal communication related to cranial nerve dysfunction
- Fear and anxiety related to loss of control and paralysis

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include the following:

- Respiratory failure
- Autonomic dysfunction

### Planning and Goals

The major goals for the patient may include improved respiratory function, increased mobility, improved nutritional status, effective communication, decreased fear and anxiety, and absence of complications.

### Nursing Interventions

#### *Maintaining Respiratory Function*

Respiratory function can be maximized with incentive spirometry and chest physiotherapy. Monitoring for changes in vital capacity and negative inspiratory force is key to early intervention for neuromuscular respiratory failure. Mechanical ventilation is required if the vital capacity falls, making spontaneous breathing impossible and tissue oxygenation inadequate.

The potential need for mechanical ventilation should be discussed with the patient and family on admission to provide time for psychological preparation and decision making. Intubation and mechanical ventilation result in less anxiety if they are initiated on a nonemergency basis to a well-informed patient. The patient may require mechanical ventilation for a long period. Nursing management of the patient requiring mechanical ventilation is discussed in Chapter 25.

Bulbar weakness that impairs the ability to swallow and clear secretions is another factor in the development of respiratory failure in the patient with Guillain-Barré syndrome. Suctioning may be needed to maintain a clear airway.

The nurse assesses the blood pressure and heart rate frequently to identify autonomic dysfunction, so that interventions can be initiated quickly if needed. Medications are administered or a temporary pacemaker is placed for clinically significant bradycardia.

#### *Enhancing Physical Mobility*

Nursing interventions to enhance physical mobility and prevent the complications of immobility are key to the function and survival of patients. The paralyzed extremities are supported in functional positions, and passive range-of-motion exercises are performed at least twice daily. DVT and pulmonary embolism are threats to the paralyzed patient. Nursing interventions are aimed at preventing DVT. Range-of-motion exercises, position changes, anticoagulation, the use of anti-embolism stockings or sequential compression boots, and adequate hydration decrease the risk of DVT.

Padding may be placed over bony prominences, such as the elbows and heels, to reduce the risk of pressure ulcers (Igulden, 2006). The need for consistent position changes every 2 hours cannot be overemphasized. The nurse evaluates laboratory test results that may indicate malnutrition or dehydration, both of which increase the risk of pressure ulcers. The nurse collaborates with the physician and dietitian to develop a plan to meet the patient's nutritional and hydration needs.

#### *Providing Adequate Nutrition*

Paralytic ileus may result from insufficient parasympathetic activity. In this event, the nurse administers IV fluids and parenteral nutrition as a supplement and monitors for the return of bowel sounds. If the patient cannot swallow because of **bulbar paralysis** (immobility of muscles), a gastrostomy tube may be placed to administer nutrients. The nurse carefully assesses the return of the gag reflex and bowel sounds before resuming oral nutrition.

#### *Improving Communication*

Because of paralysis, the patient cannot talk, laugh, or cry and therefore has no method for communicating needs or expressing emotion. Establishing some form of communication with picture cards or an eye blink system provides a means of communication. Collaboration with the speech therapist may be helpful in developing a communication mechanism that is most effective for a specific patient.

#### *Decreasing Fear and Anxiety*

The patient and family are faced with a sudden, potentially life-threatening disease, and anxiety and fear are constant themes for them. The impact of disease on the family depends on the patient's role within the family. Referral to a support group may provide information and support to the patient and family.

The family may feel helpless in caring for the patient. Mechanical ventilation and monitoring devices may frighten and intimidate them. Family members often want to participate in physical care; with instruction and support by the nurse, they should be allowed and encouraged to do so.

In addition to fear, the patient may experience isolation, loneliness, and lack of control. Nursing interventions that increase the patient's sense of control include providing

information about the condition, emphasizing a positive appraisal of coping resources, and teaching relaxation exercises and distraction techniques. The positive attitude and atmosphere of the multidisciplinary team are important to promote a sense of well-being.

Diversional activities are encouraged to decrease loneliness and isolation. Encouraging visitors, engaging visitors or volunteers to read to the patient, listening to music or books on tape, and watching television are ways to alleviate the patient's sense of isolation.

#### *Monitoring and Managing Potential Complications*

Thorough assessment of respiratory function at regular and frequent intervals is essential, because respiratory insufficiency and subsequent failure due to weakness or paralysis of the intercostal muscles and diaphragm may develop quickly. Respiratory failure is the major cause of mortality. In addition to the respiratory rate and the quality of respirations, vital capacity is monitored frequently and at regular intervals, so that respiratory insufficiency can be anticipated. Decreasing vital capacity with associated muscle weakness indicates impending respiratory failure. Signs and symptoms include breathlessness while speaking, shallow and irregular breathing, use of accessory muscles, tachycardia, weak cough, and changes in respiratory pattern.

Other complications include cardiac dysrhythmias, which necessitate ECG monitoring; transient hypertension; orthostatic hypotension; DVT; pulmonary embolism; urinary retention; and other threats to any immobilized and paralyzed patient. These require monitoring and attention to prevent them and prompt treatment if indicated.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patients with Guillain-Barré syndrome and their families are usually frightened by the sudden onset of life-threatening symptoms and their severity. Therefore, teaching the patient and family about the disorder and its generally favorable prognosis is important (Chart 64-6).

During the acute phase of the illness, the patient and family are instructed about strategies they can implement to minimize the effects of immobility and other complications. As function begins to return, family members and other home care providers are instructed about care of the patient and their role in the rehabilitation process. Preparation for discharge is an interdisciplinary effort requiring family or caregiver education by all team members, including the nurse, physician, occupational and physical therapists, speech therapist, and respiratory therapist.

**CONTINUING CARE.** Most patients with Guillain-Barré syndrome experience complete recovery. Patients who have experienced total or prolonged paralysis require intensive rehabilitation; the extent depends on the patient's needs. Approaches include a comprehensive inpatient program if deficits are significant, an outpatient program if the patient can travel by car, or a home program of physical and occupational therapy. The recovery phase may be long and requires patience as well as involvement on the part of the patient and family.

During acute care, the focus is on immediate issues and deficits. The nurse needs to remind or instruct patients and family members of the need for continuing health promotion and screening practices after this initial phase of care.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Maintains effective respirations and airway clearance
   a. Has normal breath sounds on auscultation
   b. Demonstrates gradual improvement in respiratory function

**CHART 64-6** HOME CARE CHECKLIST
***The Patient With Guillain-Barré Syndrome***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe the disease process of Guillain-Barré syndrome. | ✔ | ✔ |
| • Manage respiratory needs: tracheostomy care, suctioning. | | ✔ |
| • Demonstrate proper body mechanics regarding lifting and transfers. | | ✔ |
| • Practice gait training and strength endurance. | ✔ | ✔ |
| • Perform range-of-motion exercises. | ✔ | ✔ |
| • Perform activities of daily living and manage self-care: | | |
| • Nutrition | ✔ | ✔ |
| • Bowel and bladder management | ✔ | ✔ |
| • Skin care | ✔ | ✔ |
| • Adaptive equipment for bathing, hygiene, grooming, dressing | ✔ | ✔ |
| • Operate and explain function of medical equipment and mobility aids: walkers, wheelchairs, bedside commodes, tub transfer benches, adaptive devices. | ✔ | ✔ |
| • Use coping mechanisms and diversional activities appropriately. | ✔ | ✔ |
| • Implement safety measures in the home. | ✔ | ✔ |
| • Know how to contact and use community resources and the Guillain-Barré Syndrome Foundation International. | ✔ | ✔ |

2. Shows increasing mobility
   a. Regains use of extremities
   b. Participates in rehabilitation program
   c. Demonstrates no contractures and minimal muscle atrophy
3. Receives adequate nutrition and hydration
   a. Consumes diet adequate to meet nutritional needs
   b. Swallows without aspiration
4. Demonstrates recovery of speech
   a. Communicates needs through alternative strategies
   b. Practices exercises recommended by the speech therapist
5. Shows lessening fear and anxiety
6. Has absence of complications
   a. Breathes spontaneously
   b. Has vital capacity within normal range
   c. Exhibits normal arterial blood gases and pulse oximetry

# CRANIAL NERVE DISORDERS

Because the brain stem and cranial nerves involve vital motor, sensory, and autonomic functions of the body, these nerves may be affected by conditions arising primarily within these structures or in secondary extension from adjacent disease processes. The cranial nerves are examined separately and in sequence (see Chapter 60). Some cranial nerve deficits can be detected by observing the patient's face, eye movements, speech, and swallowing. EMG is used to investigate motor and sensory dysfunction. An MRI scan is used to obtain images of the cranial nerves and brain stem. An overview of disorders that may affect each of the cranial nerves, including clinical manifestations and nursing interventions, is presented in Table 64-1. The following discussion centers on the most common disorders of the cranial nerves: trigeminal neuralgia, a condition affecting the fifth cranial nerve, and Bell's palsy, caused by involvement of the seventh cranial nerve.

## *Trigeminal Neuralgia (Tic Douloureux)*

Trigeminal neuralgia is a condition of the fifth cranial nerve that is characterized by paroxysms of pain in the area innervated by any of the three branches, but most commonly the second and third branches of the trigeminal nerve (Mazzoni, et al., 2006) (Fig. 64-6). The pain ends as abruptly as it starts and is described as a unilateral shooting and stabbing sensation. The unilateral nature of the pain is an important feature. Associated involuntary contraction of the facial muscles can cause sudden closing of the eye or twitching of the mouth, hence the former name *tic douloureux* (painful twitch). Although the cause is not certain, vascular compression and pressure are suggested causes. As the brain changes with age, a loop of a cerebral artery or vein may compress the nerve root entry point, and this can be identified on MRI scan (Gronseth, Cruccu, Alksne, et al., 2008).

Trigeminal neuralgia occurs most often before 35 years of age and is more common in women and in people with MS compared to the general population (Gronseth, et al., 2008; Mazzoni, et al., 2006). Pain-free intervals may be measured in terms of minutes, hours, days, or longer. With advancing years, the painful episodes tend to become more frequent and agonizing. The patient lives in constant fear of attacks.

Paroxysms can occur with any stimulation of the terminals of the affected nerve branches, such as washing the face, shaving, brushing the teeth, eating, and drinking. A draft of cold air or direct pressure against the nerve trunk may also cause pain. Certain areas are called trigger points because the slightest touch immediately starts a paroxysm or episode. To avoid stimulating these areas, patients with trigeminal neuralgia try not to touch or wash their faces, shave, chew, or do anything else that might cause an attack. These behaviors are a clue to the diagnosis.

### Medical Management

#### *Pharmacologic Therapy*

Antiseizure agents, such as carbamazepine (Tegretol), relieve pain in most patients with trigeminal neuralgia by reducing the transmission of impulses at certain nerve terminals. Carbamazepine is taken with meals. Serum levels must be monitored to avoid toxicity in patients who require high doses to control the pain. Side effects include nausea, dizziness, drowsiness, and aplastic anemia. The patient is monitored for bone marrow depression during long-term therapy. Gabapentin (Neurontin) and baclofen (Lioresal) are also used for pain control. If pain control is still not achieved, phenytoin (Dilantin) may be used as adjunctive therapy.

#### *Surgical Management*

If pharmacologic management fails to relieve pain, a number of surgical options are available. Although these procedures may relieve facial pain for a few years, recurrence and complication rates are high (Hickey, 2009). The choice of procedure depends on the patient's preference and health status.

**Microvascular Decompression of the Trigeminal Nerve**

An intracranial approach is used to relieve the contact between the cerebral vessel and the trigeminal nerve root entry. With the aid of an operating microscope, the artery loop is lifted from the nerve to relieve the pressure, and a small prosthetic device is inserted to prevent recurrence of impingement on the nerve. The postoperative management is the same as for other intracranial surgeries (see Chapter 61).

**Radiofrequency Thermal Coagulation**

Percutaneous radiofrequency produces a thermal lesion on the trigeminal nerve. Although immediate pain relief is experienced, dysesthesia of the face and loss of the corneal reflex may occur. Use of stereotactic MRI for identification of the trigeminal nerve followed by gamma knife radiosurgery is being used at some medical centers.

**Percutaneous Balloon Microcompression**

Percutaneous balloon microcompression disrupts large myelinated fibers in all three branches of the trigeminal nerve. After its placement, the balloon is filled with a

**Table 64-1 DISORDERS OF CRANIAL NERVES**

| Disorder | Clinical Manifestations | Nursing Interventions |
|---|---|---|
| **Olfactory Nerve—I**<br>Head trauma<br>Intracranial tumor<br>Intracranial surgery | Unilateral or bilateral anosmia (temporary or persistent)<br>Diminished taste for food | Assess sense of smell.<br>Assess for cerebrospinal fluid rhinorrhea if patient has sustained head trauma. |
| **Optic Nerve—II**<br>Optic neuritis<br>Increased intracranial pressure<br>Pituitary tumor | Lesions of optic tract producing homonymous hemianopsia | Assess visual acuity.<br>Restructure environment to prevent injuries.<br>Teach patient to accommodate for visual loss. |
| **Oculomotor Nerve—III**<br>**Trochlear Nerve—IV**<br>**Abducens Nerve—VI**<br>Vascular<br>Brain stem ischemia<br>Hemorrhage and infarction<br>Neoplasm<br>Trauma<br>Infection | Dilation of pupil with loss of light reflex on one side<br>Impairment of ocular movement<br>Diplopia<br>Gaze palsies<br>Ptosis of eyelid | Assess extraocular movement and for nonreactive pupil. |
| **Trigeminal Nerve—V**<br>Trigeminal neuralgia<br>Head trauma<br>Cerebellopontine lesion<br>Sinus tract tumor and metastatic disease<br>Compression of trigeminal root by tumor | Pain in face<br>Diminished or loss of corneal reflex<br>Chewing dysfunction | Assess for pain and triggering mechanisms for pain.<br>Assess for difficulty in chewing.<br>Discuss trigger zones and pain precipitants with patient.<br>Protect cornea from abrasion.<br>Ensure good oral hygiene.<br>Educate patient about medication regimen. |
| **Facial Nerve—VII**<br>Bell's palsy<br>Facial nerve tumor<br>Intracranial lesion<br>Herpes zoster | Facial dysfunction; weakness and paralysis<br>Hemifacial spasm<br>Diminished or absent taste<br>Pain | Recognize facial paralysis as emergency; refer for treatment as soon as possible.<br>Teach protective care for eyes.<br>Select easily chewed foods; patient should eat and drink from unaffected side of mouth.<br>Emphasize importance of oral hygiene.<br>Provide emotional support for changed appearance of face. |
| **Vestibulocochlear Nerve—VIII**<br>Tumors and acoustic neuroma<br>Vascular compression of nerve<br>Ménière's syndrome | Tinnitus<br>Vertigo<br>Hearing difficulties | Assess pattern of vertigo.<br>Provide for safety measures to prevent falls.<br>Ensure that patient can maintain balance before ambulating.<br>Caution patient to change positions slowly.<br>Assist with ambulation.<br>Encourage use of assistive devices. |
| **Glossopharyngeal Nerve—IX**<br>Glossopharyngeal neuralgia from neurovascular compression of cranial nerves IX and X<br>Trauma<br>Inflammatory conditions<br>Tumor<br>Vertebral artery aneurysms | Pain at base of tongue<br>Difficulty in swallowing<br>Loss of gag reflex<br>Palatal, pharyngeal, and laryngeal paralysis | Assess for paroxysmal pain in throat, decreased or absent swallowing, and gag and cough reflexes.<br>Monitor for dysphagia, aspiration, and nasal dysarthric speech.<br>Position patient upright for eating or tube feeding. |
| **Vagus Nerve—X**<br>Spastic palsy of larynx; bulbar paralysis; high vagal paralysis<br>Guillain-Barré syndrome<br>Vagal body tumors<br>Nerve paralysis from malignancy, surgical trauma such as carotid endarterectomy | Voice changes (temporary or permanent hoarseness)<br>Vocal paralysis<br>Dysphagia | Assess for airway obstruction/provide airway management.<br>Prevent aspiration.<br>Support patient having voice reconstruction procedures. |
| **Spinal Accessory Nerve—XI**<br>Spinal cord disorder<br>Amyotrophic lateral sclerosis<br>Trauma<br>Guillain-Barré syndrome | Drooping of affected shoulder with limited shoulder movement<br>Weakness or paralysis of head rotation, flexion, extension; shoulder elevation | Support patient undergoing diagnostic tests. |
| **Hypoglossal Nerve—XII**<br>Medullary lesions<br>Amyotrophic lateral sclerosis<br>Polio and motor system disease, which may destroy hypoglossal nuclei<br>Multiple sclerosis<br>Trauma | Abnormal movements of tongue<br>Weakness or paralysis of tongue muscles<br>Difficulty in talking, chewing, and swallowing | Observe swallowing ability.<br>Observe speech pattern.<br>Be aware of swallowing or vocal difficulties.<br>Prepare for alternate feeding methods (tube feeding) to maintain nutrition. |

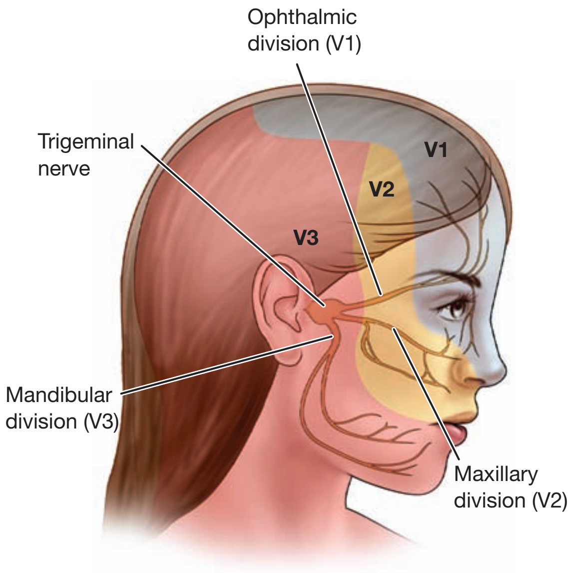



**Figure 64-6** Distribution of trigeminal nerve branches.

contrast material for fluoroscopic identification. The balloon compresses the nerve root for 1 minute and provides microvascular decompression.

## Nursing Management

### Preventing Pain

Preoperative management of a patient with trigeminal neuralgia occurs mostly on an outpatient basis and includes recognizing factors that may aggravate excruciating facial pain, such as food that is too hot or too cold or jarring of the patient's bed or chair. Even washing the face, combing the hair, or brushing the teeth may produce acute pain. The nurse can assist the patient in preventing or reducing this pain by providing instructions about preventive strategies. Providing cotton pads and room temperature water for washing the face, instructing the patient to rinse with mouthwash after eating if tooth brushing causes pain, and performing personal hygiene during pain-free intervals are all effective strategies. The patient is instructed to take food and fluids at room temperature, to chew on the unaffected side, and to ingest soft foods. The nurse recognizes that anxiety, depression, and insomnia often accompany chronic painful conditions and uses appropriate interventions and referrals. See Chapter 13 for management of patients with chronic pain.

### Providing Postoperative Care

Postoperative neurologic assessments are conducted to evaluate the patient for facial motor and sensory deficits in each of the three branches of the trigeminal nerve. If the surgery results in sensory deficits to the affected side of the face, the patient is instructed not to rub the eye because the pain of a resulting injury will not be detected. The eye is assessed for irritation or redness. Artificial tears may be prescribed to prevent dryness in the affected eye. The patient is cautioned not to chew on the affected side until numbness has diminished. The patient is observed carefully for any difficulty in eating or swallowing foods of different consistencies.

# Bell's Palsy

Bell's palsy (facial paralysis) is caused by unilateral inflammation of the seventh cranial nerve, which results in weakness or paralysis of the facial muscles on the affected side (Fig. 64-7). Although the cause is unknown, theories about causes include vascular ischemia, viral disease (herpes simplex, herpes zoster), autoimmune disease, or a combination of all of these factors. Most adults with Bell's palsy are younger than 45 years of age (Carlson & Pfadt, 2005).

Bell's palsy may be a type of pressure paralysis. The inflamed, edematous nerve becomes compressed to the point of damage, or its blood supply is occluded, producing ischemic necrosis of the nerve. The face is distorted from paralysis of the facial muscles; increased lacrimation (tearing); and painful sensations in the face, behind the ear, and in the eye. The patient may experience speech difficulties and may be unable to eat on the affected side because of weakness or paralysis of the facial muscles. Most patients recover completely, and Bell's palsy rarely recurs (Carlson & Pfadt, 2005).

## Medical Management

The objectives of treatment are to maintain the muscle tone of the face and to prevent or minimize denervation. The patient should be reassured that no stroke has occurred and that spontaneous recovery occurs within 3 to 5 weeks in most patients.

Corticosteroid therapy (prednisone) may be prescribed to reduce inflammation and edema; this reduces vascular compression and permits restoration of blood circulation to the nerve. Early administration of corticosteroid therapy appears to diminish the severity of the disease, relieve the pain, and prevent or minimize denervation (Carlson & Pfadt, 2005).

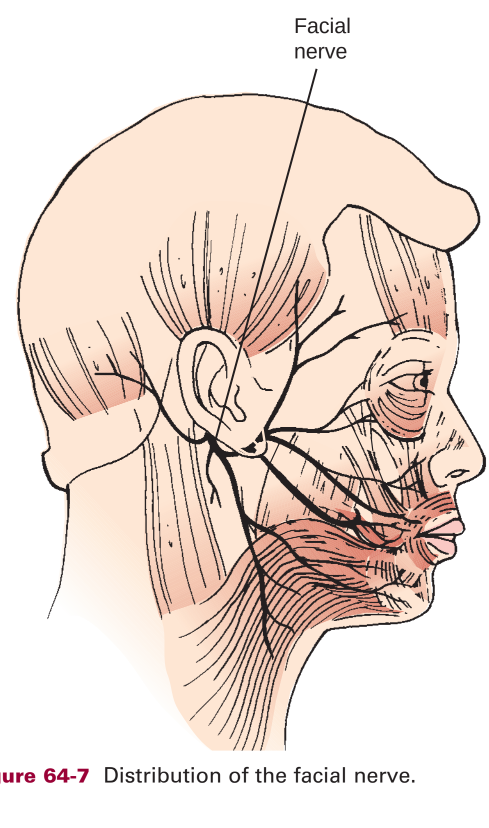



**Figure 64-7** Distribution of the facial nerve.

Facial pain is controlled with analgesic agents. Heat may be applied to the involved side of the face to promote comfort and blood flow through the muscles. Electrical stimulation may be applied to the face to prevent muscle atrophy. Although most patients recover with conservative treatment, surgical exploration of the facial nerve may be indicated if a tumor is suspected, for surgical decompression of the facial nerve, or for surgical treatment of a paralyzed face.

### Nursing Management

While the paralysis lasts, nursing care involves protection of the eye from injury. Frequently, the eye does not close completely and the blink reflex is diminished, so the eye is vulnerable to injury from dust and foreign particles. Corneal irritation and ulceration may occur. Distortion of the lower lid alters the proper drainage of tears. To prevent injury, the eye should be covered with a protective shield at night. The eye patch may abrade the cornea, however, because there is some difficulty in keeping the partially paralyzed eyelids closed. Moisturizing eye drops during the day and eye ointment at bedtime may help prevent injury (Carlson & Pfadt, 2005). The patient can be taught to close the paralyzed eyelid manually before going to sleep. Wrap-around sunglasses or goggles may be worn during the day to decrease normal evaporation from the eye.

After the sensitivity of the nerve to touch decreases and the patient can tolerate touching the face, the nurse can suggest massaging the face several times daily, using a gentle upward motion, to maintain muscle tone. Facial exercises, such as wrinkling the forehead, blowing out the cheeks, and whistling, may be performed with the aid of a mirror to prevent muscle atrophy. Exposure of the face to cold and drafts is avoided.

# DISORDERS OF THE PERIPHERAL NERVOUS SYSTEM

## *Peripheral Neuropathies*

A peripheral **neuropathy** (disorder of the nervous system) is a disorder affecting the peripheral motor and sensory nerves. Peripheral nerves connect the spinal cord and brain to all other organs. They transmit motor impulses from the brain and relay sensory impulses to the brain. Peripheral neuropathies are characterized by bilateral and symmetric disturbance of function, usually beginning in the feet and hands. The most common cause of peripheral neuropathy is diabetes with poor glycemic control (Tesfaye, Chaturvedi, Simon, et al., 2005). The major symptoms of peripheral nerve disorders are loss of sensation, muscle atrophy, weakness, diminished reflexes, pain, and paresthesia (numbness, tingling) of the extremities.

Peripheral nerve disorders are diagnosed by history, physical examination, and electrodiagnostic studies such as electroencephalography. The diagnosis of peripheral neuropathy in the geriatric population is challenging because many symptoms, such as decreased reflexes, can be associated with the normal aging process (Miller, 2009).

No specific treatment exists for peripheral neuropathy. Elimination or control of the cause may slow progression. Patients with peripheral neuropathy are at risk for falls, thermal injuries, and skin breakdown. The plan of care includes inspection of the lower extremities for skin breakdown. Assistive devices such as a walker or cane may decrease the risk of falls. Bath water temperature is checked to avoid thermal injury. Footwear should be accurately sized. Driving may be limited or eliminated, thereby disrupting the patient's sense of independence.

## *Mononeuropathy*

Mononeuropathy is limited to a single peripheral nerve and its branches. It arises when the trunk of the nerve is compressed or entrapped (as in carpal tunnel syndrome), traumatized (as when bruised by a blow), overstretched (as in joint dislocation), punctured by a needle used to inject a drug or damaged by the drugs thus injected, or inflamed because an adjacent infectious process extends to the nerve trunk. Mononeuropathy is frequently seen in patients with diabetes.

Pain is seldom a major symptom of mononeuropathy when the condition is due to trauma, but in patients with complicating inflammatory conditions such as arthritis, pain is prominent. Pain is increased with all body movements that tend to stretch, strain, or cause pressure on the injured nerve and sudden jarring of the body (eg, from coughing or sneezing). The skin in the areas supplied by nerves that are injured or diseased may become reddened and glossy, the subcutaneous tissue may become edematous, and the nails and hair in this area are altered. Chemical injuries to a nerve trunk, such as those caused by drugs injected into or near it, are often permanent.

The objective of treatment of mononeuropathy is to remove the cause, if possible (eg, freeing the compressed nerve). Local corticosteroid injections may reduce inflammation and the pressure on the nerve. Aspirin or codeine may be used to relieve pain.

Nursing care involves protection of the affected limb or area from injury, as well as appropriate patient teaching about mononeuropathy and its treatment.

# CRITICAL THINKING EXERCISES

**1** A 19-year-old college student is admitted with suspected meningitis. Identify two assessment parameters that indicate meningitis. What interventions would be included in your plan of care to protect the patient from injury? The patient's family has many questions about the disease and their risk of contracting meningitis. Develop a teaching plan that would describe meningitis and prophylactic therapy for the patient's family and close contacts.

**2** Your patient has been prescribed a new medication for the treatment of MS that requires self-injection. She reports that she has a fear of self-injection. Identify additional assessment parameters that need to be used. Develop a teaching plan for self-injection. What resources may be needed to enable her to be successful?

EBP **3** Your 40-year-old patient is being investigated for trigeminal neuralgia. What is the current evidence base for diagnostic evaluation and treatment of trigeminal neuralgia? Identify the criteria used to evaluate the strength of the evidence for diagnostic evaluation and treatment of trigeminal neuralgia. How would you use this information in developing a nursing plan of care for this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*
***Double asterisk indicates classic reference.*


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## RESOURCES

Guillain-Barré Syndrome Foundation International, http://gbs-cidp.org/
Myasthenia Gravis Foundation of America, www.myasthenia.org
National Multiple Sclerosis Society, www.nmss.org
The Neuropathy Association, Inc., www.neuropathy.org




# Management of Patients With Oncologic or Degenerative Neurologic Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the pathophysiologic processes responsible for oncologic disorders.
2. Describe brain and spinal cord tumors: their classification, clinical manifestations, diagnosis, and medical and nursing management.
3. Use the nursing process as a framework for care of patients with cerebral metastases or inoperable brain tumors.
4. Identify the pathophysiologic processes responsible for various degenerative neurologic disorders.
5. Use the nursing process as a framework for care of patients with Parkinson's disease.
6. Identify resources for patients and families with oncologic and degenerative neurologic disorders.
7. Use the nursing process as a framework for care of patients following a cervical diskectomy.

## GLOSSARY

**akathisia:** restlessness, urgent need to move around, and agitation

**bradykinesia:** very slow voluntary movements and speech

**chorea:** rapid, jerky, involuntary, purposeless movements of the extremities or facial muscles, including facial grimacing

**dementia:** a progressive organic mental disorder characterized by personality changes, confusion, disorientation, and deterioration of intellect associated with impaired memory and judgment

**dyskinesia:** impaired ability to execute voluntary movements

**dysphonia:** abnormal voice quality caused by weakness and incoordination of muscles responsible for speech

**micrographia:** small and often illegible handwriting

**neurodegenerative:** a disease, process, or condition that leads to deterioration of normal cells or function of the nervous system

**papilledema:** edema of the optic nerve

**paresthesia:** a sensation of numbness, tingling, or a "pins and needles" sensation

**radiculopathy:** disease of a spinal nerve root, often resulting in pain and extreme sensitivity to touch

**sciatica:** inflammation of the sciatic nerve, resulting in pain and tenderness along the nerve through the thigh and leg

**spondylosis:** ankylosis or stiffening of the cervical or lumbar vertebrae

The occurrence of oncologic or degenerative disease processes in the neurologic system produces a unique set of nursing challenges. Oncologic disorders include brain and spinal cord tumors. Degenerative neurologic disorders include Parkinson's disease, Huntington disease, Alzheimer's disease, amyotrophic lateral sclerosis, muscular dystrophies, and degenerative disk disease. Postpolio syndrome is thought to be degenerative in nature and is included in this chapter.

## ONCOLOGIC DISORDERS OF THE BRAIN AND SPINAL CORD

Oncologic disorders of the brain and spinal cord include several types of neoplasms, each with its own biology, prognosis, and treatment options. Because of the unique anatomy and physiology of the central nervous system (CNS), this collection of neoplasms is challenging to diagnose and treat.

### *Primary Brain Tumors*

A brain tumor is a localized intracranial lesion that occupies space within the skull. A tumor usually grows as a spherical mass, but it also can grow diffusely and infiltrate tissue. The effects of neoplasms are caused by the compression and infiltration of tissue. A variety of physiologic changes result, causing any or all of the following pathophysiologic events:

- Increased intracranial pressure (ICP) and cerebral edema
- Seizure activity and focal neurologic signs
- Hydrocephalus
- Altered pituitary function

Primary brain tumors originate from cells and structures within the brain. Secondary, or metastatic, brain tumors develop from structures outside the brain and occur in 10% to 20% of patients with cancer. Brain tumors rarely metastasize outside the CNS (Arzbaecher, 2007). Metastatic lesions to the brain can occur from the lung, breast, lower gastrointestinal tract, pancreas, kidney, and skin (melanomas).

The cause of primary brain tumors is unknown. The strongest risk factor is exposure to ionizing radiation. Both glial and meningeal neoplasms have been linked to irradiation of the cranium, with a latency period of 10 to 20 years after exposure (American Brain Tumor Association [ABTA], 2007). Many additional risk factors have been investigated, but only rare genetic mutations, familial tendencies for astrocytoma, and epilepsy and seizures show strong evidence of an association. In the case of epilepsy and seizures, the relationship is unlikely to be causal (Pollock, 2006).

An estimated 21,810 new cases of malignant brain and other nervous system tumors are projected for the year 2008 (Jemal, Siegel, Ward, et al., 2008). Secondary tumors or metastases to the brain from a systemic primary cancer are even more common than new cases of malignant brain and other nervous system tumors. The highest incidence of brain tumors in adults occurs in the fifth, sixth, and seventh decades. In adults, most brain tumors originate from glial cells (cells that make up the structure and support system of the brain and spinal cord) and are supratentorial (located above the covering of the cerebellum). Neoplastic lesions in the brain ultimately cause death by impairing vital functions, such as respiration, or by increasing ICP. Between 1990 and 2004, death rates for brain and other nervous system tumors declined in both men and women. The rates decreased by 12.6% for men and by 14.4% for women.

#### Types of Primary Brain Tumors

Brain tumors may be classified into several groups: those arising from the coverings of the brain (eg, dural meningioma), those developing in or on the cranial nerves (eg, acoustic neuroma), those originating within brain tissue (eg, glioma), and metastatic lesions originating elsewhere in the body. Tumors of the pituitary and pineal glands and of cerebral blood vessels are also types of brain tumors. Relevant clinical considerations include the location and the histologic character of the tumor. Tumors may be benign or malignant. A benign tumor, such as a colloid cyst, can occur in a vital area and can grow large enough to have serious effects (Richards & Ballard, 2008). See Chart 65-1 for the classification of brain tumors.

##### *Gliomas*

Glial tumors, the most common type of intracerebral brain neoplasm, are divided into many categories (Wen & Kesari, 2008). Astrocytomas are the most common type of glioma and are graded from I to IV, indicating the degree of malignancy (Arzbaecher, 2007). The grade is based on cellular density, cell mitosis, and appearance. Usually, these tumors spread by infiltrating into the surrounding neural connective tissue and therefore cannot be totally removed without causing considerable damage to vital structures.

Oligodendroglial tumors represent 20% of gliomas and are categorized as low grade or high grade (anaplastic) (ABTA, 2007). The histologic distinction between astrocy-

**Chart 65-1 • *Classification of Brain Tumors in Adults***

**I. Intracerebral Tumors**
- A. Gliomas—infiltrate any portion of the brain; most common type of brain tumor
  1. Astrocytomas (grades I and II)
  2. Glioblastoma multiforme (astrocytoma grades III and IV)
  3. Oligodendrocytoma (low and high grades)
  4. Ependymoma (grades I to IV)
  5. Medulloblastoma

**II. Tumors Arising From Supporting Structures**
- A. Meningiomas
- B. Neuromas (acoustic neuroma, schwannoma)
- C. Pituitary adenomas

**III. Developmental Tumors**
- A. Angiomas
- B. Dermoid, epidermoid, teroma, craniopharyngioma

**IV. Metastatic Lesions**

tomas and oligodendrogliomas is difficult to make but important, because oligodendrogliomas are more sensitive than astrocytomas to chemotherapy.

### Meningiomas

Meningiomas, which represent 15% of all primary brain tumors, are common benign encapsulated tumors of arachnoid cells on the meninges (Pollock, 2006). They are slow growing and occur most often in middle-aged adults (more often in women). Meningiomas most often occur in areas proximal to the venous sinuses. Manifestations depend on the area involved and are the result of compression rather than invasion of brain tissue. Preferred treatment for symptomatic lesions is surgery with complete removal or partial dissection.

### Acoustic Neuromas

An acoustic neuroma is a tumor of the eighth cranial nerve, the cranial nerve most responsible for hearing and balance. It usually arises just within the internal auditory meatus, where it frequently expands before filling the cerebellopontine recess. An acoustic neuroma may grow slowly and attain considerable size before it is correctly diagnosed. The patient usually experiences loss of hearing, tinnitus, and episodes of vertigo and staggering gait. As the tumor becomes larger, painful sensations of the face may occur on the same side, as a result of the tumor's compression of the fifth cranial nerve. Many acoustic neuromas are benign and can be managed conservatively. Many that continue to grow can be surgically removed and have a good prognosis (see Chapter 59) (Pollock, 2006). Some acoustic neuromas may be suitable for stereotactic radiotherapy rather than open craniotomy. Stereotactic radiotherapy is discussed later in this chapter.

### Pituitary Adenomas

Pituitary tumors represent about 10% to 15% of all brain tumors and cause symptoms as a result of pressure on adjacent structures or hormonal changes such as hyperfunction or hypofunction of the pituitary (Pollock, 2006).

#### Pressure Effects of Pituitary Adenomas

Pressure from a pituitary adenoma may be exerted on the optic nerves, optic chiasm, or optic tracts or on the hypothalamus or the third ventricle if the tumor invades the cavernous sinuses or expands into the sphenoid bone. These pressure effects produce headache, visual dysfunction, hypothalamic disorders (disorders of sleep, appetite, temperature, and emotions), increased ICP, and enlargement and erosion of the sella turcica.

#### Hormonal Effects of Pituitary Adenomas

Functioning pituitary tumors can produce one or more hormones normally produced by the anterior pituitary. There are prolactin-secreting pituitary adenomas (prolactinomas), growth hormone–secreting pituitary adenomas that produce acromegaly in adults, and adrenocorticotropic hormone (ACTH)–producing pituitary adenomas that result in Cushing's disease (Gordon, 2007). Adenomas that secrete thyroid-stimulating hormone or follicle-stimulating hormone and luteinizing hormone occur infrequently, whereas adenomas that produce both growth hormone and prolactin are relatively common.

The female patient whose pituitary gland is secreting excessive quantities of prolactin presents with amenorrhea or galactorrhea (excessive or spontaneous flow of milk). Male patients with prolactinomas may present with impotence and hypogonadism. Acromegaly, caused by excess growth hormone, produces enlargement of the hands and feet, distortion of the facial features, and pressure on peripheral nerves (entrapment syndromes). The clinical features of Cushing's disease, a condition associated with prolonged overproduction of cortisol, occur with excessive production of ACTH. Manifestations include a form of obesity with redistribution of fat to the facial, supraclavicular, and abdominal areas; hypertension; purple striae and ecchymoses; osteoporosis; elevated blood glucose levels; and emotional disorders. Endocrine disorders resulting from these tumors are discussed in Chapter 42.

### Angiomas

Brain angiomas (masses composed largely of abnormal blood vessels) are found either in or on the surface of the brain. They occur in the cerebellum in 83% of cases. Some persist throughout life without causing symptoms; others cause symptoms of a brain tumor. Occasionally, the diagnosis is suggested by the presence of another angioma somewhere in the head or by a bruit (an abnormal sound) that is audible over the skull. Because the walls of the blood vessels in angiomas are thin, these patients are at risk for hemorrhagic stroke. In fact, cerebral hemorrhage in people younger than 40 years of age should suggest the possibility of an angioma.

## Gerontologic Considerations

The most frequent tumor types in the elderly are anaplastic astrocytoma, glioblastoma multiforme, and cerebral metastases from other sites. The incidence of primary brain tumors and the likelihood of malignancy increase with age. Intracranial tumors can produce personality changes, confusion, speech dysfunction, or disturbances of gait. In elderly patients, early signs and symptoms of intracranial tumors can be easily overlooked or incorrectly attributed to cognitive and neurologic changes associated with normal aging. Neurologic signs and symptoms in the elderly must be carefully evaluated, because 10% of brain metastases occur in patients with a history of prior cancer. Researchers are investigating patterns of care and clinical outcomes of elderly patients with primary brain tumors (Barnholtz-Sloan, Williams, Maldonado, et al., 2008).

## Clinical Manifestations

Brain tumors can produce both focal or generalized neurologic signs and symptoms. Generalized symptoms reflect increased ICP, and the most common focal or specific signs and symptoms result from tumors that interfere with functions in specific brain regions. Figure 65-1 indicates common tumor sites in the brain.

### Increased Intracranial Pressure

As discussed in Chapter 61, the skull is a rigid compartment containing essential noncompressible contents: brain matter,

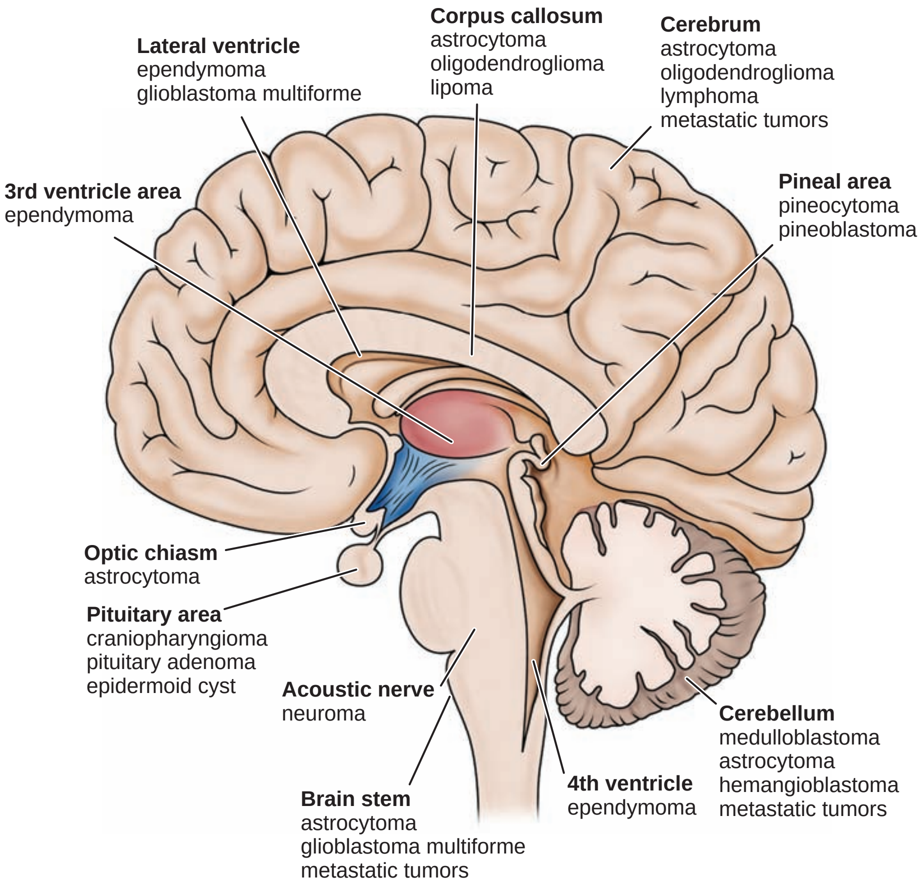



**Figure 65-1** Common brain tumor sites.

intravascular blood, and cerebrospinal fluid (CSF). According to the modified Monro-Kellie hypothesis, if any one of these skull components increases in volume, ICP increases unless one of the other components decreases in volume. Consequently, any change in volume occupied by the brain (as occurs with disorders such as brain tumor or cerebral edema) produces signs and symptoms of increased ICP.

Symptoms of increased ICP result from a gradual compression of the brain by the enlarging tumor. The effect is a disruption of the equilibrium that exists between the brain, the CSF, and the cerebral blood. As the tumor grows, compensatory adjustments may occur through compression of intracranial veins, reduction of CSF volume (by increased absorption or decreased production), a modest decrease in cerebral blood flow, or reduction of intracellular and extracellular brain tissue mass. When these compensatory mechanisms fail, the patient develops signs and symptoms of increased ICP, most often including headache, nausea with or without vomiting, and **papilledema** (edema of the optic disk) (Rowland, 2005). Personality changes and a variety of focal deficits, including motor, sensory, and cranial nerve dysfunction, are common.

### Headache

Headache, although not always present, is most common in the early morning and is made worse by coughing, straining, or sudden movement. It is thought to be caused by the tumor's invading, compressing, or distorting the pain-sensitive structures or by edema that accompanies the tumor. Headaches are usually described as deep or expanding or as dull but unrelenting. Frontal tumors usually produce a bilateral frontal headache; pituitary gland tumors produce pain radiating between the two temples (bitemporal); in cerebellar tumors, the headache may be located in the suboccipital region at the back of the head.

### Vomiting

Vomiting, seldom related to food intake, is usually the result of irritation of the vagal centers in the medulla. Forceful vomiting is described as projectile vomiting.

### Visual Disturbances

Papilledema is present in 70% to 75% of patients and is associated with visual disturbances such as decreased visual acuity, diplopia (double vision), and visual field deficits (Rowland, 2005).

## *Localized Symptoms*

Common focal or localized symptoms are hemiparesis, seizures, and mental status changes (Rowland, 2005). When specific regions of the brain are affected, additional local signs and symptoms occur, such as sensory and motor abnormalities, visual alterations, alterations in cognition, and language disturbances (eg, aphasia). The progression of the signs and symptoms is important, because it indicates tumor growth and expansion. For example, a rapidly developing hemiparesis is more typical of a highly malignant glioma than of a low-grade tumor.

Although some tumors are not easily localized because they lie in so-called silent areas of the brain (ie, areas in which functions are not definitely determined), many tumors can be localized by correlating the signs and symptoms to specific areas in the brain, as follows:

- A motor cortex tumor produces seizurelike movements localized on one side of the body, called jacksonian seizures.
- An occipital lobe tumor produces visual manifestations: contralateral homonymous hemianopsia (visual loss in half of the visual field on the opposite side of the tumor) and visual hallucinations.
- A cerebellar tumor causes dizziness, an ataxic or staggering gait with a tendency to fall toward the side of the lesion, marked muscle incoordination, and nystagmus (involuntary rhythmic eye movements), usually in the horizontal direction.
- A frontal lobe tumor frequently produces personality disorders, changes in emotional state and behavior, and an apathetic mental attitude. The patient often becomes extremely untidy and careless and may use obscene language.
- A cerebellopontine angle tumor usually originates in the sheath of the acoustic nerve and gives rise to a characteristic sequence of symptoms. Tinnitus and vertigo appear first, soon followed by progressive nerve deafness (eighth cranial nerve dysfunction). Numbness and tingling of the face and tongue occur (due to involvement of the fifth cranial nerve). Later, weakness or paralysis of the face develops (seventh cranial nerve involvement). Finally, because the enlarging tumor presses on the cerebellum, abnormalities in motor function may be present.

## Assessment and Diagnostic Findings

The history of the illness and the manner and time frame in which the symptoms evolved are key components in the diagnosis of brain tumors. A neurologic examination indicates the areas of the CNS that are involved. To assist in the precise localization of the lesion, a battery of tests is performed. Computed tomography (CT) scans, enhanced by a contrast agent, can give specific information concerning the number, size, and density of the lesions and the extent of secondary cerebral edema. CT scans can provide information about the ventricular system. A magnetic resonance imaging (MRI) scan is the most helpful diagnostic tool for detecting brain tumors, particularly smaller lesions, and tumors in the brain stem and pituitary regions, where bone is thick (Fig. 65-2). In a few instances, the appearance of a brain tumor on an MRI scan is so characteristic that a biopsy is unnecessary, especially when the tumor is located in a part of the brain that is difficult to biopsy (Rowland, 2005).

Positron emission tomography (PET) is used to supplement MRI scanning in centers where it is available. On PET scans, low-grade tumors are associated with hypometabolism and high-grade tumors show hypermetabolism. This information can be useful in making treatment decisions (ABTA, 2007). Computer-assisted stereotactic (three-dimensional) biopsy is used to diagnose deep-seated brain tumors and to provide a basis for treatment and prognosis.

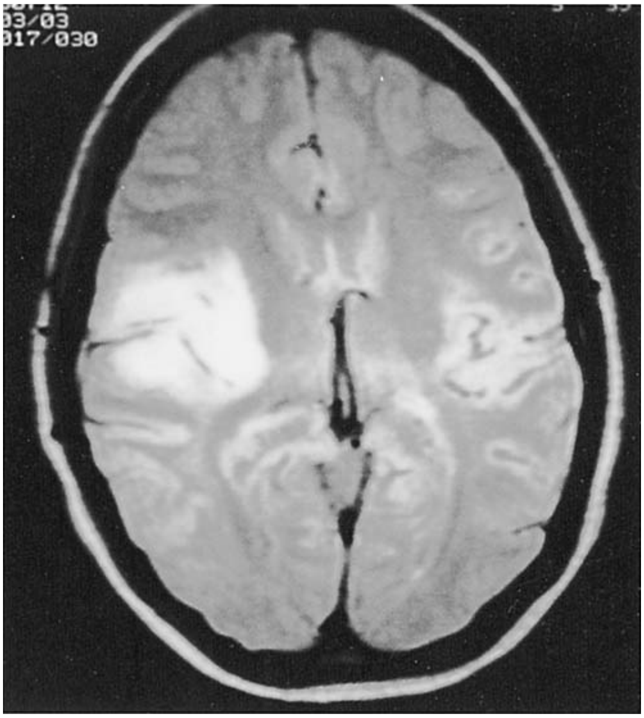



**Figure 65-2** Low-grade glioma. Magnetic resonance image of the brain shows an abnormal density in the right temporal lobe. Courtesy of the Hospital of the University of Pennsylvania, Nuclear Medicine Section, Philadelphia, PA.

Cerebral angiography provides visualization of cerebral blood vessels and can localize most cerebral tumors.

An electroencephalogram (EEG) can detect an abnormal brain wave in regions occupied by tumor; it is used to evaluate temporal lobe seizures and to assist in ruling out other disorders. Cytologic studies of the CSF may be performed to detect malignant cells, because CNS tumors can shed cells into the CSF.

## Medical Management

A variety of medical treatment modalities, including chemotherapy and external-beam radiation therapy, are used alone or in combination with surgical resection (Wen & Kesari, 2008). Radiation therapy, the cornerstone of treatment for many brain tumors, decreases the incidence of recurrence of incompletely resected tumors. Brachytherapy (the surgical implantation of radiation sources to deliver high doses at a short distance) has had promising results for primary malignancies. It is usually used as an adjunct to conventional radiation therapy or as a rescue measure for recurrent disease.

Intravenous (IV) autologous bone marrow transplantation is used in some patients who will receive chemotherapy or radiation therapy, because it can "rescue" the patient from the bone marrow toxicity associated with high doses of chemotherapy and radiation. A fraction of the patient's bone marrow is aspirated, usually from the iliac crest, and stored. The patient receives large doses of chemotherapy or radiation therapy to destroy large numbers of malignant cells. The marrow is then reinfused by IV after treatment is completed.

Gene transfer therapy uses retroviral vectors to carry genes to the tumor, reprogramming the tumor tissue for susceptibility to treatment. This approach is being tested (ABTA, 2007).

### *Surgical Management*

The objective of surgical management is to remove or destroy the entire tumor without increasing the neurologic deficit (paralysis, blindness) or to relieve symptoms by partial removal (decompression). A variety of treatment modalities may be used; the specific approach depends on the type of tumor, its location, and its accessibility. In many patients, combinations of these modalities are used. Most pituitary adenomas are treated by transsphenoidal microsurgical removal (see Chapter 61), and the remainder of tumors that cannot be removed completely are treated by radiation (Pollock, 2006). An untreated brain tumor ultimately leads to death, either from increasing ICP or from the damage the tumor causes to brain tissue.

Conventional surgical approaches require a craniotomy (incision into the skull). See Chapter 61 for a discussion of care of the patient who has undergone a craniotomy. This approach is used in patients with meningiomas, acoustic neuromas, cystic astrocytomas of the cerebellum, colloid cysts of the third ventricle, congenital tumors such as dermoid cyst, and some of the granulomas. With improved imaging techniques and the availability of the operating microscope and microsurgical instrumentation, even large tumors can be removed through a relatively small craniotomy. For patients with malignant glioma, complete removal of the tumor and cure are not possible, but the rationale for resection includes relief of ICP, removal of any necrotic tissue, and reduction in the bulk of the tumor, which theoretically leaves behind fewer cells to become resistant to radiation or chemotherapy.

Stereotactic approaches involve the use of a three-dimensional frame that allows very precise localization of the tumor; a stereotactic frame and multiple imaging studies (x-rays, CT scans) are used to localize the tumor and verify its position (Fig. 65-3). New brain-mapping technology helps determine how close diseased areas of the brain are to structures essential for normal brain function. Lasers or radiation can be delivered with stereotactic approaches. Radioisotopes such as iodine 131 ($^{131}$I) can also be implanted directly into the tumor to deliver high doses of radiation to the tumor (brachytherapy) while minimizing effects on surrounding brain tissue.

Stereotactic procedures may be performed using a linear accelerator or gamma knife to perform radiosurgery. These procedures allow treatment of deep, inaccessible tumors, often in a single session. Precise localization of the tumor is accomplished by the stereotactic approach and by minute measurements and precise positioning of the patient. Multiple narrow beams then deliver a very high dose of radiation. An advantage of this method is that no surgical incision is needed; a disadvantage is the lag time between treatment and the desired result (Pollock, 2006; Swinson & Friedman, 2008).

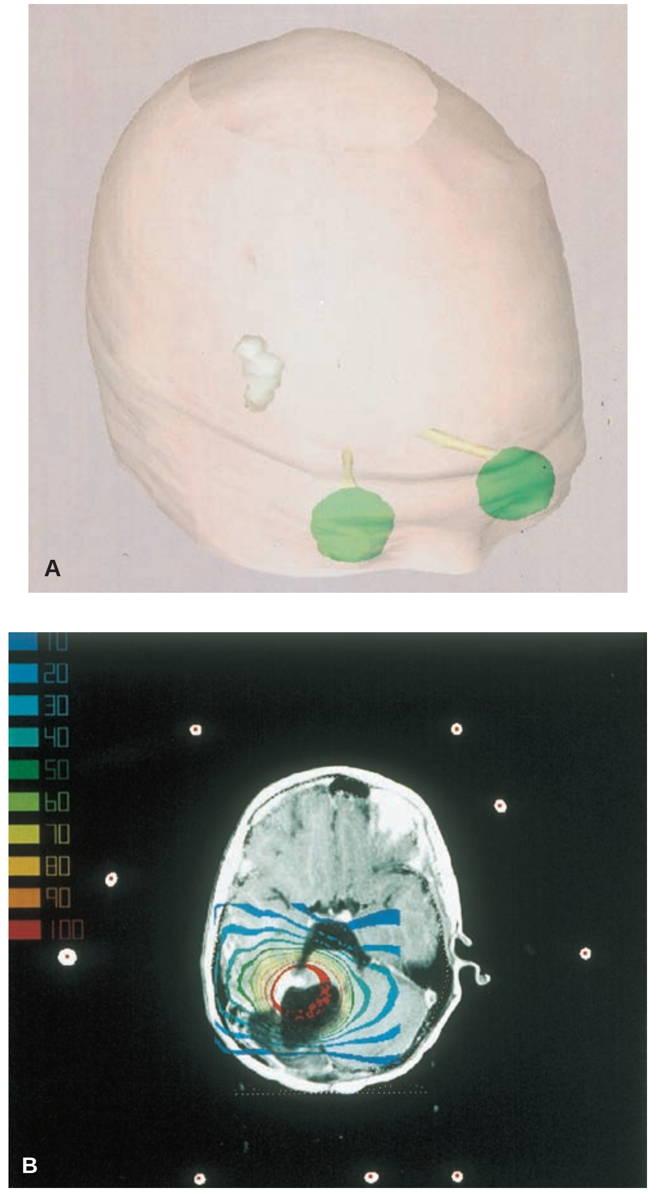



**Figure 65-3** **A,** Using stereotactic or "brain-mapping" guided approach, a 3-D computer image fuses the computed tomography image and magnetic resonance image to pinpoint the exact location of the brain tumor. This low-grade astrocytoma is localized adjacent to the brain stem, is nonoperable, and is treated with radiation. Note the optic chasm and optic nerves. **B,** Computerized image of the prescribed radiation dose.

## Nursing Management

The patient with a brain tumor may be at increased risk for aspiration as a result of cranial nerve dysfunction. Preoperatively, the gag reflex and ability to swallow are evaluated. In patients with diminished gag response, care includes teaching the patient to direct food and fluids toward the unaffected side, having the patient sit upright to eat, offering a semisoft diet, and having suction readily available. The effects of increased ICP caused by the tumor mass are reviewed in Chapter 61. The nurse performs neurologic checks, monitors vital signs, maintains a neurologic flow chart, spaces nursing interventions to prevent rapid increase in ICP, and reorients the patient when necessary to person, time, and place. Patients with changes in cognition caused by their lesion require frequent reorientation and the use of orienting devices (eg, personal possessions, photographs, lists, a

clock), supervision of and assistance with self-care, and ongoing monitoring and intervention for prevention of injury. Patients with seizures are carefully monitored and protected from injury. Motor function is checked at intervals, because specific motor deficits may occur, depending on the tumor's location. Sensory disturbances are assessed. Speech is evaluated. Eye movement and pupillary size and reaction may be affected by cranial nerve involvement.

The psychosocial effects on family caregivers of a family member who has a primary malignant brain tumor may be significant (Schmer, Ward-Smith, Latham, et al., 2008) (Chart 65-2).

The nursing process for patients undergoing neurosurgery is discussed in Chapter 61. The patient's functional abilities should be reassessed postoperatively, because changes can occur.

## Cerebral Metastases

A significant number of patients with cancer experience neurologic deficits caused by metastasis to the brain. Although metastatic lesions to the brain are the most common intracerebral tumor, their exact incidence is unknown (Raizer & Abrey, 2007). This high rate of occurrence is clinically important as more patients with all forms of cancer live longer because of improved therapies. Neurologic signs and symptoms include headache, gait disturbances, visual impairment, personality changes, altered mentation (memory loss and confusion), focal weakness, paralysis, aphasia, and seizures. These signs and symptoms can be devastating to both patient and family.

### Medical Management

The treatment of metastatic brain cancer is palliative and involves eliminating or reducing serious symptoms. Even when palliation is the goal, distressing signs and symptoms can be relieved, thereby improving the quality of life for both patient and family. Patients with intracerebral metastases who are not treated have a steady downhill course with a limited survival time, whereas those who are treated may survive for slightly longer periods. The median survival time for patients with no treatment for brain metastases is 1 month; with corticosteroid treatment alone it is 2 months; radiation therapy extends the median survival time to 3 to 6 months.

The therapeutic approach includes radiation therapy (the foundation of treatment), surgery (usually for a single intracranial metastasis), and chemotherapy; more often, some combination of these treatments is the optimal method. Gamma knife radiosurgery is considered if three or fewer lesions are present.

#### Pharmacologic Therapy

Corticosteroids are useful in relieving headache and alterations in level of consciousness. Corticosteroids such as dexamethasone (Decadron) and prednisone are thought to reduce inflammation and edema around tumors (Karch, 2008). Other medications used include osmotic diuretics (eg, mannitol [Osmitrol]) to decrease the fluid content of the brain, which leads to a decrease in ICP. Antiseizure agents (eg, phenytoin [Dilantin]) are used to prevent and treat seizures (Rowland, 2005). The pharmacologic management of pituitary tumors is complex and usually carried

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**CHART 65-2** NURSING RESEARCH PROFILE

***The Caregiver Perspective When a Family Member Has a Malignant Brain Tumor***

Schmer, C., Ward-Smith, P., Latham, S., et al. (2008). When a family member has a malignant brain tumor: The caregiver perspective. *Journal of Neuroscience Nursing, 40*(2), 78–84.

**Purpose**

There have been no significant advances in the treatment of malignant brain tumors over the past 25 years, and care is performed primarily by family members. The purpose of this study was to explore the perspective of the caregiver for a patient receiving chemotherapy for initial treatment of a malignant brain tumor.

**Design**

This was a phenomenologic study that used interviews to explore caregiver perspectives. Ten family members (seven spouses, two daughters, and one son-in-law) provided data. Semi-structured interviews took place with the caregiver while the patient was receiving chemotherapy within the first 6 months of treatment for a primary malignant brain tumor. Data analysis was conducted using Colaizzi's method, a qualitative data analysis technique, to identify themes.

**Findings**

Data analysis uncovered three main themes. The first was that the diagnosis of a brain tumor is a shock; all participants used the work *shock* when explaining their feelings on hearing the diagnosis. The second was that immediate family role changes occur; diagnosis of a primary malignant brain tumor and subsequent treatment resulted in immediate family role changes for both the patient and caregiver. The final theme was that there are psychosocial effects for the caregiver, his or her family, and the person with the brain tumor. Participants did not perceive caring for the family member as a burden.

**Nursing Implications**

Little research has focused on the experience and changing roles of family members immediately after diagnosis or during the initial treatment phase of a terminal illness. This research provides beginning knowledge for health care professionals about the experience of a family caregiver of a patient with a primary brain tumor. During the first 6 months of treatment, there was a low physical need burden but significant psychosocial effects. Nurses working with patients and families should be prepared to address these psychosocial effects (eg, family role changes).

out on an outpatient basis (Gordon, 2007). Venous thromboembolic events, such as deep vein thrombosis (DVT) and pulmonary embolism (PE), occur in about 15% of patients and are associated with significant morbidity. Anticoagulants usually are not prescribed because of the risk of CNS hemorrhage; however, prophylactic therapy with low-molecular-weight heparin is under investigation.

Chemotherapy plays a small role in managing brain metastasis because of poor penetration across the blood–brain barrier. Drug penetration and sensitivity of brain cells are two factors that determine the responsiveness of metastatic brain tumors to chemotherapy. Research is being directed at multidrug regimens and drug resistance (ABTA, 2007). Encouraging results have been seen with chemotherapeutic agents such as carmustine (BCNU), lomustine (CCNU), and PCV (a triple-drug combination of procarbazine hydrochloride, lomustine, and vincristine). Promising results have been seen with the use of topotecan (Hycamtin), another chemotherapy agent.

Pain is managed by means of a stepped progression in the doses and type of analgesic agents needed for relief. If the patient has severe pain, morphine can be infused into the epidural or subarachnoid space through a spinal needle and a catheter placed as near as possible to the spinal segment where the pain is projected. Small doses of morphine are administered at prescribed intervals (see Chapter 13).

## NURSING PROCESS

### The Patient With Cerebral Metastases or Incurable Brain Tumor

#### Assessment

The nursing assessment includes a baseline neurologic examination and focuses on how the patient is functioning, moving, and walking; adapting to weakness or paralysis and to loss of vision and speech; and dealing with seizures. Assessment addresses symptoms that cause distress to the patient and affect the quality of life, including pain, respiratory problems, bowel and bladder disorders, sleep disturbances, and impairment of skin integrity, fluid balance, and temperature regulation (Arzbaecher, 2007). Tumor invasion, compression, or obstruction may cause these disorders.

Nutritional status is assessed, because cachexia (weak and emaciated condition) is common in patients with metastases. The nurse explores changes associated with poor nutritional status (anorexia, pain, weight loss, altered metabolism, muscle weakness, malabsorption, and diarrhea) and asks the patient about altered taste sensations that may be secondary to dysphagia, weakness, and depression and about distortions and impaired sense of smell (anosmia).

The nurse takes a dietary history to assess food intake, intolerance, and preferences. Calculation of body mass index can confirm the loss of subcutaneous fat and lean body mass (see Chapter 5). Biochemical measurements are reviewed to assess the degree of malnutrition, impaired cellular immunity, and electrolyte balance (see Appendix A for normal laboratory values). A dietitian assists in determining the caloric needs of the patient.

The nurse works with other members of the health care team to assess the impact of the illness on the family in terms of home care, altered relationships, financial problems, time pressures, and family problems. This information is important in helping family members cope with the diagnosis and the changes associated with it.

#### Diagnosis

##### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Self-care deficit (feeding, bathing, and toileting) related to loss or impairment of motor and sensory function and decreased cognitive abilities
- Imbalanced nutrition, less than body requirements, related to cachexia due to treatment and tumor effects, decreased nutritional intake, and malabsorption
- Anxiety related to fear of dying, uncertainty, change in appearance, or altered lifestyle
- Interrupted family processes related to anticipatory grief and the burdens imposed by the care of the person with a terminal illness

Other nursing diagnoses of the patient with cerebral metastases may include acute pain related to tumor compression; impaired gas exchange related to dyspnea; constipation related to decreased fluid and dietary intake and medications; impaired urinary elimination related to reduced fluid intake, vomiting, and side effects of medications; sleep pattern disturbances related to discomfort and fear of dying; impairment of skin integrity related to cachexia, poor tissue perfusion, and decreased mobility; deficient fluid volume related to fever, vomiting, and low fluid intake; and ineffective thermoregulation related to hypothalamic involvement, fever, and chills. See Chapter 16 for assessment and nursing interventions for the patient with cancer.

#### Planning and Goals

The goals for the patient may include compensating for self-care deficits, improving nutrition, reducing anxiety, enhancing family coping skills, and absence of complications.

#### Nursing Interventions

##### *Compensating for Self-Care Deficits*

The patient may have difficulty participating in goal setting as the tumor metastasizes and affects cognitive function. The nurse should encourage the family to keep the patient as independent as possible for as long as possible. Increasing assistance with self-care activities is required. Because the patient with cerebral metastasis and the family live with uncertainty, they are encouraged to plan for each day and to make the most of each day. The tasks and challenges are to assist the patient to find useful coping mechanisms, adaptations, and compensations for solving problems that arise. This helps patients maintain some sense of control. An individualized exercise program helps maintain strength, endurance, and range of motion. Eventually, referral for home or hospice care may be necessary (see Chapter 17).

#### *Improving Nutrition*

Patients with nausea, vomiting, diarrhea, breathlessness, and pain are rarely interested in eating. These symptoms are managed or controlled through assessment, planning, and care. The nurse teaches the family how to position the patient for comfort during meals. Meals are planned for times when the patient is rested and in less distress from pain or the effects of treatment.

The patient needs to be clean, comfortable, and free of pain for meals, in an environment that is as attractive as possible. Oral hygiene before meals helps to improve appetite. Offensive sights, sounds, and odors are eliminated. Creative strategies may be required to make food more palatable, provide enough fluids, and increase opportunities for socialization during meals. The family may be asked to keep a daily weight chart and to record the quantity of food eaten to determine the daily calorie count. Dietary supplements, if acceptable to the patient, can be provided to meet increased caloric needs. If the patient is not interested in most usual foods, those foods preferred by the patient should be offered. When the patient shows marked deterioration as a result of tumor growth and effects, some other form of nutritional support (eg, tube feeding, parenteral nutrition) may be indicated if consistent with the patient's end-of-life preferences (Dudek, 2006). Nursing interventions include assessing the patency of the central and IV lines or feeding tube, monitoring the insertion site for infection, checking the infusion rate, monitoring intake and output, and changing the IV tubing and dressing. Family members are instructed in these techniques if they will be providing care at home. Parenteral nutrition can be provided at home if indicated.

The patient's quality of life may guide the selection, initiation, maintenance, and discontinuation of nutritional support. The nurse and family should not place too much emphasis on eating or on discussions about food, because the patient may not desire aggressive nutritional intervention. The subsequent course of action must be congruent with the wishes and choices of the patient and family.

#### *Relieving Anxiety*

Patients with cerebral metastases may be restless, with changing moods that may include intense depression, euphoria, paranoia, and severe anxiety. The response of patients to terminal illness reflects their pattern of reaction to other crisis situations. Serious illness imposes additional strains that often bring other unresolved problems to light. The patient's own coping strategies can help deal with anxious and depressed feelings. Health care providers need to be sensitive to the patient's concerns and fears.

Patients need the opportunity to exercise some control over their situation. A sense of mastery can be gained as they learn to understand the disease and its treatment and how to deal with their feelings. The presence of family, friends, a spiritual advisor, and health professionals may be supportive. Support groups such as the Brain Tumor Support Group may provide a feeling of support and strength.

Spending time with patients allows them time to talk and to communicate their fears and concerns. Open communication and acknowledgment of fears are often therapeutic. Touch is also a form of communication. These patients need reassurance that continuing care will be provided and that they will not be abandoned. The situation becomes more endurable when others share in the experience of dying. If a patient's emotional reactions are very intense or prolonged, additional help from a spiritual advisor, social worker, or mental health professional may be indicated.

#### *Enhancing Family Processes*

The family needs to be reassured that their loved one is receiving optimal care and that attention will be paid to the patient's changing symptoms and concerns. When the patient can no longer carry out self-care, the family and additional support systems (social worker, home health aide, home care nurse, hospice nurse) may be needed. End-of-life care is provided with respect, and reassurance is provided by communicating the plan of care to the family (Fields, 2007).

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient and family often have major responsibility for care at home. Therefore, teaching includes pain management strategies, prevention of complications related to treatment strategies, and methods to ensure adequate fluid and food intake (Chart 65-3). Teaching needs of the patient and family regarding care priorities are likely to change as the disease progresses. The nurse should assess the changing needs of the patient and the family and inform them about resources and services early, to assist them in dealing with changes in the patient's condition.

**CONTINUING CARE.** Home care nursing and hospice services are valuable resources that should be made available to the patient and the family early in the course of a terminal illness. Anticipating needs before they occur can assist in smooth initiation of services. Home care needs and interventions focus on four major areas: palliation of symptoms and pain control, assistance in self-care, control of treatment complications, and administration of specific forms of treatment, such as parenteral nutrition. The home care nurse assesses pain management, respiratory status, complications of the disorder and its treatment, and the patient's cognitive and emotional status. Additionally, the nurse assesses the family's ability to perform necessary care and notifies the physician about changing needs or complications if indicated.

The patient and family who elect to care for the patient at home as the disease progresses benefit from the care and support provided through hospice and palliative care services (Fields, 2007). Steps to initiate hospice care, including discussion of hospice care as an option, should not be postponed until death is imminent. Exploration of hospice care as an option should be initiated at a time when hospice services can provide support and care to the patient and family consistent with their end-of-life decisions and can assist in allowing death with dignity. End-of-life care is further described in Chapter 17.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Engages in self-care activities as long as possible
   a. Uses assistive devices or accepts assistance as needed

**CHART 65-3** HOME CARE CHECKLIST

***The Patient With Cerebral Metastases***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • State effects of the tumor according to its type and location in the brain. | ✔ | ✔ |
| • Describe side effects of treatment. | ✔ | ✔ |
| • Identify community resources, including: | | |
| • Home health services | ✔ | ✔ |
| • Hospices | ✔ | ✔ |
| • Support groups | ✔ | ✔ |
| • American Brain Tumor Association | ✔ | ✔ |
| • Identify coping strategies, such as: | | |
| • Taking control, setting daily goals, and staying positive | ✔ | ✔ |
| • Rehabilitation to improve self-care | ✔ | ✔ |
| • Relaxation techniques | ✔ | ✔ |
| • Family support | | ✔ |
| • Verbalize an understanding of the treatment plan for: | | |
| • Medications and pain control | ✔ | ✔ |
| • Nutritional needs | ✔ | ✔ |
| • Contacting the health care provider | ✔ | ✔ |

   b. Schedules periodic rest periods to permit maximal participation in self-care
2. Maintains as optimal a nutritional status as possible
   a. Eats and accepts food within limits of condition and preferences
   b. Accepts alternative methods of providing nutrition if indicated
3. Reports being less anxious
   a. Is less restless and is sleeping better
   b. Verbalizes concerns and fears about death
   c. Participates in activities of personal importance as long as feasible
4. Family members seek help as needed
   a. Demonstrate ability to bathe, feed, and care for the patient and participate in pain management and prevention of complications
   b. Express feelings and concerns to appropriate health professionals
   c. Discuss and seek hospice care as an option

## Spinal Cord Tumors

Tumors within the spine are classified according to their anatomic relation to the spinal cord. They include intramedullary lesions (within the spinal cord), extramedullary-intradural lesions (within or under the spinal dura), and extramedullary-extradural lesions (outside the dural membrane). Tumors that occur within the spinal cord or exert pressure on it cause symptoms ranging from localized or shooting pains and weakness and loss of reflexes above the tumor level to progressive loss of motor function and paralysis. Usually, sharp pain occurs in the area innervated by the spinal roots that arise from the cord in the region of the tumor. In addition, increasing sensory deficits develop below the level of the lesion.

### Assessment and Diagnostic Findings

Neurologic examination and diagnostic studies are used to make the diagnosis. Neurologic examination includes assessment of pain, loss of reflexes, loss of sensation or motor function, and the presence of weakness and paralysis. Additional assessment findings usually include pain duration for longer than 1 month and an elevated erythrocyte sedimentation rate. Helpful diagnostic studies include x-rays, radionuclide bone scans, CT scans, MRI scans, and biopsy. The MRI scan is the most commonly used and the most sensitive diagnostic tool, and it is particularly helpful in detecting epidural spinal cord compression and metastases (Rowland, 2005).

### Medical Management

Treatment of specific intraspinal tumors depends on the type and location of the tumor and the presenting symptoms and physical status of the patient. Surgical intervention is the primary treatment for most spinal cord tumors. Other treatment modalities include partial removal of the tumor, decompression of the spinal cord, chemotherapy, and radiation therapy, particularly for intramedullary tumors and metastatic lesions (Rowland, 2005).

Epidural spinal cord compression occurs in 5% to 7% of patients who die of cancer and is considered a neurologic emergency. For the patient with epidural spinal cord compression resulting from metastatic cancer (most commonly from breast, prostate, or lung), high-dose dexamethasone (Decadron) combined with radiation therapy is effective in relieving pain (Held-Warmkessel, 2005). See Chapter 16 for a discussion of care of the patient with spinal cord

compression. Palliative care may be an option for the medical management of some patients.

### Surgical Management

Tumor removal is desirable but not always possible. The goal is to remove as much tumor as possible while sparing uninvolved portions of the spinal cord. Microsurgical techniques have improved the prognosis for patients with intramedullary tumors. Prognosis is related to the degree of neurologic impairment at the time of surgery, the speed with which symptoms occurred, and the origin of the tumor. Patients with extensive neurologic deficits before surgery usually do not make significant functional recovery even after successful tumor removal.

## Nursing Management

### Providing Preoperative Care

The objectives of preoperative care include recognition of neurologic changes through ongoing assessments, pain control, and management of altered activities of daily living (ADLs) resulting from sensory and motor deficits and bowel and bladder dysfunction. The nurse assesses for weakness, muscle wasting, spasticity, sensory changes, bowel and bladder dysfunction, and potential respiratory problems, especially if a cervical tumor is present. The patient is also evaluated for coagulation deficiencies. A history of aspirin intake is obtained and reported, because the use of aspirin may impede hemostasis postoperatively. Breathing exercises are taught and demonstrated preoperatively. Postoperative pain management strategies are discussed with the patient before surgery.

### Assessing the Patient After Surgery

The patient is monitored for deterioration in neurologic status. A sudden onset of neurologic deficit is an ominous sign and may be due to vertebral collapse associated with spinal cord infarction. Frequent neurologic checks are carried out, with emphasis on movement, strength, and sensation of the upper and lower extremities. Assessment of sensory function involves pinching the skin of the arms, legs, and trunk to determine if there is loss of feeling and, if so, at what level. Vital signs are monitored at regular intervals.

### Managing Pain

The prescribed pain medication should be administered in adequate amounts and at appropriate intervals to relieve pain and prevent its recurrence. Pain is the hallmark of spinal metastasis. Patients with sensory root involvement or vertebral collapse may suffer excruciating pain, which requires effective pain management (Hickey, 2009).

The bed is usually kept flat initially. The nurse turns the patient as a unit, keeping shoulders and hips aligned and the back straight. The side-lying position is usually the most comfortable, because this position imposes the least pressure on the surgical site. Placement of a pillow between the knees of the patient in a side-lying position helps to prevent extreme knee flexion.

### Monitoring and Managing Potential Complications

If the tumor was in the cervical area, respiratory compromise due to postoperative edema may occur. The nurse monitors the patient for asymmetric chest movement, abdominal breathing, and abnormal breath sounds. For a high cervical lesion, the endotracheal tube remains in place until adequate respiratory function is ensured. The patient is encouraged to perform deep-breathing and coughing exercises.

The area over the bladder is palpated or a bladder scan is performed to assess for urinary retention. The nurse also monitors for incontinence, because urinary dysfunction usually implies significant decompensation of spinal cord function. An intake and output record is maintained. Additionally, the abdomen is auscultated for bowel sounds.

Staining of the dressing may indicate leakage of CSF from the surgical site, which may lead to serious infection or to an inflammatory reaction in the surrounding tissues that can cause severe pain in the postoperative period.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

In preparation for discharge, the patient is assessed for the ability to function independently in the home and for the availability of resources such as family members to assist in caregiving. Patients with residual sensory involvement are cautioned about the dangers of extremes in temperature. They should be alerted to the dangers of heating devices (eg, hot water bottles, heating pads, space heaters). The patient is taught to check skin integrity daily. Patients with impaired motor function related to motor weakness or paralysis may require training in ADLs and safe use of assistive devices, such as a cane, walker, or wheelchair.

The patient and family members are instructed about pain management strategies, bowel and bladder management, and assessment for signs and symptoms that should be reported promptly.

#### Continuing Care

Referral for inpatient or outpatient rehabilitation may be warranted to improve self-care abilities. A home care referral may be indicated and provides the home care nurse with the opportunity to assess the patient's physical and psychological status and the patient's and family's ability to adhere to recommended management strategies. During the home visit, the nurse determines whether changes in neurologic function have occurred. The patient's respiratory status and nutritional status are assessed. The adequacy of pain management is assessed, and modifications are made to ensure adequate pain relief. The need for hospice services or placement in an extended-care facility is discussed with the patient and family if warranted, and the patient is asked about preferences for end-of-life care. Additionally, social workers may be consulted to assist the patient and family members in identifying support groups and agencies that can provide help in coping with the disease process.

# DEGENERATIVE DISORDERS

Disorders of the central and peripheral nervous system that are **neurodegenerative** (leading to deterioration of normal cells or function of the nervous system) are characterized by the slow onset of signs and symptoms. Patients are managed

at home for as long as possible and are admitted to the acute care setting for exacerbations, treatments, and surgical interventions as needed.

## Parkinson's Disease

Parkinson's disease is a slowly progressing neurologic movement disorder that eventually leads to disability. It is the fourth most common neurodegenerative disease, and 50,000 new cases are reported each year in the United States (Chen & Fernandez, 2007; Thomure, 2006). The disease affects men more often than women. Symptoms usually first appear in the fifth decade of life; however, cases have been diagnosed as early as 30 years of age.

The degenerative or idiopathic form of Parkinson's disease is the most common; there is also a secondary form with a known or suspected cause. Although the cause of most cases is unknown, research suggests several causative factors, including genetics, atherosclerosis, excessive accumulation of oxygen free radicals, viral infections, head trauma, chronic use of antipsychotic medications, and some environmental exposures.

### Pathophysiology

Parkinson's disease is associated with decreased levels of dopamine resulting from destruction of pigmented neuronal cells in the substantia nigra in the basal ganglia region of the brain (Fig. 65-4). Fibers or neuronal pathways project from the substantia nigra to the corpus striatum, where neurotransmitters are key to the control of complex body movements. Through the neurotransmitters acetylcholine (excitatory) and dopamine (inhibitory), striatal neurons relay messages to the higher motor centers that control and refine motor movements. The loss of dopamine stores in this area of the brain results in more excitatory neurotransmitters than inhibitory neurotransmitters, leading to an imbalance that affects voluntary movement.

Clinical symptoms do not appear until 60% of the pigmented neurons are lost and the striatal dopamine level is decreased by 80%. Cellular degeneration impairs the extrapyramidal tracts that control semiautomatic functions and coordinated movements; motor cells of the motor cortex and the pyramidal tracts are not affected. Researchers are working on uncovering the exact mechanism of neurodegeneration; current theories suggest that it results from oxidative stress in a portion of the neuron known as Lewy bodies, protein aggregation, or a combination of the two mechanisms (Barker & Barasi, 2008).

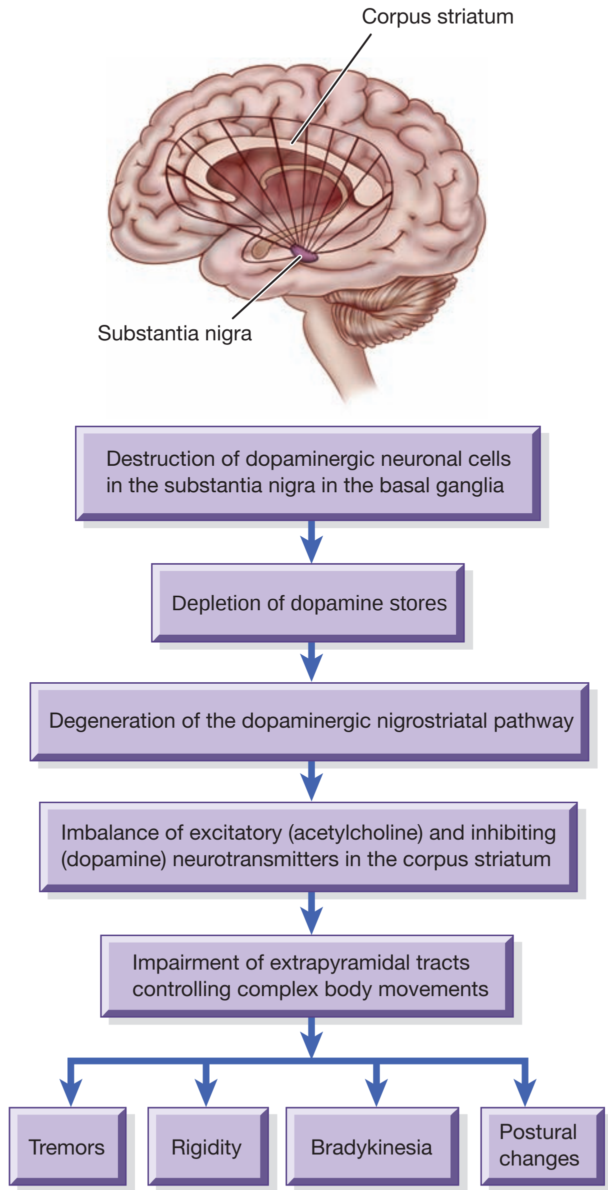



**Figure 65-4** Pathophysiology of Parkinson's disease. The nuclei in the substantia nigra project fibers to the corpus striatum. The nerve fibers carry dopamine to the corpus striatum. The loss of dopamine nerve cells from the brain's substantia nigra is thought to be responsible for the symptoms of parkinsonism.

### Clinical Manifestations

Parkinson's disease has a gradual onset, and symptoms progress slowly over a chronic, prolonged course. The cardinal signs are tremor, rigidity, **bradykinesia** (abnormally slow movements), and postural instability (Chen & Fernandez, 2007; Thomure, 2006).

#### Tremor

Although symptoms are variable, a slow, unilateral resting tremor is present in the majority of patients at the time of diagnosis (Chen & Fernandez, 2007). Resting tremor characteristically disappears with purposeful movement but is evident when the extremities are motionless. The tremor may manifest as a rhythmic, slow turning motion (pronation–supination) of the forearm and the hand and a motion of the thumb against the fingers as if rolling a pill between the fingers. Tremor is present while the patient is at rest; it increases when the patient is walking, concentrating, or feeling anxious.

#### Rigidity

Resistance to passive limb movement characterizes muscle rigidity. Passive movement of an extremity may cause the limb to move in jerky increments, referred to as lead-pipe or cog-wheel movements (Chen & Fernandez, 2007).

Involuntary stiffness of the passive extremity increases when another extremity is engaged in voluntary active movement. Stiffness of the arms, legs, face, and posture are common. Early in the disease, the patient may complain of shoulder pain due to rigidity.

#### *Bradykinesia*

One of the most common features of Parkinson's disease is bradykinesia, which refers to the overall slowing of active movement (Chen & Fernandez, 2007; Thomure, 2006). Patients may also take longer to complete activities and have difficulty initiating movement, such as rising from a sitting position or turning in bed.

#### *Postural Instability*

The patient commonly develops postural and gait problems. A loss of postural reflexes occurs, and the patient stands with the head bent forward and walks with a propulsive gait. The posture is caused by the forward flexion of the neck, hips, knees, and elbows. The patient may walk faster and faster, trying to move the feet forward under the body's center of gravity (shuffling gait). Difficulty in pivoting causes loss of balance (either forward or backward). Gait impairment and postural instability place the patient at increased risk for falls (Sadowski, Jones, Gordon, et al., 2007).

#### *Other Manifestations*

The effect of Parkinson's disease on the basal ganglia often produces autonomic symptoms that include excessive and uncontrolled sweating, paroxysmal flushing, orthostatic hypotension, gastric and urinary retention, constipation, and sexual dysfunction (Miller, 2009). Psychiatric changes include depression, **dementia** (progressive mental deterioration), delirium, and hallucinations. Depression is common; whether it is a reaction to the disorder or is related to a biochemical abnormality is uncertain. Mental changes may appear in the form of cognitive, perceptual, and memory deficits, although intellect is not usually affected. A number of psychiatric manifestations (personality changes, psychosis, dementia, and acute confusion) are common in elderly patients with Parkinson's disease. Dementia affects up to 75% of patients over the course of the disease (Weintraub & Hurtig, 2007). In addition, auditory and visual hallucinations have been reported in up to 40% of people with Parkinson's disease and may be associated with depression, dementia, lack of sleep, or adverse effects of medications.

Hypokinesia (abnormally diminished movement) is also common and may appear after the tremor. The freezing phenomenon refers to a transient inability to perform active movement and is thought to be an extreme form of bradykinesia. Additionally, the patient tends to shuffle and exhibits a decreased arm swing. As dexterity declines, **micrographia** (small handwriting) develops. The face becomes increasingly masklike and expressionless, and the frequency of blinking decreases. **Dysphonia** (soft, slurred, low-pitched, and less audible speech) may occur as a result of weakness and incoordination of the muscles responsible for speech. In many cases, the patient develops dysphagia, begins to drool, and is at risk for choking and aspiration.

Complications associated with Parkinson's disease are common and are typically related to disorders of movement. As the disease progresses, patients are at risk for respiratory and urinary tract infection, skin breakdown, and injury from falls. The adverse effects of medications used to treat the symptoms are associated with numerous complications such as dyskinesia or orthostatic hypotension (Karch, 2008).

### Assessment and Diagnostic Findings

Although laboratory tests and imaging studies are not helpful to the clinician in diagnosing Parkinson's disease, ongoing research with PET and single photon emission computed tomography (SPECT) scanning has been helpful in understanding the disease and advancing treatment. Currently, the disease is diagnosed clinically from the patient's history and the presence of two of the four cardinal manifestations: tremor, rigidity, bradykinesia, and postural changes.

Early diagnosis can be difficult because patients rarely are able to pinpoint when the symptoms started. Often, a family member notices a change such as stooped posture, a stiff arm, a slight limp, tremor, or slow, small handwriting. The medical history, presenting symptoms, neurologic examination, and response to pharmacologic management are carefully evaluated when making the diagnosis (Thomure, 2006).

### Medical Management

Treatment is directed at controlling symptoms and maintaining functional independence, because no medical or surgical approaches in current use prevent disease progression. Care is individualized for each patient based on presenting symptoms and social, occupational, and emotional needs. Pharmacologic management is the mainstay of treatment, although advances in research have led to increased surgical options. Patients are usually cared for at home and are admitted to the hospital only for complications or to initiate new treatments.

#### *Pharmacologic Therapy*

Antiparkinsonian medications act by (1) increasing striatal dopaminergic activity; (2) reducing the excessive influence of excitatory cholinergic neurons on the extrapyramidal tract, thereby restoring a balance between dopaminergic and cholinergic activities; or (3) acting on neurotransmitter pathways other than the dopaminergic pathway.

Levodopa (Larodopa) is the most effective agent and the mainstay of treatment. Levodopa is converted to dopamine in the basal ganglia, producing symptom relief. Levodopa is available in three forms: immediate-release, orally disintegrating, and sustained-release tablets (Halkias, Haq, Huang, et al., 2007). The beneficial effects of levodopa are most pronounced in the first few years of treatment. Benefits begin to wane and adverse effects become more severe over time. Confusion, hallucinations, depression, and sleep alterations are associated with prolonged use.

Within 5 to 10 years, most patients develop a response to the medication characterized by **dyskinesia** (abnormal involuntary movements), including facial grimacing, rhythmic jerking movements of the hands, head bobbing, chewing and smacking movements, and involuntary movements of the trunk and extremities. The patient may experience an

on–off syndrome in which sudden periods of near immobility ("off effect") are followed by a sudden return of effectiveness of the medication ("on effect"). Various adjunctive therapies are used to minimize dyskinesias (Chen & Fernandez, 2007). Another potential complication of long-term dopaminergic medication use is neuroleptic malignant syndrome, which is characterized by severe rigidity, stupor, and hyperthermia (Ward, 2005). Additional medications used to treat Parkinson's disease are described in Table 65-1.

### *Surgical Management*

The limitations of levodopa therapy, improvements in stereotactic surgery, and new approaches in transplantation have renewed interest in the surgical treatment of Parkinson's disease. In patients with disabling tremor, rigidity, or severe levodopa-induced dyskinesia, surgery may be considered. Although surgery provides symptom relief in selected patients, it has not been shown to alter the course of the disease or to produce permanent improvement.

#### Stereotactic Procedures

Thalamotomy and pallidotomy are effective in relieving many of the symptoms of Parkinson's disease (Rowland, 2005). Patients eligible for these procedures are those who have had an inadequate response to medical therapy; they must meet strict criteria to be eligible. Candidates eligible for these procedures are patients with idiopathic Parkinson's disease who are taking maximum doses of antiparkinsonian medications. Patients with dementia and atypical Parkinson's disease are usually not considered for stereotactic procedures. Parkinson's disease rating scales and specific neurologic tests are used to identify eligible patients.

The intent of thalamotomy and pallidotomy is to interrupt the nerve pathways and thereby alleviate tremor or rigidity. During thalamotomy, a stereotactic electrical stimulator destroys part of the ventrolateral portion of the thalamus in an attempt to reduce tremor; the most common complications are ataxia and hemiparesis. Pallidotomy involves destruction of part of the ventral aspect of the medial globus

**Table 65-1 SUMMARY OF MEDICATIONS USED TO TREAT PARKINSON'S DISEASE**

| Medications | Indications and Therapeutic Effects | Common Side Effects |
|---|---|---|
| **Anticholinergic Agents**<br>Trihexyphenidyl hydrochloride (Apo-Trihex)<br>Benztropine mesylate (Cogentin) | Control of tremor and rigidity<br>Counteract the action of acetylcholine | Blurred vision, flushing, rash, constipation, urinary retention, and acute confusional states<br>Contraindicated in patients with narrow-angle glaucoma |
| **Antiviral Agents**<br>Amantadine hydrochloride (Symmetrel) | Reduce rigidity, tremor, bradykinesia, and postural changes in early Parkinson's disease | Psychiatric disturbances (mood changes, confusion, depression, hallucinations), lower extremity edema, nausea, epigastric distress, urinary retention, headache, and visual impairment |
| **Dopamine Agonists**<br>Bromocriptine mesylate (Parlodel)<br>Pergolide (Permax) | Early Parkinson's disease as well as secondary drug therapy after carbidopa or levodopa loses effectiveness | Nausea, vomiting, diarrhea, lightheadedness, hypotension, impotence, and psychiatric effects |
| ***Nonergot Derivatives***<br>Ropinirole hydrochloride (Requip)<br>Pramipexole (Mirapex) | Early stages of Parkinson's disease | May cause drowsiness or dizziness |
| **Monoamine Oxidase Inhibitors**<br>Selegiline (Eldepryl)<br>Rasagiline (Azilect) | Inhibit dopamine breakdown | Can cause hypertensive crisis |
| **Catechol-O-Methyltransferase Inhibitors**<br>Entacapone (Comtan)<br>Tolcapone (Tasmar) | Increase the duration of action of carbidopa or levodopa<br>Reduce motor fluctuations in patients with advanced Parkinson's disease | |
| **Antidepressants**<br>***Tricyclic Antidepressants***<br>Amitriptyline hydrochloride (Elavil) | Anticholinergic and antidepressant | Hypertension, insomnia, dry mouth |
| ***Serotonin Reuptake Inhibitors***<br>Fluoxetine hydrochloride (Prozac)<br>Bupropion hydrochloride (Wellbutrin) | Antidepressant | Clinical worsening and suicide risk |
| **Antihistamines**<br>Diphenhydramine hydrochloride (Benadryl)<br>Orphenadrine citrate (Banflex)<br>Phenindamine hydrochloride (Neo-Synephrine) | May reduce tremors | Anticholinergic and sedative effects |



**Figure 65-5** A stereotactic frame is applied to a patient's head in preparation for pallidotomy. The frame immobilizes the head.

pallidus through electrical stimulation in patients with advanced disease. The procedure is effective in reducing rigidity, bradykinesia, and dyskinesia, thus improving motor function and ADLs in the immediate postoperative course. Potential complications include hemiparesis and stroke, as well as cognitive, speech, swallowing, and visual changes.

A CT scan, x-ray, MRI scan, or angiogram is used to localize the appropriate surgical site in the brain. Then the patient's head is positioned in a stereotactic frame (Fig. 65-5). After the surgeon makes an incision in the skin and a burr hole, an electrode is passed through to the target area in the thalamus or globus pallidum. The desired response of the patient to the electrical stimulation (ie, a decrease in rigidity) is the basis for the selection of the area of the brain to be destroyed. Stereotactic procedures are completed on one side of the brain at a time. If rigidity or tremor is bilateral, a 6-month interval is suggested between procedures.

#### Neural Transplantation

Ongoing research is exploring transplantation of porcine neuronal cells, human fetal cells, and stem cells (Rowland, 2005). Legal, ethical, and political concerns surrounding the use of fetal brain cells and stem cells have limited the implementation of these procedures.

#### Deep Brain Stimulation

Pacemakerlike brain implants are used to relieve tremors (Rowland, 2005). The stimulation can be bilateral or unilateral; bilateral stimulation of the subthalamic nucleus is thought to be of greater benefit to patients than results achieved with thalamotomy, pallidotomy, or fetal nigral transplantation. In deep brain stimulation, an electrode is placed in the thalamus and connected to a pulse generator that is implanted in a subcutaneous subclavicular or abdominal pouch. The battery-powered pulse generator sends high-frequency electrical impulses through a wire placed under the skin to a lead anchored to the skull (Fig. 65-6). The electrode blocks nerve pathways in the brain that cause tremors. These devices are not without complications that can result from both the surgical procedure needed for implantation and the device itself (eg, lead leakage) (Stewart, Desaloms & Sanghera, 2005).

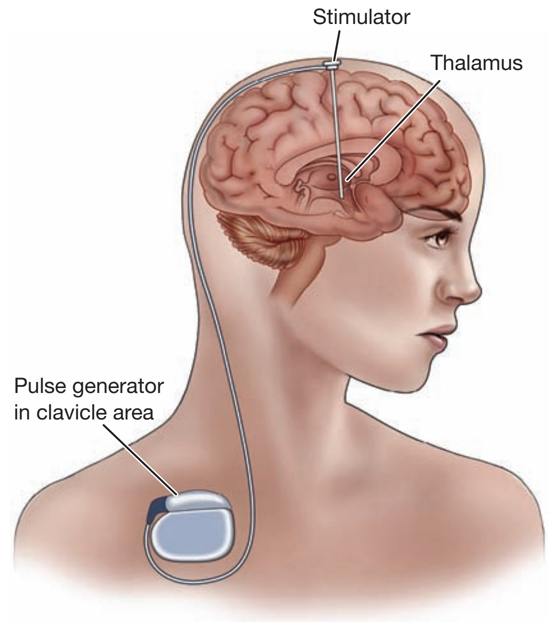



**Figure 65-6** Deep brain stimulation is provided by a pulse generator surgically implanted in a pouch beneath the clavicle. The generator sends high-frequency electrical impulses to the thalamus, thereby blocking the nerve pathways associated with tremors in Parkinson's disease.

## NURSING PROCESS

### The Patient With Parkinson's Disease

#### Assessment

Assessment focuses on how the disease has affected the patient's ADLs and functional abilities. The patient is observed for degree of disability and functional changes that occur throughout the day, such as responses to medication. Almost every patient with a movement disorder has some functional alteration and may have some type of behavioral dysfunction. The following questions may be useful to assess alterations:

- Do you have leg or arm stiffness?
- Have you experienced any irregular jerking of your arms or legs?
- Have you ever been "frozen" or rooted to the spot and unable to move?
- Does your mouth water excessively? Have you (or others) noticed yourself grimacing or making faces or chewing movements?
- What specific activities do you have difficulty doing?

During this assessment, the nurse observes the patient for quality of speech, loss of facial expression, swallowing deficits (drooling, poor head control, coughing), tremors, slowness of movement, weakness, forward posture, rigidity, evidence of mental slowness, and confusion. Parkinson's disease symptoms, as well as side effects of medications, put these patients at high risk for falls; therefore, a fall risk assessment should be conducted (Sadowski, et al., 2007).

## Diagnosis

### Nursing Diagnoses

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Impaired physical mobility related to muscle rigidity and motor weakness
- Self-care deficits (feeding, dressing, hygiene, and toileting) related to tremor and motor disturbance
- Constipation related to medication and reduced activity
- Imbalanced nutrition, less than body requirements, related to tremor, slowness in eating, difficulty in chewing and swallowing
- Impaired verbal communication related to decreased speech volume, slowness of speech, inability to move facial muscles
- Ineffective coping related to depression and dysfunction due to disease progression

Other nursing diagnoses may include sleep pattern disturbances, deficient knowledge, risk for injury, risk for activity intolerance, disturbed thought processes, and compromised family coping.

## Planning and Goals

The goals for the patient may include improving functional mobility, maintaining independence in ADLs, achieving adequate bowel elimination, attaining and maintaining acceptable nutritional status, achieving effective communication, and developing positive coping mechanisms.

## Nursing Interventions

### Improving Mobility

A progressive program of daily exercise will increase muscle strength, improve coordination and dexterity, reduce muscular rigidity, and prevent contractures that occur when muscles are not used. Walking, riding a stationary bicycle, swimming, and gardening are all exercises that help maintain joint mobility. Stretching (stretch–hold–relax) and range-of-motion exercises promote joint flexibility. Postural exercises are important to counter the tendency of the head and neck to be drawn forward and down. A physical therapist may be helpful in developing an individualized exercise program and can provide instruction to the patient and caregiver on exercising safely. Faithful adherence to an exercise and walking program helps delay the progress of the disease. Warm baths and massage, in addition to passive and active exercises, help relax muscles and relieve painful muscle spasms that accompany rigidity.

Balance may be adversely affected because of the rigidity of the arms (arm swinging is necessary in normal walking). Special walking techniques must be learned to offset the shuffling gait and the tendency to lean forward. The patient is taught to concentrate on walking erect, to watch the horizon, and to use a wide-based gait (ie, walking with the feet separated). A conscious effort must be made to swing the arms, raise the feet while walking, and use a heel–toe placement of the feet with long strides. The patient is advised to practice walking to marching music or to the sound of a ticking metronome, because this provides sensory reinforcement. Performing breathing exercises while walking helps move the rib cage and aerate parts of the lungs. Frequent rest periods aid in preventing frustration and fatigue.

### Enhancing Self-Care Activities

Encouraging, teaching, and supporting the patient during ADLs promote self-care (Stewart, et al., 2005). See Chapter 11 for rehabilitation techniques.

Environmental modifications are necessary to compensate for functional disabilities. Patients may have severe mobility problems that make normal activities impossible. Adaptive or assistive devices may be useful. A hospital bed at home with bedside rails, an overbed frame with a trapeze, or a rope tied to the foot of the bed can provide assistance in pulling up without help. An occupational therapist can evaluate the patient's needs in the home, make recommendations regarding adaptive devices, and teach the patient and caregiver how to improvise.

### Improving Bowel Elimination

The patient may have severe problems with constipation. Among the factors causing constipation are weakness of the muscles used in defecation, lack of exercise, inadequate fluid intake, and decreased autonomic nervous system activity. The medications used for the treatment of the disease also inhibit normal intestinal secretions. A regular bowel routine may be established by encouraging the patient to follow a regular time pattern, consciously increase fluid intake, and eat foods with moderate fiber content. Laxatives should be avoided. Psyllium (Metamucil), for example, decreases constipation but carries the risk of bowel obstruction (Karch, 2008). A raised toilet seat is useful, because the patient has difficulty in moving from a standing to a sitting position.

### Improving Nutrition

Patients may have difficulty maintaining their weight. Eating becomes a very slow process, requiring concentration due to a dry mouth from medications and difficulty chewing and swallowing. These patients are at risk for aspiration because of impaired swallowing and the accumulation of saliva. They may be unaware that they are aspirating; subsequently, bronchopneumonia may develop.

Monitoring weight on a weekly basis indicates whether caloric intake is adequate. Supplemental feedings increase caloric intake. As the disease progresses, a nasogastric tube or percutaneous endoscopic gastroscopy may be necessary to maintain adequate nutrition. A dietitian can be consulted regarding nutritional needs.

### Enhancing Swallowing

Swallowing difficulties and choking are common in Parkinson's disease (Chen & Fernandez, 2007). These can lead to problems with poor head control, tongue tremor, hesitancy in initiating swallowing, difficulty in shaping food into a bolus, and disturbances in pharyngeal motility. To offset these problems, the patient should sit in an upright position during mealtime. A semisolid diet with thick liquids is easier to swallow than solids; thin liquids should be avoided. Thinking through the swallowing sequence is helpful. The patient is taught to place the food on the tongue, close the lips and

teeth, lift the tongue up and then back, and swallow. The patient is encouraged to chew first on one side of the mouth and then on the other. To control the buildup of saliva, the patient is reminded to hold the head upright and make a conscious effort to swallow. Massaging the facial and neck muscles before meals may be beneficial.

#### *Encouraging the Use of Assistive Devices*

An electric warming tray keeps food hot and allows the patient to rest during the prolonged time that it may take to eat. Special utensils also assist at mealtime. A plate that is stabilized, a nonspill cup, and eating utensils with built-up handles are useful self-help devices. The occupational therapist can assist in identifying appropriate adaptive devices.

#### *Improving Communication*

Speech disorders are present in most patients with Parkinson's disease. The low-pitched, monotonous, soft speech of patients requires that they make a conscious effort to speak slowly, with deliberate attention to what they are saying. The patient is reminded to face the listener, exaggerate the pronunciation of words, speak in short sentences, and take a few deep breaths before speaking. A speech therapist may be helpful in designing speech improvement exercises and assisting the family and health care personnel to develop and use a method of communication that meets the patient's needs. A small electronic amplifier is helpful if the patient has difficulty being heard.

#### *Supporting Coping Abilities*

Support can be given by encouraging the patient and pointing out that activities will be maintained through active participation. A combination of physiotherapy, psychotherapy, medication therapy, and support group participation may help reduce the depression that often occurs. Patients with Parkinson's disease can become withdrawn. It is best if patients are active participants in their therapeutic program, including social and recreational events. A planned program of activity throughout the day prevents too much daytime sleeping as well as disinterest and apathy.

Patients often feel embarrassed, apathetic, inadequate, bored, and lonely. In part, these feelings may result from physical slowness and the great effort that even small tasks require. The patient is assisted and encouraged to set achievable goals (eg, improvement of mobility). Every effort should be made to encourage patients to carry out the tasks involved in meeting their own daily needs and to remain independent. Doing things for the patient merely to save time undermines the basic goal of improving coping abilities and promoting a positive self-concept.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** Patient and family education is important in the management of Parkinson's disease. Teaching needs depend on the severity of symptoms and the stage of the disease. Care must be taken not to overwhelm the patient and family with too much information early in the disease process. The patient's and family's need for information is ongoing as adaptations become necessary. The education plan should include a clear explanation of the disease and the goal of assisting the patient to remain functionally independent as long as possible. Every effort is made to explain the nature of the disease and its management to offset disabling anxieties and fears. The patient and family must be taught about the effects and side effects of medications and about the importance of reporting side effects to the physician (Chart 65-4).

**CONTINUING CARE.** In the early stages, the patient can be managed well at home. Family members often serve as caregivers, with home care or community services available to assist in meeting health care needs as the disease progresses. The family caregiver may be under considerable stress from living with and caring for a person with a significant disability. Providing information about treatment and care prevents many unnecessary problems. The caregiver is included in the plan and may be advised to learn stress reduction techniques, to include others in the caregiving process, to obtain periodic relief from responsibilities, and to have a yearly health assessment. Allowing family members to express feelings of frustration, anger, and guilt is often helpful to them.

The patient should be evaluated in the home for adaptation and safety needs and compliance with the plan of care. In the advanced stages, patients usually enter long-term care facilities if family support is absent. Periodically, admission to an acute care facility may be necessary for changes in medical management or treatment of complications. Nurses provide support, education, and monitoring of patients over the course of the illness.

The nurse involved in home and continuing care needs to remind the patient and family members of the importance of addressing health promotion needs such as screening for hypertension and stroke risk assessments in this predominantly elderly population. Patients are taught about the importance of these activities and are referred to appropriate health care providers. Informational booklets and a newsletter for patient education are published by the National Parkinson's Foundation, Inc., and the American Parkinson's Disease Association (see Resources).

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Strives toward improved mobility
   a. Participates in exercise program daily
   b. Walks with wide base of support; exaggerates arm swinging when walking
   c. Takes medications as prescribed
2. Progresses toward self-care
   a. Allows time for self-care activities
   b. Uses self-help devices
3. Maintains bowel function
   a. Consumes adequate fluid
   b. Increases dietary intake of fiber
   c. Reports regular pattern of bowel function
4. Attains improved nutritional status
   a. Swallows without aspiration
   b. Takes time while eating
5. Achieves a method of communication
   a. Communicates needs
   b. Practices speech exercises

**CHART 65-4** HOME CARE CHECKLIST
*The Patient With Parkinson's Disease*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Define Parkinson's disease and discuss its long-term effects. | ✔ | ✔ |
| • Identify the medication regimen and name adverse effects, and precautions. | ✔ | ✔ |
| • Discuss the risk for injury; prevent falls; implement adaptive measures in the home. | ✔ | ✔ |
| • Describe nutritional needs, dietary restrictions, dysphagia management, and ways to prevent aspiration. | ✔ | ✔ |
| • Manage constipation: fluid intake, bowel routine. | ✔ | ✔ |
| • Manage urinary problems: functional incontinence, retention (indwelling urinary catheter care, suprapubic catheter care). | ✔ | ✔ |
| • Explain effects of immobility and define preventive care: skin breakdown (frequent turning, pressure release, skin care), pneumonia (deep breathing, movement), contractures (range-of-motion exercises). | ✔ | ✔ |
| • Define benefits of daily exercise program. | ✔ | ✔ |
| • Walk and balance safely. | ✔ | |
| • Demonstrate speech and communication skills: speech exercises, communication techniques, breathing exercises. | ✔ | |
| • Name signs and symptoms of infection (urinary and respiratory) and state when health care provider should be notified. | ✔ | ✔ |
| • Describe strategies to promote self-care activities and independence. | ✔ | ✔ |
| • Identify resources: American Parkinson's Disease Association, National Parkinson's Disease Foundation, and local support groups. | ✔ | ✔ |

6. Copes with effects of Parkinson's disease
   a. Sets realistic goals
   b. Demonstrates persistence in meaningful activities
   c. Verbalizes feelings to appropriate person

## Huntington Disease

Huntington disease is a chronic, progressive, hereditary disease of the nervous system that results in progressive involuntary choreiform movement and dementia. The disease affects approximately 1 in 10,000 men or women of all races at midlife. It is transmitted as an autosomal dominant genetic disorder; therefore, each child of a parent with Huntington disease has a 50% risk of inheriting the disorder (Skirton, 2005).

A genetic marker for Huntington disease has been identified. Researchers can identify people who will develop this disease. However, genetic testing offers no hope of cure or even specific prediction of the timing of disease onset. Even though the gene was mapped in 1983 and presymptomatic testing has been offered since 1986, many patients choose not to be tested. For most people, the benefits of testing are unclear because of ethical issues and concerns about confidentiality. Genetic counseling is crucial after testing, and patients and their families may require long-term psychological counseling and emotional, financial, and legal support. People of childbearing age with a family history of Huntington disease often seek information about their risk of disease transmission.

### Pathophysiology

The basic pathology involves premature death of cells in the striatum (caudate and putamen) of the basal ganglia, the region deep within the brain that is involved in the control of movement. Cells also are lost in the cortex, the region of the brain associated with thinking, memory, perception, and judgment, and in the cerebellum, the area that coordinates voluntary muscle activity. Why the protein destroys only certain brain cells is unknown, but several theories have been proposed to explain the phenomenon (Barker & Barasi, 2008; Skirton, 2005). One possible theory is that a building block for protein called glutamine abnormally collects in the cell nucleus, causing cell death (Walker, 2007).

### Clinical Manifestations

The most prominent clinical features of the disease are **chorea** (abnormal involuntary movements), intellectual decline, and, often, emotional disturbance (Bickley, 2007; Walker, 2007). As the disease progresses, a constant writhing, twisting, uncontrollable movement may involve the entire body. These motions are devoid of purpose or rhythm, although patients may try to turn them into purposeful movement. All of the body musculature is involved. Facial movements produce tics and grimaces. Speech becomes slurred, hesitant, often explosive, and eventually

unintelligible. Chewing and swallowing are difficult, and there is a constant danger of choking and aspiration. Choreiform movements persist during sleep but are diminished.

As with speech, the gait becomes disorganized to the point that ambulation eventually is impossible. Although independent ambulation should be encouraged for as long as possible, a wheelchair usually becomes necessary. Eventually, the patient is confined to bed when the chorea interferes with walking, sitting, and all other activities. Bladder and bowel control is lost. Cognitive function is usually affected, with dementia usually occurring. Initially, the patient is aware that the disease is responsible for the myriad dysfunctions that are occurring. The mental and emotional changes that occur may be more devastating to the patient and family than the abnormal movements. Personality changes may result in nervous, irritable, or impatient behaviors. In the early stages, patients are particularly subject to uncontrollable fits of anger; profound, often suicidal depression; apathy; anxiety; psychosis; or euphoria. Judgment and memory are impaired, and dementia eventually ensues. Hallucinations, delusions, and paranoid thinking may precede the appearance of disjointed movements. Emotional and cognitive symptoms often become less acute as the disease progresses (Walker, 2007).

Onset usually occurs between 35 and 45 years of age, although about 10% of patients are children. The disease progresses slowly. Despite a ravenous appetite, patients usually become emaciated and exhausted. Patients succumb in 10 to 20 years to heart failure, pneumonia, or infection, or as a result of a fall or choking.

## Assessment and Diagnostic Findings

The diagnosis is made based on the clinical presentation of characteristic symptoms, a positive family history, the known presence of a genetic marker, and exclusion of other causes.

## Management

Although no treatment halts or reverses the underlying process, medications may reduce chorea. Thiothixene hydrochloride (Navane) and haloperidol decanoate (Haldol), which predominantly block dopamine receptors, improve the chorea in many patients. Motor signs must be assessed and evaluated on an ongoing basis so that optimal therapeutic drug levels can be reached. **Akathisia** (motor restlessness) in the overmedicated patient is dangerous because it may be mistaken for the restless fidgeting of the illness and consequently may be overlooked. In certain types of the disease, hypokinetic motor impairment resembles Parkinson's disease. In patients who present with rigidity, some temporary benefit may be obtained from antiparkinson medications, such as levodopa (Larodopa).

Patients who have emotional disturbances, particularly depression, may be helped by antidepressant medications. The threat of suicide is present particularly early in the course of the disease (Walker, 2007). Psychotic symptoms usually respond to antipsychotic medications. Psychotherapy aimed at allaying anxiety and reducing stress may be beneficial. Nurses must look beyond the disease to focus on the patient's needs and capabilities (Chart 65-5). Chart 65-6 explores an ethical issue related to end-of-life care for a patient with Huntington disease.

Several new treatments, such as fetal tissue transplantation and the use of growth factor delivered to the basal ganglia region of the brain, are under investigation (Barker & Barasi, 2008; Skirton, 2005).

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The needs of the patient and family for education depend on the nature and severity of the physical, cognitive, and psychological changes experienced by the patient. The patient and family members are taught about the medications prescribed and about signs indicating a need for change in medication or dosage. The teaching plan addresses strategies to manage symptoms such as chorea, swallowing problems, limitations in ambulation, and loss of bowel and bladder function. Consultation with a speech therapist may be indicated to assist in identifying alternative communication strategies if speech is affected.

#### Continuing Care

A program combining medical, nursing, psychological, social, occupational, speech, and physical rehabilitation services and palliative care is needed to help the patient and family cope with this severely disabling illness (Olson & Cristian, 2005). Huntington disease exacts enormous emotional, physical, social, and financial tolls on every member of the patient's family. The family needs supportive care as they adjust to the impact of the illness (Skirton, 2005; Walker, 2007). Regular follow-up visits help allay the fear of abandonment.

Home care assistance, day care centers, respite care, and eventually skilled long-term care can assist the patient and family in coping with the constant strain of the illness. Although the relentless progression of the disease cannot be halted, families can benefit from supportive care.

Voluntary organizations can be major aids to families and have been largely responsible for bringing the illness to national attention. The Huntington's Disease Foundation of America helps patients and families by providing information, referrals, family and public education, and support for research.

# *Alzheimer's Disease*

Alzheimer's disease, or senile dementia of the Alzheimer's type, is a chronic, progressive, and degenerative brain disorder that is accompanied by profound effects on memory, cognition, and ability for self-care. Approximately 4.5 million people in the United States are affected (Ganzer, 2007). Alzheimer's disease is one of the most feared disorders of modern times because of its catastrophic consequences for the patient, family, and caregivers, who are faced with many crucial end-of-life decisions. Chapter 12 discusses the manifestations, management, and nursing care of the patient with Alzheimer's disease.

# *Amyotrophic Lateral Sclerosis*

Amyotrophic lateral sclerosis (ALS) is a disease of unknown cause in which there is a loss of motor neurons (nerve cells controlling muscles) in the anterior horns of

## Chart 65-5 • *Care of the Patient With Huntington Disease*

**Nursing Diagnosis:** Risk for injury from falls and possible skin breakdown (pressure ulcers, abrasions), resulting from constant movement

**Nursing Interventions**

Pad the sides and head of the bed; ensure that the patient can see over the sides of bed.
Use padded heel and elbow protectors.
Keep the skin meticulously clean.
Apply emollient cleansing agent and skin lotion as needed.
Use soft sheets and bedding.
Have patient wear football padding or other forms of padding.
Encourage ambulation with assistance to maintain muscle tone.
Secure the patient (only if necessary) in bed or chair with padded protective devices, making sure that they are loosened frequently.

**Nursing Diagnosis:** Imbalanced nutrition, less than body requirements, due to inadequate intake and dehydration resulting from swallowing or chewing disorders and danger of choking or aspirating food

**Nursing Interventions**

Administer phenothiazines as prescribed before meals (appears to calm some patients).
Talk to the patient before mealtime to promote relaxation; use mealtime for social interaction. Provide undivided attention and help the patient enjoy the mealtime experience.
Use a warming tray to keep food warm.
Learn the position that is best for *this* patient. Keep patient as close to upright as possible while feeding. Stabilize patient's head gently with one hand while feeding.
Show the food and explain what the foods are (eg, whether hot or cold).
Encircle the patient with one arm and get as close as possible to provide stability and support while feeding. Use pillows and wedges for additional support.
Do not interpret stiffness, turning away, or sudden turning of the head as rejection; these are uncontrollable choreiform movements.
For feeding, use a long-handled spoon (iced-tea spoon). Place spoon on middle of tongue and exert slight pressure.
Place bite-sized food between patient's teeth. Serve stews, casseroles, and thick liquids.
Disregard messiness and treat the person with dignity.
Wait for the patient to chew and swallow before introducing another spoonful. Make sure that bite-sized food is small.
Give between-meal feedings. Constant movement expends more calories. Patients often have voracious appetites, particularly for sweets.
Use blenderized meals if patient cannot chew; do not repeatedly give the same strained baby foods; gradually introduce increased textures and consistencies to the diet.
For swallowing difficulties:
Apply gentle deep pressure around the patient's mouth.
Rub fingers in circles on the patient's cheeks and then down each side of the patient's throat.
Develop skill in Heimlich maneuver (to be used in the event of choking).

**Nursing Diagnosis:** Anxiety and impaired communication from excessive grimacing and unintelligible speech

**Nursing Interventions**

Read to the patient.
Employ biofeedback and relaxation therapy to reduce stress.
Consult with speech therapist to help maintain and prolong communication abilities.
Try to devise a communication system, perhaps using cards with words or pictures of familiar objects, before verbal communication becomes too difficult. Patients can indicate correct card by hitting it with hand, grunting, or blinking the eyes.
Learn how this particular patient expresses needs and wants—particularly nonverbal messages (widening of eyes, responses).
Patients can understand even if unable to speak. Do not isolate patients by ceasing to communicate with them.

**Nursing Diagnosis:** Disturbed thought processes and impaired social interaction

**Nursing Interventions**

Reorient the patient after awakening.
Have clock, calendar, and wall posters in view to assist in orientation.
Use every opportunity for one-to-one contact.
Use music for relaxation.
Have the patient wear a medical identification bracelet.
Keep the patient in the social mainstream.
Recruit and train volunteers for social interaction. Role-model appropriate and creative interactions.
Do not abandon a patient because the disease is eventually terminal. Patients are *living* until the end.

the spinal cord and the motor nuclei of the lower brain stem. It is often referred to as Lou Gehrig's disease after the famous baseball player who suffered from the disease. As motor neuron cells die, the muscle fibers that they supply undergo atrophic changes. Neuronal degeneration may occur in both the upper and lower motor neuron systems (see Chapter 60). The leading theory held by researchers is that overexcitation of nerve cells by the neurotransmitter glutamate results in cell injury and neuronal degeneration. Possible causes of ALS include autoimmune disease, free radical damage, and oxidative stress. In 5% to 10% of cases the cause is transmission of an autosomal dominant trait for familial ALS (Runge & Patterson, 2006; Tiwari, Xu & Hayward, 2005). Several risk factors have been identified, but the exact cause is still unknown (Gal, Strom, Kilty, et al., 2007; Tiwari, et al., 2005).

## Clinical Manifestations

Clinical manifestations depend on the location of the affected motor neurons, because specific neurons activate specific muscle fibers. The chief symptoms are fatigue, progressive muscle weakness, cramps, fasciculations (twitching), and incoordination. Loss of motor neurons in the anterior horns of the spinal cord results in progressive weakness and atrophy of the muscles of the arms, trunk, or legs. Spasticity usually is present, and the deep tendon stretch reflexes

CHART 65-6 **Ethics and Related Issues**

**What Constitutes Assisted Suicide?**

**Situation**

A 65-year-old man is admitted to the hospital with Huntington disease. He is in respiratory distress and near death and he is unable to communicate his wishes. The family state that they want no heroic measures, and the physician writes a "do not resuscitate" order on the chart.

**Dilemma**

The principle of beneficence and the nurse's duty to provide care conflict with the principle of respect for the person and the patient's right to death with dignity.

**Discussion**

1. Is the "do not resuscitate" order an act of assisted suicide?
2. Is it active or passive euthanasia? What is the nurse's role in caring for the patient if this action conflicts with his or her personal beliefs?
3. If no other nurse is available to provide care, does the nurse on duty have the right to refuse to provide care? Is this patient abandonment?

become brisk and overactive. Usually, the function of the anal and bladder sphincters remains intact, because the spinal nerves that control muscles of the rectum and urinary bladder are not affected.

In about 25% of patients, weakness starts in the muscles supplied by the cranial nerves, and difficulty in talking, swallowing, and ultimately breathing occurs. When the patient ingests liquids, soft palate and upper esophageal weakness causes the liquid to be regurgitated through the nose. Weakness of the posterior tongue and palate impairs the ability to laugh, cough, or even blow the nose. If bulbar muscles are impaired, speaking and swallowing are progressively difficult, and aspiration becomes a risk. The voice assumes a nasal sound, and articulation becomes so disrupted that speech is unintelligible. Some emotional liability may be present. It was traditionally believed that ALS spared cognitive function, but it is now recognized that some patients experience cognitive impairment.

The prognosis generally is based on the area of CNS involvement and the speed with which the disease progresses. Eventually, respiratory function is compromised. Death usually occurs as a result of infection, respiratory failure, or aspiration.

## Assessment and Diagnostic Findings

ALS is diagnosed on the basis of the signs and symptoms, because no clinical or laboratory tests are specific for this disease. Electromyography and muscle biopsy studies of the affected muscles indicate reduction in the number of functioning motor units. An MRI scan may show high signal intensity in the corticospinal tracts; this differentiates ALS from a multifocal motor neuropathy. Neuropsychological testing can assist in assessment and diagnosis (Phukan, Pender & Hardiman, 2007).

## Management

No specific therapy exists for ALS. The main focus of medical and nursing management is on interventions to maintain or improve function, well-being, and quality of life. The average survival time is 3 to 5 years with death due, most commonly, to respiratory insufficiency (Tiwari, et al., 2005).

The medication riluzole (Rilutek), a glutamate antagonist, is the only medication with U.S. Food and Drug Administration approval for treatment of ALS (Hickey, 2009). The action of riluzole is not clear, but its pharmacologic properties suggest that it may have a neuroprotective effect in the early stages of ALS. Symptomatic treatment and rehabilitative measures are used to support the patient and improve the quality of life. Baclofen (Lioresal), dantrolene sodium (Dantrium), or diazepam (Valium) may be useful for patients troubled by spasticity, which causes pain and interferes with self-care. Research evaluating the effect of ceftriaxone sodium (Rocephin) found that it slows the course of the disease in animals, but it has not yet been tested in humans (Brown, 2005).

Most patients with ALS are managed at home and in the community, with hospitalization for acute problems. The most common reasons for hospitalization are dehydration and malnutrition, pneumonia, and respiratory failure; recognizing these problems at an early stage in the illness allows for the development of preventive strategies. End-of-life issues include pain, dyspnea, and delirium (Olson & Cristian, 2005).

Mechanical ventilation (using negative-pressure ventilators) is an option if alveolar hypoventilation develops. Noninvasive positive-pressure ventilation is also an option. The use of noninvasive positive-pressure ventilation is particularly helpful at night and postpones the decision about whether to undergo a tracheotomy for long-term mechanical ventilation.

A patient experiencing aspiration and swallowing may require enteral feeding. A percutaneous endoscopic gastrostomy tube is inserted before the forced vital capacity drops below 50% of the predicted value. The tube can be safely placed in patients who are using noninvasive positive-pressure ventilation for ventilatory support (Hickey, 2009).

Decisions about life support measures are made by the patient and family and should be based on a thorough understanding of the disease, the prognosis, and the implications of initiating such therapy. Patients are encouraged to complete an advance directive or "living will" to preserve their autonomy in decision making. See Chapter 17 for additional discussion of end-of-life care.

The Amyotrophic Lateral Sclerosis Association has broad programs of research funding, patient and clinical services, patient information and support, and medical and public information. The *ALS Association Quarterly Newsletter* is a source of practical information (see Resources).

# Muscular Dystrophies

The muscular dystrophies are a group of incurable muscle disorders characterized by progressive weakening and wasting of the skeletal or voluntary muscles. Most of these diseases are inherited. Duchenne muscular dystrophy, the most common type, occurs in 1 of every 3500 male births

(Rowland, 2005). The pathologic features include degeneration and loss of muscle fibers, variation in muscle fiber size, phagocytosis and regeneration, and replacement of muscle tissue by connective tissue. The common characteristics of these diseases include varying degrees of muscle wasting and weakness and abnormal elevation in serum levels of muscle enzymes (Barker & Barasi, 2008). Differences among these diseases center on the genetic pattern of inheritance, the muscles involved, the age at onset, and the rate of disease progression. The unique needs of these patients, who in the past did not live to adulthood, must be addressed as they live longer because of better supportive care.

## Medical Management

Treatment of the muscular dystrophies focuses on supportive care and prevention of complications in the absence of a cure or specific pharmacologic interventions (Rowland, 2005). The goal of supportive management is to keep the patient active and functioning as normally as possible and to minimize functional deterioration. An individualized therapeutic exercise program is prescribed to prevent muscle tightness, contractures, and disuse atrophy. Night splints and stretching exercises are used to delay contractures of the joints, especially the ankles, knees, and hips. Braces may compensate for muscle weakness.

Spinal deformity is a severe problem. Weakness of trunk muscles and spinal collapse occur almost routinely in patients with severe neuromuscular disease. To help prevent spinal deformity, the patient is fitted with an orthotic jacket to improve sitting stability and reduce trunk deformity. This measure also supports cardiovascular status. In time, spinal fusion is performed to maintain spinal stability. Other procedures may be carried out to correct deformities.

Compromised pulmonary function may result either from progression of the disease or from deformity of the thorax secondary to severe scoliosis. Upper respiratory infections and fractures from falls must be vigorously treated in a way that minimizes immobilization because joint contractures become worse when the patient's activities are more restricted than usual.

Other difficulties may be manifested in relation to the underlying disease. Weakness of the facial muscles makes it difficult to attend to dental hygiene and to speak clearly. Gastrointestinal tract problems may include gastric dilation, rectal prolapse, and fecal impaction. Finally, cardiomyopathy appears to be a common complication in all forms of muscular dystrophy (Rowland, 2005).

Genetic counseling is advised for parents and siblings of the patient because of the genetic nature of this disease. The Muscular Dystrophy Association works to combat neuromuscular disease through research, programs of patient services and clinical care, and professional and public education (see Resources).

## Nursing Management

The goals of the patient and the nurse are to maintain function at optimal levels and to enhance the quality of life. Therefore, the patient's physical requirements, which are considerable, are addressed without losing sight of emotional and developmental needs. The patient and family are actively involved in decision making, including end-of-life decisions.

During hospitalization for treatment of complications, the knowledge and expertise of the patient and family members responsible for caregiving in the home are assessed. Because the patient and family caregivers often have developed caregiving strategies that work effectively for them, these strategies need to be acknowledged and accepted, and provisions must be made to ensure that they are maintained during hospitalization.

Families of adolescents and young adults with muscular dystrophy need assistance to shift the focus of care from pediatric to adult care and to understand the usual disease course. Nursing goals include assisting the adolescent to make the transition to adult values and expectations while providing age-appropriate ongoing care. The nurse may need to help build the confidence of an older adolescent or adult patient by encouraging him or her to pursue job training to become economically independent. Other nursing interventions might include guidance in accessing adult health care and finding appropriate programs in sex education.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The management goals are addressed in special rehabilitation programs or in the patient's home and community. Therefore, the patient and family require information and instruction about the disorder, its anticipated course, and care and management strategies that will optimize the patient's growth and development and physical and psychological status. Members of a variety of health-related disciplines are involved in patient and family teaching; recommendations are communicated to all members of the health care team so that they may work toward common goals (Rowland, 2005).

#### Continuing Care

Both the neuromuscular disease and the associated deformities may progress in adolescence and adulthood. Self-help and assistive devices can aid in maintaining maximum independence. These devices, recommended by physical and occupational therapists, often become necessary as more muscle groups are affected.

The family is taught to monitor the patient for respiratory problems, because respiratory infection and cardiac failure are the most common causes of death (Rowland, 2005). As respiratory difficulties develop, patients and their families need information regarding respiratory support. Options currently exist that can provide ventilatory support (eg, negative-pressure devices, positive-pressure ventilators) while allowing mobility. Patients can remain relatively independent in a wheelchair, for example, while being maintained on a ventilator at home for many years.

The patient is encouraged to continue with range-of-motion exercises to prevent contractures, which are particularly disabling. Practical adaptations must be made, however, to cope with the effects of chronic neuromuscular disability. The patient at various stages of the disease may require a manual or an electric wheelchair, gait aids, upper and lower extremity and spinal orthoses, seating systems, bathroom equipment, lifts, ramps, and additional assistive devices, all of which require a team approach. The home

care nurse assesses how the patient and family are managing, makes referrals, and coordinates the activities of the physical therapist, occupational therapist, and social services.

The patient is greatly concerned about issues surrounding the threat of increasing disability and dependence on others, accompanied by a significant deterioration in health-related quality of life. The patient is faced with a progressive loss of function, leading eventually to death. Feelings of helplessness and powerlessness are common. Each functional loss is accompanied by grief and mourning. The patient and family are assessed for depression, anger, or denial. The patient and family are assisted and encouraged to address decisions about end-of-life options before their need arises.

A psychiatric nurse clinician or other mental health professional may assist the patient to cope and adapt to the disease. By understanding and addressing the physical and psychological needs of the patient and family, the nurse provides a hopeful, supportive, and nurturing environment.

# Degenerative Disk Disease

Low back pain is the second most common neurologic disorder in the United States. It is estimated that there were more than 450,000 lumbar spinal surgeries for herniated disks, stenosis, and degenerative changes in 2003 in the United States (Agency for Healthcare Research and Quality, 2008). There are significant economic costs to patients, their families, and society. Acute low back pain lasts less than 3 months, whereas chronic or degenerative disease has a duration of 3 months or longer. Most back problems are related to disk disease.

## Pathophysiology

The intervertebral disk is a cartilaginous plate that forms a cushion between the vertebral bodies (Fig. 65-7A). This tough, fibrous material is incorporated in a capsule. A ball-like cushion in the center of the disk is called the nucleus pulposus. In herniation of the intervertebral disk (ruptured disk), the nucleus of the disk protrudes into the annulus (the fibrous ring around the disk), with subsequent nerve compression. Protrusion or rupture of the nucleus pulposus usually is preceded by degenerative changes that occur with aging. Loss of protein polysaccharides in the disk decreases the water content of the nucleus pulposus. The development of radiating cracks in the annulus weakens resistance to nucleus herniation. After trauma (falls and repeated minor stresses such as lifting incorrectly), the cartilage may be injured.

For most patients, the immediate symptoms of trauma are short-lived, and those resulting from injury to the disk do not appear for months or years. Then, with degeneration in the disk, the capsule pushes back into the spinal canal, or it may rupture and allow the nucleus pulposus to be pushed back against the dural sac or against a spinal nerve as it emerges from the spinal column (see Fig. 65-7B). This sequence produces pain due to **radiculopathy** (pressure in the area of distribution of the involved nerve endings). Continued pressure may produce degenerative changes in the involved nerve, such as changes in sensation and deep tendon reflexes.

## Clinical Manifestations

A herniated disk with accompanying pain may occur in any portion of the spine: cervical, thoracic (rare), or lumbar. The clinical manifestations depend on the location, the rate of development (acute or chronic), and the effect on the surrounding structures.

## Assessment and Diagnostic Findings

A thorough health history and physical examination are important to rule out potentially serious conditions that may manifest as low back pain, including fracture, tumor, infection, or cauda equina syndrome (Hickey, 2009).

The MRI scan has become the diagnostic tool of choice for localizing even small disk protrusions, particularly for lumbar spine disease. If the clinical symptoms are not consistent with the pathology seen on MRI, CT scanning and

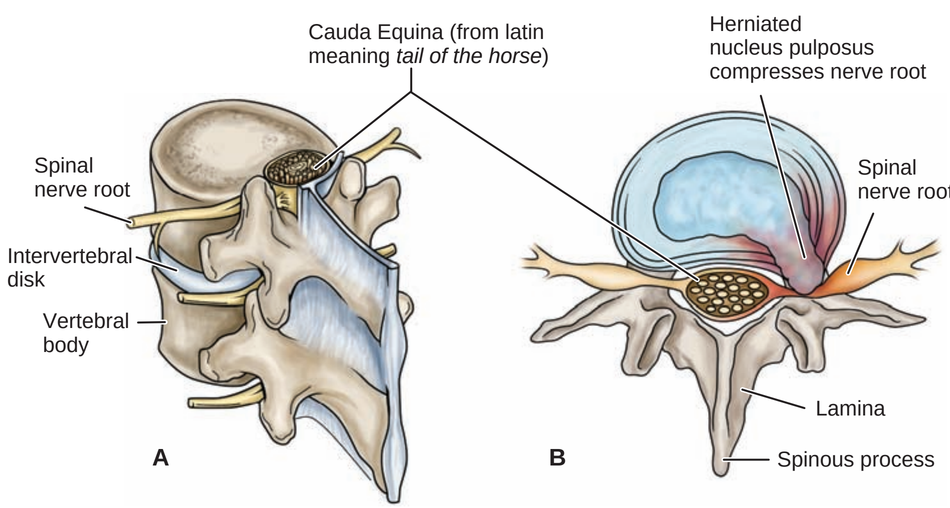



**Figure 65-7** **A,** Normal lumbar spine vertebrae, invertebral disks, and spinal nerve root. **B,** Ruptured vertebral disc.

myelography are performed. A neurologic examination is carried out to determine whether reflex, sensory, or motor impairment from root compression is present and to provide a baseline for future assessment. Electromyography may be used to localize the specific spinal nerve roots involved.

## Medical Management

Herniations of the cervical and the lumbar disks occur most commonly and are usually managed conservatively with bed rest and medication (Hickey, 2009). Surgery is sometimes necessary.

### *Surgical Management*

Surgical excision of a herniated disk is performed if there is evidence of a progressing neurologic deficit (muscle weakness and atrophy, loss of sensory and motor function, loss of sphincter control) and continuing pain or **sciatica** (leg pain resulting from sciatic nerve involvement) that are unresponsive to conservative management (Weber & Kelley, 2007). The goal of surgical treatment is to reduce the pressure on the nerve root to relieve pain and reverse neurologic deficits (Hickey, 2009). Microsurgical techniques make it possible to remove only the amount of tissue that is necessary, which preserves the integrity of normal tissue better and imposes less trauma on the body. During these procedures, spinal cord function can be monitored electrophysiologically.

To achieve the goal of pain relief, several surgical techniques are used, depending on the type and location of disk herniation, surgical morbidity, and results of previous surgery. Some of the surgical techniques available include:

- Microdiskectomy: removal of herniated or extruded fragments of intervertebral disk material
- Laminectomy: removal of the bone between the spinal process and facet pedicle junction to expose the neural elements in the spinal canal (Hickey, 2009); this allows the surgeon to inspect the spinal canal, identify and remove pathologic tissue, and relieve compression of the cord and roots
- Hemilaminectomy: removal of part of the lamina and part of the posterior arch of the vertebra
- Partial laminectomy or laminotomy: creation of a hole in the lamina of a vertebra
- Diskectomy with fusion: fusion of the vertebral spinous process with a bone graft (from iliac crest or bone bank); the object of spinal fusion is to bridge over the defective disk to stabilize the spine and reduce the rate of recurrence
- Foraminotomy: removal of the intervertebral foramen to increase the space for exit of a spinal nerve, resulting in reduced pain, compression, and edema

# *Herniation of a Cervical Intervertebral Disk*

The cervical spine is subjected to stresses that result from disk degeneration (due to aging, occupational stresses) and **spondylosis** (degenerative changes occurring in a disk and adjacent vertebral bodies). Cervical disk degeneration may lead to lesions that can cause damage to the spinal cord and its roots.

## Clinical Manifestations

A cervical disk herniation usually occurs at the C5–C6 or C6–C7 interspaces.

Pain and stiffness may occur in the neck, the top of the shoulders, and the region of the scapulae. Sometimes patients interpret these signs as symptoms of heart trouble or bursitis. Pain may also occur in the upper extremities and head, accompanied by **paresthesia** (tingling or a “pins and needles” sensation) and numbness of the upper extremities. Cervical MRI usually confirms the diagnosis.

## Medical Management

The goals of treatment are to rest and immobilize the cervical spine to give the soft tissues time to heal and to reduce inflammation in the supporting tissues and the affected nerve roots in the cervical spine. Bed rest (usually 1 to 2 days) is important because it eliminates the stress of gravity and relieves the cervical spine of the need to support the head. It also reduces inflammation and edema in soft tissues around the disk, relieving pressure on the nerve roots. Proper positioning on a firm mattress may bring dramatic relief from pain.

The cervical spine may be rested and immobilized by a cervical collar, cervical traction, or a brace. A collar allows maximal opening of the intervertebral foramina and holds the head in a neutral or slightly flexed position. The patient may have to wear the collar 24 hours a day during the acute phase. The skin under the collar is inspected for irritation. After the patient is free of pain, cervical isometric exercises are started to strengthen the neck muscles.

### *Pharmacologic Therapy*

Analgesic agents (nonsteroidal anti-inflammatory agents [NSAIDs], propoxyphene [Darvon], oxycodone [Tylox], or hydrocodone [Vicodin]) are prescribed during the acute phase to relieve pain, and sedatives may be administered to control the anxiety that is often associated with cervical disk disease. Muscle relaxants (cyclobenzaprine [Flexeril], methocarbamol [Robaxin], metaxalone [Skelaxin]) are administered to interrupt muscle spasm and to promote comfort. NSAIDs (aspirin, ibuprofen [Motrin, Advil], naproxen [Naprosyn, Anaprox]) or corticosteroids are prescribed to treat the inflammation that usually occurs in the affected nerve roots and supporting tissues. Occasionally, a corticosteroid is injected into the epidural space for relief of radicular (spinal nerve root) pain. NSAIDs are administered with food and antacids to prevent gastrointestinal irritation (Karch, 2008). Hot, moist compresses (for 10 to 20 minutes) applied to the back of the neck several times daily increase blood flow to the muscles and help relax the patient and reduce muscle spasm.

### *Surgical Management*

Surgical excision of the herniated disk may be necessary if there is a significant neurologic deficit, progression of the deficit, evidence of cord compression, or pain that either worsens or fails to improve. A cervical diskectomy, with or without fusion, may be performed to alleviate symptoms (Fowler, Anthony-Phillips, Mehta, et al., 2005). An anterior surgical approach may be used through a transverse

incision to remove disk material that has herniated into the spinal canal and foramina, or a posterior approach may be used at the appropriate level of the cervical spine. Potential complications with the anterior approach include carotid or vertebral artery injury, recurrent laryngeal nerve dysfunction, esophageal perforation, and airway obstruction. Complications of the posterior approach include damage to the nerve root or the spinal cord due to retraction or contusion of either of these structures, resulting in weakness of muscles supplied by the nerve root or cord.

Microsurgery, such as endoscopic microdiskectomy, may be performed in selected patients through a small incision, using magnification techniques. This usually results in less tissue trauma and pain, and patients consequently have a shorter hospital stay compared with those who have conventional surgery.

## NURSING PROCESS

### The Patient Undergoing a Cervical Diskectomy

#### Assessment

The patient is asked about past injuries to the neck (whiplash), because unresolved trauma can cause persistent discomfort, pain and tenderness, and symptoms of arthritis in the injured joint of the cervical spine. Assessment includes determining the onset, location, and radiation of pain and assessing for paresthesias, limited movement, and diminished function of the neck, shoulders, and upper extremities. It is important to determine whether the symptoms are bilateral; with large herniations, bilateral symptoms may be caused by cord compression. The area around the cervical spine is palpated to assess muscle tone and tenderness. Range of motion in the neck and shoulders is evaluated.

The patient is asked about any health issues that may influence the postoperative course and quality of life (Fowler, et al., 2005). It is also important to assess mood and stress levels (Starkweather, Witek-Janusek, Nockels, et al., 2006). The nurse determines the patient's need for information about the surgical procedure and reinforces what the physician has explained. Strategies for pain management are discussed with the patient.

#### Diagnosis

***Nursing Diagnoses***

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Acute pain related to the surgical procedure
- Impaired physical mobility related to the postoperative surgical regimen
- Deficient knowledge about the postoperative course and home care management

Other nursing diagnoses may include preoperative anxiety, postoperative constipation, urinary retention related to the surgical procedure, self-care deficits related to use of a neck orthosis, and sleep pattern disturbance related to disruption in lifestyle.

***Collaborative Problems/Potential Complications***

Based on all the assessment data, the potential complications may include the following:

- Hematoma at the surgical site, resulting in cord compression and neurologic deficit
- Recurrent or persistent pain after surgery

#### Planning and Goals

The goals for the patient may include relief of pain, improved mobility, increased knowledge and self-care ability, and prevention of complications.

#### Nursing Interventions

***Relieving Pain***

The patient may be kept flat in bed for 12 to 24 hours. If the patient has had a bone fusion with bone removed from the iliac crest, considerable pain may be experienced at the donor site. Interventions consist of monitoring the donor site for hematoma formation, administering the prescribed postoperative analgesic agent, positioning for comfort, and reassuring the patient that the pain can be relieved. If the patient experiences a sudden increase in pain, extrusion of the graft may have occurred, requiring reoperation. A sudden increase in pain should be promptly reported to the surgeon.

The patient may experience a sore throat, hoarseness, and dysphagia due to temporary edema. These symptoms are relieved by throat lozenges, voice rest, and humidification. A puréed diet may be given if the patient has dysphagia.

***Improving Mobility***

Postoperatively, a cervical collar (neck orthosis) is usually worn, which contributes to limited neck motion and altered mobility. The patient is instructed to turn the body instead of the neck when looking from side to side. The neck should be kept in a neutral (midline) position. The patient is assisted during position changes, to make sure that head, shoulders, and thorax are kept aligned. When assisting the patient to a sitting position, the nurse supports the patient's neck and shoulders. To increase stability, the patient should wear shoes when ambulating.

***Monitoring and Managing Potential Complications***

The patient is evaluated for bleeding and hematoma formation by assessing for excessive pressure in the neck or severe pain in the incision area. The dressing is inspected for serosanguineous drainage, which suggests a dural leak. If this occurs, meningitis is a threat. A complaint of headache requires careful evaluation. Neurologic checks are made for swallowing deficits and upper and lower extremity weakness, because cord compression may produce rapid or delayed onset of paralysis. The patient who has had an anterior cervical diskectomy is also assessed for a sudden return of radicular (spinal nerve root) pain, which may indicate instability of the spine.

Throughout the postoperative course, the patient is monitored frequently to detect any signs of respiratory difficulty, because retractors used during surgery may injure the recurrent laryngeal nerve, resulting in hoarseness and the inability to cough effectively and clear pulmonary secretions. In addition, the blood pressure and pulse are monitored to evaluate cardiovascular status.

Bleeding at the surgical site and subsequent hematoma formation may occur. Severe localized pain not relieved by analgesic agents should be reported to the surgeon. A change in neurologic status (motor or sensory function) should be reported promptly, because it suggests hematoma formation that may necessitate surgery to prevent irreversible motor and sensory deficits.

### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient's hospital stay is likely to be short; therefore, the patient and family should understand the care that is important for a smooth recovery. A cervical collar is usually worn for about 6 weeks. The patient is instructed in use and care of the cervical collar. The patient is instructed to alternate tasks that involve minimal body movement (eg, reading) with tasks that require greater body movement.

The patient is instructed about strategies for pain management and about signs and symptoms that may indicate complications that should be reported to the physician. The nurse assesses the patient's understanding of these management strategies, limitations, and recommendations. Additionally, the nurse assists the patient in identifying strategies to cope with ADLs (eg, self-care, childcare) and minimize risks to the surgical site (Chart 65-7). A discharge teaching plan is developed collaboratively by members of the health care team to decrease the risk of recurrent disk herniation. Topics include those previously discussed as well as proper body mechanics, maintenance of optimal weight, proper exercise techniques, and modifications in activity.

**CONTINUING CARE.** The patient is instructed to see the physician at prescribed intervals so that the physician can document the disappearance of old symptoms and assess the range of motion of the neck. Recurrent or persistent pain may occur despite removal of the offending disk or disk fragments. Patients who undergo discectomy usually have consented to surgery after prolonged pain; they have often

CHART 65-7

HOME CARE CHECKLIST

### *The Patient With Cervical Discectomy and Cervical Collar*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Care for the surgical incision site. | | |
| • Keep staples or sutures clean and dry and cover with dry dressing. | | ✔ |
| • Notify physician if any signs or symptoms of infection occur, such as fever, redness or irritation, drainage, increased pain. | ✔ | ✔ |
| • Demonstrate proper body mechanics and prescribed exercise techniques. | ✔ | |
| • Modify activity: | | |
| • Avoid sitting or standing for more than 30 minutes. | ✔ | |
| • Avoid twisting, flexing, extending, or rotating the neck. | ✔ | |
| • Avoid long automobile rides. | ✔ | |
| • Avoid sleeping in a prone position or use of pillows, to minimize neck flexion in bed; keep head in a neutral position. | ✔ | |
| • Use adequate mattress and chair support. | ✔ | |
| • Wear low-heeled shoes. | ✔ | |
| • Follow physician's instructions regarding lifting, climbing stairs, driving a car, sexual activity, sports, exercise, and return to work. | ✔ | |
| • Practice stress reduction and relaxation techniques. | ✔ | |
| • Care of the cervical collar: | | |
| • Wear the collar at all times until directed otherwise by the physician. | ✔ | |
| • Wash the neck twice a day with mild soap. | ✔ | ✔ |
| • Keep the neck still while the collar is open. | ✔ | |
| • With the assistance of a helper, wash the neck in steps: | | |
| • Lie flat and supine. | ✔ | |
| • Open the Velcro tabs on each side of the collar and remove its front portion. | | ✔ |
| • Gently wash and dry the neck. | | ✔ |
| • Replace the front part of the collar and refasten the tabs. | | ✔ |
| • Turn to one side with a thin pillow under the head. | ✔ | |
| • Open one tab. | ✔ | |
| • Gently wash and dry the back of the neck. Refasten the tab. | | ✔ |
| • Turn to the other side and wash and dry this side. Refasten the tab. | | ✔ |
| • Place a wrinkle-free silk scarf under the collar to increase comfort. | ✔ | ✔ |
| • ***For men:*** Shave without twisting or moving the neck. This may be done with help while lying flat or sitting. Remove only the front part of the collar for shaving. | ✔ | ✔ |

undergone repeated courses of ineffective conservative management and previous surgeries to relieve the pain. Therefore, the recurrence or persistence of symptoms postoperatively, including pain and sensory deficits, is often discouraging for the patient and family. The patient who experiences recurrence of symptoms requires emotional support and understanding. Additionally, the patient is assisted in modifying activities and in considering options for subsequent treatment. The nurse reminds the patient and family members of the need to participate in health promotion and health screening practices.

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Reports decreasing frequency and severity of pain
2. Demonstrates improved mobility
    a. Demonstrates progressive participation in self-care activities
    b. Identifies prescribed activity limitations and restrictions
    c. Demonstrates proper body mechanics
3. Is knowledgeable about postoperative course, medications, and home care management
    a. Lists the signs and symptoms to be reported postoperatively
    b. Identifies dose, action, and potential side effects of medications
    c. Identifies appropriate home care management activities and any restrictions
4. Has absence of complications
    a. Reports no increase in incision pain or sensory symptoms
    b. Demonstrates normal findings on neurologic assessment

## *Herniation of a Lumbar Disk*

Approximately 90% to 95% of lumbar disk herniations occur at the L5–S1 region (Hickey, 2009). A herniated lumbar disk produces low back pain accompanied by varying degrees of sensory and motor impairment.

### Clinical Manifestations

The patient complains of low back pain with muscle spasms, followed by radiation of the pain into one hip and down into the leg (sciatica). Pain is aggravated by actions that increase intraspinal fluid pressure, such as bending, lifting, or straining (as in sneezing or coughing), and usually is relieved by bed rest. Usually there is some type of postural deformity, because pain causes an alteration of the normal spinal mechanics. If the patient lies on the back and attempts to raise a leg in a straight position, pain radiates into the leg; this maneuver, called the straight leg-raising test, stretches the sciatic nerve. Additional signs include muscle weakness, alterations in tendon reflexes, and sensory loss.

### Assessment and Diagnostic Findings

The diagnosis of lumbar disk disease is based on the history and physical findings and the use of imaging techniques such as MRI, CT, and myelography.

### Medical Management

The objectives of treatment are to relieve pain, slow disease progression, and increase the patient's functional ability. Bed rest, previously standard in treatment of back pain, is recommended for 2 days or less (Hickey, 2009).

Because muscle spasm is prominent during the acute phase, muscle relaxants are used. NSAIDs and systemic corticosteroids may be administered to counter the inflammation that usually occurs in the supporting tissues and the affected nerve roots. Moist heat and massage help relax muscles. Strategies for increasing the patient's functional ability include weight reduction, physical therapy, and biofeedback. Exercises, prescribed by physical therapists, can help strengthen back muscles and decrease pain (Hickey, 2009). Chapter 13 describes nursing interventions for the patient with pain.

#### *Surgical Management*

In the lumbar region, surgical treatment includes lumbar disk excision through a posterolateral laminotomy and the newer techniques of microdiskectomy and percutaneous diskectomy. In microdiskectomy, an operating microscope is used to visualize the offending disk and compressed nerve roots; it permits a small incision (2.5 cm [1 inch]) and minimal blood loss and takes about 30 minutes of operating time. Generally, the hospital stay is short, and the patient makes a rapid recovery. Several minimally invasive techniques in spinal surgery have led to improved patient outcomes and lower hospital costs, and research on these techniques is ongoing (Starkweather, Witek-Janusek, Nockels, et al., 2008). Research suggests that intraoperative wound infiltration with bupivacaine hydrochloride solution decreases pain and the need for opioids postoperatively (Ersayli, Gurget, Bekar, et al., 2006).

##### Complications of Disk Surgery

A patient undergoing a disk procedure at one level of the vertebral column may have a degenerative process at other levels. A herniation relapse may occur at the same level or elsewhere, so the patient may become a candidate for another disk procedure. Arachnoiditis (inflammation of the arachnoid membrane) may occur after surgery (and after myelography); it involves an insidious onset of diffuse, frequently burning pain in the lower back, radiating into the buttocks. Disk excision can leave adhesions and scarring around the spinal nerves and dura, which then produce inflammatory changes that create chronic neuritis and neurofibrosis. Disk surgery may relieve pressure on the spinal nerves, but it does not reverse the effects of neural injury and scarring and the pain that results. Failed disk syndrome (recurrence of sciatica after lumbar diskectomy) remains a cause of disability (Hickey, 2009).



**Figure 65-8** Before the patient undergoes laminectomy surgery, the logrolling technique that will be used for turning the patient should be demonstrated. The patient's arms will be crossed and the spine aligned. To avoid twisting the spine, the head, shoulders, knees, and hips are turned at the same time so that the patient rolls over like a log. When in a side-lying position, the patient's back, buttocks, and legs are supported with pillows.

## Nursing Management

### *Providing Preoperative Care*

Most patients fear surgery on any part of the spine and therefore need explanations about the surgery and reassurance that it will not weaken the back. When data are being collected for the health history, any reports of pain, paresthesia, or muscle spasm are recorded to provide a baseline for comparison after surgery. Health issues that may influence the postoperative course and quality of life (eg, fatigue, mood, stress, patient expectations) are important to assess (Saban & Penckofer, 2007; Starkweather, et al., 2008). Preoperative assessment also includes an evaluation of movement of the extremities as well as bladder and bowel function. To facilitate the postoperative turning procedure, the patient is taught to turn as a unit (called logrolling) as part of the preoperative preparation (see Fig. 65-8). Before surgery, the patient is also encouraged to take deep breaths, cough, and perform muscle-setting exercises to maintain muscle tone.

### *Assessing the Patient After Surgery*

After lumbar disk excision, vital signs are checked frequently and the wound is inspected for hemorrhage, because vascular injury is a complication of disk surgery. Because postoperative neurologic deficits may occur from nerve root injury, the sensation and motor strength of the lower extremities are evaluated at specified intervals, along with the color and temperature of the legs and sensation of the toes. It is important to assess for urinary retention, another sign of neurologic deterioration.

In diskectomy with fusion, the patient has an additional surgical incision if bone fragments were taken from the iliac crest or fibula to serve as wedges in the spine. The recovery period is longer than for those patients who underwent diskectomy without spinal fusion, because bony union must take place.

### *Positioning the Patient*

To position the patient, a pillow is placed under the head, and the knee rest is elevated slightly to relax the back muscles. When the patient is lying on one side, however, extreme knee flexion must be avoided. The patient is encouraged to move from side to side to relieve pressure and is reassured that no injury will result from moving. When the patient is ready to turn, the bed is placed in a flat position and a pillow is placed between the patient's legs. The patient turns as a unit (logrolls) without twisting the back.

To get out of bed, the patient lies on one side while pushing up to a sitting position. At the same time, the nurse or family member eases the patient's legs over the side of the bed. Coming to a sitting or standing posture is accomplished in one long, smooth motion. Most patients walk to the bathroom on the same day as the surgery. Sitting is discouraged except for defecation.

### *Promoting Home and Community-Based Care*

#### Teaching Patients Self-Care

The patient is advised to increase activity gradually, as tolerated, because it takes up to 6 weeks for the ligaments to heal. Excessive activity may result in spasm of the paraspinal muscles.

Activities that produce flexion strain on the spine (eg, driving a car) should be avoided until healing has taken place. Heat may be applied to the back to relax muscle spasms. Scheduled rest periods are important, and the patient is advised to avoid heavy work for 2 to 3 months after surgery. Exercises are prescribed to strengthen the abdominal and erector spinal muscles. A back brace or corset may be necessary if back pain persists.

#### Continuing Care

Referral for inpatient or outpatient rehabilitation may be warranted to improve self-care abilities after medical or surgical treatment for herniation of a lumbar disk. A home care referral may be indicated and provides the home care nurse with the opportunity to assess the patient's physical and psychological status, as well as his or her ability to adhere to recommended management strategies. During the home visit, the nurse determines whether changes in neurologic function have occurred. The adequacy of pain management is assessed, and modifications are made to ensure adequate pain relief.

## *Postpolio Syndrome*

People who survived the polio epidemic of the 1950s, many of whom are now elderly, are developing new symptoms of weakness, fatigue, and musculoskeletal pain. Researchers estimate that as many as 80% of the 1,000,000 polio survivors are experiencing the phenomenon known as postpolio syndrome. Men and women appear to be equally at risk for this condition (Bartels & Omura, 2005; Elrod, Jabben, Oswald, et al., 2005).

## Pathophysiology

The exact cause of postpolio syndrome is not known, but researchers suspect that, with aging or muscle overuse, the neurons not destroyed by the poliovirus continue generating axon sprouts (Bartels & Omura, 2005). These new terminal axon sprouts reinnervate the affected muscles after the initial insult but may become more vulnerable as the body ages.

## Assessment and Diagnostic Findings

No specific diagnostic test exists for postpolio syndrome. Clinical diagnosis is made on the basis of the history and physical examination and exclusion of other medical conditions that could be causing the new symptoms. Patients report a history of paralytic poliomyelitis followed by partial or complete recovery of function, with a plateau of function and then the recurrence of symptoms. Signs and symptoms may occur decades after the original onset of poliomyelitis (Elrod, et al., 2005).

## Management

No specific medical or surgical treatment is available for this syndrome, and therefore nurses play a pivotal role in the team approach to assisting patients and families in dealing with the symptoms of progressive loss of muscle strength and significant fatigue. Other health care professionals who may assist in patient care include physical, occupational, speech, and respiratory therapists. Nursing interventions are aimed at maintaining the patient's strength as well as physical, psychological, and social well-being.

The patient needs to plan and coordinate activities to conserve energy and reduce fatigue. Rest periods should be planned and assistive devices used to reduce weakness and fatigue. Important activities should be planned for the morning, because fatigue often increases in the afternoon and evening (Bartels & Omura, 2005; Elrod, et al., 2005).

One study proposed an explanatory model of health promotion and quality of life in patients with postpolio syndrome (Stuifbergen, Seraphine, Harrison, et al., 2005). The results suggested that quality of life is the result of a complex interplay among contextual factors such as severity of impairment, antecedent variables, and health-promoting behaviors.

Pain in muscles and joints may be a problem. Nonpharmacologic techniques such as the application of heat and cold are most appropriate, because older patients may not tolerate or may have strong reactions to medications.

Maintaining a balance between adequate nutritional intake and avoiding excess calories that can lead to obesity in this sedentary group of patients is a challenge. Pulmonary hygiene and adequate fluid intake can help with airway management. Several interventions can improve sleep, including limiting caffeine intake before bedtime and assessing for nocturia. If nocturia is an issue, the patient needs to be evaluated for obstructive sleep apnea. Supportive ventilation may be appropriate, with continuous positive airway pressure if sleep apnea is a problem.

Bone density testing in patients with postpolio syndrome has revealed low bone mass and osteoporosis (Smeltzer, Zimmerman & Capriotti, 2005). Therefore, the importance of identifying risks, preventing falls, and treating osteoporosis must be discussed with patients and families. Families also need to be made aware of the possibility of changes in individual and family relationships due to the many symptoms of postpolio syndrome (Ward, 2008). The nurse also needs to remind patients and family members of the need for health promotion activities and health screening.

# CRITICAL THINKING EXERCISES

**1** A 48-year-old man is married with two young children and has been newly diagnosed with a metastatic spinal cord tumor. Assess and prioritize the patient's physiologic and psychosocial needs. Identify appropriate nursing interventions to alleviate the patient's and family's physiologic and emotional stressors. Address the patient's need for emotional support from both the nursing staff and the family.

**2** A 75-year-old woman newly diagnosed with Parkinson's disease asks what type of medication she will be given. What are the possible medication regimens that may be used to treat her disease and the common side effects of each? How would your discharge teaching targeted toward medications be modified if the patient lives alone and is hearing impaired?

EBP **3** A 45-year-old patient with Huntington disease has been referred for end-of-life care. What resources would you use to identify the current guidelines for end-of-life care? What is the current evidence base for end-of-life nursing care? Identify the criteria used to evaluate the strength of the evidence for end-of-life nursing care.

**4** A 60-year-old patient with low back pain is seen in the clinic. What nursing interventions and actions would you suggest to assist in the management of low back pain? What strategies would you advise the patient to avoid? What is the rationale for your suggestions? State the types of health promotion activities you would recommend to this patient and the rationale for your recommendations.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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American Cancer Society, www.cancer.org
American Parkinson's Disease Association, www.apdaparkinson.org/userND/index.asp
The Michael J. Fox Foundation for Parkinson's Research, Church Street Station, www.michaeljfox.org
Amyotrophic Lateral Sclerosis Association, www.alsa.org
Huntington's Disease Society of America, www.hdsa.org
Muscular Dystrophy Association, www.mda.org
National Brain Tumor Foundation, www.braintumor.org
National Parkinson Foundation, Inc., www.parkinson.org

unit 15

# Musculoskeletal Function

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Musculoskeletal Limitations Complicated by a Medical Illness

**Mrs. Waterman** is a 70-year-old woman with severe osteoarthritis of the spine and a recent history of left total hip replacement. She has been attending outpatient physical therapy sessions three times a week and uses a rolling walker at home. She has been admitted to the hospital with a partial small bowel obstruction. The health care team anticipates that the obstruction will resolve with medical treatment, and her expected length of stay is 5 to 7 days. Currently she is allowed nothing by mouth, has a Salem sump tube in place, and is receiving peripheral parenteral nutrition.

The nurse is concerned that Mrs. Waterman's already impaired physical mobility will decline further secondary to her illness and the medical treatments that make independent ambulation difficult.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.



# *Nursing Classifications and Languages*

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **IMPAIRED PHYSICAL MOBILITY**—Limitation in independent, purposeful physical movement of the body or of one or more extremities | **EXERCISE PROMOTION**—Facilitation of regular physical exercise to maintain or advance a higher degree of fitness | **MOBILITY LEVEL**—Ability to move purposefully in own environment independently with or without assistive device |
| **RISK FOR DISUSE SYNDROME**—At risk for deterioration of body systems as the result of prescribed or unavoidable musculoskeletal inactivity | **EXERCISE PROMOTION: STRENGTH TRAINING**—Facilitating regular resistive muscle training to retain or increase muscle strength | **IMMOBILITY CONSEQUENCES: PHYSIOLOGICAL**—Severity of compromise in physiological functioning due to impaired physical mobility |
| | **EMBOLUS PRECAUTIONS**—Reduction of the risk of embolus in a patient with thrombi or at risk for developing thrombus formation | |
| | **PRESSURE ULCER PREVENTION**—Prevention of pressure ulcers for an individual at high risk for developing them | |
| | **SURVEILLANCE**—Purposeful and ongoing acquisition, interpretation, and synthesis of patient data for clinical decision-making | |


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chapter 66

# Assessment of Musculoskeletal Function

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the basic structure and function of the musculoskeletal system.
2. Discuss the significance of the health history to the assessment of musculoskeletal health.
3. Describe the significance of physical assessment to the diagnosis of musculoskeletal dysfunction.
4. Specify the diagnostic tests used for assessment of musculoskeletal function.

## GLOSSARY

**atonic:** without tone; denervated muscle that atrophies
**atrophy:** shrinkagelike decrease in the size of a muscle
**bursa:** fluid-filled sac found in connective tissue, usually in the area of joints
**callus:** cartilaginous/fibrous tissue at fracture site
**cancellous bone:** latticelike bone structure; trabecular bone
**cartilage:** tough, elastic, avascular tissue at ends of bone
**clonus:** rhythmic contraction of muscle
**contracture:** abnormal shortening of muscle or joint, or both; fibrosis
**cortical bone:** compact bone
**crepitus:** grating or crackling sound or sensation; may occur with movement of ends of a broken bone or irregular joint surface
**diaphysis:** shaft of long bone
**effusion:** excess fluid in joint
**endosteum:** a thin, vascular membrane covering the marrow cavity of long bones and the spaces in cancellous bone
**epiphysis:** end of long bone
**fascia (epimysium):** fibrous tissue that covers, supports, and separates muscles

## GLOSSARY *(Continued)*

**fasciculation:** involuntary twitch of muscle fibers
**flaccid:** limp; without muscle tone
**hypertrophy:** enlargement; increase in size of muscle
**isometric contraction:** muscle tension increased, length unchanged, no joint motion
**isotonic contraction:** muscle tension unchanged, muscle shortened, joint moved
**joint:** area where bone ends meet; provides for motion and flexibility
**joint capsule:** fibrous tissue that encloses bone ends and other joint surfaces
**kyphosis:** increase in the convex curvature of the spine
**lamellae:** mature compact bone structures that form concentric rings of bone matrix; lamellar bone
**ligament:** fibrous band connecting bones
**lordosis:** increase in lumbar curvature of the spine
**ossification:** process in which minerals (calcium) are deposited in bone matrix
**osteoblast:** bone-forming cell
**osteoclast:** bone resorption cell
**osteocyte:** mature bone cell
**osteogenesis:** bone formation
**osteon:** microscopic functional bone unit
**paresthesia:** abnormal sensation (eg, burning, tingling, numbness)
**periosteum:** fibrous connective tissue covering bone
**remodeling:** process that ensures bone maintenance through simultaneous bone resorption and formation
**resorption:** removal/destruction of tissue, such as bone
**scoliosis:** lateral curving of the spine
**spastic:** having greater-than-normal muscle tone
**synovium:** membrane in joint that secretes lubricating fluid
**tendon:** cord of fibrous tissue connecting muscle to bone
**tone (tonus):** normal tension (resistance to stretch) in resting muscle
**trabeculae:** latticelike bone structure; cancellous bone

The musculoskeletal system includes the bones, joints, muscles, tendons, ligaments, and bursae of the body. The functions of these components are highly integrated; therefore, disease in or injury to one component adversely affects the others. For instance, an infection in a joint (septic arthritis) causes degeneration of the articular surfaces of the bones within the joint and local muscle atrophy.

Diseases and injuries that involve the musculoskeletal system are commonly implicated in disability and death. For example, the leading cause of disability in the United States is arthritis (Centers for Disease Control and Prevention [CDC], 2005). Osteoporosis-related fractures account for more than 432,000 hospitalizations yearly in the United States (National Osteoporosis Foundation, 2008). Musculoskeletal diseases and injuries can significantly affect overall productivity, independence, and quality of life in people of all ages. Nurses in all practice areas encounter patients with malfunction in the musculoskeletal system.

## Anatomic and Physiologic Overview

The musculoskeletal system provides protection for vital organs, including the brain, heart, and lungs; provides a sturdy framework to support body structures; and makes mobility possible. Muscles and tendons hold the bones together and joints allow the body to move. **Tendons** attach muscles to bones. They also move to produce heat that helps maintain body temperature. Movement facilitates the return of deoxygenated blood to the right side of the heart by massaging the venous vasculature. The musculoskeletal system serves as a reservoir for immature blood cells and essential minerals, including calcium, phosphorus, magnesium, and fluoride. More than 98% of total body calcium is present in bone.

### Structure and Function of the Skeletal System

There are 206 bones in the human body, divided into four categories: long bones (eg, femur), short bones (eg, metacarpals), flat bones (eg, sternum), and irregular bones (eg, vertebrae). The shape and construction of a specific bone are determined by its function and the forces exerted on it. Bones are constructed of **cancellous** (trabecular) or **cortical** (compact) bone tissue. Long bones are shaped like rods or shafts with rounded ends (Fig. 66-1). The shaft, known as the **diaphysis,** is primarily cortical bone. The ends of the long bones, called **epiphyses,** are primarily cancellous bone. The epiphyseal plate separates the epiphyses from the diaphysis and is the center for longitudinal growth in children. It is calcified in adults. The ends of long bones are covered at the joints by articular **cartilage,** which is tough, elastic, avascular tissue. Long bones are designed for weight bearing and movement. Short bones consist of cancellous bone covered by a layer of compact bone. Flat bones are important sites of hematopoiesis and frequently protect vital organs. They are made of cancellous bone layered between compact bone. Irregular bones have unique shapes related to their function. Generally, irregular bone structure is similar to that of flat bones.

Bone is composed of cells, protein matrix, and mineral deposits. The cells are of three basic types—**osteoblasts,** **osteocytes,** and **osteoclasts.** Osteoblasts function in bone formation by secreting bone matrix. The matrix consists of collagen and ground substances (glycoproteins and proteoglycans) that provide a framework in which inorganic mineral salts are deposited. These minerals are primarily composed of calcium and phosphorus. Osteocytes are mature bone cells involved in bone maintenance; they are located in lacunae (bone matrix units). Osteoclasts, located in shallow Howship's lacunae (small pits in bones), are multinuclear cells involved in dissolving and resorbing bone. The microscopic functioning unit of mature cortical bone is the **osteon** (Haversian system). The center of the osteon, the Haversian canal, contains a capillary. Around the capillary are circles of mineralized bone matrix called **lamellae.** Within the lamellae are lacunae that contain osteocytes. These are nourished through tiny structures, canaliculi (canals), which communicate with adjacent blood vessels within the Haversian system. Lacunae in cancellous bone are layered in an irregular lattice network **(trabeculae).** Red bone marrow fills the lattice network. Capillaries nourish the osteocytes located in the lacunae (Porth & Matfin, 2009).

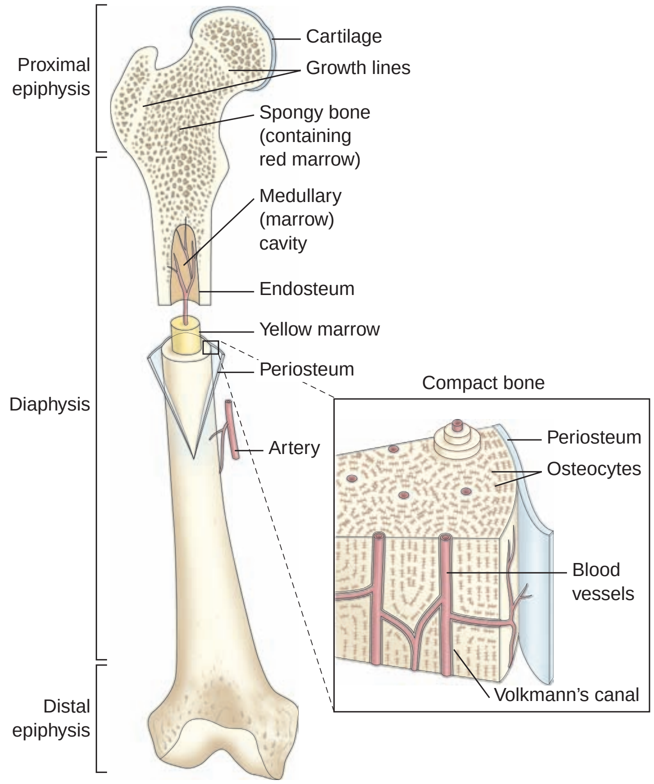



**Figure 66-1** Structure of a long bone; composition of compact bone.

Covering the bone is a dense, fibrous membrane known as the **periosteum.** This membranous structure nourishes bone and facilitates its growth. The periosteum contains nerves, blood vessels, and lymphatics. It also provides for the attachment of tendons and ligaments (Porth & Matfin, 2009).

The **endosteum** is a thin, vascular membrane that covers the marrow cavity of long bones and the spaces in cancellous bone. Osteoclasts, which dissolve bone matrix to maintain the marrow cavity, are located near the endosteum in Howship's lacunae (Porth & Matfin, 2009).

Bone marrow is a vascular tissue located in the medullary (shaft) cavity of long bones and in flat bones. Red bone marrow, located mainly in the sternum, ilium, vertebrae, and ribs in adults, is responsible for producing red blood cells, white blood cells, and platelets through a process called hematopoiesis. In adults, the long bone is filled with fatty, yellow marrow (Porth & Matfin, 2009).

Bone tissue is well vascularized. Cancellous bone receives a rich blood supply through metaphyseal and epiphyseal vessels. Periosteal vessels carry blood to compact bone through minute Volkmann's canals. In addition, nutrient arteries penetrate the periosteum and enter the medullary cavity through foramina (small openings). Arteries supply blood to the marrow and bone. The venous system may accompany arteries or may exit independently (Porth & Matfin, 2009).

### Bone Formation

**Osteogenesis** (bone formation) begins long before birth. **Ossification** is the process by which the bone matrix is formed and hard mineral crystals composed of calcium and phosphorus (eg, hydroxyapatite) are bound to the collagen fibers. These mineral components give bone its characteristic strength, whereas the proteinaceous collagen gives bone its resilience (Porth & Matfin, 2009).

### Bone Maintenance

Bone is a dynamic tissue in a constant state of turnover. During childhood, bones grow and form by a process called modeling. By early adulthood (ie, early 20s), **remodeling** is the primary process that occurs. Remodeling maintains bone structure and function through simultaneous **resorption** and osteogenesis, and as a result, complete skeletal turnover occurs every 10 years (U.S. Department of Health and Human Services [DHHS], 2004).

The balance between bone resorption and formation is influenced by the following factors: physical activity; dietary intake of certain nutrients, especially calcium; and several hormones, including calcitriol (ie, activated vitamin D), parathyroid hormone (PTH), calcitonin, thyroid hormone, cortisol, growth hormone, and the sex hormones estrogen and testosterone (DHHS, 2004).

Physical activity, particularly weight-bearing activity, acts to stimulate bone formation and remodeling. Bones subjected to continued weight bearing tend to be thick and strong. Conversely, people who are unable to engage in regular weight-bearing activities, such as those on prolonged bed rest or those with some physical disabilities, have increased bone resorption from calcium loss, and their bones become osteopenic and weak. These weakened bones may fracture easily.

Good dietary habits are integral to bone health. In particular, absorption of approximately 1000–1200 mg of calcium daily is essential to maintaining adult bone mass. This may be achieved through ingesting calcium-rich foods on a daily basis (eg, through drinking 16 to 24 ounces of milk daily).

Several hormones are vital in ensuring that calcium is properly absorbed and available for bone mineralization and matrix formation. Calcitriol functions to increase the amount of calcium in the blood by promoting absorption of calcium from the gastrointestinal tract. It also facilitates mineralization of osteoid tissue. A deficiency of vitamin D results in bone mineralization deficit, deformity, and fracture (DHHS, 2004).

PTH and calcitonin are the major hormonal regulators of calcium homeostasis. PTH regulates the concentration of calcium in the blood, in part by promoting movement of calcium from the bone. In response to low calcium levels in the blood, increased levels of PTH prompt the mobilization of calcium, the demineralization of bone, and the formation of bone cysts. Calcitonin, secreted by the thyroid gland in response to elevated blood calcium levels, inhibits bone resorption and increases the deposit of calcium in bone (DHHS, 2004).

Both thyroid hormone and cortisol have multiple systemic effects with specific effects on bones. Excessive thyroid hormone production in adults (eg, Graves' disease) can result in increased bone resorption and decreased bone formation. Increased levels of cortisol have these same effects. Patients receiving long-term synthetic cortisol or corticosteroids (ie, prednisone) are at increased risk for steroid-induced osteopenia and fractures.

Growth hormone has direct and indirect effects on skeletal growth and remodeling. It stimulates the liver and to a lesser degree the bones to produce insulinlike growth factor-1 (IGF-I), which accelerates bone modeling in children and adolescents. Growth hormone also directly stimulates skeletal growth in children and adolescents. It is believed that the low levels of both growth hormone and IGF-I that occur with aging may be partly responsible for decreased bone formation and resultant osteopenia (DHHS, 2004).

The sex hormones testosterone and estrogen have important effects on bone remodeling. Estrogen stimulates osteoblasts and inhibits osteoclasts; therefore, bone formation is enhanced and resorption is inhibited. Testosterone has both direct and indirect effects on bone growth and formation. It directly causes skeletal growth in adolescence and has continued effects on skeletal muscle growth throughout the lifespan. Increased muscle mass results in greater weight-bearing stress on bones, resulting in increased bone formation. In addition, testosterone converts to estrogen in adipose tissue, providing an additional source of bone-preserving estrogen for aging men.

During the process of bone remodeling, osteoblasts produce a receptor for activated nuclear factor-kappa B ligand (RANKL) that binds to the receptor for activated nuclear factor-kappa B (RANK) present on the cell membranes of osteoclast precursors, causing them to differentiate and mature into osteoclasts, which causes bone resorption. Conversely, osteoblasts may produce osteoprogerin (OPG), which blocks the effects of RANKL, thereby turning off the process of bone resorption. T cells that may become activated as a result of the inflammatory process may also produce RANKL, overriding the effects of OPG and causing continued bone resorption during times of stress and injury, which can lead to loss of bone matrix and fractures. Research is currently focused on developing medications that block the effects of RANKL and on developing useful laboratory tests of RANKL levels that may guide therapy aimed at reducing the risk of fractures (McCormick, 2007).

Blood supply to the bone also affects bone formation. With diminished blood supply or hyperemia (congestion),

osteogenesis and bone density decrease. Bone necrosis occurs when the bone is deprived of blood.

### Bone Healing

Most fractures heal through a combination of intramembranous and endochondral ossification processes. When a bone is fractured, the bone fragments are not patched together with scar tissue. Instead, the bone regenerates itself.

Fracture healing occurs in the bone marrow, where endothelial cells rapidly differentiate into osteoblasts; in the bone cortex, where new osteons are formed; in the periosteum, where a hard **callus** (fibrous tissue) is formed through intramembranous ossification peripheral to the fracture, and where cartilage is formed through endochondral ossification adjacent to the fracture site; and in adjacent soft tissue, where a bridging callus forms that provides stability to the fractured bones.

The process of fracture healing occurs over three phases. These include the following:

*Phase 1: Reactive phase:* When a fracture occurs, the body's response is similar to that after injury elsewhere in the body. There is bleeding into the injured tissue and formation of a hematoma at the site of the fracture. Cytokines are released that initiate the fracture healing processes by causing the proliferation of fibroblasts and that cause angiogenesis to occur (ie, the growth of new blood vessels). Granulation tissue begins to form within the clot and becomes dense.

*Phase II: Reparative phase:* During this phase, the granulation tissue is initially replaced with a callus precursor, called procallus. Fibroblasts invade the procallus and produce a denser type of callus that is composed mostly of fibrocartilage. This fibrocartilaginous callus is replaced with denser bony callus within approximately 3 to 4 weeks postinjury. Lamellar bone then forms as the bony callus calcifies months postinjury.

*Phase III: Remodeling phase:* The final phase of fracture healing results in remodeling the new bone into its former structural arrangement. Remodeling may take months to years, depending on the extent of bone modification needed, the function of the bone, and the functional stresses on the bone.

Serial x-rays are used to monitor the progress of bone healing. The type of bone fractured, the adequacy of blood supply, the surface contact of the fragments, the immobility of the fracture site, and the age and general health of the person influence the rate of fracture healing. Adequate immobilization is essential until there is x-ray evidence of bone formation with ossification.

When fractures are treated with open rigid compression plate fixation techniques, the bony fragments can be placed in direct contact. Primary bone healing occurs through cortical bone (Haversian) remodeling. Little or no cartilaginous callus develops. Immature bone develops from the endosteum. There is an intensive regeneration of new osteons, which develop in the fracture line by a process similar to normal bone maintenance. Fracture strength is obtained when the new osteons have become established.

## Structure and Function of the Articular System

The junction of two or more bones is called a **joint** (articulation). There are three basic kinds of joints: synarthrosis, amphiarthrosis, and diarthrosis joints. Synarthrosis joints are immovable (eg, the skull sutures). Amphiarthrosis joints (eg, the vertebral joints and the symphysis pubis) allow limited motion; the bones of amphiarthrosis joints are joined by fibrous cartilage. Diarthrosis joints are freely movable joints (Fig. 66-2).

There are several types of diarthrosis joints:

- *Ball-and-socket* joints (eg, the hip and the shoulder) permit full freedom of movement.
- *Hinge* joints permit bending in one direction only (eg, the elbow and the knee).
- *Saddle* joints allow movement in two planes at right angles to each other. The joint at the base of the thumb is a saddle, biaxial joint.
- *Pivot* joints are characterized by the articulation between the radius and the ulna. They permit rotation for such activities as turning a doorknob.
- *Gliding* joints allow for limited movement in all directions and are represented by the joints of the carpal bones in the wrist.

The ends of the articulating bones of a typical movable joint are covered with smooth hyaline cartilage. A tough, fibrous sheath called the **joint capsule** surrounds the articulating bones. The capsule is lined with a membrane, the **synovium,** which secretes the lubricating and shock-absorbing synovial fluid into the joint capsule. Therefore, the bone surfaces are not in direct contact. In some synovial joints (eg, the knee), fibrocartilage disks (eg, medial meniscus) are located between the articular cartilage surfaces. These disks provide shock absorption (Porth & Matfin, 2009).

**Ligaments** (fibrous connective tissue bands) bind the articulating bones together. Ligaments and muscle tendons, which pass over the joint, provide joint stability. In some joints, interosseous ligaments (eg, the cruciate ligaments of

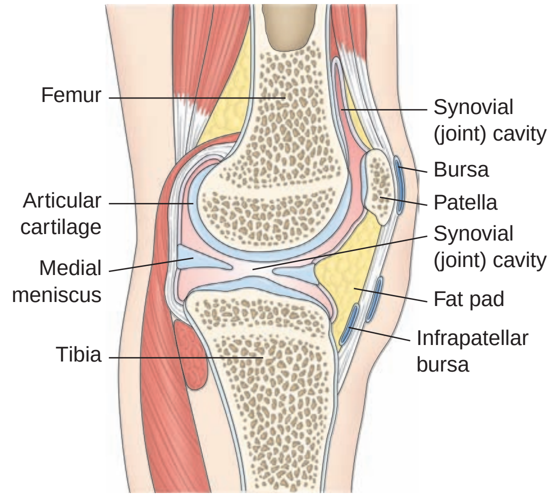



**Figure 66-2** Hinge joint of the knee.

the knee) are found within the capsule and add anterior and posterior stability to the joint.

A **bursa** is a sac filled with synovial fluid that cushions the movement of tendons, ligaments, and bones at a point of friction. Bursae can be found in the joints of the elbow, shoulder, hip, and knee.

## Structure and Function of the Skeletal Muscle System

Muscles are attached by tendons to bones, connective tissue, other muscles, soft tissue, or skin. The muscles of the body are composed of parallel groups of muscle cells (fasciculi) encased in fibrous tissue called **fascia** (epimysium). The more fasciculi contained in a muscle, the more precise the movements. Muscles vary in shape and size according to the activities for which they are responsible. Skeletal (striated) muscles are involved in body movement, posture, and heat-production functions. Muscles contract to bring the two points of attachment closer together, resulting in movement.

### *Skeletal Muscle Contraction*

Each muscle cell (also referred to as a muscle fiber) contains myofibrils, which in turn are composed of a series of sarcomeres, the actual contractile units of skeletal muscle. Sarcomeres contain thick myosin and thin actin filaments.

Muscle cells contract in response to electrical stimulation delivered by an effector nerve cell at the motor end plate. When stimulated, the muscle cell depolarizes and generates an action potential in a manner similar to that described for nerve cells. These action potentials propagate along the muscle cell membrane and lead to the release of calcium ions that are stored in specialized organelles called sarcoplasmic reticula. When there is a local increase in calcium ion concentration, the myosin and actin filaments slide across one another. Shortly after the muscle cell membrane is depolarized, it recovers its resting membrane voltage. Calcium is rapidly removed from the sarcomeres by active reaccumulation in the sarcoplasmic reticulum. When the calcium concentration in the sarcomere decreases, the myosin and actin filaments cease to interact, and the sarcomere returns to its original resting length (relaxation). Actin and myosin do not interact in the absence of calcium (Porth & Matfin, 2009).

Energy is consumed during muscle contraction and relaxation. The primary source of energy for the muscle cells is adenosine triphosphate (ATP), which is generated through cellular oxidative metabolism. At low levels of activity (ie, sedentary activity), the skeletal muscle synthesizes ATP from the oxidation of glucose to water and carbon dioxide. During periods of strenuous activity, when sufficient oxygen may not be available, glucose is metabolized primarily to lactic acid, an inefficient process compared with that of oxidative pathways. Stored muscle glycogen is used to supply glucose during periods of activity. Muscle fatigue is thought to be caused by depletion of glycogen and accumulation of lactic acid. As a result, the cycle of muscle contraction and relaxation cannot continue.

During muscle contraction, the energy released from ATP is not completely used. The excess energy is dissipated in the form of heat. During isometric contraction, almost all of the energy is released in the form of heat; during isotonic contraction, some of the energy is expended in mechanical work. In some situations (eg, shivering), the need to generate heat is the primary stimulus for muscle contraction.

The contraction of muscle fibers can result in either isotonic or isometric contraction of the muscle. In **isometric contraction,** the length of the muscles remains constant but the force generated by the muscles is increased; an example of this is pushing against an immovable wall. **Isotonic contraction,** on the other hand, is characterized by shortening of the muscle with no increase in tension within the muscle; an example of this is flexing the forearm. In normal activities, many muscle movements are a combination of isometric and isotonic contraction. For example, during walking, isotonic contraction results in shortening of the leg, and isometric contraction causes the stiff leg to push against the floor.

The speed of the muscle contraction is variable. Myoglobulin is a hemoglobinlike protein pigment present in striated muscle cells that transports oxygen. Muscles containing large quantities of myoglobulin (red muscles) have been observed to contract slowly and powerfully (eg, respiratory and postural muscles). Muscles containing little myoglobulin (white muscles) contract quickly (eg, extraocular eye muscles). Most muscles contain both red and white muscle fibers (Porth & Matfin, 2009).

### *Muscle Tone*

Relaxed muscles demonstrate a state of readiness to respond to contraction stimuli. This state of readiness, known as muscle **tone** (tonus), is produced by the maintenance of some of the muscle fibers in a contracted state. Muscle spindles, which are sense organs in the muscles, monitor muscle tone. Muscle tone is minimal during sleep and is increased when the person is anxious. A muscle that is limp and without tone is described as **flaccid;** a muscle with greater-than-normal tone is described as **spastic.** In conditions characterized by lower motor neuron destruction (eg, polio), denervated muscle becomes **atonic** (soft and flabby) and atrophies.

### *Muscle Actions*

Muscles accomplish movement by contraction. Through the coordination of muscle groups, the body is able to perform a wide variety of movements (Fig. 66-3). The prime mover is the muscle that causes a particular motion. The muscles assisting the prime mover are known as synergists. The muscles causing movement opposite to that of the prime mover are known as antagonists. An antagonist must relax to allow the prime mover to contract, producing motion. For example, when contraction of the biceps causes flexion of the elbow joint, the biceps are the prime movers, and the triceps are the antagonists. A person with muscle paralysis (a loss of movement, possibly from nerve damage) may be able to retrain functioning muscles within the synergistic group to produce the needed movement. Muscles of the synergistic group then become the prime movers.

### *Exercise, Disuse, and Repair*

Muscles need to be exercised to maintain function and strength. When a muscle repeatedly develops maximum or

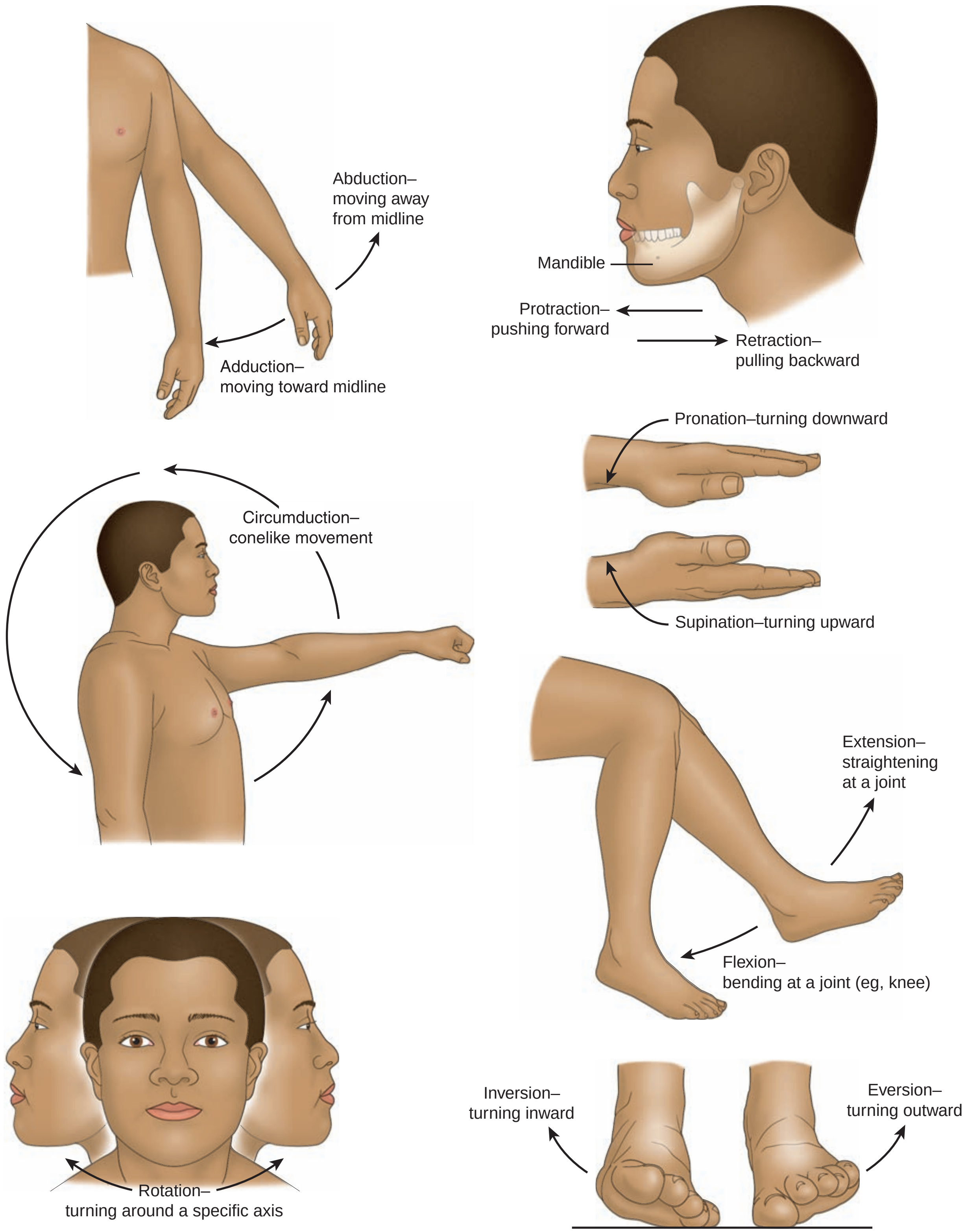



**FIGURE 66-3** Body movements produced by muscle contraction.

**Table 66-1 AGE-RELATED CHANGES OF THE MUSCULOSKELETAL SYSTEM**

| Musculoskeletal System | Structural Changes | Functional Changes | History and Physical Findings |
|---|---|---|---|
| Bones | Gradual, progressive loss of bone mass after age 30 yr<br>Vertebrae collapse | Bones fragile and prone to fracture: vertebrae, hip, wrist | Loss of height<br>Posture changes<br>Kyphosis<br>Loss of flexibility<br>Flexion of hips and knees<br>Back pain<br>Osteoporosis<br>Fracture |
| Muscles | Increase in collagen and resultant fibrosis<br>Muscles diminish in size (atrophy); wasting<br>Tendons less elastic | Loss of strength and flexibility<br>Weakness<br>Fatigue<br>Stumbling<br>Falls | Loss of strength<br>Diminished agility<br>Decreased endurance<br>Prolonged response time (diminished reaction time)<br>Diminished tone<br>Broad base of support<br>History of falls |
| Joints | Cartilage—progressive deterioration<br>Thinning of intervertebral disks | Stiffness, reduced flexibility, and pain interfere with activities of daily living | Diminished range of motion<br>Stiffness<br>Loss of height |
| Ligaments | Lax ligaments (less-than-normal strength; weakness) | Postural joint abnormality<br>Weakness | Joint pain on motion; resolves with rest<br>Crepitus<br>Joint swelling/enlargement<br>Osteoarthritis (degenerative joint disease) |

close to maximum tension over a long time, as in regular exercise with weights, the cross-sectional area of the muscle increases. This enlargement, known as **hypertrophy,** results from an increase in the size of individual muscle fibers without an increase in their number. Hypertrophy persists only if the exercise is continued. The opposite phenomenon occurs with disuse of muscle over a long period of time. Age and disuse cause loss of muscular function as fibrotic tissue replaces the contractile muscle tissue. The decrease in the size of a muscle is called **atrophy.** Bed rest and immobility cause loss of muscle mass and strength. When immobility is the result of a treatment modality (eg, casting, traction, or bedrest), the patient can decrease the effects of immobility by isometric exercise of the muscles of the immobilized part. Quadriceps contraction exercises (tightening the muscles of the thigh) and gluteal setting exercises (tightening of the muscles of the buttocks) help maintain the larger muscle groups that are important in ambulation. Active and weight-resistance exercises of uninjured parts of the body maintain muscle strength. When muscles are injured, they need rest and immobilization until tissue repair occurs. The healed muscle then needs progressive exercise to resume its preinjury strength and functional ability.

### Gerontologic Considerations

Multiple changes in the musculoskeletal system occur with aging (Table 66-1). There is a loss of height due to osteoporosis (abnormal excessive bone loss), kyphosis, thinned intervertebral disks, compressed vertebral bodies, and flexion of the knees and hips. Numerous metabolic changes, including menopausal withdrawal of estrogen and decreased activity, contribute to osteoporosis (DHHS, 2004; McCormick, 2007). Women lose more bone mass than men. In addition, bones change in shape and have reduced strength. Fractures are common. Collagen structures are less able to absorb energy. Increased inactivity, diminished neuron stimulation, and nutritional deficiencies contribute to loss of muscle strength. In addition, remote musculoskeletal problems for which the patient has compensated may become new problems with age-related changes. For example, people who have had polio and who have been able to function normally by using synergistic muscle groups may discover increasing incapacity because of a reduced compensatory ability. However, many of the effects of aging can be slowed if the body is kept healthy and active through positive lifestyle behaviors.

## Assessment

### Health History

The nursing assessment of the patient with musculoskeletal dysfunction includes an evaluation of the effects of the musculoskeletal disorder on the patient. The nurse is concerned with assisting patients who have musculoskeletal problems to maintain their general health, accomplish their activities of daily living, and manage their treatment programs. The nurse encourages optimal nutrition and prevents problems related to immobility. Through an individualized plan of nursing care, the nurse helps the patient achieve maximum health.

#### *Common Symptoms*

During the interview and physical assessment, the patient with a musculoskeletal disorder may report pain, tenderness, tightness, and abnormal sensations. The nurse assesses and documents this information.

### Pain

Most patients with diseases and traumatic conditions or disorders of the muscles, bones, and joints experience pain. Bone pain is characteristically described as a dull, deep ache that is "boring" in nature, whereas muscular pain is described as soreness or aching and is referred to as "muscle cramps." Fracture pain is sharp and piercing and is relieved by immobilization. Sharp pain may also result from bone infection with muscle spasm or pressure on a sensory nerve.

Rest relieves most musculoskeletal pain. Pain that increases with activity may indicate joint sprain, muscle strain, or compartment syndrome, whereas steadily increasing pain points to the progression of an infectious process (osteomyelitis), a malignant tumor, or neurovascular complications. Radiating pain occurs in conditions in which pressure is exerted on a nerve root. Pain is variable, and its assessment and nursing management must be individualized.

The nurse assesses the patient's pain as described in Chapter 13. Specific assessments that the nurse should make regarding the pain include the following:

- Is the body in proper alignment?
- Is there pressure from traction, bed linens, a cast, or other appliances?
- Is there tension on the skin at a pin site?

It is important that the patient's pain and discomfort be managed successfully. Not only is pain exhausting, but also, if prolonged, it can force the patient to become increasingly preoccupied and dependent (see Chapter 13).

### Altered Sensations

Sensory disturbances are frequently associated with musculoskeletal problems. The patient may describe **paresthesias,** which are burning, tingling sensations or numbness. These sensations may be caused by pressure on nerves or by circulatory impairment. Soft tissue swelling or direct trauma to these structures can impair their function. The nurse assesses the neurovascular status of the involved musculoskeletal area.

Questions that the nurse should ask regarding altered sensations include the following:

- Is the patient experiencing any abnormal sensations or numbness?
- If the abnormal sensation or feeling of numbness involves an extremity, how does this feeling compare to sensation in the unaffected extremity?
- When did the condition begin? Is it getting worse?
- Does the patient also have pain? (If the patient has pain, then the questions and assessments for pain discussed previously should be followed.)

Assessments that the nurse should make regarding the altered sensations include the following:

- If the affected part is an extremity, how does its overall appearance compare to the unaffected extremity?
- Can the patient move the affected part? If an extremity is involved, does each toe/finger have normal sensation and motion (flexion and extension), and is the skin warm or cool?
- What is the color of the part distal to the affected area? Is it pale? Dusky? Mottled? Cyanotic?
- Does rapid capillary refill occur? (The nurse can gently squeeze a nail until it blanches, then release the pressure. The amount of time for the color under the nail to return to normal is noted. Color normally returns within 3 seconds. The return of color is evidence of capillary refill.)
- Is a pulse distal to the affected area palpable? If the affected area is an extremity, how does the pulse compare to the pulse of the unaffected extremity?
- Is edema present?
- Is any constrictive device or clothing causing nerve or vascular compression?
- Does elevating the affected part or modifying its position affect the symptoms?

### *Past Health, Social, and Family History*

When assessing the musculoskeletal system, the nurse should gather pertinent data to include in the patient's health history, such as occupation (eg, does the patient's work require physical activity or heavy lifting?), exercise patterns, and dietary intake (eg, calcium and vitamin D). Concurrent health conditions (eg, diabetes, heart disease, chronic obstructive pulmonary disease, infection, preexisting disability) and related problems, such as familial or genetic abnormalities (Chart 66-1), also need to be considered when developing and implementing the plan of care.

## Physical Assessment

An examination of the musculoskeletal system ranges from a basic assessment of functional capabilities to sophisticated physical examination maneuvers that facilitate diagnosis of specific bone, muscle, and joint disorders. The extent of assessment depends on the patient's physical complaints, health history, and physical clues that warrant further exploration. The nursing assessment is primarily a functional evaluation, focusing on the patient's ability to perform activities of daily living.

Techniques of inspection and palpation are used to evaluate the patient's posture, gait, bone integrity, joint function, and muscle strength and size. In addition, assessing the skin and neurovascular status is an important part of a complete musculoskeletal assessment. The nurse also should understand and be able to perform correct assessment techniques on patients with musculoskeletal trauma. When specific symptoms or physical findings of musculoskeletal dysfunction are apparent, the nurse carefully documents the examination findings and shares the information with the physician, who may decide that a more extensive examination and a diagnostic workup are necessary.

### *Posture*

The normal curvature of the spine is convex through the thoracic portion and concave through the cervical and lumbar portions. Common deformities of the spine include **kyphosis,** an increased forward curvature of the thoracic spine; **lordosis,** or swayback, an exaggerated curvature of the lumbar spine; and **scoliosis,** a lateral curving deviation of the spine (Fig. 66-4). Kyphosis is frequently seen in elderly patients with osteoporosis and in some patients with neuromuscular diseases. Scoliosis may be congenital, idiopathic (without an identifiable cause), or the result of damage to the paraspinal muscles, as in polio. Lordosis

CHART 66-1

GENETICS IN NURSING PRACTICE

## *Musculoskeletal Disorders*

When assessing a patient with musculoskeletal complaints, nurses must not overlook the possibility of a genetic component to the patient's problems.

### Musculoskeletal Impairments Influenced by Genetic Factors

- Achondroplasia
- Congenital talipes equinovarus (clubfoot)
- Developmental dysplasia of the hip (DDH) (congenital hip dysplasia)
- Ehlers-Danlos syndrome
- Marfan syndrome
- Stickler syndrome
- Osteogenesis imperfecta
- Osteoporosis
- Scoliosis

### Nursing Assessments

**Family History**

- Assess for other similarly affected family members.
- Assess for the presence of other related genetic conditions (eg, hematologic, cardiac, integumentary conditions).
- Determine the age at onset (eg, fractures present at birth as in osteogenesis imperfecta, hip dislocation present at birth in DDH, or early-onset osteoporosis).

**Patient Assessment**

- Assess stature for general screening purposes (unusually short stature may be related to achondroplasia; unusually tall stature may be related to Marfan syndrome).
- Assess for disease-specific skeletal findings (eg, pectus excavatum, scoliosis, long fingers [Marfan syndrome], osteoarthritis of the hip and waddling gait [DDH]).
- Assess for disease-specific skin findings (eg, velvety texture with unusual scarring and/or thin fragile skin [Ehlers-Danlos syndrome]).
- Assess for other common disease-specific findings (eg, vision impairment [Stickler syndrome, Marfan syndrome], blue/gray sclerae, opalescent dentin, hearing impairment [osteogenesis imperfecta]).

### Management Issues Specific to Genetics

- Inquire whether DNA gene mutation or other genetic testing has been performed on affected family members.
- If indicated, refer patient for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, and the availability of genetic testing and gene-based interventions.
- Offer appropriate genetic information and resources.
- Assess patient's understanding of genetic information.
- Provide support to families with newly diagnosed genetic-related musculoskeletal disorders.
- Participate in management and coordination of care of patients with genetic conditions and people predisposed to develop or pass on a genetic condition.

### Genetics Resources

**Genetic Alliance—**a directory of support groups for patients and families with genetic conditions; www.geneticalliance.org

**Gene Clinics—**a listing of common genetic disorders with up-to-date clinical summaries, genetic counseling and testing information; www. geneclinics.org

**National Organization of Rare Disorders—**a directory of support groups and information for patients and families with rare genetic disorders; www. rarediseases.org

**OMIM: Online Mendelian Inheritance in Man—**a complete listing of inherited genetic conditions; www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM

is frequently seen during pregnancy as the woman adjusts her posture in response to changes in her center of gravity.

During inspection of the spine, the entire back, buttocks, and legs are exposed. The examiner inspects the spinal curves and trunk symmetry from posterior and lateral views. Standing behind the patient, the examiner notes any differences in the height of the shoulders or iliac crests. Shoulder and hip symmetry, as well as the line of the vertebral column, are inspected with the patient erect and with the patient bending forward (flexion). Scoliosis is evidenced by an abnormal lateral curve in the spine, shoulders that are not level, an asymmetric waistline, and a prominent scapula, accentuated by bending forward. Older adults experience a loss in height due to loss of vertebral cartilage and osteoporosis-related vertebral compression fractures. Therefore, an adult's height should be measured during health screenings.

### *Gait*

Gait is assessed by having the patient walk away from the examiner for a short distance. The examiner observes the patient's gait for smoothness and rhythm. Any unsteadiness or irregular movements (frequently noted in elderly patients) are considered abnormal. Limping motion is most frequently caused by painful weight bearing. In such instances, the patient can usually pinpoint the area of discomfort, thus guiding further examination. If one extremity is shorter than another, a limp may also be observed as the patient's pelvis drops downward on the affected side with each step. Limited joint motion may affect gait and a knee may be implicated. Evaluation of the knee involves the joints, bones, ligaments, tendons, and cartilage, and may include tests for the anterior and collateral ligaments, medial and lateral ligaments, and medical meniscus. In addition, a variety of neurologic conditions are associated with abnormal gaits, such as a spastic hemiparesis gait (stroke), steppage gait (lower motor neuron disease), and shuffling gait (Parkinson's disease).

### *Bone Integrity*

The bony skeleton is assessed for deformities and alignment. Symmetric parts of the body, such as extremities, are compared. Abnormal bony growths due to bone tumors may be

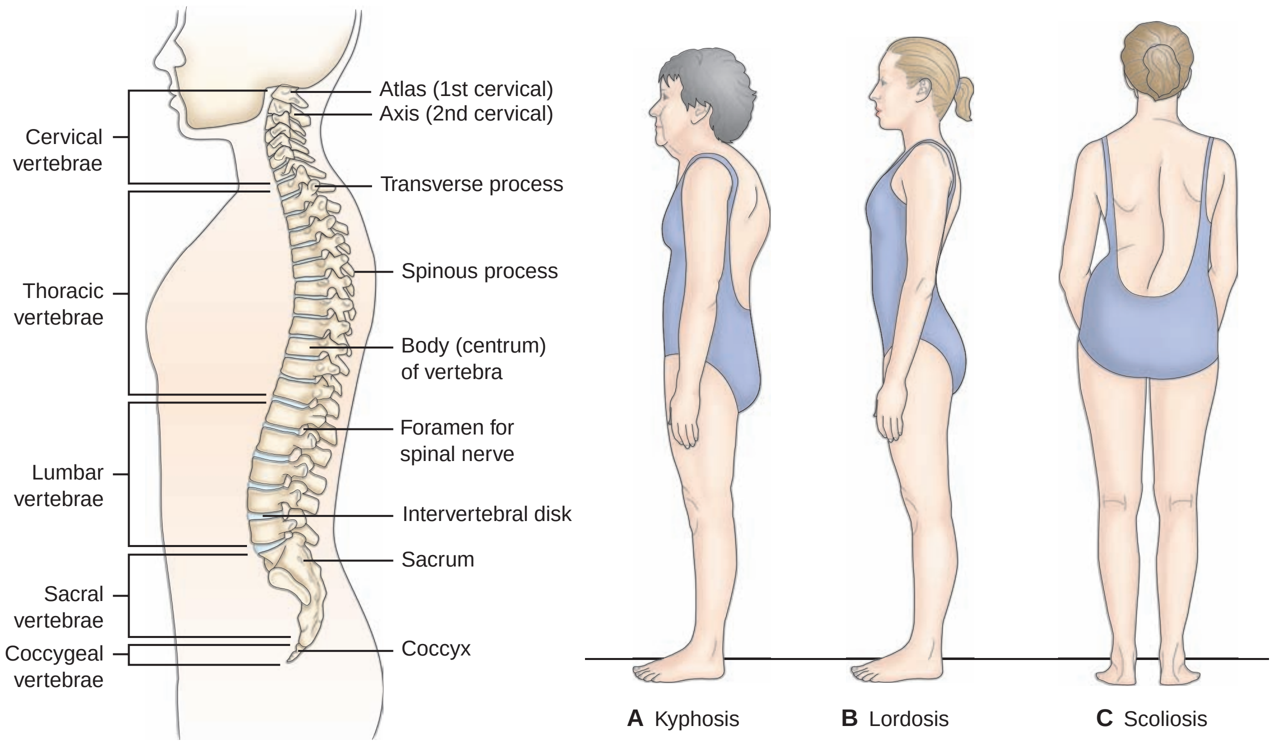



**Figure 66-4** A normal spine and three abnormalities. **A,** Kyphosis: an increased convexity or roundness of the spine's thoracic curve. **B,** Lordosis: swayback; exaggeration of the lumbar spine curve. **C,** Scoliosis: a lateral curvature of the spine.

observed. Shortened extremities, amputations, and body parts that are not in anatomic alignment are noted. Fracture findings may include abnormal angulation of long bones, motion at points other than joints, and **crepitus** (a grating sound) at the point of abnormal motion. Movement of fracture fragments must be minimized to avoid additional injury.

### Joint Function

The articular system is evaluated by noting range of motion, deformity, stability, and nodular formation. Range of motion is evaluated both actively (the joint is moved by the muscles surrounding the joint) and passively (the joint is moved by the examiner). The examiner is familiar with the normal range of motion of major joints (see Chapter 11). Precise measurement of range of motion can be made by a goniometer (a protractor designed for evaluating joint motion). Limited range of motion may be the result of skeletal deformity, joint pathology, or **contracture** (shortening of surrounding joint structures) of the surrounding muscles, tendons, and joint capsule. In elderly patients, limitations of range of motion associated with osteoarthritis may reduce their ability to perform activities of daily living.

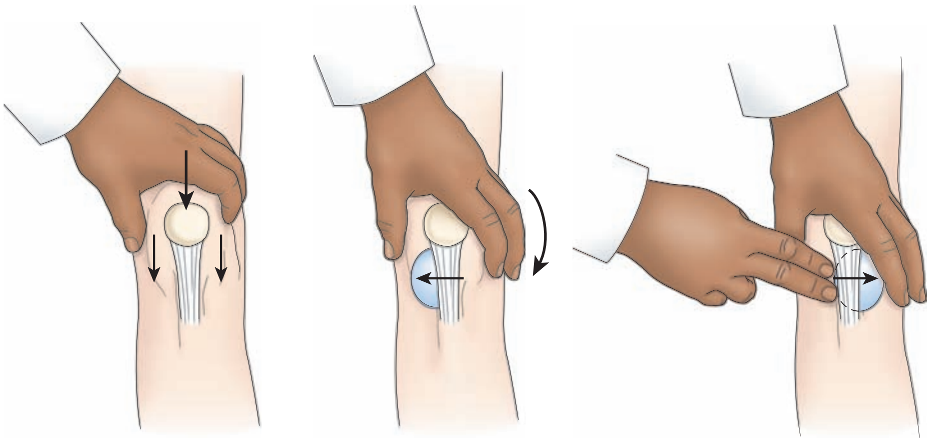
If joint motion is compromised or the joint is painful, the joint is examined for **effusion** (excessive fluid within the capsule), swelling, and increased temperature that may reflect active inflammation. An effusion is suspected if the joint is swollen and the normal bony landmarks are obscured. The most common site for joint effusion is the knee. If large amounts of fluid are present in the joint spaces beneath the patella, it may be identified by assessing for the balloon sign and for ballottement of the knee (Fig. 66-5). If inflammation or fluid is suspected in a joint, consultation with a physician is indicated.

Joint deformity may be caused by contracture, dislocation (complete separation of joint surfaces), subluxation (partial separation of articular surfaces), or disruption of structures surrounding the joint. Weakness or disruption of joint-supporting structures may result in a weak joint that requires an external supporting appliance (eg, brace).

Palpation of the joint while it is passively moved provides information about the integrity of the joint. Normally, the joint moves smoothly. A snap or crack may indicate that a ligament is slipping over a bony prominence. Slightly roughened surfaces, as in arthritic conditions, result in crepitus (grating, crackling sound or sensation) as the irregular joint surfaces move across one another.

The tissues surrounding joints are examined for nodule formation. Rheumatoid arthritis, gout, and osteoarthritis may produce characteristic nodules. The subcutaneous nodules of rheumatoid arthritis are soft and occur within and along tendons that provide extensor function to the joints. The nodules of gout are hard and lie within and immediately adjacent to the joint capsule itself. They may rupture, exuding white uric acid crystals onto the skin surface. Osteoarthritic nodules are hard and painless and represent bony overgrowth that has resulted from destruction of the cartilaginous surface of bone within the joint capsule. They are frequently seen in older adults.

Often, the size of the joint is exaggerated by atrophy of the muscles proximal and distal to that joint. This is seen in rheumatoid arthritis of the knees, in which the quadriceps muscle may atrophy dramatically. In rheumatoid arthritis,



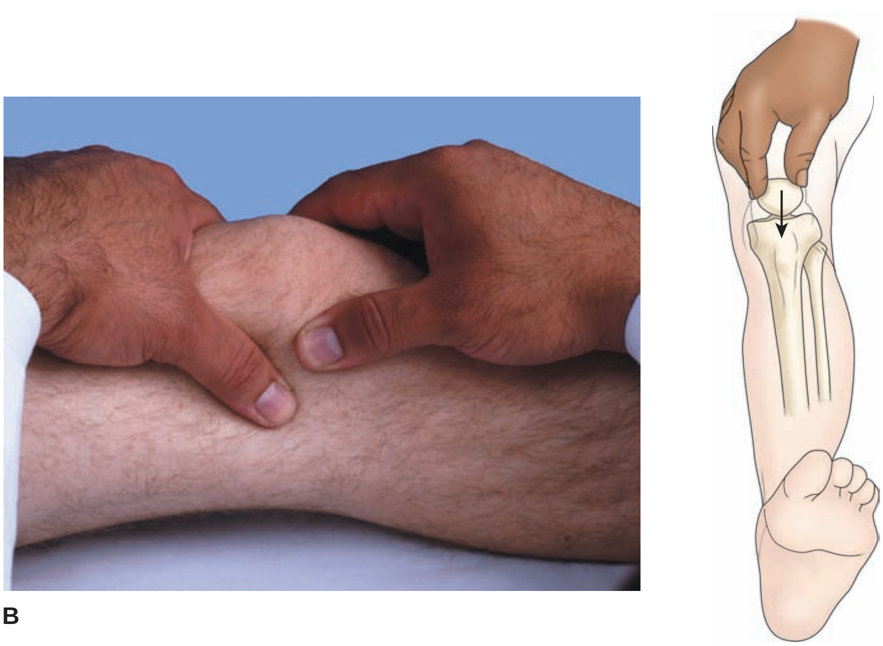




**Figure 66-5** Tests for detecting fluid in the knee. **A,** Technique for balloon sign. The medial and lateral aspects of the extended knee are milked firmly in a downward motion, which displaces any fluid downward. The examiner feels for any fluid entering the space directly inferior to the patella. When larger amounts of fluid are present, the subpatellar region feels as if it is "ballooning," and the balloon sign test is positive. **B,** Technique for ballottement sign. The medial and lateral aspects of the extended knee are milked firmly in a downward motion. The examiner pushes the patella toward the femur and observes for fluid return to the region superior to the patella. When larger amounts of fluid are present, the patella elevates, there is visible return of fluid to the region directly superior to the patella, and the ballottement test is positive. Photograph used with permission from Bickley, L. S. (2007). *Bates' guide to physical examination and history taking* (9th ed.). Philadelphia: Lippincott Williams & Wilkins.

joint involvement assumes a symmetric pattern (Fig. 66-6). (See Chapter 54 for further information about rheumatoid arthritis.)

### Muscle Strength and Size

The muscular system is assessed by noting muscular strength and coordination, the size of individual muscles, and the patient's ability to change position. Weakness of a group of muscles might indicate a variety of conditions, such as polyneuropathy, electrolyte disturbances (particularly potassium and calcium), myasthenia gravis, poliomyelitis, and muscular dystrophy. By palpating the muscle while passively moving the relaxed extremity, the nurse can determine the muscle tone. The nurse assesses muscle strength by having the patient perform certain maneuvers with and without added resistance. For example, when the biceps are tested, the patient is asked to extend the arm fully and then



**Figure 66-6** Rheumatoid arthritis joint deformity with ulnar deviation of fingers and "swan neck" deformity of fingers (ie, hyperextension of proximal interphalangeal joints with flexion of distal interphalangeal joints).

to flex it against resistance applied by the nurse. A simple handshake may provide an indication of grasp strength.

The nurse may elicit muscle **clonus** (rhythmic contractions of a muscle) in the ankle or wrist by sudden, forceful, sustained dorsiflexion of the foot or extension of the wrist. **Fasciculation** (involuntary twitching of muscle fiber groups) may be observed.

The nurse measures the girth of an extremity to monitor increased size due to exercise, edema, or bleeding into the muscle. Girth may decrease due to muscle atrophy. The unaffected extremity is measured and used as the reference standard for the affected extremity. Measurements are taken at the maximum circumference of the extremity. It is important that the measurements be taken at the same location on the extremity, and with the extremity in the same position, with the muscle at rest. Distance from a specific anatomic landmark (eg, 10 cm below the medial aspect of the knee for measurement of the calf muscle) should be indicated in the patient's record so that subsequent measurements can be made at the same point. For ease of serial assessment, the nurse may indicate the point of measurement by marking the skin. Variations in size greater than 1 cm are considered significant.

#### *Skin*

In addition to assessing the musculoskeletal system, the nurse inspects the skin for edema, temperature, and color. Palpation of the skin can reveal whether any areas are warmer, suggesting increased perfusion or inflammation, or cooler, suggesting decreased perfusion, and whether edema is present. Cuts, bruises, skin color, and evidence of decreased circulation or inflammation can influence nursing management of musculoskeletal conditions.

#### *Neurovascular Status*

It is important for the nurse to perform frequent neurovascular assessments of patients with musculoskeletal disorders (especially of those with fractures) because of the risk for tissue and nerve damage. Chart 66-2 describes tests of peripheral nerve function that the nurse may perform. One complication that the nurse needs to be alert for when assessing the patient is compartment syndrome, which is described in detail later in this unit. This major neurovascular problem is caused by pressure within a muscle compartment that increases to such an extent that microcirculation diminishes, leading to nerve and muscle anoxia and necrosis. Function can be permanently lost if the anoxic situation continues for longer than 6 hours. Assessment of neurovascular status (Chart 66-3) is frequently referred to as assessment of CMS (circulation, motion, and sensation).

## Diagnostic Evaluation

### Imaging Procedures

#### *X-Ray Studies*

X-ray studies are important in evaluating patients with musculoskeletal disorders. Bone x-rays determine bone density, texture, erosion, and changes in bone relationships. X-ray study of the cortex of the bone reveals any widening,

**CHART 66-2 Assessing for Peripheral Nerve Function**

Assessment of peripheral nerve function has two key elements: evaluation of sensation and evaluation of motion. The nurse may perform one or all of the following during a musculoskeletal assessment.

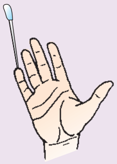
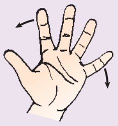
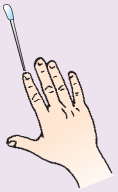
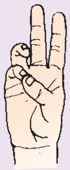
| *Nerve* | *Test of Sensation* | *Test of Movement* |
|---|---|---|
| Peroneal nerve | Prick the skin midway between the great and second toe.  | Ask the patient to dorsiflex the foot and extend the toes.  |
| Tibial nerve | Prick the medial and lateral surface of the sole.  | Ask the patient to plantar flex toes and foot.  |
| Radial nerve | Prick the skin midway between the thumb and second finger.  | Ask the patient to stretch out the thumb, then the wrist, and then the fingers at the metacarpal joints.  |
| Ulnar nerve | Prick the distal fat pad of the small finger.  | Ask the patient to abduct all fingers.  |
| Median nerve | Prick the top or distal surface of the index finger.  | Ask the patient to touch the thumb to the little finger. Also observe whether the patient can flex the wrist.  |

**Chart 66-3 • *Indicators of Peripheral Neurovascular Dysfunction***

**Circulation**

Color: Pale, cyanotic, or mottled
Temperature: Cool
Capillary refill: More than 3 seconds

**Motion**

Weakness
Paralysis

**Sensation**

Paresthesia
Unrelenting pain
Pain on passive stretch
Absence of feeling

narrowing, or signs of irregularity. Joint x-rays reveal fluid, irregularity, spur formation, narrowing, and changes in the joint structure. Multiple x-rays, with multiple views (eg, anterior-posterior, lateral), are needed for full assessment of the structure being examined. Serial x-rays may be indicated to determine the status of the healing process. After being positioned for the study, the patient must remain still while the x-rays are obtained.

#### *Computed Tomography*

A computed tomography (CT) scan, which may be performed with or without the use of contrast agents, shows in detail a specific plane of involved bone and can reveal tumors of the soft tissue or injuries to the ligaments or tendons. It is used to identify the location and extent of fractures in areas that are difficult to evaluate (eg, acetabulum). The patient must remain still during the procedure (Goodhart & Page, 2007).

#### *Magnetic Resonance Imaging*

Magnetic resonance imaging (MRI) is a noninvasive imaging technique that uses magnetic fields, radiowaves, and computers to demonstrate abnormalities (ie, tumors or narrowing of tissue pathways through bone) of soft tissues such as muscle, tendon, cartilage, nerve, and fat. Because an electromagnet is used, patients with any metal implants, clips, or pacemakers are not candidates for MRI.

***NURSING ALERT***

**Jewelry, hair clips, hearing aids, credit cards with magnetic strips, and other metal-containing objects must be removed before the MRI is performed; otherwise, they can become dangerous projectile objects or cause burns. Credit cards with magnetic strips may be erased, and nonremovable cochlear devices can become inoperable. Also, transdermal patches (eg, NicoDerm, Transderm-Nitro, Transderm Scopolamine, Catapres-TTS) that have a thin layer of aluminized backing must be removed before MRI because they can cause burns. The physician should be notified before the patches are removed.**

To enhance visualization of anatomic structures, intravenous (IV) contrast agent may be used. During the MRI, the patient must lie still and will hear a rhythmic knocking sound. Patients who experience claustrophobia may be unable to tolerate the confinement of closed MRI equipment without sedation. Open MRI systems are available, but they use lower-intensity magnetic fields, which produce lower-quality images. Advantages of open MRI include increased patient comfort, reduced problems with claustrophobic reactions, and reduced noise.

#### *Arthrography*

Arthrography is useful in identifying acute or chronic tears of the joint capsule or supporting ligaments of the knee, shoulder, ankle, hip, or wrist. A radiopaque contrast agent or air is injected into the joint cavity to visualize irregular surfaces. The joint is put through its range of motion to distribute the contrast agent while a series of x-rays is obtained. If a tear is present, the contrast agent leaks out of the joint and is evident on the x-ray image.

After an arthrogram, a compression elastic bandage is applied as prescribed and the joint is usually rested for 12 hours. The nurse provides additional comfort measures (mild analgesia, ice) as appropriate and explains to the patient that it is normal to experience clicking or crackling in the joint for a day or two after the procedure, until the contrast agent or air is absorbed.

#### *Nursing Interventions for Imaging Studies*

Before the patient undergoes an imaging study, the nurse assesses for conditions that may require special consideration during the study or that may be contraindications to the study (eg, pregnancy; claustrophobia; inability to tolerate required positioning due to age, debility, or disability; metal implants). If contrast agents will be used for CT scan, MRI, or arthrography, the patient is assessed for possible allergies (Goodhart & Page, 2007).

## Bone Densitometry

Bone densitometry is used to estimate bone mineral density (BMD). This can be performed through the use of x-rays or ultrasound. The most common modalities used include dual-energy x-ray absorptiometry (DXA or DEXA), quantitative computed tomography (QCT), and quantitative ultrasound (QUS). DXA BMD measures of the hip and spine are very accurate in estimating the extent of osteoporosis and monitoring a patient's response to treatment for osteoporosis. Peripheral DXA (pDXA) may be an alternative test that measures BMD of the forearm, finger, or heel, though its ability to project hip or spine fracture risk is less accurate than DXA. While the BMD of the heel can be used to diagnose and monitor osteoporosis, predicting hip fracture risk related to osteoporosis is best achieved through DXA of the hip; hence, it is the most commonly prescribed diagnostic test for determining BMD (Bonnick, 2005; National Osteoporosis Foundation, 2008). (See Chapter 68 for a further discussion of osteoporosis risks.)

## Bone Scan

A bone scan is performed to detect metastatic and primary bone tumors, osteomyelitis, some fractures, and aseptic necrosis. A bone-seeking radioisotope is injected

IV. The scan is performed 2 to 3 hours after the injection. At this point, distribution and concentration of the isotope in the bone are measured. The degree of nuclide uptake is related to the metabolism of the bone. An increased uptake of isotope is seen in primary skeletal disease (osteosarcoma), metastatic bone disease, inflammatory skeletal disease (osteomyelitis), and fractures that do not heal as expected.

#### Nursing Interventions

Before the patient undergoes a bone scan, the nurse inquires about possible allergies to the radioisotope and assesses for any condition that would contraindicate performing the procedure (eg, pregnancy). In addition, the patient is encouraged to drink plenty of fluids to help distribute and eliminate the isotope. Before the scan, the nurse asks the patient to empty the bladder, because a full bladder interferes with accurate scanning of the pelvic bones.

### Arthroscopy

Arthroscopy is a procedure that allows direct visualization of a joint to diagnose joint disorders. Treatment of tears, defects, and disease processes may be performed through the arthroscope. The procedure is performed in the operating room under sterile conditions; injection of a local anesthetic agent into the joint or general anesthesia is used. A large-bore needle is inserted, and the joint is distended with saline. The arthroscope is introduced, and joint structures, synovium, and articular surfaces are visualized. After the procedure, the puncture wound is closed with adhesive strips or sutures and covered with a sterile dressing. Complications are rare but may include infection, hemarthrosis, neurovascular compromise, thrombophlebitis, stiffness, effusion, adhesions, and delayed wound healing.

#### Nursing Interventions

After the arthroscopic procedure, the joint is wrapped with a compression dressing to control swelling. In addition, ice may be applied to control edema and enhance comfort. Frequently, the joint is kept extended and elevated to reduce swelling. It is important to monitor and document the neurovascular status. Analgesic agents are administered as needed. The patient is instructed about activities and exercises that may be performed. The patient and family are informed of the symptoms (eg, swelling, numbness, cool skin) to watch for in order to determine whether complications are occurring and of the importance of notifying the physician of these observations.

### Arthrocentesis

Arthrocentesis (joint aspiration) is carried out to obtain synovial fluid for purposes of examination or to relieve pain due to effusion. Examination of synovial fluid is helpful in the diagnosis of septic arthritis and other inflammatory arthropathies and reveals the presence of hemarthrosis (bleeding into the joint cavity), which suggests trauma or a bleeding disorder. Normally, synovial fluid is clear, pale, straw colored, and scanty in volume. Using aseptic technique, the physician inserts a needle into the joint and aspirates fluid. Anti-inflammatory medications may be injected into the joint. A sterile dressing is applied after aspiration. There is a risk of infection after this procedure.

### Electromyography

Electromyography (EMG) provides information about the electrical potential of the muscles and the nerves leading to them. The test is performed to evaluate muscle weakness, pain, and disability. The purpose of the procedure is to determine any abnormality of function and to differentiate muscle and nerve problems. Needle electrodes are inserted into selected muscles, and responses to electrical stimuli are recorded on an oscilloscope. Warm compresses may relieve residual discomfort after the study.

### Biopsy

Biopsy may be performed to determine the structure and composition of bone marrow, bone, muscle, or synovium to help diagnose specific diseases. The nurse teaches the patient about the procedure and assures the patient that analgesic agents will be provided. The nurse monitors the biopsy site for edema, bleeding, pain, and infection. Ice is applied as prescribed to control bleeding and edema. In addition, analgesic agents are administered as prescribed for comfort.

### Laboratory Studies

Examination of the patient's blood and urine can provide information about a primary musculoskeletal problem (eg, Paget's disease of the bone), a developing complication (eg, infection), the baseline for instituting therapy (eg, anticoagulant therapy), or the response to therapy. Before surgery, coagulation studies are performed to detect bleeding tendencies (because bone is vascular tissue).

Serum calcium levels are altered in patients with osteomalacia, parathyroid dysfunction, Paget's disease, metastatic bone tumors, or prolonged immobilization. Serum phosphorus levels are inversely related to calcium levels and are diminished in osteomalacia associated with malabsorption syndrome. Acid phosphatase is elevated in Paget's disease and metastatic cancer. Alkaline phosphatase is elevated during early fracture healing and in diseases with increased osteoblastic activity (eg, metastatic bone tumors). Bone metabolism may be evaluated through thyroid studies and determination of calcitonin, PTH, and vitamin D levels. Serum enzyme levels of creatine kinase and aspartate aminotransferase become elevated with muscle damage. Serum osteocalcin (bone GLA protein) indicates the rate of bone turnover. Urine calcium levels increase with bone destruction (eg, parathyroid dysfunction, metastatic bone tumors, multiple myeloma) (McCormick, 2007).

Specific urine and serum biochemical markers can be used to provide information about bone formation. These include urinary N-telopeptide of type 1 collagen (N-Tx) and deoxypyridinoline (Dpd), both of which reflect increased osteoclast activity and increased bone resorption. Conversely, elevated serum levels of bone-specific alkaline phosphatase (ALP), osteocalcin, and intact *N*-terminal propeptide of type 1 collagen (P1NP) reflect increased activity of osteoblasts and enhanced bone remodeling activity (McCormick, 2007).

## CRITICAL THINKING EXERCISES

EBP **1** A 72-year-old Caucasian woman arrives at the emergency department where you are the triage nurse. She is complaining of severe pain in her right groin area and has some discomfort when she puts weight on or moves her right hip. She stated that she did not fall or injure the extremity; she just was walking down the steps and felt a "force" on her right leg. There are no deformities noted. What are the first evaluation assessments that you would perform? What is the evidence base that indicates that this woman may be at increased risk for osteoporosis-related fractures? What recommendations might be made for appropriate testing in this patient? What are the most important medical history questions you would ask her?

**2** A 15-year-old high school football player came into the orthopedic office after sustaining a "direct blow" to the left knee last night during a game. He has slight edema and complains of pain with movement and weight bearing. What is your first physical assessment activity? How would you assess the stability of his left knee? What diagnostic tests are most likely indicated?

EBP **3** You are a parish nurse teaching a class to senior citizens in your parish centered on age-associated changes in the musculoskeletal system. The participants have experienced many of the changes you identify and ask you what they can do about them. What is the evidence base that supports the strategies that these elderly citizens might implement to minimize these changes and maximize musculoskeletal health? What is the strength of the evidence of the effectiveness of these strategies? Focus your teaching strategies on prevention of falls and on prevention of osteoporosis.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

American College of Sports Medicine, www.acsm.org

National Association of Orthopaedic Nurses (NAON), www.orthonurse.org

National Institute of Arthritis and Musculoskeletal and Skin Diseases, www.niams.nih.gov

National Osteoporosis Foundation, www.nof.org



chapter 67

# Musculoskeletal Care Modalities

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the preventive and health teaching needs of the patient with a cast, brace, or splint.
2. Describe the nursing management of the patient with a cast, brace, or splint.
3. Describe the various types of traction and the principles of effective traction.
4. Identify the preventive nursing care needs of the patient in traction.
5. Describe the nursing management of the patient in traction.
6. Compare the nursing needs of the patient undergoing total hip replacement with those of the patient undergoing total knee replacement.
7. Use the nursing process as a framework for care of the patient undergoing orthopedic surgery.

## GLOSSARY

**abduction:** movement away from the center or median line of the body
**adduction:** movement toward the center or median line of the body
**avascular necrosis:** death of tissue due to insufficient blood supply
**brace:** externally applied device to support the body or a body part, control movement, and prevent injury
**cast:** rigid external immobilizing device molded to contours of body part
**cast syndrome:** psychological (claustrophobic reaction) or physiologic (superior mesenteric artery syndrome) responses to confinement in body cast
**continuous passive motion (CPM) device:** a device that promotes range of motion, circulation, and healing
**edema:** soft tissue swelling due to fluid accumulation
**external fixator:** external metal frame attached to bone fragments to stabilize them
**fracture:** a break in the continuity of the bone
**heterotopic ossification:** misplaced formation of bone
**neurovascular status:** neurologic (motor and sensory components) and circulatory functioning of a body part
**open reduction with internal fixation (ORIF):** open surgical procedure to repair and stabilize a fracture
**osteomyelitis:** infection of the bone
**osteotomy:** surgical cutting of bone
**sling:** bandage used to support an arm
**splint:** device designed specifically to support and immobilize a body part in a desired position
**traction:** application of a pulling force to a part of the body
**trapeze:** overhead assistive device to promote patient mobility in bed

The management of musculoskeletal injuries and disorders frequently includes the use of casts, braces, splints, traction, surgery, or a combination of these. Patient education is essential for optimal outcomes. The nurse prepares the patient for immobilization with casts or traction, and for surgery, when indicated. Nursing care is planned to maximize the effectiveness of these treatment modalities and to prevent potential complications associated with each of the interventions. The patient is taught to manage care at home and how to safely resume activities.

# The Patient in a Cast, Splint, or Brace

## Casts

A **cast** is a rigid external immobilizing device that is molded to the contours of the body. A cast is used specifically to immobilize a reduced **fracture,** to correct a deformity, to apply uniform pressure to underlying soft tissue, or to support and stabilize weakened joints (Altizer, 2004). Generally, casts permit mobilization of the patient while restricting movement of a body part.

The condition being treated influences the type and thickness of the cast applied. Generally, the joints proximal and distal to the area to be immobilized are included in the cast. However, with some fractures, cast construction and molding may allow movement of a joint while immobilizing a fracture (eg, three-point fixation in a patellar tendon weight-bearing cast). Various types of casts include the following:

*Short-arm cast:* Extends from below the elbow to the palmar crease, secured around the base of the thumb. If the thumb is included, it is known as a *thumb spica* or *gauntlet* cast.

*Long-arm cast:* Extends from the axillary fold to the proximal palmar crease. The elbow usually is immobilized at a right angle.

*Short-leg cast:* Extends from below the knee to the base of the toes. The foot is flexed at a right angle in a neutral position.

*Long-leg cast:* Extends from the junction of the upper and middle third of the thigh to the base of the toes. The knee may be slightly flexed.

*Walking cast:* A short- or long-leg cast reinforced for strength.

*Body cast:* Encircles the trunk.

*Shoulder spica cast:* A body jacket that encloses the trunk, shoulder, and elbow.

*Hip spica cast:* Encloses the trunk and a lower extremity. A double hip spica cast includes both legs.

Figure 67-1 illustrates long-arm and long-leg casts and areas in which pressure problems commonly occur with these casts.

### Fiberglass Casts

Fiberglass casts are composed of water-activated polyurethane materials that have the versatility of plaster (see later discussion) but are lighter in weight, stronger, and more durable than plaster. In addition, they are water resistant (Altizer, 2004). They consist of an open-weave, nonabsorbent fabric impregnated with cool water–activated hardeners that bond and reach full rigid strength in minutes. Heat is given off (an exothermic reaction) while the cast is applied. Therefore, a newly applied fiberglass cast should not be placed on a plastic surface. The heat given off during this reaction can be uncomfortable, and the nurse should prepare the patient for the sensation of increasing warmth so that the patient does not become alarmed. While the cast is setting, it can be dented. Therefore, it must be handled with the palms of the hands and not allowed to rest on hard surfaces or sharp edges. Cast dents may press on the skin, causing irritation and skin breakdown.

Some fiberglass casts use a waterproof lining (Gore-Tex), which permits the patient to shower, swim, or engage in hydrotherapy (use of water for treatment). When the cast is wet, the patient is instructed to shake or drain water out of it; thorough drying is important to prevent skin breakdown. The best results are achieved with casts that can easily drain, such as short-arm casts. Heels and elbows encased in wet casts may become macerated from the trapped water and therefore are associated with more skin breakdown.

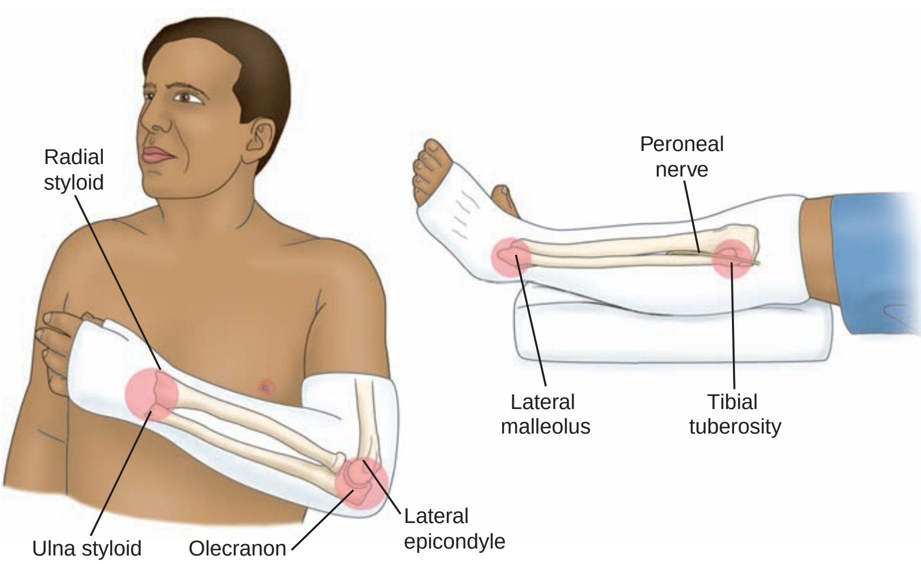



**Figure 67-1** Pressure areas in common types of casts. **Left,** Long-arm cast. **Right,** Short-leg cast.

### Plaster Casts

Casts made of plaster are less costly and achieve a better mold than fiberglass casts; however, they are not as durable and take longer to dry. Rolls of plaster of Paris-impregnated bandages are wet in cool water and applied smoothly to the body. These will also cause an exothermic reaction, similar to that seen with fiberglass casts. The crystallization process produces a rigid dressing in 15 to 20 minutes. After the plaster sets, the cast remains wet and somewhat soft. It does not have its full strength until it is dry. The plaster cast requires 24 to 72 hours to dry completely, depending on its thickness and the environmental drying conditions. A freshly applied cast should be exposed to circulating air to dry and should not be covered with clothing or bed linens or placed on plastic-coated mats or bedding. A wet plaster cast appears dull and gray, sounds dull on percussion, feels damp, and smells musty. A dry plaster cast is white and shiny, resonant to percussion, odorless, and firm.

## Splints and Braces

Many injuries that were previously treated with casts may now be treated with other immobilization devices (eg, braces, splints) (Nash, Mickan, Del Mar, et al., 2005).

Contoured **splints** of plaster or pliable thermoplastic materials may be used for conditions that do not require rigid immobilization, for those in which swelling may be anticipated, and for those that require special skin care. Splints made of thermoplastics are warmed and molded to fit the patient (eg, hand splints and thoracolumbosacral orthotics [TLSOs], clamshell-type back braces). The splint needs to immobilize and support the body part in a functional position and it must be well padded to prevent pressure, skin abrasion, and skin breakdown. The splint is overwrapped with an elastic bandage applied in a spiral fashion and with pressure uniformly distributed so that circulation is not restricted. Splints are generally indicated for short-term use (Gravlee & Van Durme, 2007).

**Braces** (ie, orthoses) are used to provide support, control movement, and prevent additional injury. They are custom fitted to various parts of the body. The orthotist adjusts the brace for fit, positioning, and motion so that movement is enhanced, any deformities are corrected, and discomfort is minimized. Braces are generally indicated for longer use than splints (Gravlee & Van Durme, 2007).

Many splints and braces are prefabricated. They may be made of plastic and other materials such as cloth, leather, metal, elastic and Velcro. Knee immobilizers, ankle stirrups, and cock-up wrist splints are types of prefabricated splints and braces.

## General Nursing Management of a Patient in a Cast, Splint, or Brace

Before the cast, brace, or splint is applied, the nurse completes an assessment of the patient's general health, presenting signs and symptoms, emotional status, understanding of the need for the device, and condition of the body part to be immobilized. Physical assessment of the part to be immobilized must include assessment of the **neurovascular status** (ie, neurologic and circulatory functioning) of the body part and degree and location of swelling, bruising, and skin abrasions. In addition, the nurse gives the patient information about the underlying pathologic condition and the purpose and expectations of the prescribed treatment regimen. This knowledge promotes the patient's active participation in and compliance with the treatment program. It is important to prepare the patient for the application of the cast, brace, or splint by describing the anticipated sights, sounds, and sensations (eg, heat from the hardening reaction of the fiberglass or plaster). The patient needs to know what to expect during application and the reason the body part must be immobilized (Chart 67-1).

The nurse must carefully evaluate pain associated with the musculoskeletal condition, asking the patient to indicate the exact site and to describe the character and intensity of the pain to help determine its cause. Most pain can be relieved by elevating the involved part, applying cold packs, and administering analgesic agents as prescribed.

*NURSING ALERT*

**A patient's unrelieved pain must be immediately reported to the physician to avoid possible paralysis and necrosis.**

Pain associated with the underlying condition (eg, fracture) is frequently controlled by immobilization. Pain due to **edema** that is associated with trauma, surgery, or bleeding into the tissues can frequently be controlled by elevation and, if prescribed, intermittent application of cold packs. Ice bags (one-third to one-half full) or cold application devices are placed on each side of the cast, if prescribed, making sure not to indent or wet the cast.

Pain may be indicative of complications. Pain associated with compartment syndrome (see Chapter 69 and later in this chapter) is relentless and is not controlled by modalities such as elevation, application of cold if prescribed, and usual dosages of analgesic agents. Severe burning pain over bony prominences, especially the heels, anterior ankles, and elbows, warns of an impending pressure ulcer. These may also occur from too-tight ace wraps used to hold splints in place. Pain decreases when ulceration occurs. Discomfort due to pressure on the skin may be relieved by elevation that controls edema or by positioning that alters pressure. It may be necessary to modify the dressing, ace wrap, or cast, or to apply a new cast.

*NURSING ALERT*

**The nurse must never ignore complaints of pain from the patient in a cast because of the possibility of problems, such as impaired tissue perfusion or pressure ulcer formation.**

Every joint that is not immobilized should be exercised and moved through its range of motion to maintain function. If the patient has a leg cast, brace, or splint, the nurse encourages toe exercises. If the patient has an arm immobilized, the nurse encourages finger exercises.

To promote healing, it is important to treat any skin lacerations and abrasions that may have occurred as a result of the trauma that caused the fracture before the cast, brace, or

## CHART 67-1 Guidelines for Applying a Cast

### Equipment

- Drape for patient
- Knitted material (eg, stockinette)
- Nonwoven roll padding
- Casting material
- Water and basin
- Cast knife or cutter

### Implementation

| Procedure | Rationale |
|---|---|
| 1. Support extremity or body part to be casted. | 1. Minimizes movement; maintains reduction and alignment; increases comfort |
| 2. Position and maintain part to be casted in position indicated by physician during casting procedure. | 2. Facilitates casting; reduces incidence of complications (eg, malunion, nonunion, contracture) |
| 3. Drape patient. | 3. Avoids undue exposure; protects other body parts from contact with casting materials |
| 4. Wash and dry part to be casted. | 4. Reduces incidence of skin breakdown |
| 5. Place at least three layers of knitted material* (eg, stockinette) over part to be casted.<br>• Apply in smooth and nonconstrictive manner.<br>• Allow additional material. | 5. Protects skin from casting materials<br>Protects skin from pressure<br>Folds over edges of cast when finishing application; creates smooth, padded edge; protects skin from abrasion |
| 6. Wrap soft, nonwoven roll padding* smoothly and evenly around part.<br>• Use additional padding around bony prominences to protect superficial nerves (eg, head of fibula, olecranon process). | 6. Protects skin from pressure of cast<br>Protects skin at bony prominences<br>Protects superficial nerves |
| 7. Apply plaster or fiberglass casting material evenly on body part.<br>• Choose appropriate-width bandage.<br>• Overlap preceding turn by half the width of the bandage.<br>• Use continuous motion, maintaining constant contact with body part.<br>• Use additional casting material (splints) at joints and at points of anticipated cast stress. | 7. Creates smooth, solid, well-contoured cast<br>Facilitates smooth application<br>Creates smooth, solid, immobilizing cast<br>Shapes cast properly for adequate support<br>Strengthens cast |
| 8. "Finish" cast.<br>• Smooth edges.<br>• Trim and reshape with cast knife or cutter. | 8. Protects skin from abrasion<br>Allows full range of motion of adjacent joints |
| 9. Remove particles of casting materials from skin. | 9. Prevents particles from loosening and sliding underneath cast |
| 10. Support cast during hardening.<br>• Handle hardening casts with palms of hands.<br>• Support cast on firm, smooth surface.<br>• Do not rest cast on hard surfaces or on sharp edges.<br>• Avoid pressure on cast. | 10. Casting materials begin to harden in minutes. Maximum hardness of nonplaster cast occurs in minutes. Maximum hardness of plaster cast occurs with drying (24 to 72 hours, depending on environment and thickness of cast).<br>Avoids denting of cast and development of pressure areas |
| 11. Promote drying of cast.<br>• Leave cast uncovered and exposed to air.<br>• Turn patient every 2 hours, supporting major joints.<br>• Fans may be used to increase air flow and speed drying. | 11. Facilitates drying |

*Nonabsorbent materials are used with nonplaster casts.

splint is applied. The nurse thoroughly cleans the skin and treats it as prescribed. The patient may require a tetanus booster if the wound is dirty and if the last known booster was administered more than 5 years ago. Sterile dressings are used to cover the injured skin. If the skin wounds are extensive, an alternative method (eg, external fixator) may be chosen to immobilize the body part. While the cast is on, the nurse observes the patient for systemic signs of infection; odors from the cast, brace, or splint; and purulent drainage staining the cast. It is important to notify the physician if any of these occur.

The nurse monitors circulation, motion, and sensation of the affected extremity, assessing the fingers or toes of the affected extremity and comparing them with those of the opposite extremity. Normal findings include minimal edema, minimal discomfort, pink color, warm to touch, rapid capillary refill response, normal sensations, and ability to exercise fingers or toes (Konstantakos, Dalstrom, Nelles,

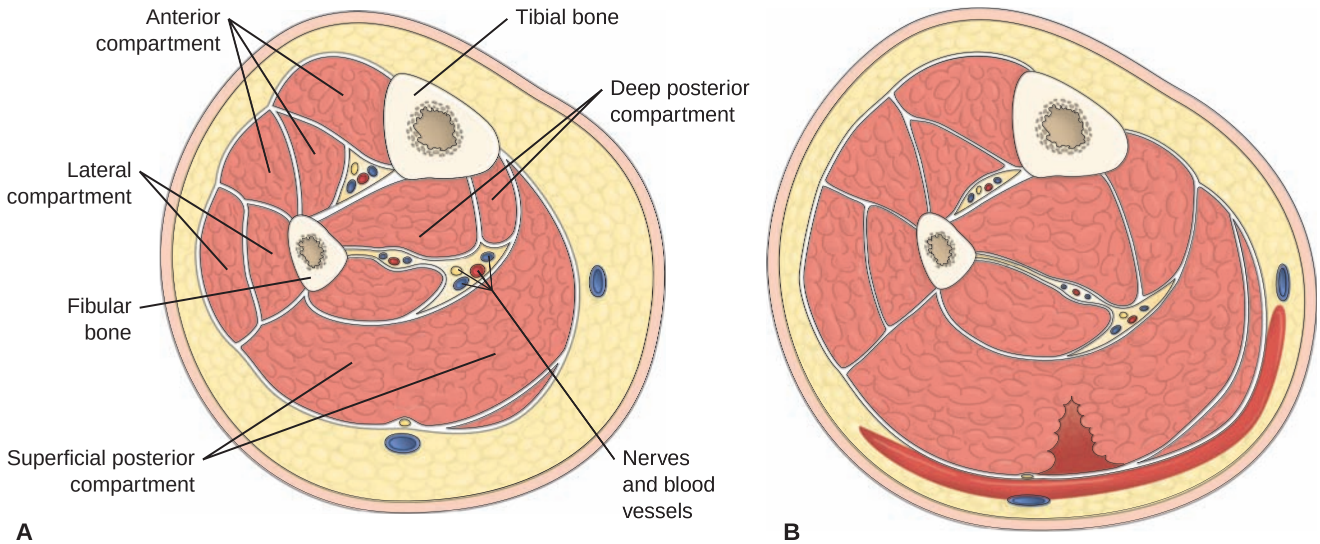



**Figure 67-2** **A,** Cross-section of normal lower leg with muscle compartments. **B,** Cross-section of lower leg with compartment syndrome. Swelling of muscles causes compression of nerves and blood vessels.

et al., 2007). The nurse encourages the patient to move all fingers or toes hourly when awake to stimulate circulation.

It is important to perform frequent, regular assessments of neurovascular status. The "five P's" that require assessment are symptoms of neurovascular compromise: ***p***ain, ***p***allor, ***p***ulselessness, ***p***aresthesia, and ***p***aralysis. Early recognition of diminished circulation and nerve function is essential to prevent loss of function. The nurse adjusts the extremity so that it is no higher than heart level to enhance arterial perfusion and control edema and notifies the physician at once if signs of compromised neurovascular status are present.

### *Monitoring and Managing Potential Complications*

Potential complications related to casts, braces, and splints include compartment syndrome, pressure ulcer formation, and disuse syndrome. These most commonly occur when a cast is applied, because the cast is not easily removable, and are least commonly associated with use of a splint, because splints tend to be used for the short term.

#### Compartment Syndrome

Edema is a natural response of the tissue to trauma. The patient may complain that the cast, brace, or splint is too tight. Vascular insufficiency and nerve compression due to unrelieved swelling can result in compartment syndrome (Fig. 67-2). Compartment syndrome occurs when there is increased tissue pressure within a limited space (eg, cast, muscle compartment) that compromises the circulation and the function of the tissue within the confined area. To relieve the pressure, the cast must be bivalved (cut in half longitudinally) while maintaining alignment, and the extremity must be elevated no higher than heart level to ensure arterial perfusion (Chart 67-2). If pressure is not relieved and circulation is not restored, a fasciotomy may be necessary to relieve the pressure within the muscle compartment. The nurse closely monitors the patient's response to conservative and surgical management of compartment syndrome (Konstantakos, et al., 2007). The nurse records neurovascular responses and promptly reports changes to the physician. (See Chapter 69 for further discussion of compartment syndrome.)

#### Pressure Ulcers

Pressure of a cast or an inappropriately applied brace on soft tissues may cause tissue anoxia and pressure ulcers. Lower extremity sites most susceptible to pressure ulcers are the heel, malleoli, dorsum of the foot, head of the fibula, and anterior surface of the patella. The main pressure sites on the upper extremity are located at the medial epicondyle of the humerus and the ulnar styloid (see Fig. 67-1).

Usually, the patient with a pressure ulcer reports pain and tightness in the area. A warm area on the cast or brace suggests underlying tissue erythema. Skin breakdown may occur. The drainage may stain the cast or brace and emit an odor. Even if discomfort does not occur with skin breakdown and tissue necrosis, there may still be extensive loss of tissue. The nurse must monitor the patient with a cast or brace for pressure ulcer development and report findings to the physician.

### Chart 67-2 • *Procedure for Bivalving a Cast*

The following procedure is followed when a cast is bivalved.

1. With a cast cutter, a longitudinal cut is made to divide the cast in half.
2. The underpadding is cut with scissors.
3. The cast is spread apart with cast spreaders to relieve pressure and to inspect and treat the skin without interrupting the reduction and alignment of the bone.
4. After the pressure is relieved, the anterior and posterior parts of the cast are secured together with an elastic compression bandage to maintain immobilization.
5. To control swelling and promote circulation, the extremity is elevated (but no higher than heart level, to minimize the effect of gravity on perfusion of the tissues).

To inspect the pressure ulcer area, the brace may be removed. For a patient with a cast, the physician may bivalve or cut an opening (window) in the cast. If the physician elects to create a window to inspect the pressure site, a portion of the cast is cut out. The affected area is inspected and possibly treated. The portion of the cast is replaced and held in place by an elastic compression dressing or tape. This prevents window edema, which is the swelling of soft tissue through the area unopposed by casting material (National Association of Orthopedic Nurses [NAON], 2007).

### Disuse Syndrome

Immobilization in a cast, brace, or splint can cause muscle atrophy and loss of strength, known as *disuse syndrome*. To prevent this, the patient needs to learn to tense or contract muscles (eg, isometric muscle contraction) without moving the part. The nurse teaches the patient with a leg cast, brace, or splint to "push down" the knee and teaches the patient in an arm cast, brace, or splint to "make a fist." Muscle-setting exercises (eg, quadriceps-setting and gluteal-setting exercises) are important in maintaining muscles essential for walking (Chart 67-3). Isometric exercises should be performed hourly while the patient is awake.

## Chart 67-3 • *Muscle-Setting Exercises*

Isometric contractions of the muscle maintain muscle mass and strength and prevent atrophy.

**Quadriceps-Setting Exercise**

- Position patient supine with leg extended.
- Instruct patient to push knee back onto the mattress by contracting the anterior thigh muscles.
- Encourage patient to hold the position for 5 to 10 seconds.
- Let patient relax.
- Have patient repeat the exercise 10 times each hour when awake.

**Gluteal-Setting Exercise**

- Position patient supine with legs extended, if possible.
- Instruct patient to contract the muscles of the buttocks.
- Encourage patient to hold the contraction for 5 to 10 seconds.
- Let the patient relax.
- Have patient repeat the exercise 10 times each hour when awake.

### *Promoting Home and Community-Based Care*

#### Teaching the Patient Self-Care

Self-care deficits occur when a portion of the body is immobilized. The nurse encourages the patient to participate actively in personal care and to use assistive devices safely. The nurse must assist the patient in identifying areas of self-care deficit and in developing strategies to achieve independence in activities of daily living (ADLs) (Chart 67-4). The patient's participation in planning and accomplishing ADLs is an important aspect of self-care, independence, maintaining control, and avoiding untoward psychological reactions, such as depression. Patient and caregiver education is also described in Chart 67-4.

## CHART 67-4 HOME CARE CHECKLIST
## *The Patient With a Cast, Splint, or Brace*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe techniques to promote cast drying (eg, do not cover, leave exposed to circulating air, handle damp plaster cast with palms of hands and do not rest the cast on hard surfaces or sharp edges that can dent soft cast). | ✔ | ✔ |
| • Describe approaches to controlling swelling and pain (eg, elevate immobilized extremity to heart level, apply intermittent ice bag if prescribed, take analgesic agents as prescribed). | ✔ | ✔ |
| • Report pain uncontrolled by elevating the immobilized limb and by analgesic agents (may be an indicator of impaired tissue perfusion—compartment syndrome or pressure ulcer). | ✔ | |
| • Demonstrate ability to transfer (eg, from a bed to a chair). | ✔ | |
| • Use mobility aids safely. | ✔ | |
| • Avoid excessive use of injured extremity; observe prescribed weight-bearing limits. | ✔ | |
| • Manage minor skin irritations (eg, for skin irritation from edge of cast, splint, or brace; pad rough edges with tape; to relieve itching, blow cool air from hair dryer; do not insert objects inside the cast, splint, or brace). | ✔ | ✔ |
| • Demonstrate exercises to promote circulation and minimize disuse syndrome. | ✔ | |
| • State indicators of complications to report promptly to physician (eg, uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage staining cast; signs of systemic infection; cast, splint, or brace breaks). | ✔ | ✔ |
| • Describe care of extremity following cast, splint, or brace removal (eg, skin care; gradual resumption of normal activities to protect limb from undue stresses; management of swelling). | ✔ | ✔ |

#### Continuing Care

For the patient with a cast that is ready for removal, the nurse should prepare the patient by explaining what to expect. The cast is cut with a cast cutter, which vibrates. The patient can feel the vibration and pressure during its use. The cutter does not penetrate deeply enough to injure the patient's skin. The cast padding is cut with scissors.

After removal of a splint, and especially after removal of a brace or cast, both of which are typically applied for longer periods of time, the formerly immobilized body part is weak from disuse, is stiff, and may appear atrophied. There may be extreme stiffness even after only a few weeks of immobilization. Therefore, support is needed when the cast, brace, or splint is removed. The skin, which is usually dry and scaly from accumulated dead skin, is vulnerable to injury from scratching. The skin needs to be washed gently and lubricated with an emollient lotion.

The nurse and physical therapist teach the patient to resume activities gradually within the prescribed therapeutic regimen. Exercises prescribed to help the patient regain joint motion are explained and demonstrated. Because the muscles are weak from disuse, the body part that has been immobilized cannot withstand normal stresses immediately. In addition, the nurse teaches the patient with noticeable swelling of the affected extremity after removal of the immobilizing device (eg, cast, brace, or splint) to continue to elevate the extremity to control swelling until normal muscle tone and use are reestablished.

## Nursing Management of the Patient With an Immobilized Upper Extremity

The patient whose arm is immobilized must readjust to many routine tasks. The unaffected arm must assume all the upper extremity activities. The nurse, in consultation with an occupational therapist, suggests devices designed to aid one-handed activities. The patient may experience fatigue due to modified activities and the weight of the cast, brace, or splint. Frequent rest periods are necessary.

To control swelling, the immobilized arm is elevated. When the patient is lying down, the arm is elevated so that each joint is positioned higher than the preceding proximal joint (eg, elbow higher than the shoulder, hand higher than the elbow).

A **sling** may be used when the patient ambulates. To prevent pressure on the cervical spinal nerves, the sling should distribute the supported weight over a large area and not on the back of the neck. The nurse encourages the patient to remove the arm from the sling and elevate it frequently.

Circulatory disturbances in the hand may become apparent with signs of cyanosis, swelling, and an inability to move the fingers. One serious effect of impaired circulation in the arm is Volkmann's contracture, a specific type of compartment syndrome. Contracture of the fingers and wrist occurs as the result of obstructed arterial blood flow to the forearm and hand. The patient is unable to extend the fingers, describes abnormal sensation (eg, unrelenting pain, pain on passive stretch), and exhibits signs of diminished circulation to the hand. Permanent damage develops within a few hours if action is not taken (see Chapter 69). This serious complication can be prevented with nursing surveillance and proper care.

Neurovascular checks must be done frequently (see Chapter 66). If a cast is used for immobility, compartment syndrome is managed in part by bivalving (cutting) the cast and releasing the constricting cast and dressings. A fasciotomy may be necessary to improve vascular status.

## Nursing Management of the Patient With an Immobilized Lower Extremity

The application of a leg cast, brace, or splint imposes a degree of immobility on the patient. Casts may include short-leg casts, extending to the knees, or long-leg casts, extending to the groin. Hinged knee braces and immobilizers typically extend from ankle to groin.

The patient's leg must be supported on pillows to heart level to control swelling, and ice packs should be applied as prescribed over the fracture site for 1 or 2 days. The patient is taught to elevate the immobilized leg when seated. The patient should also assume a recumbent position several times a day with the immobilized leg elevated to promote venous return and control swelling.

The nurse assesses circulation by observing the color, temperature, and capillary refill of the exposed toes. Nerve function is assessed by observing the patient's ability to move the toes and by asking about the sensations in the foot. Numbness, tingling, and burning may be caused by peroneal nerve injury from pressure at the head of the fibula.

*NURSING ALERT*

**Injury to the peroneal nerve as a result of pressure is a cause of footdrop (the inability to maintain the foot in a normally flexed position). Consequently, the patient drags the foot when ambulating.**

The nurse and physical therapist teach the patient how to transfer and ambulate safely with assistive devices (eg, crutches, walker) (see Chapter 11). The gait to be used depends on whether the patient is permitted to bear weight. If weight bearing is allowed, the cast, splint, or brace is reinforced to withstand the body weight. A cast boot, worn over the casted foot, provides a broad, nonskid walking surface.

## Nursing Management of the Patient With a Body or Spica Cast

Casts that encase the trunk (body cast) and portions of one or two extremities (spica cast) require special nursing strategies. Body casts are used to immobilize the spine. Hip spica casts are used for some femoral fractures and after some hip joint surgeries, and shoulder spica casts are used for some humeral neck fractures.

Nursing responsibilities include preparing and positioning the patient, assisting with skin care and hygiene, and monitoring for **cast syndrome,** (see discussion on next page) (NAON, 2007). Explaining the casting procedure helps reduce the patient's apprehension about being encased in a large cast. The nurse reassures the patient that several

people will provide care during the application, support for the injured area will be adequate, and care providers will be as gentle as possible. Medications for pain relief and relaxation administered before the procedure enable the patient to cooperate during application of the cast.

The nurse turns the patient as a unit toward the uninjured side every 2 hours to relieve pressure and to allow the cast to dry. It is important to avoid twisting the patient's body within the cast. Sufficient personnel (at least three people) or mechanical assistive devices are needed when the patient is turned because of the added weight of the cast. The nurse encourages the patient to assist in the repositioning, if not contraindicated, by use of the **trapeze** or bed rail. A stabilizing abduction bar incorporated into a spica cast should never be used as a turning device. The nurse adjusts the pillows to provide support without creating areas of pressure.

The nurse turns the patient to a prone position, twice daily if tolerated, to provide postural drainage of the bronchial tree and to relieve pressure on the back. A small pillow under the abdomen enhances comfort. The nurse can either place a pillow lengthwise under the dorsa of the feet or allow the toes to hang over the edge of the bed to prevent the toes from being forced into the mattress.

The nurse inspects the skin around the edges of the cast frequently for signs of irritation. The nurse can inspect some of the skin under the cast by pulling the skin taut and using a flashlight. The skin can be bathed and massaged by reaching under the cast edges with the fingers.

The perineal opening must be large enough for hygienic care. To protect the cast from soiling, Gore-Tex liners are used prior to hip spica casting. If the cast is not Gore-Tex lined, the nurse can insert clean dry plastic sheeting under the dry cast and over the cast edge before elimination by the patient. Usually, fracture bedpans are easier to use than regular bedpans for patients with a hip spica cast.

Patients immobilized in large casts may develop cast syndrome that may include psychological or physiologic manifestations. The psychological component is similar to a claustrophobic reaction. The patient exhibits an acute anxiety reaction characterized by behavioral changes and autonomic responses (eg, increased respiratory rate, diaphoresis, dilated pupils, increased heart rate, elevated blood pressure). The nurse needs to recognize the anxiety reaction and provide an environment in which the patient feels secure.

Physiologic cast syndrome responses (eg, superior mesenteric artery syndrome) are associated with immobility in a body cast. With decreased physical activity, gastrointestinal motility decreases, intestinal gases accumulate, intestinal pressure increases, and ileus may occur. The patient exhibits abdominal distention, abdominal discomfort, nausea, and vomiting. As with other instances of adynamic ileus, the patient is treated conservatively with decompression (nasogastric intubation connected to suction) and intravenous (IV) fluid therapy until gastrointestinal motility is restored (Adams, Hawkins, Ferdinand, et al., 2007). If the cast restricts the abdomen, the abdominal window must be enlarged. After the ileus resolves and bowel sounds resume, the patient gradually resumes an oral diet. Rarely, the distention places traction on the superior mesenteric artery, reducing the blood supply to the bowel, which can result in gangrenous bowel. The descending aorta may also sustain pressure as it may be compressed between the spine and pressure of abdominal distention, which results in ischemia. If the descending aorta becomes ischemic, its rupture could cause exsanguination and death.

*NURSING ALERT*

**The nurse monitors the patient in a large body cast for potential cast syndrome, noting bowel sounds every 4 to 8 hours, and reports distention, nausea, and vomiting to the physician.**

The patient with a body or spica cast is often cared for at home. The nurse teaches family members how to care for the patient, which includes providing hygienic and skin care, ensuring proper positioning, preventing complications, and recognizing symptoms that should be reported to the health care provider.

## The Patient With an External Fixator

**External fixators** are used to manage open fractures with soft tissue damage. They provide stable support for severe comminuted (crushed or splintered) fractures while permitting active treatment of damaged soft tissues (Fig. 67-3). Complicated fractures of the humerus, forearm, femur, tibia, and pelvis are managed with external skeletal fixators. The fracture is reduced, aligned, and immobilized by a series of pins inserted in the bone. Pin position is maintained through attachment to a portable frame. The fixator facilitates patient comfort, early mobility, and active exercise of adjacent uninvolved joints; thus, complications due to disuse and immobility are minimized (Holmes & Brown, 2005).

### Nursing Management

It is important to prepare the patient psychologically for application of the external fixator. The apparatus looks clumsy and foreign. Reassurance that the discomfort associated with the device is minimal and that early mobility is anticipated promotes acceptance of the device.

After the external fixator is applied, the extremity is elevated to reduce swelling. If there are sharp points on the fixator or pins, they are covered with caps to prevent device-induced injuries. The nurse monitors the neurovascular status of the extremity every 2 to 4 hours and assesses each pin site for redness, drainage, tenderness, pain, and loosening of the pin. Some serous drainage from the pin sites is to be expected. The nurse must be alert for potential problems caused by pressure from the device on the skin, nerves, or blood vessels and for the development of compartment syndrome (see Chapter 69). The nurse carries out pin care as prescribed to prevent pin tract infection. This typically includes cleaning each pin site separately one or two times a day with cotton-tipped applicators soaked in chlorhexidine solution (Holmes & Brown, 2005). If signs of infection are present or if the pins or clamps seem loose, the nurse notifies the physician.



**Figure 67-3** External fixation device. Pins are inserted into bone. The fracture is reduced and aligned and then stabilized by attaching the pins to a rigid portable frame. The device facilitates treatment of soft tissue damaged in complex fractures.

*NURSING ALERT*

**The nurse never adjusts the clamps on the external fixator frame. It is the physician's responsibility to do so.**

The nurse encourages isometric and active exercises as tolerated. When the swelling subsides, the nurse helps the patient become mobile within the prescribed weight-bearing limits (non–weight bearing to full weight bearing). Adherence to weight-bearing instructions minimizes the chance of loosening of the pins when stress is applied to the bone–pin interface. The fixator is removed after the soft tissue heals. The fracture may require additional stabilization by a cast or molded orthosis while healing.

The Ilizarov external fixator is a special device used to correct angulation and rotational defects, to treat nonunion (failure of bone fragments to heal), and to lengthen limbs. Tension wires are attached to fixator rings, which are joined by telescoping rods. Bone formation is stimulated by prescribed daily adjustment of the telescoping rods. It is important to teach the patient how to adjust the telescoping rods and how to perform skin care. Generally, the nurse can encourage weight bearing. After the desired correction has been achieved, no additional adjustments are made, and the fixator is left in place until the bone heals.

The nurse teaches the patient to perform pin site care according to the prescribed protocol (clean technique can be used at home [Holmes & Brown, 2005]) and to report promptly any signs of pin site infection: redness, tenderness, increased or purulent pin site drainage, or fever. The nurse also instructs the patient and family to monitor neurovascular status and report any changes promptly. The nurse teaches the patient or family member to check the integrity of the fixator frame daily and to report loose pins or clamps. A physical therapy referral is helpful in teaching the patient how to transfer, use ambulatory aids safely, and adjust to weight-bearing limits and altered gait patterns (Chart 67-5).

CHART 67-5

HOME CARE CHECKLIST

*The Patient With an External Fixator*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate prescribed pin site care. | ✔ | ✔ |
| • State signs of pin site infection (eg, redness, tenderness, increased or purulent pin site drainage) to be reported promptly. | ✔ | ✔ |
| • Describe approaches to controlling swelling and pain (eg, elevate extremity to heart level, take analgesic agents as prescribed). | ✔ | ✔ |
| • Report pain uncontrolled by elevation and analgesic agents (may be an indicator of impaired tissue perfusion, compartment syndrome, or pin tract infection). | ✔ | |
| • Demonstrate ability to transfer. | ✔ | |
| • Use mobility aids safely. | ✔ | |
| • Avoid excessive use of injured extremity; observe prescribed weight-bearing limits. | ✔ | |
| • State indicators of complications to report promptly to physician (eg, uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage; signs of systemic infection; loose fixator pins or clamps). | ✔ | ✔ |
| • Describe care of extremity after fixator removal (eg, gradual resumption of normal activities to protect limb from undue stresses). | ✔ | ✔ |

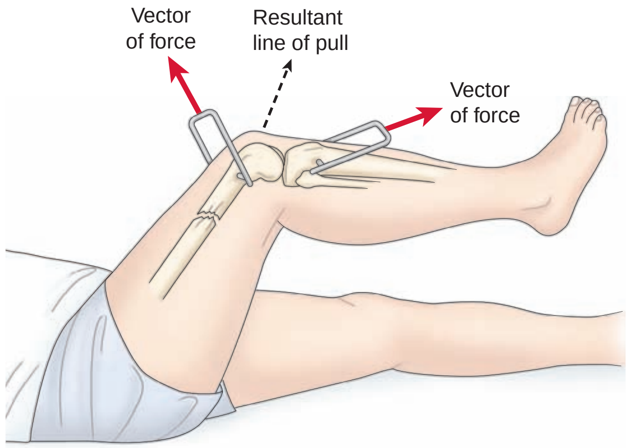



**Figure 67-4** Traction may be applied in different directions to achieve the desired therapeutic line of pull. Adjustments in applied forces may be prescribed over the course of treatment.

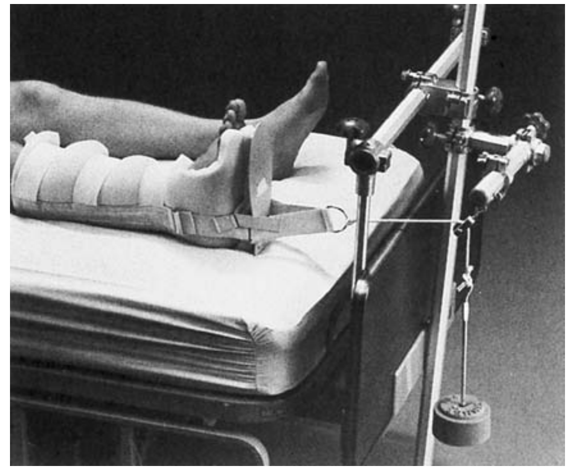


**Figure 67-5** Buck's extension traction. Lower extremity in unilateral Buck's extension traction is aligned in a foam boot and traction applied by the free-hanging weight.

## *The Patient in Traction*

**Traction** is the application of a pulling force to a part of the body. Traction is used to minimize muscle spasms; to reduce, align, and immobilize fractures; to reduce deformity; and to increase space between opposing surfaces. Traction must be applied in the correct direction and magnitude to obtain its therapeutic effects. As muscle and soft tissues relax, the amount of weight used may be changed to obtain the desired effect (NAON, 2007).

At times, traction needs to be applied in more than one direction to achieve the desired line of pull. When this is done, one of the lines of pull counteracts the other. These lines of pull are known as the vectors of force. The actual resultant pulling force is somewhere between the two lines of pull (Fig. 67-4). The effects of traction are evaluated with x-ray studies, and adjustments are made if necessary.

Traction is used primarily as a short-term intervention until other modalities, such as external or internal fixation, are possible. These modalities reduce the risk of disuse syndrome and minimize the length of hospitalization, often allowing the patient to be cared for in the home setting (NAON, 2007).

### PRINCIPLES OF EFFECTIVE TRACTION

Whenever traction is applied, countertraction must be used to achieve effective traction. Countertraction is the force acting in the opposite direction. Usually, the patient's body weight and bed position adjustments supply the needed countertraction.

The following are additional principles to follow when caring for the patient in traction:

- Traction must be continuous to be effective in reducing and immobilizing fractures.
- Skeletal traction is *never* interrupted.
- Weights are not removed unless intermittent traction is prescribed.
- Any factor that might reduce the effective pull or alter its resultant line of pull must be eliminated:
  - The patient must be in good body alignment in the center of the bed when traction is applied.
  - Ropes must be unobstructed.
  - Weights must hang freely and not rest on the bed or floor.
  - Knots in the rope or the footplate must not touch the pulley or the foot of the bed.

### TYPES OF TRACTION

There are several types of traction. *Straight* or *running traction* applies the pulling force in a straight line with the body part resting on the bed. Buck's extension traction (Fig. 67-5) is an example of straight traction. *Balanced suspension traction* (Fig. 67-6) supports the affected extremity off the bed and allows for some patient movement without disruption of the line of pull.

Traction may be applied to the skin (*skin traction*) or directly to the bony skeleton (*skeletal traction*). The mode of application is determined by the purpose of the traction. Traction can be applied with the hands (*manual traction*). This is temporary traction that may be used when applying a cast, giving skin care under a Buck's extension foam boot, or adjusting the traction apparatus.

#### Skin Traction

Skin traction is used to control muscle spasms and to immobilize an area before surgery. Skin traction is accomplished by using a weight to pull on traction tape or on a foam boot attached to the skin. The amount of weight applied must not exceed the tolerance of the skin. No more than 2 to 3.5 kg (4.5 to 8 lb) of traction can be used on an extremity. Pelvic traction is usually 4.5 to 9 kg (10 to 20 lb), depending on the weight of the patient.

Types of skin traction used for adults include Buck's extension traction (applied to the lower leg) (described below), the cervical head halter (occasionally used to treat neck pain), and the pelvic belt (sometimes used to treat back pain).

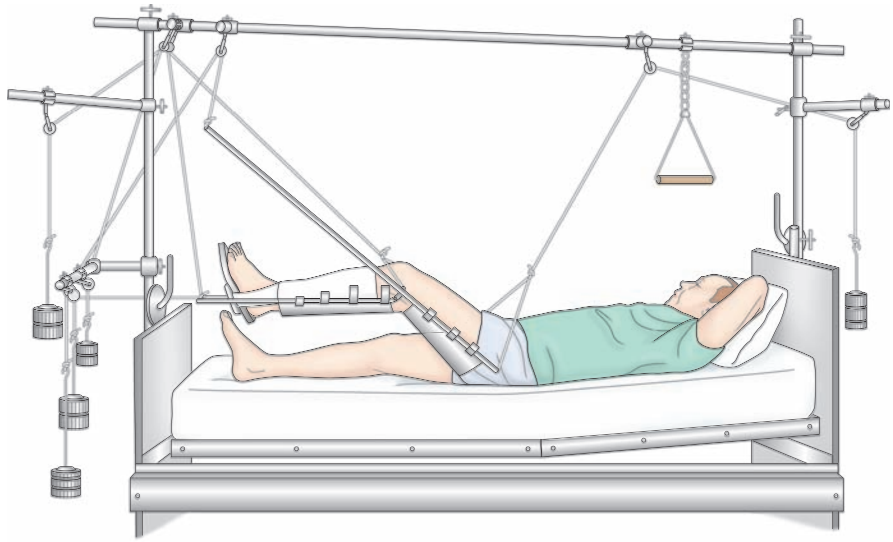


**Figure 67-6** Balanced suspension skeletal traction with Thomas leg splint. The patient can move vertically as long as the resultant line of pull is maintained.

### Buck's Extension Traction

Buck's extension traction (unilateral or bilateral) is skin traction to the lower leg. The pull is exerted in one plane when partial or temporary immobilization is desired (see Fig. 67-5). It is used to immobilize fractures of the proximal femur before surgical fixation.

Before the traction is applied, the nurse inspects the skin for abrasions and circulatory disturbances. The skin and circulation must be in healthy condition to tolerate the traction. The extremity should be clean and dry before the foam boot or traction tape is applied.

To apply Buck's traction, one nurse elevates and supports the extremity under the patient's heel and knee while another nurse places the foam boot under the leg, with the patient's heel in the heel of the boot. Next, the nurse secures Velcro straps around the leg. Traction tape overwrapped with elastic bandage in a spiral fashion may be used instead of the boot. Excessive pressure is avoided over the malleolus and proximal fibula during application to prevent pressure ulcers and nerve damage. The nurse then passes the rope affixed to the spreader or footplate over a pulley fastened to the end of the bed and attaches the prescribed weight—usually 5 to 8 pounds—to the rope.

### Nursing Interventions

#### Ensuring Effective Traction

To ensure effective skin traction, it is important to avoid wrinkling and slipping of the traction bandage and to maintain countertraction. Proper positioning must be maintained to keep the leg in a neutral position. To prevent bony fragments from moving against one another, the patient should not turn from side to side; however, the patient may shift position slightly with assistance.

#### Monitoring and Managing Potential Complications

***Skin Breakdown.*** During the initial assessment, the nurse identifies sensitive, fragile skin (common in older adults). The nurse also closely monitors the status of the skin in contact with tape or foam to ensure that shearing forces are avoided. The nurse performs the following procedures to monitor and prevent skin breakdown:

- Removes the foam boots to inspect the skin, the ankle, and the Achilles tendon three times a day. A second nurse is needed to support the extremity during the inspection and skin care.
- Palpates the area of the traction tapes daily to detect underlying tenderness.
- Provides back care at least every 2 hours to prevent pressure ulcers. The patient who must remain in a supine position is at increased risk for development of a pressure ulcer.
- Uses special mattress overlays (eg, air-filled, high-density foam) to prevent pressure ulcers.

***Nerve Damage.*** Skin traction can place pressure on peripheral nerves. When traction is applied to the lower extremity, care must be taken to avoid pressure on the peroneal nerve at the point at which it passes around the neck of the fibula just below the knee. Pressure at this point can cause footdrop. The nurse regularly questions the patient about sensation and asks the patient to move the toes and foot. The nurse should immediately investigate any complaint of a burning sensation under the traction bandage or boot. Dorsiflexion of the foot demonstrates function of the peroneal nerve. Weakness of dorsiflexion or foot movement and inversion of the foot might indicate pressure on the common peroneal nerve. Plantar flexion demonstrates function of the tibial nerve. In addition, the nurse should promptly report altered sensation or impaired motor function.

***Circulatory Impairment.*** After skin traction is applied, the nurse assesses circulation of the foot within 15 to 30 minutes and then every 1 to 2 hours. Circulatory assessment consists of the following:

- Peripheral pulses, color, capillary refill, and temperature of the fingers or toes
- Indicators of deep vein thrombosis (DVT), including unilateral calf tenderness, warmth, redness, and swelling

The nurse also encourages the patient to perform active foot exercises every hour when awake.

## Skeletal Traction

Skeletal traction is applied directly to the bone. This method of traction is used occasionally to treat fractures of the femur, the tibia, and the cervical spine. The traction is applied directly to the bone by use of a metal pin or wire (eg, Steinmann pin, Kirschner wire) that is inserted through the bone distal to the fracture, avoiding nerves, blood vessels, muscles, tendons, and joints. Tongs applied to the head (eg, Gardner-Wells or Vinke tongs) are fixed to the skull to apply traction that immobilizes cervical fractures.

The orthopedic surgeon applies skeletal traction, using surgical asepsis. The insertion site is prepared with a surgical scrub agent such as povidone–iodine solution. A local anesthetic agent is administered at the insertion site and periosteum. The surgeon makes a small skin incision and drills the sterile pin or wire through the bone. The patient feels pressure during this procedure and possibly some pain when the periosteum is penetrated.

After insertion, the pin or wire is attached to the traction bow or caliper. The ends of the pin or wire are covered with caps to prevent injury to the patient or caregivers. The weights are attached to the pin or wire bow by a rope-and-pulley system that exerts the appropriate amount and direction of pull for effective traction. Skeletal traction frequently uses 7 to 12 kg (15 to 25 lb) to achieve the therapeutic effect. The weights applied initially must overcome the shortening spasms of the affected muscles. As the muscles relax, the traction weight is reduced to prevent fracture dislocation and to promote healing.

Often, skeletal traction is balanced traction, which supports the affected extremity, allows for some patient movement, and facilitates patient independence and nursing care while maintaining effective traction. The Thomas splint with a Pearson attachment is frequently used with skeletal traction for fractures of the femur (see Fig. 67-6). Because upward traction is required, an overbed frame is used.

When skeletal traction is discontinued, the extremity is gently supported while the weights are removed. The pin is cut close to the skin and removed by the physician. Internal fixation, casts, or splints are then used to immobilize and support the healing bone.

### *Nursing Interventions*

#### Maintaining Effective Traction

When skeletal traction is used, the nurse checks the traction apparatus to see that the ropes are in the wheel grooves of the pulleys, that the ropes are not frayed, that the weights hang freely, and that the knots in the rope are tied securely. The nurse also evaluates the patient's position, because slipping down in bed results in ineffective traction.

> *NURSING ALERT*
>
> **The nurse must never remove weights from skeletal traction unless a life-threatening situation occurs. Removal of the weights completely defeats their purpose and may result in injury to the patient.**

#### Maintaining Positioning

The nurse must maintain alignment of the patient's body in traction as prescribed to promote an effective line of pull. The nurse positions the patient's foot to avoid footdrop (plantar flexion), inward rotation (inversion), and outward rotation (eversion). The patient's foot may be supported in a neutral position by orthopedic devices (eg, foot supports).

#### Preventing Skin Breakdown

The patient's elbows frequently become sore, and nerve injury may occur if the patient repositions by pushing on the elbows. In addition, patients frequently push on the heel of the unaffected leg when they raise themselves. This digging of the heel into the mattress may injure the tissues. Therefore, the nurse should protect the elbows and heels and inspect them for pressure ulcers. To encourage movement without using the elbows or heel, a trapeze can be suspended overhead within easy reach of the patient. The trapeze helps the patient move about in bed and move on and off the bedpan.

Specific pressure points are assessed for redness and skin breakdown. Areas that are particularly vulnerable to pressure caused by a traction apparatus applied to the lower extremity include the ischial tuberosity, popliteal space, Achilles tendon, and heel. If the patient is not permitted to turn on one side or the other, the nurse must make a special effort to provide back care and to keep the bed dry and free of crumbs and wrinkles. The patient can assist by holding the overhead trapeze and raising the hips off the bed. If the patient cannot do this, the nurse can push down on the mattress with one hand to relieve pressure on the back and bony prominences and to provide for some shifting of weight. A pressure-relieving air-filled or high-density foam mattress overlay may reduce the risk of pressure ulcer.

For change of bed linens, the patient raises the torso while nurses on both sides of the bed roll down and replace the upper mattress sheet. Then, as the patient raises the buttocks off the mattress, the nurses slide the sheets under the buttocks. Finally, the nurses replace the lower section of the bed linens while the patient rests on the back. Sheets and blankets are placed over the patient in such a way that the traction is not disrupted.

#### Monitoring Neurovascular Status

The nurse assesses the neurovascular status of the immobilized extremity at least every hour initially and then every 4 hours. The nurse instructs the patient to report any changes in sensation or movement immediately so that they can be promptly evaluated. DVT is a significant risk for the immobilized patient. The nurse encourages the patient to do active flexion–extension ankle exercises and isometric contraction of the calf muscles (calf-pumping exercises) 10 times an hour while awake to decrease venous stasis. In addition, anti-embolism stockings, compression devices, and anticoagulant therapy may be prescribed to help prevent thrombus formation.

**NURSING ALERT**

**The nurse must promptly investigate every report of discomfort expressed by the patient in traction. Prompt recognition of a developing neurovascular problem is essential so that corrective measures can be instituted promptly.**

***Providing Pin Site Care.*** The wound at the pin insertion site requires attention. The goal is to avoid infection and development of **osteomyelitis.** For the first 48 hours after insertion, the site is covered with a sterile absorbent nonstick dressing and a rolled gauze or Ace-type bandage. After this time, a loose cover dressing or no dressing is recommended. (A bandage is necessary if the patient is exposed to airborne dust.) Pin site care is performed initially one or two times a day. The frequency of pin care needs to be increased if mechanical looseness of pins or early signs of infection are present (eg, edema, purulent drainage, erythema, tenderness). Chlorhexidine solution is recommended as the most effective cleansing solution; however, water and saline are alternate choices (Holmes & Brown, 2005). Although hydrogen peroxide and Betadine solutions have been used, they are believed to be cytotoxic to osteoblasts and may actually damage healthy tissue (Lethaby, Temple & Santy, 2008).

The nurse must inspect the pin sites every 8 hours for reaction (ie, normal changes that occur at the pin site after insertion) and infection. Signs of reaction may include redness, warmth, and serous or slightly sanguinous drainage at the site. These signs subside after 72 hours. Signs of infection may mirror those of reaction but also include the presence of purulent drainage, pin loosening, and odor. Minor infections may be readily treated with antibiotics, whereas infections that result in systemic manifestations may additionally warrant pin removal until the infection resolves (Holmes & Brown, 2005). When pins are mechanically stable (after 48 to 72 hours), weekly pin site care is recommended.

**NURSING ALERT**

**The nurse must inspect the pin site at least every 8 hours for signs of inflammation and evidence of infection.**

Due to a lack of evidence-based research findings, controversy remains about management of crusts that may form at the pin insertion site, frequency of pin care and showering, and use of massage to release skin adherence to pins (Holmes & Brown, 2005). The patient should be taught to perform any prescribed pin site care prior to discharge from the hospital and should be provided with written follow-up instructions that include the signs and symptoms of infection. Patients permitted to take showers within 5 to 10 days of pin insertion are encouraged to leave the pins exposed to water flow. The sites are dried with a clean towel and left open to air, or dressings are applied as prescribed.

***Promoting Exercise.*** Patient exercises, within the therapeutic limits of the traction, assist in maintaining muscle strength and tone and in promoting circulation. Active exercises include pulling up on the trapeze, flexing and extending the feet, and range-of-motion and weight-resistance exercises for noninvolved joints. Isometric exercises of the immobilized extremity (quadriceps-setting and gluteal-setting exercises) are important for maintaining strength in major ambulatory muscles (see Chart 67-3). Without exercise, the patient will lose muscle mass and strength, and rehabilitation will be greatly prolonged.

## Nursing Management

### Assessing Anxiety

The nurse must consider the psychological and physiologic impact of the musculoskeletal problem, traction device, and immobility. Traction restricts mobility and independence. The equipment often looks threatening, and its application can be frightening. Confusion, disorientation, and behavioral problems may develop in patients who are confined in a limited space for an extended time. Therefore, the nurse must assess and monitor the patient's anxiety level and psychological responses to traction.

### Assisting With Self-Care

Initially, the patient may require assistance with self-care activities. The nurse helps the patient eat, bathe, dress, and toilet. Convenient arrangement of items such as the telephone, tissues, water, and assistive devices (eg, reachers, overbed trapeze) may facilitate self-care. With resumption of self-care activities, the patient feels less dependent and less frustrated and experiences improved self-esteem. Because some assistance is required throughout the period of immobility, the nurse and the patient can creatively develop routines that maximize the patient's independence.

It is important to evaluate the body part to be placed in traction and its neurovascular status (ie, color, temperature, capillary refill, edema, pulses, ability to move, and sensations) and compare it to the unaffected extremity. The nurse also assesses skin integrity along with body system functioning for baseline data. Ongoing assessment is indicated for the patient in traction.

### Monitoring and Managing Potential Complications

Immobility-related complications may include pressure ulcers, atelectasis, pneumonia, constipation, loss of appetite, urinary stasis, urinary tract infections, and venous thromboemboli formation. Early identification of preexisting or developing conditions facilitates prompt interventions to resolve them.

#### Atelectasis and Pneumonia

The nurse auscultates the patient's lungs every 4 to 8 hours to assess respiratory status and teaches the patient deep-breathing and coughing exercises to aid in fully expanding the lungs and clearing pulmonary secretions. If the patient history and baseline assessment indicate that the patient is at risk for development of respiratory complications, specific therapies (eg, use of incentive spirometer) may be indicated. If a respiratory complication develops, prompt institution of prescribed therapy is needed.

#### Constipation and Anorexia

Reduced gastrointestinal motility results in constipation and anorexia. A diet high in fiber and fluids may help

stimulate gastric motility. If constipation develops, therapeutic measures may include stool softeners, laxatives, suppositories, and enemas. To improve the patient's appetite, the patient's food preferences are included, as appropriate, within the prescribed therapeutic diet.

#### Urinary Stasis and Infection

Incomplete emptying of the bladder related to positioning in bed can result in urinary stasis and infection. In addition, the patient may find use of the bedpan uncomfortable and may limit fluids to minimize the frequency of urination. The nurse monitors the fluid intake and the character of the urine. The nurse teaches the patient to consume adequate amounts of fluid and to void every 3 to 4 hours. If the patient exhibits signs or symptoms of urinary tract infection, the nurse notifies the physician.

#### Venous Thromboembolism

Venous stasis that predisposes the patient to venous thromboembolism occurs with immobility. The nurse teaches the patient to perform ankle and foot exercises within the limits of the traction therapy every 1 to 2 hours when awake to prevent DVT. The patient is encouraged to drink fluids to prevent dehydration and associated hemoconcentration, which contribute to stasis. The nurse monitors the patient for signs of DVT, including unilateral calf tenderness, warmth, redness, and swelling (increased calf circumference). The nurse promptly reports findings to the physician for definitive evaluation and therapy.

During traction therapy, the nurse encourages the patient to exercise muscles and joints that are not in traction to prevent deterioration, deconditioning, and venous stasis. The physical therapist can design bed exercises that minimize loss of muscle strength. During the patient's exercise, the nurse ensures that traction forces are maintained and that the patient is properly positioned to prevent complications resulting from poor alignment.

## *The Patient Undergoing Orthopedic Surgery*

Many patients with musculoskeletal dysfunction undergo surgery to correct the condition. Conditions that may be corrected by surgery include unstabilized fracture, deformity, joint disease, necrotic or infected tissue, and tumors. Frequent surgical procedures include **open reduction with internal fixation (ORIF)** and closed reduction with internal fixation (fracture fragments are not surgically exposed) for fractures; arthroplasty, meniscectomy, and joint replacement for joint conditions; amputation for severe extremity conditions (eg, gangrene, massive trauma); bone graft for joint stabilization, defect filling, or stimulation of bone healing; and tendon transfer for improving motion. The goals include improving function by restoring motion and stability and relieving pain and disability. Chart 67-6 describes common orthopedic surgeries.

Indications for a surgical procedure are based on the patient's age, underlying orthopedic condition, and general physical health and the impact of joint disability on daily activities. Timing of these procedures is important to ensure maximum function. In general, surgery should be performed before surrounding muscles become contracted and atrophied and serious structural abnormalities occur.

**Chart 67-6 • *Common Orthopedic Surgical Procedures***

*Open reduction:* the correction and alignment of the fracture after surgical dissection and exposure of the fracture
*Internal fixation:* the stabilization of the reduced fracture by the use of metal screws, plates, wires, nails, and pins
*Arthroplasty:* the repair of joint problems through the operating arthroscope (an instrument that allows the surgeon to operate within a joint without a large incision) or through open joint surgery
*Hemiarthroplasty:* the replacement of one of the articular surfaces (eg, in a hip hemiarthroplasty, the femoral head and neck are replaced with a femoral prosthesis—the acetabulum is not replaced)
*Joint arthroplasty or replacement:* the replacement of joint surfaces with metal or synthetic materials
*Total joint arthroplasty or replacement:* the replacement of both articular surfaces within a joint with metal or synthetic materials
*Meniscectomy:* the excision of damaged joint fibrocartilage
*Amputation:* the removal of a body part
*Bone graft:* the placement of bone tissue (autologous or homologous grafts) to promote healing, to stabilize, or to replace diseased bone
*Tendon transfer:* the insertion of tendon to improve function
*Fasciotomy:* the incision and diversion of the muscle fascia to relieve muscle constriction, as in compartment syndrome, or to reduce fascia contracture

Because most of these are elective procedures, many patients donate their own blood during the weeks preceding their surgery. This blood is used to replace blood lost during surgery. Autologous blood transfusions eliminate many of the risks of transfusion therapy (see Chapter 33).

Blood is conserved during surgery to minimize loss. During orthopedic surgery on a limb (eg, total knee replacement [TKR]), a pneumatic tourniquet may be applied to produce a "bloodless field." This technique has the advantages of keeping the surgical field dry, minimizing blood loss, and providing some additional limb anesthesia (O'Connor & Murphy, 2007). Intraoperative blood salvage with reinfusion is used when a large volume of blood loss is anticipated. Postoperative blood salvage with intermittent autotransfusion also reduces the need for blood transfusion.

### JOINT REPLACEMENT

Patients with severe joint pain and disability may undergo joint replacement. Conditions contributing to joint degeneration include osteoarthritis, rheumatoid arthritis, trauma, and congenital deformity. Some fractures (eg, femoral neck fracture) may cause disruption of the blood supply and subsequent **avascular necrosis;** management with joint replacement may be elected over ORIF. Joints frequently replaced include the hip, knee (Fig. 67-7), and finger joints.

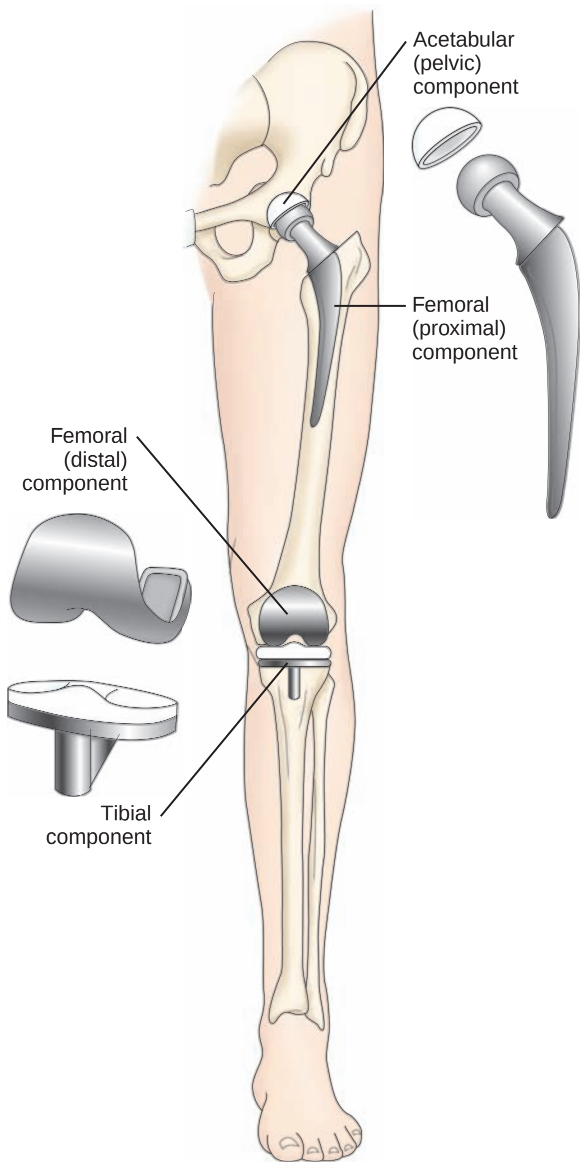



**Figure 67-7** Examples of hip and knee replacement.

Less frequently, more complex joints (shoulder, elbow, wrist, ankle) are replaced.

Most joint replacements consist of metal (eg, cobalt-chromium, titanium) and high-density polyethylene components. The joint implants may be cemented in the prepared bone with polymethylmethacrylate (PMMA), a bone-bonding agent that has properties similar to bone. Loosening of the prosthesis due to cement–bone interface failure is a common cause of prosthesis failure. Press-fit, ingrowth prostheses (porous-coated, cementless artificial joint components) that allow the patient's bone to grow into and securely fix the prosthesis in the bone are alternatives to cemented prostheses. Accurate fitting and the presence of healthy bone with adequate blood supply are important in the use of cementless components (Lucas, 2008a). Much progress has been made in reducing prosthesis failure rates through improved techniques, improved materials, and use of bone grafts.

With joint replacement, excellent pain relief is obtained in most patients. Return of motion and function depends on preoperative soft tissue condition, soft tissue reactions, and general muscle strength. Early failure of joint replacement is associated with excessive activity and preoperative joint and bone pathology.

## Nursing Interventions

Assessment of the patient and preoperative management are aimed at having the patient in optimal health at the time of surgery. Preoperatively, it is important to evaluate cardiovascular, respiratory, renal, and hepatic functions. Age, obesity, preoperative leg edema, a history of any venous thromboemboli, and varicose veins increase the risk for postoperative DVT and pulmonary embolism.

Preoperatively, it is important to assess the neurovascular status of the extremity undergoing joint replacement (Lucas, 2008a). Postoperative assessment data are compared with preoperative assessment data to identify changes and deficits. For example, an absent pulse postoperatively is of concern unless the pulse was also absent preoperatively. Nerve palsy could occur as a result of surgery.

### *Preventing Infection*

Preoperative assessment of the patient for infections, including urinary tract infection, is necessary because of the risk for postoperative infection. Any infection 2 to 4 weeks before planned surgery may result in postponement of surgery. Preoperative skin preparation frequently begins 1 or 2 days before the surgery. Airborne bacteria that contaminate the wound at the time of surgery cause most deep infections. Therefore, as with any surgery, there is strict adherence to aseptic principles, and the operating area is made as bacteria free as possible (Lucas, 2008a).

Research findings suggest that prophylactic antibiotics given 60 minutes prior to incision are effective in preventing postoperative infection (Hawn, Gray, Vick, et al., 2006). Culture of the joint during surgery may be important in identifying and treating subsequent infections.

If osteomyelitis develops, it is difficult to treat. Persistent infection at the site of the prosthesis usually requires removal of the implant and joint revision. It is not always possible to achieve a functional joint when the reconstruction procedure has to be repeated.

### *Promoting Ambulation*

Patients with total hip or total knee replacement begin ambulation with a walker or crutches within a day after surgery. The nurse and the physical therapist assist the patient in achieving the goal of independent ambulation. At first, the patient may be able to stand for only a brief period because of orthostatic hypotension. Specific weight-bearing limits on the prosthesis are based on the patient's condition, the procedure, and the fixation method. Usually, patients with cemented prostheses can proceed to weight bearing as tolerated. If the patient has a press-fit, cementless, ingrowth prosthesis, weight bearing immediately after surgery may be limited to minimize micromotion of the prosthesis in the bone (Lucas, 2008b). As the patient is able to tolerate more activity, the nurse encourages transferring to a chair several times a day for short periods and walking for progressively greater distances.

## Total Hip Replacement

Total hip replacement is the replacement of a severely damaged hip with an artificial joint. Indications for this surgery include osteoarthritis, rheumatoid arthritis, femoral neck fractures, failure of previous reconstructive surgeries (failed prosthesis, **osteotomy**), and conditions resulting from developmental dysplasia or Legg-Calve-Perthes (avascular necrosis of the hip in childhood). A variety of total hip prostheses are available. Most consist of a metal femoral component topped by a spherical ball, of metal, ceramic, or plastic, fitted into a plastic or metal acetabular socket (see Fig. 67-7).

The surgeon selects the prosthesis that is best suited to the individual patient, considering various factors, including skeletal structure and activity level. The patient has irreversibly damaged hip joints, and the potential benefits, including improved quality of life (Chart 67-7), outweigh the surgical risks. With the advent of improved prosthetic materials and operative techniques, the life of the prosthesis has been extended, and today younger patients with severely damaged and painful hip joints are undergoing total hip replacement.

### *Nursing Interventions*

The nurse must be aware of and monitor for specific potential complications associated with total hip replacement. Complications that may occur include dislocation of the hip prosthesis, excessive wound drainage, thromboembolism, infection, and heel pressure ulcer (Chart 67-8). Other complications for which the nurse must monitor include those associated with immobility. Long-term complications include **heterotopic ossification** (formation of bone in the periprosthetic space), avascular necrosis (bone death caused by loss of blood supply), and loosening of the prosthesis.

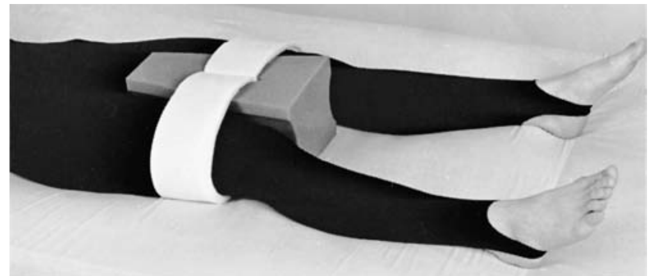


**Figure 67-8** An abduction pillow may be used after a total hip replacement to prevent dislocation of the prosthesis.

#### Preventing Dislocation of the Hip Prosthesis

For patients undergoing a posterior or posterior-lateral approach for total hip arthroplasty, maintenance of the femoral head component in the acetabular cup is essential. The nurse teaches the patient about positioning the leg in **abduction,** which helps prevent dislocation of the prosthesis. The use of an abduction splint, a wedge pillow (Fig. 67-8), or two or three pillows between the legs keeps the hip in abduction. When the nurse turns the patient in bed, it is important to keep the operative hip in abduction.

The patient's hip is never flexed more than 90 degrees. For use of the fracture bedpan, the nurse instructs the patient to flex the unaffected hip and to use the trapeze to lift

CHART 67-7 NURSING RESEARCH PROFILE

### *Quality of Life Over the Long-Term for Patients With Total Hip Replacements*

McMurray, A., Grant, S., Griffiths, S., et al. (2005). Mapping recovery after total hip replacement surgery: Health-related quality of life after three years. *Australian Journal of Advanced Nursing, 22*(4), 20–25.

**Purpose**

Total hip replacement (THR) surgery is generally considered a cost-effective and successful surgical intervention that results in improved mobility and quality of life. While many studies have examined quality-of-life outcomes among patients who have had THR, few have measured quality-of-life outcomes beyond a few weeks or months during the postoperative period. This study compared quality-of-life outcomes among patients who had THR at 12 weeks and at 3 years after hospital discharge postsurgery.

**Design**

Patients who had participated in a previous study of postoperative patients who had THR were called and invited to participate in this study. Of the original cohort of 95 participants, 62 agreed to participate in this study. Thirty-two (52%) of these patients were female, and 37 (60%) were over 75 years of age. These participants were asked to respond to items from the Short Form health survey (SF-36), which they had previously completed at 1, 2, 4, 8, and 12 weeks post–hospital discharge.

**Findings**

Thirty-six (58%) participants reported being readmitted to the hospital during the previous 3 years for health problems that were not related to their THR. Approximately half ($n = 33$) reported unmet health needs that were mostly related to non–hip-related problems. There were no significant changes found on any SF-36 scores from 12 weeks to 3 years post–hospital discharge for THR. However, the overall physical functioning scores for women were less than population-based norms, while the physical function scores among men were higher than population-based norms. Twenty-six (42%) participants reported an increase in participation of social activities from the preoperative period.

**Nursing Implications**

Many patients who have had hip replacement surgery report greater mobility and less pain that improves their ability to resume social activities postoperatively. Findings from this study suggest that gains made in engagement in social activities after THR may continue for several years postoperatively among patients with THR. Gains in other quality-of-life indicators may also persist for at least 3 years postoperatively. While men who have had THR may enjoy long-term improvements in physical function, this may not be the case for women who have had THR. Women who have had THR may require more vigilant long-term follow-up.

CHART 67-8

## PLAN OF NURSING CARE
## *The Patient With a Total Hip Replacement*

**NURSING DIAGNOSIS:** Pain related to total hip replacement
**GOAL:** Relief of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess patient for pain using a standard pain intensity scale. | 1. Pain is expected after a surgical procedure because of the surgical trauma and tissue response. Muscle spasms occur after total hip replacements. Immobility causes discomfort at pressure points. | • Describes discomfort<br>• Expresses confidence in efforts to control pain<br>• States pain is reduced; pain intensity scores are decreasing<br>• Appears comfortable and relaxed<br>• Uses physical, psychological, and pharmacologic measures to reduce pain and discomfort |
| 2. Ask patient to describe discomfort. | 2. Pain characteristics may help to determine the cause of discomfort. Pain may be due to complications (hematoma, infection, dislocation). Pain is an individual experience—it means different things to different people. | |
| 3. Acknowledge existence of pain; inform patient of available analgesic agents or muscle relaxants. | 3. The nurse can reduce the stress experienced by patient by communicating concern and availability of assistance to help the patient deal with the pain. | |
| 4. Use pain-modifying techniques. | 4. | |
| a. Administer analgesic agents as prescribed. | a. Patient will require parenteral opioids during the first 24–48 hours, and then will progress to oral analgesic agents. | |
| b. Change position within prescribed limits. | b. Use of pillows to provide adequate support and relief of pressure on bony prominences assists in minimizing pain. | |
| c. Modify environment. | c. Interactions with others, distractions, and sensory overload or deprivation may affect pain experience. | |
| d. Notify surgeon about persistent pain. | d. Surgical intervention may be necessary if pain is due to hematoma or excessive edema. | |
| 5. Evaluate and record discomfort and effectiveness of pain-modifying techniques. | 5. Effectiveness of action is based on experience; data provide a baseline about pain experiences, management, and pain relief. | |

**NURSING DIAGNOSIS:** Impaired physical mobility related to positioning, weight-bearing, and activity restrictions after hip replacement
**GOAL:** Achieves pain-free, functional, stable hip joint

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Maintain proper positioning of hip joint (abduction, neutral rotation, limited flexion). | 1. Prevents dislocation of hip prosthesis | • Maintains prescribed position<br>• No heel pressure<br>• Assists in position changes<br>• Shows increased independence in transfers<br>• Exercises hourly<br>• Participates in progressive ambulation program<br>• Actively participates in exercise regimen<br>• Uses ambulatory aids correctly and safely |
| 2. Keep pressure off heel. | 2. Prevents pressure ulcer on heel | |
| 3. Instruct and assist in position changes and transfers. | 3. Encourages patient's active participation while preventing dislocation | |
| 4. Instruct and supervise isometric quadriceps- and gluteal-setting exercises. | 4. Strengthens muscles needed for walking | |
| 5. In consultation with physical therapist, instruct and supervise progressive safe ambulation within limitations of weight-bearing prescription. | 5. Amount of weight-bearing depends on patient's condition and prosthesis; ambulatory aids are used to assist the patient with non–weight- bearing and partial weight-bearing ambulation. | |

*Continued on following page*

CHART 67-8

PLAN OF NURSING CARE

## The Patient With a Total Hip Replacement (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 6. Offer encouragement and support exercise regimen. | 6. Reconditioning exercises can be uncomfortable and fatiguing; encouragement helps patient comply with exercise program. | |
| 7. Instruct and supervise safe use of ambulatory aids. | 7. Prevents injury from unsafe use and prevents falls | |

**COLLABORATIVE PROBLEMS:** Hemorrhage; neurovascular compromise; dislocation of prosthesis; deep vein thrombosis; infection related to surgery
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Hemorrhage** | | |
| 1. Monitor vital signs, observing for shock. | 1. Changes in pulse, blood pressure, and respirations may indicate development of shock. Blood loss and stress of surgery may contribute to development of shock. | • Vital signs stabilize within normal limits.<br>• Amount of drainage decreases.<br>• No bright red bloody drainage.<br>• Hematology values are within normal limits. |
| 2. Note character and amount of drainage. | 2. Within 48 hours, bloody drainage collected in portable suction device should decrease to 25–30 mL per 8 hours. Excessive drainage (more than 250 mL in first 8 hours after surgery) and bright red drainage may indicate active bleeding. | |
| 3. Notify surgeon if patient develops shock or excessive bleeding and prepare for administration of fluids, blood component therapy, and medications. | 3. Corrective measures need to be instituted. | |
| 4. Monitor hemoglobin and hematocrit values. | 4. Anemia due to blood loss may develop. Blood replacement or iron supplementation may be needed. | |
| **Neurovascular Dysfunction** | | |
| 1. Assess affected extremity for color and temperature. | 1. The skin becomes pale and feels cool with decreased tissue perfusion. Venous congestion may produce cyanosis. | • Color normal<br>• Extremity warm<br>• Normal capillary refill<br>• Moderate edema and swelling; tissue not palpably tense<br>• Pain controllable<br>• No pain with passive dorsiflexion<br>• Normal sensations<br>• No paresthesia<br>• Normal motor abilities<br>• No paresis or paralysis<br>• Pulses strong and equal |
| 2. Assess toes for capillary refill response. | 2. After compression of the nail, rapid return of pink color indicates good capillary perfusion. | |
| 3. Assess extremity for edema and swelling. Report patient complaints of leg tightness. | 3. The trauma of surgery will cause edema. Excessive swelling and hematoma formation can compromise circulation and function. | |
| 4. Elevate extremity (keep leg lower than hip when in chair). | 4. Minimizes dependent edema | |
| 5. Assess for deep, throbbing, unrelenting pain. | 5. Surgical pain can be controlled; pain due to neurovascular compromise is not relieved by treatment. | |
| 6. Assess for pain on passive flexion of foot. | 6. With nerve ischemia, there will be pain on passive stretch. Additionally, pain or tenderness may indicate deep vein thrombosis. | |
| 7. Assess for change in sensations and numbness. | 7. Diminished pain and sensory function may indicate nerve damage. Sensation in web between great and second toe—peroneal nerve; sensation on sole of foot—tibial nerve | |

Continued

CHART 67-8

PLAN OF NURSING CARE

## *The Patient With a Total Hip Replacement* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 8. Assess ability to move foot and toes. | 8. Dorsiflexion of ankle and extension of toes indicate function of peroneal nerve. Plantar flexion of ankle and flexion of toes indicate function of tibial nerve. | |
| 9. Assess pedal pulses in both feet. | 9. Indicator of extremity circulation | |
| 10. Notify surgeon if altered neurovascular status is noted. | 10. Function of extremity needs to be preserved. | |
| **Dislocation of Prosthesis** | | |
| 1. Position patient as prescribed. | 1. Hip component positioning (femoral component in acetabular component) needs to be maintained. | • Prosthesis not dislocated<br>• Adheres to recommendations to prevent dislocation |
| 2. Use abductor splint or pillows to maintain position and to support extremity. | 2. Keeps hip in abduction and in a neutral rotation to prevent dislocation | |
| 3. Support leg and place pillows between legs when patient is turning and side-lying; turn to the unaffected side. | 3–5. Prevent dislocation | |
| 4. Avoid acute flexion of hip (head of bed at 60 degrees or less). | | |
| 5. Avoid crossing legs. | | |
| 6. Assess for dislocation of prosthesis (extremity shortens, internally or externally rotated, severe hip pain, patient unable to move extremity) | 6. Findings may indicate dislocation of prosthesis. | |
| 7. Notify surgeon of possible dislocation. | 7. Joint dislocations compromise neurovascular status and future function of extremity. | |
| **Deep Vein Thrombosis** | | |
| 1. Use anti-embolism stocking or sequential compression device as prescribed. | 1. Aids in venous blood return and prevents stasis | • Wears anti-embolism stockings; uses compression device<br>• No skin breakdown<br>• Pulses equal and strong<br>• Skin temperature normal<br>• No calf pain or tenderness<br>• Changes position with assistance and supervision<br>• Participates in exercise regimen<br>• Well hydrated<br>• No chest pain; lungs clear to auscultation; no evidence of pulmonary emboli |
| 2. Remove stocking for 20 minutes twice a day and provide skin care. | 2. Skin care is necessary to avoid breakdown. Extended removal of stockings defeats purpose of stockings. | |
| 3. Assess popliteal, dorsalis pedis, and posterior tibial pulses. | 3. Pulses indicate arterial perfusion of extremity. | |
| 4. Assess skin temperature of legs. | 4. Local inflammation will increase local skin temperature. | |
| 5. Assess for unilateral calf pain or tenderness every 8 hours. | 5. Pain or tenderness may indicate deep vein thrombosis. | |
| 6. Avoid pressure on popliteal blood vessels from equipment (eg, abductor splint straps, sequential compression stockings) or pillows. | 6. Compression of blood vessels diminishes blood flow. | |
| 7. Change position and increase activity as prescribed. | 7. Activity promotes circulation and diminishes venous stasis. | |
| 8. Supervise ankle exercises hourly. | 8. Muscle exercise promotes circulation. | |
| 9. Monitor body temperature. | 9. Body temperature increases with inflammation. | |
| 10. Encourage fluids. | 10. Dehydration increases blood viscosity. | |
| **Infection** | | |
| 1. Monitor vital signs. | 1. Temperature, pulse, and respirations increase in response to infection. (Magnitude of response may be minimal in an elderly patient.) | • Vital signs normal<br>• Well-approximated incision without drainage or excessive inflammatory response |

*Continued on following page*

CHART 67-8

PLAN OF NURSING CARE
**The Patient With a Total Hip Replacement** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 2. Use aseptic technique for dressing changes and emptying of portable drainage. | 2. Avoids introducing organisms | • Minimal discomfort; no hematoma<br>• Tolerates antibiotics |
| 3. Assess wound appearance and character of drainage. | 3. Red, swollen, draining incision is indicative of infection. | |
| 4. Assess complaints of pain. | 4. Pain may be due to wound hematoma—a possible locus of infection—that needs to be surgically evacuated. | |
| 5. Administer prophylactic antibiotics if prescribed, and observe for side effects. | 5. Infected prosthesis is avoided. | |

**NURSING DIAGNOSIS:** Risk for ineffective health maintenance related to total hip replacement
**GOAL:** Cares for self at home

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess home environment for discharge planning. | 1. Physical barriers (especially stairs, bathrooms) may limit patient's ability to ambulate and care for self at home. | • Home is accessible for patient at time of discharge<br>• Appears relaxed and develops strategies to deal with identified problems<br>• Personal assistance is available<br>• Demonstrates ability to provide necessary assistance within therapeutic prescription<br>• Complies with home care program<br>• Keeps follow-up health care appointments |
| 2. Encourage patient to express concerns about care at home; explore together possible solutions to the problem. | 2. Patient may have special problems that need to be identified and resolved. | |
| 3. Assess availability of physical assistance for health care activities. | 3. Because of limitation of mobility and limited hip range of motion, patient may require some assistance in routine health care. | |
| 4. Teach home health care regimen to caregiver. | 4. Understanding of rehabilitative regimen is necessary for compliance. | |
| 5. Instruct patient on posthospital care:<br>a. Activity limitations (hip precautions, weight-bearing limits)<br>b. Exercise instructions<br>c. Safe use of ambulatory aids<br>d. Wound care<br>e. Measures to promote healing<br>f. Medications, if any<br>g. Potential problems<br>h. Continuing health care supervision and management | 5. Lack of knowledge and poor preparation for care at home contribute to patient anxiety, insecurity, and nonadherence to therapeutic regimen. | |

the pelvis onto the pan. The patient is also reminded not to flex the affected hip.

Limited flexion is maintained during transfers and when sitting. When the patient is initially assisted out of bed, an abduction splint or pillows are kept between the legs. The nurse encourages the patient to keep the affected hip in extension, instructing the patient to pivot on the unaffected leg with assistance by the nurse, who protects the affected hip from **adduction,** flexion, internal or external rotation, and excessive weight bearing.

High-seat (orthopedic) chairs, semireclining wheelchairs, and raised toilet seats are used to minimize hip joint flexion. When sitting, the patient's hips should be higher than the knees. The patient's affected leg should not be elevated when sitting. The patient may flex the knee.

The nurse teaches the patient protective positioning, which includes maintaining abduction and avoiding internal and external rotation, hyperextension, and acute flexion. A cradle boot may be used to prevent leg rotation and to support the heel off the bed, preventing development of a pressure ulcer. The patient should use pillows between the legs when in a supine or side-lying position and when turning. Generally, the nurse instructs the patient not to sleep on the side on which the surgery was performed. At no time should the patient cross his or her legs. The patient should not bend at the waist to put on shoes and socks. Occupational therapists can provide the patient with devices to assist with dressing below the waist (Lucas, 2008b). Hip precautions should be enforced for 4 or more months after surgery (Chart 67-9). A patient who has had an anterior surgical approach may not need these precautions.

Dislocation may occur with positioning that exceeds the limits of the prosthesis. The nurse must recognize dislocation of the prosthesis. Indicators are as follows:

CHART 67-9

**PATIENT EDUCATION**

***Avoiding Hip Dislocation After Replacement Surgery With Posterior or Posterolateral Approach***

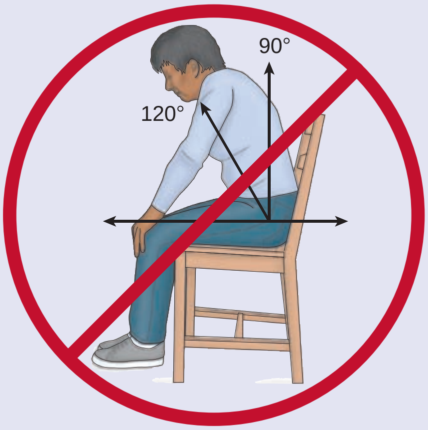
Until the hip prosthesis stabilizes after hip replacement surgery, it is necessary to follow instructions for proper positioning so that the prosthesis remains in place. Dislocation of the hip is a serious complication of surgery that causes pain and loss of function and necessitates reduction under anesthesia to correct the dislocation. Desirable positions include abduction, neutral rotation, and flexion of less than 90 degrees. When you are seated, the knees should be lower than the hip.

Methods for avoiding displacement include the following:

- Keep the knees apart at all times.
- Put a pillow between the legs when sleeping.
- Never cross the legs when seated.
- Avoid bending forward when seated in a chair.
- Avoid bending forward to pick up an object on the floor.
- Use a high-seated chair and a raised toilet seat.
- Do not flex the hip to put on clothing such as pants, stockings, socks, or shoes. Positions to avoid after total hip replacement are illustrated below.



Affected leg should not cross the center of the body




Hip should not bend more than 90 degrees



Affected leg should not turn inward

- Increased pain at the surgical site, swelling, and immobilization
- Acute groin pain in the affected hip or increased discomfort
- Shortening of the leg
- Abnormal external or internal rotation
- Restricted ability or inability to move the leg
- Reported "popping" sensation in the hip

If a prosthesis becomes dislocated, the nurse (or the patient, if at home) immediately notifies the surgeon, because the hip must be reduced and stabilized promptly so that the leg does not sustain circulatory and nerve damage. After closed reduction, the hip may be stabilized with Buck's traction or a brace to prevent recurrent dislocation. As the muscles and joint capsule heal, the chance of dislocation diminishes. Stresses to the new hip joint should be avoided for the first 8 to 12 weeks, when the risk of dislocation is greatest (Lucas, 2008b).

### Monitoring Wound Drainage

Fluid and blood accumulating at the surgical site are usually drained with a portable suction device. This prevents accumulation of fluid, which could contribute to discomfort and provide a site for infection. Drainage of 200 to 500 mL in the first 24 hours is expected; by 48 hours postoperatively, the total drainage in 8 hours usually decreases to 30 mL or less, and the suction device is then removed. The nurse promptly notifies the physician of any drainage volumes greater than anticipated.

If extensive blood loss is anticipated after total joint replacement surgery, an autotransfusion drainage system (in which the drained blood is filtered and reinfused into the patient during the immediate postoperative period) may be used to decrease the need for homologous blood transfusions.

### Preventing Deep Vein Thrombosis

The risk of venous thromboembolism (VTE) is particularly great after reconstructive hip surgery. The incidence of DVT is 48% for patients who have not had any type of VTE preventive measures instituted, which includes mechanical prophylaxis (eg, anti-embolism stockings) and pharmacologic prophylaxis (eg, antithrombotic medications) (Haas, Barrack, Westrich, et al., 2008). DVT formation can lead to pulmonary embolism (PE), which can be fatal. Therefore, the nurse must institute preventive measures and monitor the patient closely for the development of DVT and PE. Signs of DVT include calf pain, swelling, and tenderness. Medications that include fondaparinux (Arixtra) or low-molecular-weight heparin (eg, enoxaparin [Lovenox], dalteparin [Fragmin]) are indicated as prophylaxis for VTE after hip replacement surgery (Hirsh, Guyatt, Albers, et al., 2008).

### Preventing Infection

Infection, a serious complication of total hip replacement, may necessitate removal of the prosthesis. Patients who are elderly, are obese, are poorly nourished, smoke cigarettes, or

use corticosteroid medications (eg, prednisone) and patients who have diabetes, rheumatoid arthritis, concurrent infections (eg, urinary tract infection, dental abscess), or hematomas are at high risk for infection (Doherty & Way, 2006).

Potential sources of infection are avoided. If indwelling urinary catheters or portable wound suction devices are used, they are removed as soon as possible to avoid infection. Prophylactic antibiotics are prescribed if the patient needs any future surgical or invasive procedures, such as tooth extraction or cystoscopic examination.

Acute infections may occur within 3 months after surgery and are associated with progressive superficial infections or hematomas. Delayed surgical infections may appear 4 to 24 months after surgery and may cause return of discomfort in the hip. Infections occurring more than 2 years after surgery are attributed to the spread of infection through the bloodstream from another site in the body. If an infection occurs, antibiotics are prescribed. These infections may cause the prosthesis to loosen (Lucas, 2008b). Severe infections may require surgical débridement or removal of the prosthesis.

#### Promoting Home and Community-Based Care

***Teaching the Patient Self-Care.*** Before the patient prepares to leave the acute care setting, the nurse provides thorough teaching to promote continuity of the therapeutic regimen and active participation in the rehabilitation process (Chart 67-10). The nurse advises the patient of the importance of the daily exercise program in maintaining the functional motion of the hip joint and strengthening the abductor muscles of the hip, and reminds the patient that it will take time to strengthen and retrain the muscles.

Assistive devices (crutches, walker, or cane) are used for a time. After sufficient muscle tone has developed to permit a normal gait without discomfort, these devices are not necessary. In general, by 3 months, the patient can resume routine ADLs. Stair climbing is permitted as prescribed but is kept to a minimum for 3 to 6 months. Frequent walks, swimming, and use of a high rocking chair are excellent for hip exercises. Sexual intercourse should be carried out with the patient in the dependent position (flat on the back) for 3 to 6 months to avoid excessive adduction and flexion of the new hip.

At no time during the first 4 months should the patient cross the legs or flex the hip more than 90 degrees. Assistance in putting on shoes and socks may be needed. The patient should avoid low chairs and sitting for longer than 45 minutes at a time. These precautions minimize hip flexion and the risks of prosthetic dislocation, hip stiffness, and flexion contracture. Traveling long distances should be avoided unless frequent position changes are possible. Other activities to avoid include tub baths, jogging, lifting heavy loads, and excessive bending and twisting (eg, lifting, shoveling snow, forceful turning).

***Continuing Care.*** A home care nurse may assess the patient at home to assess for potential problems and monitor wound healing (see Chart 67-11 later in this chapter). The nurse, physical therapist, or occupational therapist assesses the home environment for physical barriers that may impede

### Chart 67-10 • *Providing Home Care After Hip Replacement*

**Considerations**

- Pain management
- Wound care
- Mobility
- Self-care (activities of daily living)
- Potential complications

**Nursing Interventions**

Discuss with patient methods to reduce pain:
- Periodic rest
- Distraction and relaxation techniques
- Medication therapy (eg, nonsteroidal anti-inflammatory drugs, opioid analgesic agents): actions of medications, administration, schedule, side effects

Instruct patient in the following:
- Keeping incision clean and dry
- Taking care of the wound and changing the dressing
- Recognizing signs of wound infection (eg, pain, swelling, drainage, fever)

Explain that sutures or staples will be removed 10 to 14 days after surgery.

Teach patient about the following:
- Safe use of assistive devices
- Weight-bearing limits
- How to change positions frequently
- Limitations on hip flexion and adduction (eg, avoid acute flexion and crossing legs)
- How to stand without flexing hip acutely
- Avoidance of low-seated chairs
- Sleeping with pillow between legs to prevent adduction
- Gradual increase in activities and participation in prescribed exercise regimen
- Use of important medications such as warfarin (Coumadin) and aspirin

Assess home environment for physical barriers.

Instruct patient to use elevated toilet seat and to use reachers to aid in dressing.

Encourage patient to accept assistance with activities of daily living during early convalescence until mobility and strength improve.

Arrange services and accommodations to address the patient's disability or illness, as appropriate.

Assess patient for development of potential problems, and instruct patient to report signs of potential complications:
- Dislocation of prosthesis (eg, increased pain, shortening of leg, inability to move leg, popping sensation in hip, abnormal rotation)
- Deep vein thrombosis (eg, calf pain, swelling)
- Wound infection (eg, swelling, purulent drainage, pain, fever)
- Pulmonary emboli (eg, sudden dyspnea, tachypnea, pleuritic chest pain)

Discuss with patient the need to continue regular health care (routine physical examinations) and screenings.

the patient's rehabilitation. In addition, the nurse or therapist may need to assist the patient in acquiring devices such as reachers or long-handled tongs to help with dressing, or toilet seat extenders to elevate the toilet.

After successful surgery and rehabilitation, the patient can expect a hip joint that is free or almost free of pain, has good motion, is stable, and permits normal or near-normal ambulation.

### Total Knee Replacement

Total knee replacement surgery is considered for patients who have severe pain and functional disabilities related to destruction of joint surfaces by osteoarthritis or rheumatoid arthritis. Metal and acrylic prostheses designed to provide the patient with a functional, painless, stable joint may be used. If the patient's ligaments have weakened, a fully constrained (hinged) or semiconstrained prosthesis may be used to provide joint stability. A nonconstrained prosthesis depends on the patient's ligaments for joint stability.

### Nursing Interventions

Postoperatively, the knee is dressed with a compression bandage. Ice may be applied to control edema and bleeding. The nurse assesses the neurovascular status of the leg. It is important to encourage active flexion of the foot every hour when the patient is awake. Efforts are directed at preventing complications (thromboembolism, peroneal nerve palsy, infection, limited range of motion) (Lucas, 2008b).

A wound suction drain removes fluid accumulating in the joint. Drainage ranges from 200 to 400 mL during the first 24 hours after surgery and diminishes to less than 25 mL by 48 hours, at which time the surgeon removes the drains. If extensive bleeding is anticipated, an autotransfusion drainage system may be used during the immediate postoperative period. The color, type, and amount of drainage are documented, and any excessive drainage or change in characteristics of the drainage is promptly reported to the physician.

Use of a **continuous passive motion (CPM) device** in conjunction with physical therapy is associated with decreased hospital length of stay as well as improved patient postoperative knee mobility and decreased use of analgesic agents (Milne, Brosseau, Robinson, et al., 2008). The patient's leg is placed in this device, which increases circulation and range of motion of the knee joint. The rate and amount of extension and flexion are prescribed. Usually, 10 degrees of extension and 50 degrees of flexion are prescribed initially, increasing to 90 degrees of flexion with full extension (0 degrees) by discharge (Fig. 67-9).

The nurse encourages the patient to use the CPM device. The physical therapist supervises exercises for strength and range of motion. If satisfactory flexion is not achieved, gentle manipulation of the knee joint under general anesthesia may be necessary about 2 weeks after surgery.

The nurse assists the patient to get out of bed on the evening or the day after surgery. The knee is usually protected with a knee immobilizer (eg, cast, brace, splint) and is elevated when the patient sits in a chair. The physician prescribes weight-bearing limits. Progressive ambulation, using assistive devices and within the prescribed weight-bearing limits, begins on the day after surgery.




**Figure 67-9** Lower-limb continuous passive motion (CPM) device. The Otto Bock 480E Knee CPM is 11 kg (24 lb) and combines durable construction with portability and ease of operation. CPM is best applied immediately after surgery and continued, uninterrupted, for up to 6 weeks as prescribed by the physician. Photo courtesy of Otto Bock Healthcare, Minneapolis, MN.

After discharge from the hospital, the patient may continue to use the CPM device at home and may undergo physical therapy on an outpatient basis. Late complications that may occur include infection and loosening of prosthetic components (Lucas, 2008b). Patients usually can achieve a pain-free, functional joint and participate more fully in life activities than before the surgery (Marx, Jones, Atwan, et al., 2005; Rasanen, Paavoalinen, Sintonen, et al., 2007).

## NURSING PROCESS

## Preoperative Care of the Patient Undergoing Orthopedic Surgery

### Assessment

Assessment of the patient is focused on hydration status, current medication history, and possible infection. Adequate hydration is an important goal for orthopedic patients. Immobilization and bed rest contribute to the following complications: DVT, PE, urinary stasis and associated bladder infections, and kidney stone formation. Adequate hydration decreases blood viscosity and venous stasis and ensures adequate urine flow. To determine preoperative hydration status, the nurse assesses the skin and mucous membranes, vital signs, urinary output, and laboratory values.

The medication history provides information for perioperative management. The patient with chronic illness (eg, adrenal insufficiency, rheumatoid arthritis, chronic pulmonary disease, multiple sclerosis) or with a transplanted organ frequently has received long-term administration of corticosteroid medications to control disease symptoms or prevent rejection. The corticosteroid should be administered preoperatively, intraoperatively, and postoperatively as prescribed to prevent the occurrence of acute adrenal insufficiency from suppressed adrenal function. The patient's

use of other medications, such as anticoagulants, cardiovascular agents, or insulin, needs to be documented and discussed with the surgeon and anesthesiologist to ensure adequate management.

The nurse asks the patient specifically about the occurrence of colds, dental problems, urinary tract infections, and other infections within the 2 weeks before surgery. Osteomyelitis could develop through hematologous spread. Permanent disability can result if infection occurs within a bone or joint. Preexisting infections must be resolved before elective orthopedic surgery is performed.

## Nursing Diagnoses

Based on the nursing assessment data, the patient's major preoperative nursing diagnoses related to orthopedic status may include the following:

- Acute pain related to fracture, joint degeneration, swelling, or inflammation
- Risk for peripheral neurovascular dysfunction related to swelling, constricting devices, or impaired venous return
- Risk for ineffective therapeutic regimen management related to insufficient knowledge or lack of available support and resources
- Impaired physical mobility related to pain, swelling, and possible presence of an immobilization device
- Risk for situational low self-esteem and/or disturbed body image related to impact of musculoskeletal disorder

## Planning and Goals

The major goals for the patient before orthopedic surgery may include relief of pain, adequate neurovascular function, health promotion, improved mobility, and positive self-esteem.

## Nursing Interventions

### *Relieving Pain*

Discomfort is decreased with immobilization of a fractured bone or an injured, inflamed joint. Elevation of an edematous extremity promotes venous return and reduces associated discomfort. Ice, if prescribed, relieves swelling and reduces discomfort by diminishing nerve stimulation.

Analgesic agents are frequently prescribed to control the acute pain of musculoskeletal injury or surgery and associated muscle spasm. During the immediate postoperative period, the nurse needs to discuss and coordinate the administration of effective analgesic medications (eg, opioids, nonsteroidal anti-inflammatory drugs) with the anesthesia provider and surgeon. (See Chapter 13 for a further discussion of assessment and management of pain.)

### *Maintaining Adequate Neurovascular Function*

Trauma, edema, or immobilization devices may interrupt tissue perfusion. The nurse must frequently assess neurovascular status (ie, color, temperature, capillary refill, pulses, edema, pain, sensation, motion) of the extremity and document the findings. If circulation is compromised, the nurse institutes measures to restore adequate circulation. These include promptly notifying the physician, elevating the extremity, and releasing constricting wraps or assisting with bivalving constrictive casts as prescribed.

### *Promoting Health*

The nurse assists the patient in performing activities that promote health during the perioperative period. The nurse assesses nutritional status and hydration. The nurse monitors fluid intake, urinary output, and urinalysis findings. At times, patients may intentionally limit their fluid intake to minimize the use of a bedpan. A small fracture bedpan may be more comfortable for the patient to use. An indwelling catheter should be used only when necessary to minimize the risk of urinary tract infection. A preexisting urinary tract infection must be effectively treated prior to surgery.

If the surgery is elective, the orthopedic surgeon may instruct the patient to shower with a germicidal soap at home prior to surgery. The patient may also be asked to mark the operative site prior to surgery to minimize the risk that the wrong site is selected in the operating room.

The nurse discusses with the patient and the family the need for assistance with ADLs and the therapeutic regimen during convalescence so that adequate support is available when the patient is discharged. Modification of the home environment may be necessary to accommodate the altered mobility of the patient after surgery. Referral to a social worker and case manager may be needed to ensure a smooth transition to home care.

### *Improving Mobility*

Preoperatively, the patient's mobility may be impaired by pain, swelling, and immobilizing devices (eg, splints, casts, traction). The nurse should elevate and adequately support edematous extremities with pillows. It is important to control pain before an injured part is moved by administering analgesic medication in time for it to take effect. The injured part is supported when it is moved. The nurse encourages movement within the limits of therapeutic immobility. The patient should perform active range-of-motion exercises of uninvolved joints, and, unless contraindicated, the nurse teaches gluteal-setting and quadriceps-setting isometric exercises to maintain the muscles needed for ambulation (see Chart 67-3). The patient who will be using assistive devices postoperatively may exercise to strengthen the upper extremities and shoulders. If the use of assistive devices (eg, crutches, walker, wheelchair) is anticipated, the nurse encourages the patient to practice with them preoperatively to facilitate their safe use and to promote earlier independent mobility.

### *Helping the Patient Maintain Self-Esteem*

Preoperatively, orthopedic patients may need assistance in accepting changes in body image, diminished self-esteem, or inability to perform their roles and responsibilities. The degree of assistance required in this area varies greatly, depending on the events preceding hospitalization, the surgery and rehabilitation planned, and the temporary or permanent nature of the problems. The nurse promotes a trusting relationship so that the patient feels comfortable expressing concerns and anxieties, and helps the patient examine his or her feelings about changes in self-concept. The nurse clarifies any misconceptions the patient may have and

helps the patient work through modifications needed to adapt to alterations in physical capacity and to reestablish positive self-esteem.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Reports relief of pain
   a. Uses multiple approaches to reduce pain
   b. States that medication is effective in relieving pain
   c. Moves with increasing comfort
2. Exhibits adequate neurovascular function
   a. Exhibits normal skin color
   b. Has warm skin
   c. Has normal capillary refill response
   d. Reports normal sensation and demonstrates joint motion
   e. Demonstrates reduced swelling
3. Promotes health
   a. Consumes diet appropriate to meet nutritional needs
   b. Maintains adequate hydration
   c. Abstains from smoking
   d. Practices respiratory exercises
   e. Repositions self to relieve skin pressure
   f. Engages in strengthening and preventive exercises
   g. Plans for assistance during convalescence at home
4. Maximizes mobility within therapeutic limits
   a. Requests assistance when moving
   b. Elevates edematous extremity after transfer
   c. Uses immobilizing devices and assistive devices safely as prescribed
5. Expresses positive self-esteem
   a. Acknowledges temporary or permanent changes in body image
   b. Discusses role performance changes
   c. Participates in decisions about care

# NURSING PROCESS

## Postoperative Care of the Patient Undergoing Orthopedic Surgery

## Assessment

After orthopedic surgery, the nurse continues the preoperative care plan, modifying it to match the patient's current postoperative status. The nurse reassesses the patient's needs related to pain, neurovascular status, health promotion, mobility, and self-esteem. Skeletal trauma and surgery performed on bones, muscles, or joints can produce significant pain, especially during the first 1 or 2 postoperative days. Tissue perfusion must be monitored closely, because edema and bleeding into the tissues can compromise circulation and result in compartment syndrome. Inactivity contributes to venous stasis and the development of venous thromboemboli that may include DVTs or PEs. General anesthesia, analgesia, and immobility can result in altered functioning of the respiratory, gastrointestinal, and urinary systems.

The nurse notes the prescribed limits on mobility and assesses the patient's understanding of the mobility restrictions. The nurse discusses the plan of care with the patient and encourages his or her active participation in the plan.

Frequent assessment of vital signs including pain, level of consciousness, neurovascular status, wound drainage, breath sounds, bowel sounds, and fluid balance provides the nurse with data that may suggest the possible development of complications. The nurse reports abnormal findings to the physician promptly.

With major orthopedic surgery, there is a risk for hypovolemic shock because of blood loss. Muscle dissection frequently produces wounds in which hemostasis is poor. Wounds that are closed under tourniquet control may bleed during the postoperative period. The nurse must be alert for signs of hypovolemic shock.

Changes in the patient's pulse rate, respiratory rate, or color of the skin or mucous membranes may indicate pulmonary or cardiovascular complications. Atelectasis and pneumonia are common and may be related to preexisting pulmonary disease, deep anesthesia, decreased activity, and reduced respiratory reserve due to advanced age or an underlying musculoskeletal disorder (eg, restrictive lung expansion secondary to kyphosis, rheumatoid arthritis, or osteoporosis).

Voiding in unnatural positions may contribute to urinary retention. In addition, elderly men usually have some degree of prostate enlargement and may already have difficulty voiding. Therefore, it is important to monitor urinary output.

Temperature elevations within the first 48 hours are frequently related to atelectasis or other respiratory problems. Temperature elevations during the next few days are frequently associated with urinary tract infections. Superficial wound infections take 4 to 6 days to develop. Fever from phlebitis usually occurs during the end of the first week through the second week.

Venous thromboembolus (see discussions of DVT in Chapter 31 and PE in Chapter 23) is one of the most common and most dangerous of all complications occurring in the postoperative orthopedic patient. Advanced age, venous stasis, lower extremity orthopedic surgery, and immobilization are significant risk factors. The nurse assesses the patient daily for unilateral calf swelling, tenderness, warmth, and redness. The nurse promptly reports abnormal findings to the physician.

In addition, fat emboli syndrome (FES) (see Chapter 69) may occur with orthopedic surgery. The nurse must be alert to any signs and symptoms that may suggest the development of FES. These may include respiratory distress; onset of delirium or any acute change in level of consciousness; and development of unusual skin rashes, especially a papular rash on the upper torso.

## Diagnosis

### *Nursing Diagnoses*

Based on all assessment data, the patient's major nursing diagnoses after orthopedic surgery may include the following:

- Acute pain related to the surgical procedure, swelling, and immobilization
- Risk for peripheral neurovascular dysfunction related to swelling, constricting devices, or impaired circulation
- Risk for ineffective therapeutic regimen management related to insufficient knowledge or available support and resources
- Impaired physical mobility related to pain, edema, or the presence of an immobilizing device (eg, splint, cast, or brace)
- Risk for situational low self-esteem, disturbed body image, or ineffective role performance related to impact of the musculoskeletal disorder

#### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications may include the following:

- Hypovolemic shock
- Atelectasis; pneumonia
- Urinary retention
- Infection
- Venous thromboembolism, including DVT or PE
- Constipation and fecal impaction

### Planning and Goals

The major goals for the patient after orthopedic surgery may include relief of pain, adequate neurovascular function, health promotion, improved mobility, positive self-esteem, and absence of complications.

### Nursing Interventions

#### *Relieving Pain*

After orthopedic surgery, pain can be intense. Edema, hematomas, and muscle spasms contribute to the pain. Some patients report that the pain is less than that experienced preoperatively, and only moderate amounts of analgesic agents are needed. The nurse assesses the patient's level of pain, evaluates the patient's response to therapeutic measures, and makes every effort to relieve the pain and discomfort. Pain assessment must occur on an ongoing basis and take place at least as often as vital signs are assessed.

Multiple pharmacologic approaches to pain management exist. Patient-controlled analgesia (PCA) and epidural analgesia may be prescribed to relieve the pain. If the patient is receiving preemptive analgesia on an ongoing basis via a PCA IV pump, the nurse ensures that the patient receives boluses of the analgesic agent prior to performing planned physical activities. If intramuscular and oral analgesic agents are prescribed on an as-needed basis (PRN), the nurse should administer medications on a preventive basis within the prescribed intervals if the onset of pain can be predicted (eg, 30 minutes before planned activity such as transfer or exercise). The nurse should offer the medication at set intervals.

In addition to pharmacologic approaches to controlling pain, elevation of the operative extremity and application of cold packs, if prescribed, help control edema and pain. Surgical drains inserted in the wound decrease fluid accumulation and hematoma formation. The nurse may find that repositioning, relaxation, distraction, and guided imagery help in reducing the patient's pain.

The nurse should report increasing and uncontrollable pain to the orthopedic surgeon for evaluation. Pain should diminish rapidly after the initial postoperative period. After 2 to 3 days, most patients require only occasional oral analgesia for residual muscle soreness and spasm.

#### *Maintaining Adequate Neurovascular Function*

The nurse monitors the neurovascular status of the involved body part and notifies the physician promptly of any indications of diminished tissue perfusion. The patient is reminded to perform muscle-setting, ankle, and calf-pumping exercises hourly while awake to enhance circulation.

#### *Maintaining Health*

It is important to encourage the patient to participate in the postoperative treatment regimen. A diet that includes adequate protein and vitamins is essential for wound healing. The patient progresses to a regular diet as soon as possible.

The nurse assesses the patient for early manifestations of pressure ulcers (eg, redness over bony prominences), which are a threat to any patient who must spend an extended time in bed or who is elderly, malnourished, or unable to move without assistance. Turning the patient frequently at preset intervals (eg, at least every 2 hours), washing and drying the skin, and minimizing pressure over bony prominences are necessary to avoid skin breakdown.

#### *Improving Physical Mobility*

Patients are frequently reluctant to move after orthopedic surgery. Preoperative education about the planned postoperative treatment regimen promotes patient adherence to an optimal rehabilitation regimen. Patients often increase their mobility once they have been reassured that movement within therapeutic limits is beneficial, that the nurse will provide assistance, and that discomfort can be controlled.

Metal pins, screws, rods, and plates used for internal fixation are designed to maintain the position of the bone until ossification occurs. They are not designed to support the body's weight, and they can bend, loosen, or break if stressed. The estimated strength of the bone, the stability of the fracture, reduction and fixation, and the amount of bone healing are important considerations in determining weight-bearing limits. Although the incision may appear healed, the underlying bone requires more time to repair and regain normal strength. Some orthopedic procedures require weight-bearing restrictions. The orthopedic surgeon will prescribe the weight-bearing limits and the use of protective devices (orthoses), if necessary, after surgery.

The physical therapist tailors the rehabilitation program to each patient's needs. The goal is the patient's return to the highest level of function in the shortest time possible. Rehabilitation involves progressive increases in the patient's activities and exercises. Assistive devices (crutches, walker) may be used for postoperative mobility. Preoperative practice with assistive devices helps the patient use them appropriately postoperatively. The nurse makes sure that the patient uses these devices safely (see discussions of crutch walking and use of a walker in Chapter 11).

### Maintaining Self-Esteem

The nurse and the patient set realistic goals. Increased ability to perform self-care activities within the limits of the therapeutic regimen and resumption of roles facilitate the patient's recognition of abilities and promote self-esteem, personal identity, and role performance. Acceptance of altered body image is facilitated by support provided by the nurse, family, and others.

### Monitoring and Managing Potential Complications

**HYPOVOLEMIC SHOCK.** Excessive loss of blood during or after surgery can result in shock. The nurse monitors the patient for signs and symptoms of hypovolemic shock: increased pulse rate (eg, greater than 100 bpm), decreased blood pressure (eg, less than 90/60 mm Hg), narrowed pulse pressure (eg, less than 20 mm Hg), urine output less than 30 mL/h, restlessness, change in mentation, thirst, and decreased hemoglobin and hematocrit. The nurse reports these findings to the orthopedic surgeon and assists in appropriate management. (See Chapter 15 for a discussion of managing shock.)

**ATELECTASIS AND PNEUMONIA.** The nurse monitors the patient's breath sounds and encourages deep-breathing and coughing exercises. Full expansion of the lungs prevents the accumulation of pulmonary secretions and the development of atelectasis and pneumonia. Incentive spirometry use is encouraged. If signs of respiratory problems develop (eg, increased respiratory rate, productive cough, diminished or adventitious breath sounds, fever), the nurse reports the findings to the surgeon.

**URINARY RETENTION.** The nurse closely monitors the patient's urinary output after surgery. The nurse encourages the patient to void every 3 to 4 hours to prevent urinary retention and bladder distention. It is important to provide privacy during toileting. Because the patient may need to void in an unusual position, the nurse assists the patient with positioning. Fracture bedpans may be more comfortable to use than other bedpans. Voiding in the side-lying position may be helpful to the male patient. Some male patients can void only if standing, and clarification with the surgeon of the activity prescription may be needed before the patient is assisted to a standing position.

If the patient cannot void, intermittent catheterizations may be prescribed until the patient can void independently. Indwelling urinary catheters should be used only when necessary and should be removed as soon as possible. The patient may follow a catheterization protocol that incorporates the use of a bladder scanner to estimate the amount of urine in the bladder, thereby determining if catheterization is necessary. Catheterization protocol use has decreased the number of nosocomial urinary tract infections associated with unnecessary catheterizations (Wald, Ma, Bratzler, et al., 2008).

**INFECTION.** Infection is a risk after any surgery, but it is of particular concern for the postoperative orthopedic patient because of the risk of osteomyelitis. Osteomyelitis often requires prolonged courses of IV antibiotics. At times, the infected bone and prosthesis or internal fixation device must be surgically removed. Therefore, prophylactic systemic antibiotics are usually prescribed during the perioperative and immediate postoperative periods. The nurse assesses the patient's response to these antibiotics. When changing dressings and emptying wound drainage devices, aseptic technique is essential. The nurse monitors the patient's vital signs, incision, and drainage. The nurse monitors the patient for signs of urinary tract infection. Prompt assessment for and treatment of infection are essential.

**VENOUS THROMBOEMBOLISM AND DEEP VEIN THROMBOSIS.** Prevention of DVT requires use of ankle and calf-pumping exercises, anti-embolism stockings, and sequential compression devices. Adequate hydration and early mobilization are equally important. Prophylactic fondaparinux, low-molecular-weight heparin (eg, enoxaparin, dalteparin), warfarin (Coumadin), or low-dose unfractionated heparin may be prescribed in the immediate postoperative period. Typically, fondaparinux, a low-molecular-weight heparin, or warfarin is prescribed during the later rehabilitation period for DVT prophylaxis (Hirsh, et al., 2008). The nurse monitors the patient for signs of DVT and promptly reports findings to the physician for management.

**CONSTIPATION.** Constipation is a frequently overlooked complication, because patients are discharged to a rehabilitation or home setting in 3 or 4 days. Constipation occurs because of decreased mobility and hydration, coupled with the use of opioids. Prevention of constipation requires continual monitoring of bowel function. Adequate hydration, early mobilization, and stool softeners may be prescribed to prevent fecal impaction (see Chapter 38).

### Promoting Home and Community-Based Care

**TEACHING THE PATIENT SELF-CARE.** Because the length of stay in the hospital after orthopedic surgery is usually 3 or 4 days, most convalescence and rehabilitation take place at home or in a nonacute care setting. The nurse teaches the patient and the family to recognize complications that must be reported promptly to the orthopedic surgeon. The patient must understand the prescribed medication regimen. The nurse should demonstrate proper wound care. The patient gradually resumes physical activities and adheres to weight-bearing limits. The patient must be able to perform transfers and to use mobility aids safely. If the patient has a cast or other immobilizing device, family members are instructed about how to assist the patient in a way that is safe for the patient and for the family member (eg, using proper body mechanics when assisting the patient). Specific exercises need to be taught and practiced before discharge. The nurse discusses recovery and health promotion, emphasizing a healthy lifestyle and diet (Chart 67-11).

**CONTINUING CARE.** If special equipment or home modifications are needed for safe care at home, they must be in place before the patient is discharged home. Discharge planning begins immediately after surgery. The nurse, physical therapist, and social worker can assist the patient and family in identifying their needs and in getting ready to care for the patient at home.

Frequently, home health nursing and home physical therapy are part of the discharge plan of care. These referrals provide resources and help the patient and the family

CHART 67-11

HOME CARE CHECKLIST

*The Patient Who Has Had Orthopedic Surgery*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe wound care. | ✔ | ✔ |
| • State indicators of wound infections (eg, redness, swelling, tenderness, purulent drainage, fever). | ✔ | ✔ |
| • Consume a healthy diet to promote wound and bone healing. | ✔ | |
| • Participate in prescribed exercise regimen to promote circulation and mobility. | ✔ | |
| • Use mobility aids safely. | ✔ | |
| • Observe prescribed weight-bearing and activity limits. | ✔ | |
| • Take prescribed therapeutic and prophylactic medications (eg, antibiotics, anticoagulants, analgesic agents). | ✔ | |
| • State indicators of complications to report promptly to physician (eg, uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; purulent drainage; signs of systemic infection; signs of deep vein thrombosis or pulmonary embolism). | ✔ | ✔ |
| • Identify modifications of home environment to promote safe environment and independence during recovery and rehabilitation. | ✔ | ✔ |

cope with the demands of care during recovery and rehabilitation. The nurse assesses the patient's progress and monitors for possible complications. Regular medical follow-up care after discharge needs to be arranged. The nurse reminds the patient and family about the importance of continuing health promotion and screening practices.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Reports decreased level of pain
   a. Uses multiple approaches to reduce pain
   b. Uses oral analgesic medication as needed to control discomfort
   c. Elevates extremity to control edema and discomfort
   d. Moves with greater comfort
2. Exhibits adequate neurovascular function
   a. Exhibits normal color and temperature of skin
   b. Has warm skin
   c. Has normal capillary refill response
   d. Demonstrates intact sensory and motor function
   e. Demonstrates reduced swelling
3. Promotes health
   a. Eats diet appropriate for nutritional needs
   b. Maintains adequate hydration
   c. Abstains from smoking
   d. Practices respiratory exercises
   e. Repositions self to relieve pressure on skin
   f. Engages in strengthening and preventive exercises
4. Maximizes mobility within the therapeutic limits
   a. Requests assistance when moving
   b. Elevates edematous extremity after transfer
   c. Uses immobilizing devices as prescribed
   d. Complies with prescribed weight-bearing limitation
5. Expresses positive self-esteem
   a. Discusses temporary or permanent changes in body image
   b. Discusses role performance
   c. Views self as capable of assuming responsibilities
   d. Actively participates in planning care and in the therapeutic regimen
6. Exhibits absence of complications
   a. Does not experience shock
   b. Maintains normal vital signs and blood pressure
   c. Has clear lung sounds
   d. Demonstrates wound healing without signs of infection
   e. Does not experience urinary retention
   f. Voids clear urine
   g. Exhibits no signs of DVT or PE
   h. Does not experience constipation

## CRITICAL THINKING EXERCISES

EBP **1** A 64-year-old man has had a right total knee replacement for osteoarthritis. On his second postoperative day, he complains to you that he would rather not use his CPM device, and wonders why his participation in physical therapy alone is not sufficient. How would you respond to him? Why is CPM indicated for patients who have had knee replacement surgery? What is the strength of the evidence that supports the use of CPM either singly or in tandem with physical therapy postoperatively in this patient population?

**2** A 50-year-old woman has had a repair of a fracture of her right tibia. She has a plaster cast over her right leg, with a window placed over her incision. During the

evening of her second postoperative day, she complains of increasing pain and slight paresthesias of her right toes. Opioid analgesic agents have only moderately relieved her pain. The night-shift nurse documents her findings and asks you, as the oncoming day-shift nurse, to report these findings to the orthopedic surgeon when he makes his rounds. You assess the patient after report and find that she now describes her right lower leg as "feeling tight" and that she has sensations of "pins and needles." Capillary refill of her right toes is longer than 3 seconds, and they feel much cooler than the left toes. What additional assessments might you make at this time? What is your priority nursing diagnosis and intervention?

EBP **3** You are an experienced perioperative nurse. You note that different orthopedic surgical groups have different preoperative hygiene protocols for patients undergoing total knee replacement surgery who come to the surgical center where you work. One surgical group tells its patients to shower with Betadine solution once daily for 2 days prior to surgery; another tells its patients to shower with chlorhexidine solution the morning of surgery; while another does not give any specific preoperative hygiene instructions. What is the strength of the evidence that identifies which preoperative hygiene protocol is most effective for patients scheduled to have total knee replacement surgery?

**4** A 70-year-old woman with a long-standing history of osteoarthritis has had a right total hip replacement. On the second postoperative day, a physical therapy assistant helps the patient get out of bed. She has been sitting out of bed for approximately an hour when she requests to be placed back in bed. What is the best way to accomplish this transfer from chair to bed? What specific precautions might you follow?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

National Association of Orthopaedic Nurses (NAON), www.orthonurse.org

National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, www.niams.nih.gov




# Management of Patients With Musculoskeletal Disorders

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe the nursing management, rehabilitation, and health education needs of the patient with low back pain.
2. Identify common conditions of the hand or wrist and nursing care of the patient undergoing surgery of the hand or wrist.
3. Describe common conditions of the foot and nursing care of the patient undergoing foot surgery.
4. Explain the pathophysiology, pathogenesis, prevention, and management of osteoporosis.
5. Use the nursing process as a framework for care of the patient with osteoporosis.
6. Identify the causes and related medical management of osteomalacia.
7. Identify medication modalities for the patient with Paget's disease.
8. Use the nursing process as a framework for care of the patient with osteomyelitis.
9. Describe the nursing management of the patient with a bone tumor.

## GLOSSARY

**bursitis:** inflammation of a fluid-filled sac in a joint
**contracture:** abnormal shortening of muscle or fibrosis of joint structures
**involucrum:** new bone growth around a sequestrum
**radiculopathy:** disease of a nerve root
**sciatica:** sciatic nerve pain; pain travels down back of thigh into foot
**sequestrum:** dead bone in abscess cavity
**tendinitis:** inflammation of muscle tendons

Musculoskeletal disorders, particularly impairment of the back and spine, are leading health problems and causes of disability. The functional and psychological limitations imposed on the patient may be severe. The economic costs, in terms of loss of productivity, medical expenses, and other costs that are not compensated, are estimated to exceed $100 billion in direct and indirect costs in North America yearly (Sahar, Cohen, Matan, et al., 2008).

## Low Back Pain

The number of visits to primary care providers resulting from low back pain is second only to the number of visits for upper respiratory illnesses (Sahar, et al., 2008). Most low back pain is caused by one of many musculoskeletal problems, including acute lumbosacral strain, unstable lumbosacral ligaments and weak muscles, osteoarthritis of the spine, spinal stenosis, intervertebral disk problems, and unequal leg length. Obesity, stress, and occasionally depression may contribute to low back pain. Back pain due to musculoskeletal disorders usually is aggravated by activity, whereas pain due to other conditions is not.

Older patients may experience back pain associated with osteoporotic vertebral fractures, osteoarthritis of the spine and spinal stenosis (Weiner, Sakamoto, Perera, et al., 2006). Other causes include kidney disorders, pelvic problems, retroperitoneal tumors, and abdominal aortic aneurysms.

### Pathophysiology

The spinal column can be considered an elastic rod constructed of rigid units (vertebrae) and flexible units (intervertebral disks) held together by complex facet joints, multiple ligaments, and paravertebral muscles. Its unique construction allows for flexibility while providing maximum protection for the spinal cord. The spinal curves absorb vertical shocks from running and jumping. The trunk muscles help stabilize the spine. The abdominal and thoracic muscles are important in lifting activities, working together to minimize stress on the spinal units. Disuse weakens these supporting muscular structures. Obesity, postural problems, structural problems, and overstretching of the spinal supports may result in back pain (Porth & Matfin, 2009).

The intervertebral disks change in character as a person ages. A young person's disks are mainly fibrocartilage with a gelatinous matrix. As a person ages, the fibrocartilage becomes dense and irregularly shaped. Disk degeneration is a common cause of back pain. The lower lumbar disks, L4–L5 and L5–S1, are subject to the greatest mechanical stress and the greatest degenerative changes. Disk protrusion (herniated nucleus pulposus) or facet joint changes can cause pressure on nerve roots as they leave the spinal canal, which results in pain that radiates along the nerve (Porth & Matfin, 2009). Management of intervertebral disk disease is discussed in Chapter 65.

### Clinical Manifestations

The typical patient reports either acute back pain (lasting less than 3 months) or chronic back pain (lasting more than 3 months without improvement) and fatigue. The patient may report pain radiating down the leg, which is known as **radiculopathy** or **sciatica;** presence of this symptom suggests nerve root involvement. The patient's gait, spinal mobility, reflexes, leg length, leg motor strength, and sensory perception may be affected. Physical examination may disclose paravertebral muscle spasm (greatly increased muscle tone of the back postural muscles) with a loss of the normal lumbar curve and possible spinal deformity.

### Assessment and Diagnostic Findings

The initial evaluation of acute low back pain includes a focused history and physical examination, including general observation of the patient, back examination, and neurologic testing (reflexes, sensory impairment, straight-leg raising, muscle strength, and muscle atrophy). The findings suggest either nonspecific back symptoms or potentially serious problems, such as sciatica, spine fracture, cancer, infection, or rapidly progressing neurologic deficit. If the initial examination does not suggest a serious condition, no additional testing is performed during the first 4 weeks of symptoms.

The diagnostic procedures described in Chart 68-1 may be indicated for the patient with potentially serious or prolonged low back pain. The nurse prepares the patient for these studies, provides the necessary support during the testing period, and monitors the patient for any adverse responses to the procedures.

### Medical Management

Most back pain is self-limited and resolves within 4 weeks with analgesic agents, rest, and relaxation. Based on initial assessment findings, the patient is reassured that the assessment indicates that the back pain is not due to a serious condition. Management focuses on relief of pain and discomfort, activity modification, and patient education.

Nonprescription analgesic agents such as acetaminophen (Tylenol) and nonsteroidal anti-inflammatory drugs (NSAIDs) (eg, ibuprofen [Motrin]) and prescription muscle

**Chart 68-1 • *Diagnostic Procedures for Low Back Pain***

**X-ray of the spine**—may demonstrate a fracture, dislocation, infection, osteoarthritis, or scoliosis
**Bone scan and blood studies**—may disclose infections, tumors, and bone marrow abnormalities
**Computed tomography (CT)**—useful in identifying underlying problems, such as obscure soft tissue lesions adjacent to the vertebral column and problems of vertebral disks
**Magnetic resonance imaging (MRI)**—permits visualization of the nature and location of spinal pathology
**Electromyogram (EMG) and nerve conduction studies**—used to evaluate spinal nerve root disorders (radiculopathies)
**Myelogram**—permits visualization of segments of the spinal cord that may have herniated or may be compressed
**Ultrasound**—useful in detecting tears in ligaments, muscles, tendons, and soft tissues in the back

relaxants (eg, cyclobenzaprine [Flexeril] ) are effective in relieving acute low back pain, while tricyclic antidepressants (eg, amitriptyline [Elavil) are effective in relieving chronic low back pain. Other medications, including opioids (eg, morphine), tramadol (Ultram), benzodiazepines (eg, diazepam [Valium]), and gabapentin (Neurontin) (ie, prescribed for pain from radiculopathy) are also effective, though the evidence of their effectiveness is not as strong as that for the previously noted medications. Systemic corticosteroids are generally not considered effective in alleviating low back pain (Chou & Huffman, 2007b).

Effective nonpharmacologic interventions for acute low back pain include the application of superficial heat and spinal manipulation (eg, chiropractic therapy). Cognitive-behavioral therapy (eg, biofeedback), exercise regimens, spinal manipulation, physical therapy, acupuncture, massage, and yoga are all effective nonpharmacologic interventions for treating chronic low back pain but not acute low back pain (Chou & Huffman, 2007a).

Most patients need to alter their activity patterns to avoid aggravating the pain. They should avoid twisting, bending, lifting, and reaching, all of which stress the back. The patient is taught to change position frequently. Sitting should be limited to 20 to 50 minutes based on level of comfort. Bed rest is recommended for 1 to 2 days, for a maximum of 4 days and *only* if pain is severe. A gradual return to activities and a program of low-stress aerobic exercise are recommended. Conditioning exercises for the trunk muscles are begun after about 2 weeks.

If there is no improvement within 1 month, additional assessments for physiologic abnormalities are performed. Management is based on findings.

## Nursing Assessment

The nurse asks the patient with low back pain to describe the discomfort (eg, location, severity, duration, characteristics, radiation, associated weakness in the legs). Descriptions of how the pain occurred—with a specific action (eg, opening a garage door) or with an activity in which weak muscles were overused (eg, weekend gardening)—and how the patient has dealt with the pain often suggest areas for intervention and patient teaching.

If back pain is a recurrent problem, information about previous successful pain control methods helps in planning current management. The nurse also asks how the back pain affects the patient's lifestyle. Information about work and recreational activities helps identify areas for back health education. Because stress and anxiety can evoke muscle spasms and pain, the nurse assesses environmental variables, work situations, and family relationships. In addition, the nurse assesses the effect of chronic pain on the emotional well-being of the patient. Referral to a mental health professional (eg, psychiatric advanced practice nurse) for assessment and management of stressors contributing to the low back pain and related depression may be appropriate.

During the interview, the nurse observes the patient's posture, position changes, and gait. Often, the patient's movements are guarded, with the back kept as still as possible. The patient often selects a chair of standard seat height with arms for support. The patient may sit and stand in an unusual position, leaning away from the most painful side, and may ask for assistance when undressing for the physical examination.

On physical examination, the nurse assesses the spinal curve, any leg length discrepancy, and pelvic crest and shoulder symmetry. The nurse palpates the paraspinal muscles and notes spasm and tenderness. When the patient is in a prone position, the paraspinal muscles relax, and any deformity caused by spasm subsides. The nurse asks the patient to bend forward and then laterally and notes any discomfort or limitations in movement. It is important to determine the effect of these limitations in movement on activities of daily living (ADLs). The nurse evaluates nerve involvement by assessing deep tendon reflexes, sensations (eg, paresthesia), and muscle strength. Back and leg pain on straight-leg raising (with the patient supine, the patient's leg is lifted upward with the knee extended) suggest nerve root involvement. Obesity can contribute to low back pain. If the patient is obese, the nurse completes a nutritional assessment (see Chapter 5) (Bickley, 2007).

## Nursing Management

The major nursing goals for the patient may include relief of pain, improved physical mobility, use of back-conserving techniques of body mechanics, improved self-esteem, and weight reduction (as necessary) (Chart 68-2).

The nurse assesses the patient's response to analgesic agents. As the acute pain subsides, medication dosages are reduced. The nurse evaluates and notes the patient's response to various pain management modalities. (Other generic interventions that may relieve pain are discussed in Chapter 13.)

The nurse instructs the patient with severe pain to limit activities for 1 to 2 days. Extended periods of inactivity are not effective and result in deconditioning. A firm, nonsagging mattress (a bed board may be used) is recommended. Lumbar flexion is increased by elevating the head and thorax 30 degrees using pillows or a foam wedge and slightly flexing the knees supported on a pillow. Alternatively, the patient can assume a lateral position with knees and hips flexed (curled position) with a pillow between the knees and legs and a pillow supporting the head (Fig. 68-1). A prone position should be avoided because it accentuates lordosis. The nurse instructs the patient to get out of bed by rolling to one side and placing the legs down while pushing the torso up, keeping the back straight (National Institute of Neurological Disorders and Stroke [NINDS], 2009).

As the patient achieves comfort, activities are gradually resumed, and an exercise program is initiated. Initially, low-stress aerobic exercises, such as short walks or swimming, are suggested. After 2 weeks, conditioning exercises for the abdominal and trunk muscles are started. The physical therapist designs an exercise program for the individual patient to reduce lordosis, increase flexibility, and reduce strain on the back. It may include hyperextension exercises to strengthen the paravertebral muscles, flexion exercises to increase back movement and strength, and isometric flexion exercises to strengthen trunk muscles. Each exercise period begins with relaxation. Exercise begins gradually and increases as the patient recovers.

**CHART 68-2** PATIENT EDUCATION

## *Strategies for Treating and Preventing Acute Low Back Pain*

### Treatment

- Limit bed rest; keep your knees flexed to decrease strain on your back.
- Try nonpharmacologic approaches such as application of superficial heat or chiropractic therapy.
- Pharmacologic approaches: Take nonsteroidal anti-inflammatory drugs, acetaminophen (Tylenol), and muscle relaxants as prescribed.
- Weight reduction as needed: Modify diet to achieve ideal body weight.

### Prevention

**Exercise**

- Stretch to enhance flexibility. Do strengthening exercises.
- Perform prescribed back exercises to increase function, gradually increasing time and repetitions.

**Body Mechanics**

- Practice good posture.
- Avoid twisting your body.
- Push objects rather than pull them.
- Keep load close to your body when lifting.
- Bend your knees and tighten abdominal muscles when lifting.
- Avoid overreaching.
- Use a wide base of support.

### Work Modifications

- Adjust work area to avoid stress on back.
- Adjust height of chair or work table.
- Use lumbar support in chair.
- Avoid prolonged standing and repetitive tasks.
- Avoid bending, twisting, and lifting heavy objects.
- Avoid work involving continuous vibrations.

The nurse encourages the patient to adhere to the prescribed exercise program. The patient should exercise 30 minutes daily using low-impact activities that may include speed walking, swimming, stationary bike riding, or yoga. Some patients may find it difficult to adhere to a program of prescribed exercises for a long period; in these instances, alternating activities may help facilitate compliance (NINDS, 2009). Patients are encouraged to improve their posture and use good body mechanics on a regular basis. Activities should not cause excessive lumbar strain, twisting, or discomfort; for example, activities such as horseback riding and weight lifting should be avoided.

Good body mechanics and posture are essential to avoid recurrence of back pain. The patient must be taught how to stand, sit, lie, and lift properly (Fig. 68-2). Providing the patient with a list of suggestions helps in making these long-term changes (Chart 68-3). The patient who wears high heels is encouraged to change to low heels with good arch support. The patient who is required to stand for long periods should shift weight frequently and should rest one foot on a low stool, which decreases lumbar lordosis. Patients who stand in place for a long period of time (eg, cashiers)



**Figure 68-1** Positioning to promote lumbar flexion. © B. Proud.

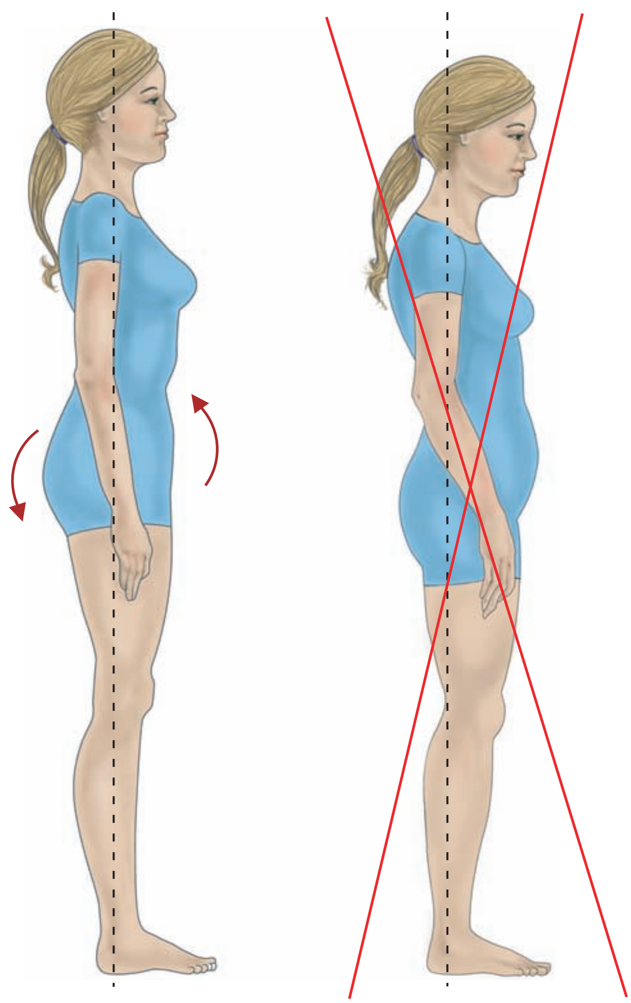


**Figure 68-2** Proper and improper standing postures. **Left,** Abdominal muscles contracted, giving a feeling of upward pull, and gluteal muscles contracted, giving a downward pull. **Right,** Slouch position, showing abdominal muscles relaxed and body out of proper alignment.

CHART 68-3

HEALTH PROMOTION

## Activities to Promote a Healthy Back

**Standing.** Advise the patient to adhere to the following guidelines:

- Avoid prolonged standing and walking.
- When standing for any length of time, rest one foot on a small stool or box to relieve lumbar lordosis.
- Avoid forward flexion work positions.
- Avoid high heels.

**Sitting.** Discuss the following strategies with the patient:

- Avoid sitting for prolonged periods.
- Sit in a straight-back chair with back well supported and arm rests to support some of the body weight; use a footstool to position knees higher than hips if necessary.
- Eradicate the hollow of the back by sitting with the buttocks "tucked under."
- Maintain back support; use a soft support at the small of the back.
- Avoid knee and hip extension. When driving a car, have the seat pushed forward as far as possible for comfort.
- Guard against extension strains—reaching, pushing, sitting with legs straight out.
- Alternate periods of sitting with walking.

**Lying.** Encourage the patient to do the following:

- Rest at intervals; fatigue contributes to spasm of the back muscles.
- Place a firm bed board under the mattress.
- Avoid sleeping in a prone position.
- When lying on the side, place a pillow under the head and one between the legs, with the legs flexed at the hips and knees.
- When supine, use a pillow under the knees to decrease lordosis.

**Lifting.** Emphasize the importance of the following strategies:

- When lifting, keep the back straight and hold the load as close to the body as possible.
- Lift with the large leg muscles, not the back muscles.
- Use trunk muscles to stabilize the spine.
- Squat while keeping the back straight when it is necessary to pick something off the floor.
- Avoid twisting the trunk of the body, lifting above waist level, and reaching up for any length of time.

**Exercising.** Daily exercise is important in the prevention of back problems.

- Walk daily and gradually increase the distance and pace of walking.
- Perform prescribed back exercises twice daily, increasing exercise gradually.
- Avoid jumping and jarring activities.

should stand on a foot cushion made of foam or rubber. The proper posture can be verified by looking in a mirror to see whether the chest is up, the abdomen is tucked in, and the shoulders are down and relaxed. Locking the knees when standing is avoided, as is bending forward for long periods.

When the patient is sitting, the knees and hips should be flexed, and the knees should be level with the hips or higher to minimize lordosis. The feet should be flat on the floor. The back needs to be supported, so patients should avoid sitting on stools or chairs that do not provide firm back support. The patient should sleep on the side with knees and hips flexed, or supine with knees supported in a flexed position. Sleeping prone should be avoided (NINDS, 2009).

The nurse instructs the patient in the safe and correct way to lift objects—using the strong quadriceps muscles of the thighs, with minimal use of weak back muscles (Fig. 68-3). With feet placed hip-width apart to provide a wide base of support, the patient should bend the knees, tighten the abdominal muscles, and lift the object close to the body with a smooth motion, avoiding twisting and jarring motions. To prevent recurrence of acute low back pain, the nurse may instruct the patient to avoid lifting more than one third of his or her weight without help.

Because of the immobility associated with low back pain, the patient may depend on other people to do various tasks. Role-related responsibilities may have been modified with the onset of low back pain. As recovery from acute low back pain and immobility progresses, the patient may resume former role-related responsibilities.

However, if these activities contributed to the development of low back pain, it may be difficult to resume them without the development of chronic low back pain, with associated disability and depression. If the patient experiences secondary gains associated with low back disability (eg, worker's compensation, easier lifestyle or workload, increased emotional support), a "low back neurosis" may develop. The patient may need help in coping with specific stressors and in learning how to control stressful situations. Psychotherapy or counseling may be needed to assist the person in resuming a full, productive life. Back clinics use multidisciplinary approaches to help the patient with pain and with resumption of role-related responsibilities.

Obesity contributes to back strain by stressing the relatively weak back muscles. Exercises are less effective and more difficult to perform when the patient is overweight. Weight reduction through diet modification may prevent

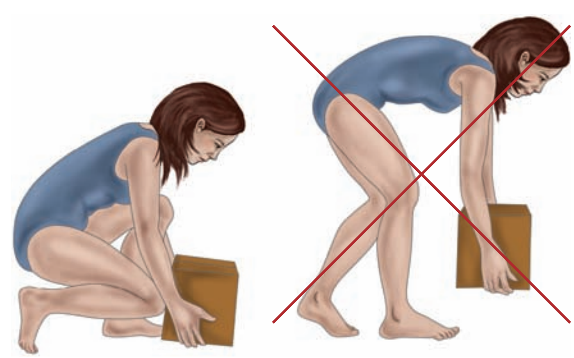


**Figure 68-3** Proper and improper lifting techniques. **Left,** Correct position for lifting. This person is using the long and strong muscles of the arms and legs and holding the object so that the line of gravity falls within the base of support. **Right,** Incorrect position for lifting because pull is exerted on the back muscles and leaning causes the line of gravity to fall outside the base.

recurrence of back pain. Weight reduction is based on a sound nutritional plan that includes a change in eating habits to maintain desirable weight. Monitoring weight reduction, noting achievement, and providing encouragement and positive reinforcement facilitate adherence. Frequently, back problems resolve as optimal weight is achieved (NINDS, 2009).

## Common Upper Extremity Problems

The structures in the upper extremities are frequently the sites of painful syndromes. The structures most frequently affected are the shoulder, wrist, and hand.

### BURSITIS AND TENDINITIS

**Bursitis** and **tendinitis** are inflammatory conditions that commonly occur in the shoulder. Bursae are fluid-filled sacs that prevent friction between joint structures during joint activity. When inflamed, they are painful. Similarly, muscle tendon sheaths become inflamed with repetitive stretching. The inflammation causes proliferation of synovial membrane and pannus formation, which restricts joint movement. Traditional conservative treatment includes rest of the extremity, intermittent ice and heat to the joint, and NSAIDs to control the inflammation and pain. Newer therapies that include extracorporeal shock wave therapy (ie, use of focused high-intensity acoustic radiation), pulsed magnetic field therapy, laser phototherapy, and radiofrequency coblation therapy (ie, use of focused radiowaves) may accelerate tendon healing, although further research is needed to determine their overall effectiveness (Sharma & Maffulli, 2005). Arthroscopic synovectomy may be considered if shoulder pain and weakness persist.

### LOOSE BODIES

Loose bodies may occur in a joint as a result of articular cartilage wear and bone erosion. These fragments interfere with joint movement, locking the joint, resulting in painful movement. Loose bodies are removed by arthroscopic surgery.

### IMPINGEMENT SYNDROME

Impingement syndrome is a general term that describes all lesions that involve the rotator cuff of the shoulder (Trampas & Kitsios, 2006). Impingement usually occurs from repetitive overhead movement of the arm or from acute trauma (Trojian, Stevenson & Agrawal, 2005), resulting in irritation and eventual inflammation of the rotator cuff tendons or the subacromial bursa as they grate against the coracoacromial arch. Stage I impingement syndrome is characterized by edema and hemorrhage of the rotator cuff tendons or subacromial bursa (Trampas & Kitsios, 2006). The patient experiences pain, shoulder tenderness, limited movement, muscle spasm, and eventual atrophy. The process may progress to a partial or complete rotator cuff tear (referred to as Stage II or Stage III impingement syndrome, respectively (Trojian, et al., 2005) (see Chapter 69 for a discussion of rotator cuff tears).

Medications used to treat Stage I impingement syndrome include oral NSAIDs (eg, ibuprofen) or intra-articular (ie, subacromial) injections of corticosteroids (eg, triamcinolone [Aristocort]). Treatment with corticosteroids generally results in speedier symptomatic improvement than that with NSAIDs, though the use of both medications concomitantly does not appear to confer any additional improvements (Trojian, et al., 2005). Application of superficial cold or heat does not improve patients' symptoms, but a therapeutic exercise program (eg, physical therapy) does reduce pain and improve shoulder function (Trampas & Kitsios, 2006) (Chart 68-4).

### CARPAL TUNNEL SYNDROME

Carpal tunnel syndrome is an entrapment neuropathy that occurs when the median nerve at the wrist is compressed by a thickened flexor tendon sheath, skeletal encroachment, edema, or a soft tissue mass. It most commonly occurs in women between 30 and 60 years of age. It is commonly caused by repetitive hand and wrist movements, but it may also be associated with arthritis, diabetes, tumors, or trauma (Schoen, 2005). Patients who perform repetitive movements or those whose hands are repeatedly exposed to cold temperatures, vibrations, or extreme direct pressure are at an increased risk for carpal tunnel syndrome. The patient experiences pain, numbness, paresthesia, and possibly weakness along the median nerve (thumb, index, and middle fingers). Tinel's sign may be used to help identify carpal tunnel syndrome (Fig. 68-4). Night pain is common.

Treatment of carpal tunnel syndrome is based on the cause of the condition. Research findings suggest that intra-articular injections of corticosteroids (eg, methylprednisolone [Medrol]) or oral corticosteroids (eg, prednisone) are very effective at relieving symptoms. Application of wrist splints to prevent hyperextension and prolonged

CHART 68-4 PATIENT EDUCATION

**Measures to Promote Shoulder Healing of Impingement Syndrome**

- Rest the joint in a position that minimizes stress on the joint structures to prevent further damage and the development of adhesions.
- Support the affected arm on pillows while sleeping to keep from turning onto the shoulder.
- Gradually resume motion and use of the joint. Assistance with dressing and other activities of daily living may be needed.
- Avoid working and lifting above shoulder level or pushing an object against a "locked" shoulder.
- Perform the prescribed daily range-of-motion and strengthening exercises.



**Figure 68-4** Tinel's sign may be elicited in patients with carpal tunnel syndrome by percussing lightly over the median nerve, located on the inner aspect of the wrist. If the patient reports tingling, numbness, and pain, the test for Tinel's sign is considered positive. From Weber, J. W. & Kelley, J. (2006). *Health assessment in nursing* (3rd ed.). Philadelphia: Lippincott Williams & Wilkins. © B. Proud.



**Figure 68-5** Dupuytren's contracture, a flexion deformity caused by an inherited trait, is a slowly progressive contracture of the palmar fascia, which severely impairs the function of the fourth, fifth, and, sometimes, middle finger.

flexion of the wrist are also effective interventions. However, yoga, laser therapy, and ultrasound therapy are ineffective therapies, as are the use of NSAIDs, diuretics, and vitamin $B_6$ (Piazzini, Aprile, Ferrara, et al., 2007).

Traditional open nerve release or endoscopic laser surgery are the two most common surgical management options for treatment of carpal tunnel syndrome. Both of these procedures are performed under local anesthesia and involve making small incisions into the affected wrist, cutting the carpal ligament so that the carpal tunnel is widened. Smaller incisions are made with the endoscopic laser procedure, and there is less scar formation and a shorter recovery time than with the open method. Following either of these procedures, the patient wears a hand splint and limits hand use during healing. The patient may need assistance with personal care and ADLs. Full recovery of motor and sensory function after either type of nerve release surgery may take several weeks or months.

## GANGLION

A ganglion, a collection of gelatinous material near the tendon sheaths and joints, appears as a round, firm, cystic swelling, usually on the dorsum of the wrist. It most frequently occurs in women younger than 50 years. The ganglion is locally tender and may cause an aching pain. When a tendon sheath is involved, weakness of the finger occurs. Treatment may include aspiration, corticosteroid injection, or surgical excision. After treatment, a compression dressing and immobilization splint are used.

## DUPUYTREN'S DISEASE

Dupuytren's disease results in a slowly progressive **contracture** of the palmar fascia, called Dupuytren's contracture, which causes flexion of the fourth and fifth fingers, and frequently the middle finger. This renders the fingers more or less useless (Fig. 68-5). It is caused by an inherited autosomal dominant trait and occurs most frequently in men who are older than 50 years and who are of Scandinavian or Celtic origin. It is also associated with arthritis, diabetes, gout, cigarette smoking, and alcoholism (Childs, 2005). It starts as a nodule of the palmar fascia. The nodule may not change, or it may progress so that the fibrous thickening extends to involve the skin in the distal palm and produces a contracture of the fingers. The patient may experience dull aching discomfort, morning numbness, cramping, and stiffness in the affected fingers. This condition starts in one hand, but eventually both hands are affected. Finger-stretching exercises or intranodular injections of corticosteroids (eg, triamcinolone) may prevent contractures (Trojian & Chu, 2007). With contracture development, palmar and digital fasciectomies are performed to improve function. Finger exercises are begun on postoperative day 1 or 2.

## NURSING MANAGEMENT OF THE PATIENT UNDERGOING SURGERY OF THE HAND OR WRIST

Surgery of the hand or wrist, unless related to major trauma, is generally an ambulatory procedure. Before surgery, the nurse assesses the patient's level and type of discomfort and limitations in function caused by the ganglion, carpal tunnel syndrome, Dupuytren's contracture, or other condition of the hand.

Neurovascular assessment of the exposed fingers every hour for the first 24 hours following surgery is essential for monitoring function of the nerves and perfusion of the hand. The nurse instructs the patient and any family caregivers on these parameters for periodic neurovascular assessment and gives instructions on when to notify the physician. The nurse compares the affected hand with the unaffected hand and the postoperative status with the documented preoperative status. The patient describes sensations in the hands and demonstrates finger mobility. With tendon repairs and nerve, vascular, or skin grafts, motor function is tested as necessary. The temperature of the affected hand is assessed. Dressings provide support but are nonconstrictive. Pain uncontrolled by analgesic agents suggests compromised neurovascular functioning.

Pain may be related to surgery, edema, hematoma formation, or restrictive bandages. To control swelling that may increase the patient's pain and discomfort, the nurse instructs the patient to elevate the hand to heart level with pillows. If the patient is ambulatory, the arm is elevated in a conventional sling with the hand at heart level.

CHART 68-5 HOME CARE CHECKLIST
*Hand Surgery*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate how to assess neurovascular status. | ✔ | ✔ |
| • State abnormal findings (eg, unrelenting pain; paralysis; paresthesia; cool, nonblanching fingers) to report to physician promptly. | ✔ | ✔ |
| • Demonstrate control of edema by elevating hand above elbow and applying ice intermittently if prescribed. | ✔ | ✔ |
| • Identify signs and symptoms of infection (eg, elevated temperature, purulent drainage). | ✔ | ✔ |
| • Demonstrate finger exercises to promote circulation, unless contraindicated. | ✔ | |
| • Describe methods to prevent wound infection (eg, keeping hand dressing clean and dry during activities of daily living). | ✔ | ✔ |
| • Describe use of prescribed medications. | ✔ | ✔ |
| • Demonstrate use of assistive devices, if appropriate. | ✔ | |

Intermittent use of ice packs to the surgical area during the first 24 to 48 hours may be prescribed to control edema. Unless contraindicated, active extension and flexion of the fingers to promote circulation are encouraged, even though movement is limited by the bulky dressing.

Generally, the pain and discomfort can be controlled by oral analgesic agents. If the patient is hospitalized, the nurse evaluates the patient's response to analgesic agents and to other pain control measures. Patient education concerning analgesic agents is important.

During the first few days after surgery, the patient needs assistance with ADLs because one hand is bandaged and independent self-care is impaired. The patient may need to arrange for assistance with feeding, bathing and hygiene, dressing, grooming, and toileting. Within a few days, the patient develops skills in one-handed ADLs and is usually able to function with minimal assistance and use of assistive devices. The nurse encourages the patient to use the involved hand, unless contraindicated, within the limits of discomfort. As rehabilitation progresses, the patient resumes use of the injured hand. Physical or occupational therapy–directed exercises may be prescribed. The nurse emphasizes compliance with the therapeutic regimen.

As with all surgery, there is a risk of infection. The nurse teaches the patient to monitor temperature and signs and symptoms that suggest an infection. It also is important to instruct the patient to keep the dressing clean and dry and to report any drainage, foul odor, or increased pain and swelling. Patient education includes aseptic wound care as well as education related to prescribed prophylactic antibiotics.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

After the patient has undergone hand surgery, the nurse teaches the patient how to monitor neurovascular status and the signs of complications that need to be reported to the surgeon (eg, paresthesia, paralysis, uncontrolled pain, coolness of fingers, extreme swelling, excessive bleeding, purulent drainage, fever). The nurse discusses prescribed medications with the patient. In addition, the nurse teaches the patient to elevate the hand above the elbow and to apply ice (if prescribed) to control swelling. Unless contraindicated, the nurse encourages extension and flexion exercises of the fingers to promote circulation. The use of assistive devices is encouraged if they would be helpful in promoting accomplishment of ADLs. For bathing, the nurse instructs the patient to keep the dressing dry by covering it with a secured plastic bag. Generally, the wound is not redressed until the patient's follow-up visit with the surgeon (Chart 68-5).

## Common Foot Problems

Disorders of the foot may be caused by poorly fitting shoes, which distort normal anatomy while inducing deformity and pain. Dermatologic problems commonly affect the feet in the form of fungal infections and plantar warts. Several systemic diseases affect the feet. Patients with diabetes are prone to develop corns and peripheral neuropathies with diminished sensation, leading to ulcers at pressure points of the foot. Patients with peripheral vascular disease and arteriosclerosis complain of burning and itching feet, resulting in scratching and skin breakdown. Foot deformities may occur with rheumatoid arthritis. Obesity can cause a host of foot anomalies, including plantar fasciitis (Cole, Seto & Gazewood, 2005).

The discomforts of foot strain are treated with rest, elevation, physiotherapy, supportive strappings, and orthotic devices. The patient must inspect the foot and skin under pads and orthotic devices for pressure and skin breakdown daily. If a "window" is cut into shoes to relieve pressure over a bony deformity, the skin must be monitored daily for breakdown from pressure exerted at the "window" area. Active foot exercises promote circulation and help strengthen the feet. Walking in properly fitting shoes is considered the ideal exercise.

### PLANTAR FASCIITIS

Plantar fasciitis, an inflammation of the foot-supporting fascia, presents as an acute onset of heel pain experienced with the first steps in the morning. The pain is localized to the

anterior medial aspect of the heel and diminishes with gentle stretching of the foot and Achilles tendon. Management includes stretching exercises, wearing shoes with support and cushioning to relieve pain, orthotic devices (eg, heel cups, arch supports, night splints), and corticosteroid injections (Cole, et al., 2005). Unresolved plantar fasciitis may progress to fascial tears at the heel and eventual development of heel spurs.

## CORN

A corn is an area of hyperkeratosis (overgrowth of a horny layer of epidermis) produced by internal pressure (the underlying bone is prominent because of a congenital or acquired abnormality, commonly arthritis) or external pressure (ill-fitting shoes). The fifth toe is most frequently involved, but any toe may be involved.

Corns are treated by a podiatrist by soaking and scraping off the horny layer, by application of a protective shield or pad, or by surgical modification of the underlying offending osseous structure. Soft corns are located between the toes and are kept soft by moisture. Treatment consists of drying the affected spaces and separating the affected toes with lamb's wool or gauze. A wider shoe may be helpful. Usually, a podiatrist is consulted to treat the underlying cause.

## CALLUS

A callus is a discretely thickened area of the skin that has been exposed to persistent pressure or friction. Faulty foot mechanics usually precede the formation of a callus. Treatment consists of eliminating the underlying causes and having the callus treated by a podiatrist if it is painful. A keratolytic ointment may be applied and a thin plastic cup worn over the heel if the callus is on this area. Felt padding with an adhesive backing is also used to prevent and relieve pressure. Orthotic devices can be made to remove the pressure from bony protuberances, or the protuberance may be excised.

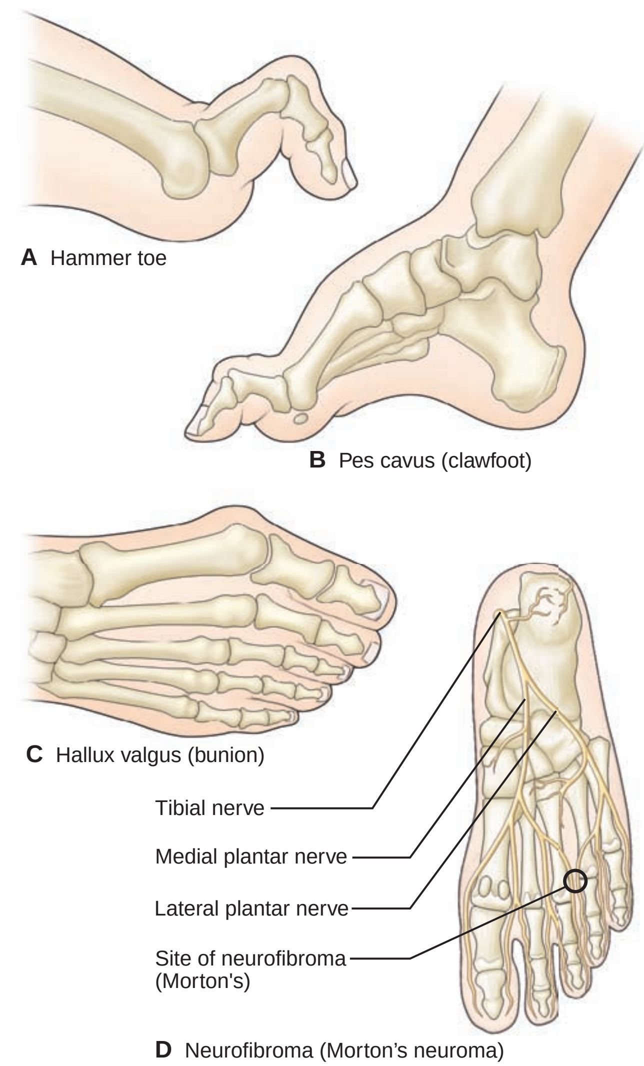



**Figure 68-6** Common foot deformities.

## INGROWN TOENAIL

An ingrown toenail (onychocryptosis) is a condition in which the free edge of a nail plate penetrates the surrounding skin, either laterally or anteriorly. A secondary infection or granulation tissue may develop. This painful condition is caused by improper self-treatment, external pressure (tight shoes or stockings), internal pressure (deformed toes, growth under the nail), trauma, or infection. Trimming the nails properly (clipping them straight across and filing the corners consistent with the contour of the toe) can prevent this problem. Active treatment consists of washing the foot twice a day, followed by the application of a local antibiotic ointment, and relieving the pain by decreasing the pressure of the nail plate on the surrounding soft tissue. Warm, wet soaks help drain an infection. A toenail may need to be excised by the podiatrist if there is severe infection.

## HAMMER TOE

Hammer toe is a flexion deformity of the interphalangeal joint, which may involve several toes (Fig. 68-6A). The condition is usually an acquired deformity. Tight socks or shoes may push an overlying toe back into the line of the other toes. The toes usually are pulled upward, forcing the metatarsal joints (ball of the foot) downward. Corns develop on top of the toes, and tender calluses develop under the metatarsal area. The treatment consists of conservative measures: wearing open-toed sandals or shoes that conform to the shape of the foot, carrying out manipulative exercises, and protecting the protruding joints with pads. Surgery (osteotomy) may be used to correct a resulting deformity. There is little evidence to support treatment of hammer toe when the patient does not report pain or other symptoms (Badlissi, Dunn, Link, et al., 2005).

## HALLUX VALGUS

Hallux valgus (commonly called a bunion) is a deformity in which the great toe deviates laterally (see Fig. 68-6C). Associated with this is a marked prominence of the medial aspect of the first metatarsophalangeal joint. There is also osseous enlargement (exostosis) of the medial side of the first metatarsal head, over which a bursa may form (secondary to pressure and inflammation). Acute bursitis symptoms include a reddened area, edema, and tenderness.

Factors contributing to bunion formation include heredity, ill-fitting shoes, and gradual lengthening and widening of the foot associated with aging. Osteoarthritis is frequently associated with hallux valgus. Treatment depends on the patient's age, the degree of deformity, and the severity of symptoms. If a bunion deformity is uncomplicated, wearing a shoe that conforms to the shape of the foot or that is molded to the foot to prevent pressure on the protruding portions may be the only treatment needed. Corticosteroid injections control acute inflammation. Surgical removal of the bunion (exostosis) and osteotomies to realign the toe may be required to improve function, appearance, and symptoms (Badlissi, et al., 2005). Complications related to bunionectomy include limited range of motion, paresthesias, tendon injury, and recurrence of deformity.

Postoperatively, the patient may have intense throbbing pain at the operative site, requiring opioid analgesia (eg, morphine). The foot is elevated to the level of the heart to decrease edema and pain. The neurovascular status of the toes is assessed. The duration of immobility and initiation of ambulation depend on the procedure used. Toe flexion and extension exercises are initiated to facilitate walking. Shoes that fit the shape and size of the foot are recommended.

## PES CAVUS

Pes cavus (clawfoot) refers to a foot with an abnormally high arch and a fixed equinus deformity of the forefoot (see Fig. 68-6B). The shortening of the foot and increased pressure produce calluses on the metatarsal area and on the dorsum of the foot. Charcot-Marie-Tooth disease (a peripheral neuromuscular disease associated with a familial degenerative disorder), diabetes mellitus, and tertiary syphilis are common causes of pes cavus. Exercises are prescribed to manipulate the forefoot into dorsiflexion and relax the toes. Orthotic devices alleviate pain and can protect the foot (Burns, Landorf, Ryan, et al., 2008). In severe cases, arthrodesis (fusion) is performed to reshape and stabilize the foot.

## MORTON'S NEUROMA

Morton's neuroma (plantar digital neuroma, neurofibroma) is a swelling of the third (lateral) branch of the median plantar nerve (see Fig. 68-6D). The third digital nerve, which is located in the third intermetatarsal (web) space, is most commonly involved. Microscopically, digital artery changes cause an ischemia of the nerve.

The result is a throbbing, burning pain in the foot that is usually relieved when the patient rests. Conservative treatment consists of inserting innersoles and metatarsal pads designed to spread the metatarsal heads and balance the foot posture. Local injections of a corticosteroid (eg, hydrocortisone [Acticort]) and a local anesthetic agent may provide relief. If these fail, surgical excision of the neuroma is necessary. Pain relief and loss of sensation are immediate and permanent.

## FLATFOOT

Flatfoot (pes planus) is a common disorder in which the longitudinal arch of the foot is diminished. It may be caused by congenital abnormalities or associated with bone or ligament injury, muscle and posture imbalances, excessive weight, muscle fatigue, poorly fitting shoes, or arthritis. Signs and symptoms include a burning sensation, fatigue, clumsy gait, edema, and pain.

Exercises to strengthen the muscles and to improve posture and walking habits are helpful. A number of foot orthoses are available to give the foot additional support.

## NURSING MANAGEMENT OF THE PATIENT UNDERGOING FOOT SURGERY

Surgery of the foot may be necessary because of various conditions, including neuromas and foot deformities (bunion, hammer toe, clawfoot). Generally, foot surgery is performed on an outpatient basis. Before surgery, the nurse assesses the patient's ambulatory ability and balance and the neurovascular status of the foot. Additionally, the nurse considers the availability of assistance at home and the structural characteristics of the home in planning for care during the first few days after surgery.

After surgery, neurovascular assessment of the exposed toes every 1 to 2 hours for the first 24 hours is essential to monitor the function of the nerves and the perfusion of the tissues. If the patient is discharged within several hours after the surgery, the nurse teaches the patient and family how to assess for edema and neurovascular status (circulation, motion, sensation). Compromised neurovascular function can increase the patient's pain (see Chart 66-3 in Chapter 66).

Pain experienced by patients who undergo foot surgery is related to inflammation and edema. Formation of a hematoma may contribute to the discomfort. To control the edema, the foot should be elevated on several pillows when the patient is sitting or lying. Ice packs applied intermittently to the surgical area during the first 24 to 48 hours may be prescribed to control edema and provide some pain relief. As activity increases, the patient may find that dependent positioning of the foot is uncomfortable. Simply elevating the foot often relieves the discomfort. Oral analgesic agents may be used to control the pain. The nurse instructs the patient and family about appropriate use of these medications.

After surgery, the patient will have a bulky dressing on the foot, protected by a light cast or a special protective boot. Limits for weight bearing on the foot will be prescribed by the surgeon. Some patients are allowed to walk on the heel and progress to weight bearing as tolerated; other patients are restricted to non–weight-bearing activities. Assistive devices (eg, crutches, walker) may be needed. The choice of the devices depends on the patient's general condition and balance and on the weight-bearing prescription. Safe use of the assistive devices must be ensured through adequate patient education and practice before discharge. Strategies to move around the house safely while using assistive devices are discussed with the patient. As healing progresses, the patient gradually resumes ambulation within prescribed limits. The nurse emphasizes compliance with the therapeutic regimen.

Any surgery carries a risk of infection. In addition, percutaneous pins may be used to hold bones in position, and these pins serve as potential sites for infection. Care must be taken

CHART 68-6

**PATIENT EDUCATION**

***Self-Care After Foot Surgery***

**Neurovascular Status**

The following signs and symptoms indicate impaired circulation and should be reported to your health care provider right away:

- Change in sensation
- Inability to move toes
- Toes or foot cool to touch
- Color changes

**Pain Management**

Methods to reduce pain include the following:

- Elevate foot to heart level.
- Apply ice as prescribed.
- Use analgesic agents as prescribed.
- Report pain that is not relieved.

**Mobility**

- Use assistive devices safely.
- Comply with prescribed weight-bearing limits.
- Wear special protective shoe over the dressing.

**Wound Care**

- Keep the dressing or cast clean and dry.
- Report signs of wound infection (eg, pain, drainage, fever) immediately.
- Follow the prescribed antibiotic regimen.
- Keep your appointment with the surgeon for the initial dressing change.

to protect the surgical wound from dirt and moisture. When bathing, the patient can secure a plastic bag over the dressing to prevent it from getting wet. Patient instructions concerning aseptic wound care and pin care may be necessary.

The nurse teaches the patient to monitor for temperature changes and infection. Drainage on the dressing, a foul odor, or increased pain and swelling could indicate infection. The nurse instructs the patient to promptly report any of these findings to the physician. If prophylactic antibiotics are prescribed, the nurse provides instruction about their correct use. The nurse plans patient teaching for home care, focusing on neurovascular status, pain management, mobility, and wound care (Chart 68-6).

## *Metabolic Bone Disorders*

### OSTEOPOROSIS

Osteoporosis is the most prevalent bone disease in the world. More than 10 million Americans have osteoporosis and an additional 33.6 million have osteopenia, the precursor to osteoporosis. The consequence of osteoporosis is bone fracture. It is projected that one of every two Caucasian women and one of every five men will have an osteoporosis-related fracture at some point in their lives (National Osteoporosis Foundation [NOF], 2008). The costs incurred from treating osteoporosis-related fractures in the United States are estimated at $20 billion annually (Sambrook & Cooper, 2006).

#### Prevention

Peak adult bone mass is achieved between the ages of 18 and 25 years in both females and males and is affected by genetic factors. Bone mass during these years is affected by nutrition, physical activity, medications, endocrine status, and general health (NOF, 2008). Risk factors for osteoporosis and their effects on bone remodeling and maintenance are noted in Figure 68-7.

Primary osteoporosis occurs in women after menopause (usually between the ages of 45 and 55 years) and in men later in life, but it is not merely a consequence of aging. Failure to develop optimal peak bone mass during childhood, adolescence, and young adulthood contributes to the development of osteoporosis. Early identification of at-risk

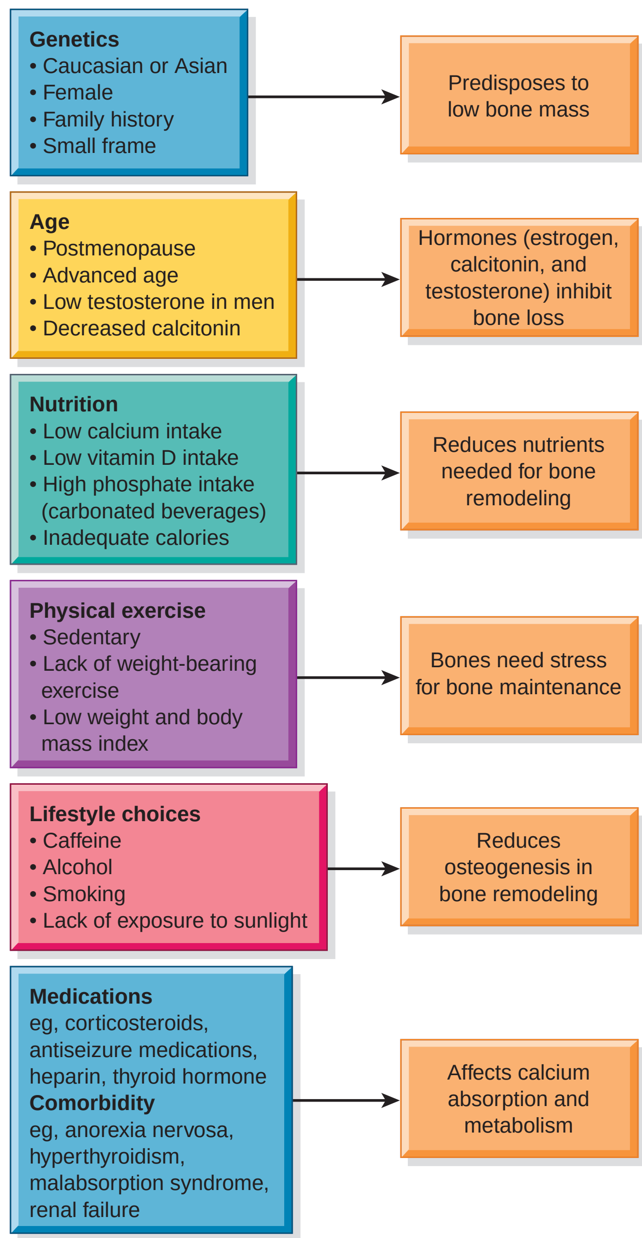



**FIGURE 68-7** Risk factors for osteoporosis, and the effects of these factors on bone.

teenagers and young adults, increased calcium intake, participation in regular weight-bearing exercise, and modification of lifestyle (eg, reduced use of caffeine, cigarettes, carbonated soft drinks, and alcohol) are interventions that decrease the risk of osteoporosis, fractures, and associated disability later in life (NOF, 2008).

Secondary osteoporosis is the result of medications or other conditions and diseases that affect bone metabolism. Specific disease states (eg, celiac disease, hypogonadism) and medications (eg, corticosteroids, antiseizure medications) that place patients at risk need to be identified and therapies instituted to reverse the development of osteoporosis (NOF, 2008). The degree of osteoporosis is related to the duration of medication therapy. When the therapy is discontinued or the metabolic problem is corrected, the progression of osteoporosis is halted, but restoration of lost bone mass usually does not occur.

## Gerontologic Considerations

The prevalence of osteoporosis in women older than 80 years is 50%. The average 75-year-old woman has lost 25% of her cortical bone and 40% of her trabecular bone. With the aging of the population, the incidence of fractures (more than 1.5 million osteoporotic fractures per year), pain, and disability associated with osteoporosis is increasing. Most residents of long-term care facilities have a low bone mineral density (BMD) and are at risk for bone fracture. It is estimated that the number of hip fractures and their associated costs will at least double by the year 2040 because of the projected aging of the U.S. population (NOF, 2008).

Asymptomatic osteoporotic-related vertebral fractures are associated with loss of height, respiratory dysfunction, increased risk of mortality, and increased risk of subsequent fractures. Elderly men are also at heightened risk for osteoporosis and fractures. One third of all hip fractures occur among men and these tend to be more lethal than those seen in women. Men are more likely than women to have secondary causes of osteoporosis that may lead to fractures, including use of corticosteroids (eg, prednisone) and excessive alcohol intake (Ebeling, 2008).

Elderly people absorb dietary calcium less efficiently and excrete it more readily through their kidneys; therefore, postmenopausal women and the elderly need to consume approximately 1200 mg of daily calcium; quantities larger than this may place patients at heightened risk for renal calculi (ie, kidney stones) or cardiovascular disease (NOF, 2008).

## Pathophysiology

Osteoporosis is characterized by reduced bone mass, deterioration of bone matrix, and diminished bone architectural strength. Normal homeostatic bone turnover is altered; the rate of bone resorption that is maintained by osteoclasts is greater than the rate of bone formation that is maintained by osteoblasts, resulting in a reduced total bone mass. The bones become progressively porous, brittle, and fragile; they fracture easily under stresses that would not break normal bone. These increase susceptibility to fracture, which occur most commonly as compression fractures (Fig. 68-8) of the thoracic and lumbar spine, hip fractures, and Colles' fractures of the wrist. These fractures may be the first clinical manifestation of osteoporosis (NOF, 2008).



**Figure 68-8** Progressive osteoporotic bone loss and compression fractures. From Rubin, E., Gorstein, F., Schwarting, R., et al. (2004). *Pathology* (4th ed.). Philadelphia: Lippincott Williams & Wilkins.

The gradual collapse of a vertebra may be asymptomatic; it is observed as progressive kyphosis. With the development of kyphosis (ie, "dowager's hump"), there is an associated loss of height (Fig. 68-9). The postural changes result in relaxation of the abdominal muscles and a protruding abdomen. The deformity may also produce pulmonary insufficiency.

Age-related loss begins soon after the peak bone mass is achieved (ie, in the fourth decade). Calcitonin, which inhibits bone resorption and promotes bone formation, is decreased. Estrogen, which inhibits bone breakdown, decreases with aging. On the other hand, parathyroid hormone (PTH) increases with aging, increasing bone turnover and resorption. The consequence of these changes is net loss of bone mass over time.

The withdrawal of estrogens at menopause or with oophorectomy causes an accelerated bone resorption that continues during the postmenopausal years. Women develop osteoporosis more frequently and more extensively than men because of lower peak bone mass and the effect of estrogen loss during menopause. More than half of all women older than 50 years show evidence of osteopenia.

## Risk Factors

Small-framed, nonobese Caucasian women are at greatest risk for osteoporosis (see Fig. 68-7). Also, Asian women of slight build are at risk for low peak BMD. African American women, who have a greater bone mass than Caucasian women, are less susceptible to osteoporosis. Men have a greater peak bone mass and do not experience sudden

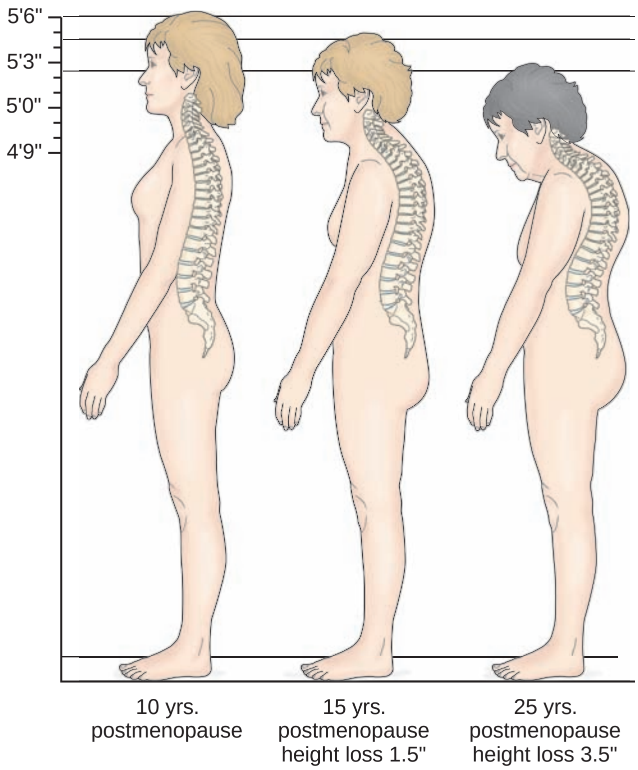



**Figure 68-9** Typical loss of height associated with osteoporosis and aging.

estrogen reduction. As a result, osteoporosis occurs in men at a lower rate and at an older age (about one decade later). It is believed that testosterone and estrogen are important in achieving and maintaining bone mass in men. Risk for osteoporosis increases with increasing age (Chart 68-7).

Nutritional factors contribute to the development of osteoporosis. A diet that includes adequate calories and nutrients needed to maintain bone, calcium, and vitamin D must be consumed. Vitamin D is necessary for calcium absorption and for normal bone mineralization. Dietary calcium and vitamin D must be adequate to maintain bone remodeling and body functions. The best source of calcium and vitamin D is fortified milk. A cup of milk or calcium-fortified orange juice contains about 300 mg of calcium. The recommended adequate intake (RAI) level of calcium for all individuals is 1000 to 1200 mg daily (NOF, 2008). The recommended vitamin D intake for adults 50 years of age and older is 800 to 1000 international units (IU) daily (NOF, 2008). Patients who have had bariatric surgery are at increased risk for osteoporosis as the duodenum is bypassed, which is the primary site for absorption of calcium (Hogan, 2005), as are patients who have gastrointestinal diseases that cause malabsorption (eg, celiac disease).

Bone formation is enhanced by the stress of weight and muscle activity. Resistance and impact exercises are most beneficial in developing and maintaining bone mass. Immobility contributes to the development of osteoporosis. When immobilized by casts, general inactivity, paralysis, or

CHART 68-7

## NURSING RESEARCH PROFILE
### *Beliefs of Osteoporosis Risks in Men and Women 50 Years of Age and Older*

Doheny, M. O., Sedlak, C. A., Estok, P. J., et al. (2007). Osteoporosis knowledge, health beliefs, and DXA T-scores in men and women 50 years of age and older. *Orthopaedic Nursing, 26*(4), 243–250.

#### Purpose

Osteoporosis is prevalent among older adults, particularly women older than 65 years of age. Although older men and postmenopausal women are at lesser risk for osteoporosis than elderly women, these populations of adults are nonetheless at risk. Yet, contemporary society seems to identify that osteoporosis is a disease of elderly women. The threefold purposes of this study were to determine if there was a difference in knowledge about osteoporosis, a difference in health beliefs related to osteoporosis, and a difference in bone density scores between men older than 50 years of age and women between 50 and 65 years of age.

#### Design

This study utilized a secondary analysis of data from a prior study of 218 healthy community-based women who were between 50 and 65 years of age and 226 healthy community-based men who were at least 50 years of age. These study participants responded to the 24-item Osteoporosis Knowledge Test (OKT), the 42-item Osteoporosis Health Belief Scale (OHBS), and the 12-item Osteoporosis Self-Efficacy Scale (OSES). In addition, they had dual-energy x-ray absorptiometry (DXA) scans performed that yielded T-scores.

#### Findings

Neither the women nor men in the sample were knowledgeable about osteoporosis, although the women's mean OKT scores were higher than the men's scores. Men believed that they were less susceptible to osteoporosis, thought that it was less serious, had less faith in the efficacy of calcium in preventing and treating osteoporosis, and felt that there were fewer barriers to exercise to prevent osteoporosis than the sampled women. Less than half of the sampled men and women had normal DXA T-scores. Less than half of each group had T-scores that were consistent with osteopenia; approximately 10% of each sample had T-scores consistent with osteoporosis.

#### Nursing Implications

Both men and women are at risk for osteoporosis by the time they reach the age of 50, yet few of these adults believe that they are at risk. Results from this study suggest that as many as 10% of healthy men who are at least 50 years of age and healthy women who are between 50 and 65 years of age may already have osteoporosis. Nurses are in ideal positions to educate these adults about their risks and provide them with education aimed at preserving bone matrix and preventing fractures associated with osteoporosis.

other disability, the bone is resorbed faster than it is formed, and osteoporosis results (Porth & Matfin, 2009).

## Assessment and Diagnostic Findings

Osteoporosis may be undetectable on routine x-rays until there has been 25% to 40% demineralization, resulting in radiolucency of the bones. When the vertebrae collapse, the thoracic vertebrae become wedge shaped and the lumbar vertebrae become biconcave. Osteoporosis is diagnosed by dual-energy x-ray absorptiometry (DXA), which provides information about BMD at the spine and hip (see Chapter 66 for further discussion of tests for BMD). The DXA scan data are analyzed and reported as T-scores (the number of standard deviations [SDs] above or below the average BMD value for a young, healthy Caucasian woman).

BMD testing is recommended for all women older than 65 years of age, for all men older than 70 years of age, for postmenopausal women and men older than 50 years of age with osteoporosis risk factors, and for all people who have had a fracture thought to occur as a consequence of osteoporosis (Bonnick, 2005; NOF, 2008). BMD studies are useful in identifying osteopenic and osteoporotic bone and in assessing response to therapy. Through early screening (using both assessment of risk factors and BMD scans), promotion of adequate dietary intake of calcium and vitamin D, encouragement of lifestyle changes, and early institution of preventive medications, bone loss and osteoporosis can be reduced, resulting in a reduced incidence of fracture.

Laboratory studies (eg, serum calcium, serum phosphate, serum alkaline phosphatase, urine calcium excretion, urinary hydroxyproline excretion, hematocrit, erythrocyte sedimentation rate [ESR]) and x-ray studies are used to exclude other possible disorders (eg, multiple myeloma, osteomalacia, hyperparathyroidism, malignancy) that contribute to bone loss.

## Medical Management

A diet rich in calcium and vitamin D throughout life, with an increased calcium intake during adolescence, young adulthood, and the middle years, protects against skeletal demineralization. Such a diet includes three glasses of skim or whole vitamin D–enriched milk or other foods high in calcium (eg, cheese and other dairy products, steamed broccoli, canned salmon with bones) daily.

Regular weight-bearing exercise promotes bone formation. From 20 to 30 minutes of aerobic exercise (eg, walking), 3 days or more a week, is recommended. Weight training stimulates an increase in BMD. In addition, exercise improves balance, reducing the incidence of falls and fractures (Chart 68-8).

### *Pharmacologic Therapy*

The first-line medications used to treat and prevent osteoporosis include calcium and vitamin D supplements and bisphosphonates. To ensure adequate calcium intake, a calcium supplement (eg, Caltrate, Citracal) with vitamin D may be prescribed and taken with meals or with a beverage high in vitamin C to promote absorption. The recommended daily dose should be split and not taken as a single dose. Common side effects of calcium supplements are abdominal distention and constipation. Other medications that might be prescribed after these medications are tried include calcitonin, selective estrogen receptor modulators, and anabolic agents (Johnson, Clifford & Smith, 2008).

Bisphosphonates that include daily or weekly oral preparations of alendronate (Fosamax) or risedronate (Actonel), monthly oral preparations of ibandronate (Boniva), or yearly intravenous (IV) infusions of zoledronic acid (Reclast) increase bone mass and decrease bone loss by inhibiting osteoclast function (Johnson, et al., 2008). These medications have demonstrated cost-effectiveness in preventing osteoporotic-related fractures in women 65 years of age and older (Pfister, Welch, Lester, et al., 2006). In particular, alendronate is very effective therapy in preventing fractures in postmenopausal women with osteoporosis (Wells, Cranney, Peterson, et al., 2008).

Adequate calcium and vitamin D intake is needed for maximum effect, but these supplements should not be taken at the same time of day as bisphosphonates. Side effects of bisphosphonates include gastrointestinal symptoms (eg, dyspepsia, nausea, flatulence, diarrhea, constipation). Some patients may develop esophageal ulcers, gastric ulcers, or osteonecrosis of the jaw related to bisphosphonate use (Johnson, et al., 2008). Patients who take oral bisphosphonates must take these medications on an empty stomach on arising in the morning with a full glass of water and must sit upright for 30 to 60 minutes after their administration.

Calcitonin (Miacalcin) directly inhibits osteoclasts, thereby reducing bone loss and increasing BMD. Calcitonin is administered by nasal spray or by subcutaneous or intramuscular injection. Side effects include nasal irritation, flushing, gastrointestinal disturbances, and urinary frequency. It should not be prescribed for patients with seafood allergies (Johnson, et al., 2008).

Selective estrogen receptor modulators (SERMs), such as raloxifene (Evista), reduce the risk of osteoporosis by preserving BMD without estrogenic effects on the uterus. They are indicated for both prevention and treatment of osteoporosis. They are contraindicated in women with a history of venous thromboembolism (Johnson, et al., 2008).

Teriparatide (Forteo) is a subcutaneously administered anabolic agent that is administered once daily. As a recombinant PTH, it stimulates osteoblasts to build bone matrix and facilitates overall calcium absorption (Johnson, et al., 2008).

### *Fracture Management*

Fractures of the hip that occur as a consequence of osteoporosis are managed surgically by joint replacement or by closed or open reduction with internal fixation (eg, hip pinning) as described in Chapters 67 and 69, respectively. Management of Colles' fractures is also described in Chapter 69. Patients need to be evaluated for osteoporosis and treated, as indicated, in order to prevent additional fractures.

Osteoporotic compression fractures of the vertebrae are managed conservatively. Additional vertebral fractures and progressive kyphosis are common. Pharmacologic and dietary treatments are aimed at increasing vertebral bone density. Most patients who experience these fractures are asymptomatic and do not require acute care management;

CHART 68-8

**HOME CARE CHECKLIST**
***Osteoporosis***

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| **Adolescents and Young Adults** | | |
| • List risk factors for osteoporosis. | ✔ | ✔ |
| • Identify calcium- and vitamin D–rich foods. | ✔ | |
| • Consume diet with adequate calcium (1000–1200 mg/day) and vitamin D. | ✔ | |
| • Engage in weight-bearing exercise daily. | ✔ | |
| • Modify lifestyle choices—avoid smoking, alcohol, caffeine, and carbonated beverages. | ✔ | |
| **Menopausal and Postmenopausal Women** | | |
| • List risk factors for osteoporosis. | ✔ | ✔ |
| • Identify calcium- and vitamin D–rich foods. | ✔ | |
| • Consume diet with adequate calcium (1000–1200 mg/day) and vitamin D. | ✔ | |
| • Discuss calcium supplements. | ✔ | |
| • Engage in weight-bearing exercise at least three times weekly. | ✔ | |
| • Engage in exercise that improves balance to reduce the incidence of falls. | ✔ | |
| • Demonstrate good body mechanics. | ✔ | |
| • Modify lifestyle choices—avoid smoking, alcohol, caffeine, and carbonated beverages. | ✔ | |
| • Discuss pharmacologic agents to maintain and enhance bone mass. | ✔ | |
| • Review concurrent medical conditions and medications with health care provider to identify factors that contribute to bone mass loss. | ✔ | ✔ |
| • Assess home environment for hazards contributing to falls. | ✔ | ✔ |
| **Men** | | |
| • List risk factors associated with osteoporosis in men, including medications (eg, corticosteroids, antiseizure medications, aluminum-containing antacids); chronic diseases (eg, kidney, lung, gastrointestinal); and undiagnosed low testosterone levels. | ✔ | ✔ |
| • Modify lifestyle choices—avoid smoking, alcohol, caffeine, and carbonated beverages. | ✔ | |
| • Engage in weight-bearing exercise daily, such as walking, weight lifting, and resistance exercise. | ✔ | |
| • Consume diet with adequate calcium (1000–1200 mg/day) and vitamin D. | ✔ | |
| • Participate in screening for osteoporosis. | ✔ | |
| • Talk with health care provider about use of medications (eg, alendronate) to enhance bone mass or to correct testosterone deficiency. | ✔ | |
| • Assess home environment for hazards contributing to falls. | ✔ | ✔ |

for those who experience pain, acute care management is indicated as outlined in the following Nursing Process section. Percutaneous vertebroplasty or kyphoplasty (injection of polymethylmethacrylate bone cement into the fractured vertebra, followed by inflation of a pressurized balloon to restore the shape of the affected vertebra) can provide rapid relief of acute pain and improve quality of life (NOF, 2008). Patients who have not responded to first-line approaches to the treatment of vertebral compression fracture can be considered for the procedure. It is contraindicated in the presence of infection, old fractures, and certain coagulopathies.

## NURSING PROCESS

### The Patient With a Spontaneous Vertebral Fracture Related to Osteoporosis

#### Assessment

Health promotion, identification of people at risk for osteoporosis, and recognition of problems associated with osteoporosis form the basis for nursing assessment. The health history includes questions concerning the

occurrence of osteopenia and osteoporosis and focuses on family history, previous fractures, dietary consumption of calcium, exercise patterns, onset of menopause, and use of corticosteroids as well as alcohol, smoking, and caffeine intake. Any symptoms the patient is experiencing, such as back pain, constipation, or altered body image, are explored.

Physical examination may disclose a fracture, kyphosis of the thoracic spine, or shortened stature. Problems in mobility and breathing may exist as a result of changes in posture and weakened muscles.

## Nursing Diagnoses

Based on the assessment data, the major nursing diagnoses for the patient who experiences a spontaneous vertebral fracture related to osteoporosis may include the following:

- Deficient knowledge about the osteoporotic process and treatment regimen
- Acute pain related to fracture and muscle spasm
- Risk for constipation related to immobility or development of ileus (intestinal obstruction)
- Risk for injury: additional fractures related to osteoporosis

## Planning and Goals

The major goals for the patient may include knowledge about osteoporosis and the treatment regimen, relief of pain, improved bowel elimination, and absence of additional fractures.

## Nursing Interventions

### *Promoting Understanding of Osteoporosis and the Treatment Regimen*

Patient teaching focuses on factors influencing the development of osteoporosis, interventions to arrest or slow the process, and measures to relieve symptoms. It is emphasized that all people continue to need sufficient calcium, vitamin D, and weight-bearing exercise to slow the progression of osteoporosis. Patient teaching related to medication therapy as described previously is important.

### *Relieving Pain*

Relief of back pain resulting from compression fracture may be accomplished by resting in bed in a supine or side-lying position several times a day. The mattress should be firm and nonsagging. Knee flexion increases comfort by relaxing back muscles. Intermittent local heat and back rubs promote muscle relaxation. The nurse instructs the patient to move the trunk as a unit and to avoid twisting. The nurse encourages good posture and teaches body mechanics. When the patient is assisted out of bed, a trunk orthosis (eg, lumbosacral corset) may be worn for temporary support and immobilization, although such a device is frequently uncomfortable and is poorly tolerated by many elderly patients (NOF, 2008). The patient gradually resumes activities as pain diminishes.

### *Improving Bowel Elimination*

Constipation is a problem related to immobility and medications. Early institution of a high-fiber diet, increased fluids, and the use of prescribed stool softeners help prevent or minimize constipation. If the vertebral collapse involves the T10–L2 vertebrae, the patient may develop a paralytic ileus. The nurse therefore monitors the patient's intake, bowel sounds, and bowel activity.

### *Preventing Injury*

Physical activity is essential to strengthen muscles, improve balance, prevent disuse atrophy, and retard progressive bone demineralization. Isometric exercises can strengthen trunk muscles. The nurse encourages walking, good body mechanics, and good posture. Daily weight-bearing activity, preferably outdoors in the sunshine to enhance the body's ability to produce vitamin D, is encouraged. Sudden bending, jarring, and strenuous lifting are avoided.

**GERONTOLOGIC CONSIDERATIONS.** Elderly people fall frequently as a result of environmental hazards, neuromuscular disorders, diminished senses and cardiovascular responses, and responses to medications. The patient and family need to be included in planning for care and preventive management regimens. For example, the home environment should be assessed for safety and elimination of potential hazards (eg, scatter rugs, cluttered rooms and stairwells, toys on the floor, pets underfoot). A safe environment can then be created (eg, well-lighted staircases with secure hand rails, grab bars in the bathroom, properly fitting footwear).

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Acquires knowledge about osteoporosis and the treatment regimen
   a. States relationship of calcium and vitamin D intake and exercise to bone mass
   b. Consumes adequate dietary calcium and vitamin D
   c. Increases level of exercise
   d. Takes prescribed medications, following instructions for administration
   e. Adheres to prescribed screening and monitoring procedures
2. Achieves pain relief
   a. Experiences pain relief at rest
   b. Experiences minimal discomfort during ADLs
   c. Demonstrates diminished tenderness at fracture site
3. Demonstrates normal bowel elimination
   a. Has active bowel sounds
   b. Reports regular pattern of bowel movements
4. Experiences no new fractures
   a. Maintains good posture
   b. Uses good body mechanics
   c. Consumes a diet high in calcium and vitamin D
   d. Engages in weight-bearing exercises (walks daily)
   e. Rests by lying down several times a day
   f. Participates in outdoor activities
   g. Creates a safe home environment
   h. Accepts assistance and supervision as needed

## OSTEOMALACIA

Osteomalacia is a metabolic bone disease characterized by inadequate mineralization of bone. As a result of faulty mineralization, there is softening and weakening of the skeleton, causing pain, tenderness to touch, bowing of the bones, and pathologic fractures. On physical examination, skeletal deformities (spinal kyphosis and bowed legs) give patients an unusual appearance and a waddling or limping gait. These patients may be uncomfortable with their appearance. As a result of calcium deficiency, muscle weakness, and unsteadiness, there is an increased risk for falls and fractures, particularly pathologic fractures of the distal radius and the proximal femur (Porth & Matfin, 2009).

### Pathophysiology

The primary defect in osteomalacia is a deficiency of activated vitamin D (calcitriol), which promotes calcium absorption from the gastrointestinal tract and facilitates mineralization of bone. The supply of calcium and phosphate in the extracellular fluid is low. Without adequate vitamin D, calcium and phosphate are not moved to calcification sites in bones.

Osteomalacia may result from failed calcium absorption (eg, malabsorption syndrome) or from excessive loss of calcium from the body. Gastrointestinal disorders (eg, celiac disease, chronic biliary tract obstruction, chronic pancreatitis, small bowel resection) in which fats are inadequately absorbed are likely to produce osteomalacia through loss of vitamin D (along with other fat-soluble vitamins) and calcium, the latter being excreted in the feces with fatty acids. In addition, liver and kidney diseases can produce a lack of vitamin D because these are the organs that convert vitamin D to its active form.

Severe renal insufficiency results in acidosis. The body uses available calcium to combat the acidosis, and PTH stimulates the release of skeletal calcium in an attempt to reestablish a physiologic pH. During this continual drain of skeletal calcium, bony fibrosis occurs, and bony cysts form. Chronic glomerulonephritis, obstructive uropathies, and heavy metal poisoning result in a reduced serum phosphate level and demineralization of bone.

Hyperparathyroidism leads to skeletal decalcification and thus to osteomalacia by increasing phosphate excretion in the urine. Prolonged use of antiseizure medication (eg, phenytoin [Dilantin], phenobarbital) poses a risk of osteomalacia, as does insufficient vitamin D (dietary, sunlight).

Osteomalacia that results from malnutrition (deficiency in vitamin D often associated with poor intake of calcium) is a result of poverty, poor dietary habits, and lack of knowledge about nutrition. It occurs most frequently in parts of the world where vitamin D is not added to food, where dietary deficiencies exist, and where sunlight is rare (Porth & Matfin, 2009).

### Gerontologic Considerations

A nutritious diet is particularly important in elderly people. Adequate intake of calcium and vitamin D is promoted. Because sunlight is necessary for synthesizing vitamin D, people should be encouraged to spend some time in the sun. Prevention, identification, and management of osteomalacia in the elderly are essential to reduce the incidence of fractures. When osteomalacia is combined with osteoporosis, the incidence of fracture increases.

### Assessment and Diagnostic Findings

On x-ray studies, generalized demineralization of bone is evident. Studies of the vertebrae may show a compression fracture with indistinct vertebral endplates. Laboratory studies show low serum calcium and phosphorus levels and a moderately elevated alkaline phosphatase concentration. Urine excretion of calcium and creatinine is low. Bone biopsy demonstrates an increased amount of osteoid, a demineralized, cartilaginous bone matrix that is sometimes referred to as "prebone."

### Medical Management

Physical, psychological, and pharmaceutical measures are used to reduce the patient's discomfort and pain. When assisting the patient to change positions, the nurse handles the patient gently, and pillows are used to support the body. As the patient responds to therapy, the skeletal discomfort diminishes.

If possible, the underlying cause of osteomalacia is corrected. Frequently, skeletal problems associated with osteomalacia resolve themselves when the underlying nutritional deficiency or pathologic process is adequately treated.

If osteomalacia is caused by malabsorption, increased doses of vitamin D, along with supplemental calcium, are usually prescribed (Lyman, 2005). Exposure to sunlight may be recommended; ultraviolet radiation transforms a cholesterol substance (7-dehydrocholesterol) present in the skin into vitamin D.

If osteomalacia is dietary in origin, a diet with adequate protein and increased calcium and vitamin D is provided. The patient is instructed about dietary sources of calcium and vitamin D (eg, fortified milk and cereals, eggs, chicken livers). The safe use of supplements is reviewed. Because high doses of vitamin D are toxic and increase the risk for hypercalcemia, the importance of monitoring serum calcium levels is stressed. Vitamin D raises the concentrations of calcium and phosphorus in the extracellular fluid and thus makes these ions available for mineralization of bone.

Long-term monitoring of the patient is appropriate to ensure stabilization or reversal of osteomalacia. Some persistent orthopedic deformities may need to be treated with braces or surgery (eg, osteotomy may be performed to correct long bone deformity).

## PAGET'S DISEASE OF THE BONE

Paget's disease (osteitis deformans) is a disorder of localized rapid bone turnover, most commonly affecting the skull, femur, tibia, pelvic bones, and vertebrae. The disease occurs in about 2% to 3% of the population older than 50 years. The incidence is slightly greater in men than in women and increases with aging. A family history has been noted, with siblings often developing the disease. The cause of Paget's disease is not known (Josse, Hanley, Kendler, et al., 2007).

### Pathophysiology

In Paget's disease, there is a primary proliferation of osteoclasts, which induce bone resorption. This is followed by a compensatory increase in osteoblastic activity that replaces the bone. As bone turnover continues, a classic mosaic (disorganized) pattern of bone develops. Because the diseased bone is highly vascularized and structurally weak, pathologic

fractures occur. Structural bowing of the legs causes malalignment of the hip, knee, and ankle joints, which contributes to the development of arthritis and back and joint pain (Josse, et al., 2007).

## Clinical Manifestations

Paget's disease is insidious; most patients never experience symptoms. Some patients do not experience symptoms but have skeletal deformity; a few patients have symptomatic deformity and pain. The condition is most frequently identified on x-ray studies performed during a routine physical examination or during a workup for another problem. Sclerotic changes, skeletal deformities (eg, bowing of the femur and tibia, enlargement of the skull, deformity of pelvic bones), and cortical thickening of the long bones occur.

In most patients, skeletal deformity involves the skull or long bones. The skull may thicken, and the patient may report that a hat no longer fits. In some cases, the cranium, but not the face, is enlarged. This gives the face a small, triangular appearance. Most patients with skull involvement have impaired hearing from cranial nerve compression and dysfunction. Other cranial nerves may also be compressed.

The femurs and tibiae tend to bow, producing a waddling gait. The spine is bent forward and is rigid; the chin rests on the chest. The thorax is compressed and immobile on respiration. The trunk is flexed on the legs to maintain balance and the arms are bent outward and forward and appear long in relation to the shortened trunk (Porth & Matfin, 2009).

Pain, tenderness, and warmth over the bones may be noted. The pain is mild to moderate, deep, and aching; it increases with weight bearing if the lower extremities are involved. Pain and discomfort may precede skeletal deformities of Paget's disease by years and are often wrongly attributed by the patient to old age or arthritis.

The temperature of the skin overlying the affected bone increases because of increased bone vascularity. Patients with large, highly vascular lesions may develop high-output cardiac failure because of the increased vascular bed and metabolic demands.

## Assessment and Diagnostic Findings

Elevated serum alkaline phosphatase concentration and urinary hydroxyproline excretion reflect increased osteoblastic activity. Higher values suggest more active disease. Patients with Paget's disease have normal blood calcium levels. X-rays confirm the diagnosis of Paget's disease. Local areas of demineralization and bone overgrowth produce characteristic mosaic patterns and irregularities. Bone scans demonstrate the extent of the disease. Bone biopsy may aid in the differential diagnosis (Porth & Matfin, 2009).

## Medical Management

Pain usually responds to NSAIDs. Gait problems from bowing of the legs are managed with walking aids, shoe lifts, and physical therapy. Weight is controlled to reduce stress on weakened bones and malaligned joints. Asymptomatic patients may be managed with diets adequate in calcium and vitamin D and periodic monitoring.

Fractures, arthritis, and hearing loss are complications of Paget's disease. Fractures are managed according to location. Healing occurs if fracture reduction, immobilization, and stability are adequate. Severe degenerative arthritis may require total joint replacement. Loss of hearing is managed with hearing aids and communication techniques used with hearing-impaired people (eg, speech reading, body language) (see Chapter 59).

### *Pharmacologic Therapy*

Patients with moderate to severe disease may benefit from specific antiosteoclastic therapy. Several medications reduce bone turnover, reverse the course of the disease, relieve pain, and improve mobility.

Calcitonin, a polypeptide hormone, retards bone resorption by decreasing the number and availability of osteoclasts. Calcitonin therapy facilitates remodeling of abnormal bone into normal lamellar bone, relieves bone pain, and helps alleviate neurologic and biochemical signs and symptoms. Calcitonin is administered subcutaneously or by nasal inhalation. Side effects include flushing of the face and nausea. The effect of calcitonin therapy is evident in 3 to 6 months through reduction of bone loss and pain.

Bisphosphonates produce rapid reduction in bone turnover and relief of pain (Keating & Scott, 2007). They also reduce serum alkaline phosphatase and urinary hydroxyproline levels. Food inhibits absorption of these medications. Adequate daily intake of calcium and vitamin D is required during therapy.

Plicamycin (Mithracin), a cytotoxic antibiotic, may be used to control the disease. This medication is reserved for severely affected patients with neurologic compromise and for those whose disease is resistant to other therapy. This medication has dramatic effects on pain reduction and on serum calcium, alkaline phosphatase, and urinary hydroxyproline levels. It is administered by IV infusion; hepatic, renal, and bone marrow function must be monitored during therapy. Clinical remissions may continue for months after the medication is discontinued.

## Gerontologic Considerations

Because Paget's disease tends to affect elderly people, careful assessment of a patient's pain and discomfort is necessary. Patient teaching helps the patient understand the treatment regimen, the need for a diet with adequate calcium and vitamin D, and how to compensate for altered musculoskeletal functioning. The home environment is assessed for safety to prevent falls and to reduce the risk of fracture. Strategies for coping with a chronic health problem and its effect on quality of life need to be developed.

# *Musculoskeletal Infections*

## OSTEOMYELITIS

Osteomyelitis is an infection of the bone that results in inflammation, necrosis, and formation of new bone (Davis, 2005). Osteomyelitis is classified as:

- Hematogenous osteomyelitis (ie, due to bloodborne spread of infection)
- Contiguous-focus osteomyelitis, from contamination from bone surgery, open fracture, or traumatic injury (eg, gunshot wound)

- Osteomyelitis with vascular insufficiency, seen most commonly among patients with diabetes and peripheral vascular disease, most commonly affecting the feet (Davis, 2005)

Patients who are at high risk for osteomyelitis include those who are poorly nourished, elderly, or obese. Other patients at risk include those with impaired immune systems, those with chronic illnesses (eg, diabetes, rheumatoid arthritis), and those receiving long-term corticosteroid therapy or other immunosuppressive agents.

Postoperative surgical wound infections occur within 30 days after surgery. They are classified as incisional (superficial, located above the deep fascia layer) or deep (involving tissue beneath the deep fascia). If an implant has been used, deep postoperative infections may occur within a year. Deep sepsis after arthroplasty may be classified as follows:

- Stage 1, acute fulminating: occurring during the first 3 months after orthopedic surgery; frequently associated with hematoma, drainage, or superficial infection
- Stage 2, delayed onset: occurring between 4 and 24 months after surgery
- Stage 3, late onset: occurring 2 or more years after surgery, usually as a result of hematogenous spread

Bone infections are more difficult to eradicate than soft tissue infections because the infected bone is mostly avascular and not accessible to the body's natural immune response. Also, there is decreased penetration by antibiotics. Osteomyelitis may become chronic and may affect the patient's quality of life.

## Pathophysiology

Over 50% of bone infections are caused by *Staphylococcus aureus*. Other pathogens that are frequently found in osteomyelitis include gram-positive organisms that include streptococci and enterococci, followed by gram-negative bacteria that include *Pseudomonas* species (Venugopalan & Martin, 2007).

The initial response to infection is inflammation, increased vascularity, and edema. After 2 or 3 days, thrombosis of the local blood vessels occurs, resulting in ischemia with bone necrosis. The infection extends into the medullary cavity and under the periosteum and may spread into adjacent soft tissues and joints. Unless the infective process is treated promptly, a bone abscess forms. The resulting abscess cavity contains dead bone tissue (the **sequestrum**), which does not easily liquefy and drain. Therefore, the cavity cannot collapse and heal, as it does in soft tissue abscesses. New bone growth (the **involucrum**) forms and surrounds the sequestrum. Although healing appears to take place, a chronically infected sequestrum remains and produces recurring abscesses throughout the patient's life. This is referred to as chronic osteomyelitis.

## Clinical Manifestations

When the infection is bloodborne, the onset is usually sudden, occurring often with the clinical and laboratory manifestations of sepsis (eg, chills, high fever, rapid pulse, general malaise). The systemic symptoms at first may overshadow the local signs. As the infection extends through the cortex of the bone, it involves the periosteum and the soft tissues. The infected area becomes painful, swollen, and extremely tender. The patient may describe a constant, pulsating pain that intensifies with movement as a result of the pressure of the collecting purulent material (ie, pus). When osteomyelitis occurs from spread of adjacent infection or from direct contamination, there are no symptoms of sepsis. The area is swollen, warm, painful, and tender to touch (Davis, 2005; Forman, Forman & Rose, 2005).

The patient with chronic osteomyelitis presents with a nonhealing ulcer that overlies the infected bone with a connecting sinus that will intermittently and spontaneously drain pus (Davis, 2005).

## Assessment and Diagnostic Findings

In acute osteomyelitis, early x-ray findings demonstrate soft tissue edema. In about 2 to 3 weeks, areas of periosteal elevation and bone necrosis are evident. Radioisotope bone scans, particularly the isotope-labeled white blood cell (WBC) scan, and magnetic resonance imaging (MRI) help with early definitive diagnosis. Blood studies reveal leukocytosis and an elevated ESR. Wound and blood culture studies are performed, although they are only positive in 50% of cases. Therefore, treatment with antibiotics may be prescribed without definitively isolating the offending organism (Davis, 2005).

With chronic osteomyelitis, large, irregular cavities; raised periosteum; sequestra; or dense bone formations are seen on x-ray. Bone scans may be performed to identify areas of infection. The ESR and the WBC count are usually normal. Anemia, associated with chronic infection, may be evident. Cultures of blood specimens and drainage from the sinus tract are frequently unreliable; antibiotic therapy is many times prescribed presumptively without isolating the offending pathogen (Davis, 2005).

## Prevention

Prevention of osteomyelitis is the goal. Elective orthopedic surgery should be postponed if the patient has a current infection (eg, urinary tract infection, sore throat) or a recent history of infection. During orthopedic surgery, careful attention is paid to the surgical environment and to techniques to decrease direct bone contamination. Prophylactic antibiotics, administered to achieve adequate tissue levels at the time of surgery and for 24 hours after surgery, are helpful. Urinary catheters and drains are removed as soon as possible to decrease the incidence of hematogenous spread of infection.

Treatment of focal infections diminishes hematogenous spread. Aseptic postoperative wound care reduces the incidence of superficial infections and osteomyelitis. Prompt management of soft tissue infections reduces extension of infection to the bone. When patients who have had joint replacement surgery undergo dental procedures or other invasive procedures (eg, cystoscopy), prophylactic antibiotics are frequently recommended.

## Medical Management

The initial goal of therapy is to control and halt the infective process. Antibiotic therapy depends on the results of blood and wound cultures. General supportive measures (eg, hydration, diet high in vitamins and protein, correction of anemia) should be instituted. The area affected with osteomyelitis is immobilized to decrease discomfort and to prevent pathologic fracture of the weakened bone (Sheff, 2005).

### *Pharmacologic Therapy*

As soon as the culture specimens are obtained, IV antibiotic therapy begins, based on the assumption that infection results from a staphylococcal organism that is sensitive to a penicillin or cephalosporin. The aim is to control the infection before the blood supply to the area diminishes as a result of thrombosis. Around-the-clock dosing is necessary to maintain a high therapeutic blood level of the antibiotic. After results of the culture and sensitivity studies are known, an antibiotic to which the causative organism is sensitive is prescribed. IV antibiotic therapy continues for 3 to 6 weeks. After the infection appears to be controlled, the antibiotic may be administered orally for up to 3 months. To enhance absorption of the orally administered medication, antibiotics should not be administered with food (Davis, 2005; Sheff, 2005).

### *Surgical Management*

If the infection is chronic and does not respond to antibiotic therapy, surgical débridement is indicated. The infected bone is surgically exposed, the purulent and necrotic material is removed, and the area is irrigated with sterile saline solution. Antibiotic-impregnated beads may be placed in the wound for direct application of antibiotics for 2 to 4 weeks (Kent, Rapp & Smith, 2006). IV antibiotic therapy is continued.

In chronic osteomyelitis, antibiotics are adjunctive therapy to surgical débridement. A sequestrectomy (removal of enough involucrum to enable the surgeon to remove the sequestrum) is performed. In many cases, sufficient bone is removed to convert a deep cavity into a shallow saucer (saucerization). All dead, infected bone and cartilage must be removed before permanent healing can occur. A closed suction irrigation system may be used to remove debris. Wound irrigation using sterile physiologic saline solution may be performed for 7 to 8 days.

The wound is either closed tightly to obliterate the dead space or packed and closed later by granulation or possibly by grafting. The débrided cavity may be packed with cancellous bone graft to stimulate healing. With a large defect, the cavity may be filled with a vascularized bone transfer or muscle flap (in which a muscle is moved from an adjacent area with blood supply intact). These microsurgery techniques enhance the blood supply. The improved blood supply facilitates bone healing and eradication of the infection. These surgical procedures may be staged over time to ensure healing. Because surgical débridement weakens the bone, internal fixation or external supportive devices may be needed to stabilize or support the bone to prevent pathologic fracture (Davis, 2005).

## NURSING PROCESS

## The Patient With Osteomyelitis

### Assessment

The patient reports an acute onset of signs and symptoms (eg, localized pain, edema, erythema, fever) or recurrent drainage of an infected sinus with associated pain, edema, and low-grade fever. The nurse assesses the patient for risk factors (eg, older age, diabetes, long-term corticosteroid therapy) and for a history of previous injury, infection, or orthopedic surgery. The patient avoids pressure and movement of the area. In acute hematogenous osteomyelitis, the patient exhibits generalized weakness due to the systemic reaction to the infection.

Physical examination reveals an inflamed, markedly edematous, warm area that is tender. Purulent drainage may be noted. The patient has an elevated temperature. With chronic osteomyelitis, the temperature elevation may be minimal, occurring in the afternoon or evening.

### Nursing Diagnoses

Based on the nursing assessment data, nursing diagnoses for the patient with osteomyelitis may include the following:

- Acute pain related to inflammation and edema
- Impaired physical mobility related to pain, use of immobilization devices, and weight-bearing limitations
- Risk for extension of infection: bone abscess formation
- Deficient knowledge related to the treatment regimen

### Planning and Goals

The patient's goals may include relief of pain, improved physical mobility within therapeutic limitations, control and eradication of infection, and knowledge of the treatment regimen.

### Nursing Interventions

#### *Relieving Pain*

The affected part may be immobilized with a splint to decrease pain and muscle spasm. The nurse monitors the neurovascular status of the affected extremity. The wounds are frequently very painful, and the extremity must be handled with great care and gentleness. Elevation reduces swelling and associated discomfort. Pain is controlled with prescribed analgesic agents and other pain-reducing techniques.

#### *Improving Physical Mobility*

Treatment regimens restrict activity. The bone is weakened by the infective process and must be protected by immobilization devices and by avoidance of stress on the bone. The patient must understand the rationale for the activity restrictions. The joints above and below the affected part should be gently moved through their range of motion. The nurse encourages full participation in ADLs within the physical limitations to promote general well-being.

#### *Controlling the Infectious Process*

The nurse monitors the patient's response to antibiotic therapy and observes the IV access site for evidence of phlebitis, infection, or infiltration. With long-term, intensive antibiotic therapy, the nurse monitors the patient for signs of superinfection (eg, oral or vaginal candidiasis, loose or foul-smelling stools).

If surgery is necessary, the nurse takes measures to ensure adequate circulation to the affected area (wound suction to prevent fluid accumulation, elevation of the area to promote venous drainage, avoidance of pressure on the grafted area), to maintain needed immobility, and to ensure the

CHART 68-9 HOME CARE CHECKLIST
**Osteomyelitis**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe osteomyelitis. | ✔ | ✔ |
| • Relieve pain with pharmacologic and nonpharmacologic interventions. | ✔ | |
| • State weight-bearing and activity restrictions. | ✔ | ✔ |
| • Demonstrate safe use of ambulatory aids and assistive devices. | ✔ | |
| • Describe use of prescribed medications. | ✔ | ✔ |
| • Comply with antibiotic regimen. | ✔ | |
| • Promote healing through aseptic dressing changes. | ✔ | ✔ |
| • Demonstrate proper wound care. | ✔ | ✔ |
| • Report signs and symptoms of continuing infection or superinfection. | ✔ | ✔ |

patient's adherence to weight-bearing restrictions. The nurse changes dressings using aseptic technique to promote healing and to prevent cross-contamination.

The nurse continues to monitor the general health and nutrition of the patient. A diet high in protein promotes a positive nitrogen balance and healing. The nurse encourages adequate hydration as well.

#### *Promoting Home and Community-Based Care*

**TEACHING PATIENTS SELF-CARE.** The patient and family are taught about the importance of strictly adhering to the therapeutic regimen of antibiotics and preventing falls or other injuries that could result in bone fracture. They need to learn to maintain and manage the IV access and IV administration equipment in the home. Teaching includes medication name, dosage, frequency, administration rate, safe storage and handling, adverse reactions, and necessary laboratory monitoring. In addition, aseptic dressing and warm compress techniques are taught.

The nurse carefully monitors the patient for the development of additional sites that are painful or sudden increases in body temperature. The nurse instructs the patient and family to observe for and report elevated temperature, drainage, odor, signs of increased inflammation, adverse reactions, and signs of superinfection.

**CONTINUING CARE.** Management of osteomyelitis, including wound care and IV antibiotic therapy, is usually performed at home. The patient must be medically stable and physically able and motivated to adhere strictly to the therapeutic regimen of antibiotic therapy. The home care environment needs to be conducive to the promotion of health and to the requirements of the therapeutic regimen.

If warranted, the nurse completes a home assessment to determine the patient's and family's abilities regarding continuation of the therapeutic regimen. If the patient's support system is questionable or if the patient lives alone, a home care nurse may be needed to assist with IV administration of the antibiotics. The nurse monitors the patient for response to the treatment, signs and symptoms of superinfections, and adverse drug reactions. The nurse stresses the importance of follow-up health care appointments and recommends age-appropriate health screening (Chart 68-9).

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences pain relief
   a. Reports decreased pain
   b. Experiences no tenderness at site of previous infection
   c. Experiences no discomfort with movement
2. Increases physical mobility
   a. Participates in self-care activities
   b. Maintains full function of unimpaired extremities
   c. Demonstrates safe use of immobilizing and assistive devices
   d. Modifies environment to promote safety and to avoid falls
3. Shows absence of infection
   a. Takes antibiotic as prescribed
   b. Reports normal temperature
   c. Exhibits no edema
   d. Reports absence of drainage
   e. Laboratory results indicate normal white blood cell count and erythrocyte sedimentation rate
   f. Wound cultures are negative
4. Adheres to therapeutic plan
   a. Takes medications as prescribed
   b. Protects weakened bones
   c. Demonstrates proper wound care
   d. Reports signs and symptoms of complications promptly
   e. Consumes a diet high in protein
   f. Keeps follow-up health care appointments
   g. Reports increased strength
   h. Reports no elevation of temperature or recurrence of pain, edema, or other symptoms at the site

## SEPTIC (INFECTIOUS) ARTHRITIS

Joints can become infected through spread of infection from other parts of the body (hematogenous spread) or directly through trauma or surgical instrumentation. Previous trauma to joints, joint replacement, coexisting arthritis, and diminished host resistance contribute to the development of an infected joint. *S. aureus* causes at least 50% of all joint infections, and 80% of cases of septic arthritis in patients with rheumatoid arthritis and diabetes. The knee is the joint that is most commonly infected (50% of cases), followed by the hip and the shoulder, respectively (Davis, 2005). Prompt recognition and treatment of an infected joint are important because accumulating purulent material results in chondrolysis (destruction of hyaline cartilage).

### Clinical Manifestations

The patient with acute septic arthritis usually presents with a warm, painful, swollen joint with decreased range of motion. Systemic chills, fever, and leukocytosis are present. Risk factors include advanced age, diabetes, rheumatoid arthritis, and preexisting joint disease or joint replacement. Elderly patients and patients taking corticosteroids or immunosuppressive medications are at heightened risk; yet, these patients may not exhibit typical clinical manifestations of infection. Therefore, they require ongoing assessment to detect infection as early as possible in the infectious process (Gavet, Tournadre, Soubrier, et al., 2005).

### Assessment and Diagnostic Findings

An assessment for the source and cause of infection is performed. Diagnostic studies include aspiration, examination, and culture of the synovial fluid. Computed tomography (CT) and MRI may reveal damage to the joint lining. Radioisotope scanning may be useful in localizing the infectious process.

### Medical Management

Prompt treatment is essential and may save a prosthesis for patients who have had joint replacement surgery. Broad-spectrum IV antibiotics are started promptly and then changed to organism-specific antibiotics after culture results are available. The IV antibiotics are continued until symptoms resolve. The synovial fluid is aspirated and analyzed periodically for sterility and decrease in WBCs.

In addition to prescribing antibiotics, the physician may aspirate the joint with a needle to remove excessive joint fluid, exudate, and debris. This promotes comfort and decreases joint destruction caused by the action of proteolytic enzymes in the purulent fluid. Occasionally, arthrotomy or arthroscopy is used to drain the joint and remove dead tissue (Davis, 2005).

The inflamed joint is supported and immobilized in a functional position by a splint that increases the patient's comfort. Analgesic agents, such as codeine, may be prescribed to relieve pain. After the infection has responded to antibiotic therapy, NSAIDs may be prescribed to limit joint damage. The patient's nutrition and fluid status is monitored. Progressive range-of-motion exercises are prescribed as soon as the patient can begin movement without exacerbating symptoms of acute pain (Davis, 2005).

If septic joints are treated promptly, recovery of normal function is expected. The patient is assessed periodically for recurrence. If the articular cartilage was damaged during the inflammatory reaction, joint fibrosis and diminished function may result.

### Nursing Management

The nurse describes the septic arthritis physiologic process to the patient and teaches the patient how to relieve pain using pharmacologic and nonpharmacologic interventions. The nurse also explains the importance of supporting the affected joint, adhering to the prescribed antibiotic regimen, and observing weight-bearing and activity restrictions. Additionally, the nurse demonstrates and encourages the patient to practice safe use of ambulatory aids and assistive devices.

The nurse teaches the patient strategies to promote healing through aseptic dressing changes and proper wound care. The patient is then encouraged to perform range-of-motion exercises after the infection subsides.

## Bone Tumors

Neoplasms of the musculoskeletal system are of various types, including osteogenic, chondrogenic, fibrogenic, muscle (rhabdomyogenic), and marrow (reticulum) cell tumors as well as nerve, vascular, and fatty cell tumors. They may be primary tumors or metastatic tumors from primary cancers elsewhere in the body (eg, breast, lung, prostate, kidney). Metastatic bone tumors are more common than primary bone tumors (Weber, 2005).

### Types

#### *Benign Bone Tumors*

Benign tumors of the bone and soft tissue are more common than malignant primary bone tumors. Benign bone tumors generally are slow growing, well circumscribed, and encapsulated; present few symptoms; and are not a cause of death.

Benign primary neoplasms of the musculoskeletal system include osteochondroma, enchondroma, bone cyst (eg, aneurysmal bone cyst), osteoid osteoma, rhabdomyoma, and fibroma. Some benign tumors, such as giant cell tumors, have the potential to become malignant.

Osteochondroma is the most common benign bone tumor. It usually occurs as a large projection of bone at the end of long bones (at the knee or shoulder). It develops during growth and then becomes a static bony mass. In fewer than 1% of patients, the cartilage cap of the osteochondroma may undergo malignant transformation after trauma, and a chondrosarcoma or osteosarcoma may develop.

Enchondroma is a common tumor of the hyaline cartilage that develops in the hand, femur, tibia, or humerus. Usually, the only symptom is a mild ache. Pathologic fractures may occur.

Bone cysts are expanding lesions within the bone. Aneurysmal (widening) bone cysts are seen in young adults, who present with a painful, palpable mass of the long bones, vertebrae, or flat bone. Unicameral (single cavity) bone cysts occur in children and cause mild discomfort and possible pathologic fractures of the upper humerus and femur, which may heal spontaneously.

Osteoid osteoma is a painful tumor that occurs in children and young adults. The neoplastic tissue is surrounded by reactive bone formation that can be identified by x-ray.

Giant cell tumors (osteoclastomas) are benign for long periods but may invade local tissue and cause destruction. They occur in young adults and are soft and hemorrhagic. Eventually, giant cell tumors may undergo malignant transformation and metastasize (Porth & Matfin, 2009).

### Malignant Bone Tumors

Primary malignant musculoskeletal tumors are relatively rare and arise from connective and supportive tissue cells (sarcomas) or bone marrow elements (multiple myeloma; see Chapter 33). Malignant primary musculoskeletal tumors include osteosarcoma, chondrosarcoma, Ewing's sarcoma, and fibrosarcoma. Soft tissue sarcomas include liposarcoma, fibrosarcoma of soft tissue, and rhabdomyosarcoma. Bone tumor metastasis to the lungs is common.

Osteosarcoma (ie, osteogenic sarcoma) is the most common and most often fatal primary malignant bone tumor. Prognosis depends on whether the tumor has metastasized to the lungs at the time the patient seeks health care. Osteosarcoma appears most frequently in children, adolescents and young adults (in bones that grow rapidly), in older people with Paget's disease of the bone, and in people with a prior history of radiation exposure. Clinical manifestations typically include localized bone pain that may be accompanied by a tender, palpable soft tissue mass. The primary lesion may involve any bone, but the most common sites are the distal femur, the proximal tibia, and the proximal humerus (Skubitz & D'Adamo, 2007).

Malignant tumors of the hyaline cartilage are called chondrosarcomas. These tumors are the second most common primary malignant bone tumor. They are large, bulky, tumors that may grow and metastasize slowly or very fast, depending on the characteristics of the tumor cells involved (ie, grade). Patients with low-grade chondrosarcomas tend to have a much better prognosis than those with high-grade chondrosarcomas (see Chapter 16 for a discussion of tumor grades). The usual tumor sites include the pelvis, femur, humerus, spine, scapula, and tibia. Metastasis to the lungs occurs in less than half of patients. When these tumors are well differentiated, large bloc excision or amputation of the affected extremity results in increased survival rates. These tumors may recur, however (Skubitz & D'Adamo, 2007).

### Metastatic Bone Disease

Metastatic bone disease (secondary bone tumor) is more common than primary bone tumors. Tumors arising from tissues elsewhere in the body may invade the bone and produce localized bone destruction (lytic lesions) or bone overgrowth (blastic lesions). The most common primary sites of tumors that metastasize to bone are the kidney, prostate, lung, breast, ovary, and thyroid. Metastatic tumors most frequently attack the skull, spine, pelvis, femur, and humerus and often involve more than one bone (polyostotic) (Porth & Matfin, 2009).

## Pathophysiology

A tumor in the bone causes the normal bone tissue to react by osteolytic response (bone destruction) or osteoblastic response (bone formation). Primary tumors cause bone destruction, which weakens the bone, resulting in bone fractures. Adjacent normal bone responds to the tumor by altering its normal pattern of remodeling. The bone's surface changes and the contours enlarge in the tumor area.

Malignant bone tumors invade and destroy adjacent bone tissue. Benign bone tumors, in contrast, have a symmetric, controlled growth pattern and place pressure on adjacent bone tissue. Malignant bone tumors invade and weaken the structure of the bone until it can no longer withstand the stress of ordinary use; pathologic fracture commonly results.

## Clinical Manifestations

Patients with metastatic bone tumor may have a wide range of associated clinical manifestations. They may be symptom-free or have pain that ranges from mild and occasional to constant and severe, varying degrees of disability, and, at times, obvious bone growth. Weight loss, malaise, and fever may be present. The tumor may be diagnosed only after pathologic fracture has occurred.

With spinal metastasis, spinal cord compression may occur. It can progress rapidly or slowly. Neurologic deficits (eg, progressive pain, weakness, gait abnormality, paresthesia, paraplegia, urinary retention, loss of bowel or bladder control) must be identified early and treated with decompressive laminectomy to prevent permanent spinal cord injury.

## Assessment and Diagnostic Findings

The differential diagnosis is based on the history, physical examination, and diagnostic studies, including CT, bone scans, myelography, arteriography, MRI, biopsy, and biochemical assays of the blood and urine. Serum alkaline phosphatase levels are frequently elevated with osteogenic sarcoma. With metastatic carcinoma of the prostate, serum acid phosphatase levels are elevated. Hypercalcemia is present with bone metastases from breast, lung, or kidney cancer. Symptoms of hypercalcemia include muscle weakness, fatigue, anorexia, nausea, vomiting, polyuria, cardiac dysrhythmias, seizures, and coma. Hypercalcemia must be identified and treated promptly.

A surgical biopsy is performed for histologic identification. Extreme care is taken during the biopsy to prevent seeding and resultant recurrence after excision of the tumor.

Chest x-rays are performed to determine the presence of lung metastasis. Surgical staging of musculoskeletal tumors is based on tumor grade and site (intracompartmental or extracompartmental), as well as on metastasis. Staging is used for planning treatment.

During the diagnostic period, the nurse explains the diagnostic tests and provides psychological and emotional support to the patient and family. The nurse assesses coping behaviors and encourages use of support systems.

## Medical Management

### Primary Bone Tumors

The goal of primary bone tumor treatment is to destroy or remove the tumor. This may be accomplished by surgical excision (ranging from local excision to amputation and disarticulation), radiation therapy if the tumor is radiosensitive, and chemotherapy (preoperative, intraoperative [neoadjuvant], postoperative, and adjunctive for possible micrometastases). Chemotherapy may be delivered intra-arterially for patients with osteosarcoma; this mode of delivery is associated with improved limb preservation (Matthews, Snell & Coats, 2006). Major gains are being made in the use of wide bloc excision with restorative grafting technique (Muscolo, Ayerza, Aponte-Tinao, et al., 2005). Survival and quality of life are important considerations in procedures that attempt to save the involved extremity.

Limb-sparing (salvage) procedures are used to remove the tumor and adjacent tissue. A customized prosthesis, total joint arthroplasty, or bone tissue from the patient (autograft) or from a cadaver donor (allograft) replaces the resected tissue. Soft tissue and blood vessels may need grafting because of the extent of the excision. Complications may include infection, loosening or dislocation of the prosthesis, allograft nonunion, fracture, devitalization of the skin and soft tissues, joint fibrosis, and recurrence of the tumor. Function and rehabilitation after limb salvage depend on positive encouragement and reducing the risk of complications.

Surgical removal of the tumor may require amputation of the affected extremity, with the amputation extending well above the tumor to achieve local control of the primary lesion (see Nursing Process: The Patient Undergoing an Amputation in Chapter 69).

Because of the danger of metastasis with malignant bone tumors, chemotherapy is started before and continued after surgery in an effort to eradicate micrometastatic lesions. The goal of combined chemotherapy is greater therapeutic effect at a lower toxicity rate with reduced resistance to the medications. There is an improved long-term survival rate when a localized osteosarcoma is removed and chemotherapy is initiated. Soft tissue sarcomas are treated with radiation, limb-sparing excision, and adjuvant chemotherapy (see Chapter 16).

### Secondary Bone Tumors

The treatment of metastatic bone cancer is palliative. The therapeutic goal is to relieve the patient's pain and discomfort while promoting quality of life.

If metastatic disease weakens the bone, structural support and stabilization are needed to prevent pathologic fracture. At times, large bones with metastatic lesions are strengthened by prophylactic internal fixation. Internal fixation of pathologic fractures, arthroplasty, or methylmethacrylate (bone cement) reconstruction minimizes associated disability and pain. Patients with metastatic disease are at higher risk than other patients for postoperative pulmonary congestion, hypoxemia, deep vein thrombosis (DVT), and hemorrhage.

Hypercalcemia results from breakdown of bone. It needs to be recognized promptly. Treatment includes hydration with IV administration of normal saline solution; diuresis; mobilization; and medications such as bisphosphonates, (eg, pamidronate [Aredia]) and calcitonin. Because inactivity leads to loss of bone mass and increased calcium in the blood, the nurse assists the patient to increase activity and ambulation.

Hematopoiesis is frequently disrupted by tumor invasion of the bone marrow or by treatment (chemotherapy or radiation). Blood component therapy restores hematologic factors. Pain can result from multiple factors, including the osseous metastasis, surgery, chemotherapy or radiation side effects, and arthritis. Pain must be assessed accurately and managed with adequate and appropriate opioid, nonopioid, and nonpharmaceutical interventions. External beam radiation to involved metastatic sites may be used. Patients with multiple bony metastases may achieve pain control with systemically administered "bone-seeking" isotopes (eg, strontium 89). See Chapter 13 for more information about pain management.

Additional therapies are used to treat the original cancer. Radiation and hormonal therapy may be effective in promoting healing of osteolytic lesions. Chemotherapy is used to control the primary disease (see Chapter 16).

## Nursing Management

The nurse asks the patient about the onset and course of symptoms. During the interview, the nurse assesses the patient's understanding of the disease process, how the patient and the family have been coping, and how the patient has managed the pain. On physical examination, the nurse gently palpates the mass and notes its size and associated soft tissue swelling, pain, and tenderness. Assessment of the neurovascular status and range of motion of the extremity provides baseline data for future comparisons. The nurse evaluates the patient's mobility and ability to perform ADLs.

The nursing care of a patient who has undergone excision of a bone tumor is similar in many respects to that of other patients who have had skeletal surgery. Vital signs are monitored; blood loss is assessed; and observations are made to assess for the development of complications such as DVT, pulmonary embolism, infection, contracture, and disuse atrophy. The affected part is elevated to reduce edema, and the neurovascular status of the extremity is assessed.

Patient and family teaching about the disease process and diagnostic and management regimens is essential. Explanation of diagnostic tests, treatments (eg, wound care), and expected results (eg, decreased range of motion, numbness, change of body contours) helps the patient deal with the procedures and changes and comply with the therapeutic regimen. The nurse can most effectively reinforce and clarify information provided by the physician by being present during these discussions.

Accurate pain assessment and use of pharmacologic and nonpharmacologic pain management techniques are used

to relieve pain and increase the patient's comfort level. The nurse works with the patient in designing the most effective pain management regimen, thereby increasing the patient's control over the pain. The nurse prepares the patient and gives support during painful procedures. Prescribed IV or epidural analgesic medications are used during the early postoperative period. Later, oral or transdermal opioid or nonopioid analgesic agents are indicated to alleviate pain. In addition, external radiation or systemic radioisotopes (eg, strontium 89) may be prescribed to control pain (see Chapter 13 for further discussion of nursing management for patients in pain).

Bone tumors weaken the bone to a point at which normal activities or even position changes can result in fracture. During nursing care, the affected extremities must be supported and handled gently. External supports (eg, splints) may be used for additional protection. At times, the patient may elect to have surgery (eg, open reduction with internal fixation, joint replacement) in an attempt to prevent pathologic fracture. Prescribed weight-bearing restrictions must be followed. The nurse and physical therapist teach the patient how to use assistive devices safely and how to strengthen unaffected extremities.

The nurse encourages the patient and family to verbalize their fears, concerns, and feelings. They need to be supported as they deal with the impact of the malignant bone tumor. Feelings of shock, despair, and grief are expected. Referral to a psychiatric advanced practice nurse, psychologist, counselor, or spiritual advisor may be indicated for specific psychological help and emotional support.

Independence versus dependence is an issue for the patient who has a malignancy. Lifestyle is dramatically changed, at least temporarily. It is important to support the family in working through the adjustments that must be made. The nurse assists the patient in dealing with changes in body image due to surgery and possible amputation (see Chapter 69 for nursing management of a patient with an amputation). It is helpful to provide realistic reassurance about the future and resumption of role-related activities and to encourage self-care and socialization. The patient participates in planning daily activities. The nurse encourages the patient to be as independent as possible. Involvement of the patient and family throughout treatment encourages confidence, restoration of self-concept, and a sense of being in control of one's life.

### Monitoring and Managing Potential Complications

#### Delayed Wound Healing

Wound healing may be delayed because of tissue trauma from surgery, previous radiation therapy, inadequate nutrition, or infection. The nurse minimizes pressure on the wound site to promote circulation to the tissues. An aseptic, nontraumatic wound dressing promotes healing. Monitoring and reporting of laboratory findings facilitate initiation of interventions to promote homeostasis and wound healing.

Repositioning the patient at frequent intervals reduces the incidence of skin breakdown and pressure ulcers. Special therapeutic beds or mattresses may be needed to prevent skin breakdown and to promote wound healing after extensive surgical reconstruction and skin grafting.

#### Inadequate Nutrition

Because loss of appetite, nausea, and vomiting are frequent side effects of chemotherapy and radiation therapy, it is necessary to provide adequate nutrition for healing and health promotion. Antiemetics and relaxation techniques reduce the adverse gastrointestinal effects of chemotherapy. Stomatitis is controlled with anesthetic or antifungal mouthwash (see Chapter 16). Adequate hydration is essential. Nutritional supplements or parenteral nutrition may be prescribed to achieve adequate nutrition.

#### Osteomyelitis and Wound Infections

Prophylactic antibiotics and strict aseptic dressing techniques are used to diminish the occurrence of osteomyelitis and wound infections. During healing, other infections (eg, upper respiratory infections) need to be prevented so that hematogenous spread does not result in osteomyelitis. If the patient is receiving chemotherapy, it is important to monitor the WBC count and to instruct the patient to avoid contact with people who have colds or other infections.

#### Hypercalcemia

Hypercalcemia is a dangerous complication of bone cancer. The symptoms must be recognized and treatment initiated promptly. Symptoms include muscular weakness, incoordination, anorexia, nausea and vomiting, constipation, electrocardiographic changes (eg, shortened QT interval and ST segment, bradycardia, heart blocks), and altered mental states (eg, confusion, lethargy, psychotic behavior). See Chapter 14 for a discussion of hypercalcemia and its management.

### Promoting Home and Community-Based Care

#### Teaching Patients Self-Care

Preparation for and coordination of continuing health care are begun early as a multidisciplinary effort. Patient teaching addresses medication, dressing changes, treatment regimens, and the importance of physical and occupational therapy programs. The nurse teaches weight-bearing limitations and special handling to prevent pathologic fractures. It is important that the patient and family know the signs and symptoms of possible complications as well as resources available for continuing care (Chart 68-10).

#### Continuing Care

Frequently, arrangements are made with a home health care agency for home care supervision and follow-up. The home care nurse assesses the patient's and family's abilities to meet the patient's needs and determines whether the services of other agencies are needed. The nurse advises the patient to have readily available the telephone numbers of people to contact in case concerns arise.

The nurse emphasizes the need for long-term health supervision to ensure cure or to detect tumor recurrence or metastasis and the need for recommended health screening. If the patient has metastatic disease, end-of-life issues may need to be explored. Referral for hospice care is made if appropriate.

CHART 68-10

HOME CARE CHECKLIST
*Bone Tumor*

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe tumor growth process. | ✔ | ✔ |
| • Control pain with pharmacologic and nonpharmacologic interventions. | ✔ | ✔ |
| • Support affected musculoskeletal area. | ✔ | |
| • Describe use of prescribed medications. | ✔ | ✔ |
| • Comply with medication regimen. | ✔ | |
| • Consume diet to promote healing and health. | ✔ | |
| • State weight-bearing and activity restrictions. | ✔ | ✔ |
| • Demonstrate safe use of ambulatory aids and assistive devices. | ✔ | |
| • Protect affected bone from pathologic fracture. | ✔ | ✔ |
| • Identify complications of tumor and therapy. | ✔ | ✔ |
| • Report signs and symptoms of complications promptly. | ✔ | ✔ |
| • Use effective coping strategies. | ✔ | |
| • Maintain role performance. | ✔ | |

## CRITICAL THINKING EXERCISES

EBP **1** You are a staff nurse employed at a family practice clinic. A 52-year-old mechanic has been seeking treatment at the clinic for low back pain of 2 weeks' duration. He has been prescribed a muscle relaxant and told to take over-the-counter NSAIDs. He is not reporting significant relief from his symptoms, though he reports taking his prescribed medications diligently. You note that this patient is obese. The patient tells you that he is getting frustrated that he continues to have significant low back pain that interferes with his ability to work. Identify other therapies or interventions that might be reasonable alternatives or adjuncts that might relieve this patient's low back pain. What is the strength of the evidence for each of these potential therapies or interventions?

**2** Your 30-year-old cousin tells you that she was diagnosed 3 months ago with impingement syndrome of her right shoulder. She was treated with intra-articular corticosteroids and physical therapy and has had a very good response to these interventions. She is a flight attendant and is concerned whether she is likely to have recurrent episodes or whether she is at risk for worse shoulder injuries. What is the likelihood that she may have either recurrence of her symptoms or worse rotator cuff injuries? What advice might you share with her so that she might continue her career as a flight attendant?

EBP **3** On the general medical unit where you are a staff nurse, a 74-year-old man is admitted with pneumonia and a history of chronic obstructive pulmonary disease (COPD). He also has a history of heavy cigarette smoking and alcohol consumption. You note during his screening process that he has lost 1 inch in height over the past year, and he has notable kyphosis of his lumbar vertebrae. What musculoskeletal condition is he at risk of developing? What specific questions would you ask him to determine the status of his bone health? Discuss the strength of the evidence that supports any risk factor reduction strategies you consider implementing.

EBP **4** At the orthopedic clinic where you work as a nurse, a 20-year-old college athlete presents for a workup because of persistent right shoulder pain with point tenderness at his proximal humerus and a palpable soft tissue mass. An extensive workup confirms an osteosarcoma. He is stunned with the diagnosis and tells you that he would rather die than have his right arm amputated (he is right-sided dominant and is his football team's quarterback). What is the evidence that supports limb salvage over amputation in patients with osteosarcoma of an extremity? What can he expect in terms of quality of life after an amputation versus more conservative limb salvage interventions? What support systems would you mobilize for this patient?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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*Asterisk indicates nursing research.*

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## RESOURCES

National Institute of Arthritis and Musculoskeletal and Skin Diseases, www.niams.nih.gov

National Osteoporosis Foundation, www.nof.org

The Paget Foundation, www.paget.org



chapter 69

# Management of Patients With Musculoskeletal Trauma

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

**1** Differentiate between contusions, strains, sprains, dislocations, and subluxations.

**2** Identify sport and occupational injuries and their signs, symptoms, and treatments.

**3** Identify the signs and symptoms of an acute fracture.

**4** Describe the treatment procedures of fracture reduction, fracture immobilization, and management of open and intra-articular fractures.

**5** Describe the prevention and management of immediate and delayed complications of fractures.

**6** Describe the rehabilitation needs of patients with fractures of the upper and lower extremities, pelvis, and hips.

**7** Describe nursing management of the elderly patient with a fracture of the hip.

**8** Describe the rehabilitation and health education needs of the patient who has had an amputation.

**9** Use the nursing process as a framework for care of the patient with an amputation.

## GLOSSARY

**allograft:** tissue harvested from a donor for use in another person

**amputation:** removal of a body part, usually a limb or part of a limb

**arthroscope:** surgical scope injected into the joint to examine or repair

**autograft:** tissue harvested from one area of the body and used for transplantation to another area of the same body

**avascular necrosis:** death of tissue secondary to a decrease or lack of perfusion

**contusion:** blunt force injury to soft tissue

**crepitus:** a grating sound or sensation by rubbing bony fragments together

**débridement:** surgical removal of contaminated and devitalized tissues and foreign material

**delayed union:** prolongation of expected healing time for a fracture

**disarticulation:** amputation through a joint

**dislocation:** complete separation of joint surfaces

**fracture:** a break in the continuity of a bone

**fracture reduction:** restoration of fracture fragments into anatomic alignment

**malunion:** healing of a fractured bone in a malaligned position

**nonunion:** failure of fractured bones to heal together

**phantom limb pain:** pain perceived in an amputated section

**RICE:** acronym for ***r***est, ***i***ce, ***c***ompression, ***e***levation

**sprain:** an injury to ligaments and muscles and other soft tissues at a joint

**strain:** a musculotendinous stress injury

**subluxation:** partial separation of joint surfaces

Injury to one part of the musculoskeletal system results in malfunction of adjacent muscles, joints, and tendons. The type and severity of injury affects the mobility of the injured area. Treatment of injury to the musculoskeletal system involves providing support to the injured part until healing is complete. Some injuries or situations require traction to be applied to maintain proper anatomical alignment of the extremity. Pain assessment and management are essential. After the immediate painful effects of the injury have decreased, treatment efforts are focused on proper exercise and mobility, with assistance if needed.

## *Contusions, Strains, and Sprains*

A **contusion** is a soft tissue injury produced by blunt force, such as a blow, kick, or fall, causing small blood vessels to rupture and bleed into soft tissues (ecchymosis, or bruising). A hematoma develops from bleeding at the site of impact. Local symptoms (pain, swelling, and discoloration) are controlled with intermittent application of cold packs applied with pressure to the site and elevation of the extremity above the heart level. Most contusions resolve in 1 to 2 weeks.

A **strain,** or a "pulled muscle or tendon," is an injury caused by overuse, overstretching, or excessive stress. Strains are graded along a continuum based on postinjury symptoms and loss of function and reflect the degree of injury. Three types of strain are recognized:

- A first-degree strain is mild stretching of the muscle or tendon. Signs and symptoms may include minor edema, tenderness, and mild muscle spasm, without noticeable loss of function.
- A second-degree strain involves partial tearing of the muscle or tendon. Signs and symptoms include loss of load-bearing strength with accompanying edema, tenderness, muscle spasm, and ecchymosis.
- A third-degree strain is severe muscle or tendon stretching with rupturing and tearing of the involved tissue. Signs and symptoms include significant pain, muscle spasm, ecchymosis, edema, and loss of function. An x-ray should be obtained to rule out bone injury, because an avulsion fracture (in which a bone fragment is pulled away from the bone by a tendon) may be associated with a third-degree strain. Magnetic resonance imaging (MRI) will reveal a third-degree strain, but x-rays do not reveal injuries to soft tissue or muscles, tendons, or ligaments.

A **sprain** is an injury to the ligaments and tendons that surround a joint. It is caused by a twisting motion or hyperextension (forcible) of a joint. The function of a ligament is to stabilize a joint while permitting mobility. A torn ligament causes a joint to become unstable. Blood vessels rupture and edema occurs; the joint is tender, and movement of the joint becomes painful. The degree of disability and pain increases during the first 2 to 3 hours after the injury because of the associated swelling and bleeding, especially if treatment is delayed. Sprains are graded in a manner similar to the grading system used for strains:

- A first-degree sprain is caused by stretching the ligamentous fibers, resulting in minimum damage. It is manifested by mild edema, local tenderness, and pain that is elicited when the joint is moved.
- A second-degree sprain involves partial tearing of the ligament. It results in increased edema, tenderness, pain with motion, joint instability, and partial loss of normal joint function.
- A third-degree sprain occurs when a ligament is completely torn or ruptured. A third-degree sprain may also cause an avulsion of the bone. Symptoms include severe pain, tenderness, increased edema, and abnormal joint motion.

### Nursing Management

Treatment of contusions, strains, and sprains consists of resting and elevating the affected part, applying cold, and using a compression bandage. (The acronym **RICE**—*r*est, *i*ce, *c*ompression, *e*levation—is helpful for remembering treatment interventions.) Rest prevents additional injury and promotes healing. Intermittent application of moist or dry cold packs for 20 to 30 minutes during the first 24 to 48 hours after injury produces vasoconstriction, which decreases bleeding, edema, and discomfort. Care must be taken to avoid skin and tissue damage from excessive cold. An elastic compression bandage controls bleeding, reduces edema, and provides support for the injured tissues. Elevation controls the swelling. If the sprain or strain is third degree, surgical repair or immobilization by a splint, brace, or cast may be necessary so that the joint will not lose its stability. The neurovascular status (circulation, motion, sensation) of the injured extremity is monitored every 15 minutes for the first 1 to 2 hours after injury; then, every 30 minutes until stable. Decreases in sensation or motion and increases in pain level should be documented and reported to the physician immediately so that compartment syndrome can be prevented (see later discussion).

After the acute inflammatory stage (eg, 24 to 48 hours after injury), heat may be applied intermittently (for 15 to 30 minutes four times a day) to relieve muscle spasm and to promote vasodilation, absorption, and repair. Depending on the severity of injury, progressive passive and active exercises may begin in 2 to 5 days. Severe sprains and strains may require 1 to 3 weeks of immobilization before exercises are initiated. Excessive exercise early in the course of treatment delays recovery. Strains and sprains take weeks or months to heal because ligaments and tendons have minimal blood supply. Splinting may be used to maintain stability at the injury site.

## *Joint Dislocations*

A **dislocation** of a joint is a condition in which the articular surfaces of the distal and proximal bones that form the joint are no longer in anatomic alignment. A **subluxation** is a partial dislocation and does not cause as much deformity as a complete dislocation. In complete dislocation, the bones are literally "out of joint." Traumatic dislocations are orthopedic emergencies because the associated joint structures, blood supply, and nerves are displaced and may be entrapped with extensive pressure on them. If a dislocation or subluxation is not reduced immediately, **avascular necrosis** (AVN) may develop. AVN of bone is caused by ischemia, which leads to necrosis or death of the bone cells.

Signs and symptoms of a traumatic dislocation include acute pain, change in positioning of the joint, shortening of the extremity, deformity, and decreased mobility. X-rays confirm the diagnosis and reveal any associated fracture.

### Medical Management

The affected joint needs to be immobilized at the scene and during transport to the hospital. The dislocation is promptly reduced and displaced parts are placed back in proper anatomic position to preserve joint function. Analgesia, muscle relaxants, and possibly anesthesia are used to facilitate closed reduction. The joint is immobilized by splints, casts, or traction and is maintained in a stable position. Neurovascular status is assessed at a minimum of every 15 minutes until stable. After reduction, if the joint is stable, gentle, progressive, active and passive movement is begun to preserve range of motion (ROM) and restore strength. The joint is supported between exercise sessions.

### Nursing Management

Nursing attention is geared to frequent assessment and evaluation of the injury including complete neurovascular assessment with proper documentation and communication with the physician. The patient and supportive family members are educated regarding proper exercises and activities as well as danger signs and symptoms to look for, such as increasing pain (even with analgesics), "numbness or tingling," and increased edema in the extremity. These signs and symptoms may indicate compartment syndrome, and if this is not identified and communicated to the treating physician, the patient may lose the extremity (see later discussion).

# *Injuries to the Tendons, Ligaments, and Menisci*

## ROTATOR CUFF TEARS

A rotator cuff tear is a tear in a tendon that connects one of the rotator muscles to the humeral head. The rotator cuff stabilizes the humeral head and is composed of four muscles and their tendons that include the supraspinatous, infraspinatous, teres minor, and subscapularis.

Rotator cuff tears may result from an acute injury or from chronic joint stresses. Patients complain of pain, limited ROM, and some joint dysfunction, including muscle weakness. In many cases, patients with a rotator cuff tear experience night pain and cannot sleep on the involved side. Patients cannot perform over-the-head activities. The acromioclavicular joint is tender. X-rays are helpful in evaluating the joint. Arthrography and MRI or ultrasound are used to determine soft tissue pathology and the extent of the rotator cuff tear.

Initial conservative management includes use of nonsteroidal anti-inflammatory drugs (NSAIDs), rest with modification of activities, injection of a corticosteroid into the shoulder joint, and progressive stretching, ROM, and lengthening exercises (Trojian, Stevenson & Agrawal, 2005). Some rotator cuff tears require arthroscopic **débridement** (removal of devitalized tissue) or arthroscopic or open acromioplasty with tendon repair. Postoperatively, the shoulder is immobilized for several days to 4 weeks. Physical therapy with shoulder exercises is begun as prescribed, and the patient is instructed in how to perform the exercises at home. Full recovery is expected in 6 to 12 months.

## EPICONDYLITIS

Epicondylitis is a chronic, painful condition that is caused by excessive, repetitive extension, flexion, pronation, and supination motions of the forearm. These motions result in inflammation (tendinitis) and minor tears in the tendons at the origin of the muscles on the lateral or medial epicondyles. Lateral epicondylitis (ie, tennis elbow) is frequently identified in someone who repeatedly extends the wrist or frequently pronates and supinates the forearm. Pain develops over the lateral epicondyle and in the extensor muscles. If action is continued, pain continues to increase (Clinton & Murthi, 2008). Medial epicondylitis (ie, golfer's or pitcher's elbow) is consistent with repetitive wrist flexion. Extreme tenderness occurs at the medial epicondyle. Pain greatly increases with wrist flexion against resistance.

Application of ice and administration of NSAIDs usually relieve the pain. In some instances, the arm is immobilized in a molded splint or cast. Because of its degenerative effects on tendons, local injection of a corticosteroid is reserved for patients with severe pain who do not respond to NSAIDs and immobilization. After pain subsides, rehabilitation exercises include gentle and gradual increased stretching of the tendons (Clinton & Murthi, 2008). A tennis elbow counterforce strap that limits extension of the elbow may be prescribed when activity is resumed.

## LATERAL AND MEDIAL COLLATERAL LIGAMENT INJURY

Lateral and medial collateral ligaments of the knee (Fig. 69-1) provide stability lateral and medial to the knee. Injury to these ligaments occurs when the foot is firmly planted and the knee is struck—either medially, causing stretching and tearing injury to the lateral collateral ligament, or laterally, causing stretching and tearing injury to the medial collateral ligament. The patient experiences an acute onset of pain, point tenderness, joint instability, and inability to walk without assistance.

### Medical Management

Early management includes RICE. The joint is evaluated for fracture. Hemarthrosis (bleeding into the joint) may develop, contributing to the pain. The joint fluid may be aspirated to relieve pressure.

Treatment depends on the severity of the injury. Conservative management includes limited weight bearing and use of a protective brace. As pain subsides, ROM exercise is encouraged. The patient's return to full activities, including sports, depends on return of motion, functional stability of the joint, and muscle strength.

If needed, surgical reconstruction may be performed immediately or it may be delayed. The leg is immobilized for approximately 6 to 8 weeks. A progressive rehabilitation program helps restore the function and strength of the knee. Rehabilitation occurs over many months, and the patient may need to wear a derotational brace while engaging in sports to prevent reinjury.

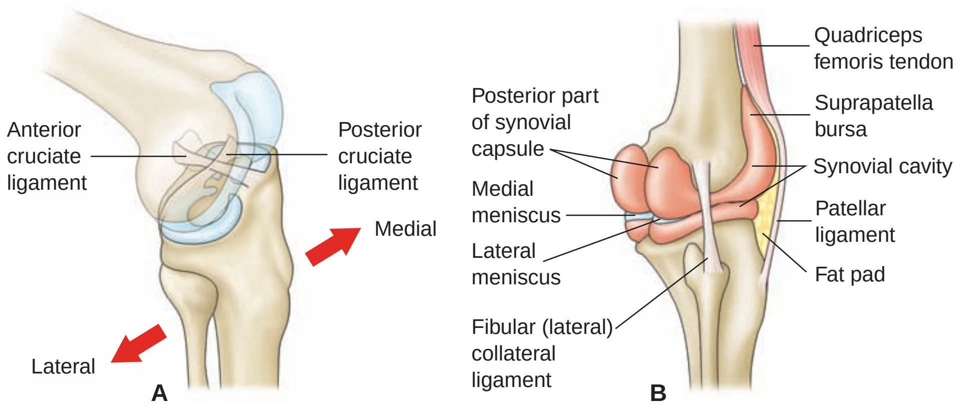



**Figure 69-1** Knee ligaments, tendons, and menisci. **A,** Anterolateral view. **B,** Posterolateral view.

## Nursing Management

The nurse instructs the patient about proper use of ambulatory devices, the healing process, and activity limitation to promote healing. Education addresses pain management, analgesic use, antibiotic use, brace use, wound care, signs and symptoms of possible complications (eg, altered neurovascular status, infection, skin breakdown), and self-care.

# CRUCIATE LIGAMENT INJURY

The anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) of the knee stabilize anterior and posterior motion of the tibia articulating with the femur (see Fig. 69-1). These ligaments cross each other in the center of the knee. Injury occurs when the foot is firmly planted and the leg sustains direct force, forward or backward. If the force is forward, the ACL suffers the impact from the force; whereas, backward force places force on the PCL. The injured person may report feeling and hearing a "pop" in the knee with this injury. If the patient exhibits significant swelling of the joint within 2 hours after the injury, the ACL or PCL may be torn. A torn cruciate ligament produces pain, joint instability, and pain with weight bearing. Immediate postinjury management includes RICE and stabilization of the joint until it is evaluated for a fracture. Severe joint effusion and hemarthrosis may require joint aspiration and wrapping with an elastic compression dressing.

Treatment depends on the severity of the injury and the effect of the injury on daily activities. Early treatment involves application of a brace and physical therapy. Surgical ACL or PCL reconstruction may be scheduled after near-normal joint ROM is achieved and includes tendon repair with grafting. This is typically performed as ambulatory arthroscopic surgery, a procedure in which the surgeon uses an **arthroscope** to visualize and repair the damage. The best surgical candidates include patients who are young and physically active. Older and less active patients, particularly with concomitant osteoarthritis, tend to benefit from nonsurgical therapy (Alford & Bach, 2004). After surgery, the patient is taught to control pain with oral analgesics and cryotherapy (a cooling pad incorporated in a dressing). The patient and family are taught about monitoring the neurovascular status of the leg, wound care, and signs of complications that need to be reported promptly to the surgeon. Exercises (ankle pumps, quadriceps sets, and hamstring sets) are encouraged during the early postoperative period. The patient must protect the graft by complying with exercise restrictions. The physical therapist supervises progressive ROM and weight bearing (as permitted). Continuous passive motion may be helpful in restoring full ROM.

# MENISCAL INJURIES

Two crescent-shaped (semilunar) cartilages in the knee, called menisci, are located on the right and left side of the proximal tibia, between the tibia and the femur (see Fig. 69-1). These structures act as shock absorbers in the knee. Normally, little twisting movement is permitted in the knee joint. Twisting of the knee or repetitive squatting and impact may result in either tearing or detachment of the cartilage from its attachment to the head of the tibia. The peripheral third of the menisci have a small amount of blood flow, which allows that portion to heal if torn.

These injuries leave loose cartilage in the knee joint that may slip between the femur and the tibia, preventing full extension of the leg. If this happens during walking or running, the patient often describes the leg as "giving way." The patient may hear or feel a click in the knee when walking, especially when extending the leg that is bearing weight. When the cartilage is attached to the front and back of the knee but torn loose laterally (bucket-handle tear), it may slide between the bones to lie between the condyles and prevent full flexion or extension. As a result, the knee "locks."

When a meniscus is torn, the synovial membrane secretes additional synovial fluid due to the irritation and the knee becomes very edematous. Initial conservative treatment includes immobilization of the knee, use of crutches, anti-inflammatory agents, analgesics, and modification of activities to avoid those that cause the symptoms. An MRI is the diagnostic tool used to detect a torn meniscus. Damaged cartilage is surgically removed (meniscectomy) arthroscopically. After surgery, a pressure dressing is applied. The most common complication is an effusion into the knee joint, which produces pain. The patient is instructed to continue quadriceps-setting and ROM exercises.

## RUPTURE OF THE ACHILLES TENDON

The Achilles tendon attaches the soleus and gastrocnemius muscles to the os calcis (ie, the heel). Traumatic rupture of the Achilles tendon, generally within the tendon sheath, occurs during activities when there is a sudden contraction of the calf muscle with the foot fixed firmly to the floor or ground. The patient experiences sharp pain and cannot plantar flex the foot because the Achilles tendon is the plantar flexor for the ankle.

Immediate surgical repair of complete Achilles tendon ruptures is usually recommended to obtain satisfactory results. After surgery, a cast or brace is used to immobilize the joint. In some situations, conservative management with a plantar-flexed cast for 6 to 8 weeks may be used. After immobilization, a heel lift is worn and progressive physical therapy to promote ankle ROM and strength is begun.

# Fractures

A **fracture** is a complete or incomplete disruption in the continuity of bone structure and is defined according to its type and extent. Fractures occur when the bone is subjected to stress greater than it can absorb. Fractures may be caused by direct blows, crushing forces, sudden twisting motions, and extreme muscle contractions. When the bone is broken, adjacent structures are also affected, resulting in soft tissue edema, hemorrhage into the muscles and joints, joint dislocations, ruptured tendons, severed nerves, and damaged blood vessels. Body organs may be injured by the force that caused the fracture or by fracture fragments.

## Types of Fractures

A *complete fracture* involves a break across the entire cross-section of the bone and is frequently displaced (removed from its normal position). An *incomplete fracture* (eg, greenstick fracture) involves a break through only part of the cross-section of the bone. A *comminuted* fracture is one that produces several bone fragments. A *closed fracture* (simple fracture) is one that does not cause a break in the skin. An *open fracture* (compound, or complex, fracture) is one in which the skin or mucous membrane wound extends to the fractured bone (Whiteing, 2008). Open fractures are graded according to the following criteria:

- Grade I is a clean wound less than 1 cm long.
- Grade II is a larger wound without extensive soft tissue damage.
- Grade III is highly contaminated, has extensive soft tissue damage, and is the most severe.

Fractures may also be described according to the anatomic placement of fragments. Specific types of fractures are reviewed in Figure 69-2.

An intra-articular fracture extends into the joint surface of a bone. Because each end of a long bone is cartilaginous, if the fracture is nondisplaced, x-rays will not always reveal the fracture because cartilage is nonradiopaque. An MRI or arthroscopy will identify the fracture and confirm the diagnosis. The joint is stabilized and immobilized with a splint or cast and no weight bearing is allowed until the fracture has healed. Intra-articular fractures often lead to posttraumatic arthritis.

## Clinical Manifestations

The clinical signs and symptoms of a fracture include acute pain, loss of function, deformity, shortening of the extremity, crepitus, and localized edema and ecchymosis. Not all of these are present in every fracture (Whiteing, 2008).

### Pain

The pain is continuous and increases in severity until the bone fragments are immobilized. The muscle spasms that accompany a fracture begin within 20 minutes after the injury and result in more intense pain than the patient reports at the time of injury. The muscle spasms can minimize further movement of the fracture fragments or can result in further bony fragmentation or malalignment.

### Loss of Function

After a fracture, the extremity cannot function properly because normal function of the muscles depends on the integrity of the bones to which they are attached. Pain contributes to the loss of function. In addition, abnormal movement (false motion) may be present.

### Deformity

Displacement, angulation, or rotation of the fragments in a fracture of the arm or leg causes a deformity that is detectable when the limb is compared with the uninjured extremity.

### Shortening

In fractures of long bones, there is actual shortening of the extremity because of the compression of the fractured bone. Sometimes muscle spasms can cause the distal and proximal site of the fracture to overlap, causing the extremity to shorten.

### Crepitus

When the extremity is gently palpated, a crumbling sensation, called **crepitus,** can be felt. It is caused by the rubbing of the bone fragments against each other.

> *NURSING ALERT*
>
> **Testing for crepitus can produce further tissue damage and should be minimized as much as possible.**

### Localized Edema and Ecchymosis

Localized edema and ecchymosis occur after a fracture as a result of trauma and bleeding into the tissues. These signs may not develop for several hours after the injury or may develop within an hour, depending on the severity of the fracture.

## Emergency Management

Immediately after injury, if a fracture is suspected, it is important to immobilize the body part before the patient is moved. Adequate splinting is essential. Joints proximal and distal to the fracture must be immobilized to prevent movement of fracture fragments. Immobilization of the long bones of the lower extremities may be accomplished by bandaging the legs together, with the unaffected extremity

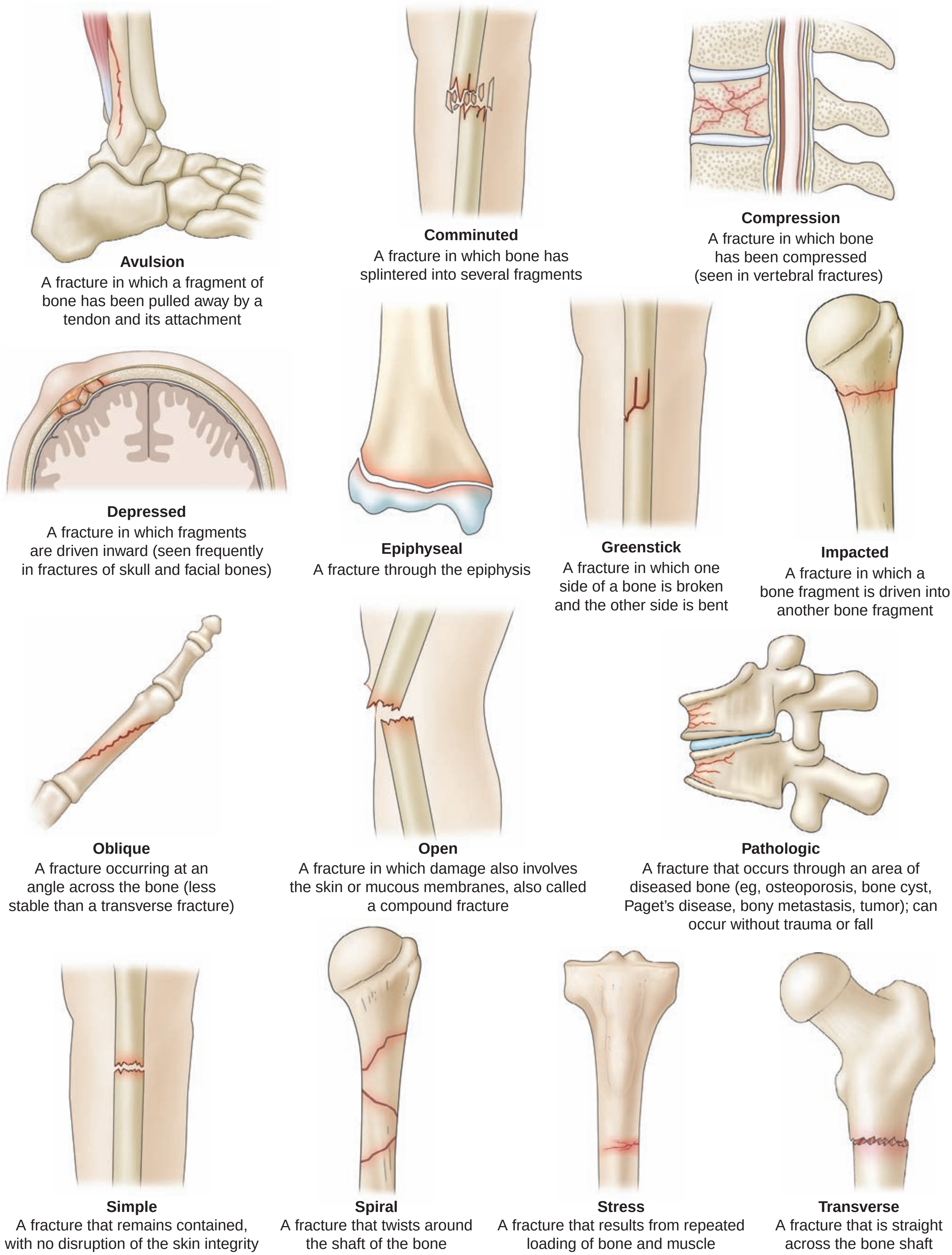



**Figure 69-2** Specific types of fractures.

serving as a splint for the injured one. In an upper extremity injury, the arm may be bandaged to the chest, or an injured forearm may be placed in a sling. The neurovascular status distal to the injury should be assessed both before and after splinting to determine the adequacy of peripheral tissue perfusion and nerve function.

With an *open fracture*, the wound is covered with a sterile dressing to prevent contamination of deeper tissues. No attempt is made to reduce the fracture, even if one of the bone fragments is protruding through the wound. Splints are applied for immobilization.

In the emergency department, the patient is evaluated completely. The clothes are gently removed, first from the uninjured side of the body and then from the injured side. The patient's clothing may be cut away. The fractured extremity is moved as little as possible to avoid more damage.

## Medical Management

### *Reduction*

**Fracture reduction** refers to restoration of the fracture fragments to anatomic alignment and positioning. Either closed reduction or open reduction may be used to reduce a fracture. The specific method selected depends on the nature of the fracture; however, the underlying principles are the same. Usually, the physician reduces a fracture as soon as possible to prevent loss of elasticity from the tissues through infiltration by edema or hemorrhage. In most cases, fracture reduction becomes more difficult as the injury begins to heal.

Before fracture reduction and immobilization, the patient is prepared for the procedure; consent for the procedure is obtained, and an analgesic is administered as prescribed. Anesthesia may be administered. The injured extremity must be handled gently to avoid additional damage.

#### Closed Reduction

In most instances, closed reduction is accomplished by bringing the bone fragments into anatomic alignment through manipulation and manual traction. The extremity is held in the aligned position while the physician applies a cast, splint, or other device. Reduction under anesthesia with percutaneous pinning may also be used. The immobilizing device maintains the reduction and stabilizes the extremity for bone healing. X-rays are obtained to verify that the bone fragments are correctly aligned.

Traction (skin or skeletal) may be used until the patient is physiologically stable to undergo surgical fixation. Use of traction and the nursing management of a patient in traction are discussed more fully in Chapter 67.

#### Open Reduction

Some fractures require open reduction. Through a surgical approach, the fracture fragments are anatomically aligned. Internal fixation devices (metallic pins, wires, screws, plates, nails, or rods) may be used to hold the bone fragments in position until solid bone healing occurs. These devices may be attached to the sides of bone, or they may be inserted through the bony fragments or directly into the medullary cavity of the bone (Fig. 69-3). Internal fixation devices ensure firm approximation and fixation of the bony fragments.

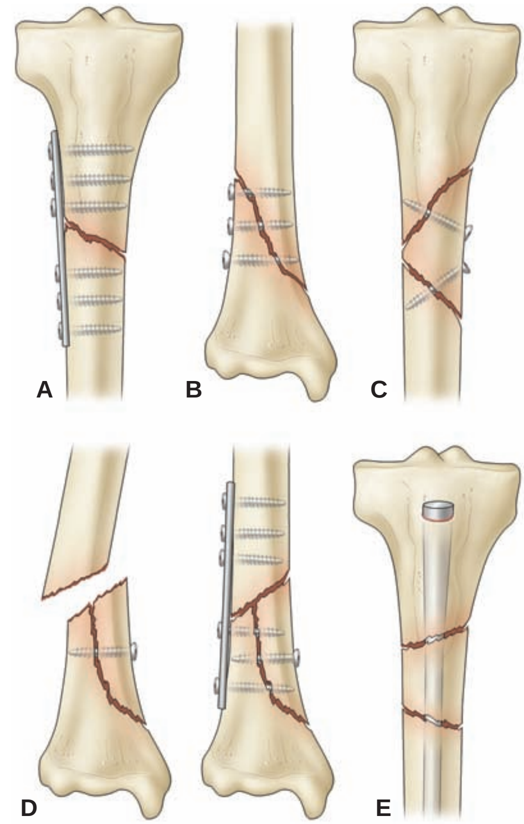



**Figure 69-3** Techniques of internal fixation. **A,** Plate and six screws for a transverse or short oblique fracture. **B,** Screws for a long oblique or spiral fracture. **C,** Screws for a long butterfly fragment. **D,** Plate and six screws for a short butterfly fragment. **E,** Medullary nail for a segmental fracture.

### *Immobilization*

After the fracture has been reduced, the bone fragments must be immobilized and maintained in proper position and alignment until union occurs. Immobilization may be accomplished by external or internal fixation. Methods of external fixation include bandages, casts, splints, continuous traction, and external fixators.

### *Maintaining and Restoring Function*

Reduction and immobilization are maintained as prescribed to promote bone and soft tissue healing. Edema is controlled by elevating the injured extremity and applying ice as prescribed. Neurovascular status (circulation, motion and sensation) is monitored routinely, and the orthopedic surgeon is notified immediately if signs of neurovascular compromise develop. Restlessness, anxiety, and discomfort are controlled with a variety of approaches, such as reassurance, position changes, and pain relief strategies, including use of analgesics. Isometric and muscle-setting exercises are encouraged to minimize atrophy and to promote circulation. Participation in activities of daily living (ADLs) is encouraged to promote independent functioning and self-esteem. Gradual resumption of activities is promoted within the therapeutic prescription. With internal fixation, the surgeon determines the amount of movement and weight-bearing stress the extremity can sustain and prescribes the level of activity.

(See Nursing Process sections in Chapter 67 for more information about caring for patients who have a cast, are in traction, or are undergoing orthopedic surgery.)

## Nursing Management

### Patients With Closed Fractures

The patient with a closed fracture has no opening in the skin at the fracture site. The fractured bones may be nondisplaced or slightly displaced, but the skin is intact. The nurse instructs the patient regarding the proper methods to control edema and pain (Chart 69-1). It is important to teach exercises to maintain the health of unaffected muscles and to increase the strength of muscles needed for transferring and for using assistive devices such as crutches, walkers, and special utensils. The patient is also taught how to use assistive devices safely. Plans are made to help patients modify the home environment as needed and to ensure safety, such as removing floor rugs or anything that obstructs walking paths throughout the house. Patient teaching includes self-care, medication information, monitoring for potential complications, and the need for continuing health care supervision. Fracture healing and restoration of strength and mobility may take an average maximum of 6 to 8 weeks, depending on the quality of the patient's bone tissue.

### Patients With Open Fractures

In an open fracture, there is a risk for osteomyelitis, tetanus, and gas gangrene. The objectives of management are to prevent infection of the wound, soft tissue, and bone and to promote healing of bone and soft tissue. Intravenous (IV) antibiotics are administered immediately upon the patient's arrival in the hospital along with tetanus toxoid if needed.

Wound irrigation and débridement are initiated in the operating room as soon as possible. The wound is cultured and bone grafting may be performed to fill in areas of bone defects. The fracture is carefully reduced and stabilized by external fixation and the wound is usually left open for 5 to 7 days for intermittent irrigation and cleansing (see Chapter 67). If there is any damage to blood vessels, soft tissue, muscles, nerves, or tendons, appropriate treatment is implemented.

With open fractures, primary wound closure is usually delayed. Heavily contaminated wounds are left unsutured and dressed with sterile gauze to permit edema and wound drainage. Wound irrigation and débridement may be repeated, removing infected and devitalized tissue and increasing vascularity in the region.

The extremity is elevated to minimize edema. It is important to assess neurovascular status frequently. Temperature is monitored at regular intervals and the patient is monitored for signs of infection. In 4 to 8 weeks, bone grafting may be necessary to bridge bone defects and to stimulate bone healing.

## Fracture Healing and Complications

Weeks to months are required for most fractures to heal. Many factors influence the time frame of the healing process (Chart 69-2). With a comminuted fracture, fragments must be properly aligned to attain the best healing possible. It is essential for the fractured bone to have blood supply to the area to facilitate the healing process. In general, fractures of flat bones (pelvis, sternum, and scapula) heal rapidly. A complex, comminuted fracture may heal slower. Fractures at the ends of long bones, where the bone is more vascular and cancellous, heal more quickly than do fractures in areas where the bone is dense and less vascular (midshaft). Weight bearing stimulates healing of stabilized fractures of the long bones in the lower extremities.

**CHART 69-1** HOME CARE CHECKLIST
*Closed Fracture*

| At the completion of the home instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe approaches to control swelling and pain (eg, elevate extremity to heart level; take analgesics as prescribed). | ✔ | ✔ |
| • Report pain uncontrolled by elevation and analgesics (may be an indicator of impaired tissue perfusion or compartment syndrome). | ✔ | ✔ |
| • Describe management of immobilizing device or care of incision. | ✔ | ✔ |
| • Consume diet to promote bone healing. | ✔ | |
| • Demonstrate ability to transfer. | ✔ | |
| • Use mobility aids and assistive devices safely. | ✔ | |
| • Avoid excessive use of injured extremity; observe prescribed weight-bearing limits. | ✔ | |
| • State indicators of complications to report promptly to physician (eg, uncontrolled swelling and pain; cool, pale fingers or toes; paresthesia; paralysis; signs of local and systemic infection; signs of venous thromboembolism; problems with immobilization device). | ✔ | ✔ |
| • State possible delayed complications of fractures (ie, delayed union; nonunion; avascular necrosis; reaction to internal fixation device; complex regional pain syndrome [CRPS], formally called reflex sympathetic dystrophy syndrome; heterotopic ossification). | ✔ | ✔ |
| • Describe gradual resumption of normal activities when medically cleared, and discuss how to protect fracture site from undue stresses. | ✔ | ✔ |

## Chart 69-2 • *Factors That Affect or Inhibit Fracture Healing*

**Factors That Enhance Fracture Healing**

- Immobilization of fracture fragments
- Maximum bone fragment contact
- Sufficient blood supply
- Proper nutrition
- Exercise: weight bearing for long bones
- Hormones: growth hormone, thyroid, calcitonin, vitamin D, anabolic steroids
- Electric potential across fracture

**Factors That Inhibit Fracture Healing**

- Extensive local trauma
- Bone loss
- Weight bearing prior to approval
- Malalignment of the fracture fragments
- Inadequate immobilization
- Space or tissue between bone fragments
- Infection
- Local malignancy
- Metabolic bone disease (eg, Paget's disease of the bone)
- Irradiated bone (radiation necrosis)
- Avascular necrosis
- Intra-articular fracture (synovial fluid contains fibrolysins, which lyse the initial clot and retard clot formation)
- Age (elderly persons heal more slowly)
- Corticosteroids (inhibit the repair rate)

If fracture healing is disrupted, bone union may be delayed or stopped completely. Factors that can impair fracture healing include inadequate fracture immobilization, inadequate blood supply to the fracture site or adjacent tissue, extensive space between bone fragments, interposition of soft tissue between bone ends, displacement of fracture fragments or ends, infection, and metabolic problems.

Complications of fractures may be either acute or chronic. Early complications include shock, fat embolism, compartment syndrome, and venous thromboemboli (deep vein thrombosis [DVT], pulmonary embolism [PE]). Delayed complications include delayed union, malunion, nonunion, AVN of bone, reaction to internal fixation devices, complex regional pain syndrome (CRPS, formerly called reflex sympathetic dystrophy [RSD]), and heterotopic ossification.

### *Early Complications*

#### Shock

Hypovolemic shock resulting from hemorrhage is more frequently noted in trauma patients with pelvic fractures and in patients with a displaced or open femoral fracture in which the femoral artery is torn by bone fragments. Treatment of shock consists of stabilizing the fracture to prevent further hemorrhage, restoring blood volume and circulation, relieving the patient's pain, providing proper immobilization, and protecting the patient from further injury and other complications. (See Chapter 15 for a discussion of shock.)

#### Fat Embolism Syndrome

After fracture of long bones or pelvic bones, or crush injuries, fat emboli may develop. Fat embolism syndrome (FES) occurs most frequently in adults younger than 40 years of age and in men. It is also more common in patients with multiple fractures (Stein, Yaekoub, Matta, et al., 2008). At the time of fracture, fat globules may diffuse from the marrow into the vascular compartment. The fat globules (ie, emboli) may occlude the small blood vessels that supply the lungs, brain, kidneys, and other organs. The onset of symptoms is rapid, typically within 12 to 48 hours of injury (Harvey, 2006), but may occur up to 10 days after injury (Whiteing, 2008).

***Clinical Manifestations.*** Presenting features include hypoxia, tachypnea, tachycardia, and pyrexia. The respiratory distress response includes tachypnea, dyspnea, crackles, wheezes, precordial chest pain, cough, large amounts of thick white sputum, and tachycardia. Occlusion of a large number of small vessels causes the pulmonary pressure to rise. Edema and hemorrhages in the alveoli impair oxygen transport, leading to hypoxia. Arterial blood gas values show the partial pressure of oxygen ($PaO_2$) to be less than 60 mm Hg, with an early respiratory alkalosis and later respiratory acidosis. The chest x-ray shows a typical "snowstorm" infiltrate. Without prompt, definitive treatment, acute pulmonary edema, acute respiratory distress syndrome (ARDS), and heart failure may develop. Cerebral disturbances (due to hypoxia and the lodging of fat emboli in the brain) are manifested by mental status changes varying from headache and mild agitation to delirium and coma.

*NURSING ALERT*

**Subtle personality changes, restlessness, irritability, or confusion in a patient who has sustained a fracture are indications for immediate arterial blood gas studies.**

With systemic embolization, the patient appears pale. Petechiae, possibly due to a transient thrombocytopenia, are noted in the buccal membranes and conjunctival sacs, on the hard palate, and over the chest and anterior axillary folds. The patient develops a fever greater than 39.5°C (103°F). Free fat may be found in the urine if emboli are filtered by the renal tubules. Acute tubular necrosis and renal failure may develop (Harvey, 2006).

***Prevention and Management.*** Immediate immobilization of fractures including early surgical fixation, minimal fracture manipulation, and adequate support for fractured bones during turning and positioning, and maintenance of fluid and electrolyte balance are measures that may reduce the incidence of fat emboli.

Prompt initiation of respiratory support, assessment, and monitoring is essential. The objectives of management are to support the respiratory system, to prevent respiratory failure, and to correct homeostatic disturbances. Acute pulmonary edema and ARDS are the most common causes of death. Respiratory support is provided with high-flow oxygen. Controlled-volume ventilation with positive end-expiratory pressure (PEEP) may be used to prevent or treat pulmonary edema. Corticosteroids may be administered IV to treat the inflammatory lung reaction and to control cerebral edema (Harvey, 2006) (see Chapter 23 for the nursing management of respiratory failure and Chapter 25 for care of the patient on a ventilator). Vasopressor medications to support

cardiovascular function are administered IV to prevent and treat hypotension, shock, and interstitial pulmonary edema. Accurate fluid intake and output records facilitate adequate fluid replacement therapy.

### Compartment Syndrome

An anatomic compartment is an area of the body encased by bone or fascia (eg, the fibrous membrane that covers and separates muscles) that contains muscles, nerves, and blood vessels. The human body has 46 anatomic compartments, and 36 of these are located in the extremities (Fig. 69-4). Compartment syndrome in an extremity is a limb-threatening condition that occurs when perfusion pressure falls below tissue pressure within a closed anatomic compartment.

Acute compartment syndrome involves a sudden and severe decrease in blood flow to the tissues distal to an area of injury that results in ischemic necrosis if prompt, decisive intervention does not occur. The patient complains of deep, throbbing, unrelenting pain, which continues to increase despite the administration of opioids and seems out of proportion to the injury. A hallmark sign is pain that occurs or intensifies with passive ROM (eg, pain intensifies with dorsiflexion of the wrist of the affected extremity). This pain can be caused by (1) a reduction in the size of the muscle

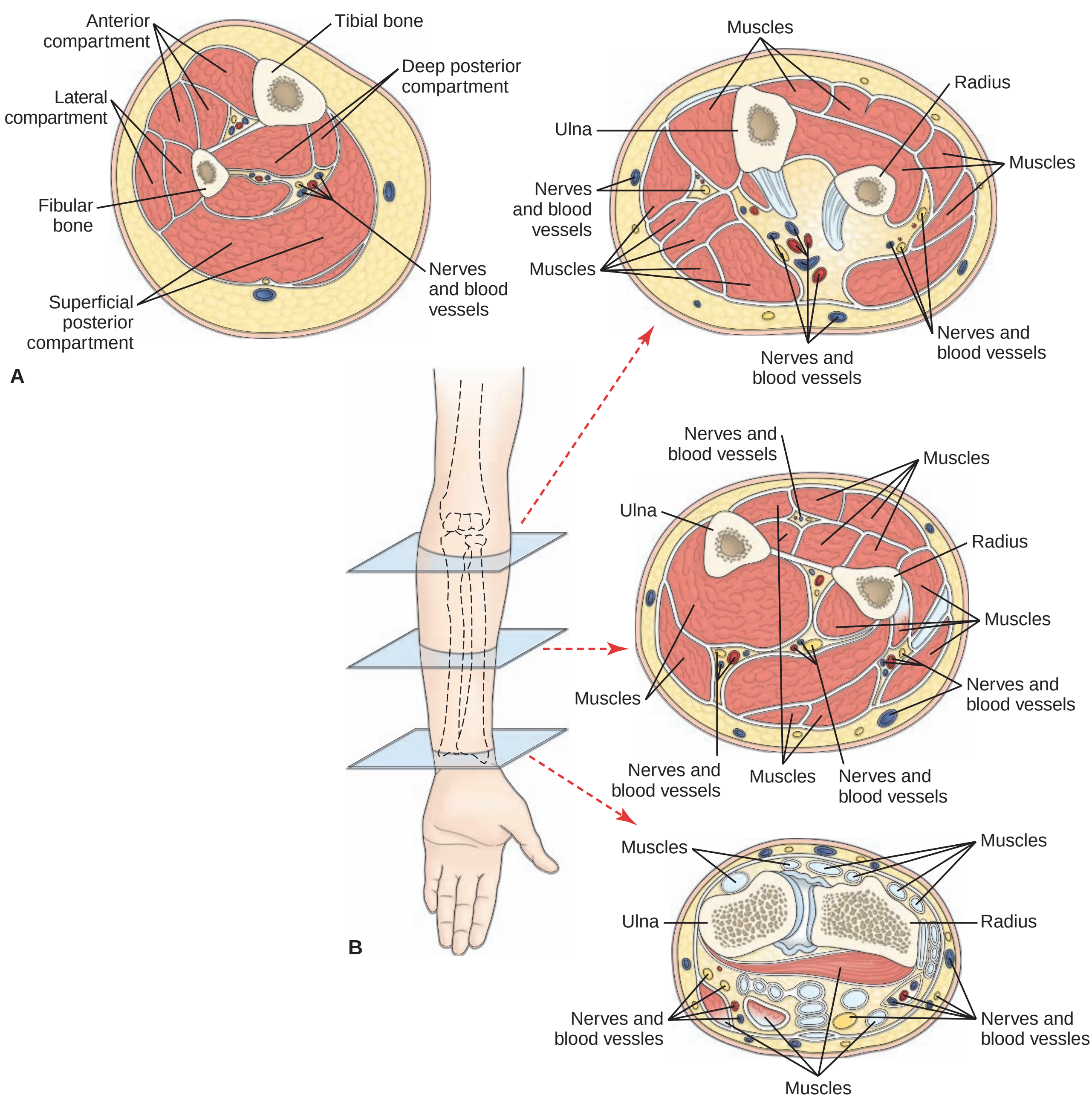



**Figure 69-4** Cross-sections of anatomic compartments. **A,** Compartments of the left lower leg. **B,** Compartments of the left forearm. From Chapman, M. W., Szabo, R. M. & Marder, R. A. (2000). *Chapman's orthopaedic surgery* (3rd ed., pp. 395–396). Philadelphia: Lippincott Williams & Wilkins.

compartment because the enclosing muscle fascia is too tight or a cast or dressing is constrictive or (2) an increase in compartment contents because of edema or hemorrhage from the fracture site. The lower leg is most frequently involved, but the forearm is also at risk (see figure 67-2 for an illustration of compartment syndrome of the lower leg). The pressure within a muscle compartment may increase to such an extent that microcirculation diminishes, causing nerve and muscle anoxia and necrosis (Konstantakos, Dalstrom, Nelles, et al., 2007). Permanent function can be lost if the anoxic situation continues for longer than 6 hours (Harvey, 2006).

***Assessment and Diagnostic Findings.*** Frequent assessment of neurovascular function after a fracture is essential and focuses on the "five Ps": *p*ain, *p*aralysis, *p*aresthesias, *p*allor, and *p*ulselessness (Whiteing, 2008). Sensory deficits include deep, throbbing, escalating pain that increases with passive stretching. Paresthesia (burning or tingling sensation) and numbness are early signs of nerve involvement. Motion is evaluated by asking the patient to flex and extend the wrist or plantarflex and dorsiflex the foot. With continued nerve ischemia and edema, the patient experiences sensations of hypoesthesia (diminished sensation followed by complete numbness). Motor weakness may occur as a late sign of nerve ischemia. No movement (paralysis) indicates nerve damage.

Peripheral circulation is evaluated by assessing color, temperature, capillary refill time, edema, and pulses. Cyanotic (ie, blue-tinged) nail beds suggest venous congestion. Pallor or dusky and cold fingers or toes and prolonged capillary refill time suggest diminished arterial perfusion. Edema may obscure the function of arterial pulsation, and Doppler ultrasonography may be used to verify a pulse. Pulselessness is a very late sign that may signify lack of distal tissue perfusion, but it is possible to have compartment syndrome with a pulse (weak) to the extremity (Konstantakos, et al., 2007).

Palpation of the muscle, if possible, reveals it to be swollen and hard. The orthopedic surgeon may measure tissue pressure by inserting a tissue pressure-monitoring device, such as a Wick catheter, into the muscle compartment (Fig. 69-5). (Normal pressure is 8 mm Hg or less.) Nerve and muscle tissues deteriorate as compartment pressure increases. Prolonged pressure of more than 30 mm Hg can result in

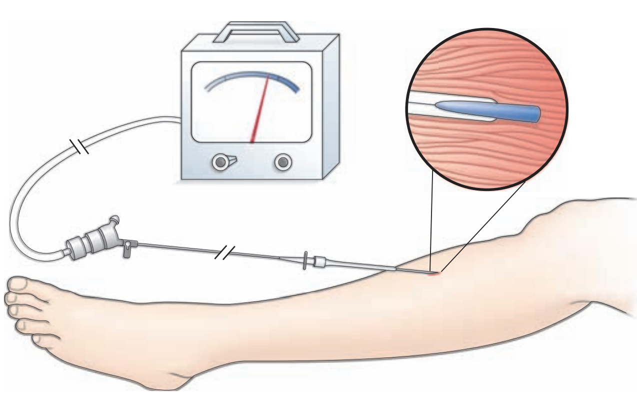


**Figure 69-5** The Wick catheter is inserted into a muscle compartment and continuously monitors compartment pressure. From Chapman, M. W., Szabo, R. M. & Marder, R. A. (2000). *Chapman's orthopaedic surgery* (3rd ed., p. 401). Philadelphia: Lippincott Williams & Wilkins.

compromised microcirculation (Hessmann, Ingelfinger & Rommens, 2007).

***Medical Management.*** Prompt management of acute compartment syndrome is essential. The surgeon needs to be notified immediately if neurovascular compromise is suspected. Delay in treatment may result in permanent nerve and muscle damage or even necrosis and amputation.

*NURSING ALERT*

**Compartment syndrome is managed by maintaining the extremity at the heart level (*not above heart level*), and opening and bivalving the cast (see Chart 67-2) or opening the splint, if one or the other are present.**

If conservative measures do not restore tissue perfusion and relieve pain within 1 hour, a fasciotomy (surgical decompression with excision of the fascia) is indicated to relieve the constrictive muscle fascia. After fasciotomy, the wound is not sutured but is left open to allow the muscle tissues to expand; it is covered with moist, sterile saline dressings or with artificial skin. The affected arm or leg is splinted in a functional position and elevated to heart level, and prescribed passive ROM exercises are usually performed every 4 to 6 hours. In 3 to 5 days, when the swelling has resolved and tissue perfusion has been restored, the wound is débrided and closed (possibly with skin grafts) (Hessmann, et al., 2007). Complications that may occur after fasciotomy include AVN and infection.

#### Other Early Complications

Venous thromboemboli, including DVT and PE, are associated with reduced skeletal muscle contractions and bed rest. Patients with fractures of the lower extremities and pelvis are at high risk for venous thromboemboli. PEs may cause death several days to weeks after injury. (See Chapter 31 for a discussion of DVT; Chapter 30 for a discussion of venous thromboemboli; and Chapter 23 for a discussion of PE.)

Disseminated intravascular coagulation (DIC) is a systemic disorder that results in widespread hemorrhage and microthrombosis with ischemia. Its causes are diverse and can include massive tissue trauma. Early manifestations of DIC include unexpected bleeding after surgery, and bleeding from the mucous membranes, venipuncture sites, and gastrointestinal and urinary tracts. The treatment of DIC is discussed in Chapter 33.

All open fractures are considered contaminated and are treated as soon as possible with IV antibiotics. Surgical internal fixation of fractures carries a risk of infection. The nurse must monitor and instruct the patient regarding signs and symptoms of infection, including tenderness, pain, redness, swelling, local warmth, elevated temperature, and purulent drainage.

### Delayed Complications

#### Delayed Union, Malunion, and Nonunion

**Delayed union** occurs when healing does not occur within the expected time frame for the location and type of fracture. Delayed union may be associated with distraction (pulling apart) of bone fragments, systemic or local infection, poor

nutrition, or comorbidity (eg, diabetes mellitus, autoimmune disease). The healing time is prolonged; but the fracture eventually heals (Whiteing, 2008).

**Nonunion** results from failure of the ends of a fractured bone to unite, whereas **malunion** results from failure of the ends of a fractured bone to unite in normal alignment. In both of these instances, the patient complains of persistent discomfort and abnormal movement at the fracture site. Factors contributing to nonunion and malunion include infection at the fracture site, interposition of tissue between the bone ends, inadequate immobilization or manipulation that disrupts callus formation, excessive space between bone fragments, limited bone contact, and impaired blood supply resulting in AVN. In nonunion, fibrocartilage or fibrous tissue exists between the bone fragments; no bone salts have been deposited. A false joint (pseudarthrosis) often develops at the site of the fracture (Whiteing, 2008).

***Medical Management.*** The physician treats nonunion with internal fixation, bone grafting, electrical bone stimulation, or a combination of these therapies. Internal fixation stabilizes the bone fragments and ensures bone contact.

Bone grafts promote osteogenesis, osteoconduction, and osteoinduction. *Osteogenesis* (bone formation) occurs after transplantation of bone because the graft contains osteoblasts, which build bony matrix. Building of this structural bony matrix promotes *osteoconduction*, the growth of blood vessels and osteoblasts within the matrix. *Osteoinduction* is the stimulation of host stem cells to differentiate into osteoblasts by several growth factors, including bone morphogenetic proteins (BMPs), particularly BMP-2, BMP-6, and BMP-9 (Boden, 2005).

Grafted bone undergoes a reconstructive process that results in a gradual replacement of the graft with new bone. During surgery the bone fragments are débrided and aligned, infection (if present) is removed, and a bone graft is placed in the bony defect. The bone graft may be an **autograft** (tissue, frequently from the iliac crest, harvested from the patient for his or her own use) or an **allograft** (tissue harvested from a donor). The bone graft fills the bone gap and provides a lattice structure for invasion by bone cells and actively promotes bone growth. The type of bone selected for grafting depends on function: cortical bone is used for structural strength, cancellous bone for osteogenesis, and corticocancellous bone for strength and rapid incorporation. Free vascularized bone autografts are grafted with their own blood supply, allowing for primary fracture healing.

After grafting, immobilization and non–weight-bearing exercises are required while the bone graft becomes incorporated and the fracture or defect heals. Depending on the type of bone grafted and the age of the patient, healing may take from 6 to 12 months or longer. Bone grafting complications include wound or graft infection, fracture of the graft, and nonunion (Boden, 2005). Specific problems associated with autografts include a limited quantity of bone available for harvest and harvest site pain that may persist for up to 2 years after harvest (Boden, 2005). Infrequent specific allograft complications include partial acceptance (lack of host and donor histocompatibility, which retards graft incorporation), graft rejection (rapid and complete resorption of the graft), and transmission of disease (rare).



**Figure 69-6** Bone healing stimulator applied to the arm. Courtesy of EBI Medical Systems, Parsippany, NJ.

Osteogenesis may be stimulated by electrical impulses; the effectiveness is similar to that of bone grafting. Use of electrical impulses is not effective with large bone gaps. The electrical stimulation modifies the tissue environment, making it electronegative, which enhances mineral deposition and bone formation that promotes bone growth. In some situations, pins that act as cathodes are inserted percutaneously, directly into the fracture site, and electrical impulses are directed to the fracture continuously. This method cannot be used when infection is present.

Another method for stimulating osteogenesis is noninvasive inductive coupling. Pulsing electromagnetic fields are delivered to the fracture for approximately 10 hours each day by an electromagnetic coil over the nonunion site (Fig. 69-6). During the electrical stimulation treatment period, which takes 3 to 6 months or longer, rigid fracture fixation with adequate support is needed.

***Nursing Management.*** The patient with a nonunion has experienced an extended time in fracture treatment and frequently becomes frustrated with prolonged therapy. The nurse provides emotional support and encouragement to the patient and encourages compliance with the treatment regimen. The orthopedic surgeon evaluates the progression of bone healing with periodic x-rays.

Nursing care for the patient with a bone graft includes pain management and monitoring the patient for possible complications. The nurse needs to reinforce educational information concerning the objectives of the bone graft, immobilization, non–weight-bearing exercises, wound care, monitoring for signs of infection, and the importance of follow-up care with the orthopedic surgeon.

Nursing care for the patient with electrical bone stimulation focuses on patient education that addresses immobilization, weight-bearing restrictions, and correct daily use of the stimulator as prescribed.

### Avascular Necrosis of Bone

AVN occurs when the bone loses its blood supply and dies. It may occur after a fracture with disruption of the blood supply to the distal area. It is also seen with dislocations, bone transplantation, prolonged high-dose corticosteroid therapy, chronic renal disease, sickle cell anemia, and other diseases. The devitalized bone may collapse or reabsorb. The patient develops pain and experiences limited movement. X-rays reveal loss of mineralized matrix and structural collapse. Treatment generally consists of attempts to revitalize the bone with bone grafts, prosthetic replacement, or arthrodesis (joint fusion).

### Reaction to Internal Fixation Devices

Internal fixation devices may be removed after bony union has taken place. However, in most patients, the device is not removed unless it produces symptoms. Pain and decreased function are the prime indications that a problem has developed. Problems may include mechanical failure (inadequate insertion and stabilization); material failure (faulty or damaged device); corrosion of the device, causing local inflammation; allergic response to the metallic alloy used; and osteoporotic remodeling adjacent to the fixation site (Bucholz, Heckman, Court-Brown, et al., 2005). If the device is removed, the bone needs to be protected from refracture related to osteoporosis, altered bone structure, and trauma.

### Complex Regional Pain Syndrome

CRPS is a painful sympathetic nervous system problem. It occurs infrequently; but when it does occur, it is most often in an upper extremity after trauma and is seen more frequently in women. Clinical manifestations of CRPS include severe burning pain, local edema, hyperesthesia, stiffness, discoloration, vasomotor skin changes (ie, fluctuating warm, red, dry and cold, sweaty, cyanotic), and trophic changes that may include glossy, shiny skin and increased hair and nail growth. This syndrome is frequently chronic, with extension of symptoms to adjacent areas of the body. Disuse muscle atrophy and bone deossification (osteoporosis) may occur with persistent CRPS.

***Nursing Management.*** Prevention may include elevation of the extremity after injury or surgery and selection of an immobilization device (eg, external fixator) that allows for the greatest ROM and functional use of the rest of the extremity. Early effective pain relief is the focus of management. Pain may need to be controlled with analgesics. NSAIDs, corticosteroids, and muscle relaxants also may be used. The nurse helps the patient to cope with CRPS manifestations and explores multiple ways to control pain (see Chapter 13).

> *NURSING ALERT*
>
> **The nurse avoids using the affected extremity for blood pressure measurements and venipuncture in the patient with CRPS.**

### Heterotopic Ossification

Heterotopic ossification (myositis ossificans) is the abnormal formation of bone, near bones or in muscle, in response to soft tissue trauma or fracture after blunt trauma or total joint replacement. The muscle is painful, and normal muscular contraction and movement are limited. Early mobilization may prevent its occurrence. Usually the bone lesion resorbs over time, but the abnormal bone eventually may need to be excised if symptoms persist.

## Fractures of Specific Sites

### CLAVICLE

Fracture of the clavicle (collar bone) is a common injury that results from a fall or a direct blow to the shoulder. The clavicle helps maintain the shoulder in the upward, outward, and backward position from the thorax. Therefore, when the clavicle is fractured, the patient assumes a protective position, slumping the shoulders and immobilizing the arm to prevent shoulder movements. The treatment goal is to align the shoulder in its normal position by means of closed reduction and immobilization.

Most of these fractures occur in the middle third of the clavicle. A clavicular strap, also called a *figure-eight bandage* (Fig. 69-7), may be used to pull the shoulders back, reducing and immobilizing the fracture. The nurse monitors the circulation and nerve function of the affected arm and compares it with the unaffected arm to determine variations, which may indicate disturbances in neurovascular status. A sling

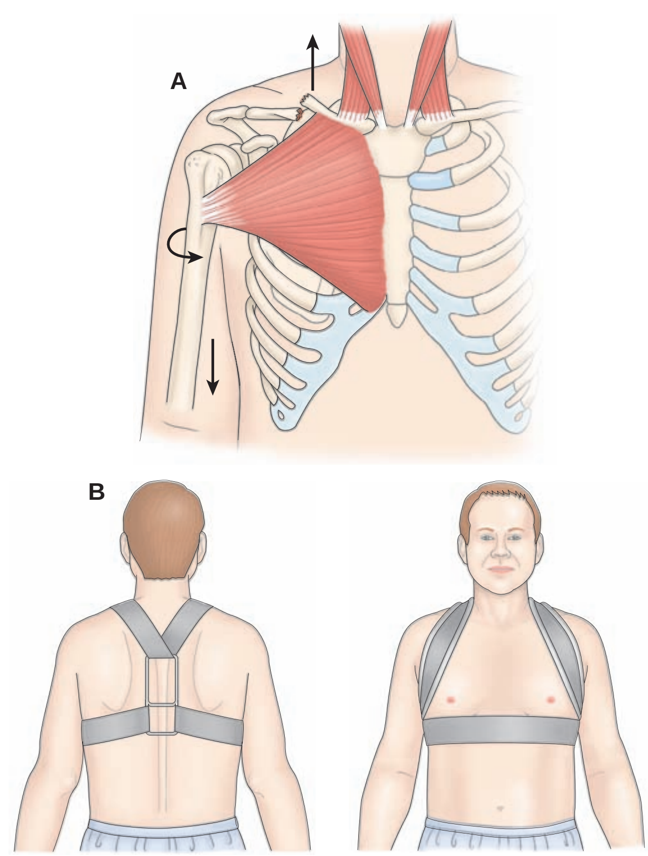



**Figure 69-7** Fracture of the clavicle. **A,** Anteroposterior view shows typical displacement in midclavicular fracture. **B,** Immobilization is accomplished with a clavicular strap.

may be used to support the arm and relieve pain. The patient may be permitted to use the arm for light activities within the range of comfort.

Fracture of the distal third of the clavicle, without displacement and ligament disruption, is treated with a sling and restricted motion of the arm. When a fracture in the distal third is accompanied by a disruption of the coracoclavicular ligament that connects the coracoid process of the scapula and the inferior surface of the clavicle, the bony fragments are frequently displaced. This type of injury may be treated by open reduction with internal fixation (ORIF) (see Chapter 67 for discussion of ORIF).

The nurse cautions the patient not to elevate the arm above shoulder level until the fracture has healed (about 6 weeks) but encourages the patient to exercise the elbow, wrist, and fingers as soon as possible. When prescribed, shoulder exercises are performed to obtain full shoulder motion (Fig. 69-8). Vigorous activity is limited for approximately 3 months.

Complications of clavicular fractures include trauma to the nerves of the brachial plexus, injury to the subclavian vein or artery from a bony fragment, and malunion.

## HUMERAL NECK

Fractures of the proximal humerus may occur through the neck of the humerus. Impacted fractures of the surgical neck of the humerus are seen most frequently in older women after a fall on an outstretched arm. Active middle-aged patients who are injured in a fall may suffer severely displaced humeral neck fractures with associated rotator cuff damage.

The patient presents with the affected arm hanging limp at the side or supported by the uninjured hand. Neurovascular

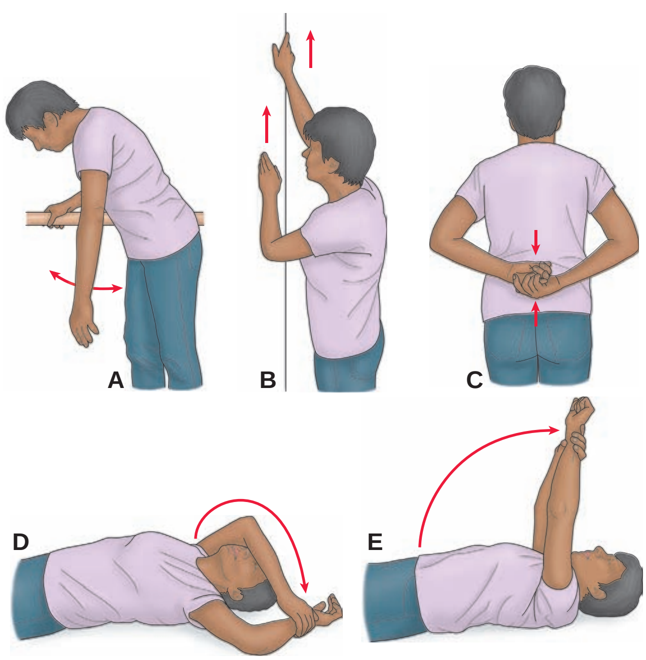



**Figure 69-8** Exercises that promote shoulder range of motion include **(A)** pendulum exercise and **(B)** wall climbing. The unaffected arm is used to assist with **(C)** internal rotation, **(D)** external rotation, and **(E)** elevation. In C, D, and E, the unaffected arm is used for power.

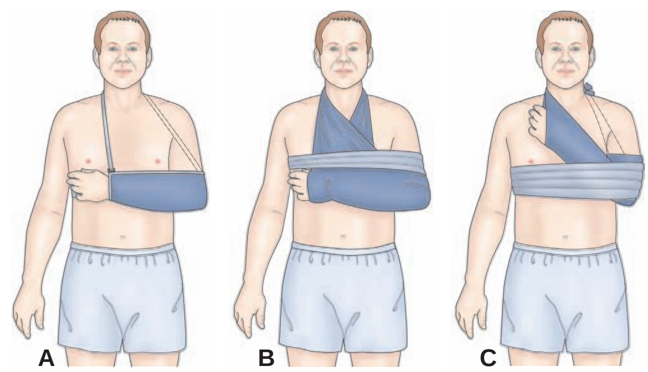



**Figure 69-9** Immobilizers for proximal humeral fractures. **A,** Commercial sling with immobilizing strap permits easy removal for hygiene and is comfortable on the neck. **B,** Conventional sling and swathe. **C,** Stockinette Velpeau and swathe are used when there is an unstable surgical neck component. This position relaxes the pectoralis major.

assessment of the extremity is essential to evaluate the full extent of injury and the possible involvement of the nerves and blood vessels of the arm.

Many impacted fractures of the surgical neck of the humerus are not displaced and do not require reduction. The arm is supported and immobilized by a sling and swathe that secure the supported arm to the trunk (Fig. 69-9). Limitation of motion and stiffness of the shoulder occur with disuse. Therefore, pendulum exercises begin as soon as tolerated by the patient. In pendulum or circumduction exercises, the physical therapist instructs the patient to lean forward and allow the affected arm to hang in abduction and rotate. These fractures require approximately 6 to 10 weeks to heal, and the patient should avoid vigorous arm activity for an additional 4 weeks. Residual stiffness, aching, and some limitation of ROM may persist for 6 months or longer.

When a humeral neck fracture is displaced, treatment consists of closed reduction, ORIF, or a total shoulder replacement. Exercises are begun after an adequate period of immobilization.

## HUMERAL SHAFT

Fractures of the shaft of the humerus are most frequently caused by (1) direct trauma that results in a transverse, oblique, or comminuted fracture or (2) an indirect twisting force that results in a spiral fracture. The nerves and brachial blood vessels may be injured with these fractures, so neurovascular assessment is essential to monitor the status of the nerve or blood vessels. Damage to either requires immediate attention.

Well-padded splints are used to initially immobilize the upper arm and to support the arm in 90 degrees of flexion at the elbow. A sling or collar and cuff support the forearm. The weight of the hanging arm and splints puts traction on the fracture site. External fixators are used to treat open fractures of the humeral shaft (see Chapter 67). ORIF of a fracture of the humerus is necessary with nerve palsy, blood vessel damage, comminuted fracture, or displaced fracture.

Functional bracing is another form of treatment used for these fractures. A contoured thermoplastic sleeve is secured in place with interlocking fabric (Velcro) closures around

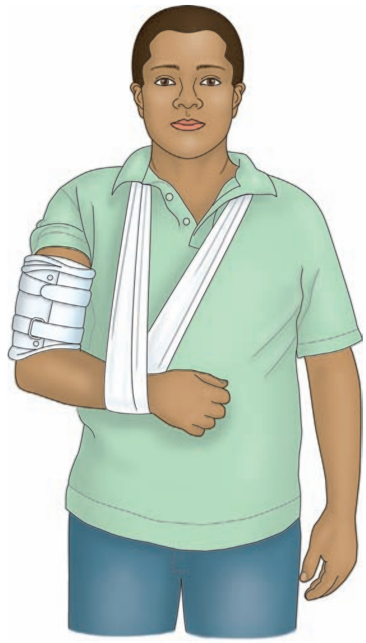


**Figure 69-10** Functional humeral brace with collar and cuff sling.

the upper arm, immobilizing the reduced fracture. As swelling decreases, the sleeve is tightened, and uniform pressure and stability are applied to the fracture. The forearm is supported with a collar and cuff sling (Fig. 69-10). Functional bracing allows active use of muscles, shoulder and elbow motion, and good approximation of fracture fragments. Pendulum shoulder exercises are performed as prescribed to provide active movement of the shoulder, thereby preventing a "frozen shoulder." Isometric exercises may be prescribed to prevent muscle atrophy. The callus that develops is substantial, and the sleeve can be discontinued in about 8 weeks. Complications that are seen with humeral shaft fractures include delayed union and nonunion because of decreased blood supply in that area.

## ELBOW

Fractures of the distal humerus result from motor vehicle crashes, falls on the elbow (in the extended or flexed position), or a direct blow. These fractures may result in injury to the median, radial, or ulnar nerves.

The patient is evaluated for paresthesia and signs of compromised circulation in the forearm and hand. The most serious complication of a supracondylar fracture of the humerus is Volkmann's contracture (an acute compartment syndrome), which results from antecubital swelling or damage to the brachial artery (Chart 69-3). The nurse needs to monitor the patient regularly for compromised neurovascular status and signs and symptoms of acute compartment syndrome. Other potential complications are damage to the joint articular surfaces and hemarthrosis (ie, blood in the joint), which may be treated by needle aspiration by the physician to relieve the pressure and pain.

The goal of therapy is prompt reduction and stabilization of the distal humeral fracture, followed by controlled active motion after swelling has subsided and healing has begun. If the fracture is not displaced, the arm is immobilized in a cast or posterior splint with the elbow at 45 to 90 degrees of flexion and placed in a sling. A thermoplastic splint is used to support the fracture.

Usually a displaced fracture is treated with ORIF. Excision of bone fragments may be necessary. Additional external support with a splint is then applied. Active finger exercises are encouraged. Gentle ROM exercise of the injured joint is begun about 1 week after internal fixation. Motion promotes healing of injured joints by producing movement of synovial fluid into the articular cartilage. Active exercise to prevent residual limitation of motion is performed as prescribed.

### Chart 69-3 • *Volkmann's Contracture*

- Observe the distal part of the extremity for swelling, skin color, nail bed capillary refill, and temperature. Compare affected and unaffected hands.
- Assess radial pulse.
- Assess for paresthesia (tingling and burning sensations) in the hand, which may indicate nerve injury or impending ischemia.
- Evaluate the patient's ability to extend and flex all the fingers.
- Explore the intensity and character of the pain.
- Directly measure tissue pressure as prescribed.
- Report indications of diminished nerve function or diminished circulatory perfusion promptly before irreparable damage occurs; fasciotomy may become necessary.

## RADIAL HEAD

Radial head fractures are common and are usually produced by a fall on an outstretched hand with the elbow extended. If blood has collected in the elbow joint, it is aspirated to relieve pain and to allow early active elbow and forearm ROM exercises. Immobilization for nondisplaced fractures is accomplished with a splint. The patient is instructed not to lift with the arm for approximately 4 weeks. If the fracture is displaced, surgery is typically indicated, with excision of the radial head when necessary. Postoperatively, the arm is immobilized in a posterior plaster splint and sling and an appropriate exercise regimen is prescribed.

## RADIAL AND ULNAR SHAFTS

Fractures of the shaft of the bones of the forearm occur more frequently in children than in adults. The radius or the ulna may be fractured at any level. Frequently, displacement occurs when both bones are broken. The forearm's unique functions of pronation and supination must be preserved with proper anatomic alignment.

If the fragments are not displaced, the fracture is treated by closed reduction with a long-arm cast applied from the upper arm to the proximal palmar crease. Circulation, motion, and sensation of the hand are assessed before and after the cast is applied. The arm is elevated to control edema. Frequent finger flexion and extension are encouraged to reduce edema. Active motion of the involved shoulder is

essential. The reduction and alignment are monitored closely by x-rays to ensure proper alignment. The fracture is immobilized for about 12 weeks; during the last 6 weeks, the arm may be in a functional forearm brace that allows exercise of the wrist and elbow. Lifting and twisting are avoided.

Displaced fractures are managed by ORIF, using a compression plate with screws, intramedullary nails, or rods. The arm is usually immobilized in a plaster splint or cast. Open and displaced fractures may be managed with external fixation devices. The arm is elevated to control swelling. Neurovascular status is assessed and documented. Elbow, wrist, and hand exercises are begun when prescribed by the physician.

## WRIST

Fractures of the distal radius (Colles fracture) are common and are usually the result of a fall on an open, dorsiflexed hand. This fracture is frequently seen in elderly women with osteoporotic bones and weak soft tissues that do not dissipate the energy of the fall. The patient presents with a deformed wrist, pain, swelling, weakness, limited finger ROM, and complaints of "tingling" in the affected hand.

Treatment usually consists of closed reduction and immobilization with a short-arm cast. For fractures with extensive comminution, ORIF, arthroscopic percutaneous pinning, or external fixation is used to achieve and maintain reduction. The wrist and forearm are elevated for 48 hours after reduction to control swelling.

Active motion of the fingers and shoulder should begin promptly. The patient is taught to perform the following exercises to reduce swelling and prevent stiffness:

- Hold the hand at the level of the heart.
- Move the fingers from full extension to flexion. Hold and release. (Repeat at least 10 times every hour when awake.)
- Use the hand in functional activities.
- Actively exercise the shoulder and elbow, including complete ROM exercises of both joints.

The fingers may swell due to diminished venous and lymphatic return. The nurse assesses the sensory function of the median nerve by pricking the distal aspect of the index finger. The motor function is assessed by the patient's ability to touch the thumb to the little finger. Diminished circulation and nerve function must be treated promptly (see previous discussion of Compartment Syndrome).

## HAND

Trauma to the hand often requires extensive reconstructive surgery. The objective of treatment is always to regain maximum function of the hand.

For a nondisplaced fracture of the phalanx (finger bone), the finger is splinted for 3 to 4 weeks to relieve pain and to protect the finger from further trauma. Displaced fractures and open fractures may require ORIF, using wires or pins.

The neurovascular status of the injured hand is evaluated and documented. Swelling is controlled by elevation of the hand. Functional use of the uninvolved portion of the hand is encouraged. Assistive devices might be recommended to aid the patient in performing ADLs until the hand has healed and functional status returns.

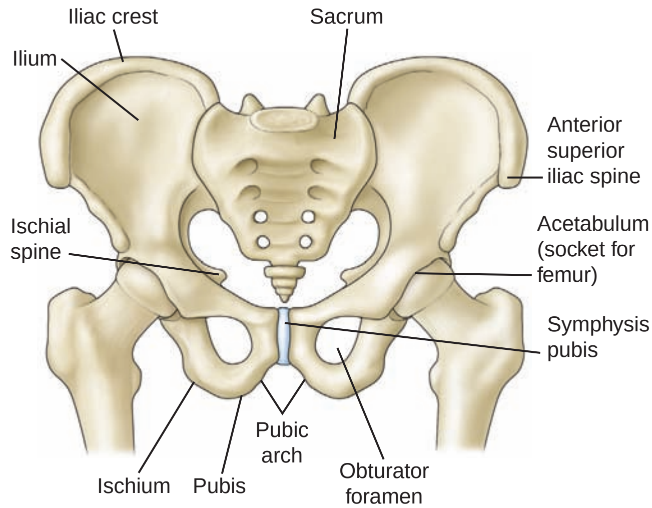



**Figure 69-11** Pelvic bones.

## PELVIS

The sacrum, ilium, pubis, and ischium bones form the pelvic bone, a fused, stable, bony ring in adults (Fig. 69-11). Falls, motor vehicle crashes, and crush injuries can cause pelvic fractures. Pelvic fractures are serious because at least two thirds of affected patients have significant and multiple injuries. Management of severe, life-threatening pelvic fractures is coordinated with the trauma team. Hemorrhage and thoracic, intra-abdominal, and cranial injuries have priority over treatment of fractures. There is a high mortality rate associated with pelvic fractures, related to hemorrhage, pulmonary complications, fat emboli, thromboembolic complications, and infection.

Signs and symptoms of pelvic fracture include ecchymosis; tenderness over the symphysis pubis, anterior iliac spines, iliac crest, sacrum, or coccyx; local edema; numbness or tingling of the pubis, genitals, and proximal thighs; and inability to bear weight without discomfort. Computed tomography (CT) of the pelvis helps determine the extent of injury by demonstrating sacroiliac joint disruption, soft tissue trauma, pelvic hematoma, and fractures. Neurovascular assessment of the lower extremities is completed to detect any injury to pelvic blood vessels and nerves (Kobziff, 2006).

Hemorrhage and shock are two of the most serious consequences that may occur. Bleeding arises mainly from the laceration of veins and arteries by bone fragments and possibly from a torn iliac artery. The peripheral pulses, especially the dorsalis pedis pulses of both lower extremities, are palpated; absence of a pulse may indicate a tear in the iliac artery or one of its branches. Peritoneal lavage or abdominal CT may be performed to detect intra-abdominal hemorrhage. The patient is handled gently to minimize further bleeding and shock (Bucholz, et al., 2005).

The nurse assesses for injuries to the bladder, rectum, intestines, other abdominal organs, and pelvic vessels and nerves. To assess for urinary tract injury, the patient's urine is analyzed for blood. A voiding cystourethrogram and an IV urogram may be performed. Laceration of the urethra is suspected in males with anterior fracture of the pelvis and blood at the urethral meatus (Bucholz, et al., 2005). Females

rarely experience a lacerated urethra. A urinary drainage catheter should not be inserted until the status of the urethra is known. Diffuse and intense abdominal pain, hyperactive or absent bowel sounds, and abdominal rigidity and resonance (free air) or dullness to percussion (blood) suggest injury to the intestines or abdominal bleeding.

Numerous classification systems have been used to describe pelvic fractures in relation to anatomy, stability, and mechanism of injury. Some fractures of the pelvis do not disrupt the pelvic ring; others disrupt the ring, which may be rotationally or vertically unstable. The severity of pelvic fractures varies. Long-term complications of pelvic fractures include malunion, nonunion, residual gait disturbances, and back pain from ligament injury.

## Stable Pelvic Fractures

Stable fractures of the pelvis (Fig. 69-12) include fracture of a single pubic or ischial ramus, fracture of ipsilateral pubic and ischial rami, fracture of the pelvic wing of the ilium (Duverney fracture), and fracture of the sacrum or coccyx. If injury results in only a slight widening of the pubic symphysis or the anterior sacroiliac joint and the pelvic ligaments are intact, the disrupted pubic symphysis is likely to heal spontaneously with conservative management. Most fractures of the pelvis heal rapidly because the pelvic bones are mostly cancellous bone, which has a rich blood supply.

Stable pelvic fractures are treated with a few days of bed rest and symptom management until discomfort is controlled. Fluids, dietary fiber, ankle and leg exercises, anti-embolism stockings to aid venous return, logrolling, deep breathing, and skin care reduce the risk of complications and increase the patient's comfort. The patient with a fractured sacrum is at risk for paralytic ileus; therefore, bowel sounds should be monitored.

The patient with a fracture of the coccyx experiences pain when sitting and when defecating. Sitz baths may be prescribed to relieve pain, and stool softeners may be given to ease defecation. As pain resolves, activity is gradually resumed with the use of assistive mobility devices. Early mobilization reduces problems related to immobility.

## Unstable Pelvic Fractures

Unstable fractures of the pelvis (Fig. 69-13) may result in rotational instability (eg, the "open book" type, in which a separation occurs at the symphysis pubis with sacroiliac

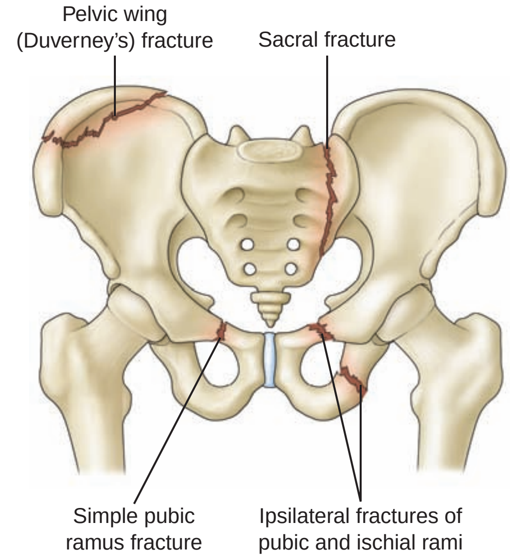



**Figure 69-12** Stable pelvic fractures.

ligament disruption), vertical instability, or a combination of both. Lateral or anterior–posterior compression of the pelvis produces rotationally unstable pelvic fractures. Vertically unstable pelvic fractures occur when force is exerted on the pelvis vertically, as may occur when the patient falls onto extended legs or is struck from above by a falling object. Vertical shear pelvic fractures involve the anterior and posterior pelvic ring with vertical displacement, usually through the sacroiliac joint. There is generally complete disruption of the posterior sacroiliac, sacrospinous, and sacrotuberous ligaments.

Immediate treatment in the emergency department of a patient with an unstable pelvic fracture includes stabilizing the pelvic bones and compressing bleeding vessels with a pelvic girdle, an external binding and stabilizing device. If major vessels are lacerated, the bleeding may be stopped through embolization using interventional radiology techniques prior to surgery. Approximately 20% of patients with unstable pelvic fractures bleed excessively, requiring more than 15 units of blood products within the first 24 hours after injury (Bongiovanni, Bradley & Kelley, 2005). These patients are at risk for hemorrhagic shock (see Chapter 15 for nursing management of the patient in shock). When the

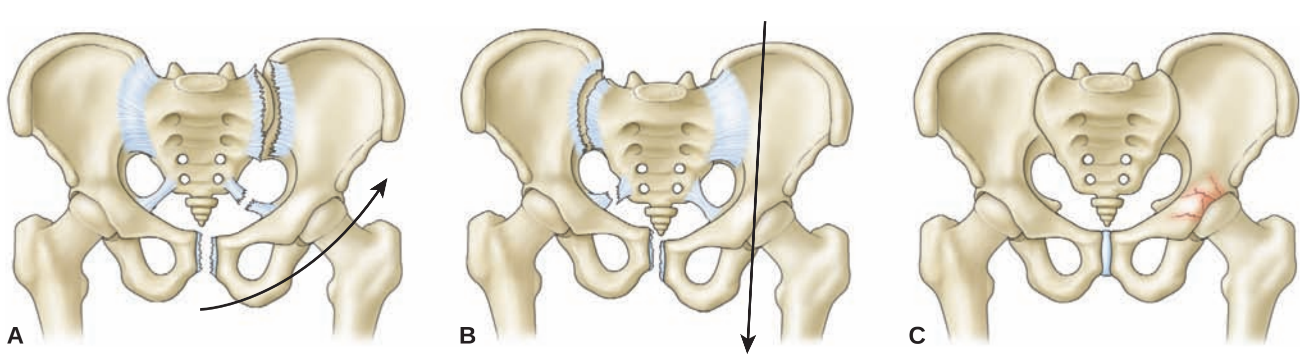



**Figure 69-13** Unstable pelvic fracture. **A,** Rotationally unstable fracture. The symphysis pubis is separated and the anterior sacroiliac, sacrotuberous, and sacrospinous ligaments are disrupted. **B,** Vertically unstable fracture. The hemipelvis is displaced anteriorly and posteriorly through the symphysis pubis, and the sacroiliac joint ligaments are disrupted. **C,** Undisplaced fracture of the acetabulum.

patient is hemodynamically stable, treatment generally involves external fixation or ORIF. These measures promote hemostasis, hemodynamic stability, comfort, and early mobilization.

### Acetabulum

Drivers and passengers sitting in the right front seat in motor vehicle crashes may forcibly propel their knees into the dashboard, injuring the knee-thigh-hip complex (Rupp & Schneider, 2004). The acetabulum is particularly vulnerable to fracture with injuries. Treatment depends on the pattern of fracture. Stable, nondisplaced fractures may be managed with traction and protective weight bearing so that the affected foot is only placed on the floor for balance. Displaced and unstable acetabular fractures are treated with open reduction, joint débridement, and internal fixation or arthroplasty. Internal fixation permits early non–weight-bearing ambulation and ROM exercise. Complications seen with acetabular fractures include nerve palsy, heterotopic ossification, and posttraumatic arthritis.

## HIP

Elderly people (particularly women) who have low bone density from osteoporosis and who tend to fall frequently have a high incidence of hip fracture. Weak quadriceps muscles, general frailty due to age, and conditions that produce decreased cerebral arterial perfusion (transient ischemic attacks, anemia, emboli, cardiovascular disease, effects of medications) contribute to the incidence of falls. Mortality rates 1 year post–hip fracture range between 12% and 32% (Schoen, 2006).

There are two major types of hip fracture. *Intracapsular fractures* are fractures of the neck of the femur. *Extracapsular fractures* are fractures of the trochanteric region (between the base of the neck and the lesser trochanter of the femur) and of the subtrochanteric region (Fig. 69-14). Fractures of the neck of the femur may damage the vascular system that supplies blood to the head and the neck of the femur, and the bone may become ischemic. For this reason, AVN is common in patients with femoral neck fractures.

Extracapsular intertrochanteric fractures have an excellent blood supply and heal more rapidly. However, extensive soft tissue damage may occur at the time of injury. It is not uncommon for the fracture to be comminuted and unstable. The elderly are particularly vulnerable to intertrochanteric fractures and do not have a prognosis as favorable as younger patients.

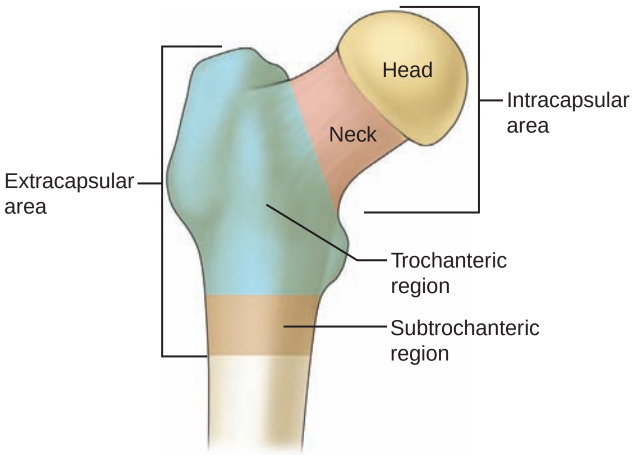



**Figure 69-14** Regions of the proximal femur.

### Clinical Manifestations

With fractures of the femoral neck, the leg is shortened, adducted, and externally rotated. The patient reports pain in the hip and groin or in the medial side of the knee. With most fractures of the femoral neck, the patient cannot move the leg without a significant increase in pain. The patient is most comfortable with the leg slightly flexed in external rotation. Impacted intracapsular femoral neck fractures cause moderate discomfort (even with movement), may allow the patient to bear weight, and may not demonstrate obvious shortening or rotational changes. With extracapsular femoral fractures of the trochanteric or subtrochanteric regions, the extremity is significantly shortened, externally rotated to a greater degree than intracapsular fractures, exhibits muscle spasm that resists positioning of the extremity in a neutral position, and has an associated area of ecchymosis. The diagnosis is confirmed by x-ray.

### Gerontologic Considerations

Hip fractures cause more than 340,000 hospitalizations annually among adults 65 years of age and older (Schoen, 2006). They are frequent contributors to physical disability and institutionalization among the elderly (Schoen, 2006). Stress and immobility related to the trauma predispose the older adult to atelectasis, pneumonia, sepsis, venous thromboemboli, pressure ulcers, and reduced ability to cope with other health problems. Many elderly people hospitalized with hip fractures exhibit delirium as a result of the stress of the trauma, unfamiliar surroundings, sleep deprivation, and medications. In addition, delirium that develops in some elderly patients may be caused by mild cerebral ischemia or mild hypoxemia. Other factors associated with delirium include responses to medications and anesthesia, malnutrition, dehydration, infectious processes, mood disturbances, and blood loss (see Chapter 12).

To prevent complications, the nurse must assess the elderly patient for chronic conditions that require close monitoring. Examination of the legs may reveal edema due to heart failure or absence of peripheral pulses from peripheral vascular disease. Similarly, chronic respiratory problems may be present and may contribute to the possible development of atelectasis or pneumonia. Coughing and deep-breathing exercises are encouraged. Frequently, elderly people take cardiac, antihypertensive, or respiratory medications that need to be continued. The patient's responses to these medications should be monitored.

Dehydration and poor nutrition may be present. At times, elderly people who live alone cannot call for help at the time of injury. A day or two may pass before assistance is provided, and as a result dehydration occurs. Dehydration contributes to hemoconcentration and predisposes the patient to the development of venous thromboemboli. Dehydration, inadequate nutritional intake, and immobility contribute to the development of pressure ulcers. Therefore, the patient needs

to be encouraged to consume adequate fluids and a healthy diet.

Muscle weakness may have initially contributed to the fall and fracture. Bed rest and immobility cause an additional loss of muscle strength unless the nurse encourages the patient to move all joints except the involved hip and knee. Patients are encouraged to use their arms and the overhead trapeze to reposition themselves. This strengthens the arms and shoulders, which facilitates walking with assistive devices.

## Medical Management

Buck's extension traction, a type of temporary skin traction, may be applied to reduce muscle spasm, to immobilize the extremity, and to relieve pain, although its efficacy has not been demonstrated in clinical trials (Parker & Handoll, 2006). The goal of surgical treatment of hip fractures is to obtain a satisfactory fixation so that the patient can be mobilized quickly and avoid secondary medical complications. Surgical treatment consists of (1) open or closed reduction of the fracture and internal fixation, (2) replacement of the femoral head with a prosthesis (hemiarthroplasty), or (3) closed reduction with percutaneous stabilization for an intracapsular fracture. Surgical intervention is carried out as soon as possible after injury. The preoperative objective is to ensure that the patient is in as favorable a condition as possible for the surgery. Displaced femoral neck fractures are treated as emergencies, with reduction and internal fixation performed within 12 to 24 hours after fracture. The femoral head is often replaced with a prosthesis if there is complete disruption of blood flow to the femoral head, which may cause AVN.

After general or spinal anesthesia, the hip fracture is reduced under x-ray visualization. A stable fracture is usually fixed with nails, a nail-and-plate combination, multiple pins, or compression screw devices (Fig. 69-15). The orthopedic surgeon determines the specific fixation device based on the fracture site or sites. Adequate reduction is important for fracture healing: the better the reduction, the better the healing.

Total hip replacement (see Chapter 67) may be used in selected patients with acetabular defects.

## Nursing Management

The immediate postoperative care for a patient with a hip fracture is similar to that for other patients undergoing major surgery (see Chapters 20 and 67). Attention is given to pain management, prevention of secondary medical problems, and early mobilization of the patient so that independent functioning can be restored (Chart 69-4).

During the first 24 to 48 hours, relief of pain and prevention of complications are important, and continuous neurovascular assessment is essential. The nurse encourages deep breathing and dorsiflexion and plantar flexion exercises every 1 to 2 hours. Thigh-high anti-embolism stockings or pneumatic compression devices are used, and anticoagulants are administered as prescribed to prevent the formation of venous thromboemboli. The nurse administers prescribed prophylactic IV antibiotics and monitors the patient's hydration, nutritional status, and urine output. A pillow placed between the legs is essential to maintain abduction and alignment and provide needed support when turning the patient.

### Repositioning the Patient

The most comfortable and safest way to turn the patient is to turn to the uninjured side. The standard method involves placing a pillow between the patient's legs to keep the affected leg in an abducted position. Proper alignment and supported abduction are maintained while turning.

### Promoting Exercise

The patient is encouraged to exercise as much as possible by means of the overbed trapeze. This device helps strengthen the arms and shoulders in preparation for protected ambulation (eg, toe touch, partial weight bearing). On the first postoperative day, the patient transfers to a chair with assistance and begins assisted ambulation. The amount of weight bearing that can be permitted depends on the stability of the fracture reduction. The physician prescribes the degree of weight bearing. In general, hip flexion and internal rotation restrictions apply only if the patient has had a hemiarthroplasty or total arthroplasty (see Chapter 67). Physical therapists

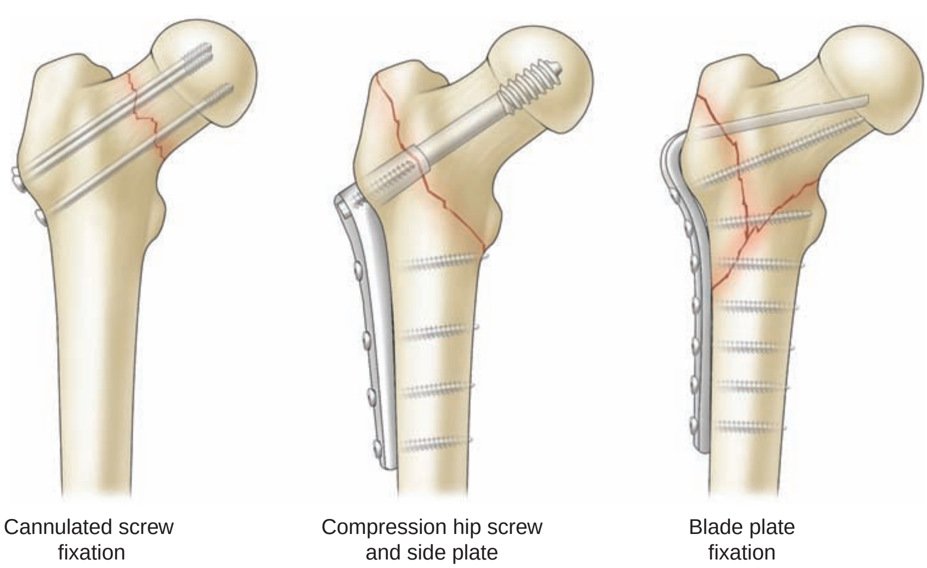



**Figure 69-15** Examples of internal fixation for hip fractures. Internal fixation is achieved through the use of screws and plates specifically designed for stability and fixation.

CHART 69-4 NURSING RESEARCH PROFILE

## Functional Recovery After Hip Fracture Surgery

Folden, S. & Tappen, R. (2007). Factors influencing function and recovery following hip repair surgery. *Orthopaedic Nursing, 26*(4), 234–241.

### Purpose

The incidence of hip fractures will rise with the projected aging of the American population. Most hip fractures are repaired surgically and incur high rates of morbidity and mortality. Although prior research identifies factors associated with functional recovery following hip repair surgery for patients with hip fractures, these studies utilized data gathered close to the time of surgery. There is sparse research targeted at identifying factors that influence functional recovery following hip repair surgery more than 1 month postoperatively. Therefore, the purpose of this study was to identify factors that are associated with improved functional recovery 3 months post–hip repair surgery.

### Design

Seventy-three patients who had hip repair surgery post–hip fracture and who were enrolled in a study on the effects of a postoperative educational intervention provided data for this study, which used secondary analysis of data from a previous study. The mean age of this sample was 73.93 years (SD = 8.40) and most participants were Caucasian (98.4%) and female (66.7%). All participants had hip repair surgery, were admitted to rehabilitation units posthospital discharge, and were planning to return to their communities postrehabilitation. Participants had to be able to read and write English and had to demonstrate satisfactory mental status by achieving a minimum score on the Mini-Mental Status Exam (MMSE) in order to be able to participate in the original study (and therefore also to provide data for this secondary analysis).

A variety of factors that affect functional recovery were assessed on these participants using self-report measures. These included fatigue, measured with the Fatigue Severity Scale (FSS); depression, measured with the Center for Epidemiologic Studies–Depression Scale (CES-D); fear of falling, measured with the Fall Efficacy Scale (FES); cognitive status, measured with the MMSE; pain, measured with a visual analog scale (VAS); performance of activities of daily living (ie, functional level), measured with the Functional Life Scale (FLS); and balance, measured with the Berg Balance Scale. Functional recovery was calculated by subtracting participants' FLS scores at 3 months from the FLS scores they reported preoperatively.

### Findings

Cognitive status and balance were the best predictors of functional recovery 3 months postdischarge among sampled patients who had hip repair surgery. In addition, men had higher functional levels 3 months postdischarge and had a greater likelihood of returning to their preoperative functional level.

### Nursing Implications

Results from this study suggest that the best predictors of functional recovery among patients who have hip repair surgery are improved balance and cognitive status. Women may be at higher risk of not achieving functional recovery. Nurses are in ideal positions to educate postoperative hip repair patients of the potential benefits of engaging in exercise regimens that improve balance, including resistance exercises, yoga, and tai chi.

work with the patient on transfers, ambulation, and the safe use of assistive devices.

The patient can anticipate discharge to home or to an extended care facility with the use of assistive devices (see Chapter 11). Some modifications in the home may be needed, such as installation of elevated toilet seats and grab bars.

#### *Monitoring and Managing Potential Complications*

Elderly people with hip fractures are prone to complications that may require more vigorous treatment. Achievement of homeostasis after injury and after surgery is accomplished through careful monitoring and collaborative management.

Neurovascular complications may occur from direct injury or edema in the area that causes compression of nerves and blood vessels. With hip fracture, bleeding into the tissues and edema are expected. Monitoring and documenting the neurovascular status of the affected leg are vital.

To prevent DVT, the nurse encourages intake of fluids and ankle and foot exercises. Anti-embolism stockings, pneumatic compression devices, and prophylactic anticoagulant therapy may be prescribed. Assessment of the patient's legs every 2 to 4 hours for signs of DVT, which may include unilateral calf tenderness, warmth, redness, and swelling, is indicated.

Pulmonary complications (eg, atelectasis, pneumonia) are a threat to elderly patients undergoing hip surgery. Coughing and deep-breathing exercises, a change of position at least every 2 hours, and the use of an incentive spirometer may help prevent respiratory complications. Pain must be treated with analgesic agents, typically opioids; otherwise, the patient may not be able to cough, deep breathe, or engage in prescribed activities. The nurse assesses breath sounds at least every 2 to 4 hours to detect adventitious or diminished sounds.

Skin breakdown is often seen in elderly patients with hip fracture. Blisters caused by tape are related to the tension of soft tissue edema under the nonelastic tape. An elastic hip wrap dressing or elastic tape applied in a vertical fashion may reduce the incidence of tape blisters. In addition, patients with hip fractures tend to remain in one position and may develop pressure ulcers. Proper skin care, especially on the bony prominences, helps to relieve pressure. High-density foam mattress overlays may provide protection by distributing pressure evenly.

Loss of bladder control (incontinence or retention) may occur. In general, the routine use of an indwelling catheter is avoided because of the high risk for urinary tract infection. If a catheter is inserted at the time of surgery, it usually

is removed on the first postoperative day. Because urinary retention is common after surgery, the nurse must assess the patient's voiding patterns. To ensure proper urinary tract function, the nurse encourages liberal fluid intake if the patient has no preexisting cardiac disease.

Delayed complications of hip fractures include infection, nonunion, AVN of the femoral head (particularly with femoral neck fractures), and fixation device problems (eg, protrusion of the fixation device through the acetabulum, loosening of hardware). Infection is suspected if the patient complains of constant pain in the hip and has an elevated erythrocyte sedimentation rate.

The nursing management of the elderly patient with a hip fracture is summarized in the Plan of Nursing Care (Chart 69-5).

#### *Health Promotion*

Osteoporosis screening of patients who have experienced hip fracture is important for prevention of future fractures. With dual-energy x-ray absorptiometry (DXA) scan testing, the risk for additional fracture can be predicted. Specific patient education regarding dietary requirements, lifestyle changes, and weight-bearing exercise to promote bone health is needed. Specific therapeutic interventions need to be initiated to slow bone loss and to build bone mineral density (see Chapter 68). Prevention of falls is also important and may be achieved through exercises to improve muscle tone and balance and through the elimination of environmental hazards.

## FEMORAL SHAFT

Considerable force is required to break the shaft of a femur in adults. Most femoral fractures occur in young adults who have been involved in a motor vehicle crash or who have fallen from a high place. Frequently, these patients have associated multiple injuries.

The patient presents with an edematous, deformed, painful thigh and cannot move the hip or the knee. The fracture may be transverse, oblique, spiral, or comminuted. Frequently the patient develops shock, because the loss of 2 to 3 units of blood into the tissues is common with these fractures. The diameter of the thigh should be closely monitored because expansion may indicate continued bleeding. Types of femoral fractures are illustrated in Figure 69-16A.

### Assessment and Diagnostic Findings

Assessment includes checking the neurovascular status of the extremity, especially circulatory perfusion of the lower leg and foot (popliteal, posterior tibial, and pedal pulses and toe capillary refill time). A Doppler ultrasound may be indicated to assess blood flow. Dislocation of the hip and knee may accompany these fractures. Knee effusion suggests ligament damage and possible instability of the knee joint.

### Medical Management

Continued neurovascular monitoring and documentation are important. The fracture is immobilized so that additional soft tissue damage does not occur. Generally, skeletal traction (Fig. 69-16B,C) or splinting is used to immobilize fracture fragments until the patient is physiologically stable and ready for ORIF procedures.

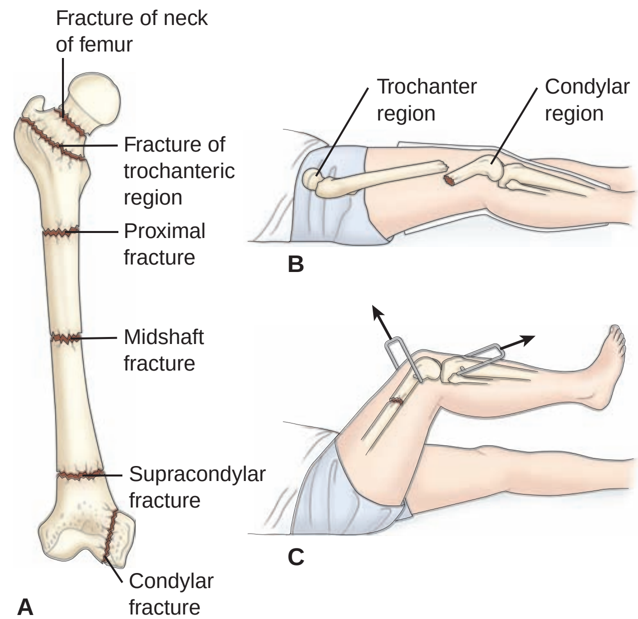



**Figure 69-16** **A,** Types of femoral fractures. **B,** Example of deformity on admission to hospital. **C,** Adequate reduction is achieved when additional wire is inserted in the lower femoral fragment and vertical lift is secured.

Internal fixation usually is carried out within 24 hours after injury (Scalea, 2008). Intramedullary locking nail devices are used for midshaft (diaphyseal) fractures. Depending on the supracondylar fracture pattern, intramedullary nailing or screw plate fixation may be used. Internal fixation permits early mobilization. A thigh cuff orthosis may be used for external support. To preserve muscle strength, the patient is instructed to exercise the hip and the lower leg, foot, and toes on a regular basis. Active muscle movement enhances healing by increasing blood supply and electrical potentials at the fracture site. Prescribed weight-bearing limits are based on the type and location of the fracture and treatment approach. Physical therapy includes ROM and strengthening exercises, safe use of assistive devices, and gait training. Ambulation stimulates fracture healing in approximately 4 to 6 months.

Compression plates and intramedullary nails are sometimes removed after 12 to 18 months due to loosening. After the plates are removed, a thigh cuff orthosis is used for several months to provide support while bone remodeling takes place.

Infrequently because of patient risk associated with anesthesia and surgery, middle shaft and distal fractures may be managed with skeletal traction. Between 2 and 4 weeks after injury, when pain and swelling have subsided, skeletal traction is removed and the patient is placed in a cast brace. The cast brace is a total contact device (ie, encircles the limb) and holds the reduced fracture. The muscle, through hydrodynamic compression, stabilizes the bone and stimulates healing. Minimal partial weight bearing is begun and is progressed to full weight bearing as tolerated. The cast brace is worn for 12 to 14 weeks.

An external fixator may be used if the patient has experienced an open fracture, has extensive soft tissue trauma, has lost bone, has an infection, or has hip and tibial fractures.

CHART 69-5

PLAN OF NURSING CARE

## *Care of the Elderly Patient With a Fractured Hip*

**NURSING DIAGNOSIS:** Acute pain related to fracture, soft tissue damage, muscle spasm, and surgery
**GOAL:** Relief of pain

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess type and location of patient's pain whenever vital signs are obtained and as needed. | 1. Pain is expected after fracture; soft tissue damage and muscle spasm contribute to discomfort; pain is subjective and is best evaluated on a pain scale of 0 to 10 and through description of characteristics and location, which are important for identifying cause of discomfort and for proposing interventions. Continuing pain may indicate development of neurovascular problems. Pain must be assessed periodically to gauge effectiveness of continuing analgesic therapy. | • Patient describes and rates pain on scale of 0 to 10<br>• Expresses confidence in efforts to control pain<br>• Expresses comfort with position changes<br>• Expresses comfort when leg is positioned and immobilized<br>• Minimizes movement of extremity before reduction and fixation<br>• Uses physical, psychological, and pharmacologic measures to reduce discomfort<br>• Describes a decrease in pain in 24 to 48 hours after surgery<br>• Requests pain medications and uses pain relief measures early in pain cycle<br>• States that positioning provides comfort<br>• Appears comfortable and relaxed<br>• Moves with increasing comfort as healing progresses |
| 2. Acknowledge existence of pain; inform patient of available analgesics; record patient's baseline discomfort. | 2. Reduces stress experienced by the patient by communicating concern and availability of help in dealing with pain. Documentation provides baseline data. | |
| 3. Handle the affected extremity gently, supporting it with hands or pillow. | 3. Movement of bone fragments is painful; muscle spasms occur with movement; adequate support diminishes soft tissue tension. | |
| 4. Apply Buck's traction if prescribed. Use trochanter roll. | 4. Immobilizes fracture to decrease pain, muscle spasm, and external rotation of hip. | |
| 5. Use pain-modifying strategies. | 5. Pain perception can be diminished by distraction and refocusing of attention. | |
| a. Modify the environment. | a. Interaction with others, distraction, and environmental stimuli may modify pain experiences. | |
| b. Administer prescribed analgesics as needed. | b. Analgesics reduce the pain; muscle relaxants may be prescribed to decrease discomfort associated with muscle spasm. | |
| c. Encourage patient to use pain relief measures to relieve pain. | c. Mild pain is easier to control than severe pain. | |
| d. Evaluate patient's response to medications and other pain-reduction techniques. | d. Assessment of effectiveness of measures provides basis for future management interventions; early identification of adverse reactions is necessary for corrective measures and care plan modifications. | |
| e. Consult with physician if relief of pain is not obtained. | e. Change in treatment plan may be necessary. | |
| 6. Position for comfort and function. | 6. Alignment of body facilitates comfort; positioning for function diminishes stress on musculoskeletal system. | |
| 7. Assist with frequent changes in position. | 7. Change of position relieves pressure and associated discomfort. | |

*Continued on following page*

CHART 69-5

## PLAN OF NURSING CARE
### *Care of the Elderly Patient With a Fractured Hip (Continued)*

**NURSING DIAGNOSIS:** Impaired physical mobility related to fractured hip
**GOAL:** Achieves pain-free, functional, stable hip

| Nursing Interventions | Rationale |
| --- | --- |
| 1. Maintain neutral positioning of hip. | 1. Prevents stress at the site of fixation. |
| 2. Use trochanter roll; roll to uninjured side. | 2. Minimizes external rotation. |
| 3. Place pillow between legs when turning. | 3. Supports leg; prevents adduction. |
| 4. Instruct and assist in position changes and transfers. | 4. Encourages patient's active participation while preventing stress on hip fixation. |
| 5. Instruct in and supervise isometric, quadriceps-setting, and gluteal-setting exercises. | 5. Strengthens muscles needed for walking. |
| 6. Encourage use of trapeze. | 6. Strengthens shoulder and arm muscles necessary for use of ambulatory aids. |
| 7. In consultation with physical therapist, instruct in and supervise progressive safe ambulation within limitations of weight-bearing prescription. | 7. Amount of weight bearing depends on the patient's condition, fracture stability, and fixation device; ambulatory aids are used to assist the patient with non–weight-bearing and partial-weight-bearing ambulation. |
| 8. Offer encouragement and support exercise regimen. | 8. Reconditioning exercises can be uncomfortable and fatiguing; encouragement helps patient comply with the program. |
| 9. Instruct in and supervise safe use of ambulatory aids. | 9. Prevents injury from unsafe use. |

**Expected Outcomes**

- Patient engages in therapeutic positioning
- Uses pillow between legs when turning
- Assists in position changes; shows increased independence in transfers
- Exercises every 2 hours while awake
- Uses trapeze
- Participates in progressive ambulation program
- Actively participates in exercise regimen
- Uses ambulatory aids correctly and safely

**NURSING DIAGNOSIS:** Risk for infection related to surgical incision
**GOAL:** Maintains asepsis

| Nursing Interventions | Rationale |
| --- | --- |
| 1. Monitor vital signs. | 1. Temperature, pulse, and respiration increase in response to infection. (Magnitude of response may be minimal in elderly patients.) |
| 2. Perform aseptic dressing changes. | 2. Avoids introducing infectious organisms. |
| 3. Assess wound appearance and character of drainage. | 3. Red, swollen, draining incision is indicative of infection. |
| 4. Assess report of pain. | 4. Pain may be due to wound hematoma, a possible locus of infection, which needs to be surgically evacuated. |
| 5. Administer prophylactic antibiotic if prescribed, and observe for side effects. | 5. Antibiotics reduce the risk for infection. |

**Expected Outcomes**

- Patient maintains vital signs within normal range
- Exhibits well-approximated incision without drainage or excessive inflammatory response
- Relates minimal discomfort; demonstrates no hematoma
- Tolerates antibiotics; exhibits no evidence of osteomyelitis

**NURSING DIAGNOSIS:** Readiness for enhanced urinary elimination related to immobility
**GOAL:** Maintains normal urinary elimination patterns

| Nursing Interventions | Rationale |
| --- | --- |
| 1. Monitor intake and output. | 1. Adequate fluid intake ensures hydration; adequate urinary output minimizes urinary stasis. |
| 2. Avoid/minimize use of indwelling catheter. | 2. Source of bladder infection. |
| 3. Perform intermittent catheterization for urinary retention. | 3. Empties bladder; reduces urinary tract infections. |

**Expected Outcomes**

- Intake and output are adequate; patient exhibits normal voiding patterns
- Demonstrates no evidence of urinary tract infection

*Continued*

CHART 69-5

PLAN OF NURSING CARE

## *Care of the Elderly Patient With a Fractured Hip* (Continued)

**NURSING DIAGNOSIS:** Readiness for enhanced coping related to injury, anticipated surgery, and dependence
**GOAL:** Uses effective coping mechanisms to modify stress

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Encourage patient to express concerns and to discuss the possible impact of fractured hip. | 1. Verbalization helps patient deal with problems and feelings. Clarification of thoughts and feelings promotes problem solving. | • Patient describes feelings concerning fractured hip and implications for lifestyle<br>• Uses available resources and coping mechanisms; develops health promotion strategies<br>• Uses community resources as needed<br>• Participates in development of health care plan |
| 2. Support use of coping mechanisms. Involve significant others and support services as needed. | 2. Coping mechanisms modify disabling effects of stress; sharing concerns lessens the burden and facilitates necessary modification. | |
| 3. Contact social services, if needed. | 3. Anxiety may be related to financial or social problems; facilitates management of problems associated with continuing care. | |
| 4. Explain anticipated treatment regimen and routines to facilitate positive attitude in relation to rehabilitation. | 4. Understanding of plan of care helps to diminish fears of the unknown. | |
| 5. Encourage patient to participate in planning. | 5. Participating in care provides for some control of self and environment. | |

**NURSING DIAGNOSIS:** Risk for disturbed thought process related to age, stress of trauma, unfamiliar surroundings, and medication therapy
**GOAL:** Remains oriented and participates in decision making

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess orientation status. | 1. Evaluate presenting orientation of patient; confusion may result from stress of fracture, unfamiliar surroundings, coexisting systemic disease, cerebral ischemia, hypoxemia, or other factors. Baseline data are important for determining change. | • Patient establishes effective communication<br>• Demonstrates orientation to time, place, and person<br>• Participates in self-care activities<br>• Remains mentally alert<br>• Avoids episodes of confusion |
| 2. Interview family regarding patient's orientation and cognitive abilities before injury. | 2. Provides data for evaluation of current findings. | |
| 3. Assess patient for auditory and visual deficits. | 3. Diminished vision and auditory acuity frequently occur with aging; glasses and hearing aid may increase patient's ability to interact with environment. | |
| a. Assist patient with use of sensory aids (eg, glasses, hearing aid) | a. Aids must be in good working order and available for use. | |
| b. Control environmental distractors | b. Facilitates communication. | |
| 4. Orient to and stabilize environment. | 4. | |
| a. Use orientation activities and aids (eg, clock, calendar, pictures, introduction of self). | a. Short-term memory may be faulty in the elderly; frequent reorientation helps. | |
| b. Minimize number of staff working with patient. | b. Consistency of caregivers promotes trust. | |
| 5. Give simple explanations of procedures and plan of care. | 5. Promotes understanding and active participation. | |
| 6. Encourage participation in hygiene and nutritional activities. | 6. Participation in routine activities promotes orientation, increases awareness of self. | |
| 7. Provide for safety.<br>a. Keep light on at night.<br>b. Have call bell available.<br>c. Provide prompt response to requests for assistance. | 7. Mechanism for securing assistance is available to patient; independent activities based on faulty judgment may result in injury. | |

*Continued on following page*

CHART 69-5

## PLAN OF NURSING CARE
## *Care of the Elderly Patient With a Fractured Hip* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 8. Assess mental responses to medications, especially sedatives and analgesics. | 8. Elderly people tend to be more sensitive to medications; abnormal responses (eg, hallucinations, depression) may occur. | |

**COLLABORATIVE PROBLEMS:** Hemorrhage; pulmonary complications; peripheral neurovascular dysfunction; deep vein thrombosis; pressure ulcers related to surgery and immobility
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Hemorrhage** | | |
| 1. Monitor vital signs, observing for shock. | 1. Changes in pulse, blood pressure, and respirations may indicate development of shock; blood loss and stress may contribute to development of shock. | • Vital signs are stabilized within normal limits<br>• Experiences no excessive or bright red drainage<br>• Exhibits stable postoperative hemoglobin and hematocrit values<br>• Patient has clear breath sounds<br>• Breath sounds present in all fields<br>• Exhibits no shortness of breath, chest pain, or elevated temperature |
| 2. Consider preinjury blood pressure values and management of coexisting hypertension, if present. | 2. Necessary for interpretation of current blood pressure determinations. | |
| 3. Note character and amount of drainage. | 3. Excessive drainage and bright red drainage may indicate active bleeding. | |
| 4. Notify surgeon if patient develops shock or excessive bleeding. | 4. Corrective measures need to be instituted. | |
| 5. Note hemoglobin and hematocrit values, and report decreases in values. | 5. Anemia due to blood loss may develop; bleeding into tissues after hip fracture may be extensive; blood replacement may be needed. | |
| **Pulmonary Complications** | | |
| 1. Assess respiratory status: respiratory rate, depth, and duration, breath sounds, sputum. Monitor temperature. | 1. Anesthesia and bed rest diminish respiratory effort and cause pooling of respiratory secretions. Adventitious breath sounds, pain on respiration, shortness of breath, blood tinged sputum, cough, etc., indicate pulmonary dysfunction. | • Vital signs are stabilized within normal limits<br>• Patient has clear breath sounds<br>• Breath sounds present in all fields<br>• Exhibits no shortness of breath, chest pain, or elevated temperature<br>• $PaO_2$ on room air within normal limits<br>• Performs respiratory exercises; uses incentive spirometer as instructed<br>• Changes position frequently<br>• Consumes adequate fluids |
| 2. Report adventitious and diminished breath sounds and elevated temperature. | 2. Elevated temperature in the early postoperative period may be due to atelectasis or pneumonia. | |
| 3. Supervise deep breathing and coughing exercises. Encourage use of incentive spirometer if prescribed. | 3. Promote optimal ventilation. Coexisting respiratory conditions diminish lung expansion. | |
| 4. Administer oxygen as prescribed. | 4. Reduced ventilatory efforts may diminish $PaO_2$ when patient is breathing room air. | |
| 5. Turn and reposition patient at least every 2 hours. Mobilize patient (assist patient out of bed) as soon as possible. | 5. Promotes optimal ventilation. Diminishes pooling of respiratory secretions. | |
| 6. Ensure adequate hydration. | 6. Liquefies respiratory secretions. Facilitates expectoration. | |
| **Peripheral Neurovascular Dysfunction** | | |
| 1. Assess affected extremity for color and temperature. | 1. The skin becomes pale and feels cool with decreased tissue perfusion. Venous congestion may cause cyanosis. | • Patient has normal color and the extremity is warm<br>• Demonstrates normal capillary refill response<br>• Exhibits moderate swelling; tissue not palpably tense<br>• States pain is tolerable |
| 2. Assess toes for capillary refill response. | 2. After compression of the nail, rapid return of pink color indicates good capillary perfusion. | |

*Continued*

CHART 69-5

PLAN OF NURSING CARE

## *Care of the Elderly Patient With a Fractured Hip* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Assess affected extremity for edema and swelling. | 3. The trauma of surgery will cause swelling; excessive swelling and hematoma formation can compromise circulation and function; edema may be due to coexisting cardiovascular disease. | • Reports no pain with passive dorsiflexion<br>• Reports normal sensations and no paresthesia<br>• Demonstrates normal motor abilities and no paresis or paralysis<br>• Has strong and equal pulses |
| 4. Elevate affected extremity. | 4. Minimizes dependent edema. | |
| 5. Assess for deep, throbbing, unrelenting pain. | 5. Surgical pain can be controlled; pain due to neurovascular compromise is refractory to treatment with analgesics. | |
| 6. Assess for pain on passive flexion of foot. | 6. With nerve ischemia, there will be pain on passive stretch. | |
| 7. Assess for sensations and numbness. | 7. Diminished pain and paresthesia may indicate nerve damage. Sensation in web between great and second toe-peroneal nerve; sensation on sole of foot-tibial nerve. | |
| 8. Assess ability to move foot and toes. | 8. Dorsiflexion of ankle and extension of toes indicate function of peroneal nerve. Plantar flexion of ankle and flexion of toes indicate functioning of tibial nerve. | |
| 9. Assess pedal pulses in both feet. | 9. Indicates circulatory status of extremities. | |
| 10. Notify surgeon if diminished neurovascular status occurs. | 10. Function of extremity needs to be preserved. | |
| **Deep Vein Thrombosis** | | |
| 1. Apply thigh-high anti-embolism stockings and/or sequential compression device as prescribed. | 1. Compression aids venous blood return and prevents stasis. | • Wears thigh-high anti-embolism stockings<br>• Uses sequential compression device<br>• Experiences no more warmth than usual in skin areas<br>• Exhibits no increase in calf circumference<br>• Demonstrates no evidence of calf tenderness, warmth, redness, or swelling<br>• Changes position with assistance and supervision<br>• Participates in exercise regimen<br>• Experiences no chest pain; has lungs clear to auscultation; presents no evidence of pulmonary emboli<br>• Exhibits no signs of dehydration; has normal hematocrit<br>• Maintains normal body temperature |
| 2. Remove stockings for 20 minutes twice a day, and provide skin care. | 2. Skin care is necessary to avoid skin breakdown. Extended removal of stocking or device defeats purpose. | |
| 3. Assess popliteal, dorsalis pedis, and posterior tibial pulses. | 3. Pulses indicate arterial perfusion of extremity. With coexisting arteriosclerotic vascular disease, pulses may be diminished or absent. | |
| 4. Assess skin temperature of legs. | 4. Local inflammation increases local skin temperature. | |
| 5. Assess calf every 4 hours for tenderness, warmth, redness, and swelling. | 5. Unilateral calf tenderness, warmth, redness, and swelling may indicate deep vein thrombosis. | |
| 6. Measure calf circumference twice daily. | 6. Increased calf circumference indicates edema or altered perfusion. | |
| 7. Avoid pressure on popliteal blood vessels from appliances or pillows. | 7. Compression of blood vessels diminishes blood flow. | |
| 8. Change patient's position and increase activity as prescribed. | 8. Activity promotes circulation and diminishes venous stasis. | |
| 9. Supervise ankle exercises hourly while patient is awake. | 9. Muscle exercise promotes circulation. | |
| 10. Ensure adequate hydration. | 10. Elderly people may become dehydrated because of low fluid intake, resulting in hemoconcentration. | |
| 11. Monitor body temperature. | 11. Body temperature increases with inflammation (magnitude of response minimal in elderly people). | |

*Continued on following page*

CHART 69-5 PLAN OF NURSING CARE

## *Care of the Elderly Patient With a Fractured Hip* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Pressure Ulcers** | | |
| 1. Monitor condition of skin at pressure points (eg, heels, sacrum, shoulders); inspect heels at least twice a day. | 1. Elderly patients are subject to skin breakdown at points of pressure because of diminished subcutaneous tissue. | • Patient exhibits no signs of skin breakdown<br>• Skin remains intact<br>• Repositions self frequently<br>• Uses protective devices |
| 2. Reposition patient at least every 2 hours. Avoid skin shearing. | 2. Avoids prolonged pressure and trauma to the skin. | |
| 3. Administer skin care, especially to pressure points. | 3. Immobility causes pressure at bony prominences; position changes relieve pressure. | |
| 4. Use special care mattress and other protective devices (eg, heel protectors); support heel off the mattress. | 4. Devices minimize pressure on skin at bony prominences. | |
| 5. Institute care according to protocol at first indication of potential skin breakdown. | 5. Early interventions prevent tissue destruction and prolonged rehabilitation. | |

**NURSING DIAGNOSIS:** Risk for ineffective health maintenance related to fractured hip and impaired mobility
**GOAL:** Exhibits health maintenance/promotion behaviors

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Assess home environment for discharge planning. | 1. Physical barriers (especially stairs, bathrooms) may limit patient's ability to ambulate and care for self at home. | • Home is accessible for patient at time of discharge<br>• Patient appears relaxed and develops strategies to deal with identified problems<br>• Has personal assistance available<br>• Demonstrates ability to use necessary assistive devices within therapeutic prescription<br>• Complies with home care program; keeps follow-up health care appointments |
| 2. Encourage patient to express concerns about care at home; explore with patient possible solutions to problems. | 2. Patient may have special problems that need to be identified so that solutions might be identified. | |
| 3. Assess availability of physical assistance for ADLs and health care activities. | 3. Because of limitation of mobility, patient requires some assistance in ADLs and routine health care. | |
| 4. Teach caregiver the home health care regimen. | 4. Understanding of rehabilitative regimen is necessary for compliance. | |
| 5. Instruct patient in posthospital care:<br>a. Activity limitations.<br>b. Reinforce exercise instructions.<br>c. Safe use of ambulatory aids.<br>d. Wound care.<br>e. Measures to promote healing (nutrition, wound care).<br>f. Medications.<br>g. Potential problems.<br>h. Continuing health care supervision. | 5. Lack of knowledge and poor preparation for care at home contribute to patient anxiety, insecurity, and nonadherence to therapeutic regimen. | |

A common complication after fracture of the femoral shaft is restriction of knee motion. Active and passive knee exercises begin as soon as possible, depending on the stability of the fracture and knee ligaments. Other complications include malunion, delayed union or nonunion, pudendal nerve palsy, and infection.

## KNEE

Fracture to the most distal portion of the femur, the patella (kneecap), and fracture to the most proximal portion of the tibia, may be defined as fractures of the knee. These fractures may be caused by motor vehicle crashes, direct blows to the knee from contact sports or intentionally inflicted trauma, or falls. The patient typically presents with acute pain to the affected knee and cannot ambulate or bear weight on the affected extremity. The affected knee is notably edematous.

### Assessment and Diagnostic Findings

If a patient presents with acute knee pain that occurs as a result of an injury (such as a fall or direct blow to the knee), a CT scan may be indicated to determine the extent of injury. Not all knee injuries are evident on x-ray. An MRI or CT scan can define the details of the injury of bone, cartilage, tendons, and ligaments. If the bones of the knee area are fractured, there is usually limited ROM and sometimes crepitus with motion.

### Medical Management

Patients with significant joint effusions may benefit from arthrocentesis to provide relief of intra-articular pressure. Anti-inflammatory and analgesic effects of NSAIDs such as ibuprofen (Motrin, Advil) may be prescribed. Other treatments that may be prescribed depend on the knee bone that is fractured and the extent of the injury, including whether the fracture is displaced or nondisplaced. Nondisplaced fractures may be effectively treated with 6 weeks of immobilization and gradual increases in weight bearing, while displaced fractures typically require ORIF surgical procedures.

## TIBIA AND FIBULA

The most common fractures below the knee are tibia and fibula fractures. Fractures of the tibia and fibula often occur in association with each other and tend to result from a direct blow, falls with the foot in a flexed position, or a violent twisting motion. The patient presents with pain, deformity, obvious hematoma, and considerable edema. Frequently, these fractures are open and involve severe soft tissue damage because there is little subcutaneous tissue in the area.

### Assessment and Diagnostic Findings

The peroneal nerve is assessed and if damaged, the patient cannot dorsiflex the great toe and has diminished sensation in the first web space. The tibial artery is assessed for damage by evaluating pulses, skin temperature, and color and by testing the capillary refill response. Hemiarthrosis or ligament damage may occur with a fracture near the joint.

The patient is monitored for an anterior acute compartment syndrome. Signs and symptoms include pain that is not relieved by analgesics, pain that increases with plantar flexion, complaints of paresthesias, and sometimes a weak or absent pulse.

### Medical Management

Most closed tibial fractures are treated with closed reduction and initial immobilization in a long-leg walking cast or a patellar tendon–bearing cast. As with other lower extremity fractures, the leg is elevated to control edema. Partial weight bearing is usually prescribed after 7 to 10 days, depending on the type of fracture. Activity decreases edema and increases circulation. The cast is changed to a short-leg cast or brace in 3 to 4 weeks, which allows for knee motion. Fracture healing takes 6 to 10 weeks. Percutaneous pins may be placed in the bone and held in position by an external fixator.

Comminuted fractures may be treated with skeletal traction, internal fixation with intramedullary nails or plates and screws, or external fixation. External support may be used with internal fixation. Hip, foot, and knee exercises are encouraged within the limits of the immobilizing device. Partial weight bearing is begun when prescribed and is progressed as the fracture heals in 4 to 8 weeks.

Open fractures are treated with external fixation. Distal fractures with extensive soft tissue damage heal slowly and may require bone grafting.

Continued neurovascular evaluation is important. The development of acute compartment syndrome requires prompt recognition and communication to the orthopedic surgeon. Other complications include delayed union, infection, impaired wound edge healing due to limited soft tissue, and loosening of the internal fixation hardware.

## RIB

Uncomplicated fractures of the lower ribs occur frequently in adults and usually result in no impairment of function. Because these fractures cause pain with respiratory effort, the patient tends to decrease respiratory excursions and refrains from coughing. As a result, tracheobronchial secretions are not mobilized, aeration of the lung is diminished, and a predisposition to atelectasis and pneumonia results. To help the patient cough and take deep breaths, the nurse may splint the chest with his or her hands. Occasionally, an anesthesia care provider administers intercostal nerve blocks to relieve pain and to permit productive coughing.

Chest strapping to immobilize the rib fracture is not used because decreased chest expansion may result in atelectasis and pneumonia. The pain associated with rib fracture diminishes significantly in 3 or 4 days, and the fracture heals within 6 weeks. In addition to atelectasis and pneumonia, complications may include a flail chest, pneumothorax, and hemothorax. The assessment and management of patients with these conditions are discussed in Chapter 23.

## THORACOLUMBAR SPINE

Fractures of the thoracolumbar spine may involve (1) the vertebral body, (2) the laminae and articulating processes, and (3) the spinous processes or transverse processes. The T12 to L2 area of the spine is most vulnerable to fracture. Fractures generally result from indirect trauma caused by excessive loading, sudden muscle contraction, or excessive motion beyond physiologic limits. Osteoporosis contributes to vertebral body collapse (compression fracture) (Bucholz, et al., 2005).

Stable spinal fractures are caused by flexion, extension, lateral bending, or vertical loading. The anterior structural column (vertebral bodies and disks) or the posterior structural column (neural arch, articular processes, ligaments) are disrupted. Unstable fractures occur with fracture dislocations and involve disruption of both anterior and posterior structural columns. There is always the potential for neural damage (eg, spinal cord injury).

The patient with a spinal fracture presents with acute tenderness, swelling, paravertebral muscle spasm, and change in the normal curves or in the gap between spinous processes. Pain is greater with moving, coughing, or weight bearing. Immobilization is essential until initial assessments have determined if there is any spinal cord injury and whether the fracture is stable or unstable (see Chapter 63). If spinal cord injury with neurologic deficit does occur, it usually requires immediate surgery (laminectomy with spinal fusion) to decompress the spinal cord.

Stable spinal fractures are treated conservatively with limited bed rest. The head of the bed is elevated less than 30 degrees until the acute pain subsides (several days). Analgesics are prescribed for pain relief. The patient is monitored for a transient paralytic ileus caused by associated retroperitoneal hemorrhage. Sitting is avoided until the pain subsides. A spinal brace or plastic thoracolumbar orthosis may be applied for support during progressive ambulation and resumption of activities.

The patient with an unstable fracture is treated with bed rest, possibly with the use of a special turning device or bed to maintain spinal alignment. Within 24 hours after fracture, open reduction, decompression, and fixation with spinal fusion and instrument stabilization are usually accomplished. Neurologic status is monitored closely during the preoperative and postoperative periods. Postoperatively, the patient may be cared for on the turning device or in a bed with a firm mattress. Progressive ambulation is begun a few days after surgery, with the patient using a body brace orthosis. Patient teaching emphasizes good posture, good body mechanics, and, after healing is sufficient, back-strengthening exercises. (Spinal cord injury is discussed in Chapter 63.)

## Sports-Related Injuries

Sport activities are very common, and, unfortunately, sports-related injuries are also common consequences. Table 69-1 displays common sports injuries, their mechanisms of injury, assessment findings, and acute care management.

### Management

Patients who have experienced sports-related injuries are often highly motivated to return to their previous level of activity. Compliance with restriction of activities and gradual resumption of activities need to be reinforced. Injured athletes are at risk for reinjury and require follow-up and monitoring. With recurrence of symptoms, athletes need to diminish their level and intensity of activity to a comfortable level. The time required to recover from a sports-related injury can be as short as a few days or considerably longer than 6 weeks, depending on the severity of the injury. Increasing activities gradually to acclimate the muscles, tendons, and joints to the sport motions will assist in recovery and rehabilitation.

### Prevention

Sports-related injuries can often be prevented by using proper equipment (eg, running shoes for joggers, wrist guards for skaters) and by effectively training and conditioning the body. Specific training needs to be tailored to the person and the sport. Stretching prior to engaging in sports or exercise had long been recommended; however, studies suggest that stretching may not prevent injury (Hart, 2005).

## Occupation-Related Injuries

According to the U.S. Department of Labor, occupation-related musculoskeletal disorders are injuries or illnesses of the muscles, nerves, tendons, joints, cartilage, and bones that occur because of exposure to work-related risks. In 2005, more than 4.2 million cases of nonfatal musculoskeletal injuries and illnesses occurred in the workplace in the private sector (eg, not including the military or government agencies); of these, 1.4 million injuries resulted in lost work days (U.S. Department of Labor, Bureau of Labor Statistics, 2005).

The most frequent types of single injuries that occurred were sprains, strains, and tears (40.8%), cuts, lacerations, and punctures (9.6%), bruises and contusions (8.7%), fractures, (7.8%), soreness and pain (5.3%), multiple injuries (4.1%), and back pain (2.9%) (U.S. Department of Labor, 2005). Management of sprains, strains, and fractures is described earlier in this chapter; management of low back pain is described in Chapter 68.

## Amputation

**Amputation** is the removal of a body part, often an extremity. Amputation of a lower extremity is often necessary because of progressive peripheral vascular disease (often a sequela of diabetes mellitus), fulminating gas gangrene, trauma (crushing injuries, burns, frostbite, electrical burns, explosions, ballistic injuries), congenital deformities, chronic osteomyelitis, or malignant tumor. Of all these causes, peripheral vascular disease accounts for most amputations of lower extremities (see Chapter 31). Amputation of an upper extremity occurs less frequently than a lower extremity and is most often necessary because of either traumatic injury or a malignant tumor. It is estimated that 1.7 million Americans has had some type of an amputation (National Lower Limb Information Center, 2006).

Amputation is used to relieve symptoms, to improve function, and, most important, to save or improve the patient's quality of life. If the health care team communicates a positive attitude, the patient adjusts to the amputation more readily and actively participates in the rehabilitative plan, learning how to modify activities and how to use assistive devices for ADLs and mobility.

### Levels of Amputation

Amputation is performed at the most distal point that will heal successfully. The site of amputation is determined by two factors: circulation in the part and functional usefulness (ie, meets the requirements for the use of a prosthesis).

The circulatory status of the extremity is evaluated through physical examination and diagnostic studies. Muscle and skin perfusion is important for healing. Doppler flow studies with duplex ultrasound, segmental blood pressure determinations, and transcutaneous $PaO_2$ of the extremity are valuable diagnostic aids. Angiography is performed if revascularization is considered an option.

The objective of surgery is to conserve as much extremity length as needed to preserve function and possibly to achieve a good prosthetic fit. Preservation of knee and elbow joints is desirable. Figure 69-17 shows the levels at which an extremity may be amputated. Most amputations involving extremities can be eventually fitted with a prosthesis.

The amputation of toes and portions of the foot can cause changes in gait and balance. A Syme amputation (modified ankle **disarticulation** amputation) is performed most frequently for extensive foot trauma and aims to produce a durable extremity end that can withstand full weight bearing. Below-knee amputation (BKA) is preferred to above-knee amputation (AKA) because of the importance of the knee joint and the energy requirements for walking. Knee disarticulations are most successful with young, active patients who can develop precise control of the prosthesis. When AKAs are performed, all possible length is preserved,

**Table 69-1 COMMON SPORTS INJURIES**

| Anatomic Area | Mechanism of Injury | Assessment Findings | Sports Activity | Acute Management |
|---|---|---|---|---|
| Clavicle fracture | Fall on shoulder or outstretched arm<br>Direct blow to the clavicle | Crepitus<br>Holds arm closely to body<br>Unable to raise affected arm above head<br>Can feel movement of both ends of clavicle | Football<br>Rugby<br>Hockey<br>Wrestling<br>Gymnastics | Sling or shoulder immobilizer<br>Ice<br>NSAIDs |
| Dislocated shoulder | *Anterior:*<br>Some combination of hyperextension, external rotation, and abduction<br>Anterior blow to shoulder<br>*Posterior:*<br>Fall on flexed and adducted arm<br>Direct axial load to humerus | Pain<br>Lack of motion<br>May feel empty shoulder socket<br>Uneven posture in comparison to other shoulder<br>Affected arm appears longer<br>Abduction limited | Rugby<br>Hockey<br>Wrestling<br>Skiing | Closed reduction<br>Immobilizer<br>Pendulum exercises |
| Dislocated elbow | Falling on a hand with a flexed elbow<br>Elbow overextended | Intense pain<br>Edema<br>Limited motion<br>Deformity<br>Ecchymosis | Football<br>Gymnastics<br>Squash<br>Wrestling<br>Cycling<br>Skiing | Immobilization<br>Ice<br>ROM exercises |
| Wrist sprain or fracture | Falling on an outstretched arm | Pain<br>Edema<br>Ecchymosis<br>Deformity<br>Limited motion | Skating<br>Hockey<br>Wrestling<br>Skiing<br>Soccer<br>Handball<br>Horseback riding | Ice<br>Elevation<br>Immobilization<br>Gentle ROM for 4 to 6 weeks (for sprain only) |
| Knee sprain | Twisting injury that produces incomplete tear of ligaments and capsule around the joint | Pain<br>Limited motion<br>Edema<br>Ecchymosis<br>Tenderness over joint<br>Joint appears stable | Basketball<br>Football<br>High jump | Ice<br>Elevation<br>Compression wrap<br>Active ROM exercises<br>Isometric exercises<br>May immobilize |
| Knee strain | Sudden forced motion causing muscle to be stretched beyond normal capacity | Pain<br>Limited motion<br>Pain aggravated by activity | Soccer<br>Swimming<br>Skiing | Ice<br>Elevation<br>Rest<br>Gradual return to activities |
| Meniscal tears of knee | Sharp, sudden pivot<br>Direct blow to knee<br>Forced internal rotation<br>Wear from repetitive squatting or climbing<br>Torsional weight-bearing force | Edema<br>*Medial tear:*<br>Pain occurs with hyperflexion, hyperextension, and turning in of knee with knee flexed<br>*Lateral tear:*<br>Pain occurs with hyperflexion and hyperextension and internal rotation of foot with knee flexed<br>*Displaced fragment:*<br>Inability to extend knee; "locked"<br>Positive McMurray's sign* | Hockey<br>Basketball<br>Football | *Conservative:*<br>RICE<br>Exercising of quadriceps and hamstrings<br>Resistive exercising<br>NSAIDs<br>Physical therapy<br>*Surgical:*<br>Arthroscopy |
| Ankle sprain | Foot is twisted, causing stretching or tearing of ligaments | Pain<br>Edema<br>Limited motion<br>Ecchymosis | Tennis<br>Basketball<br>Football<br>Skating | Immobilization in cast or brace<br>Ice<br>Elevation<br>Rest |
| Ankle strain | Sudden forced motion, stretching muscles beyond normal capacity | *Acute:*<br>Severe pain<br>*Chronic:*<br>Achy pain | Running<br>All ball sports | Immobilization in cast or brace<br>Ice<br>Elevation<br>Rest |

*Continued on following page*

**Table 69-1 COMMON SPORTS INJURIES (Continued)**

| Anatomic Area | Mechanism of Injury | Assessment Findings | Sports Activity | Acute Management |
|---|---|---|---|---|
| Ankle fracture | Inward turning on sole of foot and front of foot<br>Supination with internal rotation<br>Pronation with external rotation | Pain<br>Edema<br>Deformity<br>Inability to bear weight | Contact sports<br>Tennis<br>Basketball | Ice<br>Elevation<br>Cast (4 to 6 weeks)<br>Surgery if fracture is displaced or unstable |
| Metatarsal stress fracture | Occurs with repeated loading of bone; often in an unconditioned extremity | Forefoot pain that progressively worsens with activity<br>Minimal or no forefoot swelling | Running<br>Dance<br>Skating | Rest<br>Stop sports-related activity for 6 weeks<br>Ice<br>Weight-bearing as indicated |

NSAIDs, nonsteroidal anti-inflammatory drugs; ROM, range of motion; RICE, rest, ice, compression, elevation.
*McMurray's sign—manipulation of tibia while knee flexed produces audible "click".
Reprinted with permission from National Association of Orthopedic Nurses. (2007). *Core curriculum for orthopaedic nursing* (6th ed.). Boston: Pearson.

muscles are stabilized and shaped, and hip contractures are prevented to maximize ambulatory potential. Most people who have a hip disarticulation amputation must rely on a wheelchair for mobility.

Upper extremity amputations are performed with the goal of preserving maximal functional length. The prosthesis is fitted early to ensure maximum function.

A *staged amputation* may be used when gangrene and infection exist. Initially, a guillotine amputation (eg, nonclosed residual limb) is performed to remove the necrotic and infected tissue. The wound is débrided and allowed to drain. Sepsis is treated with systemic antibiotics. In a few days, after the infection has been controlled and the patient's condition has stabilized, a definitive amputation with skin closure is performed.

## Complications

Complications that may occur with amputation include hemorrhage, infection, skin breakdown, phantom limb pain, and joint contracture. Because major blood vessels have been severed, massive bleeding may occur. Infection is a risk with all surgical procedures. The risk of infection increases with contaminated wounds after traumatic amputation. Skin irritation caused by the prosthesis may result in

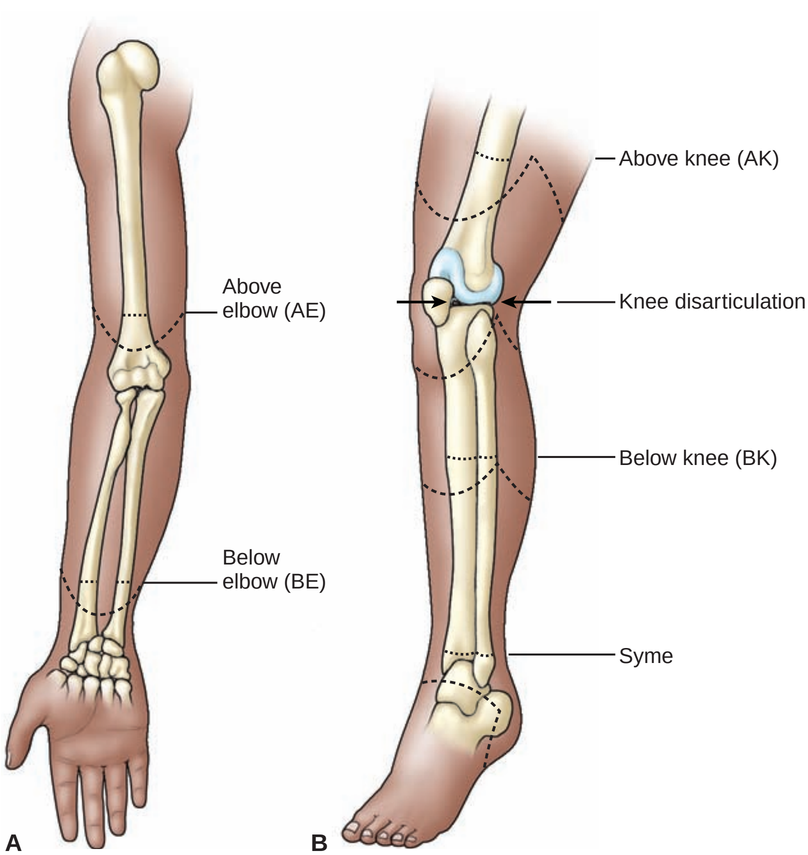



**Figure 69-17** Levels of amputation are determined by circulatory adequacy, type of prosthesis, function of the part, and muscle balance. **A,** Levels of amputation of upper extremity. **B,** Levels of amputation of lower extremity.

skin breakdown. **Phantom limb pain** is caused by the severing of peripheral nerves. Joint contracture is caused by positioning and a protective flexion withdrawal pattern associated with pain and muscle imbalance.

## Medical Management

The objective of treatment is to achieve healing of the amputation wound, the result being a nontender residual limb with healthy skin for prosthetic use. Healing is enhanced by gentle handling of the residual limb, control of residual limb edema through rigid or soft compression dressings, and use of aseptic technique in wound care to avoid infection.

A closed rigid cast dressing or an elastic residual limb shrinker that covers the residual limb may be used to provide uniform compression, to support soft tissues, to control pain, and to prevent joint contractures. Immediately after surgery, a sterilized residual limb sock is applied to the residual limb. Padding is placed over pressure-sensitive areas.

For the patient with a lower extremity amputation, the cast may be equipped to attach a temporary prosthetic extension (pylon) and an artificial foot. This rigid dressing technique is used as a means of creating a socket for immediate postoperative prosthetic fitting. The length of the prosthesis is tailored to the individual patient. Early minimal weight bearing on the residual limb with a rigid cast dressing and a pylon attached produces little discomfort. The cast is changed in about 10 to 14 days. A fever, severe pain, or a loose-fitting cast may necessitate earlier replacement.

A removable rigid dressing may be placed over a soft dressing to control edema, to prevent joint flexion contracture, and to protect the residual limb from unintentional trauma during transfer activities. This rigid dressing is removed several days after surgery for wound inspection and is then replaced to control edema. The dressing facilitates residual limb shaping.

A soft dressing with or without compression may be used if there is significant wound drainage and frequent inspection of the residual limb is required. An immobilizing splint may be incorporated in the dressing. Residual limb wound hematomas are controlled with wound drainage devices to minimize infection.

## Rehabilitation

The multidisciplinary rehabilitation team (patient, nurse, physician, social worker, physical therapist, occupational therapist, psychologist, prosthetist, vocational rehabilitation worker) helps the patient achieve the highest possible level of function and participation in life activities (Fig. 69-18). Prosthetic clinics and amputee support groups facilitate this rehabilitation process (Marzen-Groller & Bartman, 2005).

Patients who undergo amputation need support as they grieve the loss and change in body image. Their reactions can include anger, bitterness, and hostility. Psychological issues (eg, denial, withdrawal) may be influenced by the type of support the patient receives from the rehabilitation team and by how quickly ADLs and use of the prosthesis are learned. Knowing the full options and capabilities available with the various prosthetic devices can give the patient a sense of control over the resulting disability (Kelly & Dowling, 2008).

Patients who require amputation because of severe trauma are usually, but not always, young and healthy, heal rapidly, and are physically able to participate in a vigorous rehabilitation program. Because the amputation is the result of an injury, the patient needs psychological support in accepting the sudden change in body image and in dealing with the stresses of hospitalization, long-term rehabilitation, and modification of lifestyle.



**Figure 69-18** Many patients with amputations receive prostheses soon after surgery and begin learning how to use them with the help and support of the rehabilitation team, which includes nurses, physicians, physical therapists, and others.

Within the past decade, numerous U.S. soldiers have lost limbs because of ballistic injuries received while fighting in Iraq and Afghanistan. In order to best meet the complex needs of these young, previously healthy men and women, the U.S. Army instituted both a specialized treatment center for patients with amputations at Walter Reed Army Hospital in Washington, D.C., and a database registry to facilitate their long-term treatment and management. Treatment for these injured soldiers addresses not only their physical rehabilitation needs but also their emotional needs. Behavioral health services are considered key components to their therapy (Peake, 2005).

## NURSING PROCESS

### The Patient Undergoing an Amputation

#### Assessment

Before surgery, the nurse must evaluate the neurovascular and functional status of the extremity through history and physical assessment. If the patient has experienced a traumatic amputation, the nurse assesses the function and condition of the residual limb. The nurse also assesses the circulatory status and function of the unaffected extremity. If infection or gangrene develops, the patient may have

associated enlarged lymph nodes, fever, and purulent drainage. A culture and sensitivity test is obtained to determine the appropriate antibiotic therapy.

The nurse evaluates the patient's nutritional status and develops a plan for nutritional care in consultation with a dietitian or metabolic support team, if indicated. A diet with adequate protein and vitamins is essential to promote wound healing.

Any concurrent health problems (eg, dehydration, anemia, cardiac insufficiency, chronic respiratory problems, diabetes mellitus) need to be identified and treated so that the patient is in the best possible condition to withstand the surgical procedure. The use of corticosteroids, anticoagulants, vasoconstrictors, or vasodilators may influence management and prolong or delay wound healing.

The nurse assesses the patient's psychological status. Evaluation of the patient's emotional reaction to amputation is important. Grief responses to permanent alterations in body image, function, and mobility are likely. Professional counseling can help the patient cope in the aftermath of amputation surgery.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Acute pain related to amputation
- Disturbed sensory perception: phantom limb pain related to amputation
- Impaired skin integrity related to surgical amputation
- Disturbed body image related to amputation of body part
- Grieving and/or risk for complicated grieving related to loss of body part and resulting disability
- Self-care deficit: feeding, bathing/hygiene, dressing/grooming, or toileting, related to loss of extremity
- Impaired physical mobility related to loss of extremity

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include the following:

- Postoperative hemorrhage
- Infection
- Skin breakdown

## Planning and Goals

The major goals of the patient may include relief of pain, absence of altered sensory perceptions, wound healing, acceptance of altered body image, resolution of the grieving process, independence in self-care, restoration of physical mobility, and absence of complications.

## Nursing Interventions

### *Relieving Pain*

Pain may be incisional or may be caused by inflammation, infection, pressure on a bony prominence, or hematoma. Muscle spasms may add to the patient's discomfort. Surgical pain can be effectively controlled with opioid analgesics that may be accompanied with evacuation of a hematoma or accumulated fluid. Changing the patient's position or placing a light sandbag on the residual limb to counteract the muscle spasm may improve the patient's level of comfort. Evaluation of the patient's pain and responses to interventions is an important component of pain management. The pain may be an expression of grief and alteration of body image.

### *Minimizing Altered Sensory Perceptions*

A person who has had an amputation may begin to experience phantom limb pain soon after surgery or 2 to 3 months after amputation. It occurs more frequently in patients who have had AKAs. The patient describes pain or unusual sensations, such as numbness, tingling, or muscle cramps, as well as a feeling that the extremity is present, crushed, cramped, or twisted in an abnormal position. When a patient describes phantom pains or sensations, the nurse acknowledges these feelings as real and encourages the patient to verbalize when in pain so that effective treatment may be given. Although phantom sensations diminish over time for many patients, they do not occur in all patients with amputations (Ebrahimzadeh, Fattahi & Nejad, 2006).

The pathogenesis of the phantom limb phenomenon is unknown. Keeping the patient active helps decrease the occurrence of phantom limb pain. Early intensive rehabilitation and residual limb desensitization with kneading massage bring relief. Distraction techniques and activity are helpful. In addition to the nursing interventions, transcutaneous electrical nerve stimulation (TENS), ultrasound, or local anesthetics may provide relief for some patients. In addition, beta-blockers may relieve dull, burning discomfort; antiseizure medications control stabbing and cramping pain; and tricyclic antidepressants may not only alleviate phantom pain, they may also be prescribed to improve mood and coping ability.

### *Promoting Wound Healing*

The residual limb must be handled gently. Whenever the dressing is changed, aseptic technique is required to prevent wound infection and possible osteomyelitis.

> *NURSING ALERT*
>
> **If the cast or elastic dressing inadvertently comes off, the nurse must immediately wrap the residual limb with an elastic compression bandage. If this is not done, excessive edema will develop in a short time, resulting in a delay in rehabilitation. The nurse notifies the surgeon if a cast dressing comes off, so that another cast can be applied promptly.**

Residual limb shaping is important for prosthesis fitting. The nurse instructs the patient and family to apply elastic wraps on the residual limb. Using ace wraps on the residual limb is discouraged because they may apply inconsistent pressure on the residual limb, causing problems with shaping it to fit a prosthetic. After the incision is healed, the patient is instructed how to care for the residual limb.

### *Enhancing Body Image*

Amputation is a procedure that alters the patient's body image. The nurse who has established a trusting relationship

with the patient is better able to communicate acceptance of the patient who has experienced an amputation. The nurse encourages the patient to look at, feel, and care for the residual limb. It is important to identify the patient's strengths and resources to facilitate rehabilitation. The nurse helps the patient regain the previous level of independent functioning. The patient who is accepted as a whole person is more readily able to resume responsibility for self-care; self-concept improves, and body-image changes are accepted. Even with highly motivated patients, this process may take months.

#### *Helping the Patient to Resolve Grieving*

The loss of an extremity (or part of one) may come as a shock even if the patient was prepared preoperatively. The patient's behavior (eg, crying, withdrawal, apathy, anger) and expressed feelings (eg, depression, fear, helplessness) reveal how the patient is coping with the loss and working through the grieving process.

The nurse creates an accepting and supportive atmosphere in which the patient and family are encouraged to express and share their feelings and work through the grief process. The support from family and friends promotes the patient's acceptance of the loss. The nurse helps the patient deal with immediate needs and become oriented to realistic rehabilitation goals and future independent functioning. Mental health and support group referrals may be appropriate (Marzen-Groller & Bartman, 2005).

#### *Promoting Independent Self-Care*

Amputation of an extremity affects the patient's ability to provide adequate self-care. The patient is encouraged to be an active participant in self-care. The patient needs time to accomplish these tasks and must not be rushed. Practicing an activity with consistent, supportive supervision in a relaxed environment enables the patient to learn self-care skills. The patient and the nurse need to maintain positive attitudes and to minimize fatigue and frustration during the learning process.

Independence in dressing, toileting, and bathing depends on balance, transfer abilities, and physiologic tolerance of the activities. The nurse works with the physical therapist and occupational therapist to teach and supervise the patient in these self-care activities.

The patient with an upper extremity amputation has self-care deficits in feeding, bathing, and dressing. Assistance is provided only as needed; the nurse encourages the patient to learn to do these tasks, using assistive feeding and dressing aids when needed. The nurse, therapists, and prosthetist work with the patient to achieve maximum independence.

#### *Helping the Patient to Achieve Physical Mobility*

Proper positioning prevents the development of hip or knee joint contracture in the patient with a lower extremity amputation. Abduction, external rotation, and flexion of the lower extremity are avoided. The residual limb may be placed in an extended position or elevated for a brief period after surgery.

> ***NURSING ALERT***
>
> **The residual limb should not be placed on a pillow because a flexion contracture of the hip may result.**

The nurse encourages the patient to turn from side to side and to assume a prone position, if possible, to stretch the flexor muscles and to prevent flexion contracture of the hip. The patient is encouraged not to sit for long periods of time to prevent flexion contracture. The legs should remain close together to prevent an abduction deformity. The nurse encourages the patient to use assistive devices to more readily perform self-care activities and to identify what home modifications, if any, should be made to perform these activities in the home environment.

Postoperative ROM exercises are started early because contracture deformities develop rapidly. ROM exercises include hip and knee exercises for patients with BKAs and hip exercises for patients with AKAs. It is important that the patient understand the importance of exercising the residual limb.

The upper extremities, trunk, and abdominal muscles are exercised and strengthened. The extensor muscles in the arm and the depressor muscles in the shoulder play an important part in crutch walking. The patient uses an overbed trapeze to change position and strengthen the biceps. The patient may flex and extend the arms while holding weights. Doing push-ups while seated strengthens the triceps muscles. Exercises (such as hyperextension of the residual limb), conducted under the supervision of the physical therapist, also aid in strengthening muscles as well as increasing circulation, reducing edema, and preventing atrophy.

Because a patient who has had an upper extremity amputated uses both shoulders to operate the prosthesis, the muscles of both shoulders are exercised. A patient with an above-the-elbow amputation or shoulder disarticulation is likely to develop a postural abnormality caused by loss of the weight of the amputated extremity. Postural exercises are helpful.

Strength and endurance are assessed, and activities are increased gradually to prevent fatigue. As the patient progresses to independent use of the wheelchair, use of ambulatory aids, or ambulation with a prosthesis, the nurse emphasizes safety considerations. Environmental barriers (eg, steps, inclines, doors, throw rugs, wet surfaces) are identified, and methods of managing them are implemented. It is important to anticipate, identify, and manage problems associated with the use of the mobility aids. Proper instructions in using assistive devices will help prevent these problems.

Amputation of the leg changes the center of gravity; therefore, the patient may need to practice position changes (eg, standing from sitting, standing on one foot). The patient is taught transfer techniques early and is reminded to maintain good posture when getting out of bed. A well-fitting shoe with a nonskid sole should be worn. During position changes, the patient should be guarded and stabilized with a transfer belt at the waist to prevent falling.

As soon as possible, the patient with a lower extremity amputation is assisted to stand between parallel bars to allow extension of the temporary prosthesis to the floor with minimal weight bearing. How soon after surgery the patient is allowed to bear full body weight on the prosthesis depends

on the patient's physical status and wound healing. As endurance increases and balance is achieved, ambulation is started with the use of parallel bars or crutches. The patient learns to use a normal gait, with the residual limb moving back and forth while walking with the crutches. To prevent a permanent flexion deformity from occurring, the residual limb should *not* be held up in a flexed position.

The patient with an upper extremity amputation is taught how to carry out ADLs with one arm. The patient is started on one-handed self-care activities as soon as possible. The use of a temporary prosthesis is encouraged. The patient who learns to use the prosthesis soon after the amputation is less dependent on one-handed self-care activities.

The patient with an upper extremity amputation may wear a cotton T-shirt to prevent contact between the skin and shoulder harness and to promote absorption of perspiration. The prosthetist advises about cleaning the washable portions of the harness. Periodically, the prosthesis is inspected for potential problems.

The residual limb must be conditioned and shaped into a conical form to permit accurate fit, maximum comfort, and function of the prosthetic device. Elastic bandages, an elastic residual limb shrinker, or an air splint is used to condition and shape the residual limb. The nurse teaches the patient or a member of the family the correct method of bandaging.

Bandaging supports the soft tissue and minimizes the formation of edema while the residual limb is in a dependent position. The bandage is applied in such a manner that the remaining muscles required to operate the prosthesis are as firm as possible. An improperly applied elastic bandage contributes to circulatory problems and a poorly shaped residual limb.

Effective preprosthetic care is important to ensure proper fitting of the prosthesis. The major problems that can delay prosthetic fitting during this period are (1) flexion deformities, (2) nonshrinkage of the residual limb, and (3) abduction deformities of the hip.

The physician usually prescribes activities to condition or "toughen" the residual limb in preparation for a prosthesis. The patient begins by pushing the residual limb into a soft pillow, then into a firmer pillow, and finally against a hard surface. The patient is taught to massage the residual limb to mobilize the surgical incision site, decrease tenderness, and improve vascularity. Massage is usually started once healing has occurred and is first performed by the physical therapist. Skin inspection and preventive care are taught.

The prosthesis socket is custom molded to the residual limb by the prosthetist. Prostheses are designed for specific activity levels and patient abilities. Types of prostheses include hydraulic, pneumatic, biofeedback-controlled, myoelectrically controlled, and synchronized prostheses. Adjustments of the prosthetic socket are made by the prosthetist to accommodate the residual limb changes that occur during the first 6 months to 1 year after surgery.

Some patients are not candidates for a prosthesis and are thus nonambulatory patients with amputations. If use of a prosthesis is not possible, the patient is instructed in the safe use of a wheelchair to achieve independence. A special wheelchair designed for patients who have had amputations is recommended. Because of the decreased weight in the front, a regular wheelchair may tip backward when the patient sits in it. In wheelchairs designed for patients who have had amputations, the rear axle is set back about 5 cm (2 in) to compensate for the change in weight distribution.

#### *Monitoring and Managing Potential Complications*

After any surgery, efforts are made to reestablish homeostasis and to prevent complications related to surgery, anesthesia, and immobility. The nurse assesses body systems (eg, respiratory, hematological, gastrointestinal, genitourinary, skin) for problems associated with immobility (eg, atelectasis, pneumonia, DVT, PE, anorexia, constipation, urinary stasis, pressure ulcers).

Massive hemorrhage due to a loosened suture is the most threatening problem. The nurse monitors the patient for any signs or symptoms of bleeding and monitors the patient's vital signs and suction drainage.

> ***NURSING ALERT***
>
> **Immediate postoperative bleeding may develop slowly or may take the form of massive hemorrhage resulting from a loosened suture. A large tourniquet should be in plain sight at the patient's bedside so that, if severe bleeding occurs, it can be applied to the residual limb to control the hemorrhage. The nurse immediately notifies the surgeon in the event of excessive bleeding.**

Infection is a common complication of amputation. Patients who have undergone traumatic amputation have contaminated wounds. The nurse administers antibiotics as prescribed. It is important to monitor the incision, dressing, and drainage for indications of infection (eg, change in color, odor, or consistency of drainage; increasing discomfort). The nurse also assesses for systemic indicators of infection (eg, elevated temperature, leukocytosis with an increase of more than 10% bands on the differential) and promptly reports indications of infection to the surgeon.

Skin breakdown may result from immobilization or from pressure from various sources. The prosthesis may cause pressure areas to develop. The nurse and the patient assess for breaks in the skin. Careful skin hygiene is essential to prevent skin irritation, infection, and breakdown. The healed residual limb is washed and dried (gently) at least twice daily. The skin is inspected for pressure areas, dermatitis, and blisters. If they are present, they must be treated before further skin breakdown occurs. Usually a residual limb sock is worn to absorb perspiration and to prevent direct contact between the skin and the prosthetic socket. The sock is changed daily and must fit smoothly to prevent irritation caused by wrinkles. The socket of the prosthesis is washed with a mild detergent, rinsed, and dried thoroughly with a clean cloth. It must be thoroughly dry before the prosthesis is applied.

#### *Promoting Home and Community-Based Care*

**TEACHING THE PATIENT TO MANAGE SELF-CARE.** Before the patient is discharged to the home or to a rehabilitation facility, the patient and family are encouraged to become active participants in care. They participate in care of the skin, residual limb, and prosthesis as appropriate. The patient

receives ongoing instructions and practice sessions to learn to transfer and to use mobility aids and other assistive devices safely. The nurse explains the signs and symptoms of complications that must be reported to the physician (Chart 69-6).

**CONTINUING CARE IN THE HOME AND COMMUNITY.** After the patient has achieved physiologic homeostasis and has demonstrated achievement of major health care goals, rehabilitation continues either in a rehabilitation facility or at home. Continued support and evaluation by the home care nurse are essential.

The patient's home environment should be assessed prior to discharge. Modifications are made to ensure the patient's continuing care, safety, and mobility. An overnight or weekend experience at home may be tried to identify problems that were not identified on the assessment visit. Physical therapy and occupational therapy may continue in the home or on an outpatient basis. Transportation to continuing health care appointments must be arranged. The social service department of the hospital or the home health agency may be of great assistance in securing personal assistance and transportation services.

During follow-up health visits, the nurse evaluates the patient's physical and psychosocial adjustment. Periodic preventive health assessments are necessary. An elderly spouse may not be able to provide the assistance required if needed at home. Modifications in the plan of care are made on the basis of such findings. Often, the patient and family find involvement in a post-amputation support group to be of value; here they can share problems, solutions, and resources. Talking with those who have successfully dealt with a similar problem may help the patient develop a satisfactory solution.

Because patients and their family members and health care providers tend to focus on the most obvious needs and issues, the nurse reminds the patient and family about the importance of continuing health promotion and screening practices, such as regular physical examinations and diagnostic screening tests. Accessible facilities for screening, health care, and exercise are identified. Patients are instructed about their importance and are referred to appropriate health care providers.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include:

1. Experiences no pain
   a. Appears relaxed
   b. Verbalizes comfort
   c. Uses measures to increase comfort
   d. Participates in self-care and rehabilitative activities
2. Experiences no phantom limb pain
   a. Reports diminished phantom sensations
   b. Uses distraction techniques
   c. Performs residual limb desensitization massage
3. Achieves wound healing
   a. Controls residual limb edema
   b. Exhibits healed, nontender, nonadherent scar
   c. Demonstrates residual limb care

**CHART 69-6** HOME CARE CHECKLIST
***Amputation***

| At the completion of the home instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Describe approaches to controlling pain (eg, take analgesics as prescribed; use nonpharmacologic interventions). | ✔ | ✔ |
| • Report pain that is uncontrolled by analgesics and other pain management techniques. | ✔ | |
| • Describe care of residual limb and conditioning for prosthesis. | ✔ | ✔ |
| • Consume healthy diet to promote wound healing. | ✔ | |
| • Demonstrate ability to transfer. | ✔ | |
| • Use mobility and activity aids safely. | ✔ | |
| • Participate in rehabilitation program to regain functional independence. | ✔ | |
| • State indicators of complications to report promptly to physician (eg, uncontrolled pain; signs of local or systemic infection; residual limb skin breakdown). | ✔ | ✔ |
| • Identify professionals and community agencies to help with transition to home. | ✔ | ✔ |
| • Identify support group to facilitate rehabilitation. | ✔ | ✔ |
| • Describe effects of amputation on self-image. | ✔ | |
| • Acknowledge grieving as part of coping process. | ✔ | ✔ |
| • Identify modifications of home environment to promote safe environment and independence during rehabilitation. | ✔ | ✔ |
| • Identify the importance of keeping follow-up appointments and participating in health screening and health promotion activities, including exercises. | ✔ | ✔ |

4. Demonstrates improved body image and effective coping
   a. Acknowledges change in body image
   b. Participates in self-care activities
   c. Demonstrates increasing independence
   d. Projects self as a whole person
   e. Resumes role-related responsibilities
   f. Reestablishes social contacts
   g. Demonstrates confidence in abilities
5. Exhibits resolution of grieving
   a. Expresses grief
   b. Works through feelings with family and friends
   c. Focuses on future functioning
   d. Participates in support group
6. Achieves independent self-care
   a. Asks for assistance when needed
   b. Uses aids and assistive devices to facilitate self-care
   c. Verbalizes satisfaction with abilities to perform ADLs
7. Achieves maximum independent mobility
   a. Avoids positions contributing to contracture development
   b. Demonstrates full active ROM
   c. Maintains balance when sitting and transferring
   d. Increases strength and endurance
   e. Demonstrates safe transferring technique
   f. Achieves functional use of prosthesis
   g. Overcomes environmental barriers to mobility
   h. Uses community services and resources as needed
8. Exhibits absence of complications of hemorrhage, infection, or skin breakdown
   a. Does not experience excessive bleeding
   b. Maintains normal blood values
   c. Is free of local or systemic signs of infection
   d. Repositions self frequently
   e. Is free of pressure-related problems
   f. Reports any skin discomfort and irritations promptly

## Prevention of Injuries in Nursing Personnel

Nursing is consistently ranked among the top ten occupations that are most involved in occupation-related injuries and lost work days. The types of injuries that are most common include back, neck, shoulder, wrist, and knee injuries (de Castro, 2006). Most of these injuries have occurred during patient handling and movement activities. Traditional methods to prevent musculoskeletal injuries among nursing personnel during patient handling and moving have revolved around training sessions on proper body mechanics and "safe" lifting of patients and use of back belts, yet there is no research-based evidence that suggests that these methods reduce caregiver injuries (Nelson & Baptiste, 2006). The American Nurses Association (ANA) launched a "Handle with Care" campaign aimed at reducing occupational musculoskeletal work-related injuries among nurses (de Castro, 2006). In particular, the ANA advocates include that:

- Hospitals, long-term care facilities, and other health care organizations should purchase patient handling equipment (eg, inflatable lateral-assist devices to transfer patients) and train nursing personnel in their appropriate use.
- Health care organizations should institute "no lift" policies for individual nursing personnel. Rather, patient lift teams should be organized.
- Health care organizations should devise methods to assess their patient care ergonomic risks and develop algorithms for patient handling and movement that include patient transfer and movement activities.

## CRITICAL THINKING EXERCISES

**1** You are a staff nurse in the emergency department, and a patient is brought in with an open tibia/fibula fracture. He is not in respiratory distress, with an $SaO_2$ of 99%, and is communicating appropriately with you, but complains of pain. What assessments will you gather first, second, and third on this patient? Explain your rationale for the priority order of your assessments.

EBP **2** You are the nurse manager of an orthopedic unit. In the past 3 months, four of the staff members have sustained back injuries when lifting or turning patients. What is your plan to prevent similar staff injuries in the future? Are there any evidence-based guidelines that you might follow to help you prevent recurrence of these injuries?

EBP **3** You are a staff nurse on an orthopedic unit and receive a patient from surgery who had ACL repair after sustaining a "knee injury." Upon arrival to the unit, the patient appeared comfortable. His left leg was in a compression wrap and a belted brace. About 4 hours after arrival on the floor, he began to ask for pain medication. Morphine was administered as prescribed, yet 40 minutes after administration his pain level actually increased from 7 to 9 on the numeric pain scale. What assessment would you perform immediately on this patient? What should you do with the findings of the assessment? What actions do you anticipate you may initiate with this patient? What evidenced-based information supports your actions?

**4** You are a home health nurse and are assigned a new patient to your caseload, a National Guard veteran who was released from duty after having amputations of both legs after stepping on a land mine. His right leg had a below-the-knee amputation and his left leg had an above-the-knee amputation 2 months ago. Identify this patient's unique nursing, medical, physical therapy, occupational therapy, social, and emotional needs. Devise a nursing plan of care that addresses these needs.

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*
- *Handbook for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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**Asterisk indicates nursing research.*

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## RESOURCES

American College of Sports Medicine, www.acsm.org

Amputee Resource Foundation of America, Inc., www.amputeeresource.org

National Amputation Foundation, www.nationalamputation.org

National Association of Orthopaedic Nurses (NAON), www.orthonurse.com

National Institute for Occupational Safety and Health, www.cdc.gov.niosh.html

National Institute of Arthritis and Musculoskeletal and Skin Diseases, www.niams.nih.gov

U.S. Department of Labor, Occupational Safety and Health Administration, www.osha.gov

unit 16

# Other Acute Problems

## Case Study • Applying Concepts From NANDA, NIC, and NOC

### A Patient With Multiple Trauma Resulting in Hemorrhage and Risk for Shock



Rescue personnel bring 19-year-old **Anna Woo** to the emergency department (ED) after a motorcycle crash. She has facial contusions and lacerations, a fractured sternum, three fractured ribs, a hemothorax, a dislocated hip, a fractured pelvis, and multiple minor lacerations. She is moaning but responds to her name. Initial findings include an unobstructed airway with absent breath sounds in the right basilar lung field, tachypnea with 32 shallow respirations per minute, and ABG values as follows: pH 7.29; $pCO_2$ 48; $SaO_2$ 90%; $HCO_3^-$ 24. Blood pressure is 94/70; skin is cool and clammy; heart rate is 100; and peripheral pulses are intact. After a preliminary survey and placement of intravenous access lines, a chest tube is inserted. Immediately, 300 mL of bloody fluid drains into the collection chamber. Grossly bloody fluid continues to drain from the chest tube at a rate of 20 mL every 15 minutes.

Visit thePoint to view a concept map that illustrates the relationships that exist between the nursing diagnoses, interventions, and outcomes for the patient's clinical problems.

# Nursing Classifications and Languages

| NANDA NURSING DIAGNOSES | NIC NURSING INTERVENTIONS | NOC NURSING OUTCOMES |
|---|---|---|
| | | Return to functional baseline status, stabilization of, or improvement in: |
| **INEFFECTIVE BREATHING PATTERN**—Inspiration and/or expiration that does not provide adequate ventilation | **AIRWAY MANAGEMENT**—Facilitation of patency of air passages | **RESPIRATORY STATUS: AIRWAY PATENCY**—Open, clear tracheobronchial passages for air exchange |
| **IMPAIRED GAS EXCHANGE**—Excess or deficit in oxygenation and/or carbon dioxide elimination at the alveolar–capillary membrane | **RESPIRATORY MONITORING**—Collection and analysis of patient data to ensure airway patency and adequate gas exchange | **RESPIRATORY STATUS: VENTILATION**—Movement of air in and out of the lungs |
| **DEFICIENT FLUID VOLUME**—Decreased intravascular, interstitial, and/or intracellular fluid | **OXYGEN THERAPY**—Administration of oxygen and monitoring of its effectiveness | **RESPIRATORY STATUS: GAS EXCHANGE**—Alveolar exchange of carbon dioxide and oxygen to maintain arterial blood gas concentrations |
| **DECREASED CARDIAC OUTPUT**—Inadequate blood pumped by the heart to meet metabolic demands of the body | **ACID–BASE MANAGEMENT**—Promotion of acid–base balance and prevention of complications resulting from acid–base imbalance | **ELECTROLYTE AND ACID/BASE BALANCE**—Balance of electrolytes and nonelectrolytes in the intracellular and extracellular compartments of the body |
| | **HEMORRHAGE CONTROL**—Reduction or elimination of rapid and excessive blood loss | **CIRCULATION STATUS**—Unobstructed, unidirectional blood flow at an appropriate pressure through large vessels of the systemic and pulmonary circuits |
| | **IV INSERTION**—Insertion of a needle into a peripheral or central vein for the purpose of administering fluids, blood, or medications | **VITAL SIGNS**—Extent to which temperature, pulse, respiration, and blood pressure are within normal range for the individual |
| | **HYPOVOLEMIA MANAGEMENT**—Expansion of intravascular fluid volume in a patient who is volume-depleted | **CARDIAC PUMP EFFECTIVENESS**—Adequacy of blood volume ejected from the left ventricle to support systolic perfusion pressure |
| | **BLOOD PRODUCTS ADMINISTRATION**—Administration of blood or blood products and monitoring of patient's response | |
| | **VITAL SIGNS MONITORING**—Collection and analysis of cardiovascular, respiratory, and body temperature data to determine and prevent complications | |
| | **SHOCK PREVENTION**—Detecting and treating a patient at risk for impending shock | |
| | **SHOCK MANAGEMENT**—Facilitation of the delivery of oxygen and nutrients to systemic tissue with removal of cellular waste products in a patient with severely altered tissue perfusion | |


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chapter 70

# Management of Patients With Infectious Diseases

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Differentiate between colonization, infection, and disease.
2. Identify federal and local resources available to the nurse seeking information about infectious diseases.
3. Identify the benefits of vaccines recommended for health care workers.
4. Identify the reasons for Standard and Transmission-Based Precautions and discuss the elements of these standards.
5. Describe the concept of emerging infectious diseases and factors that led to the development of these diseases.
6. Use the nursing process as a framework for care of patients with sexually transmitted disease.
7. Describe home health care measures that reduce the risk of infection.
8. Use the nursing process as a framework for care of patients with infectious diseases.

## GLOSSARY

**bacteremia:** laboratory-proven presence of bacteria in the bloodstream

**community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA):** a strain of MRSA infecting persons who have not been treated in a health care setting

**carrier:** person who has an organism without apparent signs and symptoms; one who is able to transmit an infection to others

**colonization:** microorganisms present in or on a host, without host interference or interaction and without eliciting symptoms in the host

**emerging infectious diseases:** human infectious diseases with incidence increased within the past two decades or potential increase in the near future

**fungemia:** a bloodstream infection caused by a fungal organism

**health care–associated infection (HAI):** an infection not present or incubating at the time of admission to the health care setting; this term is replacing the term "nosocomial infection," which refers only to those infections acquired in a hospital

## GLOSSARY *(Continued)*

**host:** an organism that provides living conditions to support a microorganism

**immune:** person with protection from a previous infection or immunization who resists reinfection when reexposed to the same agent

**incubation period:** time between contact and onset of signs and symptoms

**infection:** condition in which the host interacts physiologically and immunologically with a microorganism

**infectious disease:** the consequences that result from invasion of the body by microorganisms that can produce harm to the body and potentially death

**latency:** time interval after primary infection when a microorganism lives within the host without producing clinical evidence

**methicillin-resistant Staphylococcus aureus (MRSA):** *Staphylococcus aureus* bacterium that is not susceptible to extended-penicillin antibiotic formulas, such as methicillin, oxacillin, or nafcillin; MRSA may occur in a health care or in a community setting

**normal flora:** persistent nonpathogenic organisms colonizing a host

**reservoir:** any person, plant, animal, substance, or location that provides living conditions for microorganisms and that enables further dispersal of the organism

**Standard Precautions:** strategy of assuming all patients may carry infectious agents and using appropriate barrier precautions for all health care worker–patient interactions

**susceptible:** not possessing immunity to a particular pathogen

**transient flora:** organisms that have been recently acquired and are likely to be shed in a relatively short period

**Transmission-Based Precautions:** precautions used in addition to Standard Precautions when contagious or epidemiologically significant organisms are recognized; the three types of Transmission-Based Precautions are Airborne, Droplet, and Contact Precautions

**vancomycin-resistant *Enterococcus* (VRE):** *Enterococcus* bacterium that is resistant to the antibiotic vancomycin

**vancomycin-resistant *Staphylococcus aureus* (VRSA):** *Staphylococcus aureus* bacterium that is not susceptible to vancomycin

**virulence:** degree of pathogenicity of an organism

An infectious disease is any disease caused by the growth of pathogenic microbes in the body. It may or may not be communicable (ie, contagious). Modern science has controlled, eradicated, or decreased the incidence of many infectious diseases. However, increases in other infections, such as those caused by antibiotic-resistant organisms and emerging infectious diseases, are of great and growing concern. Examples of these infectious diseases are presented in this chapter. Other infectious diseases are discussed in the appropriate chapters (for example, see Chapter 23 for information on tuberculosis [TB]). It is important to understand infectious causes and the treatment of contagious, serious, and common infections. Table 70-1 presents an overview of many infectious diseases, their causative organisms, mode of transmission, and usual **incubation periods** (time between contact and development of the first signs and symptoms).

The nurse plays an important role in infection control and prevention. Educating patients may decrease their risk of becoming infected or may decrease the sequelae of infection. Using appropriate barrier precautions, observing prudent hand hygiene, and ensuring aseptic care of intravenous (IV) catheters and other invasive equipment also assists in reducing infections.

# The Infectious Process

## The Chain of Infection

A complete chain of events is necessary for infection to occur. Figure 70-1 illustrates the elements of the chain and identifies points where health care workers can intervene to interrupt the chain. Six elements are necessary for infection to occur. These essentials are (1) a causative organism, (2) a reservoir of available organisms, (3) a portal or mode of exit from the reservoir, (4) a mode of transmission from reservoir to host, (5) a susceptible host, and (6) a mode of entry to the host.

### Causative Organism

The types of microorganisms that cause infections are bacteria, rickettsiae, viruses, protozoa, fungi, and helminths.

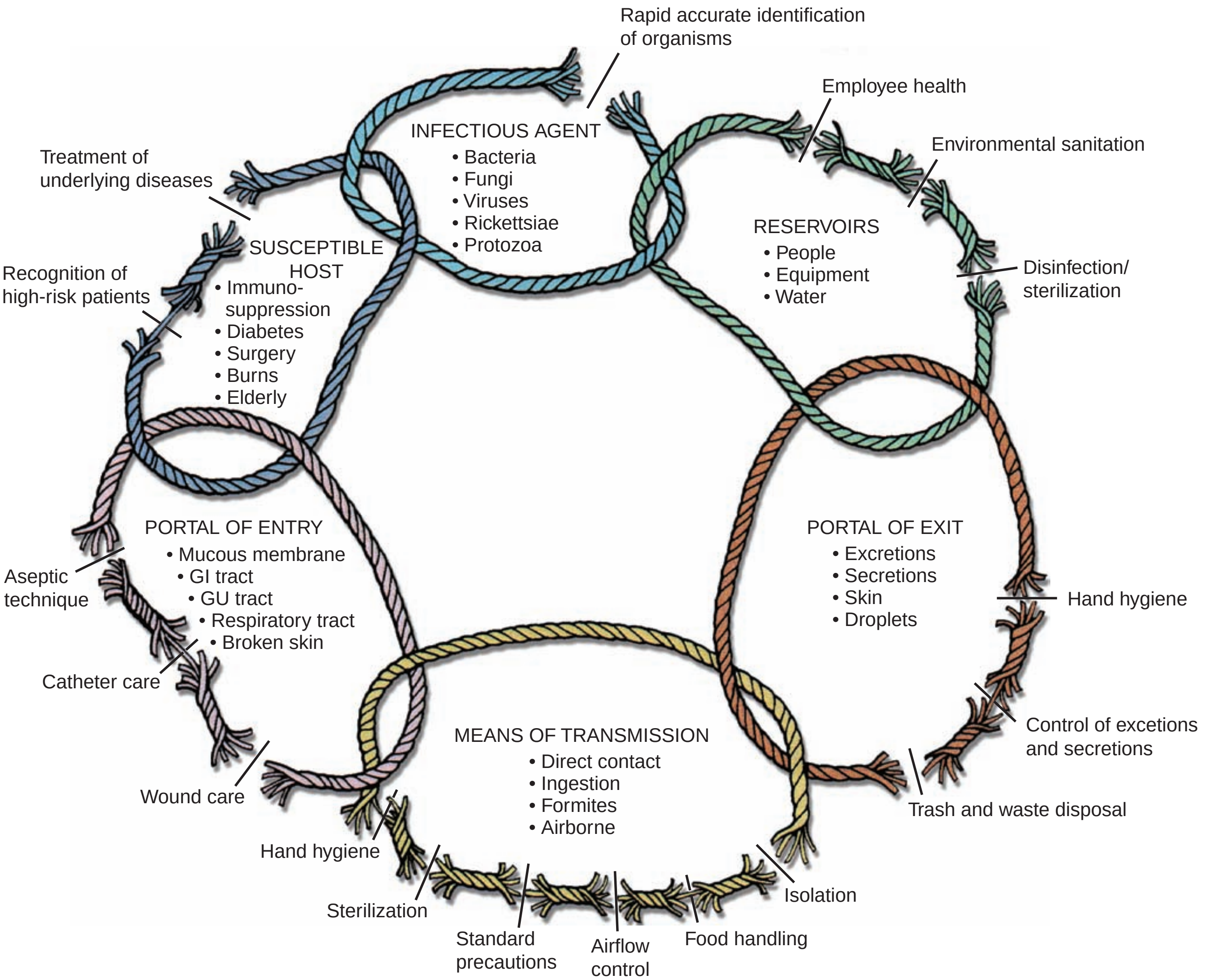



**Figure 70-1** Health care workers' interventions used to break the chain of infection transmission.

**Table 70-1 INFECTIOUS DISEASES, CAUSATIVE ORGANISMS, MODES OF TRANSMISSION, AND USUAL INCUBATION PERIODS**

| Disease or Condition | Organism | Usual Mode of Transmission | Usual Incubation Period (Infection to First Symptom) |
|---|---|---|---|
| Acquired immunodeficiency syndrome (AIDS) | Human immunodeficiency virus (HIV) | Sexual; percutaneous; perinatal | Median of 10 years |
| Amebiasis | *Entamoeba histolytica* | Contaminated water | 2–4 weeks |
| Anthrax | *Bacillus anthracis* | Airborne or contact | 2–60 days |
| Chancroid | *Haemophilus ducreyi* | Sexual | 3–5 days |
| Chickenpox | Varicella zoster | Airborne or contact | About 14 days |
| Cholera | *Vibrio cholerae* | Ingestion of water contaminated with human waste | A few hours to 5 days |
| Cryptococcosis | *Cryptococcus neoformans* | Probably by inhalation | Unknown |
| Cryptosporidiosis | *Cryptosporidium* species | Ingestion of contaminated water; direct contact with carrier | Probably 1–12 days |
| Cytomegalovirus (CMV) infection | Cytomegalovirus | Transfusion and transplantation; sexual; perinatal | Highly variable: 3–8 weeks after transfusion, 3–12 weeks after delivery of newborn |
| Diarrheal disease (common causes) | *Campylobacter* species | Ingestion of contaminated food | 3–5 days |
| | *Clostridium difficile* | Fecal–oral | Variable; in part related to the influence of antibiotics<br>12–36 hours |
| | *Salmonella* species | Ingestion of contaminated food or drink | 1–3 days |
| | *Shigella* species | Ingestion of contaminated food or drink; direct contact with carrier | 1–3 days |
| | *Yersinia* species | Ingestion of contaminated food or drink; direct contact with carrier | |
| Ebola | Ebola virus | Contact with blood or body fluids | 2–21 days |
| Gonorrhea | *Neisseria gonorrhoeae* | Sexual; perinatal | 2–7 days |
| Hand, foot, and mouth disease | Coxsackievirus | Direct contact with nose and throat secretions and with feces of infected people | 3–5 days |
| Hantavirus pulmonary syndrome (HPS) | Sin Nombre virus | Contact (direct or indirect) with rodents | Unclear |
| Foodborne hepatitis | Hepatitis A virus | Ingestion of contaminated food or drink; direct contact with carrier | 15–50 days |
| | Hepatitis E virus | Ingestion of contaminated food or drink; direct contact with carrier | Unclear |
| Bloodborne hepatitis | Hepatitis B virus | Sexual; perinatal; percutaneous | 45–160 days |
| | Hepatitis C virus | Sexual; perinatal; percutaneous | 6–9 months |
| | Hepatitis D | Sexual; perinatal; percutaneous | Unclear |
| | Hepatitis G | Percutaneous | Unclear |
| Herpangina | Coxsackievirus | Direct contact with nose and throat secretions and feces of infected people | 3–5 days |
| Herpes simplex | Human herpesvirus 1 and 2 | Contact with mucous membrane secretions | 2–12 days |
| Histoplasmosis | *Histoplasma capsulatum* | Inhalation of airborne spores | 5–18 days |
| Hookworm disease | *Necator americanus; Ancylostoma duodenale* | Contact with soil contaminated with human feces | A few weeks to many months |
| Impetigo | *Staphylococcus aureus* | Contact with *S. aureus carrier* | 4–10 days |
| Influenza | Influenza virus A, B, or C | Droplet spread | 24–72 hours |
| Lassa fever | Lassa virus | Contact with animal droppings; direct contact with blood or body fluids | 7–21 days |
| Legionnaires' disease | *Legionella pneumophila* | Airborne from water source | 2–10 days |
| Listeriosis | *Listeria monocytogenes* | Foodborne; perinatal | Unclear; probably 3–70 days |
| Lyme disease | *Borrelia burgdorferi* | Tick bite | 14–23 days |
| Lymphogranuloma venereum | *Chlamydia inguinale* | Sexual | Weeks to years |
| Malaria | *Plasmodium vivax; Plasmodium malariae; Plasmodium falciparum; Plasmodium ovale* | Bite from *Anopheles* species mosquito | 12–30 days |
| Marburg hemorrhagic fever | Marburg virus | Unknown route of transmission from animals to humans; person-to-person by droplets and direct contact | 5–10 days |
| Meningococcal meningitis or bacteremia | *Neisseria meningitidis* | Contact with pharyngeal secretions; perhaps airborne | 2–10 days |
| Mononucleosis | Epstein-Barr virus | Contact with pharyngeal secretions | 4–6 weeks |
| Mycobacterial diseases (nontuberculosis *Mycobacterium* species) | *Mycobacterium avium; Mycobacterium kansasii; Mycobacterium fortuitum; Mycobacterium gordonae;* other *Mycobacterium* species | Variable; probably contact with soil, water, or other environmental source; none is person-to-person transmissible | Variable |
| Mycoplasmal pneumonia | *Mycoplasma pneumoniae* | Droplet inhalation | 14–21 days |

*Continued*

**Table 70-1 INFECTIOUS DISEASES, CAUSATIVE ORGANISMS, MODES OF TRANSMISSION, AND USUAL INCUBATION PERIODS (Continued)**

| Disease or Condition | Organism | Usual Mode of Transmission | Usual Incubation Period (Infection to First Symptom) |
|---|---|---|---|
| Norovirus | *Norovirus* | Fecal–oral by food or water or by person-to-person spread | 24–48 hours |
| Pediculosis | *Pediculus humanus capitis* (head louse); *Phthirus pubis* (crab louse) | Direct contact | 1–2 weeks |
| Pertussis (whooping cough) | *Bordetella pertussis* | Contact with respiratory droplets | 7–10 days |
| Pinworm disease | *Enterobius vermicularis* | Direct contact with egg-contaminated articles | 4- to 6-week life cycle; often takes months of infection before recognition |
| *Pneumocystis jiroveci* pneumonia | *Pneumocystis jiroveci* | Unknown; not transmitted person-to-person | Infants: 1–2 months; adults: unclear |
| Pneumococcal pneumonia | *Streptococcus pneumoniae* | Droplet spread | Probably 1–3 days |
| Rabies | Rabies virus | Bite from rabid animal | 2–8 weeks |
| Respiratory syncytial disease | Respiratory syncytial virus | Self-inoculation by mouth or nose after contact with infectious respiratory secretions | 3–7 days |
| Ringworm | *Microsporum* species; Trichophyton species | Direct and indirect contact with lesions | 4–10 days |
| Rocky mountain spotted fever | *Rickettsia rickettsii* | Bite from infected tick | 3–14 days |
| Roseola infantum | Human herpes virus 6 | Saliva | 10–15 days |
| Rotavirus gastroenteritis | Rotavirus | Fecal–oral route | About 48 hours |
| Rubella | Rubella virus | Droplet spread; direct contact | 14–21 days |
| Scabies | *Sarcoptes scabei* | Direct skin contact | 2–6 weeks |
| Severe acute respiratory syndrome (SARS) | SARS-associated coronavirus (SARS-CoV) | Droplet; direct contact; occasionally airborne | 2–10 days |
| Smallpox | *Variola major* | Airborne and contact | 7–14 days |
| Syphilis | *Treponema pallidum* | Sexual; perinatal | 10 days to 10 weeks |
| Tetanus | *Clostridium tetani* | Puncture wound | 4–21 days |
| Trichinosis | *Trichinella spiralis* | Ingestion of insufficiently cooked foods, especially pork and beef | 10–14 days |
| Tuberculosis | *Mycobacterium tuberculosis* | Airborne | 4–12 weeks to the formation of primary lesion |
| West Nile virus | West Nile virus | Bite of infected mosquitoes; from transfusions and transplants; perinatal | 3–14 days |

### Reservoir

**Reservoir** is the term used for any person, plant, animal, substance, or location that provides nourishment for microorganisms and enables further dispersal of the organism. Infections may be prevented by eliminating the causative organisms from the reservoir.

### Mode of Exit

The organism must have a mode of exit from a reservoir. An infected host must shed organisms to another or to the environment for transmission to occur. Organisms exit through the respiratory tract, the gastrointestinal tract, the genitourinary tract, or the blood.

### Route of Transmission

A route of transmission is necessary to connect the infectious source with its new host. Organisms may be transmitted through sexual contact, skin-to-skin contact, percutaneous injection, or infectious particles carried in the air. A person who carries or transmits an organism but does not have apparent signs and symptoms of infection is called a **carrier.**

Specific organisms require specific routes of transmission for infection to occur. For example, *Mycobacterium tuberculosis* is almost always transmitted by the airborne route. Health care providers do not "carry" *M. tuberculosis* bacteria on their hands or clothing. In contrast, bacteria such as *Staphylococcus aureus* are easily transmitted from patient to patient on the hands of health care providers.

When appropriate, the nurse should explain routes of disease transmission to patients. For example, a nurse may explain that sharing a room with a patient who is infected with human immunodeficiency virus (HIV) does not pose a risk because intimate contact (ie, sexual or parenteral) is necessary for transmission to occur.

### Susceptible Host

For infection to occur, the **host** must be **susceptible** (not possessing immunity to a particular pathogen). Previous infection or vaccine administration may render the host **immune** (not susceptible) to further infection with an agent. Although exposure to potentially infectious microorganisms occurs essentially on a constant basis, people have elaborate immune systems that generally prevent infection from occurring. A person who is immunosuppressed has much greater susceptibility to infection than a healthy person.

### Portal of Entry

A portal of entry is needed for the organism to gain access to the host. Again, specific organisms may require specific portals of entry for infection to occur. For example, airborne *M. tuberculosis* does not cause disease when it settles on the skin of an exposed host; the only entry route for *M. tuberculosis* is through the respiratory tract.

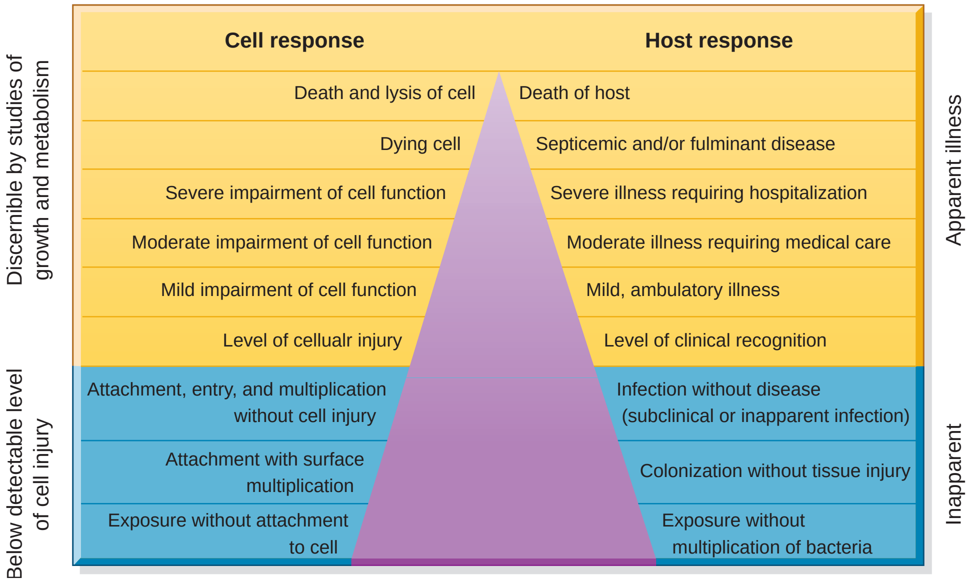



**Figure 70-2** Biologic spectrum of response to bacterial infection at the cellular level (*left*) and of the intact host (*right*). Redrawn from Evans, A. S. & Brachman, P. S. (1998). *Bacterial infections in humans.* New York: Plenum.

## Colonization, Infection, and Infectious Disease

Relatively few anatomic sites (eg, brain, blood, bone, heart, vascular system) are sterile. Bacteria found throughout the body usually provide beneficial **normal flora** to compete with potential pathogens, to facilitate digestion, or to work in other ways symbiotically with the host.

### Colonization

The term **colonization** is used to describe microorganisms present without host interference or interaction. Organisms reported in microbiology test results often reflect colonization rather than infection. The patient's health care team must interpret microbiology test results accurately to ensure appropriate treatment.

### Infection

**Infection** indicates a host interaction with an organism. A patient colonized with *S. aureus* may have staphylococci on the skin without any skin interruption or irritation. However, if the patient has an incision, *S. aureus* could enter the wound, resulting in an immune system reaction of local inflammation and migration of white cells to the site. Clinical evidence of redness, heat, and pain and laboratory evidence of white blood cells on the wound specimen smear suggest infection. In this situation, the host identifies the staphylococci as *foreign*. Infection is recognized by the host reaction (manifested by signs and symptoms) and by laboratory-based evidence of white blood cell reaction and microbiologic organism identification.

### Infectious Disease

It is important to recognize the difference between infection and infectious disease. **Infectious disease** is the state in which the infected host displays a decline in wellness due to the infection. When the host interacts immunologically with an organism but remains symptom free, the definition of infectious disease has not been met. For example, when a person is first infected with *M. tuberculosis*, infection can be detected by a positive tuberculin skin test, which demonstrates immunologic recognition. Most people who are infected with *M. tuberculosis* have latent infection, but few people (approximately 10%) actually become ill and demonstrate symptoms of TB (fever, weight loss, and advancing pneumonia). Figure 70-2 depicts response to bacterial infection at the cellular level and at the host level.

The primary source of information about most bacterial infections is the microbiology laboratory report, which should be viewed as a tool to be used along with clinical indicators to determine if a patient is colonized, infected, or diseased. Microbiology reports from clinical specimens usually show three components: the smear and stain, the culture and organism identification, and the antimicrobial susceptibility (ie, sensitivity). As a marker for the likelihood of infection, the smear and stain generally provide the most helpful information because they describe the mix of cells present at the anatomic site at the time of specimen collection. Culture and sensitivity results specify which organisms are recognized and which antibiotics actively affect the bacteria.

## Infection Control and Prevention

The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) are the principal agencies involved in setting guidelines about infection prevention. In recent years, attention to **health care–associated infections (HAIs)** has grown with increased input from the Joint Commission, the Institute for Healthcare Improvement (IHI), and Medicare.

The impact of infectious diseases changes over time as microorganisms mutate, as human behavior patterns shift, or as therapeutic options change. The CDC provides timely recommendations about many of the situations that a nurse may face when caring for or teaching a patient with an infectious disease. The CDC routinely publishes recommendations, guidelines, and summaries. Through its Internet site and its weekly journal, the *Morbidity and Mortality Weekly Report (MMWR)*, the CDC reports significant cases,

**Table 70-2 SELECTED IMPORTANT CENTERS FOR DISEASE CONTROL WEB SITES**

| Web Site | Features |
|---|---|
| www.cdc.gov | CDC home page<br>Entry point to other sites; information about current situations in infectious diseases |
| www.cdc.gov/flu | Information about influenza and links to information, data, recommendations, and updates |
| www.cdc.gov/STD | Sexually transmitted diseases information, statistics, treatment guidelines, and laboratory guidelines |
| www.bt.cdc.gov/Agent/Agentlist.asp | Bioterrorism history, bioterrorism agents, updates, situations, and recommendations |
| www.cdc.gov/vaccines/vpd-vac/default.htm | Menu-driven overview of vaccine-preventable diseases |
| www.cdc.gov/drugresistance/ | Overview of antibiotic/antimicrobial resistance, educational resources, laboratory information, and fact sheets |
| www.cdc.gov/ncidod/dhqp/index.html | Issues in health care settings, including infection control guidelines for isolation, surgical site infections, pneumonia, intravascular catheter–related infections, urinary tract infections, and infection control in long-term care facilities |
| www.cdc.gov/hiv/ | Information about the epidemiology of HIV/AIDS, including fact sheets, slide sets, and statistics |

outbreaks, environmental hazards, or other public health problems. Examples of important CDC guidelines and summaries are *Guidelines for Preventing the Transmission of Tuberculosis in Health Care Facilities* (2005g), *Updated US Public Health Service Guidelines for the Management of Occupation as Exposure to HIV and Recommendations for Post Exposure Prophylaxis* (2005e), *Sexually Transmitted Diseases Treatment Guidelines* (2006b), and *Recommended Immunization Schedules for Persons Aged 0 Through 18 years United States*, 2009 (2009d).

This chapter summarizes several aspects of infectious diseases. However, the field of infection control and prevention changes rapidly. Health care workers should seek the most current information when they address patient care concerns or develop infection control policies. Table 70-2 presents an overview of selected CDC Web sites.

## Preventing Infection in the Hospital

### Isolation Precautions

Isolation precautions are guidelines created to prevent transmission of microorganisms in hospitals. The Hospital Infection Control Practices Advisory Committee (HICPAC) of the CDC recommends two tiers of isolation precautions. The first tier, called Standard Precautions, is designed for the care of *all* patients in the hospital and is the primary strategy for preventing HAIs. The second tier, called Transmission-Based Precautions, is designed for care of patients with known or suspected infectious diseases spread by airborne, droplet, or contact routes.

#### Standard Precautions

The premise of **Standard Precautions** is that all patients are colonized or infected with microorganisms, whether or not there are signs or symptoms, and that a uniform level of caution should be used in the care of all patients. The health care worker should use additional barriers in the form of personal protective equipment (PPE), including masks, eye protection, and cover gowns, depending on the degree of expected exposure to patient excretions or secretions. The elements of Standard Precautions include hand hygiene, use of PPE, proper handling of patient care equipment and linen, environmental control, prevention of injury from sharps devices, and patients' room assignments within health care facilities. Hand hygiene, glove use, needlestick prevention, and avoidance of splash or spray of body fluids are discussed in the following sections. Chart 52-4 in Chapter 52 describes the Standard Precautions in detail.

***Hand Hygiene.*** The most frequent cause of infection outbreaks in health care institutions is spread of microorganisms by the hands of health care workers. Hands should be washed or decontaminated frequently during patient care.

**Chart 70-1 • *Hand-Hygiene Methods***

**Hand Decontamination With Alcohol-Based Product**

- After contact with body fluids, excretions, mucous membranes, nonintact skin, or wound dressings as long as hands are not visibly soiled
- After contact with a patient's intact skin (as after taking pulse or blood pressure or lifting a patient)
- In patient care, when moving from a contaminated body site to a clean body site
- After contact with inanimate objects in the patient's immediate vicinity
- Before caring for patients with severe neutropenia or other forms of severe immune suppression
- Before donning sterile gloves when inserting central catheters
- Before inserting urinary catheters or other devices that do not require a surgical procedure
- After removing gloves

**Handwashing**

- When hands are visibly dirty or contaminated with biologic material from patient care
- When health care workers do not tolerate waterless alcohol product

Chart 70-1 describes the recommended hand-hygiene methods.

When hands are visibly dirty or contaminated with biologic material from patient care, hands should be washed with soap and water. In intensive care units and other locations in which virulent or resistant organisms are likely to be present, antimicrobial agents (eg, chlorhexidine gluconate, iodophor, chloroxylenol, and triclosan) may be used. Effective handwashing requires at least *15 seconds of vigorous scrubbing,* with special attention to the area around nail beds and between fingers, where there is a high bacterial load. Hands should be thoroughly rinsed after washing.

If hands are not visibly soiled, health care providers are strongly encouraged to use alcohol-based, waterless antiseptic agents (eg, Avagard or Endure) for routine hand decontamination. These solutions are superior to soap or antimicrobial handwashing agents in their speed of action and effectiveness against microorganisms. Because they are formulated with emollients, they are usually better tolerated than other agents, and because they can be used without sinks and towels, health care workers have been found to be more compliant with their use. Nurses working in home health care or other settings where they are relatively mobile should carry pocket-size containers of alcohol-based solutions (Rhinehart & McGoldrick, 2005).

Normal skin flora usually consist of coagulase-negative staphylococci or diphtheroids. In the health care setting, workers may temporarily carry other bacteria (ie, **transient flora**) such as *S. aureus, Pseudomonas aeruginosa,* or other organisms with increased pathogenic potential. Generally, transient flora are superficially attached and are shed with hand hygiene and skin regeneration.

Hand hygiene reduces the bacterial load and decreases the risk of transfer to other patients. The Joint Commission has included hand hygiene as one of the national patient safety goals and focuses on this behavior in all surveys of health care facilities. All health care settings should have mechanisms to evaluate compliance with hand hygiene by all personnel who care for patients.

When providing patient care, nurses should not wear artificial fingernails or nail extenders because they have been epidemiologically linked to several significant outbreaks of infections. Natural nails should be kept less than 0.25 inches (0.6 cm) long, and nail polish should be removed when chipped because it can support increased bacterial growth (CDC, 2002a).

***Glove Use.*** Gloves provide an effective barrier for hands from the microflora associated with patient care. Gloves should be worn when a health care worker has contact with any patient secretions or excretions and must be discarded after each patient care contact. Because microbial organisms colonizing health care workers' hands can proliferate in the warm, moist environment provided by gloves, hands must be washed or disinfected after gloves are removed. As patient advocates, nurses have an important role in promoting hand hygiene and glove use by other hospital workers, such as laboratory personnel, technicians, and others who have contact with patients.

Compared with vinyl gloves, latex or nitrile gloves are preferred because they resist puncture better and provide greater comfort and fit. Latex gloves have been improved to reduce the incidence of latex hypersensitivity, but some workers continue to experience local skin irritation or more severe reactions, including generalized dermatitis, conjunctivitis, asthma, angioedema, and anaphylaxis (see Chapter 53). The nurse who experiences irritation or an allergic reaction associated with exposure to latex should report symptoms to an occupational health specialist or a physician.

***Needlestick Prevention.*** The most important aspect of reducing the risk of bloodborne infection is avoidance of percutaneous injury. Extreme care is essential in all situations in which needles, scalpels, and other sharp objects are handled. Used needles should not be recapped. Instead, they are placed directly into puncture-resistant containers near the place where they are used. If a situation dictates that a needle must be recapped, the nurse must use a mechanical device to hold the cap or use a one-handed approach to decrease the likelihood of skin puncture. Since 2001, the Occupational Safety and Health Administration (OSHA) has required use of needleless devices and other instruments designed to prevent injury from sharps when appropriate.

***Avoidance of Splash and Spray.*** When the health care provider is involved in an activity in which body fluids may be sprayed or splashed, appropriate barriers must be used. If a splash to the face may occur, goggles and a face mask are warranted. If the health care worker is involved in a procedure in which clothing may be contaminated with biologic material, a cover gown should be worn.

**Transmission-Based Precautions**

Some microbes are so contagious or epidemiologically significant that precautions in addition to the Standard Precautions should be used when such organisms have been identified. The CDC recommends a second tier of precautions, called **Transmission-Based Precautions.** The isolation categories are Airborne, Droplet, and Contact Precautions (Siegel, Rhinehart, Jackson, et al., 2007).

*Airborne Precautions* are required for patients with presumed or proven pulmonary TB, chickenpox, or other airborne pathogen. Airborne Precautions would also be advised if a patient were infected with smallpox (eg, as a result of a bioterrorist attack). When hospitalized, patients should be in airborne infection isolation rooms (AIIR), engineered to provide negative air pressure, rapid turnover of air, and air either highly filtered or exhausted directly to the outside. Health care providers should wear an N-95 respirator (ie, protective mask) at all times while in the patient's room.

*Droplet Precautions* are used for organisms such as influenza or meningococcus that can be transmitted by close respiratory or mucous membrane contact with respiratory secretions. While taking care of a patient requiring Droplet Precautions, the nurse should wear a face mask, but because the risk of transmission is limited to close contact, the door may remain open.

*Contact Precautions* are used for organisms that are spread by skin-to-skin contact, such as antibiotic-resistant organisms or *Clostridium difficile.* Contact Precautions are designed to emphasize cautious technique and the use of barriers for organisms that have serious epidemiologic consequences or those easily transmitted by contact between health care

## Chart 70-2 • *Summary of Types of Precautions and Patients Requiring the Precautions*

### Standard Precautions

Use Standard Precautions for the care of all patients.

### Airborne Precautions

In addition to Standard Precautions, use Airborne Precautions for patients known or suspected to have serious illnesses transmitted by airborne droplet nuclei. Examples of such illnesses include the following:

- Measles
- Varicella (including disseminated zoster)*
- Tuberculosis

### Droplet Precautions

In addition to Standard Precautions, use Droplet Precautions for patients known or suspected to have serious illnesses transmitted by large particle droplets. Examples of such illnesses include:

- Invasive *Haemophilus influenzae* type b disease, including meningitis, pneumonia, epiglottitis, and sepsis
- Invasive *Neisseria meningitidis* disease, including meningitis, pneumonia, and sepsis
- Other serious bacterial respiratory infections spread by droplet transmission, including:
- Diphtheria (pharyngeal)
- Primary atypical pneumonia (*Mycoplasma pneumoniae*)
- Pertussis
- Pneumonic plague
- Streptococcal (group A) pharyngitis, pneumonia, or scarlet fever in infants and young children
- Serious viral infections spread by droplet transmission, including:
- Adenovirus*
- Influenza
- Mumps
- Parvovirus B19
- Rubella

### Contact Precautions

In addition to Standard Precautions, use Contact Precautions for patients known or suspected to have serious illnesses easily transmitted by direct patient contact or by contact with items in the patient's environment. Examples of such illnesses include:

- Gastrointestinal, respiratory, skin, or wound infections or colonization with multidrug-resistant bacteria judged by the infection control program, based on current state, regional, or national recommendations, to be of special clinical and epidemiologic significance
- Enteric infections with a low infectious dose or prolonged environmental survival, including:
  - *Clostridium difficile*
  - For diapered or incontinent patients: enterohemorrhagic *Escherichia coli* O157:H7, *Shigella* species, hepatitis A, or rotavirus
- Respiratory syncytial virus, parainfluenza virus, or enteroviral infections in infants and young children
- Skin infections that are highly contagious or that may occur on dry skin, including:
  - Diphtheria (cutaneous)
  - Herpes simplex virus (neonatal or mucocutaneous)
  - Impetigo
  - Major (noncontained) abscesses, cellulitis, or pressure ulcers
  - Pediculosis
  - Scabies
  - Staphylococcal furunculosis in infants and young children
  - Zoster (disseminated or in the immunocompromised host)*
- Viral and hemorrhagic conjunctivitis
- Viral hemorrhagic infections (Ebola, Lassa, or Marburg)

*Certain infections require more than one type of precaution.
From Centers for Disease Control and Prevention, Atlanta, GA, 2007.

worker and patient. When possible, the patient requiring contact isolation is placed in a private room to facilitate hand hygiene and decreased environmental contamination. Masks are not needed, and doors do not need to be closed (Chart 70-2).

### *Specific Organisms with Health Care–Associated Infection Potential*

#### Clostridium Difficile

This spore-forming bacterium has significant HAI potential. A more virulent strain has affected health care facilities throughout North America in the past several years, and rates of C. *difficile* infection increased significantly in the United States since 2000 (McDonald, 2007). Infection is usually preceded by antibiotics that disrupt normal intestinal flora and allow the antibiotic-resistant C. *difficile* spores to proliferate within the intestine. The organism causes pathology by releasing toxins into the lumen of the bowel. In pseudomembranous colitis, the most extreme form of C. *difficile* infection, debris from the injured lumen of the bowel and from white blood cells, accumulates in the form of pseudomembranes or studded areas of the colon. The destruction of such a large anatomic area can produce profound sepsis.

Because antibiotics are used so extensively in health care settings, many patients are at risk for infection with C. *difficile*. The potential for health care–associated acquisition is increased because the spore is relatively resistant to disinfectants and can be spread on the hands of health care providers after contact with equipment previously contaminated with C. *difficile*. Control is best achieved by using Contact Precautions for infected patients, with use of gowns and gloves for all patient contact. Because the spores are resistant to alcohol, waterless hand products are not as effective as handwashing with soap and water for use in hand hygiene. Bleach-based solutions and cleaning products are preferred over other hospital disinfectants for environmental cleaning. Frequently touched equipment (such as the overbed table and side rails) should be cleaned daily and whenever visibly soiled. IV poles and other peripheral items should be cleaned when the patient is discharged.

### *Methicillin-Resistant Staphylococcus Aureus*

***Methicillin-resistant Staphylococcus aureus* (MRSA),** a common human pathogen, refers to *S. aureus* that is resistant to methicillin or its comparable pharmaceutic agents, oxacillin and nafcillin. Soon after penicillin was discovered in the 1940s, *S. aureus* became all but universally penicillin resistant. Alternative therapies in the form of cephalosporins and synthetic penicillin solutions such as methicillin were introduced. However, since the late 1970s, MRSA became increasingly more prevalent, and transmission within hospitals and nursing homes is well documented. In the past 10 years, MRSA has also been found in otherwise healthy people who have not been in health care settings (CDC, 2006a).

***Health Care–Associated MRSA.*** Health care providers transmit MRSA to patients easily because *S. aureus* has an affinity for skin colonization. The patient who is colonized with MRSA has an increased probability of developing health care–associated MRSA (HA-MRSA), especially when invasive procedures, such as IV therapy, respiratory therapy, or surgery are performed. The colonized patient also serves as a reservoir of MRSA that can be transmitted to others. HA-MRSA may persist as normal flora in the patient for an extended time. From the early 1990s to 2003, the proportion of MRSA in *S. aureus* samples grew from approximately 20% to approximately 60% (CDC, 2006a).

***Community-Associated MRSA.*** MRSA is not limited to health care facilities, and in recent years there has been a significant increase in the incidence of MRSA infections in children, members of sports teams, prison inmates, and in other people who have no apparent health care exposure. These **community-associated MRSA** (CA-MRSA) infections are typically caused by strains of *S. aureus* that are molecularly distinct from HA-MRSA. The CA-MRSA strains typically produce more toxins than HA-MRSA, and localized skin symptoms can lead to necrotizing fasciitis or bacteremia (Weber, 2005). Often, skin symptoms are initially mistaken for spider or bug bites. CA-MRSA infections have resulted in serious skin and soft tissue infections, pneumonia, and, in rare cases, death. Once introduced into a health care facility, the virulent CA-MRSA strains can be transmitted to other patients in a manner typically associated with HA-MRSA (Gonzalez, Rueda, Shelburne, et al., 2006).

***Control of MRSA in Health Care Facilities.*** The CDC recommends Contact Precautions for patients with MRSA colonization or infection. In recent years, there has been a growing debate about the benefits of active surveillance cultures to determine unrecognized carriers. In active surveillance, asymptomatic patients are cultured routinely (on admission or on a regular basis) to determine unrecognized carriers. Although the epidemiologic evidence does not clearly indicate whether this strategy reduces patient risk, a growing number of states have mandated this approach (Milstone & Perl, 2008). Nurses who participate in active surveillance programs must be prepared to educate patients and their families about the definitions of colonization and infection and the reason for the vigorous isolation efforts.

Vancomycin (Vancocin) and linezolid (Zyvox) are typically the preferred treatments for serious MRSA infection. However, there is concern that MRSA will eventually become resistant to even these medications because they are used so commonly. Since 2002, a very small but disturbing number of patients have been diagnosed with *S. aureus* infections that are completely resistant to vancomycin (ie, ***vancomycin-resistant Staphylococcus aureus* [VRSA]**). Researchers have also noted decreased efficacy of vancomycin both in the laboratory and in clinical settings (Wang, Hindler, Ward, et al., 2006). The threat of VRSA is considered a very serious public health concern because of the commonality and pathogenicity of *S. aureus*. Without effective antibiotics, many patients with *S. aureus* infections would have a poor outcome (CDC, 2002b). Control of MRSA is an important goal, and it may also make the emergence of VRSA strains less likely.

### *Vancomycin-Resistant Enterococcus*

***Vancomycin-resistant Enterococcus* (VRE)** is the second most frequently isolated source of HAIs in the United States. This gram-positive bacterium, which is part of the normal flora of the gastrointestinal tract, can produce significant disease when it infects blood, wounds, or the urinary tract.

*Enterococcus* has several traits that make it an easily transmittable HAI organism. It is a normal part of the gastrointestinal flora of the host; it is bile resistant and able to withstand harsh anatomic sites, such as the intestine; and it persists well on the hands of health care providers and on environmental objects.

As a relatively resistant organism at baseline, therapy for *Enterococcus* is limited to penicillin formulations (eg, ampicillin), vancomycin in combination with an aminoglycoside (eg, gentamicin), or linezolid (Zyvox). Between 1994 and 2003, the CDC recorded an increase of more than 62% in the number of cases of VRE infections in patients in intensive care units (CDC, 2004b). This rapid increase has serious implications. Because many strains of VRE are resistant to all other antimicrobial therapies, clinicians are left with few choices for effective therapy. Equally important, VRE colonization and infection may serve as a reservoir of vancomycin-resistant coded genes that may be transferred to the more virulent *S. aureus* (CDC, 2002b).

### *Multidrug-Resistant Gram-Negative Organisms*

During the past several decades, the incidence of infections caused by multidrug-resistant gram-negative organisms has also increased significantly. Extensive use of antibiotics induces resistance. The bacteria that most commonly develop resistance include *P. aeruginosa* (resistant to fluoroquinolone antibiotics and/or carbapenems), *Acinetobacter* species (resistant to many antibiotics, including carbapenems), and both *Klebsiella pneumoniae* and *Escherichia coli* (resistant to extended-spectrum beta-lactam antibiotics). These pathogens are also associated with outbreaks in health care facilities. Transmission has been associated with contamination of equipment and with transfer via the hands of health care workers (CDC, 2002b).

## Preventing Health Care-Associated Bloodstream Infections (Bacteremia and Fungemia)

Reducing the risk of health care–associated bloodstream infections requires preventive activities in addition to the Standard Precautions. If a health care–associated

**Chart 70-3 • *Conditions That Suggest the Presence of Health Care–Associated Vascular Access Device-Related Bacteremia or Fungemia***

- The patient has catheter in place, appears septic, but has no obvious reason to suggest predisposition to sepsis.
- There is no infection at another body site to indicate probable source of sepsis.
- The site of vascular line insertion is red, swollen, or draining (especially purulent drainage).
- The patient has a central vascular line in place at the onset of sepsis.
- The bloodstream infection is caused by *Candida* species or by common skin organisms such as coagulase-negative staphylococci, *Bacillus* species, or *Corynebacterium* species.
- The patient remains septic after appropriate therapy without removal of the vascular access device.

bloodstream infection occurs, early diagnosis is important to prevent complications, such as endocarditis and brain abscess. Mortality rates associated with infection by some organisms are estimated to average 18%. The estimated cost attributed to catheter-related bloodstream infections ranges from $12,000 to $54,000 per case (Pronovost, Needham, Berenholtz, et al., 2006).

**Bacteremia** is defined as the laboratory-confirmed presence of bacteria in the bloodstream. **Fungemia** is a bloodstream infection caused by a fungal organism. Any vascular access device (VAD) can serve as the source for a bloodstream infection. Most hospitalized patients receive VADs, and increasingly, long-term central catheters are used to provide IV therapy to outpatients in clinic or home settings. In all instances, the nurse must use appropriate care to reduce the risk of bacteremia and to be alert for signs of bacteremia. Chart 70-3 identifies conditions that suggest the presence of health care–associated VAD-related bacteremia or fungemia.

Hand hygiene and strict attention to aseptic technique are essential during the insertion of all VADs. Health care personnel who insert central catheters should use surgical technique, including sterile gloves, sterile gowns with long sleeves, masks, and a large drape over the patient.

#### Disinfecting Skin

The patient's own flora, traversing the exterior of a peripherally inserted catheter or contaminating the central catheter hub, is the most common bacterial source of catheter-related bacteremia (CDC, 2002b). Rarely, IV fluid itself can become contaminated and serve as a source of infection. The preferred solution for disinfection of the insertion site is chlorhexidine gluconate (CHG, Hibiclens). Alternative solutions are povidone-iodine (Betadine) or alcohol.

There is no apparent difference in risk or benefit when comparing transparent polyurethane dressings and gauze dressings. However, if blood is oozing from the catheter insertion site, a gauze dressing should be used. Most importantly, the dressing should be applied using aseptic technique and should be sealed along its entire perimeter. A highly absorbent CHG-impregnated dressing (Biopatch Antimicrobial Dressing), which releases disinfectant for up to 7 days, may be used to reduce risk in patients older than 2 months of age (Marschall, Mermel, Classen, et al., 2008).

#### Changing Infusion Sets, Caps, and Solutions

Infusion sets and stopcock caps should be changed no more frequently than every 3 days, unless an infusion set is used for the delivery of blood or lipid solutions. Infusion sets and tubing for blood, blood products, or lipid emulsions should be changed within 24 hours of initiating the infusion. Blood infusions should finish within 4 hours of hanging the blood; lipid solutions should be completed within 24 hours of hanging. There are no guidelines for the appropriate intervals for the hang time of other solutions. Injection ports should be cleaned with 70% alcohol or iodophor before accessing the system (CDC, 2002b).

## Preventing Infection in the Community

The CDC and state and local public health departments share responsibility for prevention and control of infection in the community. Methods of infection prevention include sanitation techniques (eg, water purification, disposal of sewage and other potentially infectious materials), regulated health practices (eg, the handling, storage, packaging, and preparation of food by institutions), and immunization programs. In the United States, immunization programs have markedly decreased the incidence of infectious diseases.

### *Vaccination Programs*

The goal of vaccination programs is to use wide-scale efforts to prevent specific infectious diseases from occurring in a population. Public health decisions about vaccination efforts are complex. Risks and benefits for the person and the community must be evaluated in terms of morbidity, mortality, and financial cost and benefit. The most successful vaccine programs have been ones for the prevention of smallpox, measles, mumps, rubella, polio, diphtheria, pertussis, and tetanus. Table 70-3 demonstrates this success.

More than 25 vaccines are currently licensed in the United States. Vaccines are suspensions of antigen preparations, intended to produce a human immune response to protect the host from future encounters with the organism. Because no vaccine is completely safe for all recipients, contraindications on package inserts of a vaccine must be heeded. These guidelines provide details about studied experiences with allergy and other complications and provide crucial information about refrigeration, storage, dosage, and administration. The most common adverse effects are allergic reaction to the antigen or carrier solution and the occurrence of the actual disease (often in modified form) when live vaccine is used.

The standard recommended immunization schedules for adults as developed by the CDC can be found at the CDC Web site (2009b). The schedule is revised as epidemiologic evidence warrants; nurses should consult the CDC to determine the most recent schedule. Variations to the recommended immunization schedule should be made on a case-by-case basis, depending on the patient's risk factors. The recommended vaccines for adults are designed to protect those with underlying diseases that increase infection risk, those with potential for occupational exposure, and those

**Table 70-3 IMPACT OF VACCINES IN THE TWENTIETH AND TWENTY-FIRST CENTURIES**

| Disease | 20th-Century Annual Morbidity | 2006 Total | % Decrease |
|---|---|---|---|
| Smallpox | 48,164 | 0 | 100 |
| Diphtheria | 175,885 | 0 | 100 |
| Pertussis | 147,271 | 15,632 | 89 |
| Tetanus | 1314 | 41 | 97 |
| Polio (paralytic) | 16,316 | 0 | 100 |
| Measles | 503,282 | 55 | >99.9 |
| Mumps | 152,209 | 6,584 | 96 |
| Rubella | 47,745 | 11 | >99.9 |
| Congenital rubella | 823 | 1 | 88.8 |
| *Haemophilus influenzae* (<5 years) | 20,000 (EST) | 208 (serotype b or unknown) | 99 |

Centers for Disease Control and Prevention. (2008). Atkinson, W., Hamborsky, J., McIntyre, L., et al. (Eds.). *Epidemiology and prevention of vaccine-preventable diseases* (10th ed. 2nd printing). Washington DC: Public Health Foundation.

who may be exposed to infectious agents during travel. Immunosuppressed adults (including those who have had a splenectomy) should be vaccinated for pneumococcus (*Streptococcus pneumoniae*) and meningococcus (*Neisseria meningitidis*). Health care workers should be immune to measles, mumps, rubella, pertussis, tetanus, hepatitis B, and varicella. An annual influenza vaccine is recommended for people with chronic conditions such as immune suppression, asthma, and cardiac or respiratory diseases, as well as for *all* health care workers and for people 65 years of age and older.

The CDC (2009a) gives information about individual vaccines and vaccine-preventable diseases. It also provides a 24-hour telephone hotline (see Resources below) for routine pediatric or adult vaccine advice. Advice about optimal vaccinations for travelers is also available at the CDC (2006d) Web site and by phone (see Resources).

The incidence of vaccine-preventable diseases, such as measles, mumps, rubella, and diphtheria, is affected by immigration from developing countries. Vaccine campaigns in developing countries are often financially and logistically constrained, and immigrants from such areas may be more likely than U.S. residents to be unprotected. Individual risk and epidemic risk are reduced when vaccination campaigns reach all communities, including those with a high proportion of immigrants.

### Common Vaccines

***Measles, Mumps, and Rubella Vaccine.*** Since the measles, mumps, and rubella (MMR) vaccines were licensed, endemic rubella has been eliminated in the United States (CDC, 2005a), and mumps and rubella have decreased by more than 99%. To maintain this effective public health strategy, routine MMR vaccination should be administered to children at 12 to 15 months of age, with repeat dosing at 4 to 6 years of age (CDC, 2007a).

Patients should be advised that fever, transient lymphadenopathy, or hypersensitivity reaction might occur following an MMR vaccination. The risk of side effects is greater in vaccine recipients who have not previously received the vaccine than in those who have received repeat doses. Antipyretics may be used to decrease the risk of fever.

***Varicella (Chickenpox) Vaccine and Zoster (Shingles) Vaccine.*** Varicella zoster is the virus that causes chickenpox and herpes zoster. In its natural state, the varicella virus often attacks children, causing disseminated disease in the form of chickenpox. Although the incidence of varicella is lower in adults, the severity of chickenpox and possible sequelae, including death, is substantially greater (CDC, 2007a). Transmission occurs by the airborne and contact routes. With rare exception, varicella infects a person only once. The incubation period is about 2 weeks (range, 10 to 21 days). During a prodrome of general malaise (often noticed about 2 days before the rash develops), the newly infected host is capable of transmitting the virus to other susceptible contacts. Typically, the vesicular, pustular rash spreads rapidly from few too many lesions in a matter of hours. New lesions continue to form for 2 to 3 days and appear at different stages throughout this time. By the fourth symptomatic day, the lesions begin to dry, and new lesions usually do not develop. Fever is common during the 4 to 6 days of rash progression. When the lesions have crusted, the patient is no longer contagious.

Between 1995, when the varicella vaccine was first licensed in the United States, and 2004, the incidence of chickenpox decreased by 83% to 93%. The vaccine is effective in preventing chickenpox in approximately 70% to 90% of people who receive vaccinations, and it is 90% to 100% effective in preventing severe varicella (CDC, 2007a). The vaccine should not be given to those who have depressed immune function, are pregnant, have received blood products in the past 6 months, or have demonstrated allergy to varicella vaccine.

Herpes zoster, also known as shingles, is a painful, localized rash caused by recurrent varicella. Vesicles are restricted to areas supplied by single associated nerve groups. Varicella may be transmitted from the rash of those with shingles to people who are susceptible to varicella; the new varicella infections are manifested as chickenpox. It is estimated that more than 50% of unvaccinated people who live to at least 85 years of age will develop shingles.

In 2006, the Food and Drug Administration approved Zostavax, a vaccine to reduce the risk of shingles. The vaccine is recommended for people older than 60 years of age because it reduces the risk of shingles by approximately 50% in those people (CDC, 2007a).

***Influenza Vaccine.*** Influenza is an acute viral respiratory disease that predictably and periodically causes worldwide epidemics known as pandemics. Epidemics occur every 2 to 3 years, with a highly variable degree of severity. An estimated 36,000 deaths per year are attributed to influenza or its sequelae (ie, pneumonia, cardiopulmonary collapse). Elderly people are more susceptible to influenza, and the incidence of the disease in the United States is increasing as the proportion of the elderly increases (CDC, 2007a).

Each year a new vaccine is composed of the three virus strains (two type A influenza strains and one type B influenza strain) considered most likely to occur in the coming season. If the correct influenza agents have been included in that year's vaccine, the vaccine offers approximately 70% to 90% protection for healthy children and adults younger than 65 years of age. Although less effective in preventing disease in the elderly, it decreases the severity of illness in those who become infected. In extended care facilities, the vaccine is approximately 80% effective in preventing death and 50% to 60% effective in preventing hospitalization (CDC, 2007a). The vaccine is administered as an injection with inactivated virus or as a nasal spray with live attenuated virus.

The Advisory Committee for Immunization Practices of the Public Health Service recommends annual influenza vaccinations for the following groups: people older than 50 years of age, children 6 to 59 months of age, pregnant women, residents of extended care facilities, and those with chronic medical diseases or disabilities. In addition, health care providers and household members of those in high-risk groups should receive the vaccine to reduce the risk of transmission to people vulnerable to influenza sequelae. Vaccine campaigns in health care workers and patients should be intensified when there is evidence of community influenza.

#### Reporting Problems With Vaccines

Nurses should ask parents or adult vaccine recipients to provide information about any problems encountered after vaccination. As mandated by law, a Vaccine Adverse Event Reporting System (VAERS) form must be completed with the following information: type of vaccine received, timing of vaccination, onset of the adverse event, current illnesses or medication, history of adverse events after vaccination, and demographic information about the recipient. Forms are obtained by telephone or via the Internet (see Resources section) and can be submitted online.

#### Contraindications to Vaccines

Patients who have developed encephalopathy within 7 days of a previous diphtheria, tetanus, and pertussis dose and those who have developed anaphylaxis or other moderate or severe sequelae after a previous dose should not receive further doses. Diphtheria, tetanus, and acellular pertussis (DTap) is often deferred for the child who previously developed a fever higher than 40.5°C (105°F) within 48 hours of vaccination or who had a seizure or developed a shocklike state within 3 days of previous vaccination. Some live vaccines (eg, varicella, MMR, yellow fever) are contraindicated for people who are severely immunosuppressed or who are pregnant. All decisions about vaccination should be made by the patient's primary health care provider after careful review of vaccine-specific contraindications.

### Planning for an Influenza Pandemic

A pandemic is a global outbreak of a disease. For example, influenza caused three pandemics in the 20th century. In the United States, the pandemic influenza caused more than 500,000 deaths in the 1918 "Spanish flu" pandemic, about 70,000 deaths in 1957 in the "Asian flu" pandemic, and about 34,000 deaths in 1968 in the "Hong Kong flu" pandemic. In June 2009, the WHO announced that a novel influenza virus, H1N1 had reached pandemic proportion. At the time of this printing, the extent of the H1N1 pandemic cannot be characterized, but its rapid dissemination worldwide with sustained human to human transmission in many locations was well recognized.

Subtypes of influenza viruses have pandemic potential because they constantly change within animals and secondarily within humans. As a result of these changes, essentially new viruses can "emerge" and can expose entire populations who are immunologically unprotected.

Influenza pandemics are likely to be more catastrophic than other anticipated public health problems because they last longer than other emergency events, they often occur in "waves," they deplete the available health care workforce, and they reduce the supply of medical equipment because of their widespread nature. The frequency and severity of pandemics cannot be accurately predicted, but models suggest that a medium-intensity pandemic could cause more than 200,000 deaths in the United States and quickly overwhelm the existing health care infrastructure. The CDC encourages all health care institutions to have a pandemic plan and to test the components of the plan regularly. A tool to help estimate the number of hospitalizations that will occur, the need for intensive care unit beds, and the need for ventilators can be found at http://www.cdc.gov/flu/flusurge.htm.

#### Avian Influenza Pandemic

Avian influenza (bird flu) is an infection caused by influenza viruses that chiefly infect birds and poultry. The H5N1 strain (named for the characteristics of the viral surface proteins hemagglutinin and neuraminidase) is of particular concern. It has caused a number of outbreaks in poultry since 2003, and the problem is ongoing; flocks of migratory birds have rapidly disseminated the virus throughout much of the world. Although many avian influenza viruses are natural and nonpathogenic in birds, H5N1 is unusual because of its high mortality rate in birds and because it has shown a limited ability to be transmitted from a bird source to mammals, including humans. The human mortality rate from H5N1 avian influenza has been more than 60% (WHO, 2008a). The majority of human cases of H5N1 are attributed to direct contact with poultry, but there are rare instances that suggest occasional human-to-human transmission.

Scientists are especially concerned that avian influenza H5N1 may change, either through mutation or reassortment, to become easily transmitted from human to human. If H5N1 were easily transmissible to humans, it would be likely to cause a severe pandemic because the human population has no immunity to the virus and because development of an appropriate vaccine would take too long to effectively stop the pandemic (U.S. Department of Health and Human Services [USDHHS], 2008).

The symptoms associated with H5N1 avian influenza in humans have ranged from the symptoms typically seen with seasonal influenza (cough, fever, and muscle aches) to severe pneumonia and multiorgan failure. Influenza antiviral therapy (ie, oseltamivir [Tamiflu] and zanamivir [Relenza]) is stockpiled as part of a national strategy, with hopes that they would be effective in treating humans infected with the pandemic strain of H5N1. Simple infection control strategies using careful hand hygiene and masks will be especially important in an avian influenza pandemic. Health departments throughout the country are also planning how to implement isolation programs to keep symptomatic people away from schools and work places (USDHHS, 2008).

## Home-Based Care of the Patient With an Infectious Disease

The nurse who cares for the patient with an infectious disease in the home should provide information about infection risk prevention to the patient, the family, and the caregiver (Chart 70-4). Recognizing that a health history may not identify all active or latent infections, the caregiver should carefully follow Standard Precautions in the home. The nurse should establish a work environment that facilitates hand hygiene and aseptic technique.

Family caregivers should receive an annual influenza vaccine. This is especially true if the caregiver or the patient is older than 50 years of age, has underlying cardiac or pulmonary disease, or has underlying immunosuppression.

Patients requiring home care are often people with immunosuppression from underlying conditions, such as HIV infection or cancer, or those who have treatment-induced immunosuppression, as occurs with many antineoplastic agents. Careful assessment for signs of infection is important.

### Reducing Risk to the Patient

#### Equipment Care

All caregivers must pay careful attention to disinfection and aseptic technique while using medical equipment. Catheter-related sepsis should be suspected in a patient who has unexplained fever, redness, swelling, and drainage around a vascular catheter insertion site. Indwelling urinary catheters should be discontinued whenever possible, because each day of use increases the risk of infection. The nurse should promptly report signs of urinary tract infection or of generalized sepsis to the patient's physician.

#### Patient Teaching

When assessing the risk of the immunosuppressed patient in the home environment for infection, it is important to realize that intrinsic colonizing bacteria and latent viral infections present a greater risk than do extrinsic environmental contaminants. The nurse should reassure the patient and family that their home needs to be clean but not sterile. Common-sense approaches to cleanliness and risk reduction are helpful.

For patients with neutropenia or T-cell dysfunction (eg, patients with acquired immunodeficiency syndrome [AIDS]), it is wise to restrict visits of people with potentially contagious illnesses. The patient who is severely neutropenic should not eat uncooked fruits and vegetables. The immunosuppressed patient is vulnerable to acquiring bacterial infection with enteric pathogens from food; therefore, family members should be reminded about the need to follow recommendations for hygiene and safe cooking times and temperatures.

### Reducing Risk to Household Members

Establishing reasonable barriers to infection transmission in the household is an important part of home care. The route of transmission of the organism in question must first be determined. The nurse can then teach household members strategies to reduce their risk of becoming infected. If the patient has active pulmonary TB, the public health department should be contacted to provide screening and treatment for family members. If the patient has shingles (herpes zoster), family members who have had varicella vaccine or who have previously had chickenpox are considered immune and need no precautions. However, if a family member is immunosuppressed or otherwise susceptible to varicella, maintaining physical separation may be an important strategy during the time when the patient has draining

CHART 70-4 HOME CARE CHECKLIST

**Prevention of Infection in the Home Care Setting**

| At the completion of the home care instruction, the patient or caregiver will be able to: | PATIENT | CAREGIVER |
|---|---|---|
| • Demonstrate aseptic technique in the care of technical equipment such as intravenous catheter and indwelling urinary catheter. | ✔ | ✔ |
| • Demonstrate thorough hand hygiene after patient care. (Use alcohol-based disinfectant *or* handwashing.) | ✔ | ✔ |
| • Complies with antibiotic regimen (patient) or with completion of vaccination series (patient and caregiver). | ✔ | ✔ |
| • State the rationale for thoroughly cooking all foods and storing meat products separate from other food groups. | ✔ | ✔ |
| • Use separate eating utensils and towels. | ✔ | ✔ |
| • Avoid contact with someone who has a known infectious disease. | ✔ | ✔ |

lesions. When the patient is infected with *Shigella*, *Salmonella*, *C. difficile*, hepatitis A, or other enteric organisms, the family should be reassured that common household disinfectants are effective in controlling environmental contamination.

Family members who assist in the care of a patient with a bloodborne infection such as HIV or hepatitis C can prevent transmission by carefully handling any sharp objects that are contaminated with blood. Family teaching may include discussion about the need for caution when shaving the patient; performing dressing changes; or administering any IV, intramuscular, or subcutaneous medication. To collect and dispose of used needles, syringes, and vascular access equipment, the family should use containers designed for sharps disposal. With the exception of TB, the opportunistic infections associated with AIDS do not usually pose a risk to the healthy family member. Family members should be reassured that dishes are safe to use after being washed with hot water and that linens and clothing are safe to use after being washed in a hot-water cycle.

## Nursing Management

### Assessment

The health history and physical examination and the use of diagnostic tests are important for determining the presence of infection and infectious diseases. Symptoms of infectious diseases vary significantly between and within diseases. For some infections, visible symptoms such as rash, redness, or swelling provide early warnings of infection. In other infections, such as TB and HIV, asymptomatic latency is prolonged, and infection must be determined through diagnostic procedures.

The history is obtained to establish the likelihood and probable source of infection as well as the degree of associated pathology and symptoms. The patient's previous medical record is reviewed when possible. In obtaining a health history, the following questions may be asked:

- Does the patient have a history of previous or recurrent infections?
- Has there been fever? How high has the patient's temperature been? Is the temperature constant, or does it rise and fall? Has fever been associated with chills? Has the patient taken any medication to relieve fever?
- Is there cough? Is the cough chronic or acute? Is it associated with shortness of breath? Does the cough produce sputum? Is the sputum bloody? Has the patient had a tuberculin skin test (TST) recently? If so, what were the results? Has the patient been given isoniazid (INH) prophylaxis for TB infection? Has the patient been treated for TB in the past?
- Is there pain? Where is the pain? What is the nature of the pain? Does the patient have a sore throat, headache, myalgias, or arthralgias? Is there pain on urination or other activity?
- Is there edema? Is there drainage associated with the edema? Is the edematous area warm to touch?
- Is there a draining lesion? Is the drainage associated with trauma or a previous procedure? Is the drainage purulent or clear?
- Does the patient have diarrhea, vomiting, or abdominal pain?
- Is there a rash? What is the nature of the rash—is it flat, raised, red, crusted, purulent, or lacelike? Has the patient taken medications that could induce rash? Has there been exposure to another person who has an identified infectious disease or rash?
- What is the patient's vaccination history?
- Has there been an insect or animal bite? Has there been an animal scratch or other exposure to pets, farm animals, or experimental animals?
- What medications are used? Have antibiotics been taken recently or long term? Is the patient being treated with corticosteroids, immunosuppressive agents, or chemotherapy?
- Has the patient been treated in the past for other infectious diseases? Has the patient been hospitalized for infectious diseases?
- If sexual history is pertinent, has there been sexual exposure to another person with a known sexually transmitted disease (STD)? Has the patient been treated for STDs in the past? Is the patient pregnant, or has she recently been pregnant? Has the patient been tested for HIV?
- Has the patient traveled abroad, including developing countries? What was the immunization or antimicrobial prophylaxis used for protection while traveling?
- What is the patient's occupation? What are the patient's recreational activities? Hobbies?

Because infection may occur in any body system, physical examination may reveal signs of infection at any body site. Generalized signs of chronic infection may include significant weight loss or pallor associated with anemia of chronic diseases. Acute infection may manifest with fever, chills, lymphadenopathy, or rash. Localized signs vary by source of infection. Purulent drainage, pain, edema, and redness are strongly associated with localized infection. Cough and shortness of breath may be caused by influenza, pneumonia, or TB, as well as many noninfectious causes.

### Nursing Interventions

#### Preventing Infection Transmission

Preventing the spread of infection requires an understanding of the usual routes of transmission of the organism. The hospitalized patient may pose a contagious risk to others if the disease is easily spread (such as *C. difficile*) or is spread through an airborne route (such as TB). In these situations, strict adherence to isolation measures is important in reducing the opportunity for spread. Preventing transmission of organisms from patient to patient requires participation of the health care team. Transmission of organisms on the hands and gloves of health care workers remains a common source of cross-infection in the hospital or clinic setting.

Nurses serve an important role in preventing the transfer of organisms in two ways. First, as the health professionals who spend the most time with patients, nurses have a greater opportunity for spreading organisms. It is imperative that nurses disinfect their hands before and after contact with patients and after performing a potentially hand-contaminating activity. Hands must be disinfected each time gloves are removed. For example, the nurse who has performed endotracheal suctioning should remove the gloves, wash the hands,

and put on a new pair of gloves before performing wound care on the same patient. Second, nurses can reduce hand-to-hand spread of organisms by serving as patient advocates. To the degree feasible, the nurse should observe the hand-hygiene activities of other professionals and discuss with them any lapses in technique that are observed.

#### Teaching About the Infectious Process

Interruption of transmission requires diagnosis and patient compliance with the treatment regimen. The nurse's role is to educate the patient and, in some situations, to report the case to public health officials for contact tracing and verification of follow-up.

The nurse must stress the importance of immunization to parents of young children and to others for whom vaccines are recommended, such as patients who are elderly, are immunosuppressed, or have chronic illnesses or disabilities. Nurses should recognize their personal responsibility to receive the hepatitis B vaccine and an annual influenza vaccine to reduce potential transmission to themselves and vulnerable patient groups.

Infectious diseases often seem mysterious and frequently are socially stigmatizing. Patient teaching efforts require empathy and sensitivity. For example, in the past, TB was a stigmatizing disease. The nurse may need to provide basic information to the patient who needs INH prophylaxis to promote understanding and allay anxiety that the patient may feel.

#### Controlling Fever and Accompanying Discomforts

Fever must always be investigated to determine whether infection is the source. Evidence indicates that fever, mediated by the hypothalamus, may potentiate beneficial functions in the syndrome of reactions known as *acute-phase reaction*. These reactions include changes in liver protein synthesis; alterations in serum metals, such as iron; and increased production of certain classes of white blood cells and other cells of the immune system. Most fevers are physiologically controlled so that the temperature remains below 41°C (105.8°F). However, severe fever, as occurs with meningococcal meningitis, may cause heat stroke and other complications. Even milder fevers accompanied by fatigue, chills, and diaphoresis are often uncomfortable for the patient. Whether fever is treated or untreated, adequate fluid intake is important during febrile episodes.

> **NURSING ALERT**
>
> **Because fever offers clues about infection severity and the success of antibiotic therapy, outpatients with fever should be taught to obtain accurate temperature readings. Frequently, family caregivers know that a patient has warm skin but do not disturb the patient by taking a temperature reading. Body temperature information can be very helpful in adjusting therapy or in reevaluating a preliminary diagnosis.**

#### Monitoring and Managing Potential Complications

The patient with a rapidly progressive infectious disease should have vital signs and level of consciousness closely monitored. X-ray findings and microbiologic, immunologic, hematologic, cytologic, and parasitologic laboratory values must be interpreted in the context of other clinical findings to assess the course of the infectious disease.

Antibiotic therapy is frequently complex, and modifications are necessary because of sensitivity test results and disease progression. To ensure therapeutic blood levels rapidly, antibiotic therapy should be initiated as soon as it is prescribed rather than waiting until routine medication scheduling times. The Plan of Nursing Care in Chart 70-5 describes nursing interventions for specific complications of infection.

# Diarrheal Diseases

Diarrheal diseases, which are especially prevalent in the developing world, cause significant morbidity and mortality. It is estimated that diarrheal diseases kill more than 6,000 children per day in Asia, Africa, and Latin America. The most important cause of death associated with these diseases is dehydration, and the most important treatment that decreases death rates is rehydration therapy (Guerrant & Steiner, 2005).

In the United States, the epidemiology of diarrheal diseases is changing constantly. Water disinfection, pasteurization, and appropriate food packaging have decreased the incidence of diseases such as typhoid and cholera. However, importation of foreign foods, environmental and ecological changes, and changes in diagnostic test modalities have led to recognition of important new trends and outbreaks.

## Transmission

The portal of entry of all diarrheal pathogens is oral ingestion. Although food is far from sterile, the high acidity of the stomach and the antibody-producing cells of the small bowel generally serve to decrease the potential of pathogens. Infection can occur when the infectious dose is high enough or if the food neutralizes the acidic environment. Decreased gastric acidity with disruption of normal bowel flora (as occurs after surgery), use of antimicrobial agents, and the immune dysfunction of AIDS all decrease intestinal defenses.

## Causes

There are many bacterial, viral, and parasitic causes of diarrheal diseases. Common causes of bacterial infection include *E. coli* and *Salmonella*, *Shigella*, *Campylobacter*, and *Yersinia* species. The most significant viral causes of diarrhea are *Rotavirus*, which commonly results in diarrhea in young children, and *Calicivirus* (often called *Norovirus*), a virus associated with outbreaks in long-term care facilities and cruise ships. Parasitic infections of importance include *Giardia* and *Cryptosporidium* species and *Entamoeba histolytica*.

### Campylobacter Infections

*Campylobacter* species are the most frequent cause of diarrheal disease worldwide. The bacterium, which is abundant in animal foods, is especially common in poultry but can also be found in beef and pork. Direct person-to-person transmission appears to be less common than it is for other enteric pathogens, such as *Shigella*. Guillain-Barré syndrome, a serious neurologic disorder characterized by

CHART 70-5

**PLAN OF NURSING CARE**

## *Care of the Patient With an Infectious Disease*

**NURSING DIAGNOSIS:** Risk for infection transmission
**GOAL:** Prevention of transmission of infectious agents

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Prevent patient-to-patient infection spread. | 1. Organisms that are spread through an airborne route or are very contagious through direct contact can be transmitted in a health care setting. | • No evidence of patient-to-patient transmission of infection<br>• No evidence of transmission via health care workers<br>• No occupationally acquired infections in nurses and other health care workers<br>• No evidence of transmission due to contaminated equipment<br>• Absence of bacteremia, septicemia, and sepsis<br>• Absence of urinary tract infections<br>• Absence of pneumonia |
| a. Provide isolation according to CDC guidelines and Standard Precautions. | a. CDC isolation strategies are developed to reduce the likelihood of transmission from patient to patient. | |
| b. Ensure that patients with airborne infections remain in private rooms during hospital stay. If they must leave their rooms, arrangements should be made to decrease the likelihood of contact with other patients. Rooms should be ventilated according to CDC criteria. Personal protective equipment in the form of N95 respirators should be worn as indicated.<br>The N95 respirator is the minimal level of personal protection for tuberculosis control. The "N" indicates the filter resistance to oil aerosols; and the "95" indicates that the respirator has 95% effectiveness in filtering test particles.<br>In any care setting where patients may have increased risk for the sequelae of influenza, annual influenza vaccination should be encouraged for personnel and patients. | b. Engineering controls are important in the prevention of airborne diseases. Influenza vaccine safely reduces risk of illness associated with this highly communicable, and frequently virulent, condition. | |
| c. Ensure that patients with highly transmissible, nonairborne organisms such as *Clostridium difficile* and *Shigella* species are physically separated from other patients if hygiene or institutional policy dictates. | c. Increased prevention strategies are needed when the organism has high epidemic potential. | |
| 2. Prevent health care workers' transfer of organisms from patient to patient. | 2. Transfer of organisms on the hands of health care workers is a common route of transmission. Hospital organisms colonizing the hands of health care workers may be virulent. | |
| a. Perform hand hygiene (by hand washing or by use of alcohol-based solution) consistently and thoroughly, disinfecting hands before and after each patient contact, and after procedures that offer contamination risk while caring for an individual patient. | a. Hand hygiene is important in reducing transient flora on outer epidermal layers of skin. Alcohol-based hand disinfectants are effective methods to reduce transient flora. | |
| b. Use gloves when handling any body fluid from any patient. Change gloves between patient care activities, and disinfect hands after gloves are removed. | b. Gloves provide effective barrier protection. Gloves quickly become contaminated and then become a potential vehicle for the transfer of organisms between patients. Microflora on hands are likely to proliferate while gloves are worn. | |

*Continued on following page*

CHART 70-5 PLAN OF NURSING CARE
## Care of the Patient With an Infectious Disease (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
| --- | --- | --- |
| c. Avoid wearing artificial fingernails or extenders when providing patient care. Keep natural nails less than ¼ inch long. | c. Artificial fingernails and extenders harbor microorganisms. | |
| d. Monitor the hand hygiene and glove use behaviors of health care professionals caring for the patient. | d. Poor compliance with hand hygiene among health care workers has been well documented and should be anticipated. It is important for the nurse as the patient's advocate to communicate protective behavior. | |
| 3. Prevent patient-to-health care worker transmission of infection. | 3. Health care workers may acquire infections occupationally due to close contact with patients. | |
| a. Avoid risk of infection with tuberculosis. | a. The most important element in the reduction of tuberculosis is early identification. Many of the symptoms of tuberculosis are subtle, and may be first observed by the nurse who has prolonged contact with the patient. | |
| (1) Participate in the early identification of patients with active disease. Patients will be asked about risk factors, symptoms, previous exposure, and tuberculin skin test (TST) status. | (1) Identification of patients at risk can help to prevent exposure. | |
| (2) Expedite diagnostic work-up with chest x-ray, sputum analysis for organisms, and TST administration as appropriate. | (2) Confirmation of diagnosis facilitates development of an appropriate treatment plan, including prevention of spread of infection. | |
| (3) Maintain engineering controls. Keep the patient in a private room with a closed door. | (3) Confining airflow to the immediate vicinity of the patient and exhausting air to the outside reduce the likelihood of transmission to health care workers in areas outside of the patient room. | |
| (4) Use protection in isolation room or when participating in procedures that are likely to generate cough, such as suctioning, intubation, or administering nebulized medications. | (4) N95 respirators are designed to reduce health care workers' risk. | |
| b. Avoid risk of transmission of blood-borne diseases such as hepatitis B, hepatitis C, and the human immunodeficiency virus. | b. Health care workers can contract blood-borne diseases via percutaneous injury such as needlestick or by contact with blood or body fluids to mucous membranes, such as eyes and mouth. | |
| (1) Get hepatitis B vaccination. | (1) Hepatitis B vaccine should be administered to reduce risk from this contagious blood-borne virus. | |

Continued

CHART 70-5

**PLAN OF NURSING CARE**

***Care of the Patient With an Infectious Disease*** *(Continued)*

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| (2) Use Standard Precautions as defined by the CDC. | (2) Standard Precautions are based on the recognition that most patients are not identified as infected by physical assessment or history taking. Health care workers must assume that all patients may be infected with bloodborne or other infection and must use barrier precautions appropriately for *all* patients. | |
| (3) Use "needleless" syringes and other injury-preventing devices. | (3) Use of injury-preventing devices decreases risk of transmission of blood-borne diseases. | |
| c. Avoid risk of airborne diseases.<br>(1) Receive influenza vaccination annually.<br>(2) Get vaccinated or produce proof of immunity to measles, mumps, rubella, and varicella. | c. Influenza vaccine is recommended for health care workers to reduce the likelihood of transmission in health care settings where immunocompromised patients can be exposed. | |
| 4. Prevent patient exposure to contaminated medical equipment. | 4. Technologic advances offer increased opportunity for invasive procedures. Equipment may be complex and difficult to clean. | |
| a. Ensure that equipment that is inserted through intact skin is sterilized between patient uses. | a. Sterilization renders equipment free of all microorganisms. | |
| b. Ensure that equipment that has contact with mucous membranes is sterilized or receives "high-level disinfection" between patient uses. | b. High-level disinfection renders an object free of all microorganisms with the possible exception of spore-producing organisms. | |
| c. Ensure that equipment used against intact skin is thoroughly cleaned and receives "low-level disinfection" between patient uses. | c. The disinfection goal for low-level disinfection is to reduce the load of microorganisms to a level that is not threatening to the host with intact skin. | |
| 5. Follow established guidelines for the routine removal and replacement of intravenous devices. | 5. Indwelling intravenous devices can serve as a conduit for organisms to migrate into the bloodstream. | |
| 6. Remove urinary catheters at the earliest time possible. | 6. The risk of urinary tract infections is directly proportional to the length of time that a urinary catheter remains in place. | |
| 7. Remove endotracheal and nasogastric tubes as soon as possible. | 7. The risk for pneumonia is increased as the use of indwelling equipment increases. | |

**NURSING DIAGNOSIS:** Deficient knowledge about disease, cause of infection, and preventive measures
**GOAL:** Acquisition of knowledge about the infectious process

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Listen carefully to what the patient says about illness and previous treatment. | 1. Listening facilitates detection of misunderstanding and misinformation and provides opportunity for education. | • Patient actively participates in treatment<br>• Patient complies with infection control measures |
| 2. Provide pertinent explanations about:<br>a. Organism and route of transmission<br>b. Treatment goals<br>c. Follow-up schedule<br>d. Prevention of transmission to others | 2. Knowledge about specific diagnoses and treatments may increase compliance. | |
| 3. Allow opportunities for questions and discussions. | 3. The patient's questions indicate issues that need clarification. | |

*Continued on following page*

CHART 70-5

**PLAN OF NURSING CARE**

## *Care of the Patient With an Infectious Disease* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 4. Teach the patient and family about:<br>a. Prophylaxis or immunization, if recommended<br>b. Community resources, if necessary<br>c. Means of preventing transmission within the home | 4. Understanding of the risks and precautions associated with an infectious disease may reduce the opportunity for further spread. | |

**NURSING DIAGNOSIS:** Risk for imbalanced body temperature (fever) related to the presence of infection
**GOAL:** Patient comfort and return of normal temperature

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 1. Monitor temperature, pulse, and respirations at regular intervals. | 1. Graph fever curve to help evaluate when fever occurs, how long it lasts, and whether it responds to therapy. | • Body temperature within normal limits<br>• Maintenance of fluid and electrolyte balance<br>• Patient comfortable |
| 2. Administer antipyretics as prescribed. | 2. Prompt treatment will improve outcomes. | |

**COLLABORATIVE PROBLEMS:** Among potential complications are septicemia, bacteremia, or sepsis, septic shock, dehydration, abscess formation, endocarditis, infectious disease–related cancers, and infertility
**GOAL:** Absence of complications

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| **Septicemia, Bacteremia, Sepsis** | | |
| 1. Monitor patient for evidence of infection at any location. | 1. Vigilance for bacterial or fungal infection at any site promotes early recognition and treatment and reduces the likelihood of secondary infections. | • No episode of infection<br>• Effective treatment of identified bacterial and fungal infections without progression to bloodstream infection<br>• Early improvement in septic course |
| 2. Assess treatment effectiveness of all identified infections. | 2. The natural course of some infections may be rapid unless antibiotics are administered promptly. | |
| 3. Administer antibiotics as prescribed with first dose given at the earliest time possible. | 3. Prompt treatment will improve outcomes. | |
| **Septic Shock** | | |
| 1. Routinely, and as warranted, monitor vital signs for patients with recognized infections and severely immunosuppressed patients at risk for shock. In particular, be alert for signs of:<br>a. Fever<br>b. Tachycardia (more than 90 bpm)<br>c. Tachypnea (more than 20 breaths/min)<br>d. Evidence of decreased perfusion or dysfunction of vital organs in the form of<br>(1) Change of mental status<br>(2) Hypoxemia as measured by arterial blood gases<br>(3) Elevated lactate levels<br>(4) Urine output (less than 30 mL/h) | 1. Early recognition of the signs and prompt treatment of impending shock may reduce the associated severity or mortality. | • Absence of symptoms of septic shock<br>• Hemodynamic and respiratory status within normal range |
| 2. Administer antibiotics, fluid replacement, vasopressors, and oxygen as prescribed. | 2. Therapeutic maintenance of hemodynamic and respiratory status is necessary until infection is effectively treated with antimicrobial regimen. | |
| **Dehydration** | | |
| 1. Assess for dehydration (thirst, dryness of mucous membranes, loss of skin turgor, reduced peripheral pulses, urine output less than 30 mL/h). | 1. Signs of dehydration provide a basis for fluid replacement and suggest possible further complications of circulatory collapse. | • Attains fluid balance (output approximates intake: body weight unchanged)<br>• Mucous membranes appear moist; normal skin turgor<br>• Serum electrolytes are within normal limits |
| 2. Monitor weight. | 2. Rapid changes in weight indicate fluid volume changes. | |

*Continued*

CHART 70-5

**PLAN OF NURSING CARE**

## *Care of the Patient With an Infectious Disease* (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Monitor intake and output and serum electrolyte levels. | 3. Dehydration produces a deficit in some electrolytes. Decreased urine production may indicate hypovolemia and decreased renal perfusion. | |
| 4. Replace fluids as needed. If the patient can tolerate oral fluids, offer fluids every 2–4 hours. Administer intravenous fluids as prescribed. | 4. When possible, oral hydration is preferable because the patient can select the beverage, control the rate and interval of replacement, and care for self at home. Additionally, the risks associated with vascular devices are avoided. If intravenous fluid is required, intravenous solutions are selected to facilitate intestinal reabsorption of fluid and electrolytes. | |
| **Abscess Formation** | | |
| 1. Assess vascular access sites, wound sites, pressure ulcers, and other appropriate sites for apparent collections of purulent material. | 1. Collections of purulent material often require drainage before antimicrobial therapy is effective. | • Absence of abscess<br>• Takes antibiotics as prescribed |
| 2. Assess the patient who has had abdominal surgery or trauma to abdominal area for localized signs of intra-abdominal abscess. These signs include:<br>a. Low-grade fever<br>b. Elevated peripheral white blood cell count<br>c. Localized pain<br>d. Abdominal tenderness<br>e. Visible or palpable mass<br>f. Postoperative diarrhea<br>g. GI bleeding | 2. Intra-abdominal abscess formation is most common following traumatic or surgical disruption of the GI tract. Signs are often initially subtle. | |
| 3. Assess patient who has had percutaneous abscess drainage to determine whether drainage has been successful. Be alert for all of the above signs and symptoms. | 3. After percutaneous drainage, recurrent or persistent signs of abscess may indicate the need for surgical treatment. | |
| 4. Administer antibiotics as prescribed. | 4. Antibiotics, along with drainage, are the most important elements of intra-abdominal abscess management. | |
| **Endocarditis**<br>***Prevention*** | | |
| 1. Teach patients with the following conditions about the importance of antibiotic prophylaxis for events and procedures that may introduce the risk of endocarditis:<br>a. Valvular disease<br>b. Congenital heart disease<br>c. Intracardiac prosthesis<br>d. Previous endocarditis | 1. Patients with underlying valvular disease and other cardiac abnormalities are at increased risk for “seeding” of the cardiac valves during procedures that can cause bacteremia. | • Informs health care professionals of cardiac conditions that require antibiotic prophylaxis before invasive procedures<br>• Takes prophylactic antibiotics as prescribed |
| ***Management*** | | |
| 1. Obtain blood cultures as prescribed; carefully record results. Note persistent bloodstream infections with a particular organism. | 1. A definitive diagnosis of endocarditis requires blood culture confirmation. | • Endocarditis is diagnosed, treated, and cured |
| 2. Obtain a detailed history about the duration of fever in the absence of well-recognized cause. | 2. Endocarditis should be suspected in patients who report an unexplained fever of more than 1 week’s duration | |

*Continued on following page*

CHART 70-5 PLAN OF NURSING CARE
**Care of the Patient With an Infectious Disease** (Continued)

| Nursing Interventions | Rationale | Expected Outcomes |
|---|---|---|
| 3. Administer intravenous antibiotic therapy at prescribed time schedule. | 3. Intravenous therapy is usually required for cure. The goal of therapy is complete eradication of all organisms. Careful adherence to following the scheduled administration is therefore essential. | |

**Infectious Disease-Related Cancers and Infertility**

These potential complications of infectious diseases are prevented by primary avoidance of infection. Management of them is directed toward treating each of them as a noninfectious entity. For example, the management of cancer secondary to hepatitis B is handled as an oncology issue, not as an infectious disease issue.

temporary paralysis, is a complication of approximately 1 of 1000 cases of *Campylobacter* infection.

Cooking and storing food at appropriate temperatures protects against *Campylobacter*. It is important that kitchen utensils used in meat preparation be kept away from other food to prevent *Campylobacter* transmission.

After a person is infected, the bacterium directly attacks the lumen of the intestine and may cause disease through enterotoxin release. Symptoms can range from mild abdominal cramping and minimal diarrhea to severe disease with profuse watery bloody diarrhea and debilitating abdominal cramping. Antimicrobial therapy is recommended only for patients who are seriously ill (CDC, 2005d).

### *Salmonella* Infection

*Salmonella* is a gram-negative bacillus with many species, including the very pathogenic *Salmonella typhi* (ie, typhoid fever). Of the nontyphi species, most organisms are prevalent in animal food sources. *Salmonella* species contaminate over 30% of commercially available chicken products and are frequently found in eggs (intact and with broken shells), in turkeys, and occasionally in beef (U.S. Department of Agriculture [USDA], 2008). Most of the deaths caused by *Salmonella* enteritis occur in elderly nursing home residents because of their weakened immune systems (CDC, 2005d).

Variable symptoms are associated with *Salmonella* species infection, including an asymptomatic carrier state, gastroenteritis, and systemic infection. Diarrhea with gastroenteritis is common. Disseminated disease and bacteremia, sometimes accompanied by diarrhea, occur less often.

The person with *Salmonella*-caused diarrhea can on rare occasions be a source for transmission to others. The importance of good hygiene should be emphasized, and health care workers should use special care when handling bedpans, stool specimens, or other objects that may be contaminated with feces. Hand hygiene is imperative after any contact with a person with *Salmonella* diarrhea. Although patients with systemic salmonellosis require antimicrobial therapy, those with gastroenteritis only are not usually treated, because antibiotic use may increase the period of time that the patient carries the bacteria while not improving the clinical outcome.

### *Shigella* Infection

The *Shigella* species is a gram-negative organism that invades the lumen of the intestine and causes disease and severe watery (possibly bloody) diarrhea. *Shigella* species are spread through the fecal–oral route, with easy transmission from one person to another. *Shigella* exhibits high levels of **virulence** (degree of pathogenicity of an organism); infection with a very small number of organisms can cause disease. Because transmission occurs easily with improper hygiene, it is not surprising that *Shigella* organisms disproportionately affect pediatric populations. Disease in the very young may infrequently be complicated by pulmonary or neurologic symptoms.

Antimicrobial therapy should be instituted early. Frequently, initial therapy choices must be altered when final microbiologic testing reveals the organism's sensitivity.

### *Escherichia coli*

*E. coli* is the most common aerobic organism colonizing the large bowel. When *E. coli* bacteria are cultured from fecal specimens, the results usually reflect normal flora. However, certain strains of *E. coli* with increased virulence have been responsible for significant outbreaks of diarrheal disease in recent years. These stronger pathologic strains are subgrouped as enterotoxigenic *E. coli* (ETEC) because of their production of enterotoxins. ETEC strains often cause cholera-like disease, with rapid, severe dehydration and an increased risk of death.

Several outbreaks of an *E. coli* species, 0157:H7, have been linked to the ingestion of undercooked beef and to vegetables that have been contaminated by animal waste water. This bacterium lives in the intestines of cattle and can be introduced into meat at the time of slaughter. Prevention of disease from *E. coli* 0157:H7 is aimed at teaching the public to cook ground beef thoroughly (ie, until the meat is no longer pink and the juices run clear). During an important outbreak of *E. coli* 0157:H7 that resulted from contaminated spinach in 2006, spinach from an implicated packager was recalled. Consumers were advised to boil or fry fresh spinach if there was a concern that it might be from the contaminated area (CDC, 2006c).

### *Calicivirus* (Norwalk-like Virus; Norovirus)

*Calicivirus*, which is often referred to as the Norwalk-like virus or the *Norovirus*, is a very common cause of foodborne illness. This agent has been associated with important diarrheal outbreaks in long-term care facilities, hospitals, and cruise ships. Onset of illness is usually acute, with vomiting and watery diarrhea that generally last for approximately 2 days. Dehydration is the most common complication.

*Calicivirus* is transmitted easily from person to person by direct contact and by ingesting contaminated food. Waterborne outbreaks have been associated with sewage-contaminated wells and contaminated swimming pools. Although people with *Calicivirus* infection typically recover within 2 to 3 days, they may continue to transmit the virus to others for approximately 2 more weeks.

Caliciviruses can withstand environmental extremes of heat or cold and are resistant to chemical disinfection, which are significant reasons for their epidemic potential. Control of *Calicivirus* in health care facilities requires a coordinated program with decisions about isolation, environmental disinfection, diagnosis, and coordination with public health officials. Contact Precautions should be used when caring for patients with incontinence and during outbreaks of the virus. Workers should wear masks if they are cleaning heavily soiled areas or caring for a patient who is actively vomiting. No Environmental Protection Agency (EPA)–approved disinfectants have specific claims about effectiveness for *Calicivirus*. Therefore, the CDC recommends that surface disinfection be accomplished with a freshly prepared solution of 1 part bleach to 50 parts water or with the peroxygen compound Virkon-S, which has been approved for feline *Calicivirus* and may be similarly effective for human viruses (CDC, 2005d).

### *Giardia Lamblia*

Transmission of the protozoan *Giardia lamblia* occurs when food or drink is contaminated with viable cysts of the organism. People often become infected while traveling to endemic areas or by drinking contaminated water from mountain streams within the United States. The organism can be transmitted by close contact, such as occurs in day care settings. Transmission by sexual contact has also been documented.

Frequently, the infection goes unnoticed. Infection is often recognized more easily in children than in adults. In extreme cases, the patient may experience abdominal pain and chronic diarrhea, usually described as containing mucus and fat but not blood. Microscopic examination of stool specimens reveals the trophozoite or cyst stages of the parasitic life cycle.

Metronidazole (Flagyl) is commonly used to treat *Giardia*, but success rates for this and alternative therapies are inconsistent. Patients with *Giardia* infections should be instructed that the organism can be easily transmitted in family or group settings. Personal hygiene measures should be reinforced, and those who travel or camp where water is not treated and filtered should be advised to avoid local water supplies unless water is purified before drinking or using it in cooking.

### *Vibrio Cholerae*

Although reported cases of cholera have been rare in the United States in recent decades, no discussion of infectious diarrhea is complete without mention of this very serious infectious disease. Historically, epidemics of cholera have influenced all aspects of life—from medical to political—and infection rates have been significant enough to destroy governments and armies. Cholera is always a concern when wars or natural disasters result in inadequately processed waste water. *Vibrio cholerae* also may be found naturally in brackish rivers and coastal waters.

*V. cholerae* is a gram-negative organism with several different serotypes. The type usually associated with epidemics is toxigenic *V. cholerae* 01. The organism is transmitted by contaminated food or water. Most recent cases in the United States have been from contaminated shellfish found in the Gulf of Mexico or from contaminated shellfish brought into the United States by visitors. However, even though the incidence in other *Vibrio* species increased in the aftermath of Hurricane Katrina, in 2005, there were no cases of toxigenic *V. cholerae* 01 reported (CDC, 2005f).

Cholera causes disease with a very rapid onset of copious diarrhea in which up to 1 L of fluid per hour can be lost. Dehydration, with subsequent cardiopulmonary collapse, may cause rapid progression from onset of signs and symptoms to death. Rehydration efforts should be vigorous and sustained. If oral rehydration cannot be accomplished, the patient needs IV therapy.

In the United States, cholera should be suspected in patients who have watery diarrhea after eating shellfish harvested from the Gulf of Mexico. Confirmation of the causative organism can be made by stool culture. It is imperative that all cases are reported to local and state public health authorities. People traveling to areas where cholera occurs regularly should remember the simple rule of thumb: "boil it, cook it, peel it, or forget it."

## NURSING PROCESS

## The Patient With Infectious Diarrhea

### Assessment

The most important element of assessment in the patient with diarrhea is to determine hydration status. The goal of rehydration is to correct the dehydration. Assessment includes evaluation for thirst, dryness of oral mucous membranes, sunken eyes, a weakened pulse, and loss of skin turgor. Careful observation for these signs is especially important in cases of rapidly dehydrating diseases (most notably cholera) and in younger children.

Intake and output measurements are crucial in determining fluid balance. Liquid stool should be measured and recorded, along with the frequency of stools. It is important to note the consistency and appearance of stool as key indicators of the type and severity of the diarrheal disease. The presence of mucus or blood should also be documented.

When conducting a health history, the nurse asks if the patient has recently traveled, if the patient is being treated with antibiotics, if the patient has been in contact with anyone who has recently had diarrheal disease, and what the patient has recently eaten. Frequently, patients attribute the most recent meal eaten as the cause of symptoms. However, the incubation period for most diarrheal conditions is

longer than the time interval between meals, and the nurse needs to get detailed information about the meal preceding the illness and about all food intake in the previous 3 to 4 days. When eliciting this kind of history, it is helpful to ask the patient to list every food tasted. The nurse also asks the patient if he or she is employed in a food preparation service, because the local public health departments should be notified about any person with infectious diarrhea who works in the food industry.

## Diagnosis

### *Nursing Diagnoses*

Based on the assessment data, the patient's major nursing diagnoses may include the following:

- Deficient fluid volume related to fluid lost through diarrhea
- Deficient knowledge about the infection and the risk of transmission to others

### *Collaborative Problems/Potential Complications*

Based on the assessment data, potential complications that may develop include the following:

- Bacteremia
- Hypovolemic shock

## Planning and Goals

The most important goals are maintenance of fluid and electrolyte balance, increased knowledge about the disease and risk of transmission, and absence of complications.

## Nursing Interventions

### *Correcting Dehydration Associated With Diarrhea*

The patient is assessed to determine the degree of dehydration and the amount and route of rehydration needed. Oral rehydration therapy is a strategy used to reduce the severe complications of diarrheal disease regardless of causative agent. It is inexpensive and effective for most patients, but it is often underused because of cultural beliefs discouraging oral intake during episodes of diarrhea. The World Health Organization (WHO) and the United Nations International Children's Emergency Fund (UNICEF) recommend an oral rehydration solution (ORS) for the treatment of children and adults with dehydration and electrolyte imbalance associated with cholera and other forms of diarrheal disease. It contains (in millimoles per liter) sodium, 90; potassium, 20; chloride, 80; citrate, 10; and glucose, 111.

**MILD DEHYDRATION.** The patient exhibits dry oral mucous membranes of the mouth and increased thirst. The rehydration goal at this level of dehydration is to deliver about 50 mL of ORS per 1 kg of weight over a 4-hour interval.

**MODERATE DEHYDRATION.** Common findings are sunken eyes, loss of skin turgor, increased thirst, and dry oral mucous membranes. The rehydration goal at this level of dehydration is to deliver about 100 mL/kg of ORS over 4 hours.

**SEVERE DEHYDRATION.** The patient with severe dehydration shows signs of shock (ie, rapid thready pulse, cyanosis, cold extremities, rapid breathing, lethargy, or coma) and should receive IV replacement until hemodynamic and mental status return to normal. When improvement is evident, the patient can be treated with ORS.

### *Administering Rehydration Therapy*

Because diarrheal episodes are often accompanied by vomiting, rehydration and refeeding can be difficult. Oral rehydration therapy should be delivered frequently in small amounts. When patients are persistently vomiting, they often require frequent administration of fluids by spoonfuls. IV therapy is necessary for the patient who is severely dehydrated or in shock.

It is important for children and adults with acute diarrheal symptoms to maintain caloric intake. As soon as dehydration has been corrected, an age-appropriate, unrestricted diet is allowed. Recommended foods include starches, cereals, yogurt, fruits, and vegetables. Foods that are high in simple sugars, such as undiluted apple juice or gelatin, should be avoided.

**NURSING ALERT**

**Sports drinks do not replace fluid losses correctly and should not be used.**

### *Increasing Knowledge and Preventing Spread of Infection*

Public health nurses, school nurses, and others who are involved in patient teaching should emphasize principles of safe food preparation, with special attention to meat preparation and cooking. Ground beef should be cooked until no longer pink, and all meat should be maintained at temperatures below 40°F or above 140°F. In planning events for groups of people, adequate provision for storage and reheating to temperature thresholds is important. When preparing food, it is important to use different surfaces, knives, and other equipment for meat and nonmeat items.

Diarrheal diseases discussed in this section must be reported to local or state health departments. The goal of reporting is to provide information for determining incidence trends and promptly identifying any restaurants or other food preparation establishments that have served contaminated food.

The need for rehydration and refeeding should be taught to parents of children with diarrheal disease. Beliefs about illness and food patterns may have a traditional or cultural basis, and any teaching of health facts requires cultural sensitivity.

In both homes and health care delivery settings, good hygiene and principles of Standard Precautions should be emphasized.

### *Monitoring and Managing Potential Complications*

**BACTEREMIA.** *E. coli*, *Salmonella*, and *Shigella* are organisms that can enter the bloodstream and disseminate to other organs. Blood cultures are necessary in the acutely febrile patient with diarrhea. If initial smear results reveal gram-negative organisms, antibiotic therapy is instituted.

**HYPOVOLEMIC SHOCK.** Shock associated with diarrheal diseases demands accurate intake and output assessment and vigorous fluid replacement. In rare instances, patients

with severe fluid imbalance require intensive care nursing support with aggressive hemodynamic monitoring. For further information, see Chapter 15.

## Evaluation

### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Attains fluid balance
   a. Output approximates intake
   b. Mucous membranes appear moist
   c. Skin turgor is normal
   d. Adequate amounts of fluids and calories ingested
   e. Absence of vomiting
   f. Stools are of normal color and consistency
2. Acquires knowledge and understanding about infectious diarrhea and transmission potential
   a. Takes proper precautions to prevent spread of infection to others
   b. Describes principles and techniques of safe food storage, preparation, and cooking
3. Absence of complications
   a. Temperature is within normal range
   b. Blood culture reports are negative
   c. Fluid balance is achieved

# Sexually Transmitted Diseases

An STD (also known as a sexually transmitted infection [STI]) is a disease acquired through sexual contact with an infected person. Table 70-4 identifies diseases that can be classified as STDs. Infections caused by organisms not generally considered STDs can also be transmitted during sexual contact; for example, *G. lamblia,* usually associated with contaminated water, can be transmitted through sexual exposure.

STDs are the most common infectious diseases in the United States and are epidemic in most parts of the world. Portals of entry of STD-causing microorganisms and sites of infection include the skin and mucosal linings of the urethra, cervix, vagina, rectum, and oropharynx.

**Table 70-4 CONDITIONS CLASSIFIED AS SEXUALLY TRANSMITTED DISEASES (STDS) AND THEIR ROUTES OF TRANSMISSION**

| Disease | Route(s) of Transmission |
|---|---|
| Chancroid, *Lymphogranuloma venereum,* and *Granuloma inguinale* | Sexual |
| Chlamydia | Sexual |
| Cytomegalovirus (CMV) | Sexual, less intimate contact |
| Gonorrhea | Sexual, perinatal |
| Hepatitis B (HBV) | Sexual, percutaneous, perinatal |
| Hepatitis C (HCV) | Percutaneous, probably sexual, probably perinatal |
| Herpes simplex | Sexual |
| HIV infection/AIDS | Sexual, percutaneous, perinatal |
| Human papillomavirus (HPV) | Sexual |
| Syphilis | Sexual, perinatal |

Approximately 19 million Americans become infected with STDs annually. STDs have severe health consequences. In addition, they represent a financial burden estimated to be as high as $15.3 billion per year (CDC, 2009e). To determine the most effective methods for communicating information about STDs to people between 25 and 45 years of age (those who are most at risk for STDS), the CDC sought the help of focus groups. These groups proposed that using straightforward language and personal testimonials, developing materials for targeted audiences (eg, people who want information about protecting themselves), and conducting presentations in trusted establishments (eg, churches, health care facilities) might be effective. These suggestions could serve as a resource to all health care personnel who specialize in the prevention of STDs (CDC, 2004c).

Education about prevention of STDs includes information about risk factors and behaviors that can lead to infection. Included in this education is information about the relative value of condoms in reducing risk of infection. The use of condoms to provide a protective barrier from transmission of STD-related organisms has been broadly promoted, especially since the recognition of HIV/AIDS. At first referred to as a method to ensure *safe sex,* the use of condoms has been shown to reduce but not eliminate the risk of transmission of HIV and other STDs. Thus, the term *safer sex* more appropriately connotes the public health message to be used when promoting the use of condoms.

STDs provide a unique set of challenges for nurses, physicians, and public health officials. Because of perceived stigma and possible threat to emotional relationships, people with symptoms of STDs are often reluctant to seek health care in a timely fashion. STDs may progress without symptoms and a delay in diagnosis and treatment is potentially harmful because the risk of complications for the infected person and the risk of transmission to others increase over time.

Infection with one STD suggests the possibility of infection with other diseases as well. After one STD is identified, diagnostic evaluation for others should be conducted. The possibility of HIV infection should be pursued when any STD is diagnosed.

## HUMAN IMMUNODEFICIENCY VIRUS

HIV is the causative agent of AIDS. The definition of AIDS, as determined by the CDC, sets a point in the continuum of HIV pathogenesis in which the host has clinically demonstrated profound immune dysfunction. Since 1993, the AIDS definition has also included a CD4-positive (CD4+) cell count of less than 200 cells/mm$^3$ as a threshold criterion. CD4+ cells are a subset of lymphocytes and one of the targets of HIV infection. Many opportunistic infections and neoplasms occur with severe immunosuppression.

HIV is transmitted through sexual contact or percutaneous injection of contaminated blood or from infected mother to fetus. Most people infected by the percutaneous route are IV or injecting drug users who share contaminated

needles, but transmission is also remotely possible through contaminated blood transfusion. Since 1985, all blood transfusions have been screened, and transfusion-related transmission of HIV is now extremely unlikely. Additional information about HIV is provided in Chapter 52.

### Risk to Health Care Workers

Health care workers can be infected through the percutaneous route if needlestick or other injury from a sharp object introduces contaminated blood. Prospective studies of this risk demonstrate that less than 1% of occupational exposures in which the source patient is infected with HIV lead to transmission (CDC, 2005e). Despite the rarity of transmission, health care workers are advised to use extreme care to avoid needlestick or mucous membrane exposure to blood from all patients.

In health care facilities, employers are required to provide devices designed to reduce the risk of needlestick and other injuries. Health care workers should understand the need to report a needlestick or other percutaneous exposure immediately. Since 1996, the CDC has recommended postexposure prophylaxis (PEP) for significant occupational exposures to HIV (further discussion of PEP is provided in Chapter 52). Counseling about the advisability of prophylaxis, appropriate combination of drugs, and dosing is made on a case-by-case basis.

## SYPHILIS

Syphilis is an acute and chronic infectious disease caused by the spirochete *Treponema pallidum*. It is acquired through sexual contact or may be congenital in origin.

### Stages of Syphilis

In the untreated person, the course of syphilis can be divided into three stages: primary, secondary, and tertiary. These stages reflect the time from infection and the clinical manifestations observed in that period and are the basis for treatment decisions.

*Primary syphilis* occurs 2 to 3 weeks after initial inoculation with the organism. A painless lesion at the site of infection is called a *chancre*. Untreated, these lesions usually resolve spontaneously within about 2 months.

*Secondary syphilis* occurs when the hematogenous spread of organisms from the original chancre leads to generalized infection. The rash of secondary syphilis occurs about 2 to 8 weeks after the chancre and involves the trunk and the extremities, including the palms of the hands and the soles of the feet. Transmission of the organism can occur through contact with these lesions. Generalized signs of infection may include lymphadenopathy, arthritis, meningitis, hair loss, fever, malaise, and weight loss.

After the secondary stage, there is a period of **latency,** when the infected person has no signs or symptoms of syphilis. Latency can be interrupted by a recurrence of secondary syphilis symptoms.

*Tertiary syphilis* is the final stage in the natural history of the disease. It is estimated that between 20% and 40% of those infected do not exhibit signs and symptoms in this final stage. Tertiary syphilis presents as a slowly progressive inflammatory disease with the potential to affect multiple organs. The most common manifestations at this level are aortitis and neurosyphilis, as evidenced by dementia, psychosis, paresis, stroke, or meningitis.

### Assessment and Diagnostic Findings

Because syphilis shares symptoms with many diseases, clinical history and laboratory evaluation are important. The conclusive diagnosis of syphilis can be made by direct identification of the spirochete obtained from the chancre lesions of primary syphilis. Serologic tests used in the diagnosis of secondary and tertiary syphilis require clinical correlation in interpretation. The serologic tests are summarized as follows:

- *Nontreponemal* or *reagin tests,* such as the Venereal Disease Research Laboratory (VDRL) or the rapid plasma reagin circle card test (RPR-CT), are generally used for screening and diagnosis. After adequate therapy, the test result is expected to decrease quantitatively until it is read as negative, usually about 2 years after therapy is completed.
- *Treponemal tests,* such as the fluorescent treponemal antibody absorption test (FTA-ABS) and the microhemagglutination test (MHA-TP), are used to verify that the screening test did not represent a false-positive result. Positive results usually are positive for life and therefore are not appropriate to determine therapeutic effectiveness.

### Medical Management

Treatment of all stages of syphilis is administration of antibiotics. Penicillin G benzathine is the medication of choice for early syphilis or early latent syphilis of less than 1 year's duration. It is administered by intramuscular injection at a single session. Patients with late latent or latent syphilis of unknown duration should receive three injections at 1-week intervals. Patients who are allergic to penicillin are usually treated with doxycycline (Adoxa). The patient treated with penicillin is monitored for 30 minutes after the injection to observe for a possible allergic reaction.

Treatment guidelines established by the CDC are updated on a regular basis. Recommendations provide special guidelines for treatment in the setting of pregnancy, allergy, HIV infection, pediatric infection, congenital infection, and neurosyphilis (CDC, 2006b).

### Nursing Management

Syphilis is a reportable communicable disease. In any health care facility, a mechanism must be in place to ensure that all diagnosed patients are reported to the state or local public health department to ensure community follow-up. The public health department is responsible for identification of sexual contacts, contact notification, and contact screening.

Lesions of primary and secondary syphilis may be highly infective. Gloves are worn when direct contact with lesions is likely, and hand hygiene is performed after gloves are removed. Isolation in a private room is not required (Chart 70-6).

**CHART 70-6 PATIENT EDUCATION**
***Preventing the Spread of Syphilis***

- If multiple penicillin injections are required, complete the full course of therapy.
- Refrain from sexual contact with previous or current partners until the partners have been treated.
- If you have primary or secondary syphilis, be aware that with proper treatment, skin lesions and other sequelae of infection will improve, and serology eventually will reflect cure.
- Condoms significantly reduce the risk of transmission of syphilis and other sexually transmitted diseases.
- Having multiple sexual partners increases the risk of acquiring syphilis and other sexually transmitted diseases.

## *CHLAMYDIA TRACHOMATIS* AND *NEISSERIA GONORRHOEAE* INFECTIONS

*Chlamydia trachomatis* and *Neisseria gonorrhoeae* are the most commonly reported infectious diseases in the United States. Coinfection with *C. trachomatis* often occurs in patients infected with *N. gonorrhoeae*. The greatest risk of *C. trachomatis* infection occurs in young women between 15 and 19 years of age (CDC, 2007b).

### Clinical Manifestations

#### Women

Both *C. trachomatis* and *N. gonorrhoeae* infections frequently do not cause symptoms in women. When symptoms are present, mucopurulent cervicitis with exudates in the endocervical canal is the most frequent finding. Women with gonorrhea can also present with symptoms of urinary tract infection or vaginitis.

#### Men

Although men are more likely than women to have symptoms when infected, infection with *N. gonorrhoeae* or *C. trachomatis* can be asymptomatic. When symptoms are present, they may include burning during urination and penile discharge. Patients with *N. gonorrhoeae* infection may also report painful, swollen testicles.

### Complications

In women, pelvic inflammatory disease (PID), ectopic pregnancy, endometritis, and infertility are possible complications of either *N. gonorrhoeae* or *C. trachomatis* infection. In men, epididymitis, a painful disease that may lead to infertility, may result from infection with either bacterium. In people of either gender, arthritis or bloodstream infection may be caused by *N. gonorrhoeae*.

### Assessment and Diagnostic Findings

The patient is assessed for fever, discharge (urethral, vaginal, or rectal), and signs of arthritis. Diagnostic methods used in *N. gonorrhoeae* infection include Gram stain (appropriate only for male urethral samples), culture, and nucleic acid amplification tests (NAATs). Gram stain and the direct fluorescent antibody test can be used in chlamydia. NAATs are also available for *C. trachomatis* but demand strict attention to laboratory procedures to ensure test reliability. In the female patient, samples are obtained from the endocervix, anal canal, and pharynx. In the male patient, specimens are obtained from the urethra, anal canal, and pharynx. Because *N. gonorrhoeae* organisms are susceptible to environmental changes, specimens for culture must be delivered to the laboratory immediately after they are obtained.

Because as many as 70% of chlamydial infections are asymptomatic, the CDC recommends annual *Chlamydia* testing for all pregnant women, sexually active women younger than 25 years of age, and older women with a new sexual partner or multiple partners (CDC, 2006b).

### Medical Management

Because patients are often coinfected with both gonorrhea and chlamydia, the CDC recommends dual therapy even if only gonorrhea has been laboratory proven. The CDC-recommended treatment for chlamydia is either doxycycline or azithromycin (Zithromax) and one of the following for gonorrhea: ceftriaxone (Rocephin), cefixime (Suprax), or ciprofloxacin (Cipro). These antibiotics are not recommended during pregnancy. CDC guidelines should be used to determine alternative therapy for the patient who is pregnant or allergic or who has a complicated chlamydial infection.

Patients with uncomplicated gonorrhea who are treated with CDC-recommended therapy do not routinely need to return for a proof-of-cure visit. If the patient reports a new episode of symptoms or tests are positive for gonorrhea again, the most likely explanation is reinfection rather than treatment failure. Serologic testing for syphilis and HIV should be offered to patients with gonorrhea or chlamydia, because any STD increases the risk of other STD infections.

### Nursing Management

Gonorrhea and chlamydia are reportable communicable diseases. In any health care facility, a mechanism should be in place to ensure that all diagnosed patients are reported to the local public health department to ensure follow-up of the patient. The public health department also is responsible for interviewing the patient to identify sexual contacts, so that contact notification and screening can be initiated.

The target group for preventive patient teaching about gonorrhea and chlamydia is the adolescent and young adult population. Along with reinforcing the importance of abstinence, when appropriate, education should address postponing the age of initial sexual exposure, limiting the number of sexual partners, and using condoms for barrier protection. Young women and pregnant women should also be instructed about the importance of routine screening for chlamydia.

## NURSING PROCESS

### The Patient With a Sexually Transmitted Disease

#### Assessment

The patient should be asked to describe the onset and progression of symptoms and to characterize any lesions

by location and by describing drainage, if present. Brief explanations of why the information is needed are often helpful. Clarification of terms may be necessary if either the patient or nurse uses words that are unfamiliar to the other.

Protecting confidentiality is important when discussing sexual issues. When a detailed sexual history is necessary, it is important to respect the patient's right to privacy. When obtaining a sexual history, the CDC recommends the following systematic interview of key areas, the five Ps: *p*artners, *p*revention of pregnancy, *p*rotection from STDs, *p*ractices, *p*ast history of STDs (CDC, 2006b).

Asking specific information about sexual contacts usually should be done only when the nurse is part of a team that will conduct partner notification. The nurse should describe to the patient the public health notification process and resources that are available to assist sexual partners or infants and children.

During the physical examination, the examiner looks for rashes, lesions, drainage, discharge, or swelling. Inguinal nodes are palpated to elicit tenderness and to assess swelling. Women are examined for abdominal or uterine tenderness. The mouth and throat are examined for signs of inflammation or exudate. The nurse wears gloves while examining the mucous membranes, and gloves are changed and replaced after vaginal or rectal examination.

## Diagnosis

### *Nursing Diagnoses*

Based on assessment data, the patient's major nursing diagnoses may include the following:

- Deficient knowledge about the disease and risk for spread of infection and reinfection
- Anxiety related to anticipated stigmatization and to prognosis and complications
- Noncompliance with treatment

### *Collaborative Problems/Potential Complications*

Based on assessment data, potential complications that may develop include the following:

- Increased risk for ectopic pregnancy
- Infertility
- Transmission of infection to fetus, resulting in congenital abnormalities and other outcomes
- Neurosyphilis
- Gonococcal meningitis
- Gonococcal arthritis
- Syphilitic aortitis
- HIV-related complications

## Planning and Goals

Major goals are increased patient understanding of the natural history and treatment of the infection, reduction in anxiety, increased compliance with therapeutic and preventive goals, and absence of complications.

## Nursing Interventions

### *Increasing Knowledge and Preventing Spread of Disease*

Education about STDs and prevention of the spread to others is often accomplished simultaneously. The infected patient should be told what the causative organism is and should receive an explanation of the usual course of the infection (including the interval of potential communicability to others) and possible complications. The nurse should stress the importance of following therapy as prescribed and the need to report any side effects or symptom progression.

Discussion should emphasize that the same behaviors that led to infection with one STD increase the risk for any other STD, including HIV. Methods used to contact sexual partners should be discussed. The patient should understand that until the partner has been treated, continued sexual exposure to the same person may lead to reinfection. The relative value of condoms in reducing the risk for infection with STDs should be addressed. When appropriate, the patient should be encouraged to discuss any reasons for resistance to condom use to promote thoughtful decision making about this preventive method.

### *Reducing Anxiety*

When appropriate, the patient is encouraged to discuss anxieties and fear associated with the diagnosis, treatment, or prognosis. By individualizing teaching efforts, factual information applied to specific needs may offer reassurance. Patients may need help in planning discussion with partners. If the patient is especially apprehensive about this aspect, referral to a social worker or other specialist may be appropriate. For example, such support is especially important when the patient has newly diagnosed HIV infection. Patients with HIV may benefit from programs that combine support, education, counseling, and therapeutic goals. Such programs are designed to offer coordinated care throughout the course of disease progression.

### *Increasing Compliance*

In group settings (eg, an outpatient obstetric setting) or in a one-to-one setting, open discussion about STD information facilitates patient teaching. Discomfort can be reduced by factual explanation of causes, consequences, treatments, prevention, and responsibilities. Because most communities have expanded STD prevention resources, referrals to appropriate agencies can complement individual educational efforts and ensure that later questions or uncertainties can be addressed by experts. Patients can obtain more information by accessing the CDC Web site (2009c).

### *Monitoring and Managing Potential Complications*

**INFERTILITY AND INCREASED RISK OF ECTOPIC PREGNANCY.** STDs may lead to PID and, with it, increased risk of ectopic pregnancy and infertility. For additional information, see Chapters 46 and 47.

**CONGENITAL INFECTIONS.** All STDs can be transmitted to infants in utero or at the time of birth. Complications of congenital infection can range from localized infection (eg, throat infection with *N. gonorrhoeae*), to congenital abnormalities (eg, stunting of growth or deafness from congenital syphilis), to life-threatening disease (eg, congenital herpes simplex virus).

**NEUROSYPHILIS, GONOCOCCAL MENINGITIS, GONOCOCCAL ARTHRITIS, AND SYPHILITIC AORTITIS.** STDs can cause disseminated infection. The central nervous system may be infected, as seen in cases of neurosyphilis or gonococcal

meningitis. Gonorrhea that infects the skeletal system may result in gonococcal arthritis. Syphilis can infect the cardiovascular system by forming vegetative lesions on the mitral or aortic valves.

**HUMAN IMMUNODEFICIENCY VIRUS–RELATED COMPLICATIONS.** HIV infection leads to the profound immunosuppression characteristic of AIDS. Complications of HIV infection include many opportunistic infections, including those due to *Pneumocystis jiroveci*, *Cryptococcus neoformans*, cytomegalovirus, and *Mycobacterium avium* (see Chapter 52).

### Evaluation

#### *Expected Patient Outcomes*

Expected patient outcomes may include the following:

1. Exhibits knowledge about STDs and their transmission
2. Demonstrates a less anxious demeanor
   a. Discusses anxieties and goals for treatment
   b. Inspects self for lesions, rashes, and discharge
   c. Accepts support, education, and counseling when indicated
   d. Assists with sharing information about infection with sexual partners
   e. Discusses risk-reduction behaviors and safer sex practices
3. Complies with treatment
4. Achieves effective treatment
5. Reports for follow-up examinations if necessary
6. Absence of complications

# *Emerging Infectious Diseases*

As defined by the CDC, **emerging infectious diseases** are human diseases of infectious origin that have increased within the past two decades or that are likely to increase in the near future. Examples of emerging infectious diseases presented here include West Nile virus, Legionnaires' disease, pertussis, hantavirus pulmonary syndrome, and viral hemorrhagic fevers. Some multiple resistant strains of common bacteria such as CA-MRSA and gram-negative organisms that are resistant to extended-spectrum beta-lactam antibiotics or carbapenem-based antibiotics are also often considered causes of emerging diseases. This is especially true of CA-MRSA, because its presentation in people without underlying disease and its aggressive nature in skin and soft tissue infections are different from those seen with HA-MRSA. Table 70-1 provides an overview of infectious diseases, including emerging infectious diseases.

Many factors contribute to newly emerging or re-emerging infectious diseases. These include travel, globalization of food supply and central processing of food, population growth, increased urban crowding, population movements (eg, those that result from war, famine, or man-made or natural disasters), ecologic changes, human behavior (eg, risky sexual behavior, IV/injection drug use), antimicrobial resistance, and breakdown in public health measures.

These diseases are important from an epidemiologic standpoint because their incidence has not yet stabilized. When the pattern of disease in a community is not well understood in the medical-scientific community, patients, families, and others in the community often become alarmed about these diseases. During times of increased concern about bioterrorism, whether triggered by actual events or by hoaxes, nurses have responsibility to rationally separate facts from fears. In discussions with patients and other caregivers, it is important to keep the focus on what is known and to clarify the plan for diagnosis, treatment, and containment.

## WEST NILE VIRUS

The West Nile virus was first recognized in the 1930s in Africa and was first seen in humans in the United States in 1999. Although most human infections are mild or asymptomatic, a range of presentations is possible. Approximately 20% of infected people have a mild disease called West Nile fever. These patients usually experience headache, fever, and a persistent fatigue that may continue for several months. In these patients, fewer than 1 in 150 infections develop into more serious disease, which is characterized by severe neuroinvasive illness, meningitis, encephalitis, and paralysis or poliomyelitis. The mortality rate for people with the milder West Nile fever and meningitis is less than 1%, but this rate increases to approximately 20% for those with encephalitis and as high as 50% for those with paralysis (Sejvar, 2007). Although age-related factors do not appear to affect a person's chances of acquiring West Nile virus, the risk of neuroinvasive disease is greater in those older than 64 years of age (Hayes, Komar, Nasci, et al., 2005).

The incubation period (ie, from mosquito bite to onset of symptoms) is between 3 and 14 days. Currently, there is no treatment for West Nile virus infection. Medical and nursing management consists of fluid replacement, airway management, and supportive nursing care when meningitis or symptoms are present.

Birds are the natural reservoir for the virus, and since 1999, the population of infected birds in the eastern United States has increased steadily. Mosquitoes become infected when feeding on birds and can transmit the virus to animals and humans. Although human-to-human transmission of West Nile virus is very rare, transmission has occurred as the result of occupational exposure in laboratory workers, infant exposure transplacentally and from breastfeeding, and blood transfusion or organ transplant from infected donors (CDC, 2004a).

## LEGIONNAIRES' DISEASE

Legionnaires' disease is a multisystem illness that usually includes pneumonia and is caused by the gram-negative bacterium *Legionella pneumophila*. Named after an outbreak among people attending a convention of the American Legion in 1976, its potential to cause outbreaks has been demonstrated repeatedly in hospitals and other settings. It continues to be considered an emerging infectious disease because there are new patterns in recent years. There has been an approximate 70% increase in new cases since 2003 compared with earlier time periods, and a disproportionate increase in the eastern United States (Neil & Berkeman, 2008).

*Legionella* organisms are found in many man-made and naturally occurring water sources. Although the organisms may initially be introduced to the plumbing system in low numbers, growth is enhanced by water storage, sediment, temperatures ranging from 25°C to 42°C (77°F to 107°F), and certain amoebae frequently present in water that can support intracellular growth of legionellae. As incidence appears to increase in the summer and autumn months, vacation-related exposure to hotel or cruise ship plumbing and air conditioning systems, whirlpool spas, and decorative fountains may be the causative risk.

## Pathophysiology

*L. pneumophila* is transmitted by the aerosolized route from an environmental source to a person's respiratory tract. It is not transmitted from person to person. In hospitals, patients may be exposed to aerosols created by cooling towers, water exposure from in-room plumbing, and respiratory therapy equipment. Because underlying medical conditions can increase host susceptibility and subsequent severity of disease and because hospital plumbing systems are often very complex, outbreaks occur in hospitals more frequently than at other centers within the community. The mortality rate for Legionnaires' disease may be as high as 40% in some populations (CDC, 2008a).

## Risk Factors

Risk factors for *Legionella* infection include diseases that lead to severe immunosuppression, such as AIDS, hematologic malignancy, end-stage renal disease, or use of immunosuppressive agents. Other factors associated with increased risk include diabetes, smoking, exposure to whirlpool spas, and recent travel.

## Clinical Manifestations

The lungs are the principal organs of infection; however, other organs may also be involved. The incubation period ranges from 2 to 10 days. Early symptoms may include malaise, myalgias, headache, and dry cough. The patient develops increasing pulmonary symptoms, including productive cough, dyspnea, and chest pain. Patients are usually febrile, and body temperatures may reach or exceed 39.4°C (103°F). Diarrhea and other gastrointestinal symptoms are common. In severe cases, multiorgan involvement and failure may follow.

## Assessment and Diagnostic Findings

The diagnostic approach generally involves accumulation of information obtained from the history, physical examination, x-rays, laboratory findings, and assessment of therapeutic effectiveness. Chest x-ray abnormalities may vary in severity and in location within the lungs. Laboratory tests available for the diagnosis of *Legionella* include culture or tests that detect either antigen or antibody. The most frequently used test is the urinary antigen. The greatest limitation of the test is that it detects only one subgroup of one of the several species of *Legionella*. The CDC recommends using multiple tests when Legionnaires' disease is suspected because none of the tests is completely accurate.

## Medical Management

The antibiotics of choice are azithromycin or a fluoroquinolone such as moxifloxacin (Avelox) (Mandell, Wunderink, Anzueto, et al., 2007). The antibiotic doxycycline may also be used.

## Nursing Management

The nursing management described for the patient with any pneumonia (see Chapter 23) should form the basis of care for the patient with *Legionella* pneumonia. Isolation is not required because *Legionella* is not transmitted between humans. When the patient has acquired the infection in a health care facility, water cultures should be performed to determine if the water supply is contaminated.

# PERTUSSIS

Pertussis, also known as whooping cough, a common childhood disease in the prevaccine era, is an example of a disease that has reemerged. Incidence rates declined until the 1980s, when rates for all age groups began to increase steadily for the next two decades. In the short period from 2001 to 2003, the incidence of cases in adolescents and adults more than doubled compared with the period from 1990 to 1993 (CDC, 2008b) (Fig. 70-3).

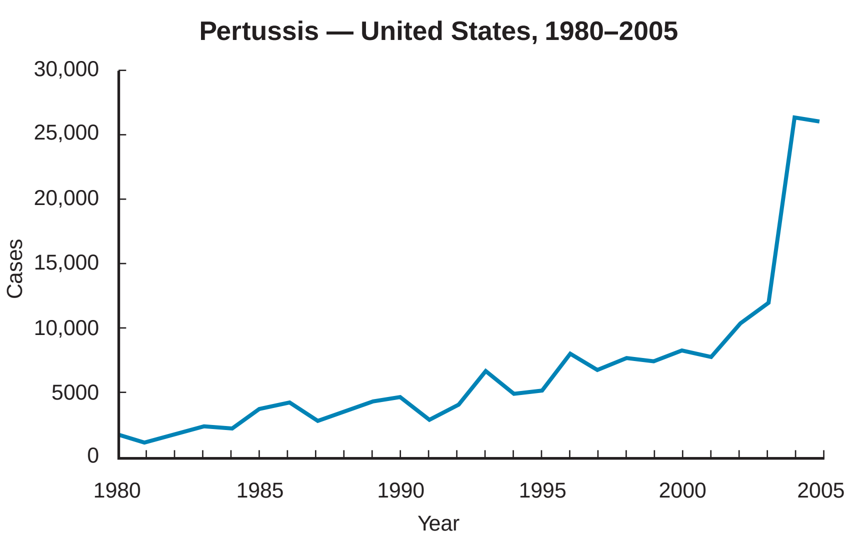



**Figure 70-3** Graph showing increased incidence of pertussis in the United States, 1980–2005. From Centers of Disease Control and Prevention. (2007). Epidemiology and prevention of vaccine preventable diseases broadcasts: Slide sets. (10th ed.). Available at: www.cdc.gov/vaccines/ed/epivac07/epivac07-slides.htm

Pertussis is highly contagious, and patients usually present to health care professionals with a sudden (paroxysmal) cough that is accompanied by a characteristic whoop, a high-pitched noise heard when inhaling. Whooping cough is caused by the bacterium *Bordetella pertussis*.

### Pathophysiology

*B. pertussis* is transmitted by droplets. The bacteria easily attach to pharyngeal epithelial cells, where they release a number of antigens, toxins, and other substances that trigger the immune system. Because most of the disease manifestations are caused by this immune reaction, patients are usually contagious only early in the disease (when the bacteria are still present) and not during the protracted period of cough (when the immune reaction is causing the pathology).

### Clinical Manifestations

Pertussis causes a range of respiratory symptoms, with cough being the most frequent. It is generally most severe for infants who have not yet been vaccinated. Pneumonia is the most common consequence of infection, but the disease can also lead to seizures, encephalopathy, and rarely death. People who have been vaccinated seldom have severe disease.

### Assessment and Diagnostic Findings

Most diagnoses of pertussis are made, at least initially, without laboratory confirmation. The clinical case definition, unless there is a preexisting condition to explain the symptoms, is a new cough lasting at least 2 weeks with inspiratory whoop or vomiting after cough. Laboratory confirmation can be made by clinical culture or by polymerase chain reaction (PCR) assay for *B. pertussis*. Serologic testing, although less reliable, can also strengthen the diagnostic suspicion. The best source for a culture is a nasopharyngeal specimen.

### Medical Management

The antibiotics of choice are azithromycin, erythromycin (Erythrocin), or clarithromycin (Biaxin). The antibiotic trimethoprim sulfate (Bactrim) may also be used (Mandell, et al., 2007). Close contacts of a patient with proven or suspected pertussis should receive prophylaxis with one of these agents to reduce the risk of disease.

### Nursing Management

Hospitalized patients with pertussis should be isolated in Droplet Precautions until they have received 5 days of appropriate therapy. Household members should receive antimicrobial prophylaxis and should be advised to report any symptoms of an upper respiratory infection.

## HANTAVIRUS PULMONARY SYNDROME

Hantavirus pulmonary syndrome is caused by a member of the Hantavirus family of viruses. In the United States, the Sin Nombre hantavirus causes severe cardiopulmonary illness, with a case mortality rate of approximately 50%. It occurs most frequently in the western United States, but the rodents known to carry the virus are found throughout the country (Vaheri & Calisher, 2002).

The diagnosis of hantavirus pulmonary syndrome should be suspected in patients who live in rural areas; who may have had exposure to rodents; and who report fever, aching muscles, and nausea. Thrombocytopenia and hemoconcentration are also common.

No specific treatment for hantavirus pulmonary syndrome has been approved. Early identification, assessment, and maintenance of respiratory status are the most important aspects of care for patients with the disease. Intake and output should be monitored closely because overhydration is possible, with resultant cardiopulmonary compromise.

Prevention requires strategies to reduce human contact with rodents and their droppings. Public health programs and clinics in rural areas should regularly teach people to eliminate rodent food sources that are in areas close to humans. Openings in walls or cabinets should be sealed. Traps should be used in areas such as sheds and barns in which humans work and rodents may enter. Gloves should be worn when removing an animal from a trap, and the trap should be disinfected with a 1:10 bleach solution. People entering such areas should be taught to avoid stirring up dust or breathing potentially contaminated dust. Brooms and vacuum cleaners should be used with caution; areas that may emit dust while being cleaned should be first dampened with a bleach solution to reduce viral contaminants and the potential for dust dispersion.

## VIRAL HEMORRHAGIC FEVERS

Viral hemorrhagic fevers are a group of illnesses caused by several families of viruses (the arenaviruses, filoviruses, bunyaviruses, and flaviviruses). These viruses cause a syndrome characterized by multisystem involvement, resulting in a damaged vascular system. Although most cases of hemorrhagic fever are severe, some cases are less acute. The viruses as a whole can be found throughout the world; however, each virus usually causes disease only in its own limited geographic area.

The Ebola and Marburg viruses, both belonging to the filovirus family, are the best-known viral hemorrhagic fever viruses. Since the 1960s, they have been the source of an irregular pattern of sporadic outbreaks. The clinical course differs among patients but often includes fever, hemorrhage, vomiting, diarrhea, cough, and jaundice. Symptoms usually occur rapidly, and the course of the illness often progresses rapidly to profound hemorrhage, organ destruction, and shock. The mortality rate ranges from 25% to 80%. When patients survive, the recovery period is often prolonged, and weakness, malaise, and cachexia are common (Heymann, 2004).

Nonhuman animals or insects appear to be the natural reservoirs of the viruses. Humans usually become infected when exposed to the natural reservoir (eg, after exposure to an unrecognized host or an insect bite). However, human-to-human transmission occurs occasionally; it involves close contact and usually occurs via the bloodborne route after exposure to blood or other body fluid. Percutaneous exposure requires only a very low inoculum of contaminated blood for transmission to occur. Mucous membrane exposure is another method of transmission. Although airborne transmission does not appear to be likely, the possibility has not been entirely eliminated.

A diagnosis of Ebola or Marburg should be considered in a patient who has a febrile, hemorrhagic illness after traveling to Asia or Africa or who has handled animals or animal carcasses from those parts of the world. The CDC should be contacted immediately when Ebola and Marburg viruses are suspected because hospital and local public health laboratories would not be able to confirm a diagnosis. Because no cases of Ebola or Marburg have been diagnosed in the United States to date, more likely diagnoses should also be considered whenever one of these diseases is a diagnostic possibility.

All health care workers who are involved in caring for patients with filoviruses must adhere to strict infection control measures. Systems must be set up to have objective observers ensure that each worker wears complete protective equipment in the form of cap, goggles, mask, gown, gloves, and shoe covers.

Treatment is largely supportive maintenance of the circulatory system and respiratory systems. It is likely that the infected patient will need ventilator and dialysis support during the acute phases of illness (CDC, 2005b). Supportive care for a patient with such a devastating disease requires psychological support for the patient and family. The patient, family, health care workers, and others in the community need substantial, coordinated education about the known elements and approach. Intervention may be required from those trained to provide psychological support for national emergencies or crises.

## Travel and Immigration

Travel, trade, migration, and wars have led to many epidemics throughout history. The potential for epidemics is greatest when travelers and immigrants introduce microorganisms to which the host population has little or no immunity. Examples of important epidemics in the Western Hemisphere have included yellow fever, malaria, hookworm, leprosy, smallpox, measles, mumps, and syphilis. The HIV epidemic demonstrates the way that travel and immigration allow a disease to spread undetected worldwide. The 2003 severe acute respiratory syndrome (SARS) outbreak demonstrates how global travel contributes to a rapidly occurring epidemic involving an unrecognized pathogen.

In the United States, an infrastructure with enforced vaccination, clean water, and insect and rodent control decreases the risk that epidemics will progress even when travel may introduce exotic microorganisms. However, the recent experience with West Nile virus has reinforced knowledge that insect transmission can lead to significant human outbreaks. Thus, the concern grows that vector-borne diseases such as dengue and malaria may increase in the United States as mosquitoes can transmit disease locally when a reservoir of infected humans is established. The CDC maintains an active surveillance system to monitor and halt the incidence of many diseases prospectively.

### Immigration and Acquired Immunodeficiency Disease Syndrome

The fact that AIDS reached pandemic proportions less than a decade after its recognition attests to the efficiency of world travel in spreading disease. Such rapid transmission rates are especially dramatic because HIV essentially requires intimate contact between two people through sexual activity or sharing blood through needles.

HIV/AIDS is now an international health disaster. Since the start of the epidemic, more than 67 million people have become infected with HIV and more than 27 million have died of AIDS. Control of the epidemic anywhere in the world requires control everywhere. More than 95% of the current burden is felt in economically depressed countries, which means that the control of the disease, using antiretroviral therapy and public health education, requires investment from nations, corporations, and people throughout the world, especially the wealthy nations (UNAIDS, 2008).

### Immigration and Tuberculosis

Although there are substantive efforts to eliminate TB in the United States, TB remains a growing epidemic in developing nations. Approximately one third of the world's population is currently infected with TB. Between 5% and 10% of those infected eventually develop disease; therefore, approximately 9 million people per year become ill with TB (WHO, 2008b). Immigration has always been an important influence in the dynamic epidemiology of TB in the United States. In 2007, the incidence of TB in the United States was 9.7 times greater in foreign-born people than in native-born people (CDC, 2008b).

The association between immigration and transmission risk is greatest in urban areas because these locations are frequently heavily populated and frequently visited by foreign-born people. These locales are also often the epicenter of the HIV epidemic. Because HIV infection depletes T cells, which are necessary for TB protection, the geographic closeness of these two microorganisms potentiates increased rates of both infections.

A positive tuberculin skin test (TST) establishes that TB infection has occurred at some time in a person's life but does not provide information about current infectivity. The reliability of TST interpretation is decreased among foreign-born people because the bacille Calmette-Guérin (BCG) vaccine is used in many countries. After receiving BCG, people often have some degree of TST reactivity for a prolonged time.

### Immigration and Vector-Borne Diseases

Malaria and dengue are diseases that cause significant morbidity and mortality throughout the developing world. These diseases may be "imported" to the United States via travel, immigration, or commerce. They are caused by microorganisms that can be spread to humans by mosquitoes in the United States that thrive in tropical zones and breed in stagnant water sources. Although malaria was eradicated in the United States in the 1950s, limited local outbreaks have occurred regularly when mosquitoes acquire the bacteria from a person recently traveling from an area in which malaria is endemic and transmit it to a small number of people. Similarly, an increase of dengue virus in the Caribbean has caused concern that outbreaks may occur in the United States.

## CRITICAL THINKING EXERCISES

**1** Several elderly patients in your community have developed skin infections caused by MRSA. What should nurses in different roles in the community do to reduce the risk of new infections and to reduce people's anxiety? What strategies are used to control MRSA in health care facilities?

**2** Several patients in your long-term care facility have developed fever and diarrhea. What steps should be taken to reduce the risk of further outbreaks?

EBP **3** Audits of hand hygiene in your health care facility demonstrate poor compliance with recommended methods of hand hygiene. What methods of hand hygiene should be used? What strategies should be used to improve compliance and to sustain appropriate behavior once acceptable rates are achieved? What is the evidence base for these practices?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

### REFERENCES AND SELECTED READINGS

#### Books


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## RESOURCES

American Lung Association, www.lungusa.org

American Public Health Association (APHA), www.apha.org

Association for Professionals in Infection Control and Epidemiology (APIC), Inc., www.apic.org

Centers for Disease Control and Prevention (CDC), www.cdc.gov

Centers for Disease Control and Prevention (CDC), adult or pediatric vaccine advice hotline, 800 232-4636

Centers for Disease Control and Prevention (CDC), traveler's vaccination advice, 877-FYI-TRIP or 877 394-8747

Department of Infectious and Parasitic Disease Pathology, Armed Forces Institute of Pathology (AFIP), www.afip.org

Infectious Diseases Society of America (IDSA), www.idsociety.org

National Foundation for Infectious Diseases (NFID), www.nfid.org

National Institute of Allergy and Infectious Diseases (NIAID), www.niaid.nih.gov/default.htm

Occupational Safety and Health Administration (OSHA), www.osha.gov

Society for Healthcare Epidemiology of America (SHEA), www.shea-online.org

Vaccine Adverse Event Reporting System, 800 822-7967, www.vaers.hhs.gov

World Health Organization (WHO), www.who.int/home-page



chapter 71

# Emergency Nursing

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Describe emergency care as a collaborative, holistic approach that includes the patient, the family, and significant others.
2. Discuss priority emergency measures instituted for the patient with an emergency condition.
3. Describe the emergency management of patients with intra-abdominal injuries.
4. Identify the priorities of care for the patient with multiple injuries.
5. Compare and contrast the emergency management of patients with heat stroke, frostbite, and hypothermia.
6. Specify the similarities and differences of the emergency management of patients with swallowed or inhaled poisons, skin contamination, and food poisoning.
7. Discuss the emergency management of patients with drug overdose and with acute alcohol intoxication.
8. Describe the significance of crisis intervention in the care of rape victims.
9. Differentiate between the emergency care of patients who are overactive, those who are violent, those who are depressed, and those who are suicidal.

## GLOSSARY

**antivenin:** antitoxin manufactured from venom of poisonous snakes to assist the patient's immune system response to an envenomation

**carboxyhemoglobin:** hemoglobin that is bound to carbon monoxide and therefore is unable to bind with oxygen, resulting in hypoxemia

**corrosive poison:** alkaline or acidic agent; causes tissue destruction after contact

**cricothyroidotomy:** surgical opening of the cricothyroid membrane to obtain an airway that is maintained with a tracheostomy or endotracheal tube

**diagnostic peritoneal lavage:** instillation of lactated Ringer's or normal saline solution into the abdominal cavity to detect red blood cells, white blood cells, bile, bacteria, amylase, or gastrointestinal contents indicative of abdominal injury

**emergent:** triage category signifying potentially life-threatening injuries or illnesses requiring immediate treatment

**envenomation:** injection of a poisonous material by sting, spine, bite, or other means

**fasciotomy:** surgical incision of the extremity to the level of the fascia to relieve pressure and restore neurovascular function to the extremity

**Hare traction:** portable in-line traction applied to the lower extremity to manage femur or hip fractures or dislocations

**minor:** triage category signifying non–life-threatening injuries or illnesses that can be routinely managed in a clinic or physician's office or that require no medical care

**nonurgent:** triage category signifying episodic or minor injury or illness in which treatment may be delayed several hours or longer without increased morbidity

**resuscitation:** triage category signifying life-threatening injuries or illnesses requiring immediate intervention

**triage:** process of assessing patients to determine management priorities

**urgent:** triage category signifying serious illness or injury that is not immediately life-threatening

The term *emergency management* traditionally refers to care given to patients with urgent and critical needs. However, because many people lack access to health care, the emergency department (ED) is increasingly used for nonurgent problems. Therefore, the philosophy of emergency management has broadened to include the concept that an emergency is whatever the patient or the family considers it to be.

Large numbers of people seek emergency care for serious life-threatening conditions, such as cardiac dysrhythmias, acute coronary syndrome (ACS), acute heart failure, pulmonary edema, and stroke. Priorities for managing these cardiac and other conditions are discussed in Chapters 27, 28, 30, and 62. Emergency management of trauma and conditions not found elsewhere in this book are discussed in this chapter. It is assumed that care and treatment are provided under the direction of a physician or emergency nurse practitioner. Facts about ED visits in the United States are presented in Chart 71-1.

## SCOPE AND PRACTICE OF EMERGENCY NURSING

The emergency nurse has had specialized education, training, experience, and expertise in assessing and identifying patients' health care problems in crisis situations. In addition, the emergency nurse establishes priorities, monitors and continuously assesses acutely ill and injured patients, supports and attends to families, supervises allied health personnel, and teaches patients and families within a time-limited, high-pressured care environment. Nursing interventions are accomplished interdependently, in consultation with or under the direction of a physician or nurse practitioner. The roles of nursing and medicine are complementary in an emergency situation. Appropriate nursing and medical interventions are anticipated based on assessment data. The emergency health care staff members work as a team in performing the highly technical, hands-on skills required to care for patients in emergency situations.

The nursing process provides a logical framework for problem solving in this environment. Patients in the ED have a wide variety of actual or potential problems, and their condition may change. Therefore, nursing assessment must be continuous, and nursing diagnoses change with the patient's condition. Although a patient may have several diagnoses at a given time, the focus is on the most life-threatening ones; often, both independent and interdependent nursing interventions are required.

### Issues in Emergency Nursing Care

Emergency nursing is demanding because of the diversity of conditions and situations that present unique challenges. These challenges include legal issues, occupational health and safety risks for ED staff, and the challenge of providing holistic care in the context of a fast-paced, technology-driven environment in which serious illness and death are encountered on a daily basis. Another dimension of emergency nursing is nursing in disasters. With the increasing use of weapons of terror and mass destruction, the emergency nurse must recognize and treat patients exposed to biologic and other weapons and anticipate nursing care in the event of a mass casualty incident (see Chapter 72).

**Chart 71-1 • *Facts About Emergency Department Visits***

In 2005, there were 115.3 million visits to emergency departments (EDs), a 31% increase from 1995. This was accompanied by a 10% decrease in the number of EDs and an increased utilization by 7%.

- The highest rate of ED visits in people 65 years of age and older were from long-term care facilities.
- More than 15.5% of patients arrived at the ED by ambulance.
- Patients with Medicaid used EDs more often than patients with private health insurance, Medicare, or self-pay.
- Injuries accounted for 41.9% of all ED visits.
- The leading causes of injuries, including falls and motor vehicle crashes, accounted for 31% of injury-related ED visits. For those injured, 36.9% were transported to designated trauma centers.
- The average ED waiting time before being seen by a health care provider for definitive treatment was 2.4 hours, with 7 of 10 patients spending less than 4 hours in the ED.

Source: National Hospital Ambulatory Medical Care Survey. (2005). *2005 Emergency department summary*. Available at: www.cdc.gov/nchs/data/ad/ad386.pdf and www.cdc.gov/nchs/data/hus/hus07.pdf#091

#### Documentation of Consent and Privacy

Consent to examine and treat the patient is part of the ED record. The patient must consent to invasive procedures (eg, angiography, lumbar puncture) unless he or she is unconscious or in critical condition and unable to make decisions. If the patient is unconscious and brought to the ED without family or friends, this fact must be documented. Monitoring of the patient's condition, as well as all instituted treatments and the times at which they were performed, must be documented. After treatment, a notation is made on the record about the patient's condition, response to the treatment, and condition at discharge or transfer and about instructions given to the patient and family for follow-up care.

The patient is also provided with a statement of the privacy policy of the health care agency, according to federal law. Patients involved in violent events are often provided with an alias, and access to the medical record, both paper and electronic, is limited to protect the privacy of the patient. A patient may also request extra privacy by limiting access to his or her room and by choosing not to receive phone calls, mail, flowers, other gifts, or certain visitors. These practices relate to the federally mandated privacy policy stipulated in the Health Insurance Portability and Accountability Act (HIPAA).

#### Limiting Exposure to Health Risks

Because of the increasing numbers of people infected with hepatitis B and C, with human immunodeficiency virus (HIV), and other infectious diseases, health care providers are at an increased risk for exposure to communicable diseases through blood, respiratory droplets, or other body fluids. This risk is further compounded in

the ED because of the common use of invasive treatments in patients who may have a wide range of conditions and who frequently cannot provide a comprehensive medical history. All emergency health care providers must adhere strictly to standard precautions for minimizing exposure.

The reemergence of tuberculosis as a major health problem is complicated by multi–drug-resistant tuberculosis and by tuberculosis concomitant with HIV infection. Early identification and adherence to transmission-based precautions for patients who are potentially infectious are crucial. Nurses in the ED are usually fitted with personal high-efficiency particulate air (HEPA) filter masks to use when treating patients with airborne diseases.

The potential for exposure to highly contagious organisms, hazardous chemicals or gases, and radiation related to acts of terrorism or natural or manmade disasters presents additional risks to ED staff (see Chapter 72 for information about decontamination procedures).

### Violence in the Emergency Department

Not only do ED staff members encounter patients who may be violent because of the effects of substance abuse, injury, or other emergencies, but they may also encounter other violent situations. Frequently, patients and families waiting for assistance are emotionally volatile. Often, waiting rooms are the sites where feelings of dissatisfaction, fear, and anger are channeled violently. Some EDs assign security officers to the area and have installed silent alarm systems or metal detectors to identify weapons in order to protect patients, families, and staff. Safety is the first priority.

It is not unusual for a patient or family member to come to the ED armed. To avoid angry confrontations, members of gangs and feuding families need to be separated in the ED, in the waiting room, and later in the inpatient nursing unit. Nurses and other personnel must be prepared to deal with these circumstances. The ED should be locked against entry if security is questionable.

Patients from prison and those who are under guard need to be handcuffed to the bed and appropriately assessed to ensure the safety of hospital staff and other patients. The following precautions are taken:

- The hand or ankle restraint (handcuff) is never released.
- A guard is always present in the room.
- The patient is placed face down on the stretcher to avoid injury from head-butting, spitting, or biting.
- Restraints are used on any violent patient as needed.
- Medication is administered as necessary to control violent behavior until definitive treatment can be obtained.

In the case of gunfire in the ED, self-protection is a priority. There is no advantage to protecting others if medical caregivers are injured. Security officers and police must gain control of the situation first, and then care is provided to the injured.

### Providing Holistic Care

Patients and families experiencing sudden injury or illness are often overwhelmed by anxiety because they have not had time to adapt to the crisis. They experience real and terrifying fear of death, mutilation, immobilization, and other assaults on their personal identity and body integrity. When confronted with trauma, severe disfigurement, severe illness, or sudden death, the family experiences several stages of crisis. The stages begin with anxiety and progress through denial, remorse and guilt, anger, grief, and reconciliation. The initial goal for the patient and family is anxiety reduction, a prerequisite to effective and appropriate coping. During this stressful time, safety is of prime importance. Close observation and preplanning are essential and security personnel are stationed nearby in the event that a patient or family member responds to stress with physical violence.

Assessment of the patient and family's psychological function includes evaluating emotional expression, degree of anxiety, and cognitive functioning. Possible nursing diagnoses include:

- General anxiety or death anxiety related to uncertain potential outcomes of the illness or trauma
- Ineffective coping related to acute situational crisis

Possible nursing diagnoses for the family include:

- Grieving
- Interrupted family processes
- Compromised or disabled family coping related to acute situational crises

#### Patient-Focused Interventions

Clinicians caring for the patient should act confidently and competently to relieve anxiety and promote a sense of security. Explanations should be given that the patient can understand. Human contact and reassuring words reduce the panic of the severely injured or ill person and aid in dispelling fear of the unknown.

The unconscious patient should be treated as if conscious; that is, the patient should be touched, called by name, and given an explanation of every procedure that is performed. As the patient regains consciousness, the nurse should orient the patient by stating his or her name, the date, and the location. This basic information should be provided repeatedly, as needed, in a reassuring way.

#### Family-Focused Interventions

The family is kept informed about where the patient is, how he or she is doing, and the care that is being given. Allowing family members to stay with the patient, when possible, also helps allay their anxieties. In many facilities, family presence during resuscitation is permitted to assist the family to cope through this difficult time. Many family members respond very well to this approach, and it provides some answers to the question "Was everything done?" (Walker, 2008). Additional interventions are based on the assessment of the stage of crisis that the family is experiencing. Measures to help family members cope with sudden death are presented in Chart 71-2.

***Anxiety and Denial.*** During these crises, family members are encouraged to recognize and talk about their feelings of anxiety. Asking questions is encouraged. Honest answers given at the level of the family's understanding must be provided. Although denial is an ego-defense mechanism that protects one from recognizing

### Chart 71-2 • *Helping Family Members Cope With Sudden Death*

- Take the family to a private place.
- Talk to the family together, so that they can grieve together.
- Reassure the family that everything possible was done; inform them of the treatment rendered.
- Avoid using euphemisms such as "passed on." Show the family that you care by touching, offering coffee, water, and the services of a chaplain.
- Encourage family members to support each other and to express emotions freely (grief, loss, anger, helplessness, tears, disbelief).
- Avoid giving sedation to family members; this may mask or delay the grieving process, which is necessary to achieve emotional equilibrium and to prevent prolonged depression.
- Encourage the family to view the body if they wish; this action helps to integrate the loss. Cover disfigured and injured areas before the family sees the body. Go with the family to see the body. Show acceptance by touching the body to give the family "permission" to touch.
- Spend time with the family, listening to them and identifying any needs that they may have for which the nursing staff can be helpful.
- Allow family members to talk about the deceased and what he or she meant to them; this permits ventilation of feelings of loss. Encourage the family to talk about events preceding admission to the emergency department. Do not challenge initial feelings of anger or denial.
- Avoid volunteering unnecessary information (eg, the patient was drinking).

painful and disturbing aspects of reality, prolonged denial is not encouraged or supported. The family must be prepared for the reality of what has happened and what may come.

***Remorse and Guilt.*** Expressions of remorse and guilt are common, with family members accusing themselves (or each other) of negligence or minor omissions. Family members are urged to verbalize their feelings to help them cope appropriately.

***Anger*.** Expressions of anger, common in crisis situations, are a way of handling anxiety and fear. Anger is frequently directed by the family at the patient, but it is also often expressed toward the physician, the nurse, or admitting personnel. The therapeutic approach is to allow the anger to be expressed and to assist the family members to identify their feelings of frustration.

***Grief.*** Grief is a complex emotional response to anticipated or actual loss. The key nursing intervention is to help family members work through their grief and to support their coping mechanisms, letting them know that it is normal and acceptable for them to cry, feel pain, and express loss. The hospital chaplain and social services staff serve as invaluable members of the team when assisting families to work through their grief.

#### Caring for Emergency Personnel

Concerted efforts have been made to focus on the needs of the ED staff, especially after serious and stressful events (Emergency Nurses Association [ENA], 2007). Events can range from a local trauma case involving children; to treating someone known to the emergency worker, such as a colleague or family member; to a more complex natural disaster or multicasualty situation. It is important to remember that all staff members may not necessarily respond in the same way; an event that is stressful for one person may not be as stressful for another. In addition, because stress is a daily occurrence in the ED, the staff may not recognize the personal effect of any one event. The availability of nonjudgmental counseling is essential to promoting a healthy staff. After serious events, critical incident stress debriefing necessary to critique individual and group performance. In addition, personal and group stress debriefing is also essential.

## Emergency Nursing and the Continuum of Care

A key principle underlying emergency care is that the patient is rapidly assessed, treated, and referred to the appropriate setting for ongoing care. This makes the ED a temporary point on the continuum of care. Most patients who receive emergency care are discharged directly from the ED to their homes, and emergency nurses must plan and facilitate the patient's safe discharge and follow-up care in the home and the community.

### *Discharge Planning*

Before discharge, verbal and written instructions for continuing care are given to the patient and the family or significant others. Many EDs have preprinted standard instruction sheets for the more common conditions, which can then be individualized. Discharge instructions should be available in a variety of languages. A language interpreter should be used as necessary to provide both written and verbal instructions.

Instructions should include information about prescribed medications, treatments, diet, activity, and when to contact a health care provider or schedule follow-up appointments. It is imperative that instructions are written legibly, use simple language, and are clear in their teaching. When providing discharge instructions, the nurse also considers any special needs the patient may have related to hearing or visual impairments. Alternate formats of instruction (eg, large print, Braille, audiotape) should be available to meet the needs of patients with hearing or visual impairments.

### *Community Services*

Before discharge, some patients require the services of a social worker to help them meet continuing health care needs. Home care resources may be contacted before discharge to arrange services. This is particularly important for patients who are elderly or disabled and who need assistance. Identifying continuing health care needs and making arrangements for meeting these needs can prevent return visits to the ED or readmission to the hospital.

For patients who are returning to long-term care facilities and for those who already rely on community agencies for continuing health care, communication about the patient's condition and any changes in health care needs that have occurred must be provided to the appropriate facilities or agencies. This communication is essential to promote continuity of care and to ensure ongoing care to meet the patient's changing health care needs.

### Gerontologic Considerations

The ED is a common point of entry into the health care system for patients 65 years and older. In fact, patients in this age group account for more than 41% of the admissions to the hospital from the ED. Of the 115 million ED visits in the United States in 2005, 2.2 million of these were patients from long-term care facilities (National Hospital Ambulatory Medical Care Survey, 2005) (see Chart 71-1). Elderly patients typically arrive with one or more presenting conditions. Nonspecific symptoms, such as weakness and fatigue, episodes of falling, incontinence, and change in mental status, may be manifestations of acute, potentially life-threatening illness in the elderly person. Emergencies in this age group may be more difficult to manage because elderly patients may have an atypical presentation, an altered response to treatment, a greater risk of developing complications, or a combination of these factors.

The elderly patient may perceive the emergency as a crisis signaling the end of an independent lifestyle or even resulting in death. The nurse should give attention to the patient's feelings of anxiety and fear.

The older patient may have limited sources of social and financial support during these times of crises. The nurse should assess the psychosocial resources of the patient (and of the caregiver, if necessary) and anticipate discharge needs. Referrals for support services (eg, to the social service department or a gerontologic nurse specialist) may be necessary.

## PRINCIPLES OF EMERGENCY CARE

By definition, emergency care is care that must be rendered without delay. In an ED, several patients with diverse health problems—some life-threatening, some not—may present to the ED simultaneously. One of the first principles of emergency care is triage.

### Triage

The word **triage** comes from the French word *trier,* meaning "to sort." In the daily routine of the ED, triage is used to sort patients into groups based on the severity of their health problems and the immediacy with which these problems must be treated.

A basic and widely used triage system that has been in use for many years has three categories: emergent, urgent, and nonurgent (Berner, 2005). **Emergent** patients have the highest priority—their conditions are life-threatening and they must be seen immediately. **Urgent** patients have serious health problems but not immediately life-threatening ones; they must be seen within 1 hour. **Nonurgent** patients have episodic illnesses that can be addressed within 24 hours without increased morbidity (Berner, 2005). A fourth category that is increasingly used is "fast-track." These patients require simple first aid or basic primary care and may be treated in the ED or safely referred to a clinic or physician's office.

A more refined comprehensive triage system, which recognizes that EDs are used for both emergency and routine health care, has been implemented. This system has five levels: resuscitation, emergent, urgent, nonurgent, and minor (Tanabe, Gimbel, Yarnold, et al., 2004). The increased number of triage levels assists the triage nurse to more precisely determine the needs of the patient and the urgency for treatment. This five-level triage system is currently used throughout the United States, Australia, the United Kingdom, and Canada.

In the five-level system, patients in the emergent category identified in the previously used three-level system have been divided into two distinct groupings, resuscitation and emergent. Patients in the **resuscitation** category need treatment immediately to prevent death. Patients in the emergent category may deteriorate rapidly and develop a major life-threatening situation or require time-sensitive treatment. Patients in the urgent category have non–life-threatening conditions but require two or more resources (defined below) to provide their care. If these patients' vital signs deviate significantly from their baseline, they may require "up-triaging" to the emergent category. Patients in the nonurgent category have non–life-threatening conditions and likely need only one resource to provide for their needs. Patients in the **minor** category have no life-threatening conditions and likely require no resources to provide their evaluation and management.

Resources include imaging studies, medications administered by intravenous (IV) or intramuscular (IM) routes, and invasive procedures. Insertion of an indwelling catheter is an example of a one-resource procedure. Use of moderate sedation is a two-resource procedure because it requires frequent monitoring and IV medications.

Triage is an advanced skill. Emergency nurses spend many hours learning to classify different illnesses and injuries to ensure that patients most in need of care do not needlessly wait. Protocols may be followed to initiate laboratory or x-ray studies while the patient is in the triage area. Collaborative protocols are developed and used by the triage nurse based on his or her level of experience. Nurses in the triage area collect additional crucial baseline data: full vital signs including pain assessment, history of the current event and past medical history, neurologic assessment findings, weight, allergies (especially to latex and medications), domestic violence screening, and necessary diagnostic data. Some facilities collect these data in a computerized system, which helps guide the nurse through assessment and documentation. The following questions reflect the minimum information that should be obtained from the patient or from the person who accompanied the patient to the ED and then are documented.

- What were the circumstances, precipitating events, location, and time of the injury or illness?
- When did the symptoms appear?
- Was the patient unconscious after the injury or onset of illness?

- How did the patient get to the ED?
- What was the health status of the patient before the injury or illness?
- Is there a history of medical illness or previous surgeries? A history of admissions to the hospital?
- Is the patient currently taking any medications, especially hormones, insulin, digitalis, or anticoagulants? Is the patient using any complementary or alternative therapies such as herbology, naturopathy, reiki, massage, or acupuncture?
- Does the patient have any allergies, especially to latex, medications, eggs, or nuts?
- Does the patient smoke or use recreational drugs? How frequently? What type? When was the last time they were used?
- Does the patient have any fears? Does the patient feel that he or she is in danger or in an unsafe situation?
- When was the last meal eaten? (This is important if general anesthesia is to be given or if the patient is unconscious.)
- When was the last menstrual period?
- Is the patient under a physician's care? What are the name and contact information for the physician?
- What was the date of the patient's most recent tetanus immunization?

In addition to the collection of initial vital signs and medical history, triage consists of providing basic first aid, which may include application of ice, bleeding control, and basic wound care, as well as initiating protocol-based orders (eg, x-rays, administering antipyretics or mild analgesics, obtaining an electrocardiogram [ECG] or urinalysis, removing sutures). The triage nurse also is responsible for and monitors the waiting area, maintains a safe environment, reassesses waiting patients, and is the initial liaison to the families of patients.

Routine ED triage protocols differ significantly from the triage protocols used in disasters and mass casualty incidents (field triage). Routine triage directs all available resources to the patients who are most critically ill, regardless of potential outcome. In field triage (or hospital triage during a disaster), scarce resources must be used to benefit the most people possible. This distinction affects triage decisions (see Chapter 72).

### Assess and Intervene

For the patient assigned to a resuscitation, emergent, or urgent triage category, stabilization, provision of critical treatments, and prompt transfer to the appropriate setting (intensive care unit, operating room, general care unit) are the priorities of emergency care. Although treatment is initiated in the ED, ongoing definitive treatment of the underlying problem is provided in other settings, and the sooner the patient is stabilized and moved to that area, the better the outcome.

A systematic approach to effectively establishing and treating health priorities is the primary survey/secondary survey approach. The primary survey focuses on stabilizing life-threatening conditions. The ED staff work collaboratively and follow the ABCD (***a***irway, ***b***reathing, ***c***irculation, ***d***isability) method:

- Establish a patent airway.
- Provide adequate ventilation, employing resuscitation measures when necessary. (Trauma patients must have the cervical spine protected and chest injuries assessed first, immediately after the airway is established.)
- Evaluate and restore cardiac output by controlling hemorrhage, preventing and treating shock, and maintaining or restoring effective circulation. This includes the prevention and management of hypothermia. In addition, peripheral pulses are examined, and any immediate closed reductions of fractures or dislocations are performed if an extremity is pulseless.
- Determine neurologic disability by assessing neurologic function using the Glasgow Coma Scale and a motor and sensory evaluation of the spine (see Chapter 60).

After these priorities have been addressed, the ED team proceeds with the secondary survey. This includes the following:

- A complete health history and head-to-toe assessment (includes a reassessment of airway and breathing parameters)
- Diagnostic and laboratory testing
- Insertion or application of monitoring devices such as ECG electrodes, arterial lines, or urinary catheters
- Splinting of suspected fractures
- Cleansing, closure, and dressing of wounds
- Performance of other necessary interventions based on the patient's condition

Once the patient has been assessed, stabilized, and tested, appropriate medical and nursing diagnoses are formulated, initial important treatment is started, and plans for the proper disposition of the patient are made. Many emergent and urgent conditions and priority emergency interventions are discussed in detail in the remaining sections of this chapter.

In addition to the management of the illness or injury, the ED nurse must also focus on providing comfort and emotional support to the patient and family. Included in this is pain management. Effective pain management must be instituted early and should include rapid-acting agents that result in minimal sedation so that the patient can continue to interact with the staff for continued assessment. Moderate sedation can help facilitate short procedures in the ED; the patient will not remember the procedure later. The patient is closely monitored during the procedure and then rapidly awakens when it is complete (see Chapter 19).

It is essential that family crisis intervention services are available for families of ED patients. Even if a patient's condition is not emergent, the situation may be perceived as such by the family. Every family needs attention and support. The chaplain and social worker may be available to assist with interventions.

## AIRWAY OBSTRUCTION

Acute upper airway obstruction is a life-threatening medical emergency.

## Pathophysiology

The airway may be partially or completely occluded. Partial obstruction of the airway can lead to progressive hypoxia, hypercarbia, and respiratory and cardiac arrest. If the airway is completely obstructed, permanent brain injury or death will occur within 3 to 5 minutes secondary to hypoxia. Air movement is absent in the presence of complete airway obstruction. Oxygen saturation of the blood decreases rapidly because obstruction of the airway prevents entry of air into the lungs. Oxygen deficit occurs in the brain, resulting in unconsciousness, with death following rapidly.

Upper airway obstruction has a number of causes, including aspiration of foreign bodies, anaphylaxis, viral or bacterial infection, trauma, and inhalation or chemical burns. For elderly patients, especially those in extended-care facilities, sedatives and hypnotic medications, diseases affecting motor coordination (eg, Parkinson's disease), and mental dysfunction (eg, dementia, mental retardation) are risk factors for asphyxiation by food. In adults, aspiration of a bolus of meat is the most common cause of airway obstruction. Peritonsillar abscesses, epiglottitis, and other acute infectious processes of the posterior pharynx can also result in airway obstruction (Marx, 2006).

## Clinical Manifestations

Typically, a person with a foreign body airway obstruction cannot speak, breathe, or cough. The patient may clutch the neck between the thumb and fingers (ie, universal distress signal). Other common signs and symptoms include choking, apprehensive appearance, refusing to lie flat, inspiratory and expiratory stridor, labored breathing, use of accessory muscles (suprasternal and intercostal retraction), flaring nostrils, increasing anxiety, restlessness, and confusion. Cyanosis and loss of consciousness develop as hypoxia worsens. Cyanosis and loss of consciousness are late signs. Action must be taken before these manifestations develop, if possible, or immediately if the patient has already exhibited these signs.

## Assessment and Diagnostic Findings

Assessment of the patient who has a foreign object occluding the airway may involve simply asking the person whether he or she is choking and requires help. If the person is unconscious, inspection of the oropharynx may reveal the offending object. X-rays, laryngoscopy, or bronchoscopy also may be performed.

## Management

If the patient can breathe and cough spontaneously, a partial obstruction should be suspected. The victim is encouraged to cough forcefully and to persist with spontaneous coughing and breathing efforts as long as good air exchange exists. There may be some wheezing between coughs. If the patient demonstrates a weak, ineffective cough, high-pitched noise while inhaling, increased respiratory difficulty, or cyanosis, the patient should be managed as if there were complete airway obstruction.

After the obstruction is removed, rescue breathing is initiated. If the patient has no pulse, cardiac compressions are instituted. These measures provide oxygen to the brain, heart, and other vital organs until definitive medical treatment can restore and support normal heart and ventilatory activity.

### *Establishing an Airway*

Establishing an airway may be as simple as repositioning the patient's head to prevent the tongue from obstructing the pharynx. Alternatively, other maneuvers, such as abdominal thrusts, the head-tilt–chin-lift maneuver, the jaw-thrust maneuver, or insertion of specialized equipment, may be needed to open the airway, remove a foreign body, or maintain the airway. In all maneuvers, the cervical spine must be protected from injury. After these maneuvers are performed, the patient is assessed for breathing by watching for chest movement and listening and feeling for air movement. In such a case, nursing diagnoses would include ineffective airway clearance related to obstruction of the airway by the tongue, an object, or fluids (blood, saliva) and ineffective breathing pattern related to airway obstruction or injury.

#### Abdominal Thrusts

The terms *subdiaphragmatic abdominal thrusts*, *abdominal thrusts*, and *Heimlich maneuver* are used interchangeably. This maneuver causes elevation of the diaphragm, forcing air from the lungs to create an artificial cough that can move and expel an obstructing foreign body from the airway. Chart 71-3 describes how to manage a foreign body obstruction using abdominal or chest thrusts.

#### Head-Tilt–Chin-Lift Maneuver

The patient is placed supine on a firm, flat surface. If the patient is lying face down, the body is turned as a unit so that the head, shoulders, and torso move simultaneously with no twisting (ie, logroll). Next, the airway is opened using either the head-tilt–chin-lift maneuver or the jaw-thrust maneuver. In the head-tilt–chin-lift maneuver, one hand is placed on the victim's forehead, and firm backward pressure is applied with the palm to tilt the head back. The fingers of the other hand are placed under the bony part of the lower jaw near the chin and lifted up. The chin and the teeth are brought forward almost to occlusion to support the jaw.

> *NURSING ALERT*
>
> **The head-tilt–chin-lift maneuver, which helps tilt the head back, should be used only if it is determined that the patient's cervical spine is not injured.**

#### Jaw-Thrust Maneuver

After one hand is placed on each side of the patient's jaw, the angles of the patient's lower jaw are grasped and lifted, displacing the mandible forward. This is a safe approach to opening the airway of a patient with suspected spinal cord injury because it can be accomplished without extending the neck.

#### Oropharyngeal Airway Insertion

An oropharyngeal airway is a semicircular tube or tubelike plastic device that is inserted over the back of the tongue into the lower posterior pharynx in a patient who is breathing spontaneously but who is unconscious (Chart 71-4). This type of airway prevents the tongue from falling back

## Chart 71-3 • *Managing a Foreign Body Airway Obstruction*

### Assess for Indications of Airway Obstruction

- Person may clutch the neck between thumb and fingers
- Weak, ineffective cough; high-pitched noises on inspiration
- Increased respiratory distress
- Inability to speak, breathe, or cough
- Collapse

### Heimlich Maneuver (Subdiaphragmatic Abdominal Thrusts)

**For Standing or Sitting Conscious Patient**

Stand behind the patient, wrap your arms around the patient's waist, and proceed as follows:

1. Make a fist with one hand, placing the thumb side of the fist against the patient's abdomen, in the midline slightly above the umbilicus and well below the xiphoid process. Grasp the fist with the other hand.
2. Press your fist into the patient's abdomen with a quick inward and upward thrust. Each new thrust should be a separate and distinct maneuver. All thrusts should be in rapid sequence.

**For Patient Lying Down (Unconscious)**

1. Position patient on the back.
2. Kneel astride the patient's thighs, facing the head.
3. Place the heel of one hand against the patient's abdomen, in the midline slightly above the umbilicus and well below the tip of the xiphoid; place the second hand directly on top of the first.
4. Press into the abdomen with a quick upward thrust. All thrusts should be in rapid sequence.

**Finger Sweep**

1. Open the adult patient's mouth by grasping both the tongue and lower jaw between the thumb and fingers and lifting the mandible (tongue-jaw lift). This maneuver is to be used *only in the unconscious adult patient.* This action draws the tongue away from the back of the throat and away from the foreign body that may be lodged there.
2. If a foreign body is visible in the mouth, insert the index finger of the other hand down along the inside of the cheek and scrape across the back of the throat.
3. Use a hooking action to dislodge the foreign body and maneuver it into the mouth for removal. Care is used to avoid forcing the object deeper into the throat.

**Chest Thrusts With Conscious Patient Standing or Sitting**

This technique is to be used *only in the patient in advanced stages of pregnancy or in the markedly obese person.*

1. Stand behind the patient with your arms under the patient's axillae to encircle the patient's chest.
2. Place the thumb side of your fist on the middle of the patient's sternum, taking care to avoid the xiphoid process and the margins of the rib cage.
3. Grasp your fist with the other hand and perform backward thrusts until the foreign body is expelled or the patient becomes unconscious. Each thrust should be administered with the intent of relieving the obstruction. All thrusts should be in rapid sequence.

**Chest Thrust With Patient Lying (Unconscious)**

This maneuver is *used only in the patient in advanced stages of pregnancy or when the rescuer cannot apply the Heimlich maneuver effectively to the unconscious, markedly obese person.*

1. Place the patient on the back and kneel close to the side of the patient's body.
2. Place the heel of your hand on the lower half of the sternum.
3. Deliver each chest thrust slowly and distinctly with the intent of relieving the obstruction.

Adapted from American Heart Association. (2005). BLS for healthcare providers. Available at: www.americanheart.org.

against the posterior pharynx and obstructing the airway. It also allows health care providers to suction secretions.

### Endotracheal Intubation

The purpose of endotracheal intubation is to establish and maintain the airway in patients with respiratory insufficiency or hypoxia. Endotracheal intubation is indicated to establish an airway for a patient who cannot be adequately ventilated with an oropharyngeal airway, bypass an upper airway obstruction, prevent aspiration, permit connection of the patient to a resuscitation bag or mechanical ventilator, or facilitate the removal of tracheobronchial secretions (Fig. 71-1). Because the procedure requires skill, endotracheal intubation is performed only by those who have had extensive training. These may include physicians, nurse anesthetists, respiratory therapists, flight nurses, and nurse practitioners. However, the emergency nurse is commonly called on to assist with intubation.

Rapid sequence intubation may be indicated, which provides management of the patient in a situation similar to that in the operating room. Medications used to facilitate rapid sequence intubation include a sedative, an analgesic, and a neuromuscular blockade agent; these are usually administered by the practitioner performing the intubation.

### Intubation With a Combitube or Laryngeal Mask Airway

If the patient is not hospitalized and cannot be intubated in the field, emergency medical personnel may insert a Combitube, which rapidly provides pharyngeal ventilation. When the tube is inserted into the trachea, it functions like an endotracheal tube (Fig. 71-2).

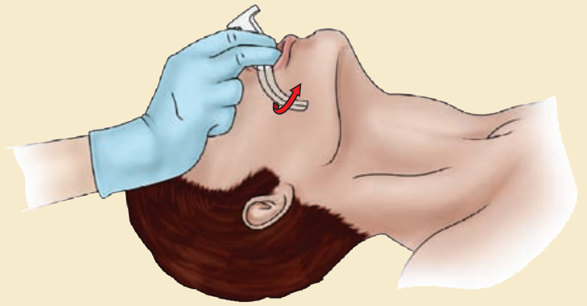
The two balloons that surround the tube are inflated after the tube is inserted. One balloon is large (100 mL) and occludes the oropharynx. This permits ventilation by forcing air through the larynx. The smaller balloon is inflated with 15 mL of air and is supposed to anchor the device in the esophagus at a site distal to the glottis; however, it can occlude the trachea if it is inadvertently placed there. Breath sounds are auscultated after balloon inflation to make sure that the oropharyngeal balloon (or cuff) does not obstruct the glottis. The patient can be ventilated through either one of the two ports (eg, tracheal or esophageal) of

## Chart 71-4 • *Inserting an Oropharyngeal Airway*

1. Measure the oral airway alongside the head. The airway should reach from lip to ear.
2. Extend the patient's head by placing one hand under the bony chin (*only if the cervical spine is uninjured*). With the other hand, tilt the head backward by applying pressure to the forehead while simultaneously lifting the chin forward.
3. Open the patient's mouth.
4. **(A)** Insert the oropharyngeal airway with the tip facing up toward the roof of the mouth until it passes the uvula. **(B)** Rotate the tip 180 degrees so that the tip is pointed down toward the pharynx. This displaces the tongue anteriorly, and the patient then breathes through and around the airway.
5. The distal end of the oropharyngeal airway is in the hypopharynx, and the flange is approximately at the patient's lips. Make sure that the tongue has not been pushed into the airway.



A



B

the tube, depending on whether the tube is placed in the trachea or esophagus.

If it is difficult to establish an airway, a laryngeal mask airway (LMA) may be inserted as an interim airway device. The design of the LMA provides a "mask" in the subglottic airway with a cuff inflated within the esophagus. It allows easy insertion for rapid airway control until a more definitive airway can be placed. Some LMAs also permit removal of secretions from the esophagus (see Chapter 19).

#### Cricothyroidotomy (Cricothyroid Membrane Puncture)

**Cricothyroidotomy** is the opening of the cricothyroid membrane to establish an airway. This procedure is used in emergency situations in which endotracheal intubation is either not possible or contraindicated, as in airway obstruction from extensive maxillofacial trauma, cervical spine injuries, laryngospasm, laryngeal edema (after an allergic reaction or extubation), hemorrhage into neck tissue, or obstruction of the larynx. A cricothyroidotomy is replaced with a formal tracheostomy when the patient is able to tolerate this procedure.

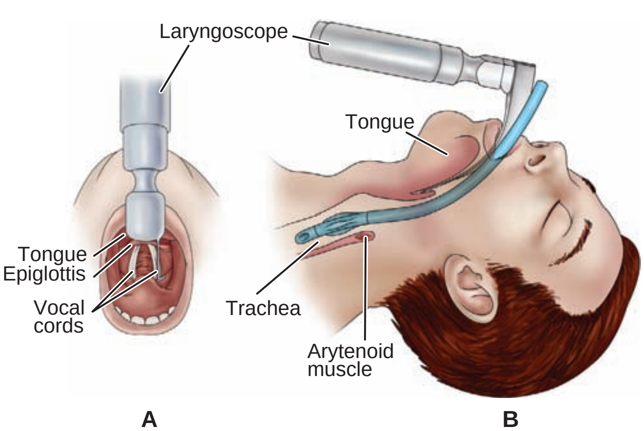



**Figure 71-1** Endotracheal intubation in a patient without a cervical spine injury. **A,** The primary glottic landmarks for tracheal intubation as visualized with proper placement of the laryngoscope. **B,** Positioning the endotracheal tube.

### *Maintaining Ventilation*

Only a few conditions, such as an obstructed airway or a sucking wound of the chest, take precedence over the immediate control of hemorrhage. After the airway is determined to be unobstructed, the nurse must ensure that ventilation is adequate by checking for equal bilateral breath sounds. Satisfactory management of ventilations may prevent hypoxia and hypercapnia. The nurse must quickly assess for absent or diminished breath sounds, open chest wounds, and difficulty delivering artificial breaths for the patient. The nurse should monitor pulse oximetry, capnography, and arterial blood gases if the patient requires airway or ventilatory assistance. A tension pneumothorax can mimic hypovolemia, so ventilatory assessment precedes assessment for hemorrhage. A pneumothorax (both simple and tension) or sucking (open) chest wound is managed with a chest tube; immediate relief of increasing positive intrathoracic pressure and maintenance of adequate ventilation should occur immediately.

## HEMORRHAGE

Stopping bleeding is essential to the care and survival of patients in an emergency or disaster situation. Hemorrhage that results in the reduction of circulating blood

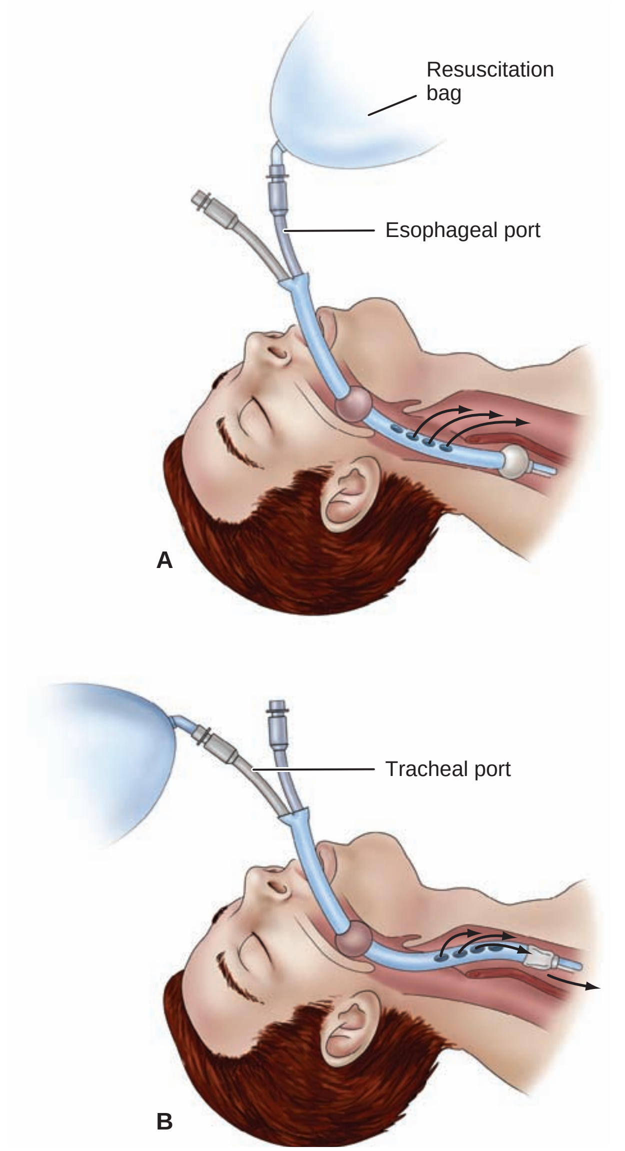



**Figure 71-2** **A,** Combitude in esophageal position. **B,** Combitude tracheal position.

volume is a primary cause of shock. Minor bleeding, which is usually venous, generally stops spontaneously unless the patient has a bleeding disorder or has been taking anticoagulants.

The patient is assessed for signs and symptoms of shock: cool, moist skin (resulting from poor peripheral perfusion), decreasing blood pressure, increasing heart rate, delayed capillary refill, and decreasing urine volume (see Chapter 15). The goals of emergency management are to control the bleeding, maintain adequate circulating blood volume for tissue oxygenation, and prevent shock. Patients who hemorrhage are at risk for cardiac arrest caused by hypovolemia with secondary anoxia. Nursing interventions are carried out collaboratively with other members of the emergency health care team.

## Management

### Fluid Replacement

Whenever a patient is hemorrhaging—whether externally or internally—a loss of circulating blood results in a fluid volume deficit and decreased cardiac output. Therefore, fluid replacement is imperative to maintain circulation. Typically, two large-gauge IV catheters are inserted to provide a means for fluid and blood replacement, and blood samples are obtained for analysis, typing, and cross-matching. Replacement fluids are administered as prescribed, depending on clinical estimates of the type and volume of fluid lost. Replacement fluids may include isotonic electrolyte solutions (eg, lactated Ringer's, normal saline), colloids, and blood component therapy.

Packed red blood cells are infused when there is massive blood loss, which may also necessitate transfusion of other blood components, including platelets and clotting factors. (See Chapter 33 for full discussion of blood component therapy indications and treatment.)

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**The infusion rate is determined by the severity of the blood loss and the clinical evidence of hypovolemia. If massive blood replacement is necessary, the blood must be warmed in a commercial blood warmer, because administration of large amounts of blood that has been refrigerated has a core cooling effect that may lead to cardiac arrest and coagulopathy.**

### Control of External Hemorrhage

If a patient is hemorrhaging externally (eg, from a wound), a rapid physical assessment is performed as the patient's clothing is cut away in an attempt to identify the area of hemorrhage. Direct, firm pressure is applied over the bleeding area or the involved artery at a site that is proximal to the wound (Fig. 71-3). Most bleeding can be stopped or at least controlled by application of direct pressure. Otherwise, unchecked arterial bleeding results in death. A firm pressure dressing is applied, and the injured part is elevated to stop venous and capillary bleeding if possible. If the injured area is an extremity, the extremity is immobilized to control blood loss.

A tourniquet is applied to an extremity only as a *last resort* when the external hemorrhage cannot be controlled in any other way and immediate surgery is not feasible. Care must be taken when applying a tourniquet because of the risk of loss of the extremity. The tourniquet is applied just proximal to the wound and tied tightly enough to control arterial blood flow. The patient is tagged with a skin-marking pencil or on adhesive tape on the forehead with a "T," stating the location of the tourniquet and the time applied (Lakstein, Blumenfeld, Sokolov, et al., 2003). If there is no arterial bleeding, the tourniquet is removed and a pressure dressing is applied. If the patient has suffered a traumatic amputation with uncontrollable hemorrhage, the tourniquet remains in place until the patient is in the operating room.

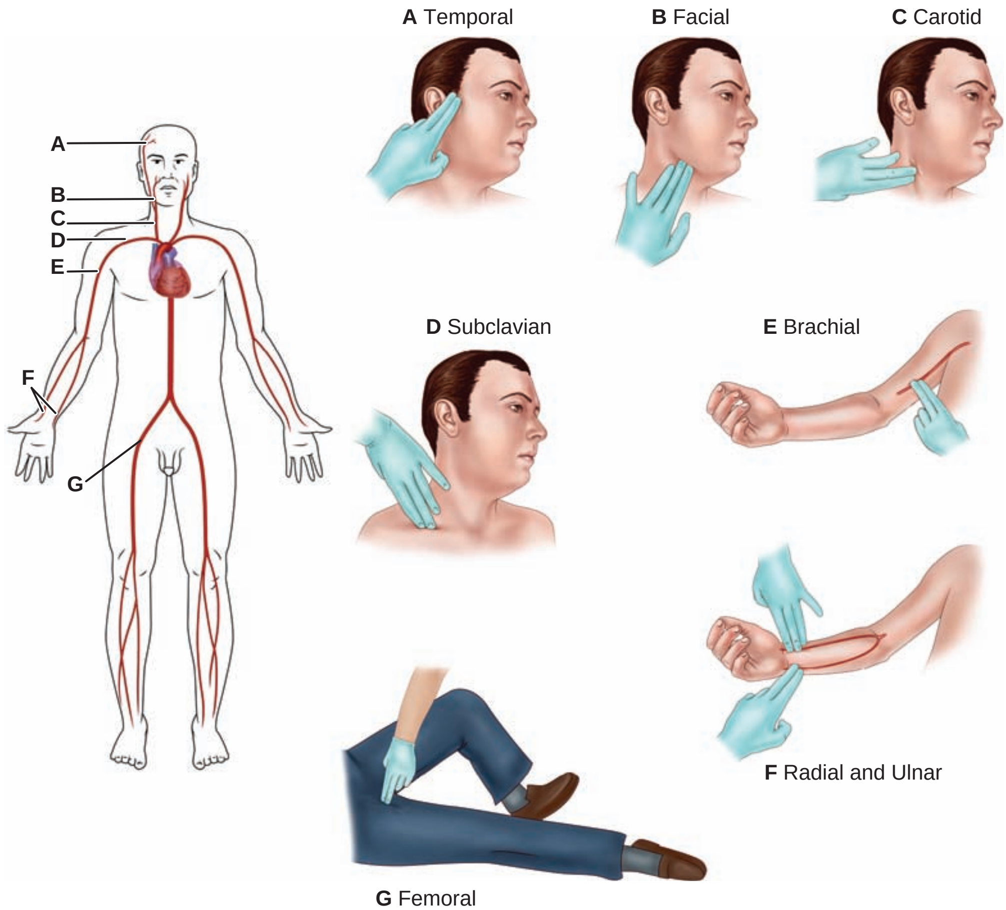



**Figure 71-3** Pressure points for control of hemorrhage.

### *Control of Internal Bleeding*

If the patient shows no external signs of bleeding but exhibits tachycardia, falling blood pressure, thirst, apprehension, cool and moist skin, or delayed capillary refill, internal hemorrhage is suspected. Typically, packed red blood cells are administered at a rapid rate, and the patient is prepared for more definitive treatment (eg, surgery, pharmacologic therapy). In addition, arterial blood gas specimens are obtained to evaluate pulmonary function and tissue perfusion and to establish baseline hemodynamic parameters, which are then used as an index for determining the amount of fluid replacement the patient can tolerate and the response to therapy. The patient is maintained in the supine position and monitored closely until hemodynamic or circulatory parameters improve, or until he or she is transported to the operating room or intensive care unit.

## HYPOVOLEMIC SHOCK

Shock is a condition in which there is loss of effective circulating blood volume. Inadequate organ and tissue perfusion follows, ultimately resulting in cellular metabolic derangements. In any emergency situation, the onset of shock should be anticipated by assessing all injured people immediately. The underlying cause of shock (hypovolemic, cardiogenic, neurogenic, anaphylactic or septic) must be determined. Of these, hypovolemia is the most common cause (see Chapter 15 for further discussion of management of hypovolemic shock).

## WOUNDS

Wounds involving injury to soft tissues can vary from minor tears to severe crushing injuries. The types of wounds that may occur are defined in Chart 71-5. The primary goal of treatment is to restore the physical integrity and function of the injured tissue while minimizing scarring and preventing infection. Proper documentation of the characteristics of the wound, using precise descriptions and correct terminology, is essential. Such information may be needed in the future for forensic evidence. Photographs are helpful because they provide an accurate, visible depiction of the wound. Photographs also become important for exigent wounds (ie, wounds that will eventually heal). Patients involved in domestic violence or trauma may need the photographs later to visually describe the extent of injury.

Determining *when* and *how* the wound occurred is important because a treatment delay increases infection risk. Using aseptic technique, the clinician inspects the wound to determine the extent of damage to underlying structures

### Chart 71-5 • Definition of Terms: Wounds

**Laceration:** skin tear with irregular edges and vein bridging
**Avulsion:** tearing away of tissue from supporting structures
**Abrasion:** denuded skin
**Ecchymosis/contusion:** blood trapped under the surface of the skin
**Hematoma:** tumorlike mass of blood trapped under the skin
**Stab:** incision of the skin with well-defined edges, usually caused by a sharp instrument; a stab wound is typically deeper than long
**Cut:** incision of the skin with well-defined edges, usually longer than deep
**Patterned:** wound representing the outline of the object (eg, steering wheel) causing the wound

or the presence of a foreign body. Sensory, motor, and vascular function is evaluated for changes that might indicate complications.

## Management

### Wound Cleansing

Hair around the wound may be clipped (only as directed) if it is anticipated that the hair will interfere with wound closure. Typically, the area around the wound is cleansed with normal saline solution or a polymer agent (eg, Shur-Clens). Antibacterial agents, such as povidone-iodine (Betadine) or hydrogen peroxide, should not be allowed to get deep into the wound without thorough rinsing. These agents are used only for the initial cleansing because they injure exposed and healthy tissue, resulting in further tissue damage.

If indicated, the area is infiltrated with a local intradermal anesthetic through the wound margins or by regional block. Patients with soft tissue injuries usually have localized pain at the site of injury. The nurse then assists with cleaning and débriding the wound. The wound is irrigated gently and copiously with sterile isotonic saline solution to remove surface dirt. Devitalized tissue and foreign matter are removed because they impede healing and may promote infection. Any small bleeding vessels are clamped, tied, or cauterized. After wound treatment, a nonadherent dressing is applied to protect the wound and to serve as a splint and as a reminder to the patient that the area is injured.

### Primary Closure

The decision to suture a wound depends on the nature of the wound, the time since the injury was sustained, the degree of contamination, and the vascularity of tissues. If primary closure is indicated, the wound is sutured or stapled, usually by the physician, with the patient receiving either local anesthesia or moderate sedation (see Chapter 19). Wound closure begins when subcutaneous fat is brought together loosely with a few sutures to close off the dead space. The subcuticular layer is then closed, and finally the epidermis is closed. Sutures are placed near the wound edge, with the skin edges leveled carefully to promote optimal healing. Instead of sutures, sterile strips of reinforced microporous tape or a bonding agent (skin glue) may be used to close clean, superficial wounds.

### Delayed Primary Closure

Delayed primary closure may be indicated if tissue has been lost or there is a high potential for infection. A thin layer of gauze (to ensure drainage and prevent pooling of exudate), covered by an occlusive dressing, may be used. The wound is splinted in a functional position to prevent motion and decrease the possibility of contracture.

If there are no signs of suppuration (formation of purulent drainage), the wound may be sutured (with the patient receiving a local anesthetic). Use of antibiotics to prevent infection depends on factors such as how the injury occurred, the age of the wound, and the risk of contamination. The site is immobilized and elevated to limit accumulation of fluid in the interstitial spaces of the wound.

Tetanus prophylaxis is administered as prescribed, based on the condition of the wound and the patient's immunization status. If the patient's last tetanus booster was administered more than 5 years ago, or if the patient's immunization status is unknown, a tetanus booster must be given (American College of Surgeons [ACS], 2008). The patient is instructed about signs and symptoms of infection and is instructed to contact the health care provider or clinic if there is sudden or persistent pain, fever or chills, bleeding, rapid swelling, foul odor, drainage, or redness surrounding the wound.

# TRAUMA

Trauma (an unintentional or intentional wound or injury inflicted on the body from a mechanism against which the body cannot protect itself) is the fourth leading cause of death in the United States. Trauma is the leading cause of death in children and in adults younger than 44 years of age. The incidence is increasing in adults older than 44 years of age. Alcohol and drug abuse are often implicated as factors in both blunt and penetrating trauma (McQuillan, VonReuden, Hartsock, et al., 2008).

## Collection of Forensic Evidence

In assessing and managing any patient with an emergency condition, but especially the patient experiencing trauma, meticulous documentation is essential. Included in documentation are descriptions of all wounds, mechanism of injury, time of events, and collection of evidence. In trauma care, the nurse must be exceedingly careful with all potential evidence, handling and documenting it properly.

The basics of care management for patients with traumatic injury include an understanding that trauma in any patient (living or dead) has potential legal or forensic implications if criminal activity is suspected. Hence, proper management from both a medical and forensic perspective is essential.

When clothing is removed from the patient who has experienced trauma, the nurse must be careful not to cut through or disrupt any tears, holes, blood stains, or dirt present on the clothing if criminal activity is suspected. Each piece of clothing should be placed in an individual paper bag. If the clothing is wet, it should be hung to dry. Clothing should not be given to families. Valuables should be inventoried and either

placed in the hospital safe or it should be clearly documented to which family member they were given. If a police officer is present to collect clothing or any other items from the patient, each item is labeled. The transfer of custody to the officer, the officer's name, the date, and the time are documented.

If suicide or homicide is suspected in a deceased trauma patient, the medical examiner examines the body on site or has the body moved to the coroner's office for autopsy. All tubes and lines must remain in place. The patient's hands must be covered with paper bags to protect evidence on the hands or under the fingernails. In the surviving patient, tissue specimens may be swabbed from the hands and nails as potential evidence. Photographs of wounds or clothing are essential and should include a reference ruler in one photo and one without the ruler.

Documentation should also include any statements made by the patient in the patient's own words and surrounded by quotation marks. A chain of evidence is essential. If the patient's case is reviewed in a court of law in the future, clear documentation assists the judicial process and helps to identify the activities that occurred in the ED.

## Injury Prevention

Any discussion of trauma management must address injury prevention. A component of the emergency nurse's daily role is to provide injury prevention information to every patient with whom there is contact, including patients admitted for reasons other than injury. The only way to reduce the incidence of trauma is through prevention.

There are three components of injury prevention. The first is education. Providing information and materials to help prevent violence and to maintain safety at home and in vehicles is important. Involvement in local injury prevention organizations, nursing organizations, and health fairs promotes wellness and safety. In practice, nursing and other health care professionals should avoid using the word "accident," because trauma events are *preventable* and should be viewed as such rather than as "fate" or "happenstance." Responsibility and accountability must be assigned to traumatic incidents, particularly because of the high rate of trauma recidivism (repeated trauma). People who are at risk for trauma and trauma recidivism should be identified and provided with education and counseling directed toward altering risky behaviors and preventing further trauma (ENA, 2007).

The second component of injury prevention is legislation. Nurses should be actively involved in safety legislation at the local, state, and federal levels. Such legislation is meant to provide universal safety measures, not to infringe on rights.

The third component is automatic protection. Airbags and automotive design are included in this category. These mechanisms provide for safety without requiring personal intervention.

## Multiple Trauma

Multiple trauma is caused by a single catastrophic event that causes life-threatening injuries to at least two distinct organs or organ systems. Patients with single-system trauma still receive full assessment, because even single-system injuries can be life-threatening or more severe than they initially appear. Mortality in patients with multiple trauma is related to the severity of the injuries and the number of systems and organs involved. Immediately after injury, the body is hypermetabolic, hypercoagulable, and severely stressed.

Care of the patient with multiple injuries requires a team approach, with one person responsible for coordinating the treatment. The nursing staff assumes responsibility for assessing and monitoring the patient, ensuring airway and IV access, administering prescribed medications, collecting laboratory specimens, and documenting activities and the patient's subsequent responses.

### Assessment and Diagnostic Findings

Evidence of trauma may be sparse or absent. Patients with multiple trauma should be assumed to have a spinal cord injury until it is proven otherwise. The injury regarded as the least significant in appearance may be the most lethal. For example, the pelvic fracture not identified until an x-ray is obtained may cause rapid and massive hemorrhage into the pelvic cavity, but an obvious amputation of the arm may have already stopped bleeding from the body's normal response of vasoconstriction.

### Management

The goals of treatment are to determine the extent of injuries and to establish priorities of treatment. Any injury interfering with a vital physiologic function (eg, airway, breathing, circulation) is an immediate threat to life and has the highest priority for immediate treatment. Essential life-saving procedures are performed simultaneously by the emergency team. As soon as the patient is resuscitated, clothes are removed or cut off and a rapid physical assessment is performed. Transfer from field management to the ED must be orderly and controlled, with attention given to the verbal report from emergency medical services. Treatment in a trauma center is appropriate for patients experiencing major trauma. Treatment priorities are presented in Chart 71-6.

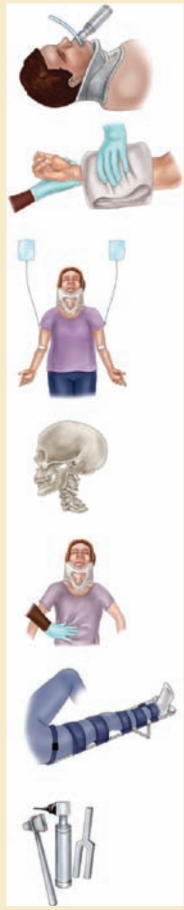
## Intra-Abdominal Injuries

Intra-abdominal injuries are categorized as penetrating or blunt trauma. *Penetrating* abdominal injuries (ie, gunshot wounds, stab wounds) are serious and usually require surgery. Penetrating abdominal trauma results in a high incidence of injury to hollow organs, particularly the small bowel. The liver is the most frequently injured solid organ. In gunshot wounds, the most important prognostic factor is the velocity at which the missile enters the body. High-velocity missiles (bullets) produce extensive tissue damage. All abdominal gunshot wounds that cross the peritoneum or are associated with peritoneal signs require surgical exploration. On the other hand, some stab wounds may be managed nonoperatively due to low velocity and less penetration of the implement (ie, weapon).

*Blunt* trauma to the abdomen may result from motor vehicle crashes, falls, blows, or explosions. Blunt trauma is commonly associated with extra-abdominal injuries to the chest, head, or extremities. Patients with blunt trauma are a

**Chart 71-6 • *Priority Management in Patients with Multiple Injuries***

1. Establish airway and ventilation.
2. Control hemorrhage.
3. Prevent and treat hypovolemic shock
4. Assess for head and neck injuries.
5. Evaluate for other injuries - reassess head and neck, chest, assess abdomen, back and extremities.
6. Splint fractures.
7. Perform a more thorough and ongoing examination and assessment.



challenge because injuries may be difficult to detect. The incidence of delayed and trauma-related complications is greater than for penetrating injuries. This is especially true of blunt injuries involving the liver, kidneys, spleen, or blood vessels, which can lead to massive blood loss into the peritoneal cavity.

## Assessment and Diagnostic Findings

As the history of the traumatic event is obtained, the abdomen is inspected as a part of the secondary survey for obvious signs of injury, including penetrating injuries, bruises, and abrasions. Abdominal assessment continues with auscultation of bowel sounds to provide baseline data from which changes can be noted. Absence of bowel sounds may be an early sign of intraperitoneal involvement, although stress can also decrease or halt peristalsis and bowel sounds. Further abdominal assessment may reveal progressive abdominal distention, involuntary guarding, tenderness, pain, muscular rigidity, or rebound tenderness along with changes in bowel sounds, all of which are signs of peritoneal irritation. Hypotension and signs and symptoms of shock may also be noted. Additionally, the chest and other body systems are assessed for injuries that frequently accompany intra-abdominal injuries.

Laboratory studies that aid in assessment include the following:

- Urinalysis to detect hematuria (indicative of a urinary tract injury)
- Serial hemoglobin and hematocrit levels to evaluate trends reflecting the presence or absence of bleeding
- White blood cell (WBC) count to detect elevation (generally associated with trauma)
- Serum amylase analysis to detect increasing levels, which suggest pancreatic injury or perforation of the gastrointestinal tract

### *Internal Bleeding*

Hemorrhage frequently accompanies abdominal injury, especially if the liver or spleen has been traumatized. Therefore, the patient is assessed continuously for signs and symptoms of external and internal bleeding. The front of the body, flanks, and back are inspected for bluish discoloration, asymmetry, abrasion, and contusion. Abdominal computed tomography (CT) scans permit detailed evaluation of abdominal contents and retroperitoneal examination. Abdominal ultrasounds can rapidly assess hemodynamically unstable patients to detect intraperitoneal bleeding. This is referred to as the focused assessment sonography for trauma (FAST) examination (Kirkpatrick, Sirois, Laupland, et al., 2005). Pain in the left shoulder is common in a patient with bleeding from a ruptured spleen, whereas pain in the right shoulder can result from laceration of the liver. During the resuscitation period, pain is managed using administration of small dosages of opioids (ACS, 2008).

### *Intraperitoneal Injury*

The abdomen is assessed for tenderness, rebound tenderness, guarding, rigidity, spasm, increasing distention, and pain. Referred pain is a significant finding because it suggests intraperitoneal injury. To determine if there is intraperitoneal injury and bleeding, the patient is usually prepared for diagnostic procedures, such as peritoneal lavage, abdominal ultrasonography, or abdominal CT scanning. **Diagnostic peritoneal lavage** (DPL), although no longer the standard diagnostic study used to evaluate a traumatized abdomen, remains a backup procedure that is easily performed and is very useful during mass casualty situations when CT scanners may not be readily available. DPL involves the instillation of 1 L of warmed lactated Ringer's or normal saline solution into the abdominal cavity. After a minimum of 400 mL has been returned, a fluid specimen is sent to the laboratory for analysis. Positive laboratory findings include a red blood cell count greater than 100,000/mm$^3$; a WBC count greater than 500/mm$^3$; or the presence of bile, feces, or food.

In patients with stab wounds, sinography may be performed to detect peritoneal penetration; a purse-string suture is placed around the wound and a small catheter is introduced through the wound. A contrast agent is then introduced through the catheter, and x-rays are taken to identify any peritoneal penetration.

### *Genitourinary Injury*

A focused genitourinary examination, which typically includes a rectal and/or vaginal examination, is performed to determine any injury to the pelvis, bladder, urethra, or intestinal

wall. To decompress the bladder and monitor urine output, an indwelling catheter is inserted after a rectal examination has been completed (not before). In the male patient, a high-riding prostate gland (abnormal position) discovered during a rectal examination indicates a potential urethral injury.

*NURSING ALERT*

**Urethral catheter insertion with a possible urethral injury is contraindicated; a urology consultation and further evaluation of the urethra are required.**

### Management

As indicated by the patient's condition, resuscitation procedures (restoration of airway, breathing, and circulation) are initiated as previously described.

With blunt trauma, the patient is kept on a stretcher to immobilize the spine. A backboard may be used for transporting the patient to the x-ray department, to the operating room, or to the intensive care unit. Cervical spine immobilization is maintained until cervical x-rays have been obtained and cervical spine injury has been ruled out. Likewise, once the patient has arrived at the definitive destination, the backboard is removed, and logrolling can be used to protect the spine until x-rays are obtained and confirm there is no evidence of injuries.

Knowing the mechanism of injury (eg, penetrating force from a gunshot or knife, blunt force from a blow) is essential to determining the type of management needed. All wounds are located, counted, and documented. If abdominal viscera protrude, the area is covered with sterile, moist saline dressings to keep the viscera from drying.

Typically, oral fluids are withheld in anticipation of surgery, and the stomach contents are aspirated with a nasogastric tube to reduce the risk of aspiration and to decompress the stomach in preparation for diagnostic procedures.

Trauma predisposes the patient to infection by disruption of mechanical barriers, exposure to exogenous bacteria from the environment at the time of injury, aspiration of vomitus, and diagnostic and therapeutic procedures (hospital-acquired infection). Tetanus prophylaxis and broad-spectrum antibiotics are administered as prescribed.

Throughout the stay in the ED, the patient's condition is continuously monitored for changes. If there is continuing evidence of shock, blood loss, free air under the diaphragm, evisceration, hematuria, severe head injury, or suspected or known abdominal injury, the patient is rapidly transported to surgery. In most cases, blunt liver and spleen injuries are managed nonsurgically.

## Crush Injuries

Crush injuries occur when a person is caught between opposing forces (eg, run over by a moving vehicle, crushed between two cars, crushed under a collapsed building).

### Assessment and Diagnostic Findings

The patient is observed for the following:

- Hypovolemic shock resulting from extravasation of blood and plasma into injured tissues after compression has been released
- Paralysis of a body part
- Erythema and blistering of skin
- Damaged body part (usually an extremity) appearing swollen, tense, and hard
- Renal dysfunction (prolonged hypotension causes kidney damage and acute renal insufficiency; myoglobinuria secondary to muscle damage can cause acute tubular necrosis and acute renal failure)

### Management

In conjunction with maintaining the airway, breathing, and circulation, the patient is observed for acute renal insufficiency. Injury to the back can cause kidney damage. Severe muscular damage may cause rhabdomyolysis, which signifies a release of myoglobin from ischemic skeletal muscle, resulting in acute tubular necrosis. In addition, major soft tissue injuries are splinted promptly to control bleeding and pain. The serum lactic acid level is monitored; a decrease to less than 2.5 mmol/L is an indication of successful resuscitation (Blow, Magliore, Claridge, et al., 1999).

If an extremity is injured, it is elevated to relieve swelling and pressure. If compartment syndrome develops, the physician may perform a **fasciotomy** (ie, surgical incision to the level of the fascia) to restore neurovascular function (see Chapter 69). Medications for pain and anxiety are then administered as prescribed, and the patient is quickly transported to the operating suite for wound débridement and fracture repair. A hyperbaric oxygen chamber (if available) may be used to hyperoxygenate crushed tissue, if indicated.

## Fractures

Immediate appropriate management of a fracture may determine the patient's eventual outcome and may mean the difference between recovery and disability. When the patient is being examined for fracture, the body part is handled gently and as little as possible. Clothing is cut off to visualize the affected body part. Assessment is conducted for pain over or near a bone, swelling (from blood, lymph, and exudate infiltrating the tissue), and circulatory disturbance. The patient is assessed for ecchymosis, tenderness, and crepitation (see Chapter 69). The nurse must remember that the patient may have multiple fractures accompanied by head, chest, spine, or abdominal injuries.

### Management

Immediate attention is given to the patient's general condition. Assessment of airway, breathing, and circulation (which includes pulses in the extremities) is conducted. The patient is also evaluated for neurologic or abdominal injuries before the extremity is treated, unless a pulseless extremity is detected.

If a pulseless extremity is identified, repositioning of the extremity to proper alignment is required. If the pulseless extremity involves a fractured hip or femur, **Hare traction** (a portable in-line traction device) may be applied to assist with alignment. If repositioning is ineffective in restoring the pulse, a rapid total-body assessment must be completed, followed by transfer of the patient to the operating room for arteriography and possible arterial repair.

After the initial evaluation has been completed, all injuries identified are evaluated and treated. The fractured body part is inspected. Using a systematic head-to-toe approach, the nurse inspects the entire body, observing for lacerations, swelling, and deformities, including angulation (bending), shortening, rotation, and asymmetry. All peripheral pulses, especially those distal to the fractured extremity, are palpated. The extremity is also assessed for coolness, blanching, and decreased sensation and motor function, which are indicative of injury to the extremity's neurovascular supply.

A splint is applied before the patient is moved. Splinting immobilizes the joint at a site distal and proximal to the fracture, relieves pain, restores or improves circulation, prevents further tissue injury, and prevents a closed fracture from becoming an open one. To splint an extremity, one hand is placed distal to the fracture and some traction is applied while the other hand is placed beneath the fracture for support. The splints should extend beyond the joints adjacent to the fracture. Upper extremities must be splinted in a functional position. If the fracture is open, a moist, sterile dressing is applied.

After splinting, the vascular status of the extremity is checked by assessing color, temperature, pulse, and blanching of the nail bed. In addition, the patient is assessed for neurovascular compromise if pain or pressure is reported. (See Chapter 69 for a complete description of fracture management.)

# ENVIRONMENTAL EMERGENCIES

## Heat Stroke

Heat stroke is an acute medical emergency caused by failure of the heat-regulating mechanisms of the body. The most common cause of heat stroke is prolonged exposure to an environmental temperature of greater than 39.2°C (102.5°F). It usually occurs during extended heat waves, especially when they are accompanied by high humidity.

People at risk for heat stroke are those not acclimatized to heat, those who are elderly or very young, those unable to care for themselves, those with chronic and debilitating diseases, and those taking certain medications (eg, major tranquilizers, anticholinergics, diuretics, beta-blockers). Exertional heat stroke occurs in healthy individuals during sports or work activities (eg, exercising in extreme heat and humidity). Hyperthermia results because of inadequate heat loss. This type of heat stroke can also cause death. Strategies used to prevent heat stroke are reviewed in Chart 71-7.

Another form of heat stroke is heat exhaustion in which the patient's temperature may be normal to 40°C (104°F). The patient demonstrates weakness, hypotension, increased heart rate, and increased thirst.

### Gerontologic Considerations

Most heat-related deaths occur in the elderly because their circulatory systems are unable to compensate for stress imposed by heat. Elderly people have a decreased ability to perspire as well as a decreased ability to vasodilate and vasoconstrict. They have less subcutaneous tissue, a decreased thirst mechanism, and a diminished ability to concentrate urine to compensate for heat. Many elderly people do not drink adequate amounts of fluid, partly because of fear of incontinence, and thus have a greater risk of heat stroke. In addition, many elderly people fear being victims of crime, so they tend to keep windows closed, even when the temperature and humidity levels are high.

**CHART 71-7 HEALTH PROMOTION**
***Preventing Heat Stroke***

- Advise the patient treated for heat stroke to avoid immediate reexposure to high temperatures; hypersensitivity to high temperatures may remain for a considerable time.
- Emphasize the importance of maintaining adequate fluid intake, wearing loose clothing, and reducing activity in hot weather.
- Advise athletes to monitor fluid losses and weight loss during workout activities or exercise and to replace fluids and electrolytes.
- Advise the patient to use a gradual approach to physical conditioning, allowing sufficient time for return to baseline temperature.
- Direct frail elderly patients living in urban settings with high environmental temperatures to places where air conditioning is available (eg, shopping mall, library, church).
- Advise patients to plan outdoor activities to avoid the hottest part of the day (between 10 A.M. and 2 P.M.).

### Assessment and Diagnostic Findings

Heat stroke causes thermal injury at the cellular level, resulting in coagulopathies and widespread damage to the heart, liver, and kidneys. Recent patient history reveals exposure to elevated ambient temperature or excessive exercise during extreme heat. When assessing the patient, the nurse notes the following symptoms: profound central nervous system (CNS) dysfunction (manifested by confusion, delirium, bizarre behavior, coma); elevated body temperature (40.6°C [105°F] or higher); hot, dry skin; and usually anhidrosis (absence of sweating), tachypnea, hypotension, and tachycardia.

### Management

The primary goal is to reduce the high body temperature as quickly as possible, because mortality is directly related to the duration of hyperthermia. Simultaneous treatment focuses on stabilizing oxygenation using the ABCs (*a*irway, *b*reathing, and *c*irculation) of basic life support. This includes establishing IV access for fluid administration.

After the patient's clothing is removed, the core (internal) temperature is reduced to 39°C (102°F) as rapidly as possible, preferably within 1 hour (Hoyt & Selfridge-Thomas, 2007). One or more of the following methods may be used as prescribed:

- Cool sheets and towels or continuous sponging with cool water
- Ice applied to the neck, groin, chest, and axillae while spraying with tepid water
- Cooling blankets
- Immersion of the patient in a cold water bath (if possible) (Auerbach, 2007)

During cooling procedures, an electric fan is positioned so that it blows on the patient to augment heat dissipation by convection and evaporation. The patient's temperature is constantly monitored with a thermistor placed in the rectum, bladder, or esophagus to evaluate core temperature. Caution is used to avoid hypothermia and to prevent hyperthermia, which may recur spontaneously within 3 to 4 hours. The cooling process should stop at 38.8°C (102°F) in order to avoid iatrogenic hypothermia (Hoyt & Selfridge-Thomas, 2007).

Throughout treatment, the patient's status is monitored carefully, including vital signs, ECG findings (for possible myocardial ischemia, myocardial infarction, and dysrhythmias), central venous pressure (CVP), and level of responsiveness, all of which may change with rapid alterations in body temperature. A seizure may be followed by recurrence of hyperthermia. To meet tissue needs exaggerated by the hypermetabolic condition, 100% oxygen is administered. Endotracheal intubation and mechanical ventilation to support failing cardiopulmonary systems may be required.

IV infusion therapy of normal saline or lactated Ringer's solution is initiated as directed to replace fluid losses and maintain adequate circulation. Fluids are administered carefully because of the dangers of myocardial injury from high body temperature and poor renal function. Cooling redistributes fluid volume from the periphery to the core.

Urine output is also measured frequently, because acute tubular necrosis may occur as a complication of heat stroke from rhabdomyolysis (myoglobin in the urine). Blood specimens are obtained for serial testing to detect bleeding disorders, such as disseminated intravascular coagulation (DIC), and for serial enzyme studies to estimate thermal hypoxic injury to the liver, heart, and muscle tissue. Permanent liver, cardiac, and CNS damage may occur.

Additional supportive care may include dialysis for renal failure, antiseizure medications to control seizures, potassium for hypokalemia, and sodium bicarbonate to correct metabolic acidosis. Benzodiazepines (eg, diazepam [Valium]) or chlorpromazine (Thorazine) may be prescribed to suppress seizure activity. Patient education regarding the prevention of heat stroke (see Chart 71-7) is also important to prevent a recurrence.

## Frostbite

Frostbite is trauma from exposure to freezing temperatures and freezing of the intracellular fluid and fluids in the intercellular spaces. It results in cellular and vascular damage. Frostbite can result in venous stasis and thrombosis. Body parts most frequently affected by frostbite include the feet, hands, nose, and ears. Frostbite ranges from first degree (redness and erythema) to fourth degree (full-depth tissue destruction).

### Assessment and Diagnostic Findings

A frozen extremity may be hard, cold, and insensitive to touch and may appear white or mottled blue-white. The extent of injury from exposure to cold is not always initially known. The patient history should include environmental temperature, duration of exposure, humidity, and the presence of wet conditions.

### Management

The goal of management is to restore normal body temperature. Constrictive clothing and jewelry that could impair circulation are removed. Wet clothing is removed as rapidly as possible. If the lower extremities are involved, the patient should not be allowed to ambulate.

Controlled yet rapid rewarming is instituted. Frozen extremities are usually placed in a 37°C to 40°C (98.6°F to 104°F) circulating bath for 30- to 40-minute spans. This treatment is repeated until circulation is effectively restored. Early rewarming appears to decrease the amount of ultimate tissue loss. During rewarming, an analgesic for pain is administered as prescribed, because the rewarming process may be very painful. To avoid further mechanical injury, the body part is not handled. Massage is contraindicated.

Once rewarmed, the part is protected from further injury and is elevated to help control swelling. Sterile gauze or cotton is placed between affected fingers or toes to prevent maceration, and a bulky dressing is placed on the extremity. A foot cradle may be used to prevent contact with bedclothes if the feet are involved. Hemorrhagic blebs, which may develop 1 hour to a few days after rewarming, are left intact and not ruptured. Nonhemorrhagic blisters are débrided to decrease the inflammatory mediators found in the blister fluid.

A physical assessment is conducted with rewarming to observe for concomitant injury, such as soft tissue injury, dehydration, alcohol coma, or fat embolism. Problems such as hyperkalemia (eg, from release of potassium in the damaged cells) and hypovolemia, which occur frequently in people with frostbite, are corrected. Risk of infection is also great; therefore, strict aseptic technique is used during dressing changes, and tetanus prophylaxis is administered as indicated. Nonsteroidal anti-inflammatory medication is prescribed for its anti-inflammatory effects and to control pain.

Additional measures that may be carried out when appropriate include the following:

- Whirlpool bath for the affected body parts to aid circulation and débridement of necrotic tissue to help prevent infection
- Escharotomy (incision through the eschar) to prevent further tissue damage, to allow for normal circulation, and to permit joint motion
- Fasciotomy to treat compartment syndrome

After rewarming, hourly active motion of any affected digits is encouraged to promote maximal restoration of function and to prevent contractures. Discharge instructions also include encouraging the patient to avoid tobacco, alcohol, and caffeine because of their vasoconstrictive effects, which further reduce the already deficient blood supply to injured tissues.

## Hypothermia

Hypothermia is a condition in which the core (internal) temperature is 35°C (95°F) or less as a result of exposure to cold or an inability to maintain body temperature in the

absence of low ambient temperatures. Urban hypothermia (extreme exposure to cold in an urban setting) is associated with a high mortality rate; elderly people, infants, people with concurrent illnesses, and the homeless are particularly susceptible. Alcohol ingestion increases susceptibility because it causes systemic vasodilation. Some medications (eg, phenothiazines) or medical conditions (eg, hypothyroidism, spinal cord injury) decrease the ability to shiver, hampering the body's innate ability to generate body heat. Trauma victims are also at risk for hypothermia resulting from treatment with cold fluids, unwarmed oxygen, and exposure during examination. The patient may also have frostbite, but hypothermia takes precedence in treatment.

## Assessment and Diagnostic Findings

Hypothermia leads to physiologic changes in all organ systems. There is progressive deterioration, with apathy, poor judgment, ataxia, dysarthria, drowsiness, pulmonary edema, acid–base abnormalities, coagulopathy, and eventual coma. Shivering may be suppressed at a temperature of less than 32.2°C (90°F), because the body's self-warming mechanisms become ineffective. The heartbeat and blood pressure may be so weak that peripheral pulses become undetectable. Cardiac dysrhythmias may also occur. Other physiologic abnormalities include hypoxemia and acidosis.

## Management

Management consists of removal of wet clothing, continuous monitoring, rewarming, and supportive care.

### Monitoring

The ABCs of basic life support are a priority. The patient's vital signs, CVP, urine output, arterial blood gas levels, blood chemistry determinations (blood urea nitrogen, creatinine, glucose, electrolytes), and chest x-rays are evaluated frequently. Body temperature is monitored with an esophageal, bladder, or rectal thermistor. Continuous ECG monitoring is performed, because cold-induced myocardial irritability leads to conduction disturbances, especially ventricular fibrillation. An arterial line is inserted and maintained to record blood pressure and to facilitate blood sampling.

### Rewarming

Rewarming methods include active internal (core) rewarming and passive or active external (spontaneous) rewarming.

*Active internal (core) rewarming* methods are used for moderate to severe hypothermia (less than 28°C to 32.2°C [82.5°F to 90°F]) and include cardiopulmonary bypass, warm fluid administration, warm humidified oxygen by ventilator, and warmed peritoneal lavage. Monitoring for ventricular fibrillation as the patient's temperature increases from 31°C to 32°C (88°F to 90°F) is essential.

*Passive or active external rewarming* is used for mild hypothermia (32.2°C to 35°C [90°F to 95°F]). Passive active rewarming uses over-the-bed heaters to the extremities and increases blood flow to the acidotic, anaerobic extremities. The cold blood from peripheral tissues has high lactic acid levels. As this blood returns to the core, it causes a significant drop in the core temperature (ie, core temperature afterdrop) and can potentially cause cardiac dysrhythmias and electrolyte disturbances. Active external rewarming uses forced air warm blankets. Care must be taken to prevent extremity burn from these devices, because the patient may not have effective sensation to feel the burn.

### Supportive Care

Supportive care during rewarming includes the following as directed:

- External cardiac compression (typically performed only as directed in patients with temperatures higher than 31°C [88°F]).
- Defibrillation of ventricular fibrillation. A patient whose temperature is less than 32°C [90°F] experiences spontaneous ventricular fibrillation if moved or touched. Defibrillation is ineffective in patients with temperatures lower than 31°C (88°F); therefore, the patient must be rewarmed first.
- Mechanical ventilation with positive end-expiratory pressure (PEEP) and heated humidified oxygen to maintain tissue oxygenation.
- Administration of warmed IV fluids to correct hypotension and to maintain urine output and core rewarming, as described previously.
- Administration of sodium bicarbonate to correct metabolic acidosis if necessary.
- Administration of antiarrhythmic medications.
- Insertion of an indwelling urinary catheter to monitor urinary output and renal function.

# Near Drowning

Near drowning is defined as survival for at least 24 hours after submersion that caused a respiratory arrest. The most common consequence is hypoxemia. Drowning is the second most common cause of unintentional death in children younger than 14 years. An estimated 8000 drownings and 90,000 near drownings occur yearly in the United States (Hoyt & Selfridge-Thomas, 2007).

Factors associated with drowning and near drowning include alcohol ingestion, inability to swim, diving injuries, hypothermia, and exhaustion. The majority of drowning events occur in pools, lakes, and bathtubs. Suicide by drowning rarely occurs in pools and rarely involves alcohol (Auerbach, 2007).

Efforts to save the patient should not be abandoned prematurely. Successful resuscitation with full neurologic recovery has occurred in near-drowning patients after prolonged submersion in cold water. This is possible because of a decrease in metabolic demands and/or the diving reflex. The near-drowning process involves the onset of hypoxia, hypercapnia, bradycardia, and dysrhythmias. If there is a violent struggle associated with the near-drowning episode, exercise-induced acidosis and tachypnea can result in aspiration. Hypoxia and acidosis cause eventual apnea and loss of consciousness. When the victim loses consciousness and makes a final effort to breathe, the terminal gasp occurs. Water then moves passively into the airways prior to death.

After resuscitation, hypoxia and acidosis are the primary complications experienced by a person who has nearly

drowned; immediate intervention in the ED is essential. Resultant pathophysiologic changes and pulmonary injury depend on the type of fluid (fresh or salt water) and the volume aspirated. Fresh water aspiration results in a loss of surfactant and, therefore, an inability to expand the lungs. Salt water aspiration leads to pulmonary edema from the osmotic effects of the salt within the lungs. If a person survives submersion, acute respiratory distress syndrome (ARDS), resulting in hypoxia, hypercarbia, and respiratory or metabolic acidosis, can occur.

### Management

Therapeutic goals include maintaining cerebral perfusion and adequate oxygenation to prevent further damage to vital organs. Immediate cardiopulmonary resuscitation is the factor with the greatest influence on survival. The most important priority in resuscitation is to manage the hypoxia, acidosis, and hypothermia. Prevention and management of hypoxia are accomplished by ensuring an adequate airway and respiration, thus improving ventilation (which helps correct respiratory acidosis) and oxygenation. Arterial blood gases are monitored to evaluate oxygen, carbon dioxide, bicarbonate levels, and pH. These parameters determine the type of ventilatory support needed. Use of endotracheal intubation with PEEP improves oxygenation, prevents aspiration, and corrects intrapulmonary shunting and ventilation–perfusion abnormalities (caused by aspiration of water). If the patient is breathing spontaneously, supplemental oxygen may be administered by mask. However, an endotracheal tube is necessary if the patient does not breathe spontaneously.

Because of submersion, the patient is usually hypothermic. A rectal probe is used to determine the degree of hypothermia. Prescribed rewarming procedures (eg, extracorporeal warming, warmed peritoneal dialysis, inhalation of warm aerosolized oxygen, torso warming) are started during resuscitation. The choice of warming method is determined by the severity and duration of hypothermia and available resources. Intravascular volume expansion and inotropic agents are used to treat hypotension and impaired tissue perfusion. ECG monitoring is initiated, because dysrhythmias frequently occur. An indwelling urinary catheter is inserted to measure urine output. Hypothermia and accompanying metabolic acidosis may compromise renal function. Nasogastric intubation is used to decompress the stomach and to prevent the patient from aspirating gastric contents.

Even if the patient appears healthy, close monitoring continues with serial vital signs, serial arterial blood gas values, ECG monitoring, intracranial pressure assessments, serum electrolyte levels, intake and output, and serial chest x-rays. After a near-drowning, the patient is at risk for complications such as hypoxic or ischemic cerebral injury, ARDS, pulmonary damage secondary to aspiration, and life-threatening cardiac arrest.

## Decompression Sickness

Decompression sickness, also called "the bends," occurs in patients who have engaged in diving (lake, as well as ocean, diving), high-altitude flying, or flying in commercial aircraft within 24 hours after diving. It occurs relatively infrequently in the United States, but its effects can be hazardous. Being aware of decompression sickness and assessing the patient properly ensures proper management and results in the least morbidity possible.

Decompression sickness results from formation of nitrogen bubbles that occur with rapid changes in atmospheric pressure. They may occur in joint or muscle spaces, resulting in musculoskeletal pain, numbness, or hypesthesia. More significantly, nitrogen bubbles can become air emboli in the bloodstream and thereby produce stroke, paralysis, or death. Taking a rapid history about the events preceding the symptoms is essential. Recompression is necessary as soon as possible and may necessitate a low-altitude flight to the nearest hyperbaric chamber.

### Assessment and Diagnostic Findings

To identify decompression sickness, a detailed history is obtained from the patient or diving partner. Evidence of rapid ascent, loss of air in the tank, buddy breathing, recent alcohol intake or lack of sleep, or a flight within 24 hours after diving suggests possible decompression sickness. Some patients describe a perfect dive yet still have the signs and symptoms of decompression sickness, and they must receive treatment for the condition.

Signs and symptoms include joint or extremity pain, numbness, hypesthesia, and loss of range of motion. Neurologic symptoms mimicking those of a stroke or spinal cord injury can indicate an air embolus. Cardiopulmonary arrest can also occur in severe cases and is usually fatal. Any neurologic symptoms should be rapidly assessed. All patients with decompression sickness need rapid transfer to a hyperbaric chamber.

### Management

A patent airway and adequate ventilation are established, as described previously, and 100% oxygen is administered throughout treatment and transport. A chest x-ray is obtained to identify aspiration, and at least one IV line is started with lactated Ringer's or normal saline solution.

The cardiopulmonary and neurologic systems are supported as needed. If an air embolus is suspected, the head of the bed should be lowered. The patient's wet clothing is removed, and the patient is kept warm. Transfer to the closest hyperbaric chamber for treatment is initiated. If air transport is necessary, low-altitude flight (below 1000 feet) is required. However, the patient who is awake and alert without central neurologic deficits may be able to travel by ground ambulance or by automobile, depending on the severity of symptoms. Throughout treatment, the patient is continually assessed, and changes are documented. If aspiration is suspected, antibiotics and other treatment may be prescribed.

## Anaphylactic Reaction

An anaphylactic reaction is an acute systemic hypersensitivity reaction that occurs within seconds or minutes after exposure to certain foreign substances, such as medications (eg, penicillin, iodinated contrast material), and other agents, such as latex, insect stings (eg, bee, wasp, yellow jacket, hornet), or foods (eg, eggs, peanuts). Repeated administration

### Chart 71-8 • *Nursing Interventions for Preventing Anaphylactic Reactions*

- Be aware of the danger of anaphylactic reactions and the early signs of anaphylaxis.
- Ask the patient about previous allergies to medications, foods, stings, latex, pollen, peanuts, nuts from trees, eggs, and so on.
- Before giving a foreign serum or other type of antigenic agent, ask the patient or caregiver whether the agent was received at some earlier time.
- Avoid giving medications to patients with hay fever, asthma, or other allergic disorders unless necessary.
- Avoid giving parenteral medications unless absolutely necessary, because anaphylactic reactions are more likely to occur when the agent is given parenterally.
- Perform a skin test before administration of certain materials known to produce anaphylactic reactions (eg, horse serum). Remember that negative skin test results do not always indicate safety and that skin testing can precipitate anaphylaxis in highly sensitive patients. Have epinephrine, intravenous infusions, and intubation and tracheostomy equipment available as precautionary measures.
- If the patient is an outpatient, keep him or her in the office, hospital, or clinic for at least 30 minutes after injection of any agent. Caution the patient to return if symptoms develop.
- Caution patients who are highly sensitive (eg, to insect bites and stings) to carry kits equipped to treat insect stings (epinephrine). Instruct the patient, family, and significant others in the use of the emergency supplies.
- Encourage patients with allergies to wear medical identification tags or bracelets.

of parenteral or oral therapeutic agents (eg, repeated exposures to penicillin) may also precipitate an anaphylactic reaction when initially only a mild allergic response occurred. Anaphylaxis prevention strategies are given in Chart 71-8.

An anaphylactic reaction is the result of an antigen–antibody interaction in a sensitized person who, as a consequence of previous exposure, has developed a special type of antibody (immunoglobulin) that is specific for that particular allergen. Immunoglobulin E (IgE) is responsible for most of the immediate types of human allergic responses. A second exposure to the same antigen results in a more severe and more rapid response (see Chapter 53).

An anaphylactic reaction produces a wide range of clinical manifestations, especially respiratory symptoms (difficulty breathing and stridor secondary to laryngeal edema), fainting, itching, swelling of mucous membranes, and a sudden decrease in blood pressure secondary to massive vasodilation that may progress to shock (Chart 71-9). (See Chapters 15 and 53 for additional discussion and management of anaphylactic reactions.)

### CHART 71-9 *Assessing for Anaphylaxis*

Be alert for the following signs and symptoms:

**Respiratory Signs**

- Nasal congestion
- Itching
- Sneezing and coughing
- Possible respiratory distress that progresses rapidly (caused by bronchospasm or edema of the larynx)
- Chest tightness
- Other respiratory difficulties, such as wheezing, dyspnea, and cyanosis

**Skin Manifestations**

- Flushing with a sense of warmth and diffuse erythema
- Generalized itching over the entire body (indicates developing general systemic reaction)
- Urticaria (hives)
- Massive facial angioedema possible with accompanying upper respiratory edema

**Cardiovascular Manifestations**

- Tachycardia or bradycardia
- Peripheral vascular collapse as indicated by
  - Pallor
  - Imperceptible pulse
  - Decreasing blood pressure
  - Circulatory failure, leading to coma and death

**Gastrointestinal Problems**

- Nausea
- Vomiting
- Colicky abdominal pains
- Diarrhea

## *Insect Stings*

A person may have an extreme sensitivity to the venoms of insects in the order Hymenoptera (bees, hornets, yellow jackets, fire ants, and wasps). Venom allergy is thought to be an IgE-mediated reaction, and it constitutes an acute emergency. Although stings in any area of the body can trigger anaphylaxis, stings of the head and neck or multiple stings are especially serious.

Clinical manifestations range from generalized urticaria, itching, malaise, and anxiety due to laryngeal edema to severe bronchospasm, shock, and death. Generally, the shorter the time between the sting and the onset of severe symptoms, the worse the prognosis.

Management includes stinger removal if the sting is from a bee because the venom is associated with sacs around the barb of the stinger itself. The stinger is removed with one quick scrape of a fingernail over the site. Wound care with soap and water is sufficient for stings. Scratching is avoided because it results in a histamine response. Ice application reduces swelling and also decreases venom absorption. An oral antihistamine and analgesic will decrease the itching and pain.

In the case of an anaphylactic or severe allergic response, the patient is treated as discussed previously in Chapter 53. Desensitization therapy should be given to people who have had systemic or significant local reactions. Patient and family education is an important measure in preventing exposure to stinging insects (Chart 71-10).

CHART 71-10 PATIENT EDUCATION
**Limiting Exposure to Stinging Insects**

To Minimize Your Chances of Being Stung:
- Avoid places where stinging insects congregate, such as camp and picnic sites, and insect feeding areas, such as flower beds, ripe fruit orchards, garbage, and fields of clover.
- Wear covering on the feet, and avoid going barefoot outdoors, because yellow jackets nest and pollinate on the ground.
- Avoid perfumes, scented soaps, and bright colors, which attract bees.
- Keep car windows closed.
- Spray garbage cans with quick-acting insecticide.
- Secure a professional exterminator to dispose of wasp and hornet nests or beehives in the home area.
- Remain motionless if an insect is buzzing around. Motion, especially running, increases the likelihood of being stung.
- If allergic, carry a self-treatment kit containing injectable (Epi-Pen) and inhalant forms of epinephrine, an oral antihistamine, and written instructions. Carry it with you at all times.

If You are Stung, Do the Following:
1. Inject self immediately with epinephrine if allergy is known or allergic response occurs.
2. Remove the stinger with one quick scrape of the fingernail. *Do not* squeeze the venom sac because this may cause injection of additional venom.
3. Clean the area with soapy water, and apply ice.
4. Report to the nearest health care facility for further examination if allergic response or allergy is suspected.

## Animal and Human Bites

Bites are a common reason for visits to the ED. Dog bites constitute 90% of these bites and are responsible for the majority of deaths from bites by a nonvenomous animal. Cat bites have a high risk of infection because of the presence of *Pasteurella* in their saliva. All animal bites must be reported to public health authorities, which must provide follow-up screening of the offending animal for rabies. If the animal cannot be located and rabies vaccination verified, rabies prophylaxis for the person who has been bitten must be instituted.

Human bites are frequently associated with rapes, sexual assaults, or other forms of battery. The human mouth contains more bacteria than that of most other animals, so a high risk of bite-related infection exists. Depending on the circumstances surrounding the event, the victim may delay seeking treatment. The ED nurse should inspect any bitten tissue for pus, erythema, or necrosis. A health care provider should take photographs, which can be used as evidence in criminal and legal proceedings. Cleansing with soap and water is then necessary, followed by the administration of antibiotics and tetanus toxoid as prescribed.

## Snake Bites

Venomous (poisonous) snakes cause 7000 to 8000 bites in the United States each year and result in 10 to 15 deaths (Hoyt & Selfridge-Thomas, 2007). Children between 1 and 9 years of age are the most likely victims. The greatest number of bites occurs during the daylight hours and early evening of the summer months. The most frequent poisonous snake bite occurs from pit vipers (Crotalidae). The most common site is the upper extremity. Of these bites, only 20% to 25% result in **envenomation** (injection of a poisonous material by sting, spine, bite, or other means). Venomous snake bites are medical emergencies (Daley & Barbee, 2008).

Nineteen different species of venomous snakes are found in various regions within the United States. Nurses should be familiar with the types of snakes common to the geographic region in which they practice.

### Clinical Manifestations

Snake venom consists primarily of proteins and has a broad range of physiologic effects. It may affect multiple organ systems, especially the neurologic, cardiovascular, and respiratory systems.

Classic clinical signs of envenomation are edema, ecchymosis, and hemorrhagic bullae, leading to necrosis at the site of envenomation. Symptoms include lymph node tenderness, nausea, vomiting, numbness, and a metallic taste in the mouth. Without decisive treatment, these clinical manifestations may progress to include fasciculations, hypotension, paresthesias, seizures, and coma (Daley & Barbee, 2008).

### Management

Initial first aid at the site of the snake bite includes having the person lie down, removing constrictive items such as rings, providing warmth, cleansing the wound, covering the wound with a light sterile dressing, and immobilizing the injured body part below the level of the heart. Airway, breathing, and circulation are the priorities of care. Ice or a tourniquet is *not* applied. Initial evaluation in the ED is performed quickly and includes information about the following:

- Whether the snake was venomous or nonvenomous; if the snake is dead, it should be transported to the ED with the patient for identification. However, caution should be taken when handling the transported snake. Frequently, the patient and family transport the snake in a stunned, not dead, state.
- Where and when the bite occurred and the circumstances of the bite
- Sequence of events, signs and symptoms (fang punctures, pain, edema, and erythema of the bite and nearby tissues)
- Severity of poisonous effects
- Vital signs
- Circumference of the bitten extremity or area at several points; the circumference of the extremity that was bitten is compared with the circumference of the opposite extremity

- Laboratory data (complete blood count, urinalysis, and coagulation studies)

The course and prognosis of snake bite injuries depend on the kind and amount of venom injected, where on the body the bite occurred, and the general health, age, and size of the patient. There is no one specific protocol for treatment of snake bites. Generally, ice, tourniquets, heparin, and corticosteroids are not used during the acute stage. Corticosteroids are contraindicated in the first 6 to 8 hours after the bite because they may depress antibody production and hinder the action of **antivenin** (antitoxin manufactured from the snake venom and used to treat snake bites).

Parenteral fluids may be used to treat hypotension. If vasopressors are used to treat hypotension, their use should be short term. Surgical exploration of the bite is rarely indicated. Typically, the patient is observed closely for at least 6 hours. The patient is *never* left unattended.

### Administration of Antivenin (Antitoxin)

Although envenomation is rare, it can occur with snake bites. An assessment of progressive signs and symptoms is essential before considering administration of antivenin, which is most effective if administered within 4 hours and no greater than 12 hours after the snake bite. Two antivenins are available: Antivenin Polyvalent (ACP) and Crotalidae Polyvalent Immune Fab Antivenin (FabAV) (Auerbach, 2007). The dose depends on the type of snake and the estimated severity of the bite. Indications for antivenin depend on the progression of symptoms, including coagulopathy and systemic reaction. Children may require more antivenin than adults because their smaller bodies are more susceptible to the toxic effects of venom.

A skin or eye test should be performed before the initial dose to detect allergy to the antivenin, because as many as 33% of patients who are given ACP (horse serum–derived antivenin) develop hypersensitivity reactions to it. Because even the skin test can cause an anaphylactic reaction, patients should not be tested unless antivenin will be given. If the dose exceeds 10 vials, serum sickness will most likely occur. Serum sickness is a type of hypersensitivity response that results in fever, arthralgias, pruritus, lymphadenopathy, and proteinuria and can progress to neuropathies.

FabAV is more potent than ACP, with less associated hypersensitivity and serum sickness (Auerbach, 2007). However, FabAV must be administered cautiously to patients receiving anticoagulation therapy. Administration of FabAV may result in a recurring coagulopathy. The dosage and administration of FabAV are different from ACP and should be reviewed carefully before the medication is given.

Before administering antivenin and every 15 minutes thereafter, the circumference of the affected part is measured. Premedication with diphenhydramine (Benadryl) or cimetidine (Tagamet) is indicated because these antihistamines may decrease the allergic response to antivenin. Antivenin is administered as an IV infusion whenever possible, although IM administration can be used.

Depending on the severity of the snake bite, the antivenin is diluted in 500 to 1000 mL of normal saline solution. The infusion is started slowly, and the rate is increased after 10 minutes if there is no reaction. The total dose should be infused during the first 4 to 6 hours after the bite. The initial dose is repeated until symptoms decrease. After symptoms decrease, the circumference of the affected part should be measured every 30 to 60 minutes for the next 48 hours to detect symptoms of compartment syndrome (swelling, loss of pulse, increased pain, and paresthesias).

The most common cause of allergic reaction to the antivenin is too-rapid infusion, although about 3% of patients with negative skin test results develop reactions unrelated to infusion rate. Reactions may consist of a feeling of fullness in the face, urticaria, pruritus, malaise, and apprehension. These symptoms may be followed by tachycardia, shortness of breath, hypotension, and shock. In this situation, the infusion should be stopped immediately and IV diphenhydramine administered. Vasopressors are used for patients in shock, and resuscitation equipment must be on standby while antivenin is infusing.

## Spider Bites

There are two venomous spiders found in the United States that typically interact with humans: the brown recluse and the black widow. Both are usually found in dark places such as closets, woodpiles, and attics, as well as in shoes.

Brown recluse spider bites are painless. Systemic effects such as fever and chills, nausea and vomiting, malaise, and joint pain develop within 24 to 72 hours. The site of the bite may appear reddish to purple in color within 2 to 8 hours after the bite. Necrosis occurs in the next 2 to 4 days in approximately 10% of cases. The center of the bite may become necrotic, and surgical débridement may be necessary. Wound care consists of cleansing with soap and water, and hyperbaric oxygen treatments may be helpful. Most wounds heal within 2 to 3 months.

Black widow spider bites feel like pinpricks. Systemic effects usually occur within 30 minutes—much more rapidly than with brown recluse spider bites. Signs and symptoms include abdominal rigidity, nausea and vomiting, hypertension, tachycardia, and paresthesias. Severe pain also develops within 60 minutes and increases over 1 to 2 days. Treatment involves application of ice to the site to decrease systemic toxin delivery. Cardiopulmonary monitoring is essential. Antivenin is effective for black widow spider bites. This antivenin is horse serum–based; therefore, testing for sensitivity must be performed prior to administration (Auerbach, 2007).

## Tick Bites

Tick bites are common in many areas of the United States, and they usually occur in grassy or wooded areas. It is important to learn the place where the bite occurred as well as the location of the bite on the body. The patient may demonstrate weakness; joint pain; skin rash, especially on the palms and soles of feet; headache; and fever. Ticks can carry diseases such as Rocky Mountain spotted fever, tularemia, and Lyme disease. The tick bite itself is not usually the problem; rather, it is the pathogen transmitted by the tick that can cause serious disease. The tick should be removed, and the patient should be informed of the signs and

symptoms of diseases carried by ticks, especially if the patient lives in an area endemic for tick-related diseases (eg, Lyme disease).

Lyme disease has three stages. Stage I presents with a "bull's eye" rash (ie, erythema migrans) that typically can be found in the axilla, groin, or thigh area and that appears within 4 weeks after the tick bite, with a peak manifestation time of 7 days after the bite. Classically, this rash is at least 5 cm in diameter with bright red borders. It is accompanied by flulike signs and symptoms that may include chills, fever, myalgia, fatigue, and headache. Without treatment, the rash subsides within 3 to 4 weeks. However, the rash and flulike manifestations can be significantly reduced within days if prompt treatment with antibiotics is initiated. If antibiotics are not administered, stage II Lyme disease may present within 4 to 10 weeks following the tick bite and may manifest with joint pain, memory loss, poor motor coordination, and meningitis. Stage III can begin anywhere from weeks to more than a year after the bite and has serious long-term chronic sequelae, including arthritis, neuropathy, myalgia, and myocarditis.

## POISONING

A poison is any substance that, when ingested, inhaled, absorbed, applied to the skin, or produced within the body in relatively small amounts, injures the body by its chemical action. Poisoning from inhalation and ingestion of toxic materials, both intentional and unintentional, constitutes a major health hazard and an emergency situation. Emergency treatment is initiated with the following goals:

- To remove or inactivate the poison before it is absorbed
- To provide supportive care in maintaining vital organ function
- To administer a specific antidote to neutralize a specific poison
- To implement treatment that hastens the elimination of the absorbed poison

### Ingested (Swallowed) Poisons

Swallowed poisons may be corrosive. **Corrosive poisons** include alkaline and acid agents that can cause tissue destruction after coming in contact with mucous membranes. Alkaline products include lye, drain cleaners, toilet bowl cleaners, bleach, nonphosphate detergents, oven cleaners, and button batteries (batteries used to power watches, calculators, or cameras). Acid products include toilet bowl cleaners, pool cleaners, metal cleaners, rust removers, and battery acid.

Control of the airway, ventilation, and oxygenation are essential. In the absence of cerebral or renal damage, the patient's prognosis depends largely on successful management of respiration and circulation. Measures are instituted to stabilize cardiovascular and other body functions. ECG, vital signs, and neurologic status are monitored closely for changes. Shock may result from the cardiodepressant action of the substance ingested, from venous pooling in the lower extremities, or from reduced circulating blood volume resulting from increased capillary permeability. An indwelling urinary catheter is inserted to monitor renal function. Blood specimens are obtained to determine the concentration of drug or poison.

Efforts are made to determine what substance was ingested; the amount; the time since ingestion; signs and symptoms, such as pain or burning sensations, any evidence of redness or burn in the mouth or throat, pain on swallowing or an inability to swallow, vomiting, or drooling; age and weight of the patient; and pertinent health history.

*NURSING ALERT*

**The local poison control center should be called if an unknown toxic agent has been taken or if it is necessary to identify an antidote for a known toxic agent.**

Measures are instituted to remove the toxin or decrease its absorption. The patient who has ingested a corrosive poison, which can be a strong acid or alkaline substance, is given water or milk to drink for dilution. However, dilution is not attempted if the patient has acute airway edema or obstruction or if there is clinical evidence of esophageal, gastric, or intestinal burn or perforation. The following gastric emptying procedures may be used as prescribed:

- Syrup of ipecac to induce vomiting in the alert patient (*never* use with corrosive poisons)
- Gastric lavage for the obtunded patient (Chart 71-11); gastric aspirate is saved and sent to the laboratory for testing (toxicology screens)
- Activated charcoal administration if the poison is one that is absorbed by charcoal
- Cathartic, when appropriate

*NURSING ALERT*

**Vomiting is never induced after ingestion of caustic substances (acid or alkaline) or petroleum distillates.**

If there is a specific chemical or physiologic antagonist (antidote), it is administered as early as possible to reverse or diminish the effects of the toxin. If this measure is ineffective, procedures may be initiated to remove the ingested substance. These procedures include administration of multiple doses of charcoal, diuresis (for substances excreted by the kidneys), dialysis, or hemoperfusion. Hemoperfusion involves detoxification of the blood by processing it through an extracorporeal circuit and an adsorbent cartridge containing charcoal or resin, after which the cleansed blood is returned to the patient.

Throughout detoxification, the patient's vital signs, CVP, and fluid and electrolyte balance are monitored closely. Hypotension and cardiac dysrhythmias are possible. Seizures are also possible because of CNS stimulation from the poison or from oxygen deprivation. If the patient complains of pain, analgesics are administered cautiously. Severe pain causes vasomotor collapse and reflex inhibition of normal physiologic functions.

After the patient's condition has stabilized and discharge is imminent, written material should be given to the patient

## CHART 71-11 *Guidelines for Assisting With Gastric Lavage*

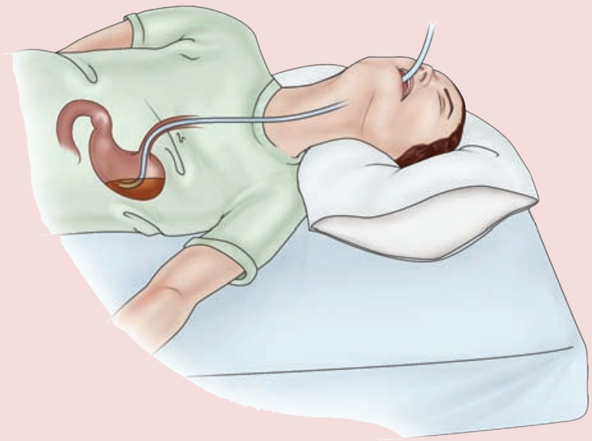
Gastric lavage is the aspiration of stomach contents and washing out of the stomach by means of a large-bore gastric tube. Gastric lavage is contraindicated after acid or alkali ingestion, in the presence of seizures, or after ingestion of hydrocarbons or petroleum distillates. It is particularly dangerous after ingestion of strong corrosive agents.

**Purposes:**

- For urgent removal of ingested substance to decrease systemic absorption
- To empty the stomach before endoscopic procedures
- To diagnose gastric hemorrhage and to arrest hemorrhage

**Equipment:**

Large-bore Levin tubes or large-bore Ewald tube
Large irrigating syringe with adapter
Large plastic funnel with adapter to fit tube
Water-soluble lubricant
Tap water or appropriate antidote (milk, saline solution, sodium bicarbonate solution, fruit juice, activated charcoal)
Container for aspirate; suction apparatus
Nasotracheal or endotracheal tubes with inflatable cuffs
Containers for specimens



During gastric lavage, the patient is positioned on the left side, which allows the gastic contents to pool and decreases the passage of fluid into the duodenum.

| Action | Rationale |
| --- | --- |
| 1. Remove dentures and inspect the oral cavity for loose teeth. | 1. This will prevent aspiration of teeth. |
| 2. Measure the distance between the bridge of the nose and the xiphoid process. Mark the tube with indelible pencil or tape. | 2. This distance is a rule-of-thumb measurement of the distance the tube must be passed to reach the stomach. This avoids curling and kinking of excess tubing in the stomach. |
| 3. Lubricate the tube with water-soluble lubricant. | 3. Lubrication eases insertion of the tube. |
| 4. If comatose, the patient is intubated with a cuffed nasotracheal or endotracheal tube before placement of the nasogastric tube. | 4. A cuffed nasotracheal or endotracheal tube decreases the risk of aspiration of gastric contents. |
| 5. Place the patient in a left lateral position with the head lowered about 15 degrees. | 5. This position decreases passage of gastric contents into the duodenum during lavage. |
| 6. Pass the tube orally while keeping the patient's head in a neutral position. Pass the tube to the adhesive marking or about 50 cm (20 in). Encourage patient to swallow to assist with passage of the tube. Then lower the head of the stretcher or bed. Have standby suction available. | 6. The depth of insertion of the tube varies according to the size of the patient. If the tube enters the trachea instead of the esophagus, the patient will experience coughing, dyspnea, stridor, and cyanosis. Positive confirmation of tube placement is accomplished by x-ray. |
| 7. Aspirate the stomach contents with the syringe attached to the tube before instilling water or an antidote. Save the specimen for analysis. Ensure correct placement before installation. | 7. Aspiration is carried out to determine that the tube is in the stomach and to remove the stomach contents. Positive confirmation of tube placement is accomplished by x-ray. |
| 8. Remove the syringe. Attach the funnel to the end of the tube, or use a 50-mL syringe to instill solution in the gastric tube. The volume of fluid placed in the stomach should be small. | 8. Overfilling of the stomach may cause regurgitation and aspiration or force the stomach contents through the pylorus. |
| 9. Elevate the funnel above the patient's head and pour 150 to 200 mL of solution into the funnel. | 9. Gravity allows the solution to flow into the tube. |
| 10. Lower the funnel and siphon the gastric contents into the container or connect to suction. | 10. The fluid should flow in freely and drain by gravity. |
| 11. Save samples of the first two washings. | 11. Keep the first washing sample isolated from other washings for toxicologic analysis. |
| 12. Repeat the lavage procedure until the returns are relatively clear and no particulate matter is seen. | 12. This usually requires a total volume of at least 2 L; some clinicians advocate the use of 5 to 20 L. |

*Continued*

CHART 71-11 **Guidelines for Assisting With Gastric Lavage** *(Continued)*

| Action | Rationale |
|---|---|
| 13. At the completion of lavage: | 13. |
| a. The stomach may be left empty. | a. The stomach is kept empty if no further medications are required. |
| b. An adsorbent (powder form of activated charcoal mixed with water to form a liquid the consistency of thick soup) may be instilled in the tube and allowed to remain in the stomach. | b. Activated charcoal reduces absorption by adsorbing (attaching to its surface) a wide range of substances; it renders the poison inaccessible to the circulation, thereby reducing its toxicity. |
| c. A saline cathartic may be instilled in the tube. | c. A cathartic may be given to hasten the elimination of remaining ingested material. |
| 14. Pinch off the tube during removal or maintain suction while the tube is being withdrawn. Keep the patient's head lower than the body. | 14. Pinching off the tube prevents aspiration and the initiation of the gag reflex. Keeping the patient's head lower than the body also helps to prevent initiation of the gag reflex. |
| 15. Warn the patient that his stools will turn black from the charcoal. | 15. Patient teaching is important to reduce anxiety. |

indicating the signs and symptoms of potential problems related to the poison ingested and signs or symptoms requiring evaluation by a physician. If poisoning was determined to be a suicide or self-harm attempt, a psychiatric consultation should be requested before the patient is discharged. In cases of inadvertent poison ingestion, poison prevention and home poison-proofing instructions should be provided to the patient and family.

## Carbon Monoxide Poisoning

Carbon monoxide poisoning may occur as a result of industrial or household incidents or attempted suicide. It is implicated in more deaths than any other toxin except alcohol. Carbon monoxide exerts its toxic effect by binding to circulating hemoglobin and thereby reducing the oxygen-carrying capacity of the blood. Hemoglobin absorbs carbon monoxide 200 times more readily than it absorbs oxygen. Carbon monoxide–bound hemoglobin, called **carboxyhemoglobin,** does not transport oxygen.

### Clinical Manifestations

Because the CNS has a critical need for oxygen, CNS symptoms predominate with carbon monoxide toxicity. A person with carbon monoxide poisoning may appear intoxicated (from cerebral hypoxia). Other signs and symptoms include headache, muscular weakness, palpitation, dizziness, and confusion, which can progress rapidly to coma. Skin color, which can range from pink or cherry-red to cyanotic and pale, is not a reliable sign. Pulse oximetry is also not valid, because the hemoglobin is well saturated. It is not saturated with oxygen, but the pulse oximeter indicates only if the hemoglobin is saturated; in this case, it is saturated with carbon monoxide rather than with oxygen.

### Management

Exposure to carbon monoxide requires immediate treatment. Goals of management are to reverse cerebral and myocardial hypoxia and to hasten elimination of carbon monoxide. Whenever a patient inhales a poison, the following general measures apply:

- Carry the patient to fresh air immediately; open all doors and windows.
- Loosen all tight clothing.
- Initiate cardiopulmonary resuscitation if required; administer 100% oxygen.
- Prevent chilling; wrap the patient in blankets.
- Keep the patient as quiet as possible.
- Do not give alcohol in any form or permit the patient to smoke.

In addition, for the patient with carbon monoxide poisoning, carboxyhemoglobin levels are analyzed on arrival at the ED and before treatment with oxygen if possible. One hundred percent oxygen is administered at atmospheric or preferably hyperbaric pressures to reverse hypoxia and accelerate the elimination of carbon monoxide. Oxygen is administered until the carboxyhemoglobin level is less than 5%. The patient is monitored continuously. Psychoses, spastic paralysis, ataxia, visual disturbances, and deterioration of mental status and behavior may persist after resuscitation and may be symptoms of permanent brain damage.

When unintentional carbon monoxide poisoning occurs, the health department should be contacted so that the dwelling or building in question can be inspected. A psychiatric consultation is warranted if poisoning was determined to be a suicide attempt.

## Skin Contamination Poisoning (Chemical Burns)

Skin contamination injuries from exposure to chemicals are challenging because of the large number of possible offending agents with diverse actions and metabolic effects. The severity of a chemical burn is determined by the mechanism of action, the penetrating strength and concentration, and the amount and duration of exposure of the skin to the chemical.

The skin should be drenched immediately with running water from a shower, hose, or faucet, except in the case of lye and white phosphorus, which should be brushed off the skin, dry.

> **NURSING ALERT**
>
> **Water should not be applied to burns from lye or white phosphorus because of the potential for an explosion or for deepening of the burn. All evidence of these chemicals should be brushed off the patient before any flushing occurs.**

The skin should be flushed with a constant stream of water as the patient's clothing is removed. The skin of health care personnel assisting the patient should be appropriately protected if the burn is extensive or if the agent is significantly toxic or is still present. Prolonged lavage with generous amounts of tepid water is important.

Attempts to determine the identity and characteristics of the chemical agent are necessary in order to specify future treatment. The standard burn treatment appropriate for the size and location of the wound (antimicrobial treatment, débridement, tetanus prophylaxis, antidote administration as prescribed) is instituted. (see Chapter 57) The patient may require plastic surgery for further wound management. The patient is instructed to have the affected area reexamined at 24 and 72 hours and in 7 days because of the risk of underestimating the extent and depth of these types of injuries.

## Food Poisoning

Food poisoning is a sudden illness that occurs after ingestion of contaminated food or drink. Botulism is a serious form of food poisoning that requires continual surveillance (see Chapter 72). Assessment questions for patients with food poisoning are discussed in Chart 71-12.

### CHART 71-12 Assessment for Food Poisoning

Use the following questions to elicit information about the circumstances surrounding the possibility of food poisoning:

- How soon after eating did the symptoms occur? (Immediate onset suggests chemical, plant, or animal poisoning.)
- What was eaten in the previous meal? Did the food have an unusual odor or taste? (Most foods causing bacterial poisoning *do not* have unusual odor or taste.)
- Did anyone else become ill from eating the same food?
- Did vomiting occur? What was the appearance of the vomitus?
- Did diarrhea occur? (Diarrhea is usually absent with botulism and with shellfish or other fish poisoning.)
- Are any neurologic symptoms present? (These occur in botulism and in chemical, plant, and animal poisoning.)
- Does the patient have a fever? (Fever is characteristic in salmonella, ingestion of fava beans, and some fish poisoning.)

The key to treatment is determining the source and type of food poisoning. If possible, the suspected food should be brought to the medical facility and a history obtained from the patient or family.

Food, gastric contents, vomitus, serum, and feces are collected for examination. The patient's respirations, blood pressure, level of consciousness, central venous pressure (CVP) (if indicated), and muscular activity are monitored closely. Measures are instituted to support the respiratory system. Death from respiratory paralysis can occur with botulism, fish poisoning, and some other food poisonings.

Because large volumes of electrolytes and water are lost by vomiting and diarrhea, fluid and electrolyte status should be assessed. Severe vomiting produces alkalosis, and severe diarrhea produces acidosis. Hypovolemic shock may also occur from severe fluid and electrolyte losses. The patient is assessed for signs and symptoms of fluid and electrolyte imbalances, including lethargy, rapid pulse rate, fever, oliguria, anuria, hypotension, and delirium. Weight and serum electrolyte levels are obtained for future comparisons.

Measures to control nausea are also important to prevent vomiting, which could exacerbate fluid and electrolyte imbalances. An antiemetic medication is administered parenterally as prescribed if the patient cannot tolerate fluids or medications by mouth. For mild nausea, the patient is encouraged to take sips of weak tea, carbonated drinks, or tap water. After nausea and vomiting subside, clear liquids are usually prescribed for 12 to 24 hours, and the diet is gradually progressed to a low-residue, bland diet.

# SUBSTANCE ABUSE

Substance abuse is the misuse of specific substances, such as drugs or alcohol, to alter mood or behavior. Drug abuse is the use of drugs for other than legitimate medical purposes. People who abuse drugs often take a variety of drugs simultaneously (such as alcohol, barbiturates, opioids, and tranquilizers), and the combination may have additive and addictive effects. "Rave" parties are large-scale parties attended by hundreds of teenagers involved in drug use. At these events, one of the most commonly used drugs is 3,4-methylenedioxymethamphetamine (MDMA), or Ecstasy, a methamphetamine-based drug that users believe produces a "harmless high." ED nurses should be aware of "rave" parties in their geographic area so they can prepare for a potential influx of patients who abuse this drug. Others may combine Ecstasy with sildenafil (Viagra); this drug combination is nicknamed "sextasy." People who abuse IV/injection drugs are at increased risk for HIV infection, acquired immunodeficiency syndrome (AIDS), hepatitis B and C, and tetanus.

Clinical manifestations vary with the substance used, but the underlying principles of management are essentially the same. Table 71-1 identifies commonly abused drugs, listing their clinical manifestations and therapeutic management. Treatment goals for a patient with a drug overdose are to support the respiratory and cardiovascular functions, to enhance clearance of the agent, and to provide for safety of the patient and staff.

**Table 71-1 EMERGENCY MANAGEMENT OF PATIENTS WITH DRUG OVERDOSE**

| Drug | Clinical Manifestations | Therapeutic Management |
|---|---|---|
| **Stimulants** | | |
| Cocaine<br>Intranasally ("snorting"): inhaled into nostrils through straws<br>By smoking ("freebasing"): cocaine hydrochloride dissolved in ether to yield a pure cocaine alkaloid base (called "crack," "rocks"); smoking in a small pipe delivers large quantities of cocaine to lungs<br>Intravenously<br>Polysubstance (cocaine and heroin) | Cocaine is a central nervous system (CNS) stimulant that can increase heart rate and blood pressure and cause hyperpyrexia, seizures, increased energy, agitation, aggression, and ventricular dysrhythmias. It produces intense euphoria, then anxiety, sadness, insomnia, and sexual indifference; cocaine hallucinations with delusions; psychosis with extreme paranoia and ideas of persecution; and hypervigilance. Chronic psychotic symptoms may persist.<br>Overall psychotic symptoms are short-lived compared to methamphetamines | 1. Maintain airway and provide respiratory support<br>2. Control seizures.<br>3. Monitor cardiovascular effects; have lidocaine and defibrillator available.<br>4. Treat for hyperthermia.<br>5. If cocaine was ingested, evacuate stomach contents and use activated charcoal to treat. Whole bowel irrigation may be necessary to treat body packers ("mules").<br>6. Refer for psychiatric evaluation and treatment in an inpatient unit that eliminates access to the drug. Include drug rehabilitation counseling. |
| **Opioids** | | |
| Heroin<br>Opium or paregoric<br>Morphine, codeine, semisynthetic derivatives: oxycodone (OxyContin), methadone, meperidine (Demerol), propoxyphene (Darvon), tramadol (Ultram), fentanyl (Sublimaze) | Acute intoxication (overdose)<br>Pinpoint pupils (may be dilated with severe hypoxia); decreased blood pressure<br>Marked respiratory depression/ arrest<br>Pulmonary edema<br>Stupor → coma<br>Seizures<br>Fresh needle marks along course of any superficial vein; skin abscesses | 1. Support respiratory and cardiovascular functions.<br>2. Establish an intravenous (IV) line; obtain blood for chemical and toxicologic analysis. Patient may be given bolus of glucose to eliminate possibility of hypoglycemia.<br>3. Give narcotic antagonist (naloxone hydrochloride IV, IM [Narcan]) as prescribed to reverse severe respiratory depression and coma.<br>4. Continue to monitor level of responsiveness and respirations, pulse, and blood pressure. Duration of action of naloxone hydrochloride is shorter than that of heroin; repeated dosages may be necessary.<br>5. Send urine for analysis; opioids can be detected in urine.<br>6. Obtain an electrocardiogram.<br>7. Do not leave patient unattended; he or she may lapse back into coma rapidly. Clinical status may change from minute to minute. Hemodialysis may be indicated for severe drug intoxication. Activated charcoal may be considered if opioids were taken orally and if the patient is alert.<br>8. Monitor for pulmonary edema, which is frequently seen in patients who abuse/overdose on narcotics.<br>9. Refer patient for psychiatric and drug rehabilitation evaluation before discharge. |
| **Barbiturates** | | |
| Pentobarbital (Nembutal), secobarbital (Seconal), amobarbital (Amytal), gamma-hydroxybutyrate (GHB, "liquid Ecstasy") | Acute intoxication (may mimic alcohol intoxication):<br>• Respiratory depression<br>• Flushed face<br>• Decreased pulse rate; decreased blood pressure<br>• Increasing nystagmus<br>• Depressed deep tendon reflexes<br>• Decreasing mental alertness<br>• Difficulty in speaking<br>• Poor motor coordination<br>• Coma, death<br>GHB:<br>• Sexual disinhibition<br>• Amnesia, myoclonus, agitation<br>• Overdoses when mixed with alcohol | 1. Maintain airway and provide respiratory support.<br>2. Endotracheal intubation or tracheostomy is considered if there is any doubt about the adequacy of airway exchange.<br>a. Check airway frequently.<br>b. Perform suctioning as necessary.<br>3. Support cardiovascular and respiratory functions; most deaths result from respiratory depression or shock.<br>4. Start infusion through large-gauge needle or IV catheter to support blood pressure; coma and dehydration result in hypotension and respond to infusion of intravenous fluids with elevation of blood pressure. Sodium bicarbonate may be prescribed to alkalinize urine; it promotes excretion of barbiturates.<br>5. Evacuate stomach contents or lavage as soon as possible to prevent absorption; repeated doses of activated charcoal may be administered. |

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**Table 71-1 EMERGENCY MANAGEMENT OF PATIENTS WITH DRUG OVERDOSE (Continued)**

| Drug | Clinical Manifestations | Therapeutic Management |
|---|---|---|
| | | 6. Assist with hemodialysis for severely overdosed patient.<br>7. Maintain neurologic and vital sign flow sheet.<br>8. Patient awakening from overdose may demonstrate combative behavior.<br>9. Refer for psychiatric and drug rehabilitation consultation to evaluate suicide potential and drug abuse. |
| **Inhalants**<br>Amyl nitrate<br>Freon<br>Propane<br>Trichloroethylene<br>Gasoline<br>Perchloroethylene<br>Toluene (metallic paint spray) | Effects mimic those of alcohol, with dizziness and imbalance<br>Euphoria, headache, altered level of consciousness to coma<br>Renal, hepatic, and cardiac toxicity<br>Aplastic anemia<br>Fetal growth retardation<br>Respiratory depression<br>Vasodilation<br>Nosebleeding<br>Circumoral red spots | 1. Provide airway support, ventilation, and oxygen.<br>2. Treat cardiac dysrhythmias and hypotension.<br>3. Provide advanced cardiac life support (ACLS) as needed.<br>4. Monitor for profound hypotension when amyl nitrate is combined with MDMA and sildenafil. |
| **Amphetamine-Type Drugs (pep pills, "uppers," "speed," "crystal meth")**<br>Amphetamine (Benzedrine)<br>Dextroamphetamine (Dexedrine)<br>Methamphetamine (Desoxyn, "speed")<br>3,4-Methylenedioxymethamphetamine (MDMA) ("Ecstasy," "Adam")*<br>3,4-Methylenedioxymethamphetamine (MDEA) ("Eve")<br>3,4-Methylenedioxyamphetamine (MDA) methylphenidate (Ritalin)<br>"ice," "rocks," "crystal meth" | Nausea, vomiting, anorexia, palpitations, tachycardia, increased blood pressure, tachypnea, anxiety, nervousness, diaphoresis, mydriasis<br>Repetitive or stereotyped behavior<br>Irritability, insomnia, agitation<br>Visual misperceptions, auditory hallucinations<br>Fearfulness, anxiety, depression, hostility, paranoia<br>Hyperactivity, rapid speech, euphoria, hyperalertness<br>Decreased inhibition<br>Seizures, coma, hyperthermia, cardiovascular collapse, rhabdomyolysis<br>MDMA is both a hallucinogenic and stimulant | 1. Provide airway support, ventilation, cardiac monitoring; insert IV line.<br>2. Use gastrointestinal (GI) evacuation in cases of oral overdose; activated charcoal, gastric lavage.<br>3. Keep in calm, cool, quiet environment; elevated temperature potentiates amphetamine toxicity. Maintain normothermia cooling the patient as necessary.<br>4. Use small doses of diazepam (Valium) (IV) or haloperidol (Haldol) as prescribed for CNS and muscular hyperactivity.<br>5. Administer appropriate pharmacologic therapy as prescribed for severe hypertension and ventricular dysrhythmias.<br>6. Treat seizures with benzodiazepines (eg, diazepam) as prescribed.<br>7. Treat sympathetic stimulation with beta-blocker agents as prescribed.<br>8. Try to communicate with patient if delusions or hallucinations are present.<br>9. Place in a protective environment (preferably psychiatric security room with video monitoring) to observe for suicide attempt.<br>10. Refer for psychiatric and drug rehabilitation evaluation. |
| **Hallucinogens or Psychedelic-Type Drugs**<br>Lysergic acid diethylamide (LSD)<br>Phencyclidine HCl (PCP, "angel dust")<br>Mescaline, psilocybin<br>Cannabinoids (marijuana)<br>Ketamine ("special K") | Nystagmus<br>Mild hypertension<br>Marked confusion bordering on panic<br>Incoherence, hyperactivity<br>Withdrawn<br>Combative behavior; delirium, mania, self-injury (lasts 6 to 12 hours)<br>Hallucinations, body image distortion<br>Hypertension, hyperthermia, renal failure<br>Flashback: recurrence of LSD-like state without having taken the drug; may occur weeks or months after drug was taken<br>Ketamine: "out-of-body" experience; increased aggressiveness | 1. Evaluate and maintain patient's airway, breathing, and circulation.<br>2. Determine by urine or serum drug screen whether the patient has ingested hallucinogenic drug or has a toxic psychosis.<br>3. Try to communicate with and reassure the patient.<br>a. "Talking down" involves understanding the process through which the patient is proceeding and helping him overcome his fears while establishing contact with reality.<br>b. Remind the patient that fear is common with this problem. |

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**Table 71-1 EMERGENCY MANAGEMENT OF PATIENTS WITH DRUG OVERDOSE (Continued)**

| Drug | Clinical Manifestations | Therapeutic Management |
|---|---|---|
| | | c. Reassure the patient that he is not losing his mind but is experiencing the effect of drugs and that this will wear off.<br>d. Instruct the patient to keep the eyes open; this reduces the intensity of reaction.<br>e. Reduce sensory stimuli: minimize noise, lights, movement, tactile stimulation.<br>4. Sedate the patient as prescribed if hyperactivity cannot be controlled; diazepam (Valium) or a barbiturate may be prescribed.<br>5. Search for evidence of trauma; hallucinogen users have a tendency to "act out" their hallucinations.<br>6. Manage seizures with benzodiazepines (eg, diazepam) as necessary.<br>7. Observe patient closely; patient's behavior may become hazardous. Have safety officers stationed near the patient's room.<br>8. Monitor for hypertensive crisis if patient has prolonged psychosis due to drug ingestion.<br>9. Place patient in a protected environment under proper medical supervision to prevent self-inflicted bodily harm.<br><br>**Management for Phencyclidine Abusers**<br>1. Place patient in a calm, supportive environment to minimize stimuli; protect from self-injury.<br>2. Avoid talking down.<br>3. Do not leave patient unobserved. Treat symptoms as they occur.<br>a. Drug effects are unpredictable and prolonged.<br>b. Symptoms are likely to exacerbate; patient becomes out of control.<br>4. Refer all patients in this category for psychiatric and drug evaluation/rehabilitation. |
| **Drugs Producing Sedation, Intoxication, or Psychological and Physical Dependence (nonbarbiturate sedatives)** | | |
| Diazepam (Valium)<br>Chlordiazepoxide (Librium)<br>Oxazepam (Serax)<br>Lorazepam (Ativan)<br>Midazolam (Versed)<br>Flunitrazepam (Rohypnol, "roofies," "date rape drug")* | Seizures, coma, circulatory collapse, death<br>Acute intoxication:<br>• Respiratory depression<br>• Decreasing mental alertness<br>• Confusion<br>• Slurred speech, decreased blood pressure<br>• Ataxia<br>• Pulmonary edema<br>• Coma, death<br><br>**Flunitrazepam:**<br>• Disinhibition with antegrade amnesia<br>• Weakness and unsteadiness with impaired judgment<br>• Powerlessness | 1. Endotracheal tube is inserted as a precaution; use assisted ventilation to stabilize and correct respiratory depression. Observe for sudden apnea and laryngeal spasm.<br>2. Assess for hypotension<br>a. Insert indwelling urinary catheter for comatose patient; decreased urinary volume is an index of reduced renal flow associated with reduced intravascular volume or vascular collapse.<br>b. Start volume expansion with saline or dextrose as prescribed.<br>3. Evacuate stomach contents; emesis; lavage; activated charcoal; cathartic.<br>4. Start ECG monitoring. Observe for dysrhythmias.<br>5. Administer flumazenil (Romazicon), a benzodiazepine antagonist (reversal agent).<br>6. Refer patient for psychiatric evaluation (potential suicide intent). |

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**Table 71-1 EMERGENCY MANAGEMENT OF PATIENTS WITH DRUG OVERDOSE (Continued)**

| Drug | Clinical Manifestations | Therapeutic Management |
|---|---|---|
| **Salicylate Poisoning**<br>Aspirin (present in compound analgesic tablets)<br>Toxic levels (150–200 mg/kg body weight)<br>Chronic toxicity (occurs in elderly due to decreased renal function)<br>Long-term intoxication (>100 mg/kg/day for more than 2 days) | Restlessness, tinnitus, deafness, blurring of vision<br>Hyperpnea, hyperpyrexia, sweating<br>Epigastric pain, vomiting, dehydration<br>Respiratory alkalosis and metabolic acidosis<br>Disorientation, coma, cardiovascular collapse<br>Coagulopathy | 1. Treat respiratory depression.<br>2. Induce gastric emptying by lavage.<br>3. Give activated charcoal to adsorb aspirin; a cathartic may be administered with charcoal to help ensure intestinal cleansing.<br>4. Support patient with IV infusions as prescribed to establish hydration and correct electrolyte imbalances, including administration of sodium bicarbonate.<br>5. Enhance elimination of salicylates as directed by forced diuresis, alkalinization of urine, peritoneal dialysis, or hemodialysis, according to severity of intoxication.<br>6. Monitor serum salicylate level for efficacy of treatment.<br>7. Administer specific prescribed pharmacologic agent for bleeding and other problems.<br>8. Concretions formed in the gut may result in prolonged exposure as they are digested.<br>9. Refer patient for psychiatric evaluation (potential suicide intent). |
| Acetaminophen (present in prescription and nonprescription analgesics, antipyretics, and cold remedies) | Lethargy to encephalopathy and death<br>GI upset, diaphoresis<br>Right upper quadrant pain<br>Abnormal liver function tests, prolonged prothrombin time, increased bilirubin, disseminated intravascular coagulation<br>Hepatomegaly leading to liver failure<br>Metabolic acidosis<br>Hypoglycemia | 1. Maintain airway.<br>2. Obtain acetaminophen level. Levels ≥140 mg/kg are toxic.<br>3. Laboratory studies—liver function tests, prothrombin time/partial thromboplastin time, complete blood count, blood urea nitrogen, creatinine.<br>4. Administer syrup of ipecac and follow emesis with activated charcoal.<br>5. Prepare for possible hemodialysis, which clears acetaminophen but does not halt liver damage.<br>6. Administer *N*-acetylcysteine (NAC, Mucomyst) as soon as possible. NAC replenishes essential liver enzymes and requires a total of 18 doses every 4 hours. Charcoal absorbs NAC; do not administer together. Repeat NAC dose if patient vomits.<br>7. Refer patient for psychiatric evaluation (potential suicide intent). |
| **Tricyclic Antidepressants (TCAs)**<br>Amitriptyline (Elavil)<br>Doxepin (Sinequan)<br>Nortriptyline (Aventyl)<br>Imipramine (Tofranil) | Dysrhythmia: ventricular fibrillation/tachycardia, tachycardia<br>Hypotension<br>Pulmonary edema, hypoxemia, acidosis<br>Confusion, agitation, coma<br>Visual hallucinations<br>Clonus, tremors, hyperactive reflexes, nystagmus, myoclonic jerking<br>Seizures<br>Blurred vision, flushing, hyperthermia | 1. Provide airway support, ventilation, cardiac monitoring; insert IV line with normal saline solution.<br>2. If within 1–2 hours after overdose, insert a nasogastric tube and instill activated charcoal with sorbitol every 4 hours × 3.<br>3. Administer a sodium bicarbonate drip to decrease dysrhythmias; the alkaline environment increases the protein binding of the metabolite.<br>4. Administer vasopressors.<br>5. Use only Class IB antiarrhythmics (eg, lidocaine), as some other types of antiarrhythmics have the same effect as TCA.<br>6. Manage seizure activity with benzodiazepines (eg, diazepam) as necessary.<br>7. Refer patient for psychiatric evaluation for potential suicide intent and evaluation of medication regimen for effectiveness. |

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**Table 71-1 EMERGENCY MANAGEMENT OF PATIENTS WITH DRUG OVERDOSE (Continued)**

| Drug | Clinical Manifestations | Therapeutic Management |
|---|---|---|
| **Selective Serotonin Reuptake Inhibitors (SSRIs) and Other Antidepressants**<br>Trazodone (Desyrel)<br>Fluoxetine (Prozac)<br>Paroxetine (Paxil)<br>Sertraline (Zoloft)<br>Venlafaxine (Effexor)<br>Escitalopram (Lexapro)<br>Bupropion (Wellbutrin) | Decreased level of consciousness, confusion<br>Respiratory depression<br>Increased heart rate<br>**Serotonin syndrome:**<br>Agitation, seizures<br>Hyperthermia, diaphoresis<br>Hypertension | 1. Administer activated charcoal with possibly whole-bowel irrigation if a sustained-release medication was taken.<br>2. Use seizure precautions and administer benzodiazepines (eg, diazepam) as ordered.<br>3. Serotonin syndrome may occur if the SSRI was taken in conjunction with dextromethorphan or meperidine. |

*Polydrug use at "rave clubs" frequently involves MDMA, alcohol, amphetamines, LSD, and sometimes dextromethorphan. Terms such as "Ecstasy" may refer to flunitrazepam (Rohypnol), GHB, ephedrine, and/or caffeine, in addition to MDMA. The Web site www.clubdrugs.gov provides more information about possible drug abuse and how it may relate to emergency nursing care.

## Acute Alcohol Intoxication

Alcohol is a psychotropic drug that affects mood, judgment, behavior, concentration, and consciousness. Many heavy drinkers are young adults or people older than 60 years of age. There is a high prevalence of alcoholism among ED patients. Because patients who abuse alcohol return frequently to the ED, they often frustrate and tax the patience of the health care professionals who care for them. Their management requires patience and thoughtful, accurate, long-term treatment (Thompson, Lande & Kalapatapu, 2008).

Alcohol, or ethanol, is a multisystem toxin and CNS depressant that causes drowsiness, impaired coordination, slurring of speech, sudden mood changes, aggression, belligerence, grandiosity, and uninhibited behavior. In excess, it can also cause stupor, coma, and death. Increasingly, underage minors and college students arrive at the ED with alcohol poisoning from binge drinking. All too frequently, the result is death.

In the ED, the patient is assessed for head injury, hypoglycemia (which mimics intoxication), and other health problems. Possible nursing diagnoses include ineffective breathing pattern related to CNS depression and risk for violence (self-directed or other-directed) related to severe intoxication from alcohol.

Treatment involves detoxification of the acute poisoning, recovery, and rehabilitation. Commonly, the patient uses mechanisms of denial and defensiveness. The nurse should approach the patient in a nonjudgmental manner, using a firm, consistent, accepting, and reasonable attitude. Speaking in a calm and slow manner is helpful because alcohol interferes with thought processes. If the patient appears intoxicated, hypoxia, hypovolemia, and neurologic impairment must be ruled out before it is assumed that the patient is intoxicated. Typically, a blood specimen is obtained for analysis of the blood alcohol level.

If drowsy, the patient should be allowed to sleep off the state of alcoholic intoxication. During this time, maintenance of a patent airway and observation for symptoms of CNS depression are essential. The patient should be undressed and kept warm with blankets. On the other hand, if the patient is noisy or belligerent, sedation may be necessary. If sedation is used, the patient should be monitored carefully for hypotension and decreased level of consciousness.

In addition, the patient is examined for alcohol withdrawal delirium and also for injuries and organic disease (such as head injury, seizures, pulmonary infections, hypoglycemia, and nutritional deficiencies) that may be masked by alcoholic intoxication. People with alcoholism suffer more injuries than the general population. Also, acute alcohol intoxication is the cause of trauma for many nonalcoholic patients. Pulmonary infections are also more common in patients with alcoholism, resulting from respiratory depression, an impaired defense system, and a tendency toward aspiration of gastric contents. The patient may show little increase in temperature or WBC count. The patient may be hospitalized or admitted to a detoxification center in an effort to examine problems underlying the substance abuse.

## Alcohol Withdrawal Syndrome/Delirium Tremens

Alcohol withdrawal syndrome is an acute toxic state that occurs as a result of sudden cessation of alcohol intake after a bout of heavy drinking or, more typically, after prolonged intake of alcohol. Severity of symptoms depends on how much alcohol was ingested and for how long. Delirium tremens may be precipitated by acute injury or infection (pneumonia, pancreatitis, hepatitis) and is the most severe form of alcohol withdrawal syndrome (Larson, 2008).

Patients with alcohol withdrawal syndrome show signs of anxiety, uncontrollable fear, tremor, irritability, agitation, insomnia, and incontinence. They are talkative and preoccupied and experience visual, tactile, olfactory, and auditory hallucinations that often are terrifying. Autonomic overactivity occurs and is evidenced by tachycardia, dilated pupils, and profuse perspiration. Usually, all vital signs are elevated in the alcoholic toxic state. Delirium tremens is a life-threatening condition and carries a high mortality rate.

The goals of management are to give adequate sedation and support to allow the patient to rest and recover without danger of injury or peripheral vascular collapse. A physical examination is performed to identify preexisting or contributing illnesses or injuries (eg, head injury, pneumonia).

A drug history is obtained to elicit information that may facilitate adjustment of any sedative requirements. Baseline blood pressure is determined, because the patient's subsequent treatment may depend on blood pressure changes.

Usually, the patient is sedated as directed with a sufficient dosage of benzodiazepines to establish and maintain sedation, which reduces agitation, prevents exhaustion, prevents seizures, and promotes sleep. The patient should be calm, able to respond, and able to maintain an airway safely on his or her own. A variety of medications and combinations of medications are used (eg, chlordiazepoxide [Librium], lorazepam [Ativan], and clonidine [Catapres]). Haloperidol (Haldol) or droperidol (Inapsine) may be administered for severe acute alcohol withdrawal syndrome. Dosages are adjusted according to the patient's symptoms (agitation, anxiety) and blood pressure response.

The patient is placed in a calm, nonstressful environment (usually a private room) and observed closely. The room remains lighted to minimize the potential for illusions (visual misrepresentations) and hallucinations. Homicidal or suicidal responses may result from hallucinations. Closet and bathroom doors are closed to eliminate shadows. Someone is designated to stay with the patient as much as possible. The presence of another person has a reassuring and calming effect, which helps the patient maintain contact with reality. To orient the patient to reality, any illusions are explained.

*NURSING ALERT*

**Restraints are used as prescribed, if necessary, if the client is aggressive or violent, but only when other alternatives have been unsuccessful. The least restrictive device that will prevent the patient from injuring self or others is used. Caution is taken to ensure that restraints are applied properly and that they are not impairing circulation to any part of the body or interfering with respirations. Restraints should be used in tandem with verbal intervention to calm the patient and promote compliance. Restraints must be released according to protocol. Physical observation (eg, skin integrity, circulatory status, respiratory status) is ongoing, and the patient's response is documented.**

Fluid losses may result from gastrointestinal losses (vomiting), profuse perspiration, and hyperventilation. In addition, the patient may be dehydrated as a result of alcohol's effect of decreasing antidiuretic hormone. The oral or IV route is used to restore fluid and electrolyte balance.

Temperature, pulse, respiration, and blood pressure are recorded frequently (every 30 minutes in severe forms of delirium) to monitor for peripheral circulatory collapse or hyperthermia (the two most serious complications). Phenytoin (Dilantin) or other antiseizure medications may be prescribed to prevent repeated withdrawal seizures.

Frequently seen complications include infections (eg, pneumonia), trauma, hepatic failure, hypoglycemia, and cardiovascular problems. Hypoglycemia may accompany alcohol withdrawal, because alcohol depletes liver glycogen stores and impairs gluconeogenesis; many patients with alcoholism also are malnourished. Parenteral dextrose may be prescribed if the liver glycogen level is depleted. Orange juice, Gatorade, or other sources of carbohydrates are given to stabilize the blood glucose level and counteract tremulousness. Supplemental vitamin therapy and a high-protein diet are provided as prescribed to counteract nutritional deficits. The patient should be referred to an alcoholic treatment center for follow-up care and rehabilitation.

# VIOLENCE, ABUSE, AND NEGLECT

## *Family Violence, Abuse, and Neglect*

EDs are often the first place where victims of family violence, abuse, or neglect go to seek help. Each year in the United States, there are 4.8 million women and 2.9 million men who experience physical assaults involving their intimate partners. Intimate partner violence (IPV) caused 1544 deaths in 2004; of these victims, 75% were females and 25% were male. Costs related to IPV are estimated to exceed $8.3 billion annually (Centers for Disease Control and Prevention [CDC], 2006a).

It is estimated that up to one third of all patients in the ED have experienced IPV at some point in their lives. Research studies suggest that as many as 44% of all women murdered by a partner had visited an ED within the 2 years prior to death. Researchers believe that most persons who have experienced IPV are willing to disclose their causes of injury, but as few as 4% to 10% of cases are accurately identified in EDs (Daugherty & Houry, 2008). ED nurses must be vigilant in their assessments of both women and men who present with injuries that may be consistent with IPV. In addition, ED nurses must be aware that men and women with disabilities are at higher risk of domestic violence and abuse than nondisabled people and should include questions to that effect in their evaluations.

It is estimated that between 700,000 and 1.2 million elders are abused or neglected annually (American Geriatrics Society, 2005). Elder abuse takes many forms, including physical, emotional, and verbal abuse; neglect; violation of personal rights; and financial abuse (see Chapters 5 and 46).

### Clinical Manifestations

When people who have been abused seek treatment, they may present with physical injuries or with health problems such as anxiety, insomnia, or gastrointestinal symptoms that are related to stress. The possibility of abuse should be investigated whenever a person presents with multiple injuries that are in various stages of healing, when injuries are unexplained, and when the explanation does not fit the physical picture (Chart 71-13). The possibility of neglect should be investigated whenever a dependent person shows evidence of inattention to hygiene, to nutrition, or to known medical needs (eg, unfilled medication prescriptions, missed appointments with health care providers). In the ED, the most common physical injuries seen are unexplained bruises, lacerations, abrasions, head injuries, or fractures. The most common clinical manifestations of neglect are malnutrition and dehydration.

**CHART 71-13** *Assessing for Abuse, Maltreatment, and Neglect*

The following questions may be helpful when assessing a patient for abuse, maltreatment, and neglect:

- I noticed that you have a number of bruises. Can you tell me how they happened? Has anyone hurt you?
- You seem frightened. Has anyone ever hurt you?
- Sometimes patients tell me that they have been hurt by someone at home or at work. Could this be happening to you?
- Are you afraid of anyone at home or work, or of anyone with whom you come in contact?
- Has anyone failed to help you to take care of yourself when you needed help?
- Has anyone prevented you from seeing friends or other people whom you wish to see?
- Have you signed any papers that you did not understand or did not wish to sign?
- Has anyone forced you to sign papers against your will?
- Has anyone forced you to engage in sexual activities within the past year?
- Has anyone prevented you from using an assistive device (eg, wheelchair, walker) within the past year?
- Has anyone you depend on refused to help you take your medicine, bathe, groom, or eat within the past year?

### Assessment and Diagnostic Findings

Nurses in EDs are in an ideal position to provide early detection and interventions for victims of IPV. This requires an acute awareness of the signs of possible abuse, maltreatment, and neglect. Nurses must be skilled in interviewing techniques that are likely to elicit accurate information. A careful history is crucial in the screening process. Asking questions in private—away from others—may be helpful in eliciting information about abuse, maltreatment, and neglect.

Whenever evidence leads one to suspect abuse or neglect, an evaluation with careful documentation of descriptions of events and drawings or photographs of injuries is important, because the medical record may be used as part of a legal proceeding. Assessment of the patient's general appearance and interactions with significant others, an examination of the entire surface area of the body, and a mental status examination are crucial.

### Management

Whenever abuse, maltreatment, or neglect is suspected, the health care provider's primary concern should be the safety and welfare of the patient. Treatment focuses on the consequences of the abuse, violence, or neglect and on prevention of further injury. Protocols of most EDs require that a multidisciplinary approach be used. Nurses, physicians, social workers, and community agencies work collaboratively to develop and implement a plan for meeting the patient's needs.

If the patient is in immediate danger, he or she should be separated from the abusing or neglecting person whenever possible. Referral to a shelter may be the most appropriate action, but many shelters are inaccessible to people with mobility limitations.

When abuse or neglect is the result of stress experienced by a caregiver who is no longer able to cope with the burden of caring for an elderly person or a person with chronic disease or a disability, respite services may be necessary. Support groups may be helpful to these caregivers. When mental illness of the abuser or neglecter is responsible for the situation, alternative living arrangements may be required.

Nurses must be mindful that competent adults are free to accept or refuse the help that is offered to them. Some patients insist on remaining in the home environment where the abuse or neglect is occurring. The wishes of patients who are competent and not cognitively impaired should be respected. However, all possible alternatives, available resources, and safety plans should be explored with the patient.

Mandatory reporting laws in most states require health care workers to report *suspected* child or elder abuse to an official agency, usually Adult (or Child) Protective Services. All that is required for reporting is the suspicion of abuse; the health care worker is not required to prove abuse or neglect. Likewise, health care workers who report suspected abuse are immune from civil or criminal liability if the report is made in good faith. Subsequent home visits resulting from the report of suspected abuse are a part of gathering information about the patient in the home environment. In addition, many states have resource hotlines for use by health care workers and by patients who seek answers to questions about abuse and neglect.

## Sexual Assault

The definition of *rape* is forced sexual acts, especially if these acts involve vaginal or anal penetration. Perpetrators and victims may be either male or female. Society is focused on the rights and care of people who have been sexually assaulted, and law enforcement agencies are increasingly sensitive and aggressive in managing these crimes. Rape crisis centers offer support and education and help people who have been sexually assaulted through the subsequent police investigation and courtroom experience.

The manner in which the patient is received and treated in the ED is important to his or her future psychological well-being. Crisis intervention should begin when the patient enters the health care facility. The patient should be seen immediately. Most hospitals have a written protocol that addresses the patient's physical and emotional needs as well as collection of forensic evidence.

In many states, the emergency nurse has the opportunity to become trained as a sexual assault nurse examiner (SANE). Preparing for this role requires specific training in forensic evidence collection, history taking, documentation, and ways to approach the patient and family. Specialized training also includes learning proper photographic methods and the use of colposcopy. Colposcopy facilitates assessment by magnifying tissues and looking for evidence of microtrauma. Evidence is collected through photography, videography, and analysis of specimens. Another tool useful to the SANE is the light-staining microscope, which enables the examiner to identify motile and nonmotile sperm

and infectious organisms. This tool saves time and also enhances assessment. The SANE complements the ED staff and they can spend more time with both the patient and police officers investigating the incident (Lynch, 2006).

## Assessment and Diagnostic Findings

The patient's reaction to rape has been termed *rape trauma syndrome* and is seen as an acute stress reaction to a life-threatening situation. The nurse performing the assessment is aware that the patient may go through several phases of psychological reactions (Lynch, 2006), which have been described as follows:

- An acute disorganization phase, which may manifest as an expressed state in which shock, disbelief, fear, guilt, humiliation, anger, and other such emotions are encountered or as a controlled state in which feelings are masked or hidden and the victim appears composed
- A phase of denial and unwillingness to talk about the incident, followed by a phase of heightened anxiety, fear, flashbacks, sleep disturbances, hyperalertness, and psychosomatic reactions that is consistent with posttraumatic stress disorder (PTSD) (see Chapter 7 for further discussion of PTSD)
- A phase of reorganization, in which the incident is put into perspective; some victims never fully recover and go on to develop chronic stress disorders and phobias

## Management

The goals of management are to provide support, to reduce the patient's emotional trauma, and to gather available evidence for possible legal proceedings. All of the interventions are aimed at encouraging the patient to gain a sense of control over his or her life.

Throughout the patient's stay in the ED, the patient's privacy and sensitivity must be respected. The patient may exhibit a wide range of emotional reactions, such as hysteria, stoicism, or feelings of being overwhelmed. Support and caring are crucial. The patient should be reassured that anxiety is natural and asked whether a support person may be called. Appropriate support is available from professional and community resources. The Rape Victim Companion Program, if available in the community, can be contacted, and the services of a volunteer can be requested. The patient should never be left alone.

### Physical Examination

A written, witnessed informed consent must be obtained from the patient (or parent or guardian if the patient is a minor) for examination, for taking of photographs, and for release of findings to police. A history is obtained only if the patient has not already talked to a police officer, social worker, or crisis intervention worker. The patient should not be asked to repeat the history. Any history of the event that is obtained should be recorded in the patient's own words. The patient is asked whether he or she has bathed, douched, brushed his or her teeth, changed clothes, urinated, or defecated since the attack, because these actions may alter interpretation of subsequent findings. The time of admission, time of examination, date and time of the alleged rape, and the patient's emotional state and general appearance (including any evidence of trauma, such as discoloration, bruises, lacerations, secretions, or torn and bloody clothing) are documented.

For the physical examination, the patient is helped to undress and is draped properly. Each item of clothing is placed in a separate paper bag. Plastic bags are not used because they retain moisture; moisture may promote mold and mildew formation, which can destroy evidence. The bags are labeled and given to appropriate law enforcement authorities.

The patient is examined (from head to toe) for injuries, especially injuries to the head, neck, breasts, thighs, back, and buttocks. Body diagrams and photographs aid in documenting the evidence of trauma. The physical examination focuses on the following:

- External evidence of trauma (bruises, contusions, lacerations, stab wounds)
- Dried semen stains (appearing as crusted, flaking areas) on the patient's body or clothes
- Broken fingernails and body tissue and foreign materials under nails (if found, samples are taken)
- Oral examination, including a specimen of saliva and cultures of gum and tooth areas

Pelvic and rectal examinations are also performed. The perineum and other areas are examined with a Wood lamp or other filtered ultraviolet light. Areas that appear fluorescent may indicate semen stains. The color and consistency of any discharge present is noted. A water-moistened rather than a lubricated vaginal speculum is used for the examination. Lubricant contains chemicals that may interfere with later forensic testing of specimens and acid phosphatase determinations. The rectum is examined for signs of trauma, blood, and semen. During the examination, the patient should be advised of the nature and necessity of each procedure and given the rationale for each question asked.

### Specimen Collection

During the physical examination, numerous laboratory specimens may be collected, including the following:

- Vaginal aspirate, examined for presence or absence of motile and nonmotile sperm
- Secretions (obtained with a sterile swab) from the vaginal pool for acid phosphatase, blood group antigen of semen, and precipitin test against human sperm and blood
- Separate smears from the oral, vaginal, and anal areas
- Culture of body orifices for gonorrhea
- Blood serum for syphilis and HIV testing and DNA analysis; a sample of serum for syphilis may be frozen and saved for future testing
- Pregnancy test if there is a possibility that the patient may be pregnant
- Any foreign material (leaves, grass, dirt), which is placed in a clean envelope
- Pubic hair samples obtained by combing or trimming. Several pubic hairs with follicles are placed in separate containers and identified as the patient's hair

To preserve the chain of evidence, each specimen is labeled with the name of the patient, the date and time of collection, the body area from which the specimen was

obtained, and the names of personnel collecting specimens. Then the specimens are given to a designated person (eg, crime laboratory technician), and an itemized receipt is obtained.

#### Treating Potential Consequences of Rape

After the initial physical examination is completed and specimens have been obtained, any associated injuries are treated as indicated. The patient is given the option of prophylaxis against sexually transmitted disease (STD) (also referred to as sexually transmitted infection [STI]). Ceftriaxone (Rocephin), administered intramuscularly with 1% lidocaine (Xylocaine), may be prescribed as prophylaxis for gonorrhea. In addition, a single oral dose of metronidazole (Flagyl) and either a single oral dose of azithromycin (Zithromax) or a 7-day oral regimen of doxycycline (Vibramycin) may be prescribed as prophylaxis for syphilis and chlamydia (CDC, 2006b).

Antipregnancy measures may be considered if the patient is of childbearing age (CDC, 2006b). A postcoital contraceptive medication, such as an oral contraceptive medication that contains levonorgestrel and ethinyl estradiol (Alesse, Seasonique), may be prescribed after a pregnancy test. To promote effectiveness, the contraceptive medication should be administered within 12 to 24 hours and no later than 72 hours after intercourse. The 21-day package rather than the 28-day package is prescribed so that the patient does not take the inert tablets by mistake. An antiemetic may be administered as prescribed to decrease discomfort from side effects. A cleansing douche, mouthwash, and fresh clothing are usually offered (Lynch, 2006).

#### Follow-Up Care

The patient is informed of counseling services to prevent long-term psychological effects. Counseling services should be made available to both the patient and the family. A referral is made to the Rape Victim Companion Program, if available. Appointments for follow-up surveillance for pregnancy and for STD and HIV testing also are made (CDC, 2006b).

The patient is encouraged to return to his or her previous level of functioning as soon as possible. When leaving the health care facility, the patient should be accompanied by a family member or friend.

## PSYCHIATRIC EMERGENCIES

A psychiatric emergency is an urgent, serious disturbance of behavior, affect, or thought that makes the patient unable to cope with life situations and interpersonal relationships. A patient presenting with a psychiatric emergency may display overactive or violent, underactive or depressed, or suicidal behaviors.

The most important concern of the ED personnel is determining whether the patient is at risk for injuring self or others. The aim is to try to maintain the patient's self-esteem (and life, if necessary) while providing care. Determining whether the patient is currently under psychiatric care is important so that contact can be made with the therapist or physician who works with the patient.

### Overactive Patients

Patients who display disturbed, uncooperative, and paranoid behavior and those who feel anxious and panicky may be prone to assaultive and destructive impulses and abnormal social behavior. Intense nervousness, depression, and crying are evident in some patients. Disturbed and noisy behavior may be exacerbated or compounded by alcohol or drug intoxication.

A reliable source for obtaining an accurate history is needed to identify events leading to the crisis. Past mental illness, hospitalizations, injuries, serious illnesses, use of alcohol or drugs, crises in interpersonal relationships, or intrapsychic conflicts are explored. Because abnormal thoughts and behavior may be manifestations of an underlying physical disorder, such as hypoglycemia, drug or alcohol toxicity, a stroke, a seizure disorder, or head injury, a physical assessment is also performed.

The immediate goal is to gain control of the situation. If the patient is potentially violent, security or local police should be nearby. Restraints are used as a *last* resort and only as prescribed. Approaching the patient with a calm, confident, and firm manner is therapeutic and has a calming effect. Helpful interventions include the following:

- Introduce yourself by name.
- Tell the patient, "I am here to help you."
- Repeat the patient's name from time to time.
- Speak in one-thought sentences and be consistent.
- Give the patient space and time to slow down.
- Show interest in, listen to, and encourage the patient to talk about personal thoughts and feelings.
- Offer appropriate and honest explanations.

A psychotropic agent (eg, one that exerts an effect on the mind) may be prescribed for emergency management of functional psychosis. However, a patient with a personality disorder should not be treated with psychotropic medications, and psychotropic medications should not be used if the patient's behavior results from the use of hallucinogens (eg, lysergic acid diethylamide [LSD]).

Agents such as chlorpromazine and haloperidol act specifically against psychotic symptoms of thought fragmentation and perceptual and behavioral aberrations. The initial dose depends on the patient's body weight and the severity of the symptoms. After administration of the initial dose, the patient is observed closely to determine the degree of change in psychotic behavior. Subsequent doses depend on the patient's response. Typically, after stabilization, the patient is transferred to an inpatient psychiatric unit or psychiatric outpatient treatment is arranged.

### Violent Behavior

Violent and aggressive behavior, usually episodic, is a means of expressing feelings of anger, fear, or hopelessness about a situation. Usually, the patient has a history of outbursts of rage, temper tantrums, or impulsive behavior. People with a tendency for violence frequently lose control when intoxicated with alcohol or drugs. Family members are the most

frequent victims of their aggression. Patients with a propensity for violence include those intoxicated by drugs or alcohol; those going through drug or alcohol withdrawal; and those diagnosed with acute paranoid schizophrenic state, acute organic brain syndrome, acute psychosis, paranoid character, borderline personality, or antisocial personality disorders.

The goal of treatment is to bring the violence under control. A specially designated room with at least two exits should be used for the interview. The door of the room should be kept open, and the nurse should remain in clear view of the staff, *staying between the patient and the door.* However, the patient's exit to the door must not be blocked, because the patient may feel trapped and threatened. No objects that could be used as weapons should be in sight, in the room, or carried in with health care personnel. If the interviewer feels anxious or uneasy about the patient's response, security staff, a family member, or another health care worker should be asked to remain in the hall nearby in the event that additional help is needed. The patient should never be left alone, because this may be interpreted as rejection or provide an opportunity for self-harm.

To bring the violence under control, it is crucial to use a calm, noncritical approach while remaining in control of the situation. Sudden movements are avoided. If the patient is carrying a weapon, the emergency health care provider should ask that it be surrendered. If the patient is unwilling to surrender the weapon, the security staff is called. If necessary, the security staff may seek further assistance from the local police department.

The patient's violent behavior is a crisis situation for the patient and the ED. Crisis intervention, achieved by talking and listening to the patient, is best accomplished by expressing an interest in the patient's well-being while attempting to tune in to the patient and remain firm. The patient's agitated state is acknowledged by statements such as, "I want to work with you to relieve your distress."

The patient is allowed the opportunity to express anger verbally. If the patient is delusional, challenging the patient is avoided. Trying to hear what the patient is saying, conveying an expectation of appropriate behavior, and making the patient aware that help is available are key. The patient should be informed that violent behavior may be frightening to others and that violence is not acceptable. Help that is available in crisis situations (from a clinic or mental health facility) should be described and offered. Often, the offer of protection by hospitalization is welcomed by the patient, who fears losing control or harming self or others. If the patient does not calm down, security personnel or police intervention may be necessary.

If these measures fail to alleviate the patient's tension, medication may be prescribed (rapid sedation with haloperidol, diazepam, or chlorpromazine) to reduce tension, anxiety, and hyperactivity. Soft restraints must be prescribed by a physician only if other measures to calm the patient have failed (Hoyt & Selfridge-Thomas, 2007). After combativeness, agitation, and fear have decreased, the patient is referred for further mental health treatment.

## Posttraumatic Stress Disorder

PTSD is the development of characteristic symptoms after a psychologically stressful event that is considered outside the range of normal human experience (eg, rape, combat, motor vehicle crash, natural catastrophe, terrorist attack). Symptoms of this disorder include intrusive thoughts and dreams, phobic avoidance reaction (avoidance of activities that arouse recollection of the traumatic event), heightened vigilance, exaggerated startle reaction, generalized anxiety, and societal withdrawal. PTSD may be acute, chronic, or delayed. PTSD often presents as multiple readmissions to the ED for minor or recurring complaints without evidence of injury. Refer to Chapter 7 for further discussion of assessment, diagnostic findings, and management of patients with PTSD.

## Underactive or Depressed Patients

In the ED, depression may be seen as the primary condition bringing the patient to the health care facility or it may be masked by anxiety and somatic complaints. The depressed person has a mood disturbance.

Any patient who is depressed may be at risk of suicide. Attempts are made to find out whether the patient has thought about or attempted suicide. Questions such as, "Have you ever thought about taking your own life?" may be helpful. Generally, the patient is relieved to have an opportunity to discuss personal feelings. If the patient is seriously depressed, relatives should be notified. The patient should never be left alone, because suicide is usually committed in solitude. See Chapter 7 for further discussion of assessment, diagnostic findings, and management of patients with depression.

## Suicidal Patients

Attempted suicide is an act that stems from depression (eg, loss of a loved one, loss of body integrity or status, poor self-image) and can be viewed as a cry for help and intervention. Males are at greater risk than females. Others at risk are elderly people; young adults; people who are enduring unusual loss or stress; those who are unemployed, divorced, widowed, or living alone; those showing signs of significant depression (eg, weight loss, sleep disturbances, somatic complaints, suicidal preoccupation); and those with a history of a previous suicide attempt, suicide in the family, or psychiatric illness.

Being aware of people at risk and assessing for specific factors that predispose a person to suicide are key management strategies. Specific signs and symptoms of potential suicide include the following:

- Communication of *suicidal intent,* such as preoccupation with death or talking of someone else's suicide (eg, "I'm tired of living. I've put my affairs in order. I'm better off dead. I'm a burden to my family.")
- History of a previous suicide attempt (the risk is much greater in these cases)

- Family history of suicide
- Loss of a parent at an early age
- Specific plan for suicide
- A means to carry out the plan

Emergency management focuses on treating the consequences of the suicide attempt (eg, gunshot wound, drug overdose) and preventing further self-injury. A patient who has made a suicidal attempt may do so again. Crisis intervention is used to determine suicidal potential, to discover areas of depression and conflict, to find out about the patient's support system, and to determine whether hospitalization or psychiatric referral is necessary. Depending on the patient's potential for suicide, the patient may be admitted to the intensive care unit, referred for follow-up care, or admitted to the psychiatric unit.

## CRITICAL THINKING EXERCISES

**1** An elderly man arrives at the ED by ambulance after a car crash. He is immobilized on a backboard with a cervical collar and an oxygen mask is in place. There is a bruise across his abdomen where the seat belt was applied. He is groaning loudly and seems confused; he cannot tell you what has happened, where he is at present, nor what day of the week it is, although he can tell you his full name. You note a shallow, rapid breathing pattern of 26 breaths per minute. How would you prioritize the patient's needs? Develop an assessment strategy, identify diagnostic studies that will benefit the patient, and describe the patient's priority treatment needs.

EBP **2** Two men choose to go ice fishing for the first time of the season. They chose to wear light clothing, expecting the cabin to be warm, but neglected to take into account the 4 inches of snow on the ground and the high humidity. They spent the day fishing on the ice without moving much. One man now presents to the ED for treatment of frostbite of his feet. His friend has been massaging them en route to the ED, and the patient insists that this makes his feet feel better. You tell them to cease massage. Describe the explanation you would give to this patient and the evidence base that guides your response. Tell how you would proceed with managing this patient's care. Describe the treatment dilemmas for this type of injury.

**3** The following four patients present to the triage desk of the ED within minutes of each other. How would you prioritize and categorize each of these patients? Which ones need immediate attention? What initial care would you provide at triage? Which patient could wait or be sent to the clinic for management?

a. A college-student with a history of exercise-induced asthma and known noncompliance to prescribed medications presents with rapid, shallow respirations and wheezing after jogging 5 miles. His girlfriend is very anxious. He has been this way for about 15 minutes.
b. An attorney who has had a cold for 3 days says she has no primary care physician and must be seen right now because she cannot breathe. Her respirations are normal, pulse oxygenation saturations are 100%, and she has complaints of sinus drainage and a headache.
c. A middle-age woman experienced sudden dyspnea and chest tightness while making dinner. Instead of calling 911, her husband drove her to the ED. She is complaining of left scapular pain and tingling in her left arm, her skin appears ashen, and she is diaphoretic.
d. An elderly woman with a known history of diabetes presents with complaints of 24 hours of vomiting. Her vital signs are normal, but she is diaphoretic and appears weak.

**4** A patient arrives to the triage area of the ED complaining of flulike symptoms. He has developed a rash that seems to be primarily located on the soles of his feet and palms of his hands. He cannot remember touching anything that he knows he is allergic to, and he has not been walking barefoot. He does like to hunt, and only a week ago was in his deer stand for most of the weekend. What potential disease symptoms are being exhibited by this patient? What other questions would you ask? What will you focus on when you examine his skin?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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***Double asterisk indicates classic reference.*

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## RESOURCES

American College of Surgeons, Committee on Trauma, www.facs.org
American Heart Association, www.americanheart.org
American Trauma Society, www.amtrauma.org
Centers for Disease Control and Prevention, www.cdc.gov
Divers Alert Network, www.diversalertnetwork.org
Emergency Nurses Association, www.ena.org
National Safety Council, www.nsc.org
Society of Trauma Nurses, http://traumanursesoc.org



chapter 72

# Terrorism, Mass Casualty, and Disaster Nursing

## LEARNING OBJECTIVES

***On completion of this chapter, the learner will be able to:***

1. Identify the necessary components of an emergency operations plan.
2. Discuss how triage in a disaster differs from triage in an emergency.
3. Develop a plan of care for a patient experiencing short-term or long-term psychological effects after a disaster.
4. Evaluate the different levels of personal protection and decontamination procedures that may be necessary during an event involving mass casualties or weapons of mass destruction (WMD).
5. Identify physical injuries that may occur after blast events.
6. Describe isolation precautions necessary for bioterrorism agents.
7. Identify the differences among the various chemical agents used in terrorist events, their effects, and the decontamination and treatment procedures that are necessary.
8. Determine the injuries associated with varying levels of radiation or chemical exposure and the associated decontamination processes.

## GLOSSARY

**biological warfare:** use of a biological agent, such as anthrax, as a WMD

**chemical warfare:** use of a chemical agent, such as chlorine, as a WMD

**decontamination:** process of removing, or rendering harmless, contaminants that have accumulated on personnel, patients, and equipment

**mass casualty incident (MCI):** situation in which the number of casualties exceeds the number of resources

**material safety data sheet (MSDS):** provides information to employees and health care providers regarding specific chemical agents; includes chemical name, physical data, chemical ingredients, fire and explosive hazard data, health and reactive data, spill or leak procedures, special protection information, and special precautions; also known as the Worker's Right to Know

**nuclear warfare:** use of nuclear contamination as a WMD

**personal protective equipment (PPE):** equipment beyond standard precautions; may include level A, B, C, and D equipment

**terrorism:** unlawful use of violence or threats of violence against people in order to coerce or intimidate

**weapons of mass destruction (WMD):** weapons used to cause widespread death and destruction

The possibility and reality of mass casualties associated with disasters, terrorism, and biologic warfare are not new to human history; nor is the concept of using **weapons of mass destruction (WMD).** In fact, the use of WMD dates as far back as the 6th century BCE for biological weapons and the year 436 BCE for chemical weapons (U.S. Army Medical Research Institute of Chemical Defense, 1999). However, geopolitical forces and interests and the availability of destructive technology have brought the possibility of more terrorist events to our doorstep. **Terrorism** systematically involves using violence to create feelings of fear. Examples include the 1993 bombing of the World Trade Center in New York City; the 1995 Oklahoma City bombing of the Murrah Federal Building; the total destruction of the World Trade Center towers and the damage to the Pentagon on September 11, 2001; and the London subway bombing of 2005. Terrorists have become increasingly sophisticated, organized, and therefore effective. It is no longer a question of *whether* a terrorist event will again lead to mass casualties, but *when* such an event will occur.

In 1999, the National Domestic Preparedness Organization, a federal agency, was developed to coordinate preparedness in the event of a terrorist attack. The Department of Homeland Security was created after the attacks of September 11, 2001, to coordinate federal and state efforts to combat terrorist activity. Every facility receiving preparedness funds must have a plan that adheres to guidelines devised by the National Incident Management System (NIMS), directed by the Federal Emergency Management Agency (FEMA).

Warfare and terrorism are just two of the reasons that health care providers need to plan for mass casualties. Airplane crashes, train crashes, toxic substance spills, and infectious disease outbreaks are other disasters that can result in casualties and tax the resources of health care facilities and their communities. In addition, natural phenomena such as floods, tornadoes, hurricanes (eg, Hurricane Katrina, the category 5 storm that struck New Orleans, Louisiana, and Biloxi, Mississippi, in 2006), fires, and earthquakes, kill and injure hundreds of thousands of people worldwide each year. Acute care facilities must be prepared for any and all of these disasters. This chapter focuses on disaster preparedness, especially providing information about possible terrorist-related injuries and illnesses that can occur after biologic, chemical, and nuclear or radiation attacks. Information about the process of responding to these emergencies is applicable to other types of mass disasters as well.

## *Federal, State, and Local Responses to Emergencies*

Many resources are available at the federal, state, and local levels to assist in the management of **mass casualty incidents (MCIs),** disasters, and emergencies. An MCI is defined as any incident that results in more patients than daily resources can handle (Emergency Nurses Association, 2007). Local communities must be prepared to act in isolation and provide competent care for up to 5 days before federal or other state resources become available (Hoyt & Selfridge-Thomas, 2007). Initiating the request for federal assistance should not be delayed, however, so that resources do not become exhausted.

**Chart 72-1 • *Disaster Levels***

Disasters are often classified by the resultant anticipated necessary response:

**Level I:** Local emergency response personnel and organizations can contain and effectively manage the disaster and its aftermath.

**Level II:** Regional efforts and aid from surrounding communities are sufficient to manage the effects of the disaster.

**Level III:** Local and regional assets are overwhelmed; statewide or federal assistance is required.

Disasters are often categorized by level to indicate the anticipated level of response (Chart 72-1). A list of local resources with specific instructions about how and when to contact these agencies or organizations should be readily available to local disaster planning committees and frequently reviewed by those committees for needed updates.

A disaster response strategy cannot succeed without appropriate physical assets and a staff trained and prepared to carry out the plan. Assets such as increased security; stockpiles of equipment and medications; and planning, drills, and training are essential (Lusby, 2006). Hazard vulnerability assessments should be performed to identify potential and actual threats that involve a particular facility and community. Mutual aid agreements among various communities must take these vulnerabilities into account. Successful execution of a response plan is based on knowledge, confidence, and readiness.

### Federal Agencies

State authorities must request federal assistance with resources through appropriate government channels. A request for federal resources generally is made when local resources have become or are expected to become depleted.

Federal agencies that may provide resources in response to an MCI or a disaster include the Department of Health and Human Services (DHHS), the Department of Justice, Department of Defense, and the Department of Homeland Security. Each of these federal departments oversees hundreds of agencies that may respond to MCIs. For example, personnel from the Federal Bureau of Investigation (FBI) (structured under the Department of Justice) may be used for scene control and collection of forensic evidence. FEMA, which is overseen by the Department of Homeland Security, can activate teams such as the Urban Search and Rescue Teams (USRTs). The DHHS administers the Centers for Disease Control and Prevention (CDC) and the National Disaster Medical System. The National Disaster Medical System has many medical support teams, such as Disaster Medical Assistance Teams (DMATs), Disaster Mortuary Response Teams (DMORTs), Veterinary Medical Assistance Teams (VMATs), and National Medical Response Teams for Weapons of Mass Destruction (NMRTs).

The DMAT organizes voluntary medical personnel who can set up and staff a field hospital; DMATs are located across the country. There are four NMRTs: the

**Table 72-1 DEPARTMENT OF HOMELAND SECURITY THREAT LEVELS**

| Level of Security Threat | Actions |
|---|---|
| Red: severe, usually site is specified | Lockdown for security<br>Prevention of parking close to the site<br>Activation of the Emergency Operation Plan and Incident Command System |
| Orange: high, risk of attack but a specific site may not yet be identified | Increased security and screenings<br>Activation of the Incident Command System |
| Yellow: elevated, possible risk but no defined site | Increased awareness and monitoring of activities<br>Continued training for the Emergency Operations Plan |
| Blue: guarded, general risk but no specific risks identified | Ensure readiness with drill practice |
| Green: low, little or no risk perceived or known | Continued preparedness with drill practice |

U.S. Department of Homeland Security, 2003.

mobile California, North Carolina, and Colorado teams and the Washington, D.C., team, which is stationary. These specialty teams were developed to respond to situations involving WMD. They consist of specially trained medical and technical personnel. The National Guard Civil Strike Teams are specially trained units that may respond to MCIs or disasters. In addition, the Department of Homeland Security designates a level of security threat that is intended to alert the country to credible threats (Table 72-1).

Additional federal resources that may be activated include the teams from the CDC. This is the main federal agency for disease prevention, and it controls activities and provides backup support to state and local health departments. Additional support is available from the American Red Cross, which provides many support systems and shelter as needed.

## State and Local Agencies

Some state and local agencies may be branches of the same agencies already listed (eg, local CDC and FBI). Other state and local resources may include the American Red Cross, poison control centers, and other local volunteer organizations. The Metro Medical Response Teams Systems are local teams of health care providers that are located in cities considered possible terrorist targets and are funded for specialty response to WMD. Many state and federal task forces have been developed to assist in the development and improvement of civilian medical response to chemical and biologic terrorism.

Most cities and all states have an Office of Emergency Management (OEM) or Office of Emergency Services (OES). The OEM/OES coordinates the disaster relief efforts at the state and local levels. The OEM/OES is responsible for providing interagency coordination during an emergency. It maintains a corps of emergency management personnel, including a leader, responders, planners, and administrative and support staff.

## The Incident Command System

The Incident Command System (ICS) is a federally mandated command structure that coordinates personnel, facilities, equipment, and communication in any emergency situation. The ICS is the center of operations for organization, planning, and transport of patients in the event of a specific local MCI. Successful incident management requires equipment compatibility, effective communication, adequate distribution of resources, and clear differentiation of members' roles. The ICS ensures that any hazardous substances used during an MCI are identified promptly and that appropriate personal protection equipment is distributed. In addition to all of these responsibilities, the ICS is also responsible for determining when an MCI has ended.

The hospital incident command system (HICS) is a modification of the ICS that is used by both hospitals and law enforcement agencies. The HICS incident commander is the hospital emergency preparedness coordinator who oversees and coordinates all efforts surrounding the event. The HICS team includes a safety officer, public information officer, liaison officer, operations chief, logistics chief, planning chief, and finance chief. Each team member has a specific responsibility and communicates directly back to the incident commander (Dara, Ashton, Farmer, et al., 2005).

# *Hospital Emergency Preparedness Plans*

Health care facilities are required by the Joint Commission to create a plan for emergency preparedness and to practice this plan at least twice a year (Joint Commission, 2006). Generally, these plans are developed by the facility's safety committee and are overseen by an administrative liaison.

Before the basic emergency operations plan (EOP) can be developed, the planning committee of the health care facility first evaluates characteristics of the community to identify the likely types of natural and man-made disasters that might occur. This hazard vulnerability analysis process is the responsibility of the local health care facility and its safety committee, safety officer, or emergency department (ED) manager. This information can be gathered by questioning local law enforcement, fire departments, and emergency medical systems and assessing the patterns of local train traffic, automobile traffic, and flood, earthquake, tornado, or hurricane activity. Consideration is also given to possible mass casualties that could arise because of the community's proximity to chemical plants, nuclear facilities, or military bases. Federal, judicial, or financial buildings, schools, and any places where large groups of people gather can be considered high-risk areas.

The emergency preparedness planning committee must have a realistic understanding of its resources. It must determine, for example, whether the facility has or needs a pharmaceutical stockpile available to treat specific chemical or biological agents (Hoyt & Selfridge-Thomas, 2007). Another scenario that might be anticipated may include the dispersal of a pulmonary intoxicant or choking agent, which would require that emergency operations planners determine how many ventilators are available within the facility and throughout the greater community. The committee might also outline how staff would triage and assign priority to patients when the number of ventilators is limited. Multiple factors influence a facility's ability to respond effectively to a sudden influx of injured patients, and the committee must anticipate various scenarios to improve its preparedness.

## Components of the Emergency Operations Plan

The principles of emergency management must be a part of the EOP design and include a comprehensive plan for tackling all potential and actual hazards. The primary goal is protection of the community. The EOP should be integrated with local, state, and federal government plans and coordinated with the private sector and volunteers. It must be coordinated in advance to achieve a single common purpose, yet the plan must be flexible enough to adapt to any likely situation at hand. Predetermined organization is essential to minimize confusion, ensure that all key operations are directed, and promote a well-coordinated response. Essential components of the EOP include the following:

- *An activation response:* The EOP activation response of a health care facility defines where, how, and when the response is initiated.
- *An internal/external communication plan:* Communication is critical for all parties involved, including communication to and from the prehospital arena (Dara, et al., 2005).
- *A plan for coordinated patient care:* A response is planned for coordinated patient care into and out of the facility, including transfers to other facilities. The site of the disaster can determine where the greater number of patients may self-refer.
- *Security plans:* A coordinated security plan involving facility and community agencies is key to the control of an otherwise chaotic situation.
- *Identification of external resources:* External resources are identified, including local, state, and federal resources and information about how to activate these resources.
- *A plan for people management and traffic flow:* "People management" includes strategies to manage the patients, the public, the media, and personnel. Specific areas are assigned, and a designated person is delegated to manage each of these groups (Dara, et al., 2005).
- *A data management strategy:* A data management plan for every aspect of the disaster will save time at every step. A backup system for charting, tracking, and staffing is developed if the facility has a computer system.
- *Demobilization response:* Deactivation of the response is as important as activation; resources should not be unnecessarily exhausted. The person who decides when the facility resumes daily activities is clearly identified. Any possible residual effects of a disaster must be considered before this decision is made.
- *An after-action report or corrective plan:* Facilities often see increased volumes of patients 3 months or more after an incident. Postincident response must include a critique and a debriefing for all parties involved, immediately and again at a later date.
- *A plan for practice drills:* Practice drills that include community participation allow for troubleshooting any issues before a real-life incident occurs.
- *Anticipated resources:* Food and water must be available for staff, families, and others who may be at the facility for an extended period.
- *MCI planning:* MCI planning includes such issues as planning for mass fatalities and morgue readiness.
- *An education plan for all of the above:* A strong education plan for all personnel regarding each step of the plan allows for improved readiness and additional input for fine-tuning of the EOP (Dara, et al., 2005).

## Initiating the Emergency Operations Plan

Notification of a disaster situation to a health care facility varies with each situation. Generally, the notification to the facility comes from outside sources unless the initial incident occurred at the facility. The disaster activation plan should clearly state how the EOP is to be initiated. If communication is functioning, field incident command will give notice of the approximate number of arriving patients, although the number of self-referring patients will not be known.

### *Identifying Patients and Documenting Patient Information*

Patient tracking is a critical component of casualty management. Disaster tags, which are numbered and include triage priority, name, address, age, location and description of injuries, and treatments or medications given, are used to communicate patient information. The tag should be securely placed on the patient and remain with the patient at all times. The tag number and the patient's name, if known, are recorded in a disaster log. The log is used by the command center to track patients, assign beds, and provide families with information.

### *Triage*

Triage is the sorting of patients to determine the priority of their health care needs and the proper site for treatment. In nondisaster situations, health care workers assign a high priority and allocate the most resources to those who are the most critically ill. For example, a young adult who has a chest injury and is in full cardiac arrest would receive advanced cardiopulmonary resuscitation, including medications, chest tubes, intravenous (IV) fluids, blood, and possibly emergency surgery in an effort to restore life. However, in a disaster, when health care providers are faced with a large number of casualties, the fundamental principle

**Table 72-2 TRIAGE CATEGORIES DURING A MASS CASUALTY INCIDENT (MCI)**

| Triage Category | Priority | Color | Typical Conditions |
|---|---|---|---|
| **Immediate:** Injuries are life-threatening but survivable with minimal intervention. Individuals in this group can progress rapidly to expectant if treatment is delayed. | 1 | Red | Sucking chest wound, airway obstruction secondary to mechanical cause, shock, hemothorax, tension pneumothorax, asphyxia, unstable chest and abdominal wounds, incomplete amputations, open fractures of long bones, and 2nd/3rd degree burns of 15%–40% total body surface area. |
| **Delayed:** Injuries are significant and require medical care, but can wait hours without threat to life or limb. Individuals in this group receive treatment only after immediate casualties are treated. | 2 | Yellow | Stable abdominal wounds without evidence of significant hemorrhage; soft tissue injuries; maxillofacial wounds without airway compromise; vascular injuries with adequate collateral circulation; genitourinary tract disruption; fractures requiring open reduction, débridement, and external fixation; most eye and CNS injuries. |
| **Minimal:** Injuries are minor and treatment can be delayed hours to days. Individuals in this group should be moved away from the main triage area. | 3 | Green | Upper extremity fractures, minor burns, sprains, small lacerations without significant bleeding, behavioral disorders or psychological disturbances. |
| **Expectant:** Injuries are extensive and chances of survival are unlikely even with definitive care. Persons in this group should be separated from other casualties, but not abandoned. Comfort measures should be provided when possible. | 4 | Black | Unresponsive patients with penetrating head wounds, high spinal cord injuries, wounds involving multiple anatomical sites and organs, 2nd/3rd degree burns in excess of 60% of body surface area, seizures or vomiting within 24 hours after radiation exposure, profound shock with multiple injuries, agonal respirations; no pulse, no blood pressure, pupils fixed and dilated. |

guiding resource allocation is to do the greatest good for the greatest number of people. Decisions are based on the likelihood of survival and consumption of available resources. Therefore, this same patient, and others with conditions associated with a high mortality rate, would be assigned a low triage priority in a disaster situation, even if the person is conscious. Although this may sound uncaring, from an ethical standpoint the expenditure of limited resources on people with a low chance of survival, and denial of those resources to others with serious but treatable conditions, cannot be justified.

The triage officer rapidly assesses those injured at the disaster scene. Patients are immediately tagged and transported or given life-saving interventions. One person performs the initial triage while other emergency medical services (EMS) personnel perform life-saving measures (eg, intubation) and transport patients. Although EMS personnel carry out initial field triage, secondary and continuous triage at all subsequent levels of care is essential.

Staff should control all entrances to the acute care facility so that incoming patients are directed to the triage area first. The triage area may be outside the entry or just at the door of the ED. This facilitates the triage of all patients, including those arriving by medical transport and those who walk into the ED. Some patients who have already been seen in the field may be reclassified in the triage area, based on their current presentation.

Triage categories separate patients according to severity of injury. A special color-coded tagging system is used during an MCI so that the triage category is immediately obvious. There are several triage systems in use across the country, and every nurse should be aware of the system used by his or her facility and community. The North Atlantic Treaty Organization (NATO) triage system is one that is widely used. It consists of four colors—red, yellow, green, and black. Each color signifies a different level of priority. Table 72-2 describes each category and gives examples of how different injuries would be classified. (See Chapter 71 for discussion of triage in non-MCI situations.)

### Managing Internal Problems

Each facility must determine its supply lists based on its own needs assessment. The Red Cross has developed a basic survival/shelter resource kit. The EOP committee should determine the top 10 critical medications used during normal day-to-day operations and then anticipate which other medications may be required in a disaster or an MCI. For example, the health care facility might plan to have available a stockpile of antidotes (eg, cyanide kits) or antibiotics used in treating biologic agents. Information should be available about stocking or restocking any of the basic and special supplies, how those supplies are requested, and the time required to receive those supplies.

### Communicating With the Media and Family

Communication is a key component of disaster management. Communication within the vast team of disaster responders is paramount; however, effective, informative communication with the media and worried family members is also crucial.

#### Managing Media Requests for Information

Although the media have an obligation to report the news and can play a significant positive role in communication, the number of reporters and newscasters and their support teams can be overwhelming, possibly compromising operations and patient confidentiality. A clearly defined process for managing media requests that includes a designated spokesperson, the public information officer, a site for the

**Chart 72-2 • *Cultural Considerations***

Any disaster or mass casualty incident can be expected to involve members of diverse religious, ethnic, and cultural groups or may be targeted at and predominately affect a specific religious or ethnic group. Health care providers likewise include members of all religious, ethnic, and cultural backgrounds and should bear in mind that victims may have:

- Language difficulties that increase fears and frustrations
- Specific religious practices related to medical treatment, hygiene, or diet
- Specific places/times for prayer
- Rituals about handling the dead
- Timing of funeral services

Some religious communities have plans for emergencies and disasters, and local hospitals should integrate these plans to the extent possible into their emergency operations plans.

dissemination of information (away from patient care areas), and a regular schedule for providing updates should be part of the disaster plan.

The EOP helps prevent the release of contradictory or inaccurate information. Initial statements should focus on current efforts and what is being done to better understand the scope and impact of the situation. Information about casualties should not be released. Security staff should not allow media personnel access to patient care areas.

#### Caring for Families

Friends and family members converging on the scene must be cared for by the facility. The public information officer's role is to provide direction for the families and provide them with information as it becomes available. They may be feeling intense anxiety, shock, or grief and should be provided with information and updates about their loved ones as soon as possible and regularly thereafter. They should not be in the triage or treatment areas but in a designated area staffed by available social workers, counselors, therapists, or clergy. Access to this area should be controlled to prevent families from being disturbed. Chart 72-2 discusses cultural variables to consider when coping with disaster-related injuries and death.

### *The Nurse's Role in Disaster Response Plans*

The role of the nurse during a disaster varies. Nurses may be asked to perform duties outside their areas of expertise and may take on responsibilities normally held by physicians or advanced practice nurses. For example, a critical care nurse may intubate a patient or even insert a chest tube. A nurse may perform wound débridement or suturing. A nurse may serve as the triage officer.

Although the exact role of a nurse in disaster management depends on the specific needs of the facility at the time, it should be clear which nurse or physician is in charge of a given patient care area and which procedures each individual nurse may or may not perform. Assistance can be obtained through the HICS, and nonmedical personnel can provide services where possible. For example, family members can provide nonskilled interventions for their loved ones. Nurses should remember that nursing care in a disaster focuses on essential care from a perspective of what is best for all patients.

New settings and atypical roles for nurses arise during a disaster; for example, the nurse may provide shelter care in a temporary housing area or bereavement support and assistance with identification of deceased loved ones. People may require crisis intervention, or the nurse may participate in counseling other staff members and in Critical Incident Stress Management. Special care may be warranted for at-risk populations during a disaster (Chart 72-3).

#### Considering Ethical Conflicts

Disasters can present a disparity between the resources of the health care agency and the needs of the victims. This generates ethical dilemmas for nurses and other health care providers. Issues include conflicts related to the following:

- Rationing care
- Futile therapy
- Consent
- Duty
- Confidentiality
- Resuscitation
- Assisted suicide

Nurses may find it difficult to not provide care to the dying or to withhold information to avoid spreading fear and panic. Clinical scenarios that are unimaginable in normal circumstances confront the nurse in extreme instances. Other ethical dilemmas may arise out of health care providers' instincts for self-protection and protection of their families. For example, what should a pregnant nurse do when incoming disaster victims have been exposed to radiation yet too few nurses are available?

Nurses can plan for the ethical dilemmas they will face during disasters by establishing a framework for evaluating

**Chart 72-3 • *Caring for People With Disabilities During a Disaster***

When a disaster occurs, the multiple agencies involved attempt to provide food, water, and shelter to all those affected. People with disabilities have specific needs that require attention. It is recommended that people with disabilities have a personal support network to check on them after a disaster and to provide needed assistance. They should also have a back-up system and an evacuation plan. Agencies need to be aware that service animals are also affected during a disaster and may be brought to shelters with their companions.

Evacuation assistance is imperative for people with disabilities. Directions to personal equipment (eg, communication aids, medications, oxygen) should be available to rescue personnel. In a rapid evacuation, mobility devices, oxygen, suction, and medications will be needed at the shelters. Special efforts to keep those with vision or hearing impairment informed should be implemented. People skilled in sign language are also valuable resources during a disaster. On its Web site, the American Red Cross provides a handbook for disaster preparedness for people with disabilities: www.redcross.org/services/disaster/ beprepared/ disability/html

ethical questions before they arise and by identifying and exploring possible responses to difficult clinical situations. They can consider how the fundamental ethical principles of utilitarianism, beneficence, and justice will influence their decisions and care in disaster response (see Chapter 3).

**Managing Behavioral Issues**

Although most people pull together and function well during a disaster, both people and communities suffer immediate and sometimes long-term psychological trauma. Common responses to disaster include the following:

- Depression
- Anxiety
- Somatization (fatigue, general malaise, headaches, gastrointestinal disturbances, skin rashes)
- Posttraumatic stress disorder (PTSD)
- Substance abuse
- Interpersonal conflicts
- Impaired performance

Factors that influence a person's response to disaster include the degree and nature of the exposure to the disaster, loss of friends and loved ones, existing coping strategies, available resources and support, and the personal meaning attached to the event. Other factors, such as loss of home and valued possessions, extended exposure to danger, and exposure to toxic contamination, also influence response and increase the risk of adjustment problems. Those exposed to the dead and injured, those endangered by the event, the elderly, children, emergency first responders, and health care personnel caring for victims are considered to be at higher risk for emotional sequelae.

Nurses can assist disaster victims through active listening and providing emotional support, giving information, and referring patients to therapists or social workers. Health care workers must refer people to mental health care services because experience has shown that few disaster victims seek these services, and early intervention minimizes psychological consequences. Nurses can also discourage victims from subjecting themselves to repeated exposure to the event through media replays and news articles, and encourage them to return to normal activities and social roles when appropriate.

***Critical Incident Stress Management***

Critical Incident Stress Management (CISM) is an approach to preventing and treating the emotional trauma that can affect emergency responders as a consequence of their jobs and that can also occur to anyone involved in a disaster or MCI. CISM is handled by its own teams, which are available to the OEM. There are 350 such teams in the United States. All branches of emergency services have CISM teams, as do the military and many industries (eg, airline industry).

Components of a management plan include education before an incident occurs about critical incident stress and coping strategies; field support (ensuring that staff get adequate rest, food, and fluids, and rotating work loads) during an incident; and defusings, debriefings, demobilization, and follow-up care after the incident.

Defusing is a process by which the person receives education about recognition of stress reactions and management strategies for handling stress. Debriefing is a more complicated intervention; it involves a 2- to 3-hour process during which participants are asked about their emotional reactions to the incident, what symptoms they may be experiencing (eg, flashbacks, difficulty sleeping, intrusive thoughts), and other psychological ramifications. In follow-up, members of the CISM team contact the participants of a debriefing and schedule a follow-up meeting if necessary. People with ongoing stress reactions are referred to mental health specialists.

# Preparedness and Response

## Recognition and Awareness

Preparedness for terrorism and other disasters includes awareness of the potential for covert use of WMD, self-protection, and early detection, containment, or decontamination of substances and agents that may affect others by secondary exposure. The strength of many toxins, mobility of many members of society, and long incubation periods for some organisms and diseases can result in an epidemic that can quickly and silently spread across the entire country. For example, a formerly healthy person with a rapid onset of flulike symptoms can have an ominous illness, such as anthrax or severe acute respiratory syndrome (SARS), both of which are discussed in more detail later in the chapter.

Nurses should have a heightened awareness of trends that may suggest deliberate dispersal of toxic or infectious agents, including the following:

- An unusual increase in the number of people seeking care for fever, respiratory, or gastrointestinal symptoms
- Clusters of patients who present with the same unusual illness from a single location. For example, clusters can be from a specific geographic location, such as a city, or from a single sporting or entertainment event.
- A large number of rapidly fatal cases, especially when death occurs within 72 hours after hospital admission.
- Any increase in disease incidence in a normally healthy population. These cases should be reported to the state health department and to the CDC.

If any of these trends are noted, an extensive patient history is taken in an attempt to identify the possible agent involved. This history includes an occupational, work, and environmental assessment, in addition to the regular admission history. An exposure history contains, at a minimum, information about current and past exposures to possible hazards and an assessment of the patient's typical day and any deviations in routines. The work history includes, at a minimum, a description of all previous jobs, including short-term, seasonal, and part-time employment and any military service. The environmental history includes assessment of present and previous home locations, water supply, and any hobbies, to name a few factors. The admission history should include such information as recent travel and contact with others who have been ill or have recently died of a fatal illness. This is just a brief review of the extensive history that may need to be obtained to identify an

exposure agent (Agency for Toxic Substances and Disease Registry, 2009).

Suspicions or findings are reported to the appropriate resources in the facility and to proper authorities in the community. Resources can include the infection control department, **material safety data sheets (MSDS)** or the Chemtrac database, the state health department, the CDC, the local poison control center, and many Internet sites (Dara, et al., 2005). Reporting furnishes data elements to those agencies responsible for epidemiology and response. Reporting also allows for sharing of information among facilities and jurisdictions and can help determine the source of infections or exposure and prevent further exposures and even deaths.

## Personal Protective Equipment

Another component of preparedness and response involves the protection of the health care provider by additional **personal protective equipment (PPE).** Chemical or biologic agents and radiation are silent killers and are generally colorless and odorless. The purpose of PPE is to shield health care workers from the chemical, physical, biologic, and radiologic hazards that may exist when caring for contaminated patients. The U.S. Environmental Protection Agency (EPA) has divided protective clothing and respiratory protection into the following four categories, levels A through D:

- Level A protection is worn when the highest level of respiratory, skin, eye, and mucous membrane protection is required. This includes a self-contained breathing apparatus (SCBA) and a fully encapsulating, vapor-tight, chemical-resistant suit with chemical-resistant gloves and boots.
- Level B protection requires the highest level of respiratory protection but a lesser level of skin and eye protection than with level A situations. This level of protection includes the SCBA and a chemical-resistant suit, but the suit is not vapor tight (Hoyt & Selfridge-Thomas, 2007).
- Level C protection requires the air-purified respirator, which uses filters or sorbent materials to remove harmful substances from the air. A chemical-resistant coverall with splash hood, chemical-resistant gloves, and boots are included in level C protection.
- Level D protection is the typical work uniform.

Levels C and D PPE are the levels most often used in hospital facilities (Hoyt & Selfridge-Thomas, 2007).

Protective equipment must be donned before contact with a contaminated patient. The acute care facility's standard precaution PPE (level D) generally is not adequate for protection from a chemically, biologically, or radiologically contaminated patient. Level C PPE is adequate for the average patient exposure. The health care provider must use equipment that is capable of providing protection against the agent involved. This may mean using a splash suit along with a full-face positive-pressure or negative-pressure respirator (a filter-type gas mask) or even an SCBA for medical personnel in the field.

No single PPE is capable of protecting against all hazards. Under no circumstances should responders wear any PPE without proper training, practice, and fit testing of respirator masks as necessary.

## Decontamination

**Decontamination,** the process of removing accumulated contaminants, is critical to the health and safety of health care providers by preventing secondary contamination. The decontamination plan should establish procedures and educate employees about decontamination procedures, identify the equipment needed and methods to be used, and establish methods for disposal of contaminated materials (Dara, et al., 2005).

Although many principles and theories surround decontamination of a patient, authorities agree that, to be effective, decontamination must include a minimum of two steps. The first step is removal of the patient's clothing and jewelry and then rinsing the patient with water. Depending on the type of exposure, this step alone can remove a large amount of the contamination and decrease secondary contamination. The second step consists of a thorough soap-and-water wash and rinse. When patients arrive at the facility after being assessed and treated by a prehospital provider, it should not be assumed that they have been thoroughly decontaminated. The hospital must be prepared to perform additional decontamination prior to entry into the facility. The hospital personnel may also treat "walking wounded" who did not receive any decontamination at the scene.

# *Natural Disasters*

Natural disasters may result in mass casualties. Natural disasters can occur anywhere at any time and include events such as tornadoes, hurricanes, floods, avalanches, tidal waves (eg, tsunamis), earthquakes, and volcanic eruptions. In the event of a natural disaster, loss of communications, potable water, and electricity is usually the greatest obstacle to a well-coordinated emergency response, and preparatory planning is essential. Even wireless technology (eg, cellular phones, computers, other communication devices) may not be functional.

The majority of the immediate casualties are trauma related. These mass casualties tax the trauma system to its limits to provide triage, transport of patients (in poor weather and road conditions), and management within the trauma centers. The majority of patients usually begin arriving within an hour of the event. However, the "walking wounded" may not seek care for 5 days to 2 weeks after the event or may seek care for injuries received during clean-up activities. Casualties arrive at hospitals in three waves. The first wave consists of minimally (generally) injured people who arrive of their own accord. The second wave consists of severely injured patients. The third wave consists of injured patients who arrive after they are discovered by rescuers. For example, in the event of earthquakes, buildings collapse and cause the majority of fatalities from injuries that primarily involve the head and chest (Kano, 2005). The majority of the patients usually begin arriving within an hour of the event; the "walking wounded" may not seek care for 5 days to 2 weeks after the event or may seek care for injuries inflicted during the clean-up activities.

Excessive exposure to the natural elements and the need for food and water (by both patients and emergency responders) are critical issues. Without cover (eg, buildings may be unsafe or destroyed) or potable water (eg, water may

be either contaminated or unavailable), injuries from exposure to heat, cold, or contaminated food or water can occur. Safety equipment that protects rescue workers from injury, exposure, and potentially dangerous animals (eg, snakes, alligators, spiders) must be readily available. Rescue workers may also injure themselves in the process of extrication or cleanup (eg, chain saws, building collapse). Hypothermia can occur rapidly in workers who are exposed to water at temperatures of 23.9°C (75°F) or less. As is true during all disasters, mental health workers and shelters are needed throughout the community. Veterinary assistance is also essential because pets are frequently abandoned and injured. In addition, emergency response workers must be prepared to treat the most common ailments experienced after exposure to a specific natural disaster. For instance, pulmonary problems peak with earthquakes and volcanic eruptions because of the increased particulate matter in the air. Most volcano-related deaths are from suffocation. After floods or water disasters, waterborne transmission of agents such as *Escherichia coli,* salmonella, shigella, typhoid, leptospirosis, malaria, and tularemia are common and cause widespread disease. In addition, other waterborne hazards can include human exposure to poisonous snakes and alligators in the flood waters.

In some instances, early warning systems have assisted in decreasing the number of deaths from tornadoes and hurricanes. However, even with the advent of early warning systems, some people are unable or unwilling to leave prior to the occurrence of the natural disaster. When buildings collapse, rapid response to identify and remove trapped victims is the only means of improving survivability. There is a direct relationship between time trapped and survival; fewer than 50 percent of people survive if they are trapped more than 2 to 6 hours. Water-damaged buildings are not safe and require extensive examination before experts can ensure safe occupancy. Larger-scale issues that can cause significant later morbidity and mortality include the absence of water purification, waste removal, removal of human and animal remains, and vector control. Removal or disposal of biologic, chemical, and nuclear agents must also be considered.

## Weapons of Terror

Although biologic, chemical, and radiologic events are not everyday events, they can occur at any facility, and every nurse needs to know the basics of caring for affected patients. An explosion may spread the dangerous material. Therefore, treatment of blast injuries must be anticipated and planned.

### Blast Injury

Examples of recent highly publicized bombings that have caused significant injuries or loss of lives include those in a disco in Tel Aviv in 2001, in the London subway system in 2005, and on the Mumbai (India) commuter trains in 2006. Terrorist bombings occur frequently throughout the Middle East today, particularly in Iraq and Afghanistan. Several types of bombs are typically used, resulting in various injuries.

#### Types of Explosive Devices

Commonly used bombs include pipe bombs, Molotov cocktails, fertilizer bombs, and "dirty" bombs (so-called because they spread radiation). The most commonly utilized bomb is the pipe bomb, which consists of relatively low-velocity explosives and may also contain nails or other implements that cause more damage when the explosive ignites. Another type of commonly used explosive device is the Molotov cocktail, which uses a common flammable liquid such as gasoline in a glass bottle and a source of ignition, such as a rag. This forms a simple yet effective incendiary device. Other common explosive devices include fertilizer bombs, which were used in the Oklahoma City bombing in 1995, and dirty bombs, which include a radioactive source that spreads radiation after the initial blast. Common hazards following a bombing include secondary devices (set to explode at a predetermined time, typically after the arrival of rescue personnel), building collapse, contamination from biological, chemical, or radiological weapons, and the presence of terrorists among the patients and bystanders. The entire scene of the bombing is a crime scene and is treated as such. Triage of patients involved in a bombing is the same as for all disasters, with a heightened awareness that serious internal injuries from the blast wave may not be evident.

#### Physical Injuries

The actual blast that occurs during the initial seconds of the bombing causes a pressure wave or primary blast wave. Injuries can result from the impact of the explosion, the primary blast wave, or shrapnel within the bomb. The majority of injuries are caused by the primary blast wave (CDC, 2006). A blast wave has four effects. These include spalling, which refers to the pressure wave; implosion, which refers to rupture of organs from entrapped gases; shearing, which refers to the blast response of different body tissues dependent on their density; and irreversible work, which refers to the presence of forces that exceed the tensile strength of an organ or tissue.

Different phases of the blast may result in common injuries that include blast lung, tympanic membrane rupture, and head and abdominal injuries (Table 72-3). Although approximately 50% to 70% of deaths result from head injuries, the majority of head injuries are not life-threatening (CDC, 2006). Bombings that occur in enclosed spaces amplify the blast wave, resulting in more pressure wave injuries. Distance from the blast, whether the blast space was enclosed, composition of the explosive, whether a building collapsed, and the efficiency of medical resources available after the blast all affect patient outcomes after a blast injury.

**Blast Lung**

Blast lung results from the blast wave as it passes through air-filled lungs. The result is hemorrhage and tearing of the lung, ventilation-perfusion mismatch, and possible air emboli. Typical signs and symptoms include dyspnea, hypoxia, tachypnea or apnea (depending on severity), cough, chest pain, and hemodynamic instability. Management involves providing respiratory support that includes administration of supplemental oxygen, but may also require intubation and mechanical ventilation. If a hemothorax or pneumothorax is present, a chest tube must be inserted to re-expand the lung. In the event of an air embolus, the patient should be immediately placed in the prone left lateral position to

**Table 72-3 PHASES OF BLASTS AND ASSOCIATED COMMON INJURIES**

| Phase of Blast Injury | Common Injuries |
|---|---|
| Primary: results from pressure wave | Pulmonary barotraumas, including pulmonary contusions<br>Head injuries, including concussion, other severe brain injuries<br>Tympanic membrane rupture, middle ear injury<br>Abdominal hollow organ perforation, hemorrhage |
| Secondary: results from debris or shrapnel within the bomb or from the scene | Penetrating trunk, skin, and soft tissue injuries<br>Fractures, traumatic amputations |
| Tertiary: results from pressure wave that causes the victim to be thrown, resulting in traumatic injury | Head injuries<br>Fractures, including skull |
| Quaternary: results from preexisting conditions exacerbated by the force of the blast or by postblast injury complications | Severe injuries with complex injury patterns: burns, crush injuries, head injuries<br>Common preexisting conditions that become exacerbated: COPD, asthma, cardiac conditions, diabetes, and hypertension |
| Quinary: thought to result from a hyperinflammatory state commonly seen in bystanders near to the blast and due to toxic substances or uncommon explosives | Hyperpyrexia<br>Diaphoresis |

COPD, chronic obstructive pulmonary disease

Kluger, Y., Nimrod, A., Biderman, P., et al. (2006). The quinary pattern of blast injury. *Journal of Emergency Management, 4*(1), 51–55.

prevent migration of the embolus and will require emergent treatment in a hyperbaric chamber. Complications following blast lung can include respiratory failure as well as acute respiratory distress syndrome (ARDS) (see Chapter 23 for further discussion).

### Tympanic Membrane Rupture

The tympanic membrane (TM) is the most frequent injury after subjection to a pressure wave because it is the body's most sensitive organ to pressure. There is an increased incidence of TM rupture when a blast occurs in close proximity to the patient and when it occurs in an enclosed space. Signs and symptoms include hearing loss, tinnitus, pain, dizziness, and otorrhea. The majority of TM ruptures heal spontaneously. Approximately 5% of patients with TM rupture from a blast will require hearing aids, whereas the majority will suffer only mild high-frequency hearing loss (Ritenour, Wickley, Ritenour, et al., 2008). Other ear injuries may include ossicular disruption and impaction of foreign bodies.

### Abdominal and Head Injuries

Blast abdomen may be evidenced by abdominal hemorrhage and internal organ injury. The typical signs and symptoms of internal abdominal injury can include pain, guarding, rebound tenderness, rectal bleeding, nausea, and vomiting (see Chapter 71 for further discussion of abdominal trauma) (CDC, 2006).

Head injuries are typically minor but those that are severe result in the majority of postblast deaths. These injuries can occur without a direct blow to the head and may result from the blast itself, building collapse, or flying debris. Concussions commonly occur postblast and the usual follow-up evaluation and treatment for postconcussive syndrome is indicated (see Chapter 62 for further discussion of head injuries) (CDC, 2006).

### *Special Populations*

Special populations may have different blast-associated risks. For instance, the elderly are particularly susceptible to bone fractures because they tend to have decreased bone density. They also tend to have more preexisting morbid conditions that may be exacerbated by the explosion. Pregnant patients' abdomens are particularly susceptible to placental shear forces that may result in abruptio placentae. People with mobility disabilities may have difficulty extricating themselves from the site of the blast (CDC, 2006).

## Biologic Weapons

Biologic weapons are weapons that spread disease among the general population or the military.

### *Effects of Biologic Weapons*

**Biologic warfare** is a covert method of effecting terrorist objectives. Biologic weapons are easily obtained and easily disseminated and can result in significant mortality and morbidity. The potential use of biologic agents calls for continuous increased surveillance by health departments and an increased index of suspicion by clinicians. Many biologic weapons result in signs and symptoms similar to those of common disease processes. Appropriate management of a biologic threat includes rapid recognition of the potential agent; use of proper PPE; decontamination, isolation or quarantine of infected patients when appropriate; and the administration of appropriate vaccinations, antidotes, or medications to people at risk.

Biologic agents are delivered in either a liquid or dry state, applied to foods or water, or vaporized for inhalation or direct contact. Vaporization may be accomplished through spray or explosives loaded with the agent. Because of increases in business and pleasure travel by people in industrialized nations, an agent could be released in one city and affect people in other cities thousands of miles away. The vector can be an insect, animal, or person, or there may be direct contact with the agent itself.

The following is a discussion of two of the agents most likely to be used or weaponized. Table 72-4 describes other easily weaponized biologic agents.

**Table 72-4 EXAMPLES OF BIOLOGIC AGENTS THAT CAN BE USED AS WEAPONS**

| Agent/Organism | Contagion | Decontamination and Protective Equipment | Signs and Symptoms | Treatment (Mortality Rate) |
|---|---|---|---|---|
| Tularemia—*Francisella tularensis:* gram-negative coccobacillus, one of the most infectious bacteria known | Direct contact with infected animals or aerosolized as a bioterror weapon; bites<br>Not contagious through human-to-human contact | Standard barrier precautions<br>Clothing and linens should be laundered under the usual hospital protocol | *Initial:* Abrupt onset of fever, fatigue, chills, headache, lower backache, malaise, rigor, coryza, dry cough, and sore throat without adenopathy. Nausea and vomiting or diarrhea possible.<br>*As disease progresses:* Sweating, fever, progressive weakness, anorexia, and weight loss demonstrate continued illness.<br>*Mortality secondary to:* pneumonitis (if inhalation is the source) with copious watery or purulent sputum, hemoptysis, respiratory insufficiency, sepsis, and shock. | Streptomycin or gentamicin/aminoglycoside for 10–14 days.<br>Inhalation tularemia must be treated within 48 hours of onset.<br>In mass casualty situations, doxycycline or ciprofloxacin is recommended.<br>For persons exposed to tularemia, tetracycline or doxycycline is recommended for 14 days.<br>(Mortality rate = 2%) |
| *Botulism—Clostridium botulinum:* Botulinum blocks acetylcholine-containing vesicles from fusing with the terminal membranes of the motor-neuron end-plate, resulting in a flaccid paralysis. | Direct contact<br>Not contagious through human-to-human contact | Any skin exposure to the botulism toxin can be treated with soap and water or a 0.1% hypochlorite solution<br>Standard precautions are used when treating patients with botulism | *Gastrointestinal botulism:* abdominal cramps, nausea, vomiting, and diarrhea.<br>*Inhalation botulism:* fever; symmetric descending flaccid paralysis with multiple cranial nerve palsies. Classic signs and symptoms include diplopia, dysphagia, dry mouth, lack of fever, and alert mental status. Other possible symptoms include ptosis of the eyelids, blurred vision, enlarged sluggish pupils, dysarthria, and dysphonia.<br>*Mortality secondary to:* airway obstruction and inadequate tidal volume. | Supportive ventilatory therapy is necessary if respiratory infection occurs.<br>Aminoglycosides and clindamycin are contraindicated because they exacerbate neuromuscular blockage.<br>Equine antitoxin is used to minimize subsequent nerve damage. There is a 2% rate of anaphylaxis to the antitoxin; therefore, diphenhydramine (Benadryl) and epinephrine must be immediately available for use.<br>Supportive care—mechanical ventilation, nutrition, fluids, prevention of complications<br>(Mortality rate = 5%) |
| Plague—*Yersinia pestis:* nonsporulating gram-negative coccobacillus. The bacterium causes destruction and necrosis of the lymph nodes. | Contagious<br>*Bubonic plague:* transmitted through flea bites with no person-to-person transmission<br>*Pneumonic plague:* transmitted through respiratory droplet contact | Isolation barrier precautions with full face respirators; the patient should wear a mask<br>Rooms should receive a terminal cleaning<br>Clothing and linens with body fluids on them should be cleaned with the usual disinfectant<br>Routine precautions should be used in the case of death | *Bubonic plague:* Sudden fever and chills, weakness, a swollen and tender lymph node (bubo) in the groin, axilla, or cervical area. The resultant bacteremia progresses to septicemia from the endotoxin and, finally, shock and death.<br>*Primary septicemic plague:* Disseminated intravascular coagulation (DIC), necrosis of small vessels, purpura, and gangrene of the digits and nose (black death).<br>*Pneumonic plague:* Severe bronchospasm, chest pain, dyspnea, cough, and hemoptysis. There is a 100% mortality associated with pneumonic plague if not treated within the first 24 hours. | Streptomycin or gentamicin for 10–14 days. Tetracycline or doxycycline is an acceptable alternative if an aminoglycoside cannot be given.<br>People with close contact exposure (<2 m) require prophylaxis with doxycycline for 7 days.<br>(Mortality rate = 50%) |

## *Types of Biologic Agents*

### Anthrax

Anthrax is recognized as the most likely weaponized biologic agent available and has been recognized as a highly debilitating agent for centuries. *Bacillus anthracis* is a naturally occurring gram-positive, encapsulated rod that lives in the soil in the spore state throughout the world. The bacterium sporulates (ie, is liberated) when exposed to air and is infective only in the spore form. Contact with infected animal products (raw meat) or inhalation of the spores results in infection. Cattle and other herbivores are vaccinated against anthrax to prevent transmission through contaminated meat.

It is believed that approximately 8000 to 50,000 spores must be inhaled to put a person at risk (Tasota, Henker & Hoffman, 2002). As an aerosol, anthrax is odorless and invisible and can travel a great distance before disseminating;

hence, the site of release and the site of infection can be miles apart.

***Clinical Manifestations.*** Anthrax is caused by replicating bacteria that release toxin, resulting in hemorrhage, edema, and necrosis. The incubation period is 1 to 6 days. There are three primary methods of infection: skin contact, inhalation, and gastrointestinal ingestion. Skin lesions (the most common infection) cause edema with pruritus and macule or papule formation, resulting in ulceration with 1- to 3-mm vesicles. A painless eschar develops, which falls off in 1 to 2 weeks.

Ingestion of anthrax results in fever, nausea and vomiting, abdominal pain, bloody diarrhea, and occasionally ascites. If severe diarrhea develops, decreased intravascular volume becomes the primary treatment concern. The bacterium targets the terminal ileum and cecum. Sepsis can occur.

Inhaling anthrax results in the most severe clinical manifestations. Its symptoms mimic those of the flu, and usually treatment is sought only when the second stage of severe respiratory distress occurs. Current antibiotic therapy does not halt the progress of the disease. Inhaled anthrax can incubate for up to 60 days, making it difficult to identify its source. Initial signs and symptoms include cough, headache, fever, vomiting, chills, weakness, mild chest discomfort, dyspnea, and syncope, without rhinorrhea or nasal congestion. Most patients have a brief recovery period followed by the second stage within 1 to 3 days, characterized by fever, severe respiratory distress, stridor, hypoxia, cyanosis, diaphoresis, hypotension, and shock. These patients require optimization of oxygenation, correction of electrolyte imbalances, and ventilatory and hemodynamic support. More than 50% of these patients have hemorrhagic mediastinitis on a chest x-ray (a hallmark sign) (Auerbach, 2007). The disease can also progress to include meningitis with subarachnoid hemorrhage. Death results approximately 24 to 36 hours after the onset of severe respiratory distress. The mortality rate approaches 100%.

***Treatment.*** At present, anthrax is penicillin sensitive; however, strains of penicillin-resistant anthrax are thought to exist. Recommended treatment includes penicillin (Penicillin V), erythromycin (E-mycin, Erythrocin), gentamicin (Garamycin), or doxycycline (Vibramycin). If antibiotic treatment begins within 24 hours after exposure, death can be prevented. In a mass casualty situation, treatment with ciprofloxacin (Cipro) or doxycycline is recommended. Treatment is continued for 60 days. For patients who have been directly exposed to anthrax but have no signs and symptoms of disease, ciprofloxacin or doxycycline is used for prophylaxis for 60 days.

Standard precautions are the only ones indicated to protect the caregiver exposed to a patient infected with anthrax. The patient is not contagious, and the disease cannot spread from person to person. Equipment should be cleaned using standard hospital disinfectant. After death, cremation is recommended because the spores can survive for decades and represent a threat to morticians and forensic medicine personnel.

There is a vaccine for anthrax that has been used in the military; however, it is not yet widely used because it requires multiple time-interval–sensitive boosters and has up to a 48% systemic reaction rate. The federal government is investigating the potential for development of a community-wide vaccine that has fewer side effects and that requires fewer boosters.

#### Smallpox

Smallpox (variola) is classified as a DNA virus. It has an incubation period of approximately 12 days. It is extremely contagious and is spread by direct contact, by contact with clothing or linens, or by droplets from person to person only after the fever has decreased and the rash phase has begun (Karwa, Currie & Kvetan, 2005). There is an associated 30% case-fatality rate (ie, the likelihood of fatality per case diagnosed). Aerosolization of the virus would result in widespread dissemination.

The World Health Organization declared smallpox eradicated in 1977 and stopped worldwide vaccination in 1980. In the United States, the last child was vaccinated in 1972. Therefore, a large portion of the current population has no immunity to the virus. A smallpox vaccination plan introduced in 2003 proposed that a designated number of ED staff receive the first vaccinations to ensure that ED staff would be immunized in the event of a smallpox outbreak. The government estimated that 0.1% of those people receiving the vaccine would have serious side effects. Of these, approximately 4% would have life-threatening complications, and 0.1% would die. Plans for any type of select or mass vaccinations for smallpox are not under current consideration, given the risks associated with vaccination.

***Clinical Manifestations.*** Signs and symptoms of smallpox infection include high fever, malaise, headache, backache, and prostration. After 1 to 2 days, a maculopapular rash appears, evolving at the same rate, beginning on the face, mouth, pharynx, and forearms (Fig. 72-1). Only then does the rash progress to the trunk and also become vesicular to pustular (Hoyt & Selfridge-Thomas, 2007). There is a large amount of the virus in the saliva and pustules. Smallpox is contagious only after the appearance of the rash. There are two forms of smallpox, variola major and variola minor. Variola major is more common, results in a higher fever and more extensive rash, and has a 30% case-fatality rate. Hemorrhagic smallpox, a subtype of variola major, includes all of the above signs and symptoms plus a dusky erythema and petechiae leading to frank hemorrhage of the skin and mucous membranes, and it results in death by day 5 or 6.

***Treatment.*** Treatment includes supportive care with antibiotics for any additional infection. The patient must be isolated with the use of transmission precautions. Laundry and biologic wastes should be autoclaved before being washed with hot water and bleach. Standard decontamination of the room is effective. All people who have household or face-to-face contact with the patient after the fever begins should be vaccinated within 4 days to prevent infection and death. A patient with a temperature of 38°C (101°F) or higher within 17 days after exposure must be placed in isolation. Cremation is preferred for all deaths because the virus can survive in scabs for up to 13 years.

#### Severe Acute Respiratory Syndrome

Not all mass casualty biologic events are terrorist based. The SARS outbreak in 2003 is a prime example of a

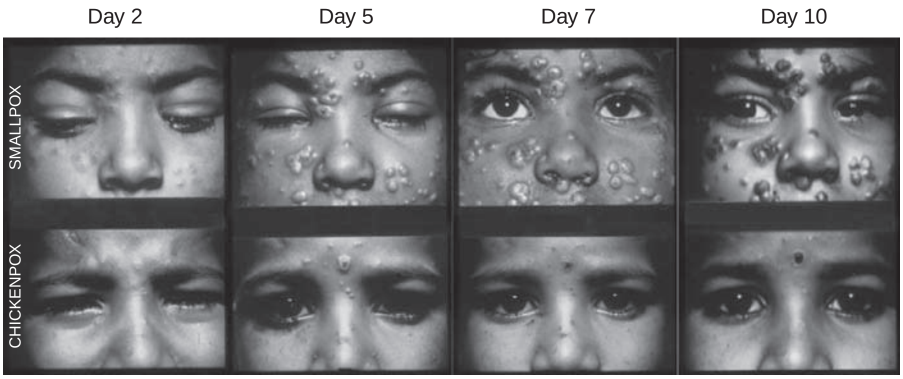



**Figure 72-1** Comparison of progression of smallpox rash and chicken pox rash. From World Health Organization. (2001). WHO slide set on the diagnosis of smallpox. Reproduced by permission of the World Health Organization. Available at: www.who.int/emc/diseases/smallpox/slideset/index.htm

non–terrorist-based mass casualty biologic event. The disease started as "atypical" pneumonia in China in February and spread to 29 countries throughout the world by July. Air travel and worldwide trade have increased the possibility that any contagious disease may spread rapidly.

SARS is caused by a virus, officially named SARS-CoV. Its incubation period is 2 to 10 days. People at risk include health care workers who have had unprotected exposure to SARS-CoV. See Chapter 23 for further discussion of SARS.

## Chemical Weapons

Agents that may be used in **chemical warfare** or for terrorist purposes are overt agents in that the effects are more apparent and occur more quickly than those caused by biologic weapons Refer to Table 72-5 for an overview of common chemical agents.

### *Characteristics of Chemicals*

#### Volatility

Volatility is the tendency for a chemical to become a vapor. The most common volatile agents are phosgene and cyanide. Most chemicals are heavier than air, except for hydrogen cyanide. Therefore, in the presence of most chemicals, people should stand up to avoid heavy exposure (because the chemical will sink toward the floor or ground).

#### Persistence

Persistence means that the chemical is less likely to vaporize and disperse. More volatile chemicals do not evaporate very quickly. Most industrial chemicals (eg, cyanide) are not very persistent. Weaponized agents (chemicals developed as weapons by the military or terrorists [eg, mustard gas]) are more likely than industrial chemicals to penetrate skin and mucous membranes and also cause secondary exposure.

#### Toxicity

Toxicity is the potential of an agent to cause injury to the body. The median lethal dose ($LD_{50}$) is the amount of the chemical that will cause death in 50% of those who are exposed. The median effective dose ($ED_{50}$) is the amount of the chemical that will cause signs and symptoms in 50% of those who are exposed. The concentration time (CT) is the concentration released multiplied by the time exposed (mg/min). For example, if 1000 mg of a chemical is released

**TABLE 72-5 COMMON CHEMICAL AGENTS**

| Agent | Action | Signs and Symptoms | Decontamination and Treatment |
|---|---|---|---|
| **Nerve Agents** | | | |
| Sarin<br>Soman organophosphates | Inhibition of cholinesterase | Increased secretions, gastrointestinal motility, diarrhea, bronchospasm. | Soap and water<br>Supportive care<br>Benzodiazepine<br>Pralidoxime<br>Atropine |
| **Blood Agent** | | | |
| Cyanide | Inhibition of aerobic metabolism | Inhalation—tachypnea, tachycardia, coma, seizures. Can progress to respiratory arrest, respiratory failure, cardiac arrest, death. | Sodium nitrite<br>Sodium thiocyanate<br>Amyl nitrate<br>Hydroxocobalamin |
| **Vesicant Agents** | | | |
| Lewisite<br>Sulfur mustard<br>Nitrogen mustard<br>Phosgene | Blistering agents | Superficial to partial-thickness burn with vesicles that coalesce. | Soap and water<br>Blot; do not rub dry |
| **Pulmonary Agents** | | | |
| Phosgene<br>Chlorine | Separation of alveoli from capillary bed | Pulmonary edema, bronchospasm. | Airway management<br>Ventilatory support<br>Bronchoscopy |

and the time a person is exposed to this amount of chemical is 10 minutes, then the concentration time would be 10,000 mg/min.

**Latency**

Latency is the time from absorption to the appearance of signs and symptoms. Sulfur mustards and pulmonary agents have the longest latency, whereas other vesicants, nerve agents, and cyanide produce signs and symptoms within seconds.

**Limiting Exposure**

Evacuation is essential, as is removal of the person's clothing and decontamination as close to the scene as possible and before transport of the exposed person. Soap and water are effective means of decontamination in most cases. Staff involved in decontamination efforts must wear PPE and contain and dispose of the runoff after decontamination procedures.

### *Types of Chemicals*

**Vesicants**

Vesicants are chemicals that cause blistering and result in burning, conjunctivitis, bronchitis, pneumonia, hematopoietic suppression, and death. Examples of vesicants include lewisite, phosgene, nitrogen mustard, and sulfur mustard. In World War I and in the Iran–Iraq conflict of 1980 to 1988, vesicants were used to disable opponents. Vesicants were the primary incapacitating agents, resulting in minimal (less than 5%) death but large numbers of injuries (Dara, et al., 2005). Liquid sulfur mustard was the most frequently used vesicant in these conflicts.

***Clinical Manifestations.*** The initial presentation after exposure to a vesicant is similar to that of a large superficial to partial-thickness burn in the warm and moist areas of the body (ie, perineum, axillae, antecubital spaces). There is stinging and erythema for approximately 24 hours, followed by pruritus, painful burning, and small vesicle formation after 2 to 18 hours. These vesicles can coalesce into large, fluid-filled bullae. Lewisite and phosgene result in immediate pain after exposure. Tissue damage occurs within minutes.

If the eye is exposed, there is pain, photophobia, lacrimation, and decreased vision. This progresses to conjunctivitis, blepharospasm, corneal ulcer, and corneal edema.

Respiratory effects are more serious and often are the cause of mortality with vesicant exposure. Purulent fibrinous pseudomembrane discharge may cause obstruction of the airways. Gastrointestinal exposure may cause nausea and vomiting, leukopenia, and upper gastrointestinal bleeding.

***Treatment.*** Appropriate decontamination includes soap and water. Scrubbing and the use of hypochlorite solutions should be avoided because they increase penetration. Once the substance has penetrated, it cannot be removed. Eye exposure requires copious irrigation. For respiratory exposure, intubation and bronchoscopy to remove necrotic tissue are essential. With lewisite exposure, dimercaprol (BAL in oil) is administered intravenously for systemic toxicity and topically for skin lesions. All persons with sulfur mustard exposures should be monitored for 24 hours for delayed (latent) effects.

**Nerve Agents**

The most toxic agents in existence are the nerve agents such as sarin, soman, tabun, VX, and organophosphates (pesticides). They are inexpensive, effective in small quantities, and easily dispersed. In the liquid form, nerve agents evaporate into a colorless, odorless vapor. Organophosphates are similar in nature to the nerve agents used in warfare and are readily available. Nerve agents can be inhaled or absorbed percutaneously or subcutaneously. These agents bond with acetylcholinesterase, so that acetylcholine is not inactivated; the adverse result is continuous stimulation (hyperstimulation) of the nerve endings. Carbamates, which are insecticides originally extracted from the Calabar bean, are derivatives of carbamic acid; they are nerve agents that specifically inhibit acetylcholinesterase for several hours and then spontaneously become unbound from the acetylcholinesterase. However, organophosphates require the formation of new enzyme (acetylcholinesterase) before nervous system function can be restored.

A very small drop of a nerve agent is enough to result in sweating and twitching at the site of exposure. A larger amount results in more systemic symptoms. Effects can begin anywhere from 30 minutes up to 18 hours after exposure. The more common organophosphates and carbamates (eg, sevin and malathion) that are used in agriculture result in less severe symptoms than do those used in warfare or in terrorist attacks. In an ordinary situation (eg, nonwarfare, nonterrorist attack situation), a patient could arrive at the ED having been unintentionally or intentionally exposed to organophosphates in a suicidal attempt.

***Clinical Manifestations.*** Signs and symptoms of nerve gas exposure are those of cholinergic crisis and include bilateral miosis, visual disturbances, increased gastrointestinal motility, nausea and vomiting, diarrhea, substernal spasm, indigestion, bradycardia and atrioventricular block, bronchoconstriction, laryngeal spasm, weakness, fasciculations, and incontinence. The patient must be examined in a dark area to truly identify miosis. Neurologic responses include insomnia, forgetfulness, impaired judgment, depression, and irritability. A lethal dose results in loss of consciousness, seizures, copious secretions, fasciculations, flaccid muscles, and apnea.

***Treatment.*** Decontamination with copious amounts of soap and water or saline solution for 8 to 20 minutes is essential. The water is blotted off, not wiped off, the skin. Fresh 0.5% hypochlorite solution (bleach) can also be used. The airway is maintained, and suctioning is frequently required. Plastic airway equipment should not be used because plastic will absorb sarin gas and may result in continued exposure to the agent.

Atropine 2 to 4 mg is administered by IV, followed by 2 mg every 3 to 8 minutes for up to 24 hours of treatment. Alternatively, IV atropine 1 to 2 mg/h may be administered until clear signs of anticholinergic activity have returned (decreased secretions, tachycardia, and decreased gastrointestinal motility). Another medication that may serve as an antidote is pralidoxime (Protopam), which allows cholinesterase

to become active against acetylcholine. Pralidoxime 1 to 2 g in 100 to 150 mL of normal saline solution is administered over 15 to 30 minutes. Pralidoxime has no effect on secretions and may have any of the following side effects: hypertension, tachycardia, weakness, dizziness, blurred vision, and diplopia. Diazepam (Valium) or other benzodiazepines are used to control seizures, to decrease fasciculations, and to alleviate apprehension and agitation.

Military personnel believed to be at risk for chemical attack are provided with Mark I automatic injectors, which contain 2 mg atropine and 600 mg pralidoxime chloride. Diazepam may be administered by a partner.

#### Blood Agents

Blood agents such as hydrogen cyanide and cyanogen chloride have a direct effect on cellular metabolism, resulting in asphyxiation through alterations in hemoglobin. Cyanide is an agent that has profound systemic effects. It is commonly used in the mining of gold and silver and in the plastics and dye industries. In 1984, the Union Carbide pesticide plant in Bhopal, India, inadvertently released large amounts of cyanide in an industrial disaster and hundreds of deaths occurred.

A cyanide release is often associated with the odor of bitter almonds. In house fires, cyanide is released during the combustion of plastics, rugs, silk, furniture, and other construction materials. There is a significant correlation between blood cyanide and carbon monoxide levels in patients who survive fires, and in many cases, the cause of death is cyanide poisoning.

***Clinical Manifestations.*** Cyanide can be ingested, inhaled, or absorbed through the skin and mucous membranes. Cyanide is protein bound and inhibits aerobic metabolism, leading to respiratory muscle failure, respiratory arrest, cardiac arrest, and death. Its inhalation results in flushing, tachypnea, tachycardia, nonspecific neurologic symptoms, stupor, coma, and seizure preceding respiratory arrest.

***Treatment.*** Rapid administration of amyl nitrate, sodium nitrite, and sodium thiosulfate is essential to the successful management of cyanide exposure. First, the patient is intubated and placed on a ventilator. Next, amyl nitrate pearls are crushed and placed in the ventilator reservoir to induce methemoglobinemia. Cyanide has a 20% to 25% higher affinity for methemoglobin than it does for hemoglobin; it binds methemoglobin to form either cyanomethemoglobin or sulfmethemoglobin. The cyanomethemoglobin is then detoxified in the liver by the enzyme rhodanese. Next, IV sodium nitrite is administered to induce the rapid formation of methemoglobin. IV sodium thiosulfate is then administered; it has a higher affinity for cyanide than methemoglobin does and stimulates the conversion of cyanide to sodium thiocyanate, which can be excreted by the kidneys. Although they may be life-saving, these emergency medications do have side effects: sodium nitrite can result in severe hypotension, and thiocyanate can cause vomiting, psychosis, arthralgia, and myalgia.

The production of methemoglobin is contraindicated in patients with smoke inhalation, because they already have decreased oxygen-carrying capacity secondary to the carboxyhemoglobin produced by smoke inhalation. In facilities where a hyperbaric chamber is available, it may be used to provide oxygenation while the previously discussed therapies are initiated. An alternative suggested treatment for cyanide poisoning is hydroxocobalamin (vitamin $B_{12}$a). Hydroxocobalamin binds cyanide to form cyanocobalamin (vitamin $B_{12}$). It must be administered by IV in large doses. Administration of vitamin $B_{12}$a can result in a transient pink discoloration of mucous membranes, skin, and urine. In high doses, tachycardia and hypertension can occur, but they usually resolve within 48 hours.

#### Pulmonary Agents

Pulmonary agents such as phosgene and chlorine destroy the pulmonary membrane that separates the alveolus from the capillary bed, disrupting alveolar–capillary oxygen transport mechanisms. Capillary leakage results in fluid-filled alveoli. Phosgene and chlorine both vaporize, rapidly causing this pulmonary injury. Phosgene has the odor of fresh-mown hay.

Signs and symptoms include pulmonary edema with shortness of breath, especially during exertion. An initial hacking cough is followed by frothy sputum production. A particulate air-filter mask is the only protection required to protect health care personnel. Phosgene does not injure the eyes.

## Nuclear Radiation Exposure

The threat of **nuclear warfare** or radiation exposure is very real with the availability of nuclear material and easily concealed simple devices, such as the so-called dirty bomb, for dispersal. A dirty bomb is a conventional explosive (eg, dynamite) that is packaged with radioactive material that scatters when the bomb is detonated. It disperses radioactive material and may be called a radiologic weapon, but is not a nuclear weapon, which uses a complex nuclear fission reaction that is thousands of times more devastating than the dirty bomb.

Sources of radioactive material include not only nuclear weapons but also reactors and simple radioactive samples, such as weapons-grade plutonium or uranium, freshly spent nuclear fuel, or medical supplies (eg, radium, certain cesium isotopes) used in cancer treatments and radiology. Exposure of a large number of people can be accomplished by placing a radioactive sample in a public place. Thousands may be exposed this way; some may be immediately affected, and others may require health monitoring for many years to assess long-term effects. The effectiveness of these weapons was demonstrated in the devastating results of the bombings of Hiroshima and Nagasaki in World War II.

Nuclear reactor incidents have occurred in the Chernobyl (1986) and Three Mile Island (1979) nuclear facilities. There were 31 official deaths on the day of the Chernobyl incident, which involved a core meltdown and explosion, releasing radiation throughout the community. The long-term effects of this incident, including increased incidence of thyroid cancers and leukemia, continue to be evaluated.

Any terrorist-sponsored or unintentional radiation release can be sizable and may require the entire hospital and prehospital staff to be prepared, recognize signs and symptoms of exposure, and rapidly treat victims without contamination of personnel, visitors, patients, or the facility itself.

### Types of Radiation

Atoms consist of protons, neutrons, and electrons. The protons and neutrons are in balance in the nucleus. The protons repel each other because they are all positively charged. The number of protons is specific for each element in the periodic table. There is a specific ratio of protons and neutrons for each different atom, and the result is element stability. When an element is radioactive, there is an imbalance in the nucleus, resulting from an excess of neutrons.

To achieve stability, a radioactive nuclide can eject particles until the most stable number (an even number) of protons and neutrons exists. A proton can become a neutron by ejecting a positron; conversely, a neutron can become a proton by ejecting a negative electron. An alpha particle is released when two protons and two electrons are ejected.

Alpha particles cannot penetrate the skin. A thin layer of paper or clothing is all that is necessary to protect the skin from alpha radiation. However, this low-level radiation can enter the body through inhalation, ingestion, or injection (open wound). Only localized damage occurs.

Beta particles have the ability to moderately penetrate the skin to the layer in which skin cells are being produced. This high-energy radiation can cause skin damage if the skin is exposed for a prolonged period and can cause injury if beta particles penetrate the skin.

Gamma radiation is a short-wavelength electromagnetic energy that is emitted when there is excess core nucleus energy. Gamma particles are penetrating. Therefore, it is difficult to shield against gamma radiation. X-rays are an example of gamma radiation. Gamma radiation often accompanies both alpha particle and beta particle emission.

### Measurement and Detection

Radiation is measured in several different units. The *rad* is the basic unit of measurement. A rad is equivalent to 0.01 J of energy per kilogram of tissue. To determine the damaging effect of the rad, a conversion to the *rem* (roentgen equivalents human) is necessary. The rem reflects the type of radiation absorbed and the potential for damage. For example, 200,000 mrem results in mild radiation sickness (1 rem = 1000 mrem) (Dara, et al., 2005). Typical natural yearly exposure for a person is 360 mrem. Another important concept is *half-life*. The half-life of a radioactive product is the time it takes to lose half of its radioactivity.

The only way to detect radiation is through a device that determines the exposure per minute. There are various devices for this purpose. The Geiger counter (or Geiger-Mueller survey meter) can measure background radiation quickly through detection of gamma radiation and some beta radiation. With high-level radiation, the Geiger counter may underestimate exposure. Other devices include the ionization chamber survey meter, alpha monitors, and dose-rate meters. Personal dosimeters are simple tools that identify radiation exposure and are worn by radiology personnel.

### Exposure

Exposure is affected by time, distance, and shielding. The longer a person is within the radiation area, the higher the exposure. Also, the larger the amount of radioactive material in the area, the greater the exposure. The farther away the person is from the radiation source, the lower the exposure. Shielding from the radiation source also decreases exposure.

Three types of radiation-induced injury can occur: external irradiation, contamination with radioactive materials, and incorporation of radioactive material into body cells, tissues, or organs:

- *External irradiation* exposure occurs when all or part of the body is exposed to radiation that penetrates or passes completely through the body. In this type of exposure, the person is not radioactive and does not require special isolation or decontamination measures. Irradiation does not necessarily constitute a medical emergency.
- *Contamination* occurs when the body is exposed to radioactive gases, liquids, or solids either externally or internally. If internal, the contaminant can be deposited within the body. Contamination requires immediate medical management to prevent incorporation.
- *Incorporation* is the actual uptake of radioactive material into the cells, tissues, and susceptible organs. The organs involved are usually the kidneys, bones, liver, and thyroid.

Sequelae of contamination and incorporation can occur days to years later. The thyroid gland can be largely protected from radiation exposure by administration of stable iodine (potassium iodide, or KI) before or promptly after the intake of radioactive iodine (Dara, et al., 2005).

Priorities in the treatment of any type of radiation exposure are always treatment of life-threatening injuries and illnesses first, followed by measures to limit exposure, contamination control, and finally decontamination.

### Decontamination

Hospital and community disaster plans should be in effect when managing a radiation disaster. Access restriction is essential to prevent contamination of other areas of the hospital. Triage outside the hospital is the most effective means of preventing contamination of the facility itself. Floors are covered to prevent tracking of contaminants throughout the treatment areas. Strict isolation precautions should be in effect. All air ducts and vents must be sealed to prevent spread. Waste is controlled through double-bagging and the use of plastic-lined containers outside of the facility. All radiation-contaminated waste must be disposed in appropriate color-coded yellow and magenta canisters.

Staff are required to wear protective clothing, such as water-resistant gowns, two pairs of gloves, masks, caps, goggles, and booties. Dosimetry devices should be worn by all staff members participating in patient care. The radiation safety officer in the hospital should be notified immediately to assist with surveys (using a radiation survey meter) of the incoming patients and to provide dosimeters to all staff personnel involved in direct care of exposed patients. There is minimal risk to staff if the patients are properly surveyed and decontaminated. The majority of patients can be safely decontaminated with soap and water.

Each patient arriving at the hospital should first be surveyed with the radiation survey meter for external contamination and then directed toward the decontamination area as needed. Decontamination occurs outside of the ED with

a shower, collection pool, tarp, and collection containers for patient belongings, as well as soap, towels, and disposable paper gowns for patients. Water runoff needs to be contained. Patients who are uninjured can perform self-decontamination with handheld showers. After the patient has showered, a resurvey is conducted to determine whether the radioactive contaminants have been removed. Additional washings should occur until the patient is free of contamination. It is important to ensure that during showers previously clean areas are not contaminated with runoff from the washed contaminated areas (eg, hair should be washed in a position that protects the body from contamination). Wounds are irrigated and then covered with a water-resistant dressing prior to total body decontamination.

Internal contamination or incorporation requires decontamination through catharsis, gastric lavage with chelating agents (agents that bind with radioactive substances and are then excreted), or both. Samples of urine, feces, and vomitus are surveyed to determine internal contamination levels. Biologic samples are taken through nasal and throat swabs, and a complete blood count with differential is obtained.

### Acute Radiation Syndrome

Acute radiation syndrome (ARS) can occur after exposure to radiation. It is the dose, rather than the source, that determines whether ARS develops. Factors that determine whether the patient's response to exposure will result in ARS include a high dose (minimum 100 rad) and rate of radiation with total body exposure and penetrating-type radiation. Age, medical history, and genetics also affect the outcome after exposure. The course is predictable. Table 72-6 identifies the phases of ARS.

Each body system is affected differently in ARS. Systems with cells that rapidly reproduce are most commonly affected. The effects on the hematopoietic system include decreased numbers of lymphocytes, granulocytes, thrombocytes, and reticulocytes. It is the first system affected and serves as an indicator of the severity of radiation exposure (Dara, et al., 2005). A predictor of outcome is the absolute lymphocyte count at 48 hours after exposure. A significant exposure would be indicated by blood lymphocyte counts of 300 to 1200/mm$^3$. Barrier precautions should be implemented to protect the patient from infection. Neutrophils decrease within 1 week, platelets decrease within 2 weeks, and red blood cells decrease within 3 weeks. Hemorrhagic complications, fever, and sepsis are common.

The gastrointestinal system, with its rapidly reproducing cells, is also readily affected by radiation. Doses of radiation required to produce symptoms are approximately 600 rad or higher. The gastrointestinal symptoms usually occur at the same time as the changes in the hematopoietic system. Nausea and vomiting occur within 2 hours after exposure. Sepsis, fluid and electrolyte imbalance, and opportunistic infections can occur as complications. An ominous sign is the presence of high fever and bloody diarrhea; these typically appear on day 10 after exposure.

The central nervous system is affected when the dose exceeds 1000 rad (Dara, et al., 2005). The symptoms occur when damage to the blood vessels of the brain results in fluid leakage. Signs and symptoms include cerebral edema, nausea, vomiting, headache, and increased intracranial pressure (ICP). Increased ICP heralds a poor outcome and imminent death. Central nervous system injury with this amount of exposure is irreversible and occurs before hematopoietic or gastrointestinal system symptoms appear. Cardiovascular collapse is usually seen in conjunction with these injuries.

Skin effects can also indicate the dose of radiation exposure. With exposure of 600 to 1000 rad, erythema occurs; it can disappear within hours, and then reappear. The exposed patient must be evaluated hourly for the presence of erythema. With exposures greater than 1000 rad, desquamation (radiation dermatitis) of the skin occurs. Necrosis becomes evident within a few days to months at doses greater than 5000 rad.

Secondary injury can occur when the radiation exposure occurs during a traumatic event such as a blast or burn. Trauma in addition to radiation exposure increases patient mortality. Attention must first be directed toward the primary assessment for trauma. Airway, breathing, circulation, and fracture reduction require immediate attention. All definitive treatments must occur within the first 48 hours. Thereafter, all surgical procedures should be delayed for 2 to 3 months because of the potential for delayed wound healing and the possible development of opportunistic infections several weeks after exposure.

### Survival

There are three categories of predicted survival after radiation exposure: probable, possible, and improbable. Triage of victims at the scene, after decontamination, is conducted using the routine system for disaster triage. Presenting signs

**TABLE 72-6 PHASES OF EFFECTS OF RADIATION EXPOSURE**

| Phase | Time of Occurrence | Signs and Symptoms |
|---|---|---|
| Prodromal phase (presenting symptoms) | 48–72 h after exposure | Nausea, vomiting, loss of appetite, diarrhea, fatigue<br>High-dose radiation: fever, respiratory distress, and increased excitability |
| Latent phase (a symptom-free period) | After resolution of prodromal phase; can last up to 3 wk<br>With high-dose radiation, latent period is shorter | Decreasing lymphocytes, leukocytes, thrombocytes, red blood cells |
| Illness phase | After latent period phase | Infection, fluid and electrolyte imbalance, bleeding, diarrhea, shock, and altered level of consciousness |
| Recovery phase OR | After illness phase | Can take weeks to months for full recovery |
| Death | After illness phase | Increased intracranial pressure is a sign of impending death |

and symptoms determine the potential for survival and therefore the category of predicted survival during triage.

*Probable* survivors have either no initial symptoms or only minimal symptoms (eg, nausea and vomiting), or these symptoms resolve within a few hours. These patients should have a complete blood count drawn and may be discharged with instructions to return if any symptoms recur.

*Possible* survivors present with nausea and vomiting that persist for 24 to 48 hours. They experience a latent period, during which leukopenia, thrombocytopenia, and lymphocytopenia occur. Barrier precautions and protective isolation are implemented if the patient's lymphocyte count is less than 1200/$mm^3$. Supportive treatment includes administration of blood products, prevention of infection, and provision of enhanced nutrition.

*Improbable* survivors have received more than 800 rad of total body penetrating irradiation. People in this group demonstrate an acute onset of vomiting, bloody diarrhea, and shock. Any neurologic symptoms suggest a lethal dose of radiation (CDC, 2005). These patients still require decontamination to prevent further contamination of the area and of others. Personal protection is essential, because it is virtually impossible to fully decontaminate these patients; all of their internal organs have been irradiated. The survival time is variable; however, death usually occurs swiftly due to shock. If there are no neurologic symptoms, patients may be alert and oriented, similar to a patient with extensive burns. In a mass casualty situation, these patients would be triaged into the black category, where they will receive comfort measures and emotional support. If it is not a mass casualty situation, aggressive fluid and electrolyte therapies are essential.

## CRITICAL THINKING EXERCISES

**1** You are the triage nurse at the receiving facility for casualties after a tornado. As you prepare to set up a triage station, "walking wounded" begin to arrive on their own. Among them is a hysterical adult woman with a facial abrasion who is otherwise apparently unharmed, carrying a 7-year-old child who has a Glasgow Coma Scale (GCS) score of 6 and is apneic. A 20-year-old man believes he has broken his arm; if fractured, it appears to be a closed fracture and the arm is warm with good pulses. As you quickly assess these patients, an ambulance arrives with an 80-year-old man with a sucking chest wound who is apneic and with a pulse barely palpable only at the carotids. The emergency medical services (EMS) personnel were unable to intubate him. In addition, a 15-year-old girl arrives with a cold pulseless foot from an obvious ankle fracture dislocation. How would you initially tag and triage these patients to provide optimal use of resources, remembering that this is only the first wave of injuries from multiple building collapses? Family members, members of the press, and city officials also begin arriving at the hospital in large numbers. How should the family members be managed? How should the other people be managed?

**2** A patient arrives at the triage desk of the emergency department complaining of a sudden onset of a high fever and respiratory flulike symptoms. He has recently returned from a trip to Asia. At this point, there are no skin signs that suggest disease. What signs and symptoms should you identify if you suspect a biologic warfare agent or contagious process? Which agents cause pneumonia-like signs and symptoms? What precautions should be taken to protect staff and patients? What type of isolation would be typical if you suspected a contagion that is transmitted by the respiratory tract? Would you consider the patient's recent travel to Asia an important piece of information?

**3** You are a member of the safety committee at your hospital. The committee is charged with updating the hospital's emergency operations plan (EOP). What types of disasters may occur in and around your facility? How do you determine the hazards and vulnerability of your facility? How does your facility plan comply with the National Incident Management System requirements? What plan for triage will be included in the EOP? What types of personal protective equipment (PPE) will you recommend?

**4** Your facility is closest to a bombing event on the mass transit system. You initiate the hospital emergency plan. What special considerations should you address, including possible use of chemical and biological weapons? What types of blast injuries do you expect? How many phases of injury are involved with a blast effect?

The Smeltzer suite offers these additional resources to enhance learning and facilitate understanding of this chapter:

- thePoint online resource, thepoint.lww.com/Smeltzer12E
- Student CD-ROM included with the book
- *Study Guide to Accompany Brunner & Suddarth's Textbook of Medical-Surgical Nursing*

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## RESOURCES

Agency for Toxic Substances and Disease Registry, www.atsdr.cdc.gov
American Red Cross, http://redcross.org/services/disaster/beprepared
Centers for Disease Control and Prevention, www.cdc.gov
U.S. Department of Homeland Security, www.dhs.gov/training.fema.gov



# appendix A

# Diagnostic Studies and Interpretation

## Test Value Studied

Reference Ranges—Hematology
Reference Ranges—Serum, Plasma and Whole Blood Chemistries
Reference Ranges—Immunodiagnostic Tests
Reference Ranges—Urine Chemistry
Reference Ranges—Cerebrospinal Fluid (CSF)
Miscellaneous Values

## Selected Abbreviations Used in Reference Ranges

### *Conventional Units*

kg = kilogram
gm = gram
mg = milligram
μg = microgram
μμg = micromicrogram
ng = nanogram
pg = picogram
dL = 100 milliliters
mL = milliliter
gm = gram
$mm^3$ = cubic millimeter
fL = femtoliter
mM = millimole
nM = nanomole
mOsm = milliosmole
mm = millimeter
μm = micron or micrometer
mm Hg = millimeters of mercury
U = unit
mU = milliunit
μU = microunit
mEq = milliequivalent
IU = International Unit
mIU = milliInternational Unit

### *SI Units*

g = gram
L = liter
d = day
h = hour
mol = mole
mmol = millimole
μmol = micromole
nmol = nanomole
pmol = picomole

**Table A-1 REFERENCE RANGES—HEMATOLOGY***

| Determination | Reference Range: Conventional Units | Reference Range: SI Units | Clinical Significance |
|---|---|---|---|
| $A_2$ hemoglobin | 2.0%–3.2% of total hemoglobin | Mass fraction: 0.015–0.035 of total hemoglobin | Increased in certain types of thalassemia |
| Bleeding time | 1.5–9.5 min | 1.5–9.5 min | Prolonged in thrombocytopenia, defective platelet function, and aspirin therapy |
| Factor V assay (pro-accelerin factor) | 60%–140% | | |
| Factor VIII assay (antihemophiliac factor) | 60%–140% | | Deficient in classical hemophilia |
| Factor IX assay (plasma thromboplastin component) | 60%–140% | | Deficient in Christmas disease (pseudohemophilia) |
| Factor X (Stuart factor) | 60%–140% | | Deficient in Stuart clotting defect |
| Fibrinogen | 200–400 mg/dL | 2–4 g/dL | Increased in pregnancy, infections accompanied by leukocytosis, nephrosis<br>Decreased in severe liver disease, abruptio placentae |
| Fibrin split (degradation) products | <5 μg/mL | <5 μg/mL | Increased in disseminated intravascular coagulation |
| Fibrinolysins (whole blood clot lysis time) | No lysis in 24 h | | Increased activity associated with massive hemorrhage, extensive surgery, transfusion reactions |

*Continued on following page*

**Table A-1 REFERENCE RANGES—HEMATOLOGY* (Continued)**

| Determination | Reference Range: Conventional Units | Reference Range: SI Units | Clinical Significance |
|---|---|---|---|
| Partial thrombo-plastin time (activated) | Lower limit of normal: 20–25 sec; Upper limit of normal: 32–39 sec | | Prolonged in deficiency of fibrinogen, factors II, V, VIII, IX, X, XI, and XII, and in heparin therapy |
| Prothrombin consumption | Lower limit of normal: 10 sec<br>Lower limit of normal: 14 sec | | Impaired in deficiency of factors VIII, IX, and X |
| Prothrombin time | 9.5–12 sec | | Prolonged by deficiency of factors I, II, V, VII, and X, fat malabsorption, severe liver disease, coumarin anticoagulant therapy |
| INR | 1.0<br>2–3 for therapy in atrial fibrillation, deep vein thrombosis, and pulmonary enbolism<br>2.5–3.5 for therapy in prosthetic heart valves | | INR used to standardize the prothrombin time and anticoagulation therapy |
| Erythrocyte count | Males: 4,600,000–6,200,000/cu mm<br>Females: 4,200,000–5,400,000/cu mm | $4.6–6.2 \times 10^{12}$/L<br>$4.2–5.4 \times 10^{12}$/L | Increased in severe diarrhea and dehydration, polycythemia, acute poisoning, pulmonary fibrosis<br>Decreased in all anemias, in leukemia, and after hemorrhage when blood volume has been restored |
| **Erythrocyte indices** | | | |
| Mean corpuscular volume (MCV) | 84–96 cu µm | 84–96 fL | Increased in macrocytic anemias; decreased in microcytic anemia |
| Mean corpuscular hemoglobin (MCH) | 28–33 µµg/cell | 28–33 pg | Increased in macrocytic anemias; decreased in microcytic anemia |
| Mean corpuscular hemoglobin concentration (MCHC) | 33%–35% | Concentration fraction: 0.33–0.35 | Decreased in severe hypochromic anemia |
| Reticulocytes | 0.5%–1.5% of red cells | Number fraction: 0.005–0.015 | Increased with any condition stimulating increase in bone marrow activity (ie, infection, blood loss [acute and chronically following iron therapy in iron deficiency anemia], polycythemia rubra vera)<br>Decreased with any condition depressing bone marrow activity, acute leukemia, late stage of severe anemias |
| Erythrocyte sedimentation rate (ESR)—Westergren method | Males under 50 yr: <15 mm/h<br>Males over 50 yr: <20 mm/h<br>Females under 50 yr: <25 mm/h<br>Females over 50 yr: <30 mm/h | <15 mm/h<br><20 mm/h<br><25 mm/h<br><30 mm/h | Increased in tissue destruction, whether inflammatory or degenerative; during menstruation and pregnancy; and in acute febrile diseases |
| Erythrocyte sedimentation ratio—Zeta centrifuge | <50 yr: <55%<br>50–80 yr: 40%–60% | Volume fraction: <0.55<br>0.40–0.60 | Significance similar to ESR |
| Hematocrit | Males: 42%–52%<br>Females: 35%–47% | Volume fraction: 0.42–0.52<br>Volume fraction: 0.35–0.47 | Decreased in severe anemias, anemia of pregnancy, acute massive blood loss<br>Increased in erythrocytosis of any cause, and in dehydration or hemoconcentration associated with shock |
| Hemoglobin | Males: 13–18 gm/dL<br>Females: 12–16 gm/dL | 2.02–2.79 mmol/L<br>1.86–2.48 mmol/L | Decreased in various anemias, pregnancy, severe or prolonged hemorrhage, and with excessive fluid intake<br>Increased in polycythemia, chronic obstructive pulmonary disease, failure of oxygenation because of congestive heart failure, and normally in people living at high altitudes |
| Hemoglobin F | Less than 2% of total hemoglobin | Mass fraction: <0.02 | Increased in infants and children, and in thalassemia and many anemias |

*Continued*

**Table A-1 REFERENCE RANGES—HEMATOLOGY* (Continued)**

| Determination | Reference Range: Conventional Units | Reference Range: SI Units | Clinical Significance |
|---|---|---|---|
| Leukocyte alkaline phosphatase | Score of 15–130 (varies among labs) | | Increased in polycythemia vera, myelofibrosis, and infections<br>Decreased in chronic granulocytic leukemia, paroxysmal nocturnal hemoglobinuria, hypoplastic marrow, and viral infections, particularly infectious mononucleosis |
| Leukocyte count | Total: 4,500–11,000/cu mm | $4.5–11 \times 10^9$/L | |
| Neutrophils | 45%–73% | Number fraction: 0.45–0.73 | Neutrophils increased with acute infections, trauma or surgery, leukemia, malignant disease, necrosis; decreased with viral infections, bone marrow suppression, primary bone marrow disease |
| Eosinophils | 0%–4% | Number fraction: 0.00–0.04 | Eosinophils increased in allergy, parasitic disease, collagen disease, subacute infections; decreased with stress, use of some medications (ACTH, epinephrine, thyroxine) |
| Basophils | 0%–1% | Number fraction: 0.00–0.01 | Basophils increased with acute leukemia and following surgery or trauma; decreased with allergic reactions, stress, allergy, parasitic disease, use of corticosteroids |
| Lymphocytes | 20%–40% | Number fraction: 0.2–0.4 | Lymphocytes increased with infectious mononucleosis, viral and some bacterial infections, hepatitis; decreased with aplastic anemia, SLE, immunodeficiency including AIDS |
| Monocytes | 2%–8% | Number fraction: 0.02–0.08 | Monocytes increased with viral infections, parasitic disease, collagen and hemolytic disorders; decreased with use of corticosteroids, RA, HIV infection |
| Platelet count | 150,000–450,000/cu mm | $0.15–0.45 \times 10^{12}$/L | Increased in malignancy, myeloproliferative disease, rheumatoid arthritis, and postoperatively; about 50% of patients with unexpected increase of platelet count will be found to have a malignancy<br>Decreased in thrombocytopenic purpura, acute leukemia, aplastic anemia, and during cancer chemotherapy |

*Laboratory values may vary according to the techniques used in different laboratories.

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES**

| Determination | Normal Adult Reference Range: Conventional Units | Normal Adult Reference Range: SI Units | Clinical Significance: Increased | Clinical Significance: Decreased |
|---|---|---|---|---|
| Acetoacetate | 0.2–1.0 mg/dL | 19.6–98 μmol/L | Diabetic ketoacidosis<br>Fasting | |
| Acetone | 0.3–2.0 mg/dL | 51.6–344.0/μmol/L | Diabetic ketoacidosis<br>Toxemia of pregnancy<br>Carbohydrate-free diet<br>High-fat diet | |
| Acid, total phosphatase | Males: 2–12 UL<br>Females: 0.3–9.2 UL | Males: 2–12 UL<br>Females: 0.3–9.2 UL | Carcinoma of prostate<br>Advanced Paget's disease<br>Hyperparathyroidism<br>Gaucher's disease | |
| Acid, phosphatase, prostatic—RIA | 2.5–3.37 ng/mL | 2.5–3.37 μg/L | Carcinoma of prostate | |
| Alkaline phosphatase | Adults: 50–120 UL | 50–120 UL | Conditions reflecting increased osteoblastic activity of bone<br>Rickets<br>Hyperparathyroidism<br>Hepatic disease<br>Bone disease | |

*Continued on following page*

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Alkaline phosphatase, thermostable fraction | Hepatic: >25%<br>Combined: 10%–25%<br>Skeletal: <10% | | | |
| Adrenocorticotropic hormone (ACTH) (plasma)—RIA* | <50 pg/mL | <50 ng/L | Pituitary-dependent Cushing's syndrome<br>Ectopic ACTH syndrome<br>Primary adrenal atrophy | Adrenocortical tumor<br>Adrenal insufficiency secondary to hypopituitarism |
| Aldolase | 3–8 Sibley-Lehninger U/dL at 37°C | 22–59 mU/L at 37°C | Hepatic necrosis<br>Granulocytic leukemia<br>Myocardial infarction<br>Skeletal muscle disease | |
| Aldosterone (plasma)—RIA | Supine: 3–10 ng/dL<br>Upright: 5–30 ng/dL<br>Adrenal vein: 200–800 ng/dL | 0.08–0.30 nmol/L<br>0.14–0.90 nmol/L<br>5.54–22.16 nmol/L | Primary aldosteronism<br>Secondary aldosteronism | Addison's disease |
| Alpha-1-antitrypsin | 110–140 mg/dL | 1.1–1.4 g/L | | Certain forms of chronic lung and liver disease in young adults |
| Alpha-1-fetoprotein | <15 ng/mL | <15 μg/L | Hepatocarcinoma<br>Metastatic carcinoma of liver<br>Germinal cell carcinoma of the testicle or ovary<br>Fetal neural tube defects—elevation in maternal serum | |
| Alpha-hydroxybutyric dehydrogenase | <140 U/L | <140 U/L | Myocardial infarction<br>Granulocytic leukemia<br>Hemolytic anemias<br>Muscular dystrophy | |
| Ammonia (plasma) | 15–45 μg/dL (varies with method) | 11–32/μmol/L | Severe liver disease<br>Hepatic decompensation | |
| Amylase | 60–160 Somogyi U/dL | 111–296 U/L | Acute pancreatitis<br>Mumps<br>Duodenal ulcer<br>Carcinoma of head of pancreas<br>Prolonged elevation with pseudocyst of pancreas<br>Increased by medications that constrict pancreatic duct sphincters: morphine, codeine, cholinergics | Chronic pancreatitis<br>Pancreatic fibrosis and atrophy<br>Cirrhosis of liver<br>Pregnancy (2nd and 3rd trimesters) |
| Arsenic | <70 μg/dL; poisoning: 100–150 μg/dL | <0.93–2.6 μmol/L; poisoning: 133–6.65 μmol/L | Intentional or unintentional poisoning<br>Excessive occupational exposure | |
| Ascorbic acid (vitamin C) | 0.4–1.5 mg/dL | 23–85 μmol/L | Large doses of ascorbic acid as a prophylactic against the common cold | |
| ALT (alanine aminotransferase), formerly SGPT | Males: 10–40 U/mL<br>Females: 8–35 U/mL | Males: 0.17–0.68 μkat/L<br>Females: 0.14–0.60 μkat/L | Same conditions as AST (SGOT), but increase is more marked in liver disease than AST (SGOT) | |
| AST (aspartate aminotransferase), formerly SGOT | Males: 10–40 U/L<br>Females: 15–30 U/L | Males: 0.34–0.68 μkat/L<br>Females: 0.25–0.51 μkat/L | Myocardial infarction<br>Skeletal muscle disease<br>Liver disease | |
| Bilirubin | Total: 0.3–1.0 mg/dL<br>Direct: 0.1–0.4 mg/dL<br>Indirect: 0.1–0.4 mg/dL | 5–17 μmol/L<br>1.7–3.7 μmol/L<br>3.4–11.2 μmol/L | Hemolytic anemia (indirect)<br>Biliary obstruction and disease<br>Hepatocellular damage (hepatitis)<br>Pernicious anemia<br>Hemolytic disease of newborn | |
| **Blood gases** | | | | |
| Oxygen, arterial (whole blood): | | | | |
| Partial pressure ($PaO_2$) | 85–95 mm Hg | 10.64–12.64 kPa | Polycythemia | Anemia<br>Cardiac or pulmonary disease |

*Continued*

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Saturation ($SaO_2$) | 95%–99% | Volume fraction: 0.95–0.99 | | Cardiac decompensation<br>Chronic obstructive lung disease |
| Carbon dioxide, arterial (whole blood) partial pressure ($PaCO_2$) | 35–45 mm Hg | 4.66–5.99 kPa | Respiratory acidosis<br>Metabolic alkalosis | Respiratory alkalosis<br>Metabolic acidosis |
| pH (whole blood, arterial) | 7.35–7.45 | 7.35–7.45 | Vomiting<br>Hyperventilation<br>Fever<br>Intestinal obstruction | Uremia<br>Diabetic ketoacidosis<br>Hemorrhage<br>Nephritis |
| Brain (B-type) natriuretic peptide (BNP) | <100 pg/mL | 100 ng/L | Heart failure<br>Cardiac volume overload | |
| Calcitonin | Basal: <19 pg/mL<br>Stimulation test<br>Males: <350 pg/mL<br>Females: <100 pg/mL | 19 ng/L<br><br><350 ng/L<br><100 ng/L | Medullary carcinoma of the thyroid<br>Some nonthyroid tumors<br>Zollinger-Ellison syndrome | |
| Calcium | 8.6–10.2 mg/dL | 2.15–2.55 mmol/L | Tumor or hyperplasia of parathyroid<br>Hypervitaminosis D<br>Multiple myeloma<br>Nephritis with uremia<br>Malignant tumors<br>Sarcoidosis<br>Hypoparathyroidism<br>Skeletal immobilization<br>Excess calcium intake: milk alkali syndrome | Hyperthyroidism<br>Diarrhea<br>Celiac disease<br>Vitamin D deficiency<br>Acute pancreatitis<br>Nephrosis<br>After parathyroidectomy |
| $CO_2$, venous | Adults: 24–32 mEq/L<br>Infants: 18–24 mEq/L | 24–32 mmol/L<br>18–24 mmol/L | Tetany<br>Respiratory disease<br>Intestinal obstruction<br>Vomiting | Acidosis<br>Nephritis<br>Eclampsia<br>Diarrhea<br>Anesthesia |
| Catecholamines (plasma)—RIA | Epinephrine: <100 pg/mL<br>Norepinephrine: <400 pg/mL<br>Dopamine: <143 pg/mL | <540 pmol/L<br><2360 pmol/L<br><935 pmol/L | Pheochromocytoma | |
| Ceruloplasmin | 20–40 mg/dL | 1.26–2.52 μmol/L | | Wilson's disease (hepatolenticular degeneration) |
| Chloride | 97–107 mEq/L | 97–107 mmol/L | Nephrosis<br>Nephritis<br>Urinary obstruction<br>Cardiac decompensation<br>Anemia | Diabetes mellitus<br>Diarrhea<br>Vomiting<br>Pneumonia<br>Heavy metal poisoning<br>Cushing's syndrome<br>Intestinal obstruction<br>Febrile conditions |
| Cholesterol | 150–200 mg/dL | 3.9–5.2 mmol/L | Lipemia<br>Obstructive jaundice<br>Diabetes<br>Hyperthyroidism | Pernicious anemia<br>Hemolytic anemia<br>Hypothyroidism<br>Severe infection<br>Terminal states of debilitating disease |
| Cholesterol esters | 60%–70% of total | Fraction of total cholesterol: 0.6–0.7 | | The esterified fraction decreases in liver diseases |
| Cholinesterase | Serum: 0.6–1.6 delta pH<br>Red cells: 0.6–1 delta pH | 0.6–1.6 U<br>0.6–1 U | Nephrosis<br>Exercise | Nerve gas exposure (greater effect on red cell activity)<br>Insecticide poisoning |
| Chorionic gonadotropin, beta subunit | 0–5 IU/L | 0–5 IU/L | Pregnancy<br>Hydatidiform mole<br>Choriocarcinoma | Threatened abortion<br>Ectopic pregnancy |

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**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES (Continued)**

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Complement, $C_3$ | 80–170 mg/dL | 0.8–1.7 g/L | Some inflammatory diseases, acute myocardial infarction, cancer | Acute glomerulonephritis<br>Disseminated lupus erythematosus with renal involvement |
| Complement, $C_4$ | 18–51 mg/dL | 180–510 mg/L | Some inflammatory diseases, acute myocardial infarction, cancer | Often decreased in immunologic disease, especially with active systemic lupus erythematosus<br>Hereditary angioneurotic edema |
| Complement, total (hemolytic) | 90%–94% complement | 25–70 U/mL | Some inflammatory diseases | Acute glomerulonephritis<br>Epidemic meningitis<br>Subacute bacterial endocarditis |
| Copper | 70–150 μg/dL | 11–24 μmol/L | Cirrhosis of liver<br>Pregnancy | Wilson's disease |
| Cortisol-RIA | 8 AM: 5–25/μg/dL<br>4 PM: 3–16 μg/dL | 138–690 nmol/L<br>83–442 nmol/L | Stress: infectious disease, surgery, burns, etc.<br>Pregnancy<br>Cushing's syndrome<br>Pancreatitis<br>Eclampsia | Addison's disease<br>Anterior pituitary hypofunction |
| C-peptide reactivity | 0.9–4.0 ng/mL | 0.9–4.0 μg/L | Insulinoma | Diabetes mellitus |
| Creatine | 0.2–0.8 mg/mL | 15.3–61 μmol/L | Pregnancy<br>Skeletal muscle necrosis or atrophy<br>Starvation<br>Hyperthyroidism | |
| Creatine phosphokinase (CPK) | Males: 50–325 mU/mL<br>Females: 50–250 mU/mL | 50–325 U/L<br>50–250 U/L | Myocardial infarction<br>Skeletal muscle diseases<br>Intramuscular injections<br>Crush syndrome<br>Hypothyroidism<br>Alcohol withdrawal delirium<br>Alcoholic myopathy<br>Cerebrovascular disease | |
| Creatine kinase (CK) isoenzymes | MM band present (skeletal muscle)-<br>MB band absent (heart muscle) | | MB band increased in myocardial infarction, ischemia | |
| Creatinine | 0.7–1.4 mg/dL | 62–124 μmol/L | Nephritis<br>Chronic renal disease | |
| Creatinine clearance | Males: 85–125 mL/min<br>Females: 75–115 mL/min | 1.42–2.08 mL/s<br>1.25–1.92 mL/s | | Kidney diseases<br>Kidney diseases |
| Cryoglobulins, qualitative | Negative | | Multiple myeloma<br>Chronic lymphocytic leukemia<br>Lymphosarcoma<br>Systemic lupus erythematosus<br>Rheumatoid arthritis<br>Infective subacute endocarditis<br>Some malignancies<br>Scleroderma | |
| 11-Deoxycortisol | 1 μg/dL | <0.029 μmol/L | Hypertensive form of virilizing adrenal hyperplasia due to an 11-β-hydroxylase defect | |
| Dibucaine number | Normal: 70%–85% inhibition<br>Heterozygote: 50%–65% inhibition<br>Homozygote: 16%–25% inhibition | | | Important in detecting carriers of abnormal cholinesterase activity who are susceptible to succinylcholine anesthetic shock |

*Continued*

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Dihydrotestosterone | Males: 50–210 ng/dL<br>Females: none detectable | 1.72–7.22 nmol/L | | Testicular feminization syndrome |
| Estradiol—RIA | Females:<br>Follicular: 10–90 pg/mL<br>Midcycle: 100–500 pg/mL<br>Luteal: 50–240 pg/mL<br>Follicular phase: 2–20 ng/dL<br>Midcycle: 12–40 ng/dL<br>Luteal phase: 10–30 ng/dL<br>Postmenopausal: 1–5 ng/dL<br>Males: 0.5–5 ng/dL | <br>37–370 pmol/L<br>367–1835 pmol/L<br><br>184–881 pmol/L | Pregnancy, ovarian tumor | Ovarian failure |
| Estriol—RIA | Nonpregnant females: <0.5 ng/mL<br>Pregnant females:<br>1st trimester: up to 1 ng/mL<br>2nd trimester: 0.8–7 ng/mL<br>3rd trimester: 5–25 ng/mL | <1.75 nmol/L<br><br><br>Up to 3.5 nmol/L<br>2.8–24.3 nmol/L<br>17.4–86.8 nmol/L | Pregnancy | Ovarian failure |
| Estrogens, total—RIA | Females: cycle days:<br>Day 1–10: 61–394 pg/mL<br>Day 11–20: 122–437 pg/mL<br>Day 21–30: 156–350 pg/mL<br>Males: 40–115 pg/mL | <br>61–394 ng/L<br>122–437 ng/L<br>156–350 ng/L<br>40–115 ng/L | Pregnancy<br>Measured on a daily basis, can be used to evaluate response of hypogonadotrophic, hypoestrogenic women to human menopausal or pituitary gonadotropin | Fetal distress<br>Ovarian failure |
| Estrone—RIA | Females:<br>Day 1–10:4.3–18 ng/dL<br>Day 11–20:7.5–19.6 ng/dL<br>Day 21–30: 13–20 ng/dL<br>Males: 2.5–7.5 ng/dL | <br>15.9–66.6 pmol/L<br>27.8–72.5 pmol/L<br>48.1–74 pmol/L<br>9.3–27.8 pmol/L | Pregnancy | Ovarian failure |
| Ferritin—RIA | Males: 20–250 ng/mL<br>Females: 12–250 ng/mL | 20–250 μg/L<br>12–250 μg/L | Nephritis<br>Hemochromatosis<br>Certain neoplastic diseases<br>Acute myelogenous leukemia<br>Multiple myeloma | Iron deficiency |
| Folic acid—RIA | 2.5–20 ng/mL | 6–46 nmol/L | | Megaloblastic anemias of infancy and pregnancy<br>Inadequate diet<br>Liver disease<br>Malabsorption syndrome<br>Severe hemolytic anemia |
| Follicle stimulating hormone (FSH)—RIA | Males: 2–10 mIU/mL<br>Females:<br>Follicular phase: 5–20 mIU/mL<br>Peak of middle cycle: 12–30 mIU/mL<br>Luteinic phase: 5–15 mIU/mL<br>Menopausal females: 40–200 mIU/mL | <br><br>5–20 IU/L<br>12–30 IU/L<br>5–15 IU/L<br>40–200 IU/L | Menopause and primary ovarian failure | Pituitary failure |
| Galactose | <5 mg/dL | <0.28 mmol/L | | Galactosemia |
| Gamma glutamyl transpeptidase | Males: 20–30 U/L<br>Females: 1–24 U/L | 0.03–0.5/μkat/L<br>0.02–0.4/μkat/L | Hepatobiliary disease<br>Drug toxicity<br>Myocardial infarction<br>Renal infarction<br>Zollinger-Ellison syndrome | |
| Gastrin—RIA | Fasting: 50–155 pg/mL<br>Postprandial: 80–170 pg/mL | 50–155 ng/L<br>80–170 ng/L | Peptic ulceration of the duodenum<br>Pernicious anemia | |

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**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Glucose | Fasting: 60–110 mg/dL<br>Postprandial (2 h):<br>65–140 mg/dL | 3.3–6.05 mmol/L<br><br>3.58–7.7 mmol/L | Diabetes mellitus<br>Nephritis<br>Hypothyroidism<br>Early hyperpituitarism<br>Cerebral lesions<br>Infections<br>Pregnancy<br>Uremia | Hyperinsulinism<br>Hyperthyroidism<br>Late hyperpituitarism<br>Pernicious vomiting<br>Addison's disease<br>Extensive hepatic damage |
| Glucose tolerance (oral) | Features of a normal response:<br>1. Normal fasting between 60–110 mg/dL<br>2. No sugar in urine<br>3. Upper limits of normal:<br>Fasting = 125<br>1 hour = 190<br>2 hours = 140<br>3 hours = 125 | <br><br>3.3–6.05 mmol/L<br><br>6.88 mmol/L<br>10.45 mmol/L<br>7.70 mmol/L<br>6.88 mmol/L | Two-hour value >200 mg/dL (11.1 mmol/L) is diagnostic for diabetes mellitus | Decreased 2- and 3-hour values may occur with hypoglycemia in diabetes mellitus |
| Glucose-6-phosphate dehydrogenase (red cells) | Screening:<br>Decolorization in 20–100 min<br>Quantitative: 1.86–2.5 IU/mL RBC | <br><br>1860–2500 U/L | | Drug-induced hemolytic anemia<br>Hemolytic disease of newborn |
| Glycoprotein (alpha-1-acid) | 50–120 mg/dL | 0.5–1.2 g/L | Neoplasm<br>Tuberculosis<br>Diabetes mellitus complicated by degenerative vascular disease<br>Pregnancy<br>Rheumatoid arthritis<br>Rheumatic fever<br>Infectious liver disease<br>Lupus erythematosus | |
| Growth hormone—RIA | Males: 0–4 ng/mL<br>Females: 0–18 ng/mL | 0.4 μg/L<br>0–18 μg/L | Acromegaly | Hypopituitarism |
| Haptoglobin | 30–200 mg/dL | 0.3–2.0 g/L | Pregnancy<br>Estrogen therapy<br>Chronic infections<br>Various inflammatory conditions | Hemolytic anemia<br>Hemolytic blood transfusion reaction |
| Hemoglobin (plasma) | 0.5–5 mg/dL | 5–50 mg/L | Transfusion reactions<br>Paroxysmal nocturnal hemoglobinuria<br>Intravascular hemolysis | Anemia, pregnancy, chronic renal failure |
| Glycohemoglobin (GHB, hemoglobin $A_{1c}$, hemoglobin A1) | Nondiabetics and diabetics with good control:<br>4.4%–6.4% | | Suboptimal glucose control | |
| Hexosaminidase, total | Controls: 333–375 nM/mL/h | 333–375 μmol/L/h | Sandhoff's disease | Tay-Sachs disease and heterozygotes |
| Hexosaminidase A | Controls: 49%–68% of total<br>Heterozygotes: 26%–45% of total<br>Tay-Sachs disease:<br>0%–4% of total<br>Diabetics: 39%–59% of total | Fraction of total: 0.49–0.68<br>0.26–0.45<br><br>0–0.04<br>0.39–0.59 | | |
| High-density lipoprotein cholesterol (HDL cholesterol) | Males: 35–70 mg/dL<br>Females: 35 –85 mg/dL | 0.91–1.81 mmol/L<br>0.91–2.20 mmol/L | | HDL cholesterol is lower in patients with increased risk for coronary heart disease |
| 17 Hydroxy-progesterone—RIA | Males: 0.5–2.0 ng/mL<br>Females: 0.2–3.0 ng/mL<br>Children: <1.0 ng/mL | 1.5–6.0 nmol/L<br>0.6–9.0 nmol/L<br><3.0 nmol/L | Congenital adrenal hyperplasia<br>Pregnancy<br>Some cases of adrenal or ovarian adenomas | |

*Continued*

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Immunoglobulin A | Adults: 80–400 mg/dL | 0.8–4.0 g/L | Gamma A myeloma<br>Wiskott-Aldrich syndrome<br>Autoimmune disease<br>Hepatic cirrhosis | Ataxia telangiectasis<br>Agammaglobulinemia<br>Hypogamma-globulinemia, transient<br>Dysgammaglobulinemia<br>Protein-losing enteropathies |
| Immunoglobulin D | 0.5–12.0 mg/dL | 5–120 mg/L | IgD multiple myeloma<br>Some patients with chronic infectious diseases | |
| Immunoglobulin E | <1.0 mg/mL | <10 mg/L | Allergic patients and those with parasitic infections | |
| Immunoglobulin G | Adults: 600–1800 mg/dL | 6.0–18.0 g/L | IgG myeloma<br>Following hyperimmunization<br>Autoimmune disease states<br>Chronic infections | Congenital and acquired hypogam-maglobu-linemia<br>IgA myelomas,<br>Waldenström's (IgM) macroglobulinemia<br>Some malabsorption syndromes<br>Extensive protein loss |
| Immunoglobulin M | Adults: 55–250 mg/dL | 0.55–2.5 g/L | Waldenström's macroglobulinemia<br>Parasitic infections<br>Hepatitis | Agammaglobulinemias<br>Some IgG and IgA myelomas<br>Chronic lymphatic leukemia |
| Insulin—RIA | 5–25 μU/mL | 0.2–1 μg/L | Insulinoma<br>Acromegaly | Diabetes mellitus |
| Iron | 50–160/μg/dL | 9–29 μmol/L | Pernicious anemia<br>Aplastic anemia<br>Hemolytic anemia<br>Hepatitis<br>Hemochromatosis | Iron deficiency anemia |
| Iron-binding capacity | IBC: 250–350 μg/dL<br>TIBC: 250–475 μg/dL<br>% Saturation: 20–50 | 45–63 μmol/L<br>45–85 μmol/L<br>Fraction of total iron-binding capacity: 0.2–0.5 | Iron deficiency anemia<br>Acute and chronic blood loss<br>Hepatitis | Chronic infectious diseases<br>Cirrhosis |
| Isocitric dehydrogenase | 50–180 U | 0.83–3 UIL | Hepatitis, cirrhosis<br>Obstructive jaundice<br>Metastatic carcinoma of the liver<br>Megaloblastic anemia | |
| Lactic acid (whole blood) | Venous: 5–15 mg/dL<br>Arterial: 3–11 mg/dL | 0.5–1.7 mmol/L<br>0.36–1.25 mmol/L | Increased muscular activity<br>Congestive heart failure<br>Hemorrhage<br>Shock<br>Lactic acidosis<br>Some febrile infections<br>May be increased in severe liver disease | |
| Lactic dehydrogenase (LDH) | 90–176 mU/mL | 90–176 U/L | Untreated pernicious anemia<br>Myocardial infarction<br>Pulmonary infarction<br>Liver disease | |
| *Lactic dehydrogenase isoenzymes<br>Total lactic dehy-drogenase | 90–176 mU/mL | 90–176 U/L<br>Fraction of total LDH: | LDH-1 and LDH-2 are increased in myocardial infarction, megaloblastic anemia, and hemolytic anemia | |
| LDH-1<br>LDH-2<br>LDH-3<br>LDH-4<br>LDH-5 | 22%–36%<br>35%–46%<br>13%–26%<br>3%–10%<br>2%–12% | 0.2–0.36<br>0.35–0.46<br>0.13–0.26<br>0.03–0.10<br>0.02–0.12 | LDH-4 and LDH-5 are increased in pulmonary infarction, congestive heart failure, and liver disease | |
| Lead (whole blood) | Up to 40 μg/dL | Up to 2 μmol/L | Lead poisoning | |
| Leucine aminopeptidase | 80–200 U/mL | 19.2–48 U/L | Liver or biliary tract diseases<br>Pancreatic disease<br>Metastatic carcinoma of liver and pancreas<br>Biliary obstruction | |

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**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| Determination | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| | Conventional Units | SI Units | Increased | Decreased |
| [†]Lipase | <200 U/mL | <200 U/L | Acute and chronic pancreatitis<br>Biliary obstruction<br>Cirrhosis<br>Hepatitis<br>Peptic ulcer | |
| Lipids, total | 400–800 mg/dL | 4–8 g/L | Hypothyroidism<br>Diabetes mellitus<br>Nephrosis<br>Glomerulonephritis<br>Hyperlipoproteinemias | Hyperthyroidism |
| Low-density lipoprotein cholesterol (LDL cholesterol) | mg/dL<br>desirable levels:<br><160 if no coronary artery disease (CAD) and <2 risk factors<br><130 if no CAD and 2 or more risk factors<br><100 if CAD present | | LDL cholesterol is higher in patients with increased risk for coronary heart disease | |
| Luteinizing hormone—RIA | Males: 1.5–9.3 mU/mL<br>Females:<br>Follicular phase: 1.9–12.5 mU/mL<br>Midcycle: 8.7–76.3 mU/mL | 1.5–9.3 U/L<br><br>1.9–12.5 U/L<br>8.7–76.3 U/L | Pituitary tumor<br>Ovarian failure | Pituitary failure |
| Lysozyme (muramidase) | 4.0–15.6 µg/mL | 0.28–1.10 µmol/L | Certain types of leukemia (acute monocytic leukemia)<br>Inflammatory states and infections | Acute lymphocytic leukemia |
| Magnesium | 1.3–2.3 mg/dL | 0.62–0.95 mmol/L | Excess ingestion of magnesium-containing antacids | Chronic alcoholism<br>Severe renal disease<br>Diarrhea<br>Defective growth |
| Mercury | <10 µg/L | <50 µmol/L | Mercury poisoning | |
| Myoglobin | 5–70 ng/mL | 5–70 µg/mL | Myocardial infarction<br>Myocardial ischemia<br>Rhabdomyolysis<br>Malignant hyperthermia | Rheumatoid arthritis<br>Myasthenia gravis |
| 5′ Nucleotidase | 3.2–11.6 IU/L | 3.2–11.6 U/L | Hepatobiliary disease | |
| Osmolality | 275–300 mOsm/kg | 275–300 mmol/L | Diabetes insipidus, osmotic diuresis | Inappropriate secretion of ADH<br>Addison's disease |
| Parathyroid hormone | 10–65 pg/mL | 10–65 ng/L | Hyperparathyroidism, chronic renal failure | Hypoparathyroidism |
| Phenylalanine | 1.2–3.5 mg/dL 1st week<br>0.7–3.5 mg/dL thereafter | 0.07–0.21 mmol/L<br>0.04–0.21 mmol/L | Phenylketonuria | |
| Phosphohexose isomerase | 20–90 IU/L | 20–90 U/L | Malignancy<br>Disease of heart, liver, and skeletal muscles | |
| Phospholipids | 125–300 mg/dL | 1.25–3 g/L | Diabetes mellitus<br>Nephritis | |
| Phosphorus, inorganic | 2.5–4.5 mg/dL | 0.8–1.45 mmol/L | Chronic nephritis<br>Hypoparathyroidism | |
| Potassium | 3.5–5 mEq/L | 3.5–5 mmol/L | Renal Failure<br>Acidosis<br>Cell lysis<br>Tissue breakdown or hemolysis | Hyperparathyroidism<br>Vitamin D deficiency<br>GI losses<br>Diuretic administration |
| Prealbumin | 16.0–35.0 mg/dL | 160–350 mg/L | Malnutrition<br>Severe or chronic illness<br>Liver disease | |

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**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Progesterone—RIA | Follicular phase: up to 0.8 ng/mL<br>Luteal phase: 10–20 ng/mL<br>End of cycle: <1 ng/mL<br>Pregnant: up to 50 ng/mL in 20th week | 2.5 nmol/L<br>31.8–63.6 nmol/L<br><3 nmol/L<br>Up to 160 nmol/L | Useful in evaluation of menstrual disorders and infertility and in the evaluation of placental function during pregnancies complicated by toxemia, diabetes mellitus, or threatened miscarriage | |
| Prolactin—RIA | 4–30 ng/mL | 4–30 μg/L | Pregnancy<br>Functional or structural disorders of the hypothalamus<br>Pituitary stalk section<br>Pituitary tumors | |
| Prostate-specific antigen | <4 ng/mL | | Prostatic cancer, benign prostatic hyperplasia, prostatitis | |
| Protein, total<br>Albumin<br>Globulin | 6–8 gm/dL<br>3.5–5.5 g/dL<br>1.7–3.3 g/dL | 60–80 g/L<br>40–55 g/L<br>17–33 g/L | Hemoconcentration<br>Shock<br>Globulin fraction increased in multiple myeloma, chronic infection, liver disease | Malnutrition<br>Hemorrhage<br>Loss of plasma from burns<br>Proteinuria |
| Protein<br>Electrophoresis<br>Albumin<br>Alpha-1 globulin<br>Alpha-2 globulin<br>Beta globulin<br>Gamma globulin | <br><br>3.5–5.5 g/dL<br>0.15–0.25 g/dL<br>0.43–0.75 g/dL<br>0.5–1.0 g/dL<br>0.6–1.3 g/dL | 35–50 g/L<br><br>40–55 g/L<br>1.5–2.5 g/L<br>4.3–7.5 g/L<br>5–10 g/L<br>6–13 g/L | | |
| Protoporphyrin erythrocyte (whole blood) | Males: 11–45 μg/dL<br>Females: 19–52 μg/dL | 0.20–0.80 μmol/L<br>0.34–0.92 μmol/L | Lead toxicity<br>Erythropoietic porphyria | |
| Pyridoxine | 5–30 ng/mL | 20–1.21 nmol/L | | A wide spectrum of clinical conditions, such as mental depression, peripheral neuropathy, anemia, neonatal seizures, and reactions to certain drug therapies |
| Pyruvic acid (whole blood) | 0.3–0.9 mg/dL | 34–102 μmol/L | Diabetes mellitus<br>Severe thiamine deficiency<br>Acute phase of some infections, possibly secondary to increased glycogenolysis and glycolysis | |
| Renin (plasma)—RLA | Normal diet:<br>Supine: 0.3–1.9 ng/mL/h<br>Upright: 0.6–3.6 ng/mL/h<br>Low salt diet:<br>Supine: 0.9–4.5 ng/mL/h<br>Upright: 4.1–9.1 ng/mL/h | <br>0.08–0.52 ng/L/S<br>0.16–1.00 μg/L/S<br><br>0.25–1.25 μg/L/S<br>1.13–2.53 μg/L/S | Renovascular hypertension<br>Malignant hypertension<br>Untreated Addison's disease<br>Primary salt-losing nephropathy<br>Low-salt diet<br>Diuretic therapy<br>Hemorrhage | Frank primary aldosteronism<br>Increased salt intake<br>Salt–retaining steroid therapy<br>Antidiuretic hormone therapy<br>Blood transfusion |
| Sodium | 135–145 mEq/L | 135–145 mmol/L | Hemoconcentration<br>Nephritis<br>Pyloric obstruction | Alkali deficit<br>Addison's disease<br>Myxedema |
| Sulfate (inorganic) | 0.5–1.5 mg/dL | 0.05–0.15 mmol/L | Nephritis<br>Nitrogen retention | |

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**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Testosterone—RIA | Females: 20–80 ng/dL<br>Males: 240–1200 ng/dL | 0.7–2.8 nmol/L<br>18.3–41.8 nmol/L | Females:<br>Polycystic ovary<br>Virilizing tumors | Males:<br>Orchidectomy for neoplastic disease of the prostate or breast<br>Estrogen therapy<br>Klinefelter's syndrome<br>Hypopituitarism<br>Hypogonadism<br>Hepatic cirrhosis |
| $T_3$ (triiodothyronine) uptake | 24%–34% | Relative uptake fraction: 0.24–0.34 | Hyperthyroidism<br>Thyroxine-binding globulin (TBG) deficiency<br>Androgens and anabolic steroids | Hypothyroidism<br>Pregnancy<br>TBG excess<br>Estrogens and antiovulatory drugs |
| $T_3$ total circulating—RIA | 70–204 ng/dL | 1.08–3.14 nmol/L | Pregnancy<br>Hyperthyroidism | Hypothyroidism |
| $T_4$ (thyroxine)—RIA | 5–11 μg/dL | 65–138 nmol/L | Hyperthyroidism<br>Thyroiditis<br>Elevated thyroxine-binding proteins caused by oral contraceptives<br>Pregnancy | Primary and pituitary hypothyroidism<br>Idiopathic involvement<br>Cases of diminished thyroxine-binding proteins caused by androgenic and anabolic steroids<br>Hypoproteinemia<br>Nephrotic syndrome |
| $T_4$, free | 0.8–2.7 ng/dL | 10.3–35 pmol/L | Euthyroid patients with normal free thyroxine levels may have abnormal T3 and T4 levels caused by drug preparations | |
| Thyroid-stimulating hormone (TSH)—RIA | | 0.4–4.2 mIU/L | Hypothyroidism | Hyperthyroidism |
| Thyroid-binding globulin | 10–26 μg/dL | 100–260/μg/L | Hypothyroidism<br>Pregnancy<br>Estrogen therapy<br>Oral contraceptive use<br>Genetic and idiopathic liver disease | Use of androgens and anabolic steroids<br>Nephrotic syndrome<br>Marked hypoproteinemia |
| Transferrin | 200–380 mg/dL | 2.3–3.2 g/L | Pregnancy<br>Iron deficiency anemia due to hemorrhaging<br>Acute hepatitis<br>Polycythemia<br>Oral contraceptive use | Pernicious anemia in relapse<br>Thalassemic and sickle cell anemia<br>Chromatosis<br>Neoplastic and hepatic diseases<br>Malnutrition |
| Triglycerides | 100–200 mg/dL | 1.13–3.8 mmol/L | Increased risk for atherosclerosis | |
| Troponin | | | | |
| Troponin I | <0.35 ng/mL | <0.35 μg/L | Myocardial infarction | |
| Troponin T | <0.2 ng/mL | <0.2 μg/L | Rhabdomyolysis<br>Severe crushing injuries | |
| Tryptophan | 1.4–3 mg/dL | 68.6–147 nmol/L | Tyrosinosis | Tryptophan-specific malabsorption syndrome |
| Tyrosine | 0.5–4 mg/dL | 27.6–220.8 mmol/L | Acute glomerulonephritis | Severe hepatic failure |
| Urea nitrogen (BUN) | 10–20 mg/dL | 3.6–7.2 mmol/L | Obstructive uropathy<br>Mercury poisoning<br>Nephrotic syndrome | Pregnancy |
| Uric acid | 2.5–8 mg/dL | 0.15–0.5 mmol/L | Gouty arthritis<br>Acute leukemia<br>Lymphomas treated by chemotherapy<br>Toxemia of pregnancy | Defective tubular reabsorption |
| Viscosity | 1.4–1.8 relative to water at 37°C (98.6°F) | | Patients with marked increases of the gamma globulins<br>Hypervitaminosis A | |

*Continued*

**Table A-2 REFERENCE RANGES—SERUM, PLASMA, AND WHOLE BLOOD CHEMISTRIES (Continued)**

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| Determination | Conventional Units | SI Units | Increased | Decreased |
| Vitamin A | 30–120 μg/dL | 1.05–4.20 μmol/L | | Vitamin A deficiency<br>Celiac disease<br>Sprue<br>Obstructive jaundice<br>Giardiasis<br>Parenchymal hepatic disease |
| Vitamin $B_1$ (thiamine) | 1.6–4 μg/dL | 47.4–135.7 nmol/L | | Anorexia<br>Beriberi<br>Polyneuropathy<br>Cardiomyopathies |
| Vitamin $B_6$ (pyridoxal phosphate) | 5–30 ng/mL | 20–121 nmol/L | | Chronic alcoholism<br>Malnutrition<br>Uremia<br>Neonatal seizures<br>Malabsorption, such as celiac syndrome |
| Vitamin $B_{12}$—RIA | 200–900 pg/mL | 148–666 pmol/L | Hepatic cell damage and in association with the myeloproliferative disorders (the highest levels are encountered in myeloid leukemia) | Strict vegetarianism<br>Alcoholism<br>Pernicious anemia<br>Total or partial gastrectomy<br>Ileal resection<br>Sprue and celiac disease<br>Fish tapeworm infestation |
| Vitamin E | 0.5–1.8 mg/dL | 12–42 μmol/L | | Vitamin E deficiency |
| Xylose absorption test | 2 hr, 30–50 mg/dL | 2–3.35 mmol/L | | Malabsorption syndrome |
| Zinc | 55–150 μg/dL | 7.65–22.95 μmol/L | Coronary artery disease<br>Arteriosclerosis<br>Industrial exposure | Metastatic liver disease<br>Tuberculosis<br>Sprue |

*By radioimmunoassay.
†Varies among methods.

**Table A-3 REFERENCE RANGES—IMMUNODIAGNOSTIC TEST**

| Determination | Normal Value | Clinical Significance |
|---|---|---|
| Acetylcholine receptor binding antibody | Negative or <0.03 nmol/L | Considered to be diagnostic for myasthenia gravis in patients with symptoms. |
| Anti-ds-DNA antibody | <70 U by enzyme-linked immunosorbent assay (ELISA)<br><1:20 by indirect fluorescence | Valuable in supporting diagnosis or monitoring disease activity and prognosis of systemic lupus erythematosus (SLE). |
| Antiglomerular basement membrane antibody | Negative or less than 5εUL | Primarily used in the differential diagnosis of glomerular nephritis induced by antiglomerular basement membrane antibodies from other types of glomerular nephritis. |
| Anti-insulin antibody | <3% binding of labeled beef and pork insulin by patient's serum; or <9 mIU/L | Helpful in determining the best therapeutic agent in diabetics and the cause of allergic manifestations. Also used to identify insulin resistance. |
| Antinuclear antibody | Negative, <1:40 | Increased in SLE, chronic hepatitis, scleroderma, leukemia, and mononucleosis. |
| Anti-parietal cell antibody | Negative | Helpful in diagnosing chronic gastric disease and differentiating autoimmune pernicious anemia from other megaloblastic anemias. |
| Antiribonucleoprotein antibody | Negative | Helpful in differential diagnosis of systemic rheumatic disease. |
| Antiscleroderma antibody | Negative | Highly diagnostic for scleroderma. |
| Anti-Smith antibody | Negative | Highly diagnostic of SLE. |
| Anti-SS-A/anti-SS-B antibody | Negative | SS-A antibodies are found in Sjögren's syndrome alone or associated with lupus.<br>SS-B antibodies are associated with primary Sjögren's syndrome. |
| Antithyroglobulin and antimicrosomal antibodies | <1:100 titer by gelatin or hemagglutination | Presence and concentration is important in evaluation and treatment of various thyroid disorders, such as Hashimoto's thyroiditis and Graves' disease. May indicate previous antoimmune disorders. |
| CA 15-3 tumor marker | <30 IU/mL | Increased in metastatic breast cancer. |
| CA 19-9 tumor marker | <37 IU/mL | Increased in pancreatic, hepatobiliary, gastric, and colorectal cancer, gallstones. |

*Continued on following page*

**Table A-3 REFERENCE RANGES—IMMUNODIAGNOSTIC TEST (Continued)**

| Determination | Normal Value | Clinical Significance |
|---|---|---|
| CA 125 | 0–35 IU/mL | Increased in colon, upper gastrointestinal (GI), ovarian, and other gynecologic cancers: pregnancy, peritonitis. |
| Carcinoembryonic antigen (CEA)—RLK | 0–2.5 μg/L (nonsmoker)<br>0–5/μg/L (smoker) | The repeatedly high incidence of this antigen in cancers of the colon, rectum, pancreas, and stomach suggests that CEA levels may be useful in the therapeutic monitoring of these conditions, but it is not a screening test. |
| Cold agglutinins | Negative or <1:32 | Increased in mycoplasma pneumonia, viral illness, mononucleosis, multiple myeloma, scleroderma. |
| C-reactive protein | <1mg/dL (<10 mg/L) | Increase indicates active inflammation. |
| High sensitivity assay for C-reactive protein (hs-CRP) | 0.2–8.0 mg/L | Cardiovascular disease risk. |
| Cytomegalovirus antibodies (CMV IgG) | Negative: <0.9 units/mL | Positive >1:0 unit/mL if exposed to CMV at any time. Acute and convalescent specimens can help identify acute infection. |
| Cytomegalovirus antibodies (CMV IgM) | Negative: <0:79<br>Equivocal: 0:80–1.20 | Positive >1:20 usually indicates acute infection.<br>Repeat specimen in 1–2 weeks for equivocal result. |
| Epstein-Barr virus serology (viral capsid antigen IgG and IgM, early antigen IgG, and nuclear antigen IgG) | Negative: <1:20 or <1:20 for each individual test | Differentiation of acute from chronic or old infection by interpretation of table below. |

**EBV Interpretation**

| | *VCA-IgG* | *VCA-IgM* | *EA-IgG* | *EBV-NA* |
|---|---|---|---|---|
| Susceptible | – | – | – | – |
| Acute infection | + | + | ± | – |
| Convalescent phase | + | ± | ± | + |
| Chronic or reactivated | + | – | + | ± |
| Old infection | ± | – | – | + |

Antibody present: +
Antibody absent: –
VCA, viral capsid antigen; EA, early antigen; EBV-NA, Epstein Barr virus-nuclear antigen

| Determination | Normal Value | Clinical Significance |
|---|---|---|
| Hepatitis A virus antibodies, IgM (HAV-Ab/IgM) | Negative | Positive in acute-stage hepatitis A; develops early in disease. |
| Hepatitis A virus antibodies, IgG (HAV-Ab/IgG) | Negative | Positive if previous exposure and immunity to hepatitis A. |
| Hepatitis B surface antigen (HBsAg) | Negative | Positive in acute-stage hepatitis B. |
| Hepatitis B surface antibody (HBsAb) | Negative | Positive if previous exposure and immunity to hepatitis B. |
| Hepatitis C virus antibodies | Negative | Positive in exposure to hepatitis C virus; may indicate acute, chronic, or cleared infection. |
| Hepatitis C virus RNA | Negative | Positive in hepatitis C infection, can be quantitative |
| Homocysteine | 0.54–2.30 mg/L (4–17 μmol/L) | Cardiovascular disease risk<br>Folic acid deficiency<br>Vitamin $B_{12}$ deficiency |
| Infectious mononucleosis tests (monospot, monotest, heterophile antigen test, Epstein-Barr virus [EBV], antiviral capsid antigen IgM and IgG) | Negative | Positive monospot and monotest are presumptive, positive EBV IgM and IgG indicate acute and recent or past infection, respectively. |
| Lyme disease titer | Negative, <1:256 by indirect fluorescent antibody method; nonreactive by ELISA | Positive results help diagnose Lyme disease.<br>False positive may occur with high rheumatoid factor titers or syphilis.<br>Positive ELISA confirmed by Western blot test. |
| Pyroglobulin test | Negative | These abnormal proteins may be associated with myeloma, lymphoma, polycythemia vera, and SLE. |
| Rheumatoid factor | Negative or less than 40 IU/mL | Elevated in rheumatoid arthritis, lupus endocarditis, tuberculosis, syphilis, sarcoidosis, cancer. |
| T and B cell lymphocyte surface markers<br>T-helper/T-suppressor ratio | T and B cell lymphocyte surface markers:<br>Percent T cells (CD2) 60–88%<br>Percent helper cells (CD4) 34–67%<br>Percent suppressor cells (CD8) 10–42%<br>Percent B cells (CD19) 3–21%<br>Absolute counts:<br>Lymphocytes 0.66–4.60 thou/mL<br>T cells 644–2201 cells/mL<br>Helper cells 493–1191 cells/mL<br>Suppressor T cells 182–785 cells/mL<br>B cells 92–392 cells/mL<br>Lymphocyte ratio:<br>$T_H/T_S$ ratio >1 | Used to evaluate immune system by identifying the specific cells involved in the immune response. Valuable in diagnosis of lymphocytic leukemia, lymphoma, and immunodeficiency diseases including acquired immunodeficiency syndrome, and in the assessment of patient response to chemotherapy and radiation. |

**Table A-4 REFERENCE RANGES—URINE CHEMISTRY**

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Acetone and acetoacetate | Zero | | Diabetic ketoacidosis | |
| | | | Starvation | |
| Aldosterone | With normal salt diet: | | | |
| | Normal: 4–20 µg/24 h | 11.1–55.5 nmol/24h | Primary aldosteronism (adrenocortical tumor) | |
| | Renovascular: 10–40 µg/24 h | 27.7–111 nmol/24 h | | |
| | Tumor: 20–100 µg/24 h | 55.4–277 nmol/24 h | Secondary aldosteronism | |
| | | | Salt depletion | |
| | | | Potassium loading | |
| | | | ACTH in large doses | |
| | | | Cardiac failure | |
| | | | Cirrhosis with ascites formation | |
| | | | Nephrosis | |
| | | | Pregnancy | |
| Alpha amino nitrogen | 50–200 mg/24 h | 3.6–14.3 nmol/24 h | Leukemia | |
| | | | Phenylketonuria | |
| | | | Other metabolic diseases | |
| Amylase | 35–260 units excreted per h | 6.5–48.1 U/h | Acute pancreatitis | |
| Arylsulfatase A | >2.4 U/mL | | | |
| Bence-Jones protein | None detected | | Myeloma | Metachromatic leukodystrophy |
| Calcium | 100–250 mg/24 h | 2.5–6.2 mmol/24 h | Hyperparathyroidism | |
| | | | Vitamin D intoxication | |
| | | | Fanconi's syndrome | Hypoparathyroidism |
| Catecholamines | Total: 0–275 µg/24 h | 0–275 µg/24 h | Pheochromocytoma | Vitamin D deficiency |
| | Epinephrine: 10%–40% | Fraction total: 0.10–8.4 | Neuroblastoma | |
| | Norepinephrine: 60%–90% | Fraction total: 0.60–0.90 | | |
| Chorionic gonadotrophin, qualitative (pregnancy test) | Negative | | Pregnancy | |
| | | | Chorionepithelioma | |
| | | | Hydatidiform mole | |
| Copper | 15–60 µg/24 h | 0.22–0.9 µmol/24 h | Wilson's diseases | |
| | | | Cirrhosis | |
| | | | Nephrosis | |
| Coproporphyrin | 50–300 µg/24 h | 0.075–0.45 µmol/24 h | Poliomyelitis | |
| | | | Lead poisoning | |
| | | | Porphyria | |
| Cortisol, free | 20–90 µg/24 h | 55.2–248.4 nmol/d | Cushing's syndrome | |
| Creatinine | Males: 1–2 g/24 h | 8.8–17.7 mmol/24 h | Muscular dystrophy | |
| | Females: 0.8–1.8 g/24 h | 7.1–15.9 mmol/24 h | Fever | |
| | | | Carcinoma of liver | |
| | | | Pregnancy | |
| | | | Hyperthyroidism | |
| | | | Myositis | |
| Creatine | 0–270 mg/24 h | 0–2.05 mmol/24 h | Typhoid fever | Muscular atrophy |
| | | | Salmonella infections | Anemia |
| | | | Tetanus | Advanced degeneration of kidneys |
| | | | | Leukemia |
| Creatinine clearance | Males: 85–125 mL/min | 1.42–2.08 mL/s | | Renal diseases |
| | Females: 75–115 mL/min | 1.25–1.92 mL/s | | |
| Cystine and cysteine | 10–100 mg/24 h | 0.08–0.83 mmol/24 h | Cystinuria | |
| Delta aminolevulinic acid | 0–0.54 mg/dL | 0–40/µmol/L | Lead poisoning | |
| | | | Porphyria hepatica | |
| | | | Hepatitis | |
| | | | Hepatic carcinoma | |
| 11-Desoxycortisol | 20–100 µg/24 h | 0.6–2.9/µmol/d | Hypertensive form of virilizing adrenal hyperplasia due to an 11-beta hydroxylase defect | |
| Estriol (placental) | Weeks of pregnancy | µm/24 h | mmol/24 h | Decreased values occur with fetal distress of many conditions, including preeclampsia, placental insufficiency, and poorly controlled diabetes mellitus |
| | 12 | <1 | <3.5 | |
| | 16 | 2–7 | 7–24.5 | |
| | 20 | 4–9 | 14–32 | |
| | 24 | 6–13 | 21–45.5 | |
| | 28 | 8–22 | 28–77 | |
| | 32 | 12–43 | 42–150 | |
| | 36 | 14–45 | 49–158 | |
| | 40 | 19–46 | 66.5–160 | |

*Continued on following page*

**Table A-4 REFERENCE RANGES—URINE CHEMISTRY** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Estrogens, total (fluorometric) | Females:<br>Onset of menstruation: 4–25 µg/24 h<br>Ovulation peak: 28–100 µg/24 h<br>Luteal peak: 22–105 µg/24 h<br>Menopausal: 1.4–19.6 µg/24 h<br>Males: 5–18 µg/24 h | <br>4–25 µg/24 h<br>28–100 µg/24 h<br>22–105 µg/24 h<br>1.4–19.6 µg/24 h<br>5–18 µg/24 h | Hyperestrogenism due to gonadal or adrenal neoplasm | Primary or secondary amenorrhea |
| Etiocholanolone | Males: 1.9–6 mg/24 h<br>Females: 0.5–4 mg/24 h | 6.5–20.6 µmol/24 h<br>1.7–13.8 µmol/24 h | Adrenogenital syndrome<br>Idiopathic hirsutism | |
| Follicle-stimulating hormone—RIA | Females:<br>Follicular: 5–20 IU/24 h<br>Luteal: 5–15 IU/24 h<br>Midcycle: 15–60 IU/24 h<br>Menopausal: 50–100 IU/24 h<br>Males: 5–25 IU/24 h | <br>5–20 IU/d<br>5–15 IU/d<br>15–60 IU/d<br>50–100 IU/d<br>5–25 IU/d | Menopause and primary ovarian failure | Pituitary failure |
| Glucose | Negative | | Diabetes mellitus<br>Pituitary disorders<br>Increased ICP<br>Lesion in floor of 4th ventricle | |
| Hemoglobin and myoglobin | Negative | | Extensive burns<br>Transfusion of incompatible blood<br>Myoglobin increased in severe crushing injuries to muscles | |
| Homovanillic acid | | 5.5–27.5 µmol/d | Neuroblastoma | Addison's disease |
| 17-hydroxycorticosteroids | 8 mg/24 h<br>2–10 mg/24 h | 5.5–27.5 µmol/d | Cushing's disease | Anterior pituitary hypofunction |
| 5-Hydroxyindoleacetic acid, qualitative | Negative | | Malignant carcinoid tumors | |
| 17-ketosteroids, total | Males: 10–22 mg/24 h<br>Females: 6–16 mg/24 h | 35–76 µmol/24h<br>21–55 µmol/24h | Interstitial cell tumor of testes<br>Simple hirsutism, occasionally<br>Adrenal hyperplasia<br>Cushing's syndrome<br>Adrenal cancer, virilism<br>Adrenoblastoma | Thyrotoxicosis<br>Female hypogonadism<br>Diabetes mellitus<br>Hypertension<br>Debilitating disease of mild to moderate severity<br>Eunuchoidism<br>Addison's disease<br>Panhypopituitarism<br>Myxedema<br>Nephrosis |
| Lead | <125 µg/24 h | <60 µmol/24 h | Lead poisoning | |
| Luteinizing hormone | Males: 5–18 IU/24 h<br>Females:<br>Follicular phase: 2–25 IU/24 h<br>Ovulatory peak: 30–95 IU/24 h<br>Luteal phase: 2–20 IU/24 h<br>Postmenopausal: 40–110 IU/24 h | <br><br>2–25 IU/d<br>30–95 IU/d<br>2–20 IU/d<br>40–110 IU/d | Pituitary tumor<br>Ovarian failure | Failure of pituitary or hypothalamus<br>Anorexia nervosa |
| Metanephrines, total | <1.4 mg/24 h | <7 µmol/24h | Pheochromocytoma; a few patients with pheochromocytoma may have elevated urinary metanephrines but normal catecholamines and vanillylmandelic acid (VMA) | |
| Osmolality | 250–900 mOsm/kg | 250–900 mmol/kg | Useful in the study of electrolyte and water balance | |

*Continued*

**Table A-4 REFERENCE RANGES—URINE CHEMISTRY** (Continued)

| | Normal Adult Reference Range | | Clinical Significance | |
|---|---|---|---|---|
| **Determination** | **Conventional Units** | **SI Units** | **Increased** | **Decreased** |
| Oxalate | Up to 45 mg/24 h | Up to 500/μmol/24 h | Primary hyperoxaluria | |
| Phenylpyruvic acid qualitative | Negative | | Phenylketonuria | |
| Phosphorus, inorganic | 0.9–1.3 g/24 h | 29–42 mmol/24 h | Hypoparathyroidism<br>Vitamin D intoxication<br>Paget's disease<br>Metastatic neoplasm to bone | Hypoparathyroidism<br>Vitamin D deficiency |
| Porphobilinogen, qualitative | Negative | | Chronic lead poisoning<br>Acute porphyria<br>Liver disease | |
| Porphobilinogen quantitative | 0–1 mg/24 h | 0–4.4 μmol/24 h | Acute porphyria<br>Liver disease | |
| Porphyrins, qualitative | Negative | | See porphyrins, quantitative | |
| Porphyrins, quantitative (coproporphyrin and uroporphyrin) | Coproporphyrin: 50–160 μg/24 h<br>Uroporphyrin: up to 50 μg/24 h | 0.075–0.24 μmol/24h<br>Up to 0.06 μmol/24 h | Porphyria<br>Lead poisoning (only coproporphyrin increased) | |
| Potassium | 26–123 mEq/24 h | 26–123 mmol/24 h | Hemolysis<br>Chronic renal failure<br>Acidosis<br>Cushing's disease<br>Corpus luteum cysts | Diarrhea<br>Adrenocortical insufficiency |
| Pregnanediol | Females:<br>Proliferative phase: 0.5–1.5 mg/24 h<br>Luteal phase: 2–7 mg/24 h<br>Menopause: 0.2–1 mg/24 h | <br>1.6–4.8 μmol/24 h<br>6–22 μmol/24 h<br>0.6–3.1 μmol/24 h | When placental tissue remains in the uterus following parturition<br>Some cases of adrenocortical tumors | Placental dysfunction<br>Threatened abortion<br>Intrauterine death |
| Pregnancy: Weeks of gestation | mg/24 h | μmol/24 h | | |
| 10–12 | 5–15 | 15.6–47 | | |
| 12–18 | 5–25 | 15.6–78.0 | | |
| 18–24 | 15–33 | 47.0–103.0 | | |
| 24–28 | 20–42 | 62.4–131.0 | | |
| 28–32 | 27–47 | 84.2–146.6 | | |
| Pregnanetriol | Females: 0.1–2.2 mg/24 h<br>Males: 0.4–2.5 mg/24 h | 0.3–6.5 μmol/24 h<br>1.2–7.5 μmol/24 h | Congenital adrenal androgenic hyperplasia | |
| Protein | <150 mg/24 h | <150 mg/24 h | Nephritis<br>Cardiac failure<br>Mercury poisoning<br>Bence-Jones protein in multiple myeloma<br>Febrile states<br>Hematuria | |
| Sodium | 75–200 mEq/24 h | 75–200 mmol/24 h | Useful in detecting gross changes in water and salt balance | |
| Titratable acidity | 20–40 mEq/24 h | 20–40 mmol/24 h | Metabolic acidosis | Metabolic alkalosis |
| Urea nitrogen | 9–16 gm/24 h | 0.32–0.57 mol/L | Excessive protein catabolism | Impaired kidney function |
| Uric acid | 250–750 mg/24 h | 1.48–4.43 mmol/24 h | Gout | Nephritis |
| Urobilinogen | Random urine: <0.25 mg/dL<br>24-hour urine: up to 4 mg/24 h | <0.42 mol/24 h<br>Up to 6.76 μmol/24 h | Liver and biliary tract disease<br>Hemolytic anemias | Complete or nearly complete biliary obstruction<br>Diarrhea |
| Vanillylmandelic acid (VMA) | 0.7–6.8 mg/24 h | 3.5–34.3 μmol/24 h | Pheochromocytoma<br>Neuroblastoma<br>Ingestion of coffee, tea, aspirin, bananas, and several different drugs | Renal insufficiency |
| Xylose absorption test (5-hour) | 16%–33% of ingested xylose | Fraction absorbed: 0.16–0.33 | | |
| Zinc | 0.15–1.2 mg/24 h | 2.3–18.4 μmol/24h | | Malabsorption syndromes |

**TABLE A-5 REFERENCE RANGES—CEREBROSPINAL FLUID (CSF)**

| Determination | Normal Adult Reference Range: Conventional Units | SI Units | Clinical Significance: Increased | Decreased |
|---|---|---|---|---|
| Albumin | 15–30 mg/dL | 150–300 mg/L | Certain neurologic disorders<br>Lesion in the choroid plexus or blockage of the flow of CSF<br>Damage to the blood–brain barrier<br>Bacterial meningitis | |
| Cell count (white blood cells) | 0–5 cells per cu mm | 0–5 × $10^6$/L | Neurosyphilis<br>Anterior poliomyelitis<br>Encephalitis lethargica | |
| Chloride | 120–130 mEq/L | 120–130 mmol/L | Uremia | Acute generalized meningitis<br>Tuberculous meningitis |
| Glucose | 40–80 mg/dL; 50%–80% of blood glucose value | 2.75–4.13 mmol/L | Diabetes mellitus<br>Diabetic coma<br>Epidemic encephalitis<br>Uremia | Acute meningitis<br>Tuberculous meningitis<br>Insulin shock<br>Subarachnoid hemorrhage |
| Glutamine | 6–15 mg/dL | 0.41–1 mmol/L | Hepatic encephalopathies, including Reye's syndrome<br>Hepatic coma<br>Cirrhosis | |
| IgG | <5 mg/dL | <50 mg/L | Damage to the blood–brain barrier<br>Multiple sclerosis<br>Neurosyphilis<br>Subacute sclerosing panencephalitis<br>Chronic phases of CNS infections | |
| Lactic acid | 4.5–28.8 mg/dL | 0.5–3.2 mmol/L | Bacterial meningitis<br>Hypocapnia<br>Hydrocephalus<br>Brain abscesses<br>Cerebral ischemia<br>Fungal meningitis | |
| Lactate dehydrogenase | 1/10 that of serum level | Activity fraction: 0.1 of serum | CNS disease<br>Acute meningitis | |
| Protein | 16–45 mg/dL | 150–450 mg/L | Tubercular meningitis<br>Neurosyphilis<br>Poliomyelitis<br>Guillain-Barré syndrome<br>Subdural hematoma<br>Brain tumor<br>Multiple sclerosis | |

**TABLE A-6 MISCELLANEOUS VALUES**

| Determination | Normal Values | Clinical Significance: Conventional Units | Clinical Significance: SI Units |
|---|---|---|---|
| Acetaminophen | Zero | Therapeutic level = 10–30 μg/mL | 10–30 mg/L |
| Aminophylline (theophylline) | Zero | Therapeutic level = 10–20/μg/mL | 10–20 mg/L |
| Bromide | Zero | Therapeutic level = 5–50 mg/dL | 50–500 mg/L |
| Carbamazepine | Zero | Therapeutic level = 4–12 μg/mL | 34–51 μmol/L |
| Carbon monoxide | 0%–2% | Symptoms with 10%–30% saturation | |
| Chlordiazepoxide | Zero | Therapeutic level = 0.7–1.0 μg/mL | 0.7–1.0 mg/L |
| Diazepam | Zero | Therapeutic level = 0.2–1.0 μg/mL | 0.2–1.0 mg/L |
| Digitoxin | Zero | Therapeutic level = 18–35 ng/mL | 18–35 μg/L |
| Digoxin | Zero | Therapeutic level = 0.8–2 ng/mL | 0.8–2/μg/L |
| Ethanol | 0%–0.01% | Legal intoxication level = 0.1% or above | |
| | | 0.3%–0.4% = marked intoxication | |
| | | 0.4%–0.5% = alcoholic stupor | |
| Fosphenytoin | Zero | 10–20 mg/L | |
| Gentamicin | Zero | Therapeutic level = 4–10 μg/mL | 4–10 mg/L |
| Lithium | Zero | Therapeutic level = 0.6–1.2 mEq/L | 0.6–1.2 mmol/L |
| Methanol | Zero | May be fatal in concentration as low as 10 mg/dL | 100 mg/L |
| Phenobarbital | Zero | Therapeutic level = 15–40 μg/mL | 15–40 mg/L |
| Phenytoin | Zero | Therapeutic level = 10–20 μg/mL | 10–20 mg/L |
| Primidone | Zero | Therapeutic level = 5–12 μg/mL | 5–12 mg/L |
| Quinidine | Zero | Therapeutic level = 0.2–0.5 mg/dL | 2–5 mg/L |
| Salicylate | Zero | Therapeutic level = 2–25 mg/dL | 20–250 mg/L |
| | | Toxic level = >30 mg/dL | 300 mg/L |
| Vancomycin | Zero | Therapeutic peak 20–40 μg/mL | |
| Amitriptyline | Zero | Therapeutic trough 5–10 μg/mL | |
| | | Therapeutic level 80–200 ng/mL | 289–722 nmol/L |
| Doxepin | Zero | Therapeutic level 150–250 ng/mL (includes metabolites) | 540–900 nmol/L |
| Imipramine | Zero | Therapeutic level 100–300 ng/mL (includes metabolites) | 360–1070 nmol/L |
| Lidocaine | Zero | Therapeutic level 1.5–5 μg/mL | 6.4–21.4 μmol/L |
| Methotrexate | Zero | Toxic (48 h after high dose) 454 mg/mL | 1000 mmol/L |
| Propranolol | Zero | Therapeutic level 50–100 ng/mL | 193–386 nmol/L |
| Valproic acid | Zero | Therapeutic level 50–100 ng/mL | 347–693 μmol/L |

## REFERENCES


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# appendix B Understanding Clinical Pathways

Clinical pathways (also called critical pathways) are care plans developed collaboratively by physicians, nurses, physical and occupational therapists, technicians, pharmacists, speech therapists, case managers, and other staff members involved in patient care. Nurses are instrumental in ensuring the successful use of clinical pathways and can best contribute by gaining a thorough understanding of why and how pathways are used.

## Understanding and Using Clinical Pathways in Patient Care

Clinical pathways grew out of financial upheaval in the health care industry. They represent a significant change in how patient care is managed. In the past (and currently for many patients), each health care discipline developed its own plan of care and used the patient's medical record as the primary communication tool. Each care provider needed to read the notes of health care providers of other disciplines to get a complete picture of the plan of care and the patient's progress. Although there was probably general agreement about how patient progress would be facilitated and measured, individual steps in the processes of care and outcomes to be achieved were often not identified and communicated. The physician managed the case and most patients remained in the hospital until they required very little care or could be discharged home or transferred to a convalescent center. A hospital stay of 2 to 3 weeks in an acute care facility was not unusual.

## Cost and Effects

Although this system worked for decades, it was expensive. The federal government and insurance companies balked at paying these costs when highly skilled care was no longer needed. As a result, the number of days of hospitalization that a patient with a specific diagnosis required was determined. Then insured parties were paid only for that number of days. Decreasing the length of stay was seen as one way to decrease costs and save money. Patients were discharged to home or rehabilitation centers much sooner than before. They were weaker, had relatively fresh incisions, or often could not independently perform even minimal self-care. As hospital stays became shorter, nurses, physicians, consumers, and regulatory agencies expressed concerns about the quality of care. These concerns compelled hospital administrators and clinicians to develop new ways to measure and manage costs, quality, and outcomes. Assessment of how patient care was provided exposed inefficiencies, including lack of face-to-face communication among disciplines. Case management was developed and widely adopted to provide more cost-effective care while saving hundreds of thousands of dollars yearly.

## Case Management

Using the case management model, care is planned collaboratively so that important events, such as initiation of physical therapy, home care consultation, or discontinuation of invasive treatments, occur on a schedule that clinicians, through research or experience, have identified as optimum for enhancing recovery. Care is mapped out by day or by other pivotal time intervals, and goals or desired outcomes are specified for each time frame. When the patient has met all the goals, he or she is ready for discharge to home or to the next level of care. Responsibility for monitoring the patient's progress and tracking variance or deviation from the pathway is given to the case manager, who usually (but not always) is a nurse. The tool on which all this information is contained is the clinical pathway. The purposes of a clinical pathway are to

- Promote quality care and improve clinical outcomes
- Standardize important aspects of care
- Reduce unnecessary delays in care
- Reduce costs

## Elements of a Clinical Pathway

Clinical pathways are now used in a variety of settings and cover diverse diagnoses and conditions. They are often developed by individual organizations and, although the format varies from institution to institution, clinical pathways have major features in common.

## Patient Population

The first important element of the clinical pathway is the patient population (Fig. B-1A). Each pathway clearly specifies those patients who are appropriate for inclusion on the pathway. Pathways tend to cover patient groups in which the treatment and recovery are relatively predictable. Diagnosis-related groups (DRGs) are usually used to identify patients for a specific pathway, but qualifiers may be added. For example, a pathway for community-acquired pneumonia may exclude patients with *Pneumocystis* pneumonia or underlying obstructive pulmonary disease because those patients require highly individualized treatment plans and may not respond as quickly to intervention as patients without these underlying disorders.

A B

**EMERGENCY DEPARTMENT CRITICAL PATH: PNEUMONIA Exclusion Criteria:** Clients with HIV, neutropenia, severe hypotension, steroid dependency > 20 mg/day, those requiring mechanical ventilation, or clients on immunosuppressives or chemotherapy.

| | 2ND HOUR | 3RD HOUR | 4TH HOUR |
|---|---|---|---|
| **ASSESSMENTS** | REASSESSMENT/ASSESSMENT RESPONSE TO TREATMENT | REASSESSMENT/ASSESSMENT RESPONSE TO TREATMENT | REASSESSMENT/ASSESSMENT RESPONSE TO TREATMENT |
| **CONSULTS** | IF INDICATED NOTIFY ADMITTING RESIDENT | | |
| **LABS, DIAGNOSTICS PROCEDURES** | 1. AP/LAT CXR RESULT 2. CBC, SMA7 3. BLOOD CULTURES X2 4. SPUTUM C + S/gmst. Y__N__ 5. ABG IF PULSE OX <92% RA 6. EKG FEMALE >55 MALE >45 OR CLINICALLY INDICATED | | |
| **INTERVENTIONS** | SAFETY MEASURES AS PER STANDARD | | |
| **IV/MEDICATION** | 1. SALINE LOCK 2. O2 THERAPY AS PER ORDER 3. ANTIBIOTIC AS PER ALGORITHM AFTER BLOOD CULTURE AND ATTEMPT AT SPUTUM CULTURE | | |

| **Community Acquired** | **Institutional** |
|---|---|
| **Is the client allergic to PCN?** | **Is the client allergic to PCN?** |
| **No:** Ceftriaxone 1 gm q24 • | **No:** Ticarcillin/Clavulanate 3.1gm q6 • |
| **Yes:** TMP/SMX 2 amps (320mg/1600mg) IV q12 • | **Yes:** Ciprofloxacin 400 mg IV q12 • and Clindamycin 600mg IV q8 • |
| **CIRCLE MEDICATION: TIME OF ADMINISTRATION _______** | **CIRCLE MEDICATION: TIME OF ADMINISTRATION _______** |

C

| | 2ND HOUR | 3RD HOUR | 4TH HOUR |
|---|---|---|---|
| **TEACHING** | 1. REASSURE AND INFORM PT/SO RE: TX PLAN AND INTERVENTIONS 2. PROVIDE CLIENT WITH PSYCHOLOGICAL SUPPORT 3. PT/FAMILY CAN VERBALIZE DISCHARGE INSTRUCTIONS? Y__N__ 4. PT/FAMILY RECEIVED WRITTEN DISCHARGE INSTRUCTIONS? Y__N__ | 1. REASSURE AND INFORM PT/SO RE: TX PLAN AND INTERVENTIONS 2. PROVIDE CLIENT WITH PSYCHOLOGICAL SUPPORT 3. PT/FAMILY CAN VERBALIZE DISCHARGE INSTRUCTIONS? Y__N__ 4. PT/FAMILY RECEIVED WRITTEN DISCHARGE INSTRUCTIONS? Y__N__ | 1. REASSURE AND INFORM PT/SO RE: TX PLAN AND INTERVENTIONS 2. PROVIDE CLIENT WITH PSYCHOLOGICAL SUPPORT 3. PT/FAMILY CAN VERBALIZE DISCHARGE INSTRUCTIONS? Y__N__ 4. PT/FAMILY RECEIVED WRITTEN DISCHARGE INSTRUCTIONS? Y__N__ |
| **D/C PLANNING AND FOLLOW-UP** | DISPOSITION: 1. ADMITTED RM#_____ 2. TREATED AND REFERRED 3. TX TO OTHER INSTITUTION 4. NOT EXAMINED OR TREATED 5. LEFT AMA 6. DOA/DIED IN ED TIME OF DISCHARGE_______ | DISPOSITION: 1. ADMITTED RM#_____ 2. TREATED AND REFERRED 3. TX TO OTHER INSTITUTION 4. NOT EXAMINED OR TREATED 5. LEFT AMA 6. DOA/DIED IN ED TIME OF DISCHARGE_______ | DISPOSITION: 1. ADMITTED RM#_____ 2. TREATED AND REFERRED 3. TX TO OTHER INSTITUTION 4. NOT EXAMINED OR TREATED 5. LEFT AMA 6. DOA/DIED IN ED TIME OF DISCHARGE_______ |
| **OUTCOMES** | 1. CLINICALLY STABLE 2. PULSE OX > 92% (W OR W/O $O_2$) Y__N__ 3. HR 60–135 Y__N__ 4. RR 12–35 Y__N__ 5. SBP >90 Y__N__ 6. RECEIVED FIRST DOSE OF ANTIBIOTICS Y__N__ | 1. CLINICALLY STABLE 2. PULSE OX > 92% (W OR W/O $O_2$) Y__N__ 3. HR 60–135 Y__N__ 4. RR 12–35 Y__N__ 5. SBP >90 Y__N__ 6. RECEIVED FIRST DOSE OF ANTIBIOTICS Y__N__ | 1. CLINICALLY STABLE 2. PULSE OX > 92% (W OR W/O $O_2$) Y__N__ 3. HR 60–135 Y__N__ 4. RR 12–35 Y__N__ 5. SBP >90 Y__N__ 6. RECEIVED FIRST DOSE OF ANTIBIOTICS Y__N__ |

D

| SIGNATURE | TIME | INITIAL | SIGNATURE | TIME | INITIAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

**Shaded Area Represents MD Decision Point

**Figure B-1** Key elements of a clinical pathway. (**A**) Patient population clearly defined. (**B**) Clinically meaningful time frames. (**C**) Interventional categories. (**D**) Outcomes for each time frame should be specific and measurable. Reproduced with permission from Graduate Hospital, Philadelphia, Pennsylvania.

## Time Frames

All pathways are divided into useful time frames, for example, minutes, hours, days, weeks, or phases (Fig. B-1B). Conditions requiring emergency treatment (eg, myocardial infarction, head injury, stroke) might be divided into 15-minute intervals, whereas conditions requiring chronic care (eg, chronic pain, spinal cord injury rehabilitation) may be divided into weekly or monthly intervals. An example of interventions by phases might be seen in postanesthesia care pathways.

**Clinical Pathway:** ____________________
(Department Name)

**Patient's Name:** ____________________ **MedRecNo:** _ _ _ _ _ _

(Please list each code separately)

| **Date** | **Path Day #** | **Variance Code** | **Comment / Action Taken** |
|---|---|---|---|
| __ / __ / __ | | | |
| __ / __ / __ | | | |
| __ / __ / __ | | | |
| __ / __ / __ | | | |
| __ / __ / __ | | | |

**A**

## VARIANCE CODES

**Patient's Condition/Problem**

**A1. Operative**
- A1a. Further surgery to control bleeding
- A1b. Further surgery for other reason
- A1c. Perioperative myocardial infarction
- A1d. Tamponade (early or late)
- A1e. Dissection

**A2. Infection**
- A2a. Sternum, requiring debridement
- A2b. Sternum, superficial (antibiotics and dressings only)
- A2c. Leg
- A2d. Urinary tract infection
- A2e. Sepsis

**A3. Neurological**
- A3a. Stroke, temporary or permanent deficit
- A3b. Delirium
- A3c. Coma
- A3d. Confusion or agitation

**A4. Respiratory**
- A4a. Prolonged ventilation
- A4b. Acute respiratory distress syndrome
- A4c. Respiratory failure, reintubation
- A4d. Pneumonia
- A4e. Atelectasis

**A5. Renal**
- A5a. Renal failure
- A5b. Dialysis

**A6. Cardiac**
- A6a. Atrial arrhythmia
- A6b. Ventricular arrhythmia
- A6c. Heart block with or without pacemaker implantation
- A6d. Heart failure
- A6e. Cardiac arrest
- A6f. Hemodynamic instability
- A6g. Unable to wean off inotropic agents

**A7. Vascular**
- A7a. Deep vein thrombosis
- A7b. Limb ischemia

**Other Condition/Problem**

**A8. Other**
- A8a. Major gastrointestinal complication requiring surgery (eg, bleeding, perforation, ileus)
- A8b. Minor gastrointestinal complication requiring bowel rest (eg, ileus, nausea, high nasogastric output)
- A8c. Large volume of chest-tube drainage
- A8d. Poor wound healing (ie, significant sterile drainage from leg or chest wound)
- A8e. Pulmonary embolism
- A8f. Anticoagulant complication
- A8g. Thromboembolism
- A8h. Activity intolerance
- A8i. Medication reaction
- A8j. Altered skin integrity

**B: Practitioner Related**
- B1. Practitioner unavailability
- B2. Transcription error
- B3. Incorrect sequencing of therapy
- B4. Delay in consult or referral
- B5. Incomplete discharge planning
- B6. Delay or cancel test or procedure
- B7. Discharge day delay
- B8. Other

**C: Hospital/System**
- C1. Bed unavailable (state issue)
- C2. Equipment or supplies not available
- C3. Results not available
- C4. Unable to schedule test, procedure, or therapy
- C5. Case, test, procedure, or therapy delayed
- C6. Preoperative teaching not documented
- C7. Follow-up after discharge not documented

**D: Family/Placement**
- D1. Extended care not available
- D2. Homecare not available
- D3. Patient or family delaying discharge planning
- D4. Financial issues
- D5. Other

Form used at Westchester County Medical Center for tracking variances from clinical pathway for cardiac surgery (CABG).

**B**

**Figure B-2** Variance record. (**A**) Blank pages for recording variance. (**B**) Variance codes. Reproduced with permission from *Critical Care Nurse, 17*(16), December 1997, pp. 29–30.

# Acute Ischemic Stroke Critical Pathway Card

| | **Admission Day / /**<br>**Day 0-1 (1st 24 hrs)**<br>**ER to ASU/NICU (or direct to ASU)** | **Day 2 / /**<br>**ASU** | **Day 3 / /**<br>**ASU/General Floor** |
|---|---|---|---|
| **Goals/Outcomes** | Identify acute ischemic stroke patient<br>Document time of symptom onset<br>Evaluate for appropriate treatment options and/or clinical trial<br>Avoid Aspiration<br><br>**NIH Stroke Scale (NIHSS)** ______<br>**Barthel Index** _____ | Neuro status stabilized/improved<br>Avoid medical complications (Aspiration, Fever, Infection)<br>Initial Diagnostic tests results documented<br>Rehab therapies initiated as appropriate<br>**t-PA pts. transferred from NICU to ASU** | Neuro status stabilized/improved<br>Avoid medical complications<br>Diagnostic tests documented<br>Rehab therapies continued as appropriate<br>Pt/Family understands disease process<br>**Transfer from ASU→Floor**<br>Discharge if appropriate<br>**NIHSS** ______ **Barthel Index** _____ (upon dischrg) |
| **Laboratory/ Diagnostic Tests** | **STAT CT brain without contrast**<br>**EKG**<br>**CXR**<br>**Carotid Dopplers**<br>**Echocardiogram**<br>**To Consider:**<br>• MRI/MRA<br>• CTA<br>• TCD<br><br>CBC, PT/PTT<br>SMA-7<br>SMA-12<br>ESR<br>RPR<br>UA (if febrile)<br>**To Consider:**<br>• ACLA, LA<br>• ANA, RF<br>• Fibrinogen level<br>• Protein C & S, AT III (if age <55; venous infarct) | Fasting Lipid profile<br>Fasting Homocysteine level<br>Follow up on abnormal tests as needed<br>PTT daily if on heparin<br>PT/INR daily if on warfarin<br>If patient received t-PA:<br>CT brain without contrast<br>**To Consider:**<br>• **MRI/MRA**<br>• CTA<br>• TCD (if VB circulation)<br>• TEE | PTT if on heparin<br>PT/INR if on warfarin<br>Follow-up abnormal tests<br><br>**To Consider:**<br>• Modified Barum Swallow<br>• SPECT<br>• Angiogram |
| **Assessments/RN Interventions** | VS as per Unit/t-PA protocol<br>Neuro check as per Unit/t-PA protocol<br>Cardiac monitoring<br>Continuous Pulse Ox, and titrate $O_2$ to keep $SpO_2$ > 95%<br>Bowel/Bladder/Skin assessment<br>Avoid foley cath<br>Compression boots (unless anticoagulated)<br>HOB up 30°/Aspiration Precautions<br>Institute Falls Risk Precautions<br>Barthel Index completed and documented | VS and Neuro checks per Unit protocol<br>Cardiac monitoring<br>Continuous Pulse Ox, and titrate $O_2$ to keep $SpO_2$ > 95%<br>Bowel/Bladder/Skin assessment<br>Avoid foley cath<br>Compression boots (unless anticoagulated)<br>HOB up 30°/Aspiration Precautions<br>Pulmonary toilet<br>Turn q2h if pt on bed rest<br>ROM as per Rehab if paralysis exists<br>Hand/foot splint as per Rehab as needed | VS and Neuro checks per Unit protocol<br>Cardiac monitoring (ASU)<br>Continuous Pulse Ox, and titrate $O_2$ to keep $SpO_2$ > 95%<br>Bowel/Bladder/Skin assessment<br>Avoid foley cath<br>Compression boots (unless anticoagulated)<br>HOB up 30°/Aspiration Precautions<br>Pulmonary toilet<br>Turn q2h if pt on bed rest<br>ROM as per Rehab, if paralysis exists<br>Hand/foot splint as per Rehab as needed<br><br>**To Consider:**<br>• D/C cardiace monitor & Pulse Ox & transfer to floor<br>**-or-**<br>• D/C to home |
| **Medications/ Treatments** | IV NSS<br>Evaluate admission medications<br>BP meds w/parameters as needed<br>Acetaminophen 650 mg p.o./PR q 4° prn temp > 100°<br>Sliding Scale Insulin as needed<br>Bowel regimen prn<br><br>**To Consider:**<br>• Antiplatelet treament<br>• IV heparin<br>• t-PA (No ASA, Heparin or Warfarin for 24 hrs.–Refer to t-PA protocol)<br>• Investigational drug (refer to Protocol) | Renew IVF or IV to heplock<br>Reassess BP meds w/parameters as needed<br>Acetaminophen 650 mg p.o./PR q 4° prn temp > 100°<br>Sliding Scale Insulin as needed<br>Bowel regimen prn<br>Continue from Day One as needed<br>Antiplatelet Therapy<br>IV Heparin<br><br>**To Consider:**<br>• Warfarin if indicated<br>• If pt recieved t-PA, begin antiplatelet treatment or heparin as appropriate<br>• Investigational drug, follow Protocol | Renew IVF, IV to hep lock, or D/C IV<br>Reassess BP meds w/parameters as needed<br>Acetaminophen 650 mg p.o./PR q 4° prn temp > 100°<br>Sliding Scale Insulin and restart diabetic regimen if appropriate<br>Bowel regimen prn<br><br>Continue as appropriate<br>-Antiplatelet Therapy<br>-IV Heparin → Warfarin<br><br>If investigational Drug, follow Protocol |
| **Consults** | **Notify Case Manager on Admission**<br>**Notify Social Work on Admission**<br>**Consult as Needed:**<br>• Physical Medicine & Rehabilitation (PM&R)<br>• Speech Therapy<br>• Primary MD<br>• Cardiology | **Completion of consults ordered Day 1**<br>**Consult as Needed:**<br>• Home Health<br>• Rehab Coordinator<br>• Neuropsych<br>• Neurosurgery<br>• Vascular Surgery | **Completion of Consults ordered Day 2**<br>GI if feeding tube needed |
| **Activity** | Bed rest (HOB up 30°)<br>**-or-**<br>Increase activity as tolerated<br>**To Consider:**<br>• Pt may come off monitor for testing or traveling to Rehab Dept. | Bed rest (HOB up 30°)<br>Increase activity as tolerated<br>**-or-**<br>Increase activity per PM&R | Increase activity as tolerated<br>**-or-**<br>**Pt. seen by PT/OT**<br>Increase activity per PM&R |
| **Nutrition** | Nutrition Screen<br>NPO/Aspiration Precautions<br>**-or-**<br>Diet as recommended by Speech | NPO/Aspiration Precautions<br>Advance diet or per Speech/Dietitian recommendations<br><br>**To Consider:**<br>• Temporary Feeding tube | NPO/Aspiration Precautions<br>Tube feeding per Dietitian recommendations<br>**-or-**<br>Advance diet per Speech/Dietitian Guidelines |
| **Patient/Family Education D/C Planning** | Orient to unit routine<br>Educate about disease process<br>Educate about diagnostic tests and meds<br>Discharge Planning Assessment Initiated | Educate about diagnostic tests and meds<br>Discuss discharge care options | Ongoing Stroke Education<br>Start Warfarin teaching as needed<br><br>**Finalize disp. plans (Home, Rehab, SNF)**<br>**Discharge if appropriate** |
| **Comments** | | | |

**Figure B-3** Clinical pathway for acute ischemic stroke. Courtesy of Thomas Jefferson University Hospital, Philadelphia, PA. Available at www.stroke-site.org

# Acute Ischemic Stroke Critical Pathway Card

| | **Day 4** / / <br><br>**ASU/General Floor** | **Day 5-7** / / <br><br>**ASU/General Floor** | **Post Discharge Care/Home Health** |
|---|---|---|---|
| **Goals/Outcomes** | Neuro status stabilized/improved<br>Pt transferred to floor<br>Rehab therapies continued as appropriate<br>NIHSS and Barthel Index documented, if patient dis-charged<br>Discharge if appropriate<br><br>**NIHSS _____ Barthel Imdex _____ (upon discharge)** | Neuro status stabilized/improved<br>Special diagnostic tests documented<br>Rehab therapies continued as appropriate<br>NIHSS and Barthel Index documented, if patient discharged<br>Discharge if appropriate<br><br>**NIHSS _____ Barthel Imdex _____ (upon discharge)** | Maintain compliance with meds, diet and risk factor reduction<br>Follow-up with Primary MD/Neurology<br>Absence of recurrent symptoms<br>Return to baseline activity level<br>Recognise Signs & Symptoms and when to call Physician<br>Advance diet accordingly |
| **Laboratory/ Diagnostic Tests** | PTT if on heparin<br>PT/INR if on warfarin<br>Follow-up abnormal tests<br><br>**To Consider:**<br>• Modified Barium Swallow | PTT if on heparin<br>PT/INR if on warfarin | Labs per MD order<br>-PT/INR if on warfarin<br>-CBC q2 weeks x 3 months if on Ticlopidine |
| **Assessments/RN Interventions** | VS and Neuro Checks per Unit Protocol<br>Cardiac monitoring (ASU)<br>Continuous Pulse Ox, and titrate O2 to keep SpO2 > 95%<br>Bowel/Bladder/Skin Assessment<br>Avoid foley cath<br>Compresssion boots (unless anticoagulated)<br>HOB up 30°/Aspiration Precautions<br>Turn q2h if pt on bed rets<br>ROM as per Rehab, if paralysis exists<br>Hand/foot splint as per Rehab as needed<br><br>**To Consider:**<br>• D'C cardiac monitoring & Pulse Ox & transfer to floor<br>**-or-**<br>• D'C to home | VS and Neuro checks per Unit Protocol<br>Cardiac monitoring as needed<br>Continuous Pulse Ox as needed<br>Bowel/Bladder/Skin Assessment<br>Avoid foley cath<br>Compresssion boots (unless anticoagulated)<br>HOB up 30°/Aspiration Precautions<br>Turn q2h if pt on bed rets<br>ROM as per Rehab, if paralysis exists<br>Hand/foot splint as per Rehab as needed | Vital Signs<br>Assess for and educate about recurrent signs and stmptoms of TIA/Stroke<br>Complete Oasis Tool<br>Asses PT/OT/Speech and swallow needs<br>Assess feeding tube functioning<br>Evaluate support systems<br>Bowel/Bladder Training |
| **Medications/ Treatments** | IV to hep lock or D'C IV<br>Reassess BP meds and parameters as needed<br>Consider antihypertensive regimen<br>Acetaminophen 650mg p.o./PR q4 prn temp. > 100<br>Diabetic regimen if appropriate<br>Bowel regimen prn<br><br>Continue as appropriate<br>-Antiplatelet therapy<br>-IV Heparin Æ Warfarin (D'C heparin when INR 2-3)<br><br>If Investigational Drug, follow Protocol | IV to hep lock or D'C IV<br>Adjust antihypertensive regimen as needed<br>Adjust diabetic regimen as needed<br><br>Continue as appropriate<br>-Antiplatelet Therapy<br>-IV Heparin → Warfarin (D'C heparin when INR 2-3)<br><br>If Investigational Drug, follow Protocol | Review medications<br>Set up med schedule via mediplan or calendar |
| **Consults** | | Feeding tube placement if needed | Home Health Aid as needed<br>Home PT/OT/Speech as needed<br>Social Work /Registered Dietician if needed<br>Case Management telephone follow-up |
| **Activity** | Increase activity as tolerated<br>**-or-**<br>Increase activity per PM&R | Increase activity as tolerated/as per Rehab guidelines | Encourage increase in activity as tolerated<br>Exercise/Therapy protocols as per PT/OT |
| **Nutrition** | Increase tube feedings as tolerated as per Dietitian Guidelines<br>**-or-**<br>Advance diet as tolerated/as per Speech/Dietitian recommendations | NPO for feeding tube placement<br>**-or-**<br>Advance diet as tolerated per Speech/Dietitian recommendations | Reinforce prescribed diet<br>Refer as necessary to Out-Patient Dietitian X5077<br>Consider Swallow re-eval for removal of feeding tube |
| **Patient/Family Education D/C Planning** | Ongoing Stroke Education<br>Warfarin teaching as needed<br><br>**Finalize disp. plans (Home, Rehab, SNF)**<br>**Discharge if appropriate** | Ongoing Stroke Education<br>Warfarin teaching as needed<br><br>**D'C instructions based on disposition plans**<br>**Discharge if appropriate** | Reinforce signs/symptoms of stroke and need for urgent intervention<br>Reinforce importance of risk factor reduction and med compliance<br>Reinforce need to stay on meds<br>Encourage pt/family that rehab process continues long after hospital stay and to continue to work towards improvement<br>Advise on the availability of community/ financial/ transportation resources<br>Warfarin teaching as needed |
| **Comments** | | | |

**Figure B-3** (Continued).

UNIT NO.

NAME

ADDRESS

BIRTH DATE:

VISIT NUMBER:

(if handwritten, record name, unit no., birth date, and visit no.)

**PERMANENT PART OF MEDICAL RECORD**

# YALE NEW HAVEN HOSPITAL CLINICAL PATHWAY

## ACUTE CORONARY SYNDROME WITH OR WITHOUT PERCUTANEOUS CORONARY INTERVENTION [F-5021]

**DIAGNOSIS:** ❑ **RO/MI** ❑ **UNSTABLE ANGINA (USA)** ❑ **NON ST ELEVATION MI** ❑ **ST ELEVATION MI (STEMI)**

### *EXPECTED OUTCOMES - PATIENT IS FREE FROM:

| DATE: | DATE: | DATE: | DATE: | DATE: |
|---|---|---|---|---|
| **Patient Problem** | **Patient Problem** | **Patient Problem** | **Patient Problem** | **Patient Problem** |
| • Myocardial ischemia (angina, ST/ T-wave ECG changes, SOB)<br>• Dysrhythmias<br>• Hypotension / hypertension<br>• Bleeding / hematoma<br>• Hypoxemia (by $SpO_2$, ABG's)<br>• Heart Failure<br>• Maladaptive coping mechanisms<br>• Education barriers (language, impaired vision or hearing, dementia, developmentally delayed)<br>• Inability to verbalize understanding of:<br>- reportable conditions (CP, etc)<br>- activity limitations<br>- plan of care<br>• Self-care deficit-unable to return home/previous residence | • Myocardial ischemia<br>• Dysrhythmias<br>• Hypotension / hypertension<br>• Bleeding / hematoma<br>• Hypoxemia<br>• Heart Failure<br>• Maladaptive coping mechanisms<br>• Education barriers (language, impaired vision or hearing, dementia, developmentally delayed)<br>• Inability to verbalize understanding of:<br>- reportable conditions<br>- activity limitations<br>- plan of care<br>• Self-care deficit-unable to return home/previous residence | • Myocardial ischemia<br>• Dysrhythmias<br>• Hypotension / hypertension<br>• Bleeding / hematoma<br>• Hypoxemia<br>• Heart Failure<br>• Maladaptive coping mechanisms<br>• Education barriers (language, impaired vision or hearing, dementia, developmentally delayed)<br>• Inability to verbalize understanding of:<br>- reportable conditions<br>- activity limitations<br>- plan of care<br>• Self-care deficit-unable to return home/previous residence | • Myocardial ischemia<br>• Dysrhythmias<br>• Hypotension / hypertension<br>• Bleeding / hematoma<br>• Hypoxemia<br>• Heart Failure<br>• Maladaptive coping mechanisms<br>• Education barriers (language, impaired vision or hearing, dementia, developmentally delayed)<br>• Inability to verbalize understanding of:<br>- reportable conditions<br>- activity limitations<br>- plan of care<br>• Self-care deficit-unable to return home/previous residence | • Myocardial ischemia<br>• Dysrhythmias<br>• Hypotension / hypertension<br>• Bleeding / hematoma<br>• Hypoxemia<br>• Heart Failure<br>• Maladaptive coping mechanisms<br>• Education barriers (language, impaired vision or hearing, dementia, developmentally delayed)<br>• Inability to verbalize understanding of:<br>- reportable conditions<br>- activity limitations<br>- plan of care<br>• Self-care deficit-unable to return home/previous residence |
| **AMI Quality Indicators** | | | | |
| • Aspirin<br>• Beta Blocker<br>• If STEM - Primary PTCA within 90 minutes | • Aspirin<br>• Beta Blocker | • Aspirin<br>• Beta Blocker | • Aspirin<br>• Beta Blocker | • If LDL > 100 mg/dl - D/C on statin<br>• Discharged on ASA, beta blocker<br>• EF ≤40%– D/C on ACEI<br>• Complete D/C instructions provided<br>• Smoking cessation advice |

* Variance reporting - circle variance, write History and Progress note, individualize Clinical Pathway - If problem cannot be resolved within 8-12 hour shift, add problem to IPOC/NPOC

**Figure B-4** Clinical pathway for acute coronary syndrome with or without percutaneous coronary intervention. Courtesy of Yale New Haven Hospital, New Haven, CT.

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**PERMANENT PART OF MEDICAL RECORD**

# YALE NEW HAVEN HOSPITAL CLINICAL PATHWAY

# ACUTE CORONARY SYNDROME WITH OR WITHOUT PERCUTANEOUS CORONARY INTERVENTION [F-5021]

**INTERVENTIONS**

| | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: |
|---|---|---|---|---|---|
| **PATIENT/FAMILY EDUCATION** | Initiate GPE: YATAP /SCALES | Initiate GPE: YATAP /SCALES | Initiate GPE: YATAP /SCALES | Initiate GPE: YATAP /SCALES | Initiate GPE: YATAP /SCALES |
| | *Method* *Response* *Initials* | *Method* *Response* *Initials* | *Method* *Response* *Initials* | *Method* *Response* *Initials* | *Method* *Response* *Initials* |
| **Key**<br>**Patient Response / Teaching Method** | ventilator | ventilator | ventilator | ventilator | ventilator |
| **G=Good V=Verbal**<br>**F=Fair W=Written**<br>**P=Poor TV= Video**<br>**R=Refused** | Monitoring equipment | Monitoring equipment | Monitoring equipment | Monitoring equipment | Monitoring equipment |
| **G = complete understanding/ independent in performing skill** | other: | other: | other: | other: | other: |
| **F = limited understanding requires reminders/ multiple cues to demonstrate skill** | symptoms to report | symptoms to report | symptoms to report | symptoms to report | symptoms to report |
| **P = no understanding/ unable to demonstrate skill** | plan of care / priority problems | plan of care / priority problems | plan of care / priority problems | plan of care / priority problems | plan of care / priority problems |
| | diet | diet | diet | diet | diet |
| | activity | activity | activity | activity | activity |
| | smoking cessation | smoking cessation | smoking cessation | smoking cessation | smoking cessation |
| | medications | medications | medications | medications | medications |
| | weigh / monitor for HF symptoms daily | weigh / monitor for HF symptoms daily | weigh / monitor for HF symptoms daily | weigh / monitor for HF symptoms daily | weigh / monitor for HF symptoms daily |
| **Booklets Distributed:** | emotions/coping with illness | emotions/coping with illness | emotions/coping with illness | emotions/coping with illness | emotions/coping with illness |
| ❑ **Coumadin**<br>❑ **Heart Failure** | risk factors | risk factors | risk factors | risk factors | risk factors |
| ❑ **Patient Pathway**<br>❑ **Take Care**<br>❑ **Stent** | tests/procedures | tests/procedures | tests/procedures | tests/procedures | tests/procedures |
| ❑ **Stepping Toward Control**<br>❑ **Straight from the Heart**<br>❑ **Quit Smoking for Life**<br>❑ **Women's Heart Advantage**<br>❑ **Other:** | other: | other: | other: | other: | other: |

**Figure B-4** (*Continued*).

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**PERMANENT PART OF MEDICAL RECORD**

# YALE NEW HAVEN HOSPITAL
# CLINICAL PATHWAY

## ACUTE CORONARY SYNDROME WITH OR WITHOUT PERCUTANEOUS CORONARY INTERVENTION [F-5021]

**INTERVENTIONS**

| | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: |
|---|---|---|---|---|---|
| **ASSESSMENT** | Cardiac risk factors:<br>❑ premature family history<br>❑ tobacco use within year<br>❑ diabetes<br>❑ hypertension<br>❑ hypercholesterolemia<br>❑ obesity<br>❑ sedentary<br>Signs and symptoms of:<br>angina/angina equivalent<br>hypoxemia<br>decreased perfusion<br>bleeding<br>maladaptive coping<br>Cardiac rate/rhythm per CMP: Continuous ECG monitoring<br>Hemodynamic parameter, T, RR, lung sound, $SpO_2$<br>Other: ______<br>______<br>______<br>❑ PA catheter per NOPM<br>❑ ABP per NOPM<br>❑ EF 40% or HF present – I&O weight per SCALES Program<br>❑ DM - finger sticks ac & hs or as ordered<br>Follow diagnostic and lab data | Cardiac risk factors:<br>❑ premature family history<br>❑ tobacco use within year<br>❑ diabetes<br>❑ hypertension<br>❑ hypercholesterolemia<br>❑ obesity<br>❑ sedentary<br>Signs and symptoms of:<br>angina/angina equivalent<br>hypoxemia<br>decreased perfusion<br>bleeding<br>maladaptive coping<br>Cardiac rate/rhythm per CMP<br>Hemodynamic parameter, T, RR, lung sound, $SpO_2$<br>Other: ______<br>______<br>______<br>❑ EF 40% or HF present – I&O weight per SCALES Program<br>❑ DM - finger sticks ac & hs or as ordered<br>Follow diagnostic and lab data<br>If discharge-dependent labs drawn, label specimens with special sticker | Signs and symptoms of:<br>angina/angina equivalent<br>hypoxemia<br>decreased perfusion<br>bleeding<br>maladaptive coping<br>Cardiac rate/rhythm per CMP<br>Hemodynamic parameter, T, RR, lung sound, $SpO_2$<br>Other: ______<br>______<br>______<br>❑ EF 40% or HF present – I&O weight per SCALES Program<br>❑ DM - finger sticks ac & hs or as ordered<br>Follow diagnostic and lab data<br>If discharge-dependent labs drawn, label specimens with special sticker | Signs and symptoms of:<br>angina/angina equivalent<br>hypoxemia<br>decreased perfusion<br>bleeding<br>maladaptive coping<br>Cardiac rate/rhythm per CMP<br>Hemodynamic parameter, T, RR, lung sound, $SpO_2$<br>Other: ______<br>______<br>______<br>❑ EF 40% or HF present – I&O weight per SCALES Program<br>❑ DM - finger sticks ac & hs or as ordered<br>Follow diagnostic and lab data<br>If discharge-dependent labs drawn, label specimens with special sticker | Signs and symptoms of:<br>angina/angina equivalent<br>hypoxemia<br>decreased perfusion<br>bleeding<br>maladaptive coping mechanisms<br>D/C continuous ECG monitoring<br>❑ EF 40% or HF present – I&O weight per SCALES Program<br>❑ DM - finger sticks ac & hs or as ordered<br>If discharge-dependent labs drawn, label specimens with special sticker |
| **MEDICATIONS** | ***SAAB (Statin, ASA, ACEI, Beta Blocker) if indicated**<br>Consider: IV GP IIB / IIIA platelet inhibitor, clopidogrel, anticoagulant, nitrate, nicotine replacement tx/bupropion, if tobacco user<br>$O_2$ via N/C @2L/min<br>IV fluids or IID as ordered | ***SAAB if indicated**<br>Consider: IV GP IIB / IIIA platelet inhibitor, clopidogrel, anticoagulant, nitrate, nicotine replacement tx/bupropion, if tobacco user<br>$O_2$ via N/C @2L/min<br>IV fluids or IID as ordered | ***SAAB if indicated**<br>Consider: IV GP IIB / IIIA platelet inhibitor, anticoagulant, nitrate, clopidogrel<br>Consider discontinuing $O_2$ via N/C @ 2L/min if $SPO_2$ 95%<br>IV fluids or IID as ordered | ***SAAB if indicated**<br>Consider: IV GP IIB / IIIA platelet inhibitor, anticoagulant, nitrate, clopidogrel<br>IV fluids or IID as ordered | ***SAAB if indicated**<br>**If EF 40% discharge on ACE I; if not prescribed,** document rationale<br>IV fluids or IID as ordered |
| **PAIN**<br>**Ischemic pain** | Assess for pain with vital signs & within one hour of an intervention for pain<br>Interventions - CMP: Anginal Symptoms | Assess for pain with vital signs & within one hour of an intervention for pain<br>Interventions - CMP: Anginal Symptoms | Assess for pain with vital signs & within 1 hour of an intervention for pain<br>Interventions - CMP: Anginal Symptoms | Assess for pain with vital signs & within 1 hour of an intervention for pain<br>Interventions - CMP: Anginal Symptoms | Assess for pain with vital signs & within 1 hour of an intervention for pain<br>Interventions - CMP: Anginal Symptoms |
| **Other pain source** | Add on to IPOC/NPOC | Add onto IPOC/NPOC | Add onto IPOC/NPOC | Add onto IPOC/NPOC | Add on to IPOC/NPOC |

**Figure B-4** (*Continued*).

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**PERMANENT PART OF MEDICAL RECORD**

# YALE NEW HAVEN HOSPITAL CLINICAL PATHWAY

# ACUTE CORONARY SYNDROME WITH OR WITHOUT PERCUTANEOUS CORONARY INTERVENTION [F-5021]

**INTERVENTIONS**

| | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: | DATE: UNIT: |
|---|---|---|---|---|---|
| **TESTS / PROCEDURES** | Labs:<br>*** Lipid profile,**<br>troponin - draw at: ________<br>CK, CK/MB every 8 hrs X 3 – draw at: ______ ______ ______<br>CBC, platelets, lytes, bun/CR, LFTs, PT/PTT<br>CXR, ECG (with RV leads if IWMI)<br>❑ stress test with imaging<br>❑ cardiac echo - EF ________%<br>❑ other: ________<br>**REFER TO PAGE 5 OF INTERVENTIONS**<br>❑ cardiac catheterization<br>❑ PTCA /stent: ________<br>❑ brachytherapy | ❑ stress test with imaging<br>❑ cardiac echo - EF ________%<br>❑ other: ________<br>**REFER TO PAGE 5 OF INTERVENTIONS**<br>❑ cardiac catheterization<br>❑ PTCA /stent: ________<br>❑ brachytherapy | ❑ stress test with imaging<br>❑ cardiac echo - EF ________%<br>❑ other: ________<br>**REFER TO PAGE 5 OF INTERVENTIONS**<br>❑ cardiac catheterization<br>❑ PTCA /stent: ________<br>❑ brachytherapy | ❑ stress test with imaging<br>❑ cardiac echo - EF ________%<br>❑ other: ________<br>**REFER TO PAGE 5 OF INTERVENTIONS**<br>❑ cardiac catheterization<br>❑ PTCA /stent: ________<br>❑ brachytherapy | ❑ stress test with imaging<br>❑ cardiac echo - EF ________%<br>❑ other: ________<br>**REFER TO PAGE 5 OF INTERVENTIONS**<br>❑ cardiac catheterization<br>❑ PTCA /stent: ________<br>❑ brachytherapy |
| **ACTIVITY** | ❑ Bed rest<br>❑ Bed rest with bedside commode<br>❑ Bed rest - OOB to bathroom | ❑ USA: Advance as tolerated<br>❑ AMI: Out of bed to chair tid; Ambulate 50 ft, bathroom privileges<br>❑ Other: ________ | ❑ USA: Advance as tolerated<br>❑ AMI: Out of bed to chair as tolerated; Ambulate 100 - 300 ft; Shower sitting - with supervision<br>❑ Other: ________ | ❑ USA: Advance as tolerated<br>❑ AMI: Out of bed to chair as tolerated; Ambulate 100 - 300 ft; Shower sitting - with supervision<br>❑ Other: ________ | ❑ USA: Advance as tolerated<br>❑ AMI: Ambulates 300-400 ft tid/qid<br>❑ Other: ________ |
| **DISCHARGE PROCESS** | Identify key contact person and current home care services | Determine self-management needs (home care services, transportation, care provider)<br>If Discharge Day: complete W-10, CR Referral and Written Instructions in CCSS. If AMI, assure quality indicators are addressed | Determine self-management needs<br>If Discharge Day: complete W-10, CR Referral and Written Instructions in CCSS. If AMI, assure quality indicators are addressed | Determine self-management needs<br>If Discharge Day: complete W-10, CR Referral and Written Instructions in CCSS. If AMI, assure quality indicators are addressed | If Discharge Day: complete W-10, CR Referral and Written Instructions in CCSS. If AMI, assure quality indicators are addressed |
| **SIGN OFF**<br>**PRINT NAME**<br>**SIGN**<br>**SHIFT** | | | | | |

**Figure B-4** (*Continued*).

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**PERMANENT PART OF MEDICAL RECORD**

# YALE NEW HAVEN HOSPITAL CLINICAL PATHWAY

# ACUTE CORONARY SYNDROME WITH OR WITHOUT PERCUTANEOUS CORONARY INTERVENTION [F-5021]

**INTERVENTIONS**

| | PRE-PROCEDURE<br>DATE: | POST-PROCEDURE<br>DATE: |
|---|---|---|
| **MEDICATIONS** | If allergy to contrast dye, consider prophylactic therapy<br>Consider hydration<br>If creatinine ≥ 1.3 mg/dl, consider acetylcystein 20%- 600 mg bidfor 2 days<br>Diabetes: give 1/2 NPH dose, cover with sliding scale; Hold Metformin for 48 hours<br>Hold warfarin<br>ASA<br>PO platelet inhibitor if stent anticipated<br>Discontinue heparin on-call to CV Lab as prescribed | Offer pain medication and sedatives PRN<br>IV hydration<br>Hold Metformin<br>If on warfarin pre-procedure, consider restarting<br>ASA<br>If stent placed - p.o. platelet inhibitor<br>Ensure order written to continue/discontinue heparin; If prescribed begin infusion 4-6 hours after sheath is removed. |
| **TESTS / PROCEDURES** | | PTCA only:<br>ECG, I&O, CK with MB in AM___________<br>❑ Femostop per CCSS orders - Remove @ ___________<br>❑ ACT prior to sheath removal @ _____ Pull sheaths when ACT ≤ 175<br>If receiving IIBIIIA platelet inhibitor, draw platelets 4 hours after bolus/infusion initiated - Draw @ _____________ |
| **ASSESSMENT** | Establish baseline lower extremity circulation, movement, sensation (CMS) bilaterally<br>Comfort level or pain with vital signs | Vital signs every 30 minutes X 6, then as needed<br>Monitor CMS of affected extremity and catheter insertion site for bleeding, hematoma every 15 min X 4, every 30 min X2, then every 1 hr<br>Comfort level/pain with vital signs |
| **ACTIVITY** | | Post cardiac catheterization:<br>Right-sided catheterization - bed rest 4 hours OOB @ ____________<br>Left-sided catheterization - bed rest 6 hours OOB @ _____________<br>Immobolize affected extremity, head of bed <30°<br>If vascular closure device used: ambulate after 1-2 hrs of bed rest or when puncture site stable: OOB @ ___________________<br>Post PTCA:<br>bed rest while arterial sheaths in place<br>maintain bed rest 6-8 hours after sheaths removed - OOB @ _________<br>head of bed <30°<br>If vascular closure devise used: Bed rest x 4hrs then ambulate (see CMP)<br>If IIB IIIA inhibitor infusing - bed rest untill infusion completed |
| **PATIENT / FAMILY EDUCATION**<br>Key — **Patient response**: G = good, F = fair, P = poor; **Teaching Method**: V = Verbal, W = Written, TV = Video | **Method** / **Response** / **Initials**<br>pre-procedure teaching – sensations/experiences ______ ______ ______<br>other: ____________________ | **Method** / **Response** / **Initials**<br>activity restrictions post-procedure ______ ______ ______<br>hold pressure on groin to cough or sneeze ____________________<br>call nurse for loss of sensation in extremity below puncture site or bleeding |
| **DIET** | If afternoon procedure scheduled - light breakfast, then NPO | Resume diet - encourage PO fluids unless contraindicated |

**Figure B-4** (*Continued*).

## Interventional Categories

Interventional categories consist of the groups of activities that make up a comprehensive treatment plan and are shown in the left-hand column of the pathway (Fig. B-1C). Although the order in which they are listed varies, these categories typically include

- Tests
- Treatments and nursing interventions
- Consultations
- Medications
- Diet
- Activity
- Patient and family education
- Discharge planning

## Outcomes

Defined outcomes provide the focus for patient care activities for the various disciplines. Pathways include outcomes identified for each time interval (Fig. B-1D). They should be realistic, reflect incremental progress, and be achievable by 90% of the population. Pathway outcomes include physiologic, psychological, social, and educational outcomes.

## Variance Record

The variance record (Fig. B-2) is an extremely important part of the pathway and represents the mechanism through which improvements in patient care can be accomplished. Variance is defined as any deviation from the pathway. Because all events on the pathway are critical to recovery, deviations can negatively affect outcomes. If the pathway calls for a specific test or treatment on day 2 and it is not carried out on day 2, a variance has occurred. If the patient is to ambulate 3 times a day and ambulates only once, a variance has occurred. The variance and the causes are recorded. Some variance records require a written note; others use code numbers or electronic systems to record variance (see Fig. B-2).

Case managers collect and analyze the variance data to identify trends in patient care and outcomes. For example, a pneumonia pathway may specify that the first dose of antibiotics be given within 3 hours of admission to the hospital (delays in administration of the first dose of an antibiotic are associated with increased morbidity and mortality). The case manager reviews the variance records and determines that only 40% of pneumonia patients are receiving the antibiotic in the specified time frame. Assessment of the issue reveals that delays are a result of the length of time it takes for the medication order to be taken off the chart and delivered to the pharmacy and the length of time it takes for the medication to be delivered. The pneumonia pathway team discusses this issue and determines that the first dose of medication should be given in the emergency department since the emergency department stocks these medications. The pathway is then revised to reflect this change in care. At the next review, the case manager reports that 92% of pneumonia patients on the clinical pathway received their antibiotics within 1 to 2 hours of admission. This example illustrates how pathway use and variance data collection provide the forum for assessing an issue, determining a plan of action, implementing the plan, and evaluating the effectiveness of the plan.

## The Nurse's Role

Nurses have a key role in all aspects of clinical pathway use. Participating in the development of the pathway is the first step. Because nurses begin and end the chain of staff involved in delivering care, they have a unique perspective in how health care systems work to enhance or impede the delivery of care. In the above example about antibiotic administration, staff nurses were able to identify the issue quickly and suggest solutions. Staff from other disciplines, being single links in the chain, cannot supply this global view of the problem.

Nurses are also responsible for initiating the pathway for appropriate patients and ensuring that the various events occur as planned. In some care settings or conditions, case managers who are advanced practice nurses closely follow pathway patients; in others, staff nurses or community-based nurses function as case managers. In any setting, enhancing and monitoring outcome achievement is a nursing activity. Patients may be given a printed copy of the patient pathway for reference. The pathway describes the care plan in simple language and pictures. The nurse discusses the pathway with the patient and focuses on achieving specific outcomes.

Nurses are also responsible for completing required documentation. Well-designed pathways strive for simplicity and should not duplicate documentation required elsewhere. For example, a separate nursing plan of care is not necessary when using a clinical pathway. The outcome section of the pathway usually requires documentation; other areas may need to be checked off or initialed so that other providers can readily see what has been accomplished. Documenting variance and initiating steps to address the variance are equally important, as is participating in redesigning care practices to promote the highest quality of cost-effective care.

## Pathways in Practice

Several pathways are provided in the following pages to demonstrate the variety of formats the nurse may encounter. Figure B-3 is a pathway used at Thomas Jefferson University Hospital for patients with acute ischemic stroke. The pathway provides clear expected outcomes as well as a variety of checklists identifying all significant and sequential aspects of patient care. Figure B-4 is a pathway used at Yale New Haven Hospital for a patient with acute coronary syndrome with or without percutaneous coronary intervention.

Whatever format is used or condition treated, clinical pathways are documents in transition; they will change as research suggests better treatment strategies and as variance data are analyzed. Nurses' participation in these processes is essential for the successful implementation of clinical pathways and, ultimately, the opportunity to improve patient care.

# INDEX

Page numbers followed by c indicate charts; those followed by f indicate figures; those followed by t indicate tables.

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